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Master

A Cost Analysis on Reablement in the Municipality of Kristiansand

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Preface

This master thesis is a part of the requirements for the master program in Business Administration at the University of Agder, Kristiansand. The thesis was written in our last semester of a 2-year master degree with a major in Financial Economics. The thesis makes up 30 ECTS out of the total 120 ECTS from the master program.

We decided to write a thesis relevant to our major, where we could use and build upon our knowledge in econometrics, statistics and data analysis. The interest in these subjects arose from a motivation to be able to use the theory and methods learned in a real case. Knowledge in these specific areas is in great demand and it is important to understand both in smaller and larger scales. We went to our supervisor Jochen Jungeilges and discussed our ideas, and he introduced us to care-economics and more specifically to reablement. National and local politicians are focusing on changing the way patients are rehabilitated after illness and injury, and economics plays a large role in the decision-making. Professor Jungeilges motivated us and gave us an insight into the lack of research and the potential of this new form of rehabilitation. The importance of understanding care-economics and the way it is researched was the reason we chose to take on this case.

We want to take this opportunity to express our gratitude to our supervisor Professor Jochen Jungeilges, and the representative for Kristiansand municipality, Ph.D. candidate Tore Bersvendsen. They played an essential role during the whole process by providing us with the data and guiding us through our problems, the statistics used, and the results. Jungeilges and Bersvendsen gave us valuable feedback and advice as we set out to do something we were new to.

We would also like to thank family and friends for the constant support and motivation during this busy and challenging period of our lives.

Kristiansand, 03.06.2019

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1. Introduction

1.1 The Research Problem

"Do patients who have received reablement have a lower expected cost per week compared to patients who have not received the treatment, in the subpopulation of patients in the municipality of Kristiansand who have been to a short-term institution at least once?"

This thesis will also include an effort to explain the expected costs per week for patients in Kristiansand in the subpopulation by using time-varying and time-constant covariates.

1.2 What Is Reablement

Reablement is a relatively new form of rehabilitation. The target group for this intervention is older patients that have experienced a loss of function, and an inability to perform everyday tasks (Førland & Skumsnes, 2016, p. 11). This form of rehabilitation aims to help patients be able to live at home longer after illness or accidents, by focusing on what is most important to each individual. Hopefully they will be able to live a normal life at home, with little to no help. By investing a considerable amount of service-hours over a set number of weeks (usually 4-10 weeks depending on the municipality) intensively, the hope is that the patient will cost less in the long run, and the patient is able to avoid going to an institution.

This is different from traditional rehabilitation in the sense that it is carried out in the patients homes or in a close proximity to the home. Physical therapists, nurses, occupational therapists and other occupational groups/specialists with rehabilitation expertise work together with the traditional home care service that is provided in the municipality. This is to ensure a interdisciplinary expertise so that the patient has the best possible care. The municipality of Kristiansand provides two different options based on the patients needs; reablement in an institution or what they call “rehabilitation in the home”, which is typical reablement (Kristiansand Kommune, 2019).

Kristiansand is still in its early phase of providing reablement to the residents, so it is subject to be further analyzed both for patient satisfaction, physical results for patients, but also the actual cost benefits of the treatment. We are not too familiar with what the criteria for being chosen into reablement is, but we do know that some basic potential for improvement in the patients mobility needs to be present to invest in a costly programme. What is known is that the municipality of Kristiansand offered reablement to most patients in the observed time period after illness or injury, even to younger patients - the youngest reablement-patient being 51 in the selected subpopulation that will be examined. In most literature (with some variance) it is stated that reablement focuses on patients 65 and over.

1.3 Motivation/Background

Western populations in general are growing older and putting a strain on existing financial and human resources (United Nations Economic Commission for Europe , 2015), and discussions of this challenge have begun on an international platform. The United Nations Economic Commision for Europe (UNECE) in its Policy brief on ageing of February 2015 (number 15), states that a commitment was made at the Regional Implementation Strategy of MIPAA; “*To strive to ensure quality of life at all ages and maintain independent living including health and well-being”(UNECE, 2015)*. A new Ministerial declaration was made in Vienna in 2012, where member states of the UNECE committed *“to raising awareness about and enhancing the potential of older persons for the benefit of our societies and to increasing their quality of life by enabling their personal fulfilment in later years, as well as their participation in social and economic development.”(UNECE, 2015).*

Over the last few years, reablement has spread in Scandinavia (Birkeland, Langeland, Tuntland, Jacobsen & Førland, 2018, p. 2). Internally in Norway more and more municipalities have started to implement it with high expectations both for the users and for the municipalities themselves. The Norwegian parliament has seen the importance of a change in rehabilitation. What is different about Norway compared to other countries that have tried reablement is that cost of labor is higher than a majority of other countries. Norway's labour cost per hour in 2016 was € 50.2 compared to the EU average of €25.4, and €29.8 in the Euro area. The UK who have also conducted research on reablement had labour costs of € 26.7 per hour in 2016 (Eurostat, 2017, p.3). The current parliament has stated that they want to "*contribute to a professional transition of the municipal health and care service through stronger emphasis on rehabilitation, prevention and early intervention*"(Helse- og omsorgskomiteen, 2018, p. 6). Reablement is an example that early efforts and rehabilitation can contribute to increased quality of life and better functioning of users. For this reason, the Norwegian government granted funding for testing and developing models for reablement in the state budgets for 2013-2015. Over these three years, the Norwegian Directorate of Health allocated NOK 63,4 million in grants to 47 municipalities (Langeland & Førland, 2016).

According to Statistics Norway, SSB, Norway will for the first time in recorded history have more citizens above the age of 65 than under the age of 19, in about 15 years time. In their projections, it says that by the year 2060, 20% of the population will be above the age of 70 compared to 12% in 2018 (Andersen, 2018). For the welfare state to be able to handle this financially, new and innovative measures need to be taken.

While researching this topic, we came across multiple qualitative studies, but few strong quantitative from the economic perspective. The findings in these papers indicate that patients in Norway appreciate the independence and avoiding going to special facilities (Langeland & Førland, 2016), however it can be difficult to validate the hypothesis that reablement patients will cost less in the long run compared to non-reablement patients from previous studies. A selection of the previous studies will be discussed in section 2.

The research in this paper contributes to coming closer to understanding the costs of reablement. This particular research into the cost of reablement patients in the subpopulation that has been chosen in this municipality, has not been done before. The paper differs from previous studies in the way that it is specific for patients in Kristiansand that have been to a short-term institution at least once in the observed period. In addition, an effort has been made to make the research transparent and easily replicable. By using panel data analysis in the form of Pooled OLS and Fixed Effects estimation, the actual costs, and some demographic variables, the results will give an indication on how the costs evolve differently across different patients.

1.4 Main findings

The main findings in our study are that patients in Kristiansand who have been to a short-term institution at least once have about 1043 NOK lower expected mean costs per week in the overall observed time period if they are in the intervention group, compared to the patients outside of the intervention group. While a patient is receiving the treatment, the mean expected costs per week are approximately 1602 NOK higher than for patients who do not receive reablement, and the expected costs stay higher until the end of the observed period.

1.5 Structure

The thesis starts with a summary of previous studies in section 2 to get an idea of the research that has already been done, and what kind of results they have given. Section 3 explains the dataset, the subpopulation and how it was processed. In addition there is a subsection that explains how some variables were created. Section 4 outlines the specific statistical methods applied. The results of the regressions are given in section 5, and the results are discussed in section 6. Full tables, additional information and the reflection note are found in the appendix.

2. Literature Review

Reablement has taken an international perspective, with a number of countries in the western world embracing it as a possible way to counter the effects of an increase in the older population as well as a tool for resource management. As early as the year 2000, the municipality of Östersund in Sweden initiated the earliest known form of reablement in Scandinavia as a means to deal with the economic challenges the municipality was facing, by having more people outside of the rehabilitation centres (NOU:2011:11, p. 64). This new approach in Östersund, though primarily meant to tackle an economic challenge which was being faced at the time, has many similarities with traditional forms of rehabilitation, mainly targeted at geriatrics or accident victims.

In Resnick and Fleishell (2002, p. 91), came up with a 5 step approach that sought to develop a restorative care program. They were motivated by a study which had been carried out on 2285 patients who had been recently admitted in 59 long term care facilities in Maryland which exposed the level of dependence of individuals under care. The level of dependence for activities such as bathing, dressing and toilet activities exceeded 70%. Resnick and Fleishell (2002, p. 92) came up with a list of interventions they considered to help with restoring functionality among older people. These interventions among others included motivators for the patient as well as nursing interventions pointing out patient capabilities, identifying individual needs and setting realistic goals for the patient.

Tinetti et. al. (2002), found in their research that a person receiving reablement had a 50% higher likelihood of not having to visit an emergency department or require other home help services than a person not having received home help. They concluded that this meant that a reablement was cost effective. However this is difficult to validate since they did not carry out a cost benefit analysis. We know that in the period a patient receives reablement the costs incurred for the team which will help the patient are very high (Tessier et. al., 2016) and therefore not carrying out a cost analysis undermines the conclusion reached by Tinetti. In a more recent investigation on 843 post-hospital patients, Tinetti et. al. (2012) concluded that restorative care resulted in a third less readmissions than usual care. Tinetti et. al.(2012) and (2002), recognizes the cost drivers in reablement and possible cost outcomes, nonetheless they do not go further in their studies to prove the real cost implications.

In a non-randomised trial in Western Australia by Lewin and Vandermeulen (2010), in the years between 2001 to 2003, the trial involved 100 persons in the restorative program and 100 persons in institutional care. This study noted health benefits to those on the restorative program compared to those in the control group. Linear and logistic regression was used in this analysis of data and follow up points at 3 months and 1 year were made. A major criticism to this work is the duration of the experiment. A one year period is not enough to guarantee the effectiveness or durability of the gains that may have been made. This study like others does not carry out a cost assessment, an area we will attempt to explore in this thesis.

One of the earliest attempts at investigating the effectiveness of reablement in Norway was by Tuntland, Aaslund et. al. (2015) who carried out a parallel randomised controlled trial for a rural municipality in Norway on a group of 61 older adults split into two over a period of 10 weeks. Improved activity and satisfaction with levels of performance attained by the participants were noted. Results showed a significant improvement in their capabilities as a result of reablement. However the size of the sample left room for type 2 error and made it impossible to generalise on the findings.

The increase in care usage is not affecting European countries alone, but most of the developed western countries. In their pioneering work where they used a randomised control trial study design, Lewin and Allan (2014), compared use and costs of healthcare for individuals using restorative care versus conventional health care. Lewin and Allan (2014) argued that reablement, or restorative care as it is known in Australia, can be a cost effective long term plan compared to the traditional home care. They also argued that identifying the social, health and cultural characteristics which impact the demand for services is important to the success of reablement. They emphasised the import role played by the selection criteria, as this is critical in comparing improvements or lack of, from before one enters the program to when one leaves as well as at follow up points. Their results revealed that reablement beneficiaries used fewer home care hours having a mean of 117,3 hours and had lower total home care costs of AU $5570 compared to mean 191,2 hours and AU$ 8541 for conventional care.

The first study in Norway, which put focus on cost effectiveness of reablement, Kjerstad and Tuntland (2016), established that not only was reablement more cost effective than usual care in the 3 month follow up period after treatment, but the patients who were part of the study were more satisfied compared to patients in traditional care. This study revealed that demand for usual care services were significantly lower 6 months after a patient accessed reablement. However, they made an interesting finding in regards to the way reablement was implemented in this particular municipality. Reablement is focused on individuals and the beneficiary chooses what they needed to be trained in. Kjærstad and Tuntland discovered that some older patients were more interested in community based activities, which were not limited to within their home environment. Consequently, these cases did not lead to a significant change in the older patients needs at home, and thus their costs remained high. The authors recommend that caution should be exercised, and smart methods should be used when drafting the reablement plan together with the beneficiary. A major critic to their work is the size of their sample which is only 61 people, making it difficult to generalise on their findings.

Another rare focus on costs came from Lewin and Alfonso (2013), in a study on reablement in Australia they sought to establish whether there was evidence of long term cost-effectiveness. This study is peculiar in that it also examines how long the benefits lasted and used a longer follow up period of 3 and 5 years compared to other studies. Their study had two sources of beneficiaries, the first was that of patients who were recommended into the program by their community and would receive 12 weeks of reablement and the second was that of elderly patients discharged from hospital and would receive 8 weeks of reablement. Results from their research pointed to a mean cost reduction for an individual of nearly 12 500 Australian dollars over a 5 year period in both groups. They also noted that the patients who had gone through the reablement programme were less likely to receive home help services in the following 3 year period after the treatment with the effect lasting much longer in the group referred from the community.

The aim of reablement according to Thome et. al. (2003), is to make a positive impact on the quality of life of beneficiaries by improving the capacity to be self sustaining and ensuring that the individual/patient stays home longer before they can be admitted into a care home. King et. al. (2011) viewed staying at home for a longer period of time as an opportunity for home care services to improve their efficacy. Their study introduced collaborative goal setting, in order to make an individualised plan. This collaborative effort helped reveal that some older people were receiving services they did not need, removing some unnecessary costs and increasing efficiency. However because this study was carried over a small participant population of 187 which had come down to 157 by the time the next assessment was made at 7 months, this makes it difficult to generalise such findings.

Parsons and Sheridan (2013) noted that traditional forms of care don't fully explore the potential of an individual's physical capabilities and independence. Their investigation found that most elderly people lose most of their ability to carry out some physical tasks after they have been through a period of hospitalization. This leads to an increased dependency to carry out tasks which they might have otherwise managed to do for themselves, and with increased dependency comes in ability to do tasks by themselves. In their research trial of 2013, Parsons and Sheridan noted that a group who underwent reablement had improved scores on the Short Physical Performance Battery (SPPB). However they also noted that a person's level of function at the time they come into the program has a significant bearing on their level of success, with people with high levels of disability also show low capabilities after reablement.

While reablement is being embraced by most researchers and studies in recent times, Legg, Gladman et. al., (2015) carried out a review of reablement in its formative years in Britain with a focus to investigate if public funded reablement was effective. In their conclusions they noted that there was not enough evidence to prove that reablement was indeed more effective than usual care. However they were quick to emphasize that lack of evidence does not necessarily mean that it is not effective.They were not convinced that reablement was properly defined and were concerned that it was just a different name for traditional rehabilitation. They suggested more investigation into the concept as they felt that it dealt with concerns which were already being taken care of by existing forms of rehabilitation and that it was a one size fits all approach which did not work. However contrary to some of the assertions by Legg et al, research carried out in Norway, Canada and Australia, reveal that reablement is not a one size fits all approach. COPM is used in most cases to help make an individually suited program for the beneficiary with active participation of the beneficiary in the goal setting, (King et al 2011).

Bersvendsen, T. et.al. in their systematic review of reablement, managed to classify it into 3 categories; cost and consequences, health benefits, and health service usage. In exploring these areas they noted that while there exists substantial literature on reablement , most of the findings were not possible to replicate due to omission of methods used to arrive to conclusions in these research articles. Another discovery they made was that there was insufficient research on costs effects of reablement.

In our search for relevant literature we came face to face with the observations made by Bersvendsen et.al. There was in most cases small sample sizes, arbitrary declarations on cost effectiveness with no transparent statistical investigations to support them. We aim to contribute to this part of the research on reablement by producing a paper based on a clear investigation path with a rich patient group supported by a well fitting baseline. As opposed to most of the research work we have come across, we will endeavour to produce a work that is statistically sound and which other scholars will be able to replicate in their attempts to approve or disprove our eventual findings.

3. Data

The dataset used in this thesis is panel data, as there are multiple individuals recorded multiple times over a period of time. Panel data is a combination of cross-sectional data and time series. In this case thousands of patients recorded weekly over three years. There are some observations missing because not all patients have observations for every week in the observed time-period. Patients have entered after the data collection had started, and they some have left before the data collection was over. There may also have been deaths in the sample so observations stopped. The panel is therefore unbalanced; at least one panel member is not observed every period. To use the dataset and perform panel analysis, it was imported into the statistical software package STATA, which was used as a tool to answer the research question.

3.1 Data Source

The municipality of Kristiansand provided us with the dataset containing various information on 5575 patients in Kristiansand. The observed time-period was 159 weeks, collected from January 2014 to December 2016. Some values are missing for a part of the patients, as not all of the patients were observed for the whole 3 years. The mean number of weeks a patient was observed was 80. The data was anonymized and contained information on the area the patient lived in including institutions, their age, gender, marital status, and the kind of treatments they received over the observed period. For each treatment, the number of hours or days were given so that a cost-variable could be created from a table of cost per service hour or day in a given institution.

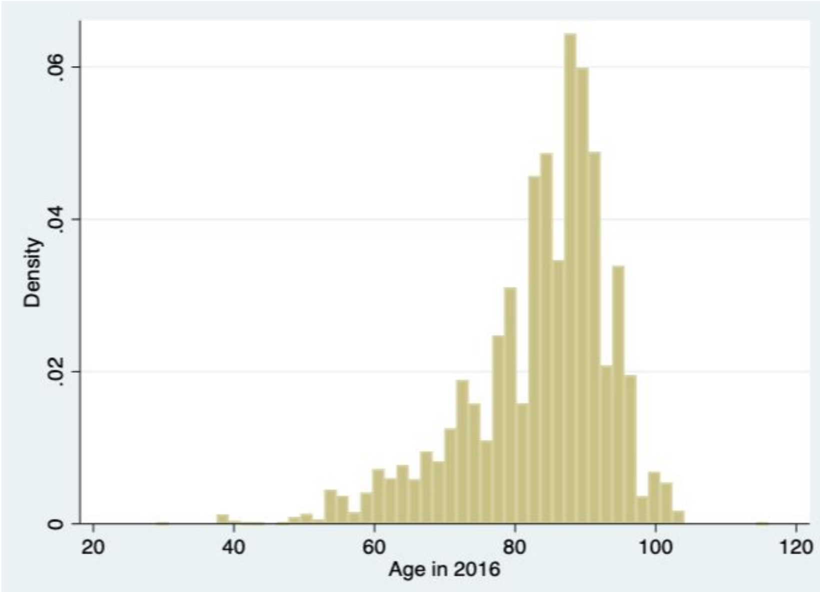
3.2 The Subpopulation

The data used in the regression in this thesis was a subpopulation taken from the 5575 patients. The subpopulation was selected by including patients who have been to a short-term institution at least once in the observed period, and removing the rest. The municipality is interested in taking a closer look at the costs in this group in particular. Individuals who have been to a short term institution are already most likely at a weaker state than the average person. After removing patients who have never been to a short-term institution, we were left with 147 972 observations for 1797 individuals.

14.25% of this subpopulation have received reablement in the observed period, while the rest (85.75%), have not. The mean cost per week for the subpopulation is 6861 NOK. There is a difference between the two groups in the subpopulation, where the mean cost per week is 5201 NOK for patients who have received the intervention, and 7227 NOK for the patients who have not.

The mean age in both groups of the subpopulation is similar. The mean age in the subpopulation is 83, which is the same as in the non-reablement group. Patients who received reablement in the observed period had a mean age of 84. While the age of the patients in the subpopulation spans from 29 to 116, the youngest patient in the intervention group is 51 and the oldest is 102. From the figure below, you can see that most patients in the subpopulation are between 80 and 95.

Figure 1: Histogram of the patients ages in the subpopulation.



68% of the subpopulation presumably live alone, while 32% live with a spouse or partner in the house. In the intervention group 74% live alone, and 26% live with a spouse or a partner. In the non-intervention group 67% live alone, and 33% with a partner or spouse. In the subpopulation mean cost per week is 6653 NOK for patients living alone, and 7539 NOK for those not living alone.

The subpopulation is 42% male and 58% female. Within the subpopulation, the intervention-group consist of 31% males and 69% females, and the other group is made up of 44% males and 56% females. There are more women in the sample than men, but the biggest difference between genders is in the intervention-group.

Even though the data collection period was 159 weeks, the mean number of observed weeks in the subpopulation is 80 weeks. There is a difference between the two groups in the subpopulation. The reablement patients have a mean number of observed weeks of 85, and the rest have 79 weeks as the mean.

3.3 Variables Created

The data that was provided contained useful information, however there was a need for additional variables to fully examine the costs. To be able to use cost as a dependent variable in the model, a new variable was created called “cost” because this was not explicitly given in the dataset. The hourly rates for treatments or nurses were multiplied with the given hours each patient had that week. For the treatment-institutions, daily rates were used and multiplied with the number of days the given person was in an institution. The service-costs were provided to us by a representative from the municipality and represent actual costs. All of the costs were then added into one single variable, “cost”, for each patient for each week observed.

The cost table was the following (all values in NOK):

Variable	Cost per hour	Cost per day	Creating one new variable for each cost-category by adding hours or days for every variable with identical costs
Home nurse hours per week	685		Home nurse hours per week
Home nurse night hours per week*	685		
Home nurse hours per week for patient in residential care home	685		
Reablement hours per week	685		
Home care hours per week	482		Home care hours per week
Home care hours per week for a patient in a residential care home	482		
Short-term institution days per week		3200	Short-term institution days per week
Special patient institution days per week		3200	
Rehabilitation institution days per week		3200	
Special patient institution		2150	Long-term institution days per week
Long-term institution		2150	

*Home nurse night is only included in "cost", not in "cost2". All other variables are the same in "cost" and "cost2".

Cost = (685* Home nurse hours per week) + (482* Home care hours per week) + (3200* Short-term institution days per week) + (2150* Long-term institution days per week).

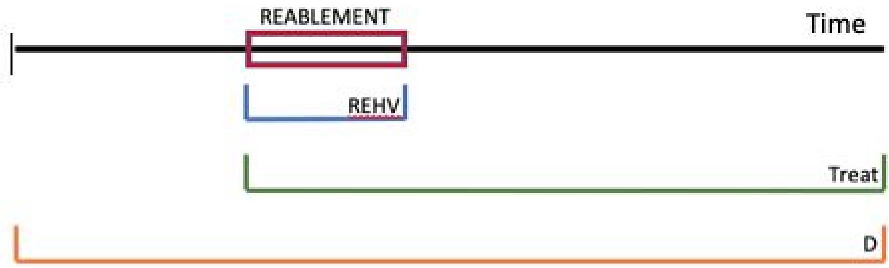
Because home-nurse at night is a special service in Kristiansand, and not given to patients regularly, a second cost variable was created not including home-nurse at night. This variable is called “cost2”. All regressions were run twice, once with “cost” and once with “cost2” to see if there was a significant difference in results.

The variable in the data that represented reablement is called REHV, and was given. REHV was equal to 1 while a patient was in reablement-treatment, and zero when they were not. This binary variable changes over time, and only indicates the exact period of time a patient received the treatment. While this is important to research, two more variables were created for reablement patients. One was created to be time-invariant to represent the whole period of time the patients were observed, and the other for the period from when a patient receives reablement, to the end of the observed period (also time-varying).

One reablement-variable that was created, and not given, was “D”. This is the time-invariant variable. For the individuals who have received reablement, this variable is 1 from the beginning to the end of the observed period, while it is 0 for patients who have not received reablement. “D” was created from the given variable “REHV”.

The second reablement-variable created, “Treat”, is binary and time-varying. It is 0 until a patient receives reablement, and then changes to 1 until the end of the observed period. “Treat” was given to us in a do-file for STATA by a representative for the municipality. The reason for having 3 different variables for reablement is to illustrate how the costs change once one gets reablement. This way we can look at cost for the whole observed period, while a person is receiving reablement, and from they receive the treatment until the end of the observed period. To illustrate:

Figure 2: Illustration for a patient who receives reablement.



The black line represents the observed time period, and the red box marks out the time span during which the patient receives reablement. The blue line illustrates where the variable "REHV" is 1. The green line illustrates where the variable "Treat" is equal to 1, and the orange illustrates variable "D"=1. Outside of these marked areas, the variables are 0 for reablement-patients. For patients who did not receive reablement, the variables are equal to zero the whole time.

The last variable that was made was "Alone". "Alone" is a binary variable. Due to marital status being classified by law, some assumptions needed to be made. There is a hypothesis that a patient who lives alone will have a higher cost per week than a patient who lives with a spouse or partner. For a patient to be sent home from an institution, it is easier to let them go earlier if they have a partner at home that can keep an eye on them. Since institutions are costly, a few days extra in it can result in significantly higher costs overall. If a person does not live alone, they would in theory not need as much outside-help as a person living alone. It was challenging to establish whether or not a person lives alone from the given variables, so it is not 100% accurate. The variables included in "Alone" were the following:

- Widow/widower
- Separated/divorced
- Unmarried
- Spouse/partner in an institution
    - they are married or have a partner, but the partner is in an institution, so the patient would be alone at home

If a person is not in “Alone”, they are in the “Married or partner” category. In other words, if “Alone”=0, then the individual is married or has a partner. If “Alone”=1 then they live alone. There was an option for the patients to not give out this specific information. The few observations we had for patients who did not give their marital status were randomly assigned into “Alone” and “Married or partner”.

3.4 Variables Given And Included In The Regressions

In addition to the created variables, age and gender were included in the regressions. These variables were given in the data. Age was given for all 3 years of the observed period, meaning the age of the individual patient in 2014, 2015 and 2016 in 3 separate columns. The age used in the regression was the age in 2016. Adding all 3 ages would not give any benefits, and 2 out of the 3 variables would be omitted because of collinearity in any case. There is no underlying reason for choosing the age in 2016, it was random. Because of the nature of the data, this variable is time-constant even if age changes every year. The hypothesis beforehand is that expected cost will increase as the age increases because of natural decline of health and independence/mobility.

The subpopulation is 58% female, and 42% male. There seemed to be an assumption from the municipality that the costs are higher for male patients. The reason for this is unknown, however it is included in the regressions to control for this fact and to see if there is a correlation between gender and expected mean cost per week. “Male” is a variable where if it is equal to 1 the patient is male, and if it is 0, the patient is female. This is time-constant.

In panel data you have a time variable and an individual variable. In this case they are called “ID” and “Week”, which are self explanatory. The ID´s are individual for each patient, and “Week” denotes the week in which the observations were taken for the individual patient. These variables were added in the regression to take into account unobserved individual effects and “time-shocks” that can have an impact on the results. This could be an increase in injuries during winter-months, or individuals who have significantly higher/lower costs compared to the rest for unobserved reasons. If these effects were to change the dependent variable "cost", then the results would not reflect an accurate estimation of coefficients. When they are controlled for, the effects should be captured by the error term(s).

Lastly, the variable "Ansvar", is a categorical variable that shows the area the patient lives in. If this variable is equal to 0, then the patient is in a treatment-institution. A 3 digit-code means that the patient is in a residential care home, while the 4-digit codes represent the 11 different home-nurse areas in Kristiansand. This variable is added in the regression to control for the effects the place the patient lives in could have on cost. Some residential care homes may be run differently, or patients may live in certain areas to be close to treatment-facilities. Some areas may also have a higher concentration of older individuals, and this might have an effect on the dependent variable.

Before the data can be utilized, the models and underlying econometrics need to be defined and presented. The models are chosen from the nature of the dataset.

4. Econometrics of Panel Data - Methodology

4.1 Panel Data

Our choice of model was influenced by the nature of our data, we noted the individuals had multiple observations on them over a period of time. Panel data presents us with more information from the data and increased possibilities on areas to test as compared to either time series alone or cross sections on their own.

4.2 Advantages of Panel Data

Baltagi and Levin(1992) show that, in panel data individuals or firms are heterogeneous, heterogeneity can be a source of bias in our data. The heterogeneity in panel data can be controlled for, as opposed to pure cross-section data or pure time series data. When we control for the heterogeneity we eliminate the possibilities of bias in our data.

With Panel data it is possible to study the dynamics of adjustments. This means being able to observe how long an activity takes, how long it lasts and how fast it takes place. Baltagi (2005) says panel data allows for the measurement of individual progressions over time.

Construction and measurement of complicated models such as technical efficiency is done more effectively in panel data than in pure cross-section or pure time-series. When dealing with distributed lag models fewer restrictions need to be imposed in panel data than in a time-series study (Hsiao, 2003).

In panel data one is better able to deal with multicollinearity because of the variability added by the cross-section dimension. In contrast to time series which have higher occurrence of multicollinearity (Baltagi, 2005). In addition the high number of data points in panels results in more degrees of freedom and together with reduced collinearity give efficient economic estimates(Hsiao, 2003, p.3).

Identification and measurement of effects, is easily done in panel data than pure cross-section data or pure time-series data alone. It is easier to determine the effect of a “shock” to a state, and the extent of that effect, through panel data. In this case holding other characteristics constant will isolate the intended observation and make it easier to analyse (Blatagi, 2005, p. 6). Panel data also enables us to make more accurate predictions on individuals than we could do with pure time series. If we have similar behaviour of individuals given certain conditions, panel data gives us the possibilities of learning more about one individual through monitoring how the others behave(Hsiao, 2003, p. 7).

4.3 Limitations of panel data

Kasprzyk et. al. (1989), state that panel data can be compromised by design and data collection problems. Noncooperation by a respondent may lead to incomplete recording for example changes in marital status or income may lead to non-cooperation (Lillard, L. A. and Panis, C. W. A, 1998, p. 437), or incidence where a respondent does not remember the exact answer to a question and non-coverage of a segment of the population of interest can lead to

Measurement error distortions, occur when a respondent gives incorrect information deliberately or when misrecording of response occur (Kalton, Kasprzyk and MacMillen, 1989). Inconsistencies in the data should alert the user of the panel data of the risk of measurement error, this risk may lead to incorrect conclusions being reached using the data.

Missing observations in panel data can be a result of attrition, this can be due to individuals leaving the research, either through relocating to another place or as a result of death of the individual. Attrition is prevalent in health and medical research (Greene, 2008, p. 61). While nonresponse as a result of attrition also occurs in pure time series, it is more pronounced in panels as subsequent waves are affected by the same none response (Baltagi, 2005, p. 8).

Attrition falls under the group of selectivity problems which also include nonresponse and self-selectivity which occurs when an individual who fits into a sample refuses to be part of a crucial part of the investigation resulting in his participation areas being recorded as blanks while his primary characteristics remain as part of the investigation.

The time span of the panel is critical in giving reliable estimates, however lengthening the panel will also result in it being exposed to attrition, where some participants may die during the investigation or may need to relocate to other areas. In addition to avoid incorrect inferences in long time span panels, cross-section dependencies should be accounted for(Baltagi, 2005, p. 8).

4.4 Regression Model

To answer our research question, we settled on OLS model for the time-invariant reablement variable. Having read numerous research articles on reablement we were faced with with upto 9 different models ranging from bootstrap to Cox-hazard among others. Based on the discussion in section **3** we produced the following model:

Our Model :

This model is a pooled OLS(POLS) model for a patient with reablement from the beginning to the end of the period. We estimate D_i with pooled OLS because it is time invariant, the concept of pooled OLS will be introduced below in **4.5.1**

$$Cost_{it} = \beta_0 + \beta_1 D_i + \beta_2 Gender_i + \beta_3 Age_i + \beta_4 Alone_i + \beta_5 (Area)_{it} + \beta_6 (ID)_i + \beta_7 (Week)_t + \varepsilon_{it}$$

(4-1)

• $\varepsilon_{it} = \alpha_i + u_{it} + \theta_t$

The error term is composed α_i which captures the effect associated with the *i*th individual (ID) and θ_t the effect associated with the *t*th period (Week). Where *i*=1....,N and *t*=1…,T, This shows us that it is not only the independent variables that account for the variation in the dependent variable(Cost) (Mundlak, 1979, p.69). u_{it} varies over individuals and time to capture all that is not explained by the dependent variable(Brooks, 2014, p. 529).

The model below is a fixed effects model for the period when a patient access treatment to the end of the period. We can not use the POLS to estimate variables that do not vary over time like "Treat" and "REHV.

$Cost_{it} = \beta_0 + \beta_1 Treat_{it} + \beta_2 Gender_i + \beta_3 Age_i + \beta_4 Alone_i + \beta_5 (Area)_{it} + \beta_6 (ID)_i + \beta_7 (Week)_t + \varepsilon_{it}$
(4-2)

•$\varepsilon_{it} = \alpha_i + u_{it} + \theta_t$

This model is a fixed effects model for the period REHV when a patient is in reablement treatment.

$Cost_{it} = \beta_0 + \beta_1 REHV_{it} + \beta_2 Gender_i + \beta_3 Age_i + \beta_4 Alone_i + \beta_5 (Area)_{it} + \beta_6 (ID)_i + \beta_7 (Week)_t + \varepsilon_{it}$
(4-3)

•$\varepsilon_{it} = \alpha_i + u_{it} + \theta_t$

As mentioned in section **3.3**, when running our regressions; D, Treat and REHV will be run twice, the first with the dependent variable as Cost (Costs including home night nurse hours) and Cost2 (without home night nurse hours).

4.5 The General Regression Model and Assumptions

The basis of our model is the general regression model as presented by Greene (2003, p. 182):

$$y_{it} = x'_{it}\beta + z'_i\alpha + \varepsilon_{it} \qquad \textbf{(4-4)}$$
$$= x'_{it}\beta + c_i + \varepsilon_{it.}$$

We have K regressors in x_{it}. The individual effects are captured in $z'_i\alpha$. z_i has a constant term and observable individual or group variables such as gender and location as well as unobservables such as preferences and skills all which are time invariant. When z_i is observed for all individuals we have an ordinary linear model fitted by least squares. c_i is unobservable and constant over time. We will employ the following models:

4.5.1 Pooled OLS Model

Pooled OLS is the panel data equivalent for ordinary OLS, while the assumptions for ordinary OLS apply to pooled OLS which make it a best linear unbiased estimate (BLUE), the following assumptions must be met in order to sufficiently and consistently estimate β, (Greene, 2008, s.185):

- $E[\varepsilon_{it} \mid x_{i1}, x_{i2},\ldots,x_{iTi}]=0$, zero conditional mean
- $Cov[\varepsilon_{it}, \varepsilon_{js} \mid x_{i1}, x_{i2},\ldots, x_{iTi}] = 0$ if $i \neq j$ or $t \neq s$, independence across observations.
- $Var[\varepsilon_{it} \mid x_{i1}, x_{i2},\ldots, x_{iTi}] = \sigma^2_{\varepsilon}$, homoscedasticity

Model Estimation:

In the event assumptions underlying the OLS estimation of the pooled model are not met the estimator is likely to be compromised by the heterogeneity when it differs across individuals. The unobserved heterogeneity induces autocorrelation. If only the first two assumptions hold the model may be consistent but the estimator of its asymptotic variance will lead to an underestimation of the true variance of the estimator (Greene 2008, p. 185).

If all 3 assumptions hold then we get:

$$\text{Avar}(\hat{\beta}) = \hat{\sigma}^2[E(\Sigma'_i\Sigma_i)]^{-1}/N \qquad \textbf{(4-5)}$$

and thus the appropriate estimator of Avar($\hat{\beta}$) would be:

$$\hat{\sigma}^2(X'X)^{-1} = \hat{\sigma}^2\left(\sum_{i=1}^{N}\sum_{t=1}^{T} x_{it}'x_{it}\right)^{-1}, \qquad \textbf{(4-6)}$$

where $\hat{\sigma}$ is the ols variance of estimator from the pooled regression (Wooldridge, 2010, p. 193).

The homoscedastic assumption is at times restrictive it is advisable to get the robust estimate of Avar($\hat{\beta}$). According to Wooldridge the estimator is completely robust to all forms of arbitrary heteroskedasticity as well as arbitrary serial correlation. The full robust variance estimator known as robust with cluster option in the stata computer program, is presented as follows:

$$\widehat{Avar}\ \hat{\beta} = \left(\sum_{i=1}^{N} X'_i X\right)^{-1}\left(\sum_{i=1}^{N}\sum_{t=1}^{T}\sum_{s=1}^{T} \hat{u}_{it}\hat{u}_{is} X`_{it} X`_{is}\right)\left(\sum_{i=1}^{N} X`X\right)^{-1}, \qquad \textbf{(4-7)}$$

where $\hat{u}$ i Tx1 pooled ols residuals, (Wooldridge, 2010, p 197).

4.5.2 Fixed Effects Model

The name fixed effects arises from the omitted effects c_i in the general model **(4-4)** which have a correlation with the included variables. Fixed effects enable us to explore within variations and identify causal relationships in our data. Differences across groups are captured in the constant term. Assumptions of Fixed Effects Model by Wooldridge (2010):

- $E(u_{it} \mid x_i, c_i) = 0$, t=1,2,...,T. Strict exogeneity
- $\text{rank}(\Sigma^T_{t=1}E(x'_{it}x_{it}) = \text{rank}[E(X_iX_i)] = K$
- $E(u_iu_i'|x_i,c_i) = \sigma^2_u I_T$,

Model Estimation:

In fixed effects we cannot estimate the coefficients of the time invariant variables. The effects of these unobserved variables must be removed before estimation. Therefore we estimate β to transform the equation so we can be rid of the effects of α_i (Greene, 2008). We can estimate using the Least Squares Estimation where:

y_i and X_i be T observations for ith unit, i be a Tx1 column of ones, e_i be the associated vector Tx1of vector disturbances

$$y_i = X_i\beta + \mathbf{i}\alpha_i + \varepsilon_i \,. \qquad \textbf{(4-7)}$$

$$\mathbf{y} = [\mathbf{X}\ \mathbf{d}_1\ \mathbf{d}_2, \ldots, \mathbf{d}_n]\begin{bmatrix}\beta \\ \alpha\end{bmatrix} + \varepsilon, \qquad \textbf{(4-8)}$$

where d_i is the dummy variable indicating the ith unit.

$$y = X\beta + D\alpha + \varepsilon.$$

This model is called the least squares dummy variable(LSDV), (Greene, 2008, p. 195).
In the case that N is large,it might be challenging to calculate the dummy variables in the LSDV (Brooks, 2014, p. 530).

$$\hat{\beta}_{fe} = \left(\sum_{i=1}^{N} \ddot{x}'_i\ddot{x}_i\right)^{-1}\left(\sum_{i=1}^{N} \ddot{x}_i'\ddot{y}_i\right)=\left(\sum_{i=1}^{N}\sum_{t=1}^{T} {}'\ddot{x}_{it}\ddot{x}_{it}\right)^{-1}\left(\sum_{i=1}^{N}\sum_{t=1}^{T} \ddot{x}'_{it}\ddot{y}_{it}\right), \qquad \textbf{(4-9)}$$

Therefore one can employ the within estimation above which makes use of time variation with in each cross section (Wooldridge, 2010, p. 304):

4.6 Model Diagnostics

Identifying the right model to use is critical and even more important in ensuring that the assumptions of the model hold.Violation of assumptions of a model can give rise to a model that has several problems such as incorrect coefficient estimates of the β, incorrect standard errors and inappropriate distributions assumed for testing (Brooks, 2014, p. 180). This makes it imperative to carry out diagnostic tests for a model.

4.6.1 Heteroskedasticity

Variance of the error term is assumed to be constant, that is we assume homoscedasticity (Wooldridge, 2010, p.192). If the errors are not constant then we have a case of heteroskedasticity. Detection of heteroscedasticity can be done by carrying out either the Goldfield - Quandt test (1965) or Whites Test (1980). For the purposes of our investigations we used the Modified Wald Test (xttest3 in Stata) which is compatible with our panel data. Ignoring the presence of heteroskedasticity increases the risk of misleading inferences as standard errors would be incorrect. There are several ways of dealing with heteroskedasticity if it is detected. One can use the weighted least squares also known as GLS, log transformation or heteroskedasticity standard error estimates such as the robust(option), (Brooks, 2014, p. 185).

4.6.2 Autocorrelation

Autocorrelation assumes errors are uncorrelated with one another. In pooled OLS it is necessary to test for autocorrelation because it should not be present if we want a model dynamic in the conditional mean, (Hsiao, 2004).We can detect autocorrelation by carrying out the xtserial test in stata for panel data. We can also use the durbina in stata on panel data. The main consequence of letting autocorrelation exist is that there will be inefficiency in the coefficient estimates, they cease to be best linear unbiased estimate (BLUE). To deal with autocorrelation, one can employ the GLS procedure or the Cochrane Orcutt(Brooks, 2014, p. 199).

4.6.3 Multicollinearity

Multicollinearity occurs when explanatory variables are highly correlated with each other. For the purposes of of our investigations we measured multicollinearity by the value inflation method(vif) in STATA. Remedies for multicollinearity include, dropping one of the collinear variables, however this may result in the problem of specification, a situation where a variable belonging to a model is dropped(Greene, 2008, p.61). An alternative would be to transform highly correlated variables into a ratio (Brooks, 2014, s. 210).

4.6.4 Normality

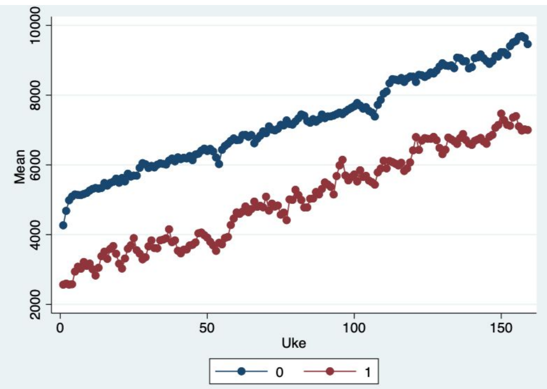
Normality in distributions means they are not skewed and will have a recorded coefficient kurtosis of 3. Testing can be done using the Bera-Jarque method, however for the purposes of this investigation we employed the pnorm r command for our panel data. It should be noted that the absence of normality does not have any consequence in large samples (Brooks, 2014).

5. Results of Panel Data Regressions And Model Diagnostics Tests

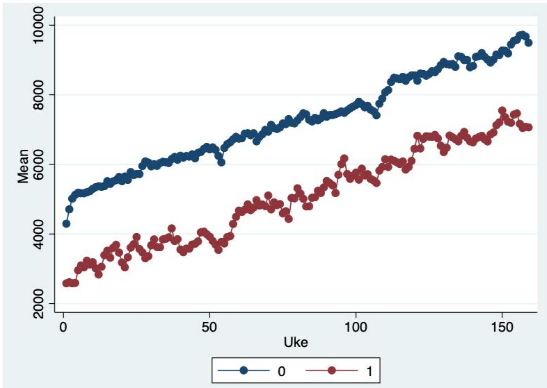
5.1 Initial View of Costs

Before the results of the regressions are presented, graph 1 and 2 show the mean cost per week of patients who have received reablement versus those who have not. The blue line represents patients in the subpopulation who have not received reablement in the observed period of time, and the red represents the patients in the subpopulation who have received reablement. The graphs do not take into account anything other than the exact costs given in the “cost” and “cost2” variables. Without controlling for any factors or running regressions, the average reablement-patient has lower mean costs per week than non-reablement patients.

Graph 1: mean cost per week reablement vs. non-reablement patients



Graph 2: mean cost per week reablement vs. non-reablement patients excluding night-nurse



The y-axis is the mean cost, and the x-axis represents the weeks observed. It is important to note that there could be accumulations of higher or lower costs some weeks for unrelated reasons, or a higher/lower concentration of patients observed in some weeks.

5.2 Regression Results For “D”

5.2.1 First model without “ID”, “Area” and “Week”

The following table is the result of running the first model (4-1), but without including “ID”, “Area” and “Week”. Comparing the mean expected cost per week in the two tables, -2022 for “cost” and -2024 for “cost2”, shows that there is not a big difference in including night-nurse.

Table 1: Pooled OLS for “cost” and “cost2” without including variables for “ID”, “Area code” and “Week”.

Variable	Coefficient (cost/cost2)	Std. error (cost/cost2)	t-value (cost/cost2)	p-value (cost/cost2)
D	-2022.24/ -2023.83	45.32/ 45.08	-44.62/ -44.89	0.0000/ 0.0000
Alone	-933.41/ -925.15	42.67/ 42.45	-21.88/ -21.80	0.0000/ 0.0000
Age in 2016	21.09/ 22.40	1.73/ 1.72	12.19/ 13.02	0.0000/ 0.0000
Male	-83.66/ -97.78	37.59/ 37.39	-2.23/ -2.62	0.026/ 0.009
Constant	6215.09/ 6074.33	149.65/ 148.87	41.53/ 40.80	0.0000/ 0.0000

The results show that patients in the intervention-group have 2022/2024 NOK lower expected mean cost per week in the overall period than patients outside of the intervention. Patients living alone have 933/925 NOK lower expected mean costs per week than patients living with a partner or spouse. Mean expected cost per week is 21/22 NOK higher for every extra year added in the age. Male patients have 84/98 NOK lower expected mean costs per week than female patients.

5.2.2 First model without "ID" and "Week"

To get a more accurate result that reflects real expected costs, area codes were included to control for them - that is, holding them constant. The area code variable is a categorical variable, and the following tables are the output of the pooled ols regression. The baseline that the different "area"-coefficients are compared to is "Area"=0, which is when a patient lives in an institution. The full table is in appendix 4 and 5.

Table 2: Running first model for "cost" without "ID" and "Week"

Linear regression

cost	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
D	115.922	27.803	4.17	0.000	61.428	170.416	***
Alone	114.150	25.490	4.48	0.000	64.190	164.111	***
Agein2016	-16.218	1.035	-15.66	0.000	-18.247	-14.189	***
Male	71.045	22.202	3.20	0.001	27.530	114.560	***
Area code:							
0	0.000	.	.	.	.	.	
2	-14700.000	800.236	-18.37	0.000	-16300.000	-13100.000	***
126	-9974.248	262.062	-38.06	0.000	-10500.000	-9460.613	***
209	-6946.742	163.686	-42.44	0.000	-7267.564	-6625.921	***
353	1367.284	147.193	9.29	0.000	1078.788	1655.780	***
434	-9386.784	141.591	-66.30	0.000	-9664.300	-9109.268	***
444	-6561.852	193.605	-33.89	0.000	-6941.313	-6182.391	***
1116	-8943.187	50.914	-175.65	0.000	-9042.977	-8843.397	***
1542	-12300.000	53.344	-230.06	0.000	-12400.000	-12200.000	***
1667	-13200.000	44.115	-299.41	0.000	-13300.000	-13100.000	***
2051	-13100.000	48.279	-270.33	0.000	-13100.000	-13000.000	***
2142	-12200.000	41.377	-294.67	0.000	-12300.000	-12100.000	***
2730	-12000.000	44.149	-271.22	0.000	-12100.000	-11900.000	***
3424	-11500.000	42.865	-269.34	0.000	-11600.000	-11500.000	***
3449	-12200.000	42.243	-288.97	0.000	-12300.000	-12100.000	***
3789	-11300.000	42.131	-267.11	0.000	-11300.000	-11200.000	***
4413	-12700.000	46.712	-272.04	0.000	-12800.000	-12600.000	***
4446	-12100.000	47.005	-257.85	0.000	-12200.000	-12000.000	***
Constant	16549.660	91.532	180.81	0.000	16370.260	16729.060	***

Table 3: Running first model for "cost2" without "ID" and "Week"

Linear regression

cost2	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
D	112.789	27.340	4.12	0.000	59.202	166.375	***
Alone	117.802	25.066	4.70	0.000	68.674	166.931	***
Agein2016	-14.902	1.018	-14.64	0.000	-16.898	-12.907	***
Male	58.591	21.832	2.68	0.007	15.801	101.382	***
Area code:							
0	0.000	.	.	.	.	.	
2	-15500.000	786.910	-19.70	0.000	-17000.000	-14000.000	***
126	-9939.441	257.698	-38.57	0.000	-10400.000	-9434.358	***
209	-6916.891	160.960	-42.97	0.000	-7232.370	-6601.412	***
353	1386.609	144.742	9.58	0.000	1102.918	1670.301	***
434	-9359.299	139.233	-67.22	0.000	-9632.194	-9086.404	***
444	-6526.000	190.381	-34.28	0.000	-6899.142	-6152.858	***
1116	-9048.908	50.066	-180.74	0.000	-9147.036	-8950.779	***
1542	-12300.000	52.456	-233.65	0.000	-12400.000	-12200.000	***
1667	-13200.000	43.380	-304.48	0.000	-13300.000	-13100.000	***
2051	-13000.000	47.475	-274.56	0.000	-13100.000	-12900.000	***
2142	-12300.000	40.688	-301.12	0.000	-12300.000	-12200.000	***
2730	-12000.000	43.414	-275.84	0.000	-12100.000	-11900.000	***
3424	-11500.000	42.151	-273.89	0.000	-11600.000	-11500.000	***
3449	-12200.000	41.539	-293.77	0.000	-12300.000	-12100.000	***
3789	-11300.000	41.430	-271.67	0.000	-11300.000	-11200.000	***
4413	-12700.000	45.934	-276.71	0.000	-12800.000	-12600.000	***
4446	-12100.000	46.222	-262.64	0.000	-12200.000	-12000.000	***
Constant	16420.825	90.007	182.44	0.000	16244.413	16597.238	***

When all other variables equal zero, 16 550/16 421 NOK per week is the default predicted value of mean cost. The predicted mean cost for the overall period is 116/113 NOK higher per week for patients who has received reablement than for patients who have not. Patients living alone have a 114/118 NOK higher expected cost per week than the patients in the "married/partner" category. Age is now 16/15 NOK lower per week with each extra year added. Male patients expected mean cost per week is 71/59 higher than females.

The "area code" looks consistent, except for area 353. Area 353 is the only positive coefficient, meaning the only observed area with higher expected mean cost per week than the institution "Area"=0. The reason for this is assumed to be because of a significantly more costly patient than the rest of the observed group. To control for this factor, the next regression was run for model 4-1.

5.2.3 First full model

Table 4: Full first model for "cost" and "cost2"

Variable	Coefficient (cost/cost2)	Standard error (cost/cost2)	t-value (cost/cost2)	p-value (cost/cost2)
D	-1042.56/ -1003.79	341.23/ 339.27	-3.06/ -2.96	0.0023/ 0.0031
Alone	3374.51/ 3384.82	208.36/ 205.52	16.20/ 16.47	0.0000/ 0.0000
Age in 2016	236.85/ 228.12	7.90/ 7.83	29.99/ 29.13	0.0000/ 0.0000
Male	-4330.54/ -4391.33	172.19/ 170.09	-25.15/ -25.82	0.0000/ 0.0000
Constant	-895.05/ -149.92	745.92/ 737.65	-1.20/ -0.20	0.2303/ 0.8390

These tables are the result of model 4-1 presented in part 4. Patients with reablement have 1043/1004 NOK lower expected mean cost per week than the patients without reablement in the full observed period. Patients living alone have 3375/3385 NOK higher expected cost per week than patients not living alone. Expected mean cost per week increases by 237/228 NOK for each extra year in the patients age. Male patients expected mean cost per week is 4331/4391 NOK lower than female patients.

5.3 Regression Results For "Treat"

5.3.1 Second model without "ID" and "Week"

Full tables in Appendix 6 and 7. Without controlling for "ID" and "Week", the following results are given for model 4-2:

Table 5: Running second model for "cost" and "cost2" without "ID" and "Week"

Variable	Coefficient (cost/cost2)	Standard error (cost/cost2)	t-value (cost/cost2)	p-value (cost/cost2)
Treat	1904.93/ 1882.17	35.55/ 35.18	53.58/ 53.50	0.0000/ 0.0000
Alone	Omitted	--	--	--
Age in 2016	Omitted	--	--	--
Male	Omitted	--	--	--
Constant	14949.71/ 14 925.28	14.78/ 14.63	1011.39/ 1020.32	0.0000/ 0.0000

The constant default expected mean cost per week is 14950/14925 NOK. For the period from when a patient receives reablement until the end of the observed period, the expected mean cost per week is 1905/1882 NOK higher for reablement patients than for non-reablement patients.

Variables "Alone", "Age in 2016" and "Male" are omitted in the fixed effects model because of collinearity. Therefore we can not say what the effects are in this particular model.

5.3.2 Second full model

The following table is the full second model (4-2) where "ID" and "Week" are controlled for.

Table 6: Full second model

Variable	Coefficient (cost/cost2)	Standard error (cost/cost2)	t-value (cost/cost2)	p-value (cost/cost2)
Treat	1192.58/ 1180.45	36.90/ 36.52	32.32/ 32.32	0.0000/ 0.0000
Alone	Omitted	--	--	--
Age in 2016	Omitted	--	--	--
Male	Omitted	--	--	--
Constant	13 451.75/ 13 441.60	79.13/ 78.32	169.99/ 171.62	0.0000/ 0.0000

The constant default expected mean cost per week is 13 452/13 442 NOK. For the period from when a patient receives reablement until the end of the observed period, the expected mean cost per week is 1193/1180 NOK higher for reablement patients than for non-reablement patients.

The variables “Alone”, “Age in 2016” and “Male” are omitted due to collinearity.

5.4 Regression Results For “REHV”

5.4.1 Third model without “ID” and “Week”

The full tables for the table 9 are found in appendix 8 and 9. Without controlling for “ID” and “Week” the following results are given for model 4-3:

Table 7: Running third model for "cost" and "cost2" without "ID" and "Week"

Variable	Coefficient (cost/cost2)	Standard error (cost/cost2)	t-value (cost/cost2)	p-value (cost/cost2)
REHV	1680.52/ 1664.94	61.86/ 61.21	27.17/ 27.20	0.0000/ 0.0000
Alone	Omitted	--	--	--
Age in 2016	Omitted	--	--	--
Male	Omitted	--	--	--
Constant	15 153.71/ 15 126.84	14.38/ 14.23	1053.76/ 1062.95	0.0000/ 0.0000

The constant default expected mean cost per week is 15 154/15 127 NOK. For the period a patients is receiving reablement, the expected mean cost per week is 1681/1665 NOK higher for reablement patients than for non-reablement patients.

The variables "Alone", "Age in 2016" and "Male" are omitted due to collinearity.

5.4.2 Third full model

The following table is the full third model (4-3) where "ID" and "Week" are controlled for.

Table 8: Full third model

Variable	Coefficient (cost/cost2)	Standard error (cost/cost2)	t-value (cost/cost2)	p-value (cost/cost2)
REHV	1601.91/ 1587.04	60.71/ 60.09	26.38/ 26.41	0.0000/ 0.0000
Alone	Omitted	--	--	--
Age in 2016	Omitted	--	--	--
Male	Omitted	--	--	--
Constant	13 429.81/ 13 419.90	79.22/ 78.41	169.52/ 171.15	0.0000/ 0.0000

The constant default expected mean cost per week is 13 430/13 420 NOK. For the period a patients is receiving reablement, the expected mean cost per week is 1602/1587 NOK higher for reablement patients than for non-reablement patients.

The variables "Alone", "Age in 2016" and "Male" are omitted due to collinearity.

5.5 Model Diagnostics

To ensure that we had consistent, efficient and true estimators we tested all the models, by way of diagnostic techniques for multicollinearity, heteroscedasticity and autocorrelation. In the Fixed effects models (Treat and REHV) we detected no presence of multicollinearity after employing the vif test. We then ran the xttest3 for heteroscedasticity and the result was there was no heteroscedasticity lastly we tested for autocorrelation which was not also not detected in these tests.

For model 4-1 there was no incidence of multicollinearity in both cases. There is however a hint of heteroscedasticity however this can be controlled for in our model by having the robust as part of our model. There is no autocorrelation. The new Stata 15 program has a default control for multicollinearity while incidence of heteroscedasticity can be controlled by robust and the cluster option (vce in STATA). This was done for the full model 4-1. Results of these tests are in Appendix(10 to 21).

There was a problem with the normality of the models, however this should not impose any big problems in the results because the population is large. The assumption of normality is also often misunderstood in statistics. When using multiple regression, the normality assumption only applies to the error term, not to the independent variables.

The results for this study have been controlled for multicollinearity, autocorrelation and heteroscedasticity by use of variance covariance estimator(vce) and clustering in stata, we can therefore confirm that the estimates of the full models are consistent, efficient and true estimates of our data.

5.6 Summarized Results

Over the complete observed time-period, in the subpopulation of patients in the municipality of Kristiansand who have been to a short-term institution at least once, patients who received reablement had lower expected mean costs per week than patients without the treatment. This was shown in the first graphs, and in the regression results for “D”(4-1). During the period of time a patient was in reablement-treatment, the expected mean costs per week were higher than for those without the treatment, and they stayed higher until the end of the observed time-period. The last part was shown in the regression results for “Treat” and “REHV” (4-2 and 4-3).

Due to “Alone”, “Age in 2016” and “Male” being omitted in the second and third model, the only results are from the first model. In general, patients living alone had higher expected mean costs per week than those not living alone. The mean expected cost decreased with increased age before controlling for “ID” and “Week”, however, expected mean cost increased with increased age when these variables were added in the regression. Male patients had higher expected mean cost per week before “ID” and “Week” were taken into the model, and the expected mean costs became lower for male patients when “ID” and “Week” were controlled for.

6. Discussion

In this paper, we presented three models with the aim to analyze the effect reablement has on expected cost for a patient in Kristiansand that has been to a short term-institution at least once. The 7 tables presented showed significant results that give an indication on the relationship between cost and reablement, age, gender and whether or not a patient lives alone. The findings were interesting and an addition to the research on reablement, however there are some limitations that will be discussed in this part of the thesis.

6.1 Findings

This thesis sought to establish "*whether patients who have received reablement have a lower expected cost per week compared to patients who have not received the treatment, in the subpopulation of patients in the municipality of Kristiansand who have been to a short-term institution at least once*". We established that over the complete observed period measured in "D", reablement resulted in 1043 NOK (1004 NOK without including night-nurse) lower expected mean patient costs per week compared to the patients without reablement treatment. This result supports the findings of a Norwegian study by Kjerstad and Tuntland (2016) as well as two other studies done outside of Norway by Lewin et.al. (2013) and Lewin et.al. (2014).

We also found that in the period in which a patient received reablement accounted for higher expected costs per week than a person without treatment, and the costs stayed higher until the end of the observed period. It is expected that the cost for the treatment is high (Lewin et.al., 2014) and that the expected benefits result in lower costs over time after the treatment. The Australian studies by Lewin et.al. in 2013, showed that benefits started to manifest after 2 years, in contrast to our data in which the mean observed period per patient is 80 weeks. Our result can therefore neither confirm nor deny the statement by Lewin, even though the results contrast his findings in the sense that cost stays higher even after treatment.

The relationship between an increase in age and expected cost reveals that the older a patient gets, the higher the expected costs are. It is not uncommon that the older a patient gets, the more service and help they need due to a natural decline in health. Even though there was a negative relationship between age and expected cost in one of the regressions (4-1 without including “ID” and “Week”), once the full model was used, there was a significant result with 237/228 NOK higher expected cost per week with each extra year added in the age.

The results of the regression outlined in model 4-1 without controlling for “ID” and “Week” indicate higher expected mean cost per week for men. When running the full 4-1 model in table 4 male patients have about 4331 NOK lower expected mean cost per week. This is a high per-week cost difference judging by the first indication from calculating mean cost per week simply from the data collected (no regression). Without having too much inside-knowledge about the healthcare in the municipality, it is difficult to say what this difference comes from.

Tables 2 and 3 show slightly higher cost per week for patients living alone compared to those who do not. When you look at full model 4-1 in table 4, the costs difference is significantly higher. With patients living alone having 3375/3385 NOK higher expected cost per week than those who live with a partner, this is a big difference on a per-week basis. We are uncertain about the quality of this variable as there is no way of knowing definitively if a patient lives alone or not. The mean cost of a patient in the “alone” category is 6653 NOK, and 7539 NOK for a patient in the married/partner category calculated from the given data (no regression). The higher mean cost per week for married/partner may have changed in the regression because unobserved individual effects are taken into account, and unusually high or low costs that drive the mean are controlled for.

6.2 Shortcomings Of The Results

The patient group was relatively large, however the reablement-group was small in comparison to the non-reablement group. Out of the 1797 patients in the subpopulation, only 14% had received reablement in the observed time-period. While this population is still larger than the population of Kjerstad and Tuntland (2016) who had a sample of 61 people, it is still narrow.

The mean number of weeks a patient was observed in this research was 80. 80 weeks may not be enough to generalize the long-term cost benefits of reablement, and in this case the costs before a patient receives reablement is either low or zero in many cases. There is no data of their history before reablement and the observed period, which makes the results open to more variance than what is captured in the models.

One thing that could have been improved would be to add another variable for reablement which only takes into account the period of time from when a person is done with the reablement-program. The "Treat" variable starts from when a patient receives reablement, so it includes the costs in reablement-treatment which are higher than the mean cost for an average patient outside of reablement. This fact can drive up the mean costs per week after reablement as well.

In addition the prerequisites for getting approved for reablement is unknown to us, which leaves room for some systematic difference in the patient groups that has not been accounted for in this research.

Even if this thesis has room for improvement, it is transparent and adds new and interesting knowledge to the important issue of reablement in a specific subpopulation of patients in Kristiansand. It also suggests that it is important to look at the costs more carefully despite the high expectations from municipalities.

6.3 Further research

The research in this paper can be built upon. A similar type of research should be done with a longer time-horizon with longer follow-up periods. It would be interesting to see long-term cost effects on a 10+ year span. This is because some more recent research is starting to indicate that the cost benefits of reablement have an "expiration-date", and decline after some years.

With the spread of reablement and the implementation into different municipalities, there is a need to look further into it, and to research the economic implications more thoroughly. Economics plays a large part in the decision making process for policy makers. If reablement is universally thought to only give positive cost benefits without the proper cost-effectiveness analysis supporting it, unfavourable decisions may be made that could have been avoided. Without generalizing the results given in our research, the results indicate that the cost benefits of reablement are not definitive or guaranteed. One should still improve the current rehabilitation offered and try to develop new and innovative ways to deal with the increase of care-expenditure due to an ageing population. The way reablement is implemented and widely used today may be a bit naive when looking at the actual scientific work. That being said, it is difficult to establish the cost benefits without actually trying the programme on a bigger scale.

7. Conclusion

The aim of this study was to establish whether a patient who has received reablement incurs less costs than one who has not been through reablement. We presented three models with the aim to analyse the effect reablement has on expected costs for a patient in Kristiansand, who has been to a short term institution at least once. Our results in model 4-1 revealed that patients in the intervention group have 1043 NOK lower mean expected costs per week than patients not included in the reablement program. Model 4-3 revealed that expected costs are higher for patients in the period of reablement compared to patients not receiving reablement in the same period. The final model, 4-2, showed that costs from the day one receives reablement until the end of the observed period would remain higher going against our expectations.

Reablement has the potential to assist in reducing health costs related to older individuals. To be able to utilize the intervention to its fullest potential, more research needs to be done to be able to establish the point at which the cost-benefits start to show.

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9. Appendix

1) Additional information on the subpopulation used:

AGE	Youngest	Oldest	Mean	
	29	116	83,4	
MARITAL STATUS	“Alone”	Married	Mean cost per week alone	Mean cost per week married
	68%	32%	6653	7539
GENDER	Male	Female	Mean cost per week male	Mean cost per week female
	42%	58%	7000	6775
REABLEMENT	Yes	No	Mean cost per week with Reablement	Mean cost per week without Reablement
	14,25%	85,75%	5201	7227
MEAN COST PER WEEK	With night-nurse	Without night-nurse		
	6861	6830		
WEEKS OBSERVED	Mean overall	Reablement	Not Reablement	
	80 weeks	85 weeks	79 weeks	

2) Model 4-1 for cost without "Area", "ID" and "Week"

Source	SS	df	MS			
				Number of obs	=	147,972
				F(4, 147967)	=	651.76
Model	1.1615e+11	4	2.9037e+10	Prob > F	=	0.0000
Residual	6.5923e+12	147,967	44552704.3	R-squared	=	0.0173
				Adj R-squared	=	0.0173
Total	6.7085e+12	147,971	45336450.9	Root MSE	=	6674.8

cost	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
D	-2022.236	45.31837	-44.62	0.000	-2111.059	-1933.413
Alone	-933.4143	42.66923	-21.88	0.000	-1017.045	-849.7835
Male	-83.66335	37.58944	-2.23	0.026	-157.3379	-9.988803
Agein2016	21.08508	1.729068	12.19	0.000	17.69614	24.47402
_cons	6215.09	149.6493	41.53	0.000	5921.781	6508.4

3) Model 4-1 for cost2 without "Area", "ID" and "Week"

Source	SS	df	MS			
				Number of obs	=	147,972
				F(4, 147967)	=	659.77
Model	1.1635e+11	4	2.9088e+10	Prob > F	=	0.0000
Residual	6.5235e+12	147,967	44087492	R-squared	=	0.0175
				Adj R-squared	=	0.0175
Total	6.6398e+12	147,971	44872605.5	Root MSE	=	6639.8

cost2	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
D	-2023.833	45.08115	-44.89	0.000	-2112.191	-1935.475
Alone	-925.1537	42.44587	-21.80	0.000	-1008.347	-841.9607
Male	-97.78254	37.39267	-2.62	0.009	-171.0714	-24.49365
Agein2016	22.40021	1.720017	13.02	0.000	19.02901	25.77141
_cons	6074.329	148.8659	40.80	0.000	5782.555	6366.103

4) Model 4-1 for cost without "ID" and "Week"

Linear regression

cost	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
D	115.922	27.803	4.17	0.000	61.428	170.416	***
Alone	114.150	25.490	4.48	0.000	64.190	164.111	***
Agein2016	-16.218	1.035	-15.66	0.000	-18.247	-14.189	***
Male	71.045	22.202	3.20	0.001	27.530	114.560	***
Area code:							
0	0.000	.	.	.	.	.	
2	-14700.000	800.236	-18.37	0.000	-16300.000	-13100.000	***
126	-9974.248	262.062	-38.06	0.000	-10500.000	-9460.613	***
209	-6946.742	163.686	-42.44	0.000	-7267.564	-6625.921	***
353	1367.284	147.193	9.29	0.000	1078.788	1655.780	***
434	-9386.784	141.591	-66.30	0.000	-9664.300	-9109.268	***
444	-6561.852	193.605	-33.89	0.000	-6941.313	-6182.391	***
1116	-8943.187	50.914	-175.65	0.000	-9042.977	-8843.397	***
1542	-12300.000	53.344	-230.06	0.000	-12400.000	-12200.000	***
1667	-13200.000	44.115	-299.41	0.000	-13300.000	-13100.000	***
2051	-13100.000	48.279	-270.33	0.000	-13100.000	-13000.000	***
2142	-12200.000	41.377	-294.67	0.000	-12300.000	-12100.000	***
2730	-12000.000	44.149	-271.22	0.000	-12100.000	-11900.000	***
3424	-11500.000	42.865	-269.34	0.000	-11600.000	-11500.000	***
3449	-12200.000	42.243	-288.97	0.000	-12300.000	-12100.000	***
3789	-11300.000	42.131	-267.11	0.000	-11300.000	-11200.000	***
4413	-12700.000	46.712	-272.04	0.000	-12800.000	-12600.000	***
4446	-12100.000	47.005	-257.85	0.000	-12200.000	-12000.000	***
Constant	16549.660	91.532	180.81	0.000	16370.260	16729.060	***

Mean dependent var	6863.414	SD dependent var	6733.467
R-squared	0.661	Number of obs	147904.000
F-test	13758.494	Prob > F	0.000
Akaike crit. (AIC)	2867085.650	Bayesian crit. (BIC)	2867303.545

*** *p<0.01*, ** *p<0.05*, * *p<0.1*

5) Model 4-1 for cost2 without "ID" and "Week"

Linear regression

cost2	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
D	112.789	27.340	4.12	0.000	59.202	166.375	***
Alone	117.802	25.066	4.70	0.000	68.674	166.931	***
Agein2016	-14.902	1.018	-14.64	0.000	-16.898	-12.907	***
Male	58.591	21.832	2.68	0.007	15.801	101.382	***
Area code:							
0	0.000	.	.	.	.	.	
2	-15500.000	786.910	-19.70	0.000	-17000.000	-14000.000	***
126	-9939.441	257.698	-38.57	0.000	-10400.000	-9434.358	***
209	-6916.891	160.960	-42.97	0.000	-7232.370	-6601.412	***
353	1386.609	144.742	9.58	0.000	1102.918	1670.301	***
434	-9359.299	139.233	-67.22	0.000	-9632.194	-9086.404	***
444	-6526.000	190.381	-34.28	0.000	-6899.142	-6152.858	***
1116	-9048.908	50.066	-180.74	0.000	-9147.036	-8950.779	***
1542	-12300.000	52.456	-233.65	0.000	-12400.000	-12200.000	***
1667	-13200.000	43.380	-304.48	0.000	-13300.000	-13100.000	***
2051	-13000.000	47.475	-274.56	0.000	-13100.000	-12900.000	***
2142	-12300.000	40.688	-301.12	0.000	-12300.000	-12200.000	***
2730	-12000.000	43.414	-275.84	0.000	-12100.000	-11900.000	***
3424	-11500.000	42.151	-273.89	0.000	-11600.000	-11500.000	***
3449	-12200.000	41.539	-293.77	0.000	-12300.000	-12100.000	***
3789	-11300.000	41.430	-271.67	0.000	-11300.000	-11200.000	***
4413	-12700.000	45.934	-276.71	0.000	-12800.000	-12600.000	***
4446	-12100.000	46.222	-262.64	0.000	-12200.000	-12000.000	***
Constant	16420.825	90.007	182.44	0.000	16244.413	16597.238	***

Mean dependent var	6832.975	SD dependent var	6698.932
R-squared	0.669	Number of obs	147904.000
F-test	14248.885	Prob > F	0.000
Akaike crit. (AIC)	2862118.075	Bayesian crit. (BIC)	2862335.970

*** *p<0.01*, ** *p<0.05*, * *p<0.1*

6) Model 4-2 for cost without “ID” and “Week”

```
Fixed-effects (within) regression               Number of obs     =    147,904
Group variable: ID                              Number of groups  =      1,797

R-sq:                                           Obs per group:
     within  = 0.7426                                         min =          1
     between = 0.6403                                         avg =       82.3
     overall = 0.6500                                         max =        159

                                                F(18,146089)      =   23417.30
corr(u_i, Xb)  = 0.0476                         Prob > F          =     0.0000
```

cost	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
Treat	1904.93	35.55014	53.58	0.000	1835.252	1974.607
Alone	0	(omitted)				
Agein2016	0	(omitted)				
Male	0	(omitted)				
Area						
2	-14090.65	512.3801	-27.50	0.000	-15094.91	-13086.4
126	-9355.555	204.4019	-45.77	0.000	-9756.178	-8954.931
209	-7959.487	144.512	-55.08	0.000	-8242.728	-7676.247
353	-6198.456	169.7574	-36.51	0.000	-6531.177	-5865.735
434	-8243.358	129.3701	-63.72	0.000	-8496.921	-7989.795
444	-5339.28	206.7726	-25.82	0.000	-5744.55	-4934.01
1116	-10278.92	68.50105	-150.05	0.000	-10413.18	-10144.66
1542	-11609.41	62.96912	-184.37	0.000	-11732.83	-11486
1667	-12751.86	54.4903	-234.02	0.000	-12858.66	-12645.06
2051	-12504.05	66.90888	-186.88	0.000	-12635.19	-12372.91
2142	-11814.89	49.32464	-239.53	0.000	-11911.57	-11718.21
2730	-11921.74	54.84985	-217.35	0.000	-12029.24	-11814.24
3424	-10392.2	49.19623	-211.24	0.000	-10488.62	-10295.78
3449	-12001.8	47.2634	-253.93	0.000	-12094.44	-11909.17
3789	-10813.02	46.12504	-234.43	0.000	-10903.42	-10722.61
4413	-12010.79	57.50918	-208.85	0.000	-12123.51	-11898.07
4446	-12271.67	61.26148	-200.32	0.000	-12391.74	-12151.6
_cons	14949.71	14.7814	1011.39	0.000	14920.74	14978.68

7) Model 4-2 for cost2 without "ID" and "Week"

Fixed-effects (within) regression		Number of obs	= 147,904
Group variable: ID		Number of groups	= 1,797
R-sq:		Obs per group:	
within	= 0.7467	min	= 1
between	= 0.6506	avg	= 82.3
overall	= 0.6582	max	= 159
		F(18,146089)	= 23931.18
corr(u_i, Xb)	= 0.0496	Prob > F	= 0.0000

cost2	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Treat	1882.174	35.18139	53.50	0.000	1813.219	1951.129
Alone	0	(omitted)				
Agein2016	0	(omitted)				
Male	0	(omitted)				
Area						
2	-14299.94	507.0653	-28.20	0.000	-15293.77	-13306.1
126	-9354.069	202.2817	-46.24	0.000	-9750.537	-8957.601
209	-7921.533	143.013	-55.39	0.000	-8201.836	-7641.23
353	-6174.732	167.9965	-36.76	0.000	-6504.002	-5845.462
434	-8231.09	128.0282	-64.29	0.000	-8482.023	-7980.158
444	-5339.472	204.6278	-26.09	0.000	-5740.538	-4938.405
1116	-10291.75	67.79051	-151.82	0.000	-10424.62	-10158.88
1542	-11623.74	62.31596	-186.53	0.000	-11745.87	-11501.6
1667	-12764.3	53.92509	-236.70	0.000	-12869.99	-12658.6
2051	-12511.23	66.21486	-188.95	0.000	-12641.01	-12381.45
2142	-11839.07	48.81301	-242.54	0.000	-11934.74	-11743.4
2730	-11920.51	54.2809	-219.61	0.000	-12026.9	-11814.12
3424	-10387.1	48.68593	-213.35	0.000	-10482.52	-10291.67
3449	-12007.72	46.77315	-256.72	0.000	-12099.4	-11916.05
3789	-10823.33	45.6466	-237.11	0.000	-10912.8	-10733.86
4413	-12021.88	56.91265	-211.23	0.000	-12133.43	-11910.33
4446	-12241.95	60.62603	-201.93	0.000	-12360.78	-12123.13
_cons	14925.28	14.62808	1020.32	0.000	14896.61	14953.95

8) Model 4-3 for cost without “ID” and “Week”

```
Fixed-effects (within) regression               Number of obs     =    147,904
Group variable: ID                              Number of groups  =      1,797

R-sq:                                           Obs per group:
     within  = 0.7389                                         min =          1
     between = 0.6417                                         avg =       82.3
     overall = 0.6501                                         max =        159

                                                F(18,146089)      =   22965.74
corr(u_i, Xb)  = 0.0399                         Prob > F          =     0.0000
```

cost	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
REHV	1680.517	61.85517	27.17	0.000	1559.282	1801.752
Alone	0	(omitted)				
Agein2016	0	(omitted)				
Male	0	(omitted)				
Area						
2	-14132.32	516.0882	-27.38	0.000	-15143.84	-13120.8
126	-8581.699	205.4295	-41.77	0.000	-8984.337	-8179.061
209	-7804.049	145.5314	-53.62	0.000	-8089.288	-7518.811
353	-6063.01	170.9657	-35.46	0.000	-6398.1	-5727.921
434	-8279.656	130.3048	-63.54	0.000	-8535.051	-8024.261
444	-5252.011	208.2646	-25.22	0.000	-5660.205	-4843.816
1116	-10299.38	68.99805	-149.27	0.000	-10434.61	-10164.14
1542	-11681.27	63.41215	-184.21	0.000	-11805.56	-11556.99
1667	-12746.9	54.88785	-232.24	0.000	-12854.48	-12639.32
2051	-12588.58	67.38525	-186.82	0.000	-12720.65	-12456.51
2142	-11793.67	49.67967	-237.39	0.000	-11891.04	-11696.29
2730	-12108.25	55.17358	-219.46	0.000	-12216.39	-12000.11
3424	-10355.2	49.56185	-208.93	0.000	-10452.34	-10258.06
3449	-12020.8	47.62847	-252.39	0.000	-12114.15	-11927.45
3789	-10947.2	46.45532	-235.65	0.000	-11038.25	-10856.15
4413	-12101.66	57.89649	-209.02	0.000	-12215.13	-11988.18
4446	-12283.83	61.70962	-199.06	0.000	-12404.78	-12162.88
_cons	15153.71	14.38065	1053.76	0.000	15125.52	15181.89

9) Model 4-3 for cost2 without "ID" and "Week"

```
Fixed-effects (within) regression               Number of obs     =    147,904
Group variable: ID                              Number of groups  =      1,797

R-sq:                                           Obs per group:
     within  = 0.7431                                         min =          1
     between = 0.6520                                         avg =       82.3
     overall = 0.6582                                         max =        159

                                                F(18,146089)      =   23474.55
corr(u_i, Xb)  = 0.0417                         Prob > F          =     0.0000
```

cost2	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
REHV	1664.939	61.21134	27.20	0.000	1544.966	1784.912
Alone	0	(omitted)				
Agein2016	0	(omitted)				
Male	0	(omitted)				
Area						
2	-14341.12	510.7164	-28.08	0.000	-15342.12	-13340.13
126	-8589.341	203.2912	-42.25	0.000	-8987.788	-8190.894
209	-7767.934	144.0166	-53.94	0.000	-8050.203	-7485.664
353	-6040.919	169.1862	-35.71	0.000	-6372.52	-5709.317
434	-8266.958	128.9485	-64.11	0.000	-8519.694	-8014.221
444	-5253.216	206.0969	-25.49	0.000	-5657.162	-4849.27
1116	-10311.99	68.27987	-151.03	0.000	-10445.82	-10178.17
1542	-11694.75	62.75211	-186.36	0.000	-11817.74	-11571.75
1667	-12759.45	54.31653	-234.91	0.000	-12865.91	-12652.99
2051	-12594.8	66.68385	-188.87	0.000	-12725.5	-12464.1
2142	-11818.13	49.16257	-240.39	0.000	-11914.49	-11721.77
2730	-12104.86	54.59929	-221.70	0.000	-12211.87	-11997.85
3424	-10350.68	49.04598	-211.04	0.000	-10446.81	-10254.55
3449	-12026.61	47.13272	-255.16	0.000	-12118.99	-11934.23
3789	-10956.03	45.97178	-238.32	0.000	-11046.13	-10865.92
4413	-12111.64	57.29386	-211.40	0.000	-12223.94	-11999.35
4446	-12254.02	61.0673	-200.66	0.000	-12373.71	-12134.33
_cons	15126.84	14.23096	1062.95	0.000	15098.95	15154.73

10) Vif 4-1

```
. vif
```

Variable	VIF	1/VIF
D	1.10	0.907282
Male	1.12	0.893087
Alone	1.12	0.892125
Agein2016	1.08	0.927871
Areacode		
2	1.00	0.999043
126	1.01	0.990627
209	1.01	0.986700
353	1.02	0.980812
434	1.02	0.980685
444	1.01	0.987325
1116	1.12	0.894635
1542	1.11	0.899355
1667	1.16	0.863467
2051	1.13	0.883071
2142	1.18	0.845935
2730	1.23	0.811501
3424	1.20	0.831111
3449	1.20	0.830250
3789	1.21	0.825271
4413	1.15	0.866700
4446	1.13	0.881329
Mean VIF	1.11	

11) Imtest 4-1

```
. imtest
```

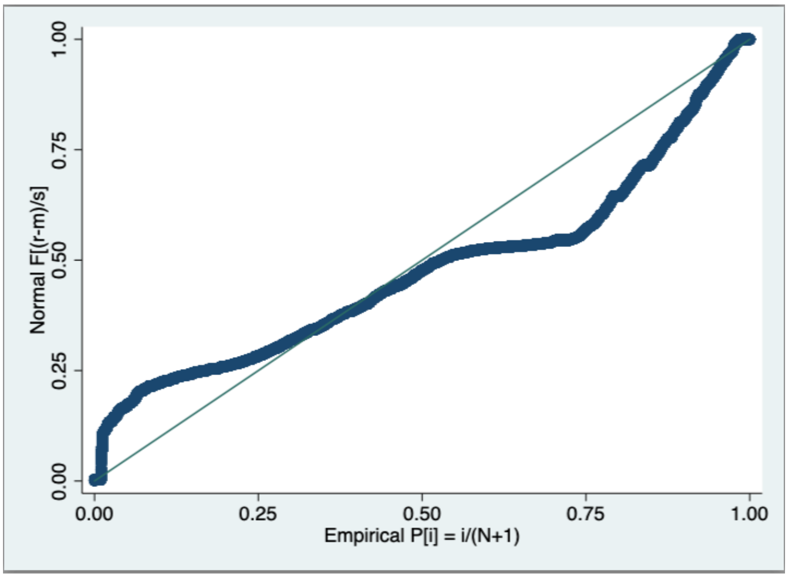
Cameron & Trivedi's decomposition of IM-test

Source	chi2	df	p
Heteroskedasticity	63451.83	91	0.0000
Skewness	11214.97	21	0.0000
Kurtosis	-4953788.14	1	1.0000
Total	-4879121.34	113	1.0000

12) xtserial 4-1

```
. xtserial cost Areacode D Male Alone Agein2016

Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation
    F(  1,     1746) =    1579.131
           Prob > F =      0.0000
```

13) Normality 4-1



14) vif 4-2

```
. vif
Print
    Variable |       VIF       1/VIF
-------------+----------------------
    Areacode |
          2  |      1.00    0.999046
        126  |      1.01    0.988714
        209  |      1.01    0.986538
        353  |      1.02    0.980887
        434  |      1.02    0.980688
        444  |      1.01    0.987354
       1116  |      1.12    0.896217
       1542  |      1.11    0.899273
       1667  |      1.16    0.863142
       2051  |      1.13    0.884585
       2142  |      1.18    0.847408
       2730  |      1.21    0.829722
       3424  |      1.20    0.834314
       3449  |      1.19    0.839206
       3789  |      1.20    0.836391
       4413  |      1.15    0.866680
       4446  |      1.13    0.882559
       Treat |      1.08    0.927991
        Male |      1.11    0.897299
       Alone |      1.12    0.892501
   Agein2016 |      1.08    0.927869
-------------+----------------------
    Mean VIF |      1.11
```

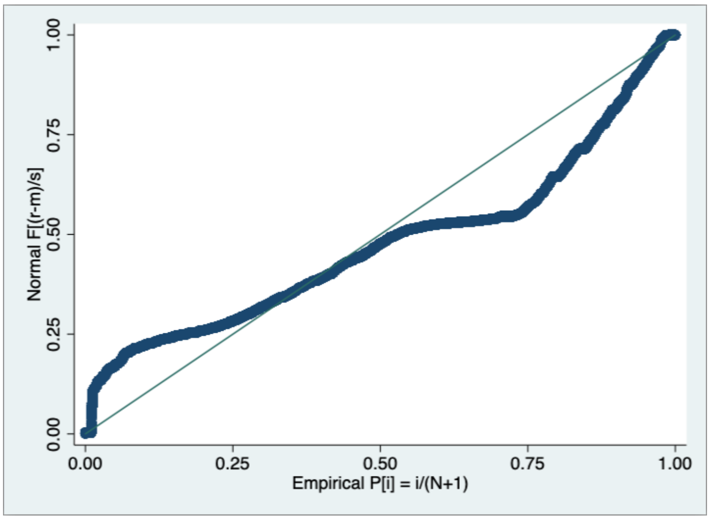
15) xttest 4-2

```
. xttest3

Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (1797)  =   3.2e+34
Prob>chi2 =       0.0000
```

16) xtserial 4-2

```
Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation
    F(  1,     1746) =   1579.265
           Prob > F =      0.0000
```

17) Normality 4-2



18) Vif 4-3

```
. vif
```

Variable	VIF	1/VIF
Areacode		
2	1.00	0.999054
126	1.01	0.992965
209	1.01	0.986823
353	1.02	0.981725
434	1.02	0.980813
444	1.01	0.987395
1116	1.12	0.896175
1542	1.11	0.899349
1667	1.16	0.863196
2051	1.13	0.884160
2142	1.18	0.846971
2730	1.18	0.845601
3424	1.18	0.849998
3449	1.18	0.846341
3789	1.19	0.842344
4413	1.15	0.867356
4446	1.13	0.882263
REHV	1.01	0.990326
Male	1.11	0.899923
Alone	1.12	0.892906
Agein2016	1.08	0.927847
Mean VIF	1.10	

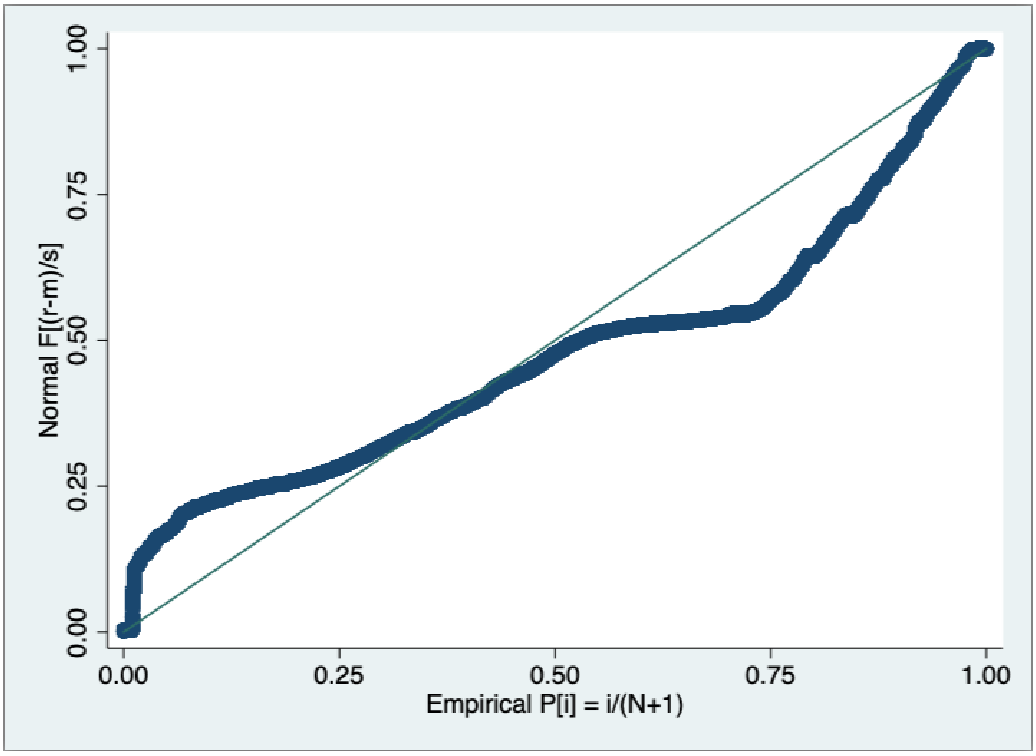
19) xttest 4-3

```
Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (1797)  =  6.1e+33
Prob>chi2 =       0.0000
```

20) xtserial 4-3

```
Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation
    F(  1,     1746) =   1594.320
           Prob > F =      0.0000
```

21) Normality 4-3



22) DO-FILE for the Thesis

```
use
"/Users/selmahasic/Desktop/Panel_master_students2(2)/Panel_master_students2.d
ta", clear
xtset ID Uke
set matsize 2000
ssc install xttest3

//Narrow down subpopulation to only patients that have been to a short-term
institution least once//
egen kortdummy = max(KORT), by(ID)
drop if kortdummy == 0
xtsum ID

rename Uke Week
rename Ansvar Areacode
rename Mann Male
rename Alder16 Agein2016

//Combining alone into one demographic variable//
egen Alone = rowmax(Ugift Sep_skilt Enke_enkem Gift_sam_inst)

//Generate total hours for nurse and care//
gen total = HJNA_t_u + HJSY_t_u + HJSY_b_t_u + REHV_t_u
rename total tothomenurse
gen total = HJHJ_t_u + HJHJ_b_t_u
rename total tothomecare
//generate new variable to implement the cost//
gen yx = tothomenurse * 685
rename yx costhomenurse
gen yx = tothomecare * 482
rename yx costhomecare

//Generate total days for short and long term and rename//
gen total = KORT_d_u + STERK_d_u + REHA_d_u
rename total totshortsterk

//Generate new variable to implement cost for the days//
```

```
gen yx = totshortsterk * 3200
rename yx costshortsterk
gen yx = LANG_d_u * 2150
rename yx costlong

//Generate new total Y variable//
gen total = costhomenurse + costhomecare + costshortsterk + costlong
rename total cost
summarize cost

drop tothomenurse tothomecare costhomenurse costhomecare totshortsterk
costshortsterk costlong

//Create cost2 excluding home nurse night (HJNA_t_u)//
//Generate total hours for nurse and care//
gen total = HJSY_t_u + HJSY_b_t_u + REHV_t_u
rename total tothomenurse
gen total = HJHJ_t_u + HJHJ_b_t_u
rename total tothomecare

//Generate new variable to implement the cost//
gen yx = tothomenurse * 685
rename yx costhomenurse
gen yx = tothomecare * 482
rename yx costhomecare

//Generate total days for short and long term and rename//
gen total = KORT_d_u + STERK_d_u + REHA_d_u
rename total totshortsterk

//Generate new variable to implement cost for the days//
gen yx = totshortsterk * 3200
rename yx costshortsterk
gen yx = LANG_d_u * 2150
rename yx costlong

//Make cost-variable
gen total = costhomenurse + costhomecare + costshortsterk + costlong
```

```
rename total cost2
summarize cost2

drop tothomenurse tothomecare costhomenurse costhomecare totshortsterk
costshortsterk costlong

//Create D
by ID: egen D=max(REHV)

//Create Treat
gen Treat=REHV
replace Treat=. if Treat==0
gen byte down=Treat
by ID (Uke), sort: replace down = down[_n-1] if missing(down)
replace Treat=down
replace Treat=0 if Treat==.

drop down

//Chekc mean cost for different groups
xtsum cost if Male==0
xtsum cost if Male==1

xtsum cost if Alone==0
xtsum cost if Alone==1

xtsum cost if D==0
xtsum cost if D==1

xtsum cost
xtsum cost2

xtsum ID if Male==0
xtsum ID if Male==1

xtsum ID if Alone==0
xtsum ID if Alone==1
```

```
xtsum ID if D==0
xtsum ID if D==1

xtsum Week
xtsum Week if D==0
xtsum Week if D==1

xtsum Agein2016

//Graph for cost and cost2
lgraph cost Week D
lgraph cost2 Week D



//REGRESSIONS + Diagnostics

//D
reg cost D Male Alone Agein2016
reg cost2 D Male Alone Agein2016

reg cost D Male Alone Agein2016 i.Areacode
reg cost2 D Male Alone Agein2016 i.Areacode

//Diagnostics for D without ID and Week

reg cost D Male Alone Agein2016 i.Areacode
vif

reg cost D Male Alone Agein2016 i.Areacode
imtest

reg cost D Male Alone Agein2016 i.Areacode
predict res
pnorm r
drop res

xtserial cost Areacode D Male Alone Agein2016
```

```
reg cost2 D Male Alone Agein2016 i.Areacode
vif

reg cost2 D Male Alone Agein2016 i.Areacode
imtest

reg cost2 D Male Alone Agein2016 i.Areacode
predict res
pnorm r
drop res

xtserial cost2 Areacode D Male Alone Agein2016

//Regression for full model with vce
quietly reg cost D Male Alone Agein2016 i.Areacode i.Week i.ID, vce(cluster
ID)
estimate table, drop(i.ID i.Week i.Areacode) p b t se

quietly reg cost2 D Male Alone Agein2016 i.Areacode i.Week i.ID, vce(cluster
ID)
estimate table, drop(i.ID i.Week i.Areacode) p b t se

//Treat
xtreg cost Treat Male Alone Agein2016 i.Areacode, fe
xtreg cost2 Treat Male Alone Agein2016 i.Areacode, fe

//Diagnostics for Treat without "ID" and "Week"
reg cost Treat Male Alone Agein2016 i.Areacode, fe
vif

xtreg cost Treat Male Alone Agein2016 i.Areacode, fe
xttest3

xtreg cost Treat Male Alone Agein2016 i.Areacode, fe
predict res
pnorm r
drop res
```

```
xtserial cost Treat Male Alone Agein2016 i.Areacode, output


reg cost2 Treat Male Alone Agein2016 i.Areacode, fe
vif

xtreg cost2 Treat Male Alone Agein2016 i.Areacode, fe
xttest3

xtreg cost2 Treat Male Alone Agein2016 i.Areacode, fe
predict res
pnorm r
drop res

xtserial cost2 Treat Male Alone Agein2016 i.Areacode, output

//Regression for full model
quietly xtreg cost Treat Male Alone Agein2016 i.Areacode i.Week i.ID, fe
estimate table, drop(i.ID i.Week i.Areacode) p b t se

quietly xtreg cost2 Treat Male Alone Agein2016 i.Areacode i.Week i.ID, fe
estimate table, drop(i.ID i.Week i.Areacode) p b t se

//REHV
xtreg cost REHV Male Alone Agein2016 i.Areacode, fe
xtreg cost2 REHV Male Alone Agein2016 i.Areacode, fe

//Diagnostics for REHV without "ID" and "Week"
reg cost REHV Male Alone Agein2016 i.Areacode, fe
vif

xtreg cost REHV Male Alone Agein2016 i.Areacode, fe
xttest3

xtreg cost REHV Male Alone Agein2016 i.Areacode, fe
predict res
pnorm r
drop res
```

```
xtserial cost REHV Male Alone Agein2016 i.Areacode, output


reg cost2 REHV Male Alone Agein2016 i.Areacode, fe
vif

xtreg cost2 REHV Male Alone Agein2016 i.Areacode, fe
xttest3

xtreg cost2 REHV Male Alone Agein2016 i.Areacode, fe
predict res
pnorm r
drop res

xtserial cost2 REHV Male Alone Agein2016 i.Areacode, output

//Regression for full model
quietly xtreg cost REHV Male Alone Agein2016 i.Areacode i.Week i.ID, fe
estimate table, drop(i.ID i.Week i.Areacode) p b t se

quietly xtreg cost2 REHV Male Alone Agein2016 i.Areacode i.Week i.ID, fe
estimate table, drop(i.ID i.Week i.Areacode) p b t se
```

23) ***Reflection paper on the broad themes of internationalisation, innovation and accountability.***

The aim of this thesis was to research reablement further, more specifically in the municipality of Kristiansand in a subpopulation of patients who have been to a short-term institution at least once in the observed period. The economic research on reablement is weak as it is a relatively new form of rehabilitation. This form of rehabilitation aims to help patients be able to live at home longer after illness or accidents, by focusing on what is most important to each individual. Hopefully they will avoid going to special treatment-facilities. By investing a considerable amount of service-hours over a set number of weeks (usually 4-10 weeks depending on the municipality) intensively, the hypothesis is that the patient will cost society less in the long run, and the patient is able to help themselves at home.

With western populations, including Norway, having a growing older population, steps need to be taken to adjust to this fact. There is a real challenge facing us with the cost of taking care of older patients rising. Previous studies on this theme are inconclusive, with some finding evidence to support the hypothesis, and some not finding any evidence to support it. The former research is also not transparent and hard to replicate, in addition to most of them having small samples or short time-horizons. The motivation to write our thesis came from all of this combined. We wanted to contribute to understanding the economic effects of reablement, attempt to test it on a slightly bigger scale, and present the research transparently.

The results were interesting as the mean expected cost per week was lower in the overall observed period for reablement-patients than for the non reablement-patients, and this supports the hypothesis. However, while a person receives the treatment the mean expected cost per week is higher than for the average person, and the cost stays higher until the end of the observed time-period. This is in direct contrast of the hypothesis. The conclusion was found using panel data regression models (3 different ones), and the results were significant. The drawbacks to our research is that the mean observed time period is relatively low, with a mere 80 weeks. In a known study in this field, the researchers (Lewin et.al.) claim that the positive effects of lower cost for these patients start to show after 2 years. Even if the observed time period for data-collection spanned over 3 years, the mean number of weeks a single patient was observed was less than 2 years. This is typical for panel data because not all patients will respond over such a long period of time.

As briefly mentioned in the beginning of the reflection note, the topic of reablement has an international connection with countries such as the US, Australia, the UK and countries in Scandinavia amongst others have started to implement it. Since there is little knowledge about the economic effects of reablement, all research is subject to be used in an international setting because economics plays a big part in selecting rehabilitation programs for municipalities and countries. Economics and healthcare-policies go beyond country borders and research in this field is in most cases universally applicable. This can be seen in the way economics, econometrics, statistics and finance is tough globally, it is all based on the same principles no matter where you learn it.

We are fortunate to have a university in Kristiansand that offers a major in Finance because it is in great demand both domestically and internationally. Students learn valuable skills that can be used in a variety of settings. We as students also get to work on an issue that concerns a considerable amount of people with the knowledge accumulated in the master programme. The type of research done in this master thesis in particular can be used to affect how policies are decided in governments and municipalities.

Since reablement was developed in more recent time, this thesis helps with innovation in healthcare, and has findings that need to be considered when deciding whether or not one want to offer the treatment in municipalities. Even if there are mixed results on this topic and our findings contrast the claims, this can help policy makers think twice before deciding, or add funds to further the research. This could lead to innovation and development in the current programme, and maybe some day to an even better solution. It is important to look at all of the research in a broader and more international perspective. Curiosity and other researchers work help lead to new and visionary solutions to current problems.

When it comes to responsibility, the clear link here is that all research in a relatively new field could be used in a decision-making process. Since the municipality of Kristiansand gave us the data set and will read this thesis, there is great responsibility on our part to deliver reliable and accurate results. A big part of policy makers don't have an extensive background in statistics and economics so the results also need to be presented in a responsible and clear way. Any parts that can be misinterpreted or needs to be taken with caution, we need to make clear. If anyone is to use the findings in this thesis, mistakes and misinformation due to not doing our job correctly or carefully, the responsibility falls on us. This is why we were careful to include our limitations and shortcomings, and avoided generalizing.

The ethics of care-economics are important. Deciding on policies purely based on economic effects can be catastrophic. Health care is intricate and involves a broader ethical understanding to best take care of the people who are in need of help, and depend on this. Reablement is shown to have a positive effect on the patients who go through with it based on their feedback in multiple studies. People in general appreciate being able to stay at home longer and avoid going to institutions. It is important for a human being to feel like they can take care of themselves to some degree and not depend on someone entirely. Independence is greatly appreciated. Nonetheless there are always ethical concerns that need to be taken when it comes to patient-care. Will we for example have enough specialists and rehabilitation-workers to help everyone if reablement is offered to anyone? Will patients have to wait longer to get care? Could this affect the results because proper care in not given? These questions are hard to answer at this stage but need to be considered.

Finally, our knowledge in econometrics, statistics, and health care challenges in a municipality has been developed through writing this thesis. Our understanding for the topics has grown and this gives us important insight to better reflect in the future. Our hope is that reablement will be researched more extensively, and that our contribution will help someone. In the future we would like to see research papers be more transparent in how they achieved their results so that they can be replicated to validate, and that more attention is given to the cost-effectiveness part of reablement. The treatment is spreading fast internationally, and must have stronger evidence of cost benefits if it is to keep manifesting. From an economist's perspective it is concerning to see a rehabilitation programme be invested in to this degree without many cost-analyses.