Wealthy healthy, a causal relationship?

Niels van Opstal

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Abstract

This paper tries to find a causal relationship from wealth to health in the Netherlands using a difference in differences analysis. In this study, the treatment used for the difference in differences analysis is the sudden drop in housing prices caused by the financial crisis and the subsequent bounce back of the housing prices. The control group consists of people who rent a house and the treatment group consists of people who own a house. This makes the net wealth of the treatment group more to the change in housing prices than the net wealth of the control group. Self-assessed health is used as the health variable . The data used consists of 3 waves from the Dutch Household Survey. The study found no evidence of a significant causal effect of wealth on health in the short run.

1 Introduction

The positive correlation between health and wealth has been shown many times. Pollack et al. (2007) for example found 29 studies that tested for the correlation between health and wealth. But "since most of the studies identified were cross-sectional, causal inferences cannot be made" (Pollack et al., 2007, p. 263). Health and wealth could easily be endogenous. Wealth could affect health through better access to health care and better living conditions. Health could affect wealth through the ability to work and thus accumulate wealth. It could also be possible that for example time preference affects both the accumulation of wealth and health (Meer, Miller, & Rosen, 2003).

As Aittomäki, Martikainen, Laaksonen, Lahelma, and Rahkonen (2010) point out, "Wealth in particular is not directly affected by changes in labor market participation that may radically alter the current income level". They find that wealth is highly relevant in explaining health.

Even though the correlation between health and wealth is researched a lot and a majority of these researches find positive results, the body of literature addressing the causality between health and wealth is smaller and does find mixed results. As Meer et al. (2003) point out, more research needs to be done on the subject of direction of causality between health and wealth. This is especially important for public policy since it cannot simply rely on correlations.

The goal of this paper is to examine the causality between health and wealth in the Netherlands. Especially, this paper will try to find a causal relation from wealth to health. This paper will try to deal with the endogeneity between health and wealth using a difference in difference analysis. The treatment group consists of home-owners and the control group consists of people who rent a house. Two different treatments will be used. First, the financial crisis in 2008 as it affected housing prices and secondly the bounce-back of the housing prices after the financial crisis. The change in housing prices should affect the net wealth of the home-owners more than the net wealth of tenants since the wealth of home owners is more exposed to changes in housing prices than the wealth of tenants. It stands to reason that the change in housing prices does not directly affect or is affected by health status of the home-owner or home-renters alike. So if there is a causal effect from wealth to health, the health of the home owners should thus react differently to the change in housing prices than the health of the tenants. The wealth of a person will be defined as the net worth of a person, i.e. all their assets minus their liabilities. Each person will be placed into one of two categories, i.e. healthy (1) or not healthy (0), based on their self-assessed health.

To examine causal relationship between health and wealth the data from the DNB Household Survey (DHS) from CentERdata will be used. These data is described as a dataset allowing to study both the psychological as well as the economic aspects of financial behavior. The survey was first launched in 1993 and collects data yearly. The data has information of health, housing, possessions among other thing. ("DHS data access — CentERdata.nl," n.d.). Using different waves of this dataset will allow this paper to try and find a causal

relationship using the difference in difference analysis.

The paper will be structured as follows. The first chapter will discuss relevant literature on the subject of causality between health and wealth. The second chapter will briefly explore the constitutional points of interest for this paper in the Netherlands. The third chapter will describe the data and the variables used in this study. The fourth chapter will describe the different statistical methods used. First will be described how a correlation between wealth and health will be found. Secondly the method that will be used to test for a causal relationship will be described. The fifth chapter will present the results found by the statistical analyses. The sixth chapter will present results from different robustness tests and the final chapter will conclude this paper and present some improvements and ideas for further research

2 Related Literature

In their article Should Health Studies Measure Wealth, Pollack et al. (2007) systematically analyze a total of 29 articles that used health as the dependent variable and wealth and at least one other socioeconomic-status variable as independent variables. Of the 29 articles analyzed, 14 used self assed health as their health variable. Most of those articles reported positive or mixed results. The other 15 articles used different variables for health such as: mortality, chronic conditions, functional status and mental health. Of the total of 29 studies, 15 found positive results, 10 found mixed results and only 4 found negative results. They conclude that there is a significant correlation between health and wealth. Especially when the wealth variables were constructed from detailed questions instead of simpler questions (for example just a single question). It should however be noted that they only check for correlation and do not address causality.

There are however some studies that do address causality in the health wealth connection and some find insignificant causal effects. Meer et al. (2003) use a straightforward instrumental variable strategy to deal with the endogeneity. They use inheritance as the instrument because, they reason, it does affect health but does not directly affect health nor is it affected by health. They do not find a significant effect from wealth on health by using inheritance as the instrument variable. They conclude that short run changes in wealth do not affect health. They do however note: "This finding does not rule out the possibility of a long-term impact of wealth on health" (Meer et al., 2003, p. 729). Kim and Ruhm (2012) also use inheritance as exogenous wealth shocks and also find no significant effect on health. Au and Johnston (2015) even find that wealth shocks in the form of inheritance might even increase obesity in women. As obesity is an indicator or not so good health, this result is surprising as it contradicts the positive correlation between wealth and health.

Apouey and Clark (2015) also find small or negligible effects on general health using lottery winnings and inheritance as instruments. They do however find that lottery winnings do produce better mental health but also increase

smoking and social drinking. They note that "health is not a holistic concept, and we need to both be clear about what kind of health we are talking about and be ready for the possibility that different types of health behave in very different ways" (p. 536).

It could however be argued that inheritance might not be a good instrument to find a causal effect in this case. Most people will know whether or not they will inherit something. Because people know they will inherit something it will not come as a truly exogenous wealth shock. They will make their decisions prior to receiving the inheritance with the inheritance in mind, therefore it could have an effect on health before the inheritance is inherited . Since winning the lottery is less predictable, lottery winnings might be a better instrument in this case.

Michaud and Soest (2008) also find no causal effects of wealth on health. They use a dynamic panel data model to test for the causality. As they note in their conclusion, the data they use consists only of elderly couples. They suggest that there might be a causal effect in different age groups and that it would be interesting to see if there are differences between countries to see if institutions have an impact on the possible causal relationship.

There are studies that do find a significant causal effect of wealth on health. Cai (2009) for example, she focuses on health transitions instead of health status itself to avoid the endogeneity of wealth and health. She finds that wealthy people are less likely of transitioning from healthy to unhealthy compared to people in the lower end of the wealth distribution. This, she argues, is evidence that there might be a causal effect of wealth on health. She proposes four different explanations of the causal effect of wealth on health. Firstly, because the study focuses on people in Australia malnutrition might not be an issue but eating less healthy food is associated with people with less economic recourses. Secondly, people with more wealth may live in better and healthier environments. Thirdly, even in a country with universal health care system such as Australia, wealthier people might still receive more health services that less wealthy people. Finally, wealth could give people more freedom in making decisions, thus experiencing less chronic stress which leads to poor health. So there are several ways in which wealth could exert an effect on health. Testing via which effect wealth does affect health was out of the scope of her paper.

Keese and Schmitz (2014) find a significant causal effect between indebtedness and worse physical and mental health. They control for the unobserved heterogeneity between health and indebtedness by using fixed-effects methods and also a subsample of constantly employed individuals plus lagged debt variables. By using those methods they reduce the problem of the endogeneity. Although they do not search for a causal relationship between wealth and health, debt is part of net wealth which is the interest of this paper.

3 Institutional section

As Michaud and Soest (2008) pointed out, institutions of different countries might have an impact on the relationship between wealth and health. Since the

data consists of respondents from the Netherlands it is important to look at what impact Dutch institutions might have on the relationship between health and wealth. There are two subjects of interest here: the obligated health insurance, the paying of salary for a sick person with and without a permanent contract.

In the Netherlands, every Dutch citizen is obligated to have a health insurance. There is a basic insurance and more expensive insurances which will cover more. With the basic insurance all visits to the family physician are covered and if you are treated with a referral from the family physician most of the treatments are covered as well. There also is a mandatory yearly deductible which is set at a minimum of 385 (Eigen risico. Wat is het en waarom betaalt u het? - Zilveren Kruis, 2009) and a maximum of 885. The person who buys the insurance can set his own deductible somewhere between those values and it can be argued that the rational individual who has poor health will always set their deductible as low as possible. Someone can also receive a "zorgtoeslag", a benefit to pay your health insurance, if you are eligible. Therefore, everyone has, and can afford, an health insurance.

The other point of interest is the paying of salary when you are sick. If someone is sick and has a permanent contract he gets payed at least 70% of their salary in the first year. If 70% of the salary is below the minimum loan, they get payed at least the minimum loan. The second the person still gets paid 70% of their salary but in the second year it can be less than minimum loan. If the person does receive less than the minimum loan in the second year he can apply for a benefit which makes the total income equal to the minimum year. (UWV, n.d.) When a person without a permanent contract gets sick, salary will continue to be paid for the duration of the contract. When someone is still sick when the contracts ends, he or she can possibly get a benefit (Het Juridisch Loket, n.d.). Therefore, someone who has an income from working but is unable to keep working due to poor health will keep roughly the same income.

Since every Dutch person will have an insurance, a causal effect from health to wealth is less likely in the Netherlands than in other countries where not everyone has a health insurance. The reason for that is the fact that the negative health shocks caused by treatment of a disease or hospital care are being paid by the insurance. Therefore the negative wealth shock of for example hospital treatment is almost non-existent.

Also, because an income is not lost when a person is unable to work due to health problems a causal effect from health to wealth is less likely to exists in the Netherlands. Because someone keep an income when they are unable to work due to poor health, wealth is less likely to be impacted by bad health in the longer run. Also because the height of the benefit depends on the income before a person gets sick, people do not only keep an income but also an income which is in line with their income before becoming sick.

Hurd and Kapteyn (2005) also point there are "generous income maintenance provisions [that] aim to mitigate any adverse effect of health related earnings interruptions" (Hurd & Kapteyn, 2005, p. 311) in the Netherlands. They add to this that since healthcare is basically universal, the explanation that different access to healthcare is due to differences in wealth or income is of

limited importance.

4 Data

Data The data consists of different (yearly) waves from the DHS. The data is collected every year by the CentERdata. The DHS consists of six questionnaires, General Information on the Household, Household and Work, Accommodation and Mortgages, Health and Income, Assets and Liabilities and Economic and Psychological Concepts. ("DHS data access | CentERdata.nl," n.d.) Besides the questionnaire data, the CentERdata also provides two aggregated data files, the aggregated income data and the aggregated wealth data. This paper will only use the Health and Income questionnaire which includes the self-rated health variable and the aggregated wealth data. The aggregated wealth data is made up from different questionnaires and consists of all the assets and liabilities someone might have.

The health variable is a categorical variable with two options, either healthy or not healthy. The data received from the DHS has five categories for health: poor, not so good, fair, good and excellent. People were placed in one of these categories by self assessment. Self assessed health is a good predictor for mortality (Idler Benyamini, 1997). which is a good indicator for health. Individuals who considered themselves to be in poor or not so good health are placed in the not healthy category. The persons that consider themselves to be in fair, good or excellent health will be placed in the healthy category.

To check if there is a correlation between wealth and health, a wealth variable was created. For wealth, this paper uses the net wealth of a person. Someone might well own a nice car and a house, but if he has a loan for the car and two mortgages on the house, he might still have a negative net wealth. To calculate the net wealth, all the assets of a person have been added together and the liabilities have been subtracted from the assets. The questionnaires are quite detailed on wealth which is important as was pointed out by Pollack et al. (2007).

The assets and liabilities that could be found in the aggregated wealth data and of which the net worth variable consists of can be seen in table 1.

This paper uses the waves from 2007, 2013 and 2017. As is clearly visible in figure 1, the housing prices peaked somewhere in 2008. Because the data is collected throughout the whole year it makes sense to take 2007 as the pre treatment year. Because the financial crisis hit in September 2008 it might have affected some observations while others not. 2013 is the year when the housing prices were at the lowest in the Netherlands. If wealth would cause short-term changes in health, it should be visible in the regression 2007 – 2013 and 2013 - 2017. So in the first case, 2007 is the pre treatment year and 2013 the post-treatment year. In the second case, 2013 is the pre-treatment year and 2017 the post-treatment year. Because this paper is interested in the effect of the

Assets	Liabilities
checking accounts	private loans
employer-sponsored savings plans	extended lines of credit
savings or deposits not mentioned earlier	outstanding debts
deposit books	finance debts
savings certificates	loans from family or friends
single-premium annuity insurance policies	study loans
savings or endowment insurance policies	credit card debts
growth funds	loans not mentioned before
mutual funds and/or mutual fund accounts negative balance	checking accounts with
bonds and/or mortgage bonds	
stocks and shares	
put options bought	
put options written	
call options bought	
call options written	
pieces of real estate, not being used for own accommodations	
value of life insurance mortgage real estate	
cars	
motorbikes	
boats	
(site-)caravans/trailers	
money lent out to family or friends	
savings or investments not mentioned before	
stocks from substantial holding	
business equity(professions)	
business equity self-employed	

Table 1: Assets and liabilities of net worth

Year	size treatment group	size control group	Total observations
2007	835 (46.14%)	974 (53.84%)	1809
2013	807 (48.94%)	842 (51.06%)	1649
2017	1161 (52.42%)	1054 (47.58%)	2215

Table 2: distribution of individuals in the control and treatment group

Variable	Treatment group	2007	2013	2017
Health	Yes	0.97	0.96	0.96
		(0.18)	(0.20)	(0.18)
	No	0.95	0.95	0.92
		(0.22)	(0.22)	(0.27)
Net worth	Yes	275,271	256,521	263,053
		(329,037)	(249,175)	(91,215)
	No	25,400	28,933	31,530
		(75,946)	(291,670)	(102,177)

Table 3: Summary statistics 2007, 2013, 2017

difference in housing prices, housing prices of single years will be used instead of averages. When for example the average housing prices of 2004 until 2007 will be used and the average housing prices of 2009 until 2013, the difference between the two averages will almost completely be canceled out against each other. This will make the effect of the change in housing prices less noticeable on the net wealth.

Table two shows the number of observations per year and the size of the treatment group, consisting of home-owners and the control group, consisting of tenants. In all the three years the ratio of treatment group to control group is rather consistent and lies around 1:1.

Table three shows the summary statistics of respectively 2007, 2013 and 2017. In all of the three years both the control and treatment group have a fairly high chance of being healthy but the treatment group has a slightly higher chance of being healthy. In the treatment group of 2007, 97% of the people are healthy, in 2013 and 2017 that is 96%. In the control group 95% of the people observed are healthy in 2007 and 2013 and 92% of the people are healthy in 2017. Since the means of the health of both groups are within range of the standard deviations, it can be noted that there is no significant difference between health in the treatment and control group in any of the years. This is important as it indicates that the characteristics across the different treatment groups should be successfully balanced.

The average net worth of the treatment group decreases between 2007 and 2013 and then increases between 2013 and 2017. The average net worth of control group increases between 2007 and 2013 and also between 2013 and 2017. Since the house prices also decrease between 2007 and 2013 and increase between 2013 and 2017 this indicates that the average net worth of home owners does

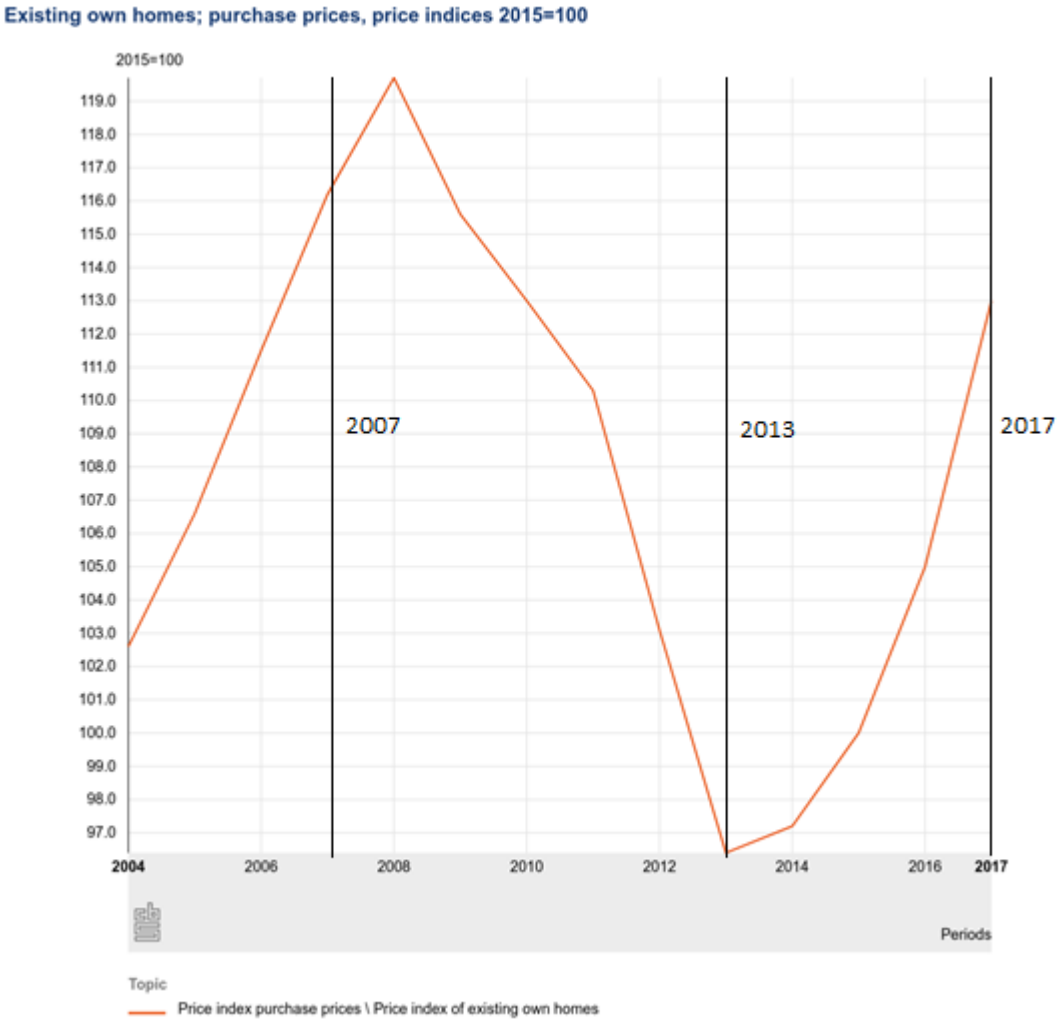

Figure 1: Caption

behave in line with the housing prices while the net worth of the tenants does not, as was expected.

5 Methods

First this paper will use a simple ordinary least squares (OLS) regression. In this OLS regression health will be the dependent variable and wealth will be the independent variable. Health is defined as a categorical variable where someone can be either healthy, with value 1, or unhealthy, with a value of 0. Wealth is the net worth of a person as shown above.

Secondly, this paper uses a difference in difference (DD) analysis to look for a causal effect from wealth to health. Health is defined in the same way as in the OLS regression. A DD analysis is a quasi-experimental design with a treatment group, a control group and a treatment. A DD analysis is used to estimate the effect of a treatment by comparing the differences in the outcomes between before and after the treatment between the treatment and the control group.

The treatment group, control group and the treatment itself will be defined as follows. The treatment this paper uses is the financial crisis of 2008 in which housing prices dropped suddenly and sharply as is visible in figure 1. Another treatment that will be used is the bounce-back of the housing prices after the financial crisis which started in 2013. It can be assumed that the health of people did not directly cause the financial crisis, or that health was directly affected by the crisis. The treatment group consists of people who own one or more houses and the control group consists of people who rent a house. Although the net worth of tenants might also have been impacted in the years after the financial crisis, the home owners are exposed more to a wealth shock due to the change in housing prices. Therefore the net wealth of the control group should be affected less than the net wealth of the treatment group by the changes in the housing prices.

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Regressions will be done on two different groups of observations, one group will consist of all observations and the second group will consist only on the

same persons observed before and after the treatment. There is a difference in those groups because even though the survey tries to get the same people every year to fill it out, it does of course not have a perfect return rate of the respondents. Because the characteristics should be equally distributed between the control and treatment group, as was noted above, and the participants of the survey randomly selected, observed persons before and after the treatment do not necessarily need to be the same persons. Also, because the first group is bigger, the estimations should be better. For certainty, the second group is added which should show the same results as the first group.

The following regression model will be used for the difference in difference analysis:

$$Health_{it} = \beta_0 + \beta_1 * Time_t + \beta_2 * Treated_i + \beta_3 * Time * Treated + \epsilon_{it} \quad (1)$$

Where Time is the time trend in the control group, Treated is the difference between the two groups pre-intervention and Time * Diff is the difference in change over time. If the Time * Diff coefficient is statistically different from zero, there is an effect from the treatment on the dependent variable. The coefficients will be estimated with an OLS regression.

Therefore the hypotheses are:

$$H_0 : \beta_3 = 0 \quad (2)$$

$$H_a : \beta_3 \neq 0 \quad (3)$$

More specifically, β_3 is expected to be smaller than zero in the 2007 – 2013 regression since the housing prices decreased in this period and the health of the treatment group should therefore decrease more than the health of the control group. β_3 is expected to be greater than 0 in the 2013 – 2017 regression since the housing prices increased in this period and the health of the treatment group should therefore have increased more than the health of the control group.

To show that the difference in difference analysis will give the desired causal effect, let Y_{1igt} be the health of person i, in group g at period t if the person owns a house. Also, let Y_{0igt} be the health of person i in group g at period t if the person is a tenant. Here the group g is either the treatment group, i.e., home-owners (1) or the control group, i.e., tenants(0) and the period i is either before (0) or after the treatment (1).

Assume that:

$$Y_{0i} = E[Y_i, g, t] = \gamma_g + \lambda_t \quad (4)$$

Equation 4 tells us that in absence of the sudden changes in housing prices caused by the financial crisis, the health of a person is equal to the sum of a time-invariant group effect (Y_g) and a time effect that is the same in both the groups (λ_t).

Let D_{it} be a dummy for the interaction between home-owners and the period. Therefore it is only one when the group is home owners and the period is post-treatment. In the other three cases, D_{it} is zero. Observed health, Y_{igt}, can then be written as:

$$Y_{igt} = \gamma_g + \lambda_t + \delta D_{it} + \epsilon_{igt} \tag{5}$$

if it is assumed that $\mathrm{E}[\mathrm{Y}_{1igt} - Y_0 igt \mid g, t] = \delta$, a constant. In equation (5), we get $\mathrm{E}[\epsilon_{igt} \mid g, t] = 0$. Therefore we get:

$$E[Y_{igt} \mid g = TE, t = post] - E[Y_{igt} \mid g = TE, t = pre] = \lambda_{post} - \lambda_{pre} \tag{6}$$

and

$$E[Y_{igt} \mid g = HO, t = post] - E[Y_{igt} \mid g = HO, t = pre] = \lambda_{post} = \lambda_{pre} + \delta \tag{7}$$

Therefore, the population difference in differences is:

$$\begin{aligned}(E[Y_{igt} \mid g = HO, t = post] - E[Y_{igt} \mid g = HO, t = pre])- \\ (E[Y_{igt} \mid g = TE, t = post] - E[Y_{igt} \mid g = TE, t = pre]) = \delta\end{aligned} \tag{8}$$

Here δ is the causal effect of interest which is estimated through the model described in equation (1). The parameters in the model of equation (1) can be seen in the light of the model described in equation (5) in the following way:

$$\beta_0 = E[Y_{igt} \mid g = TE, t = pre] = \gamma_{TE} + \lambda_{pre} \tag{9}$$

So β_0 is the sum of the time invariant group effect of the tenants and the time effect of the pre-treatment period. therefore it is the average health of the control group in the pre-treatment period.

$$\beta_1 = E[Y_{igt} \mid g = TE, t = post] - E[Y_{igt} \mid g = TE, t = pre] = \lambda_{post} - \lambda_{pre} \tag{10}$$

β_1 is the time effect of tenants group post treatment minus the time effect of the tenants post treatment. That is equal to the difference in the average health before and after the treatment.

$$\beta_2 = E[Y_{igt} \mid g = HO, t = pre] - E[Y_{igt} \mid g = TE, t = pre] = \gamma_{HO} - \gamma_{TE} \tag{11}$$

Therefore β_2 is the difference in the time invariant group effect between the home owners and tenants before the treatment. That is the same as to say the difference in average health before the treatment between the two groups.

$$\begin{aligned}(E[Y_{igt} \mid g = HO, t = post] - E[Y_{igt} \mid g = HO, t = pre])- \\ (E[Y_{igt} \mid g = TE, t = post] - E[Y_{igt} \mid g = TE, t = pre])\end{aligned} \tag{12}$$

So this is the difference in differences between average health before and after the treatment of the home owners and the tenants.

Because characteristics could differ and therefore explain some of the variation in health in the first group (i.e. all the observations) an extra regression on that group will be run which includes some extra variables. The extra variables are net income, education and gender because they can all be assumed to have an effect on health. This is not necessary in the second group because these differences should cancel out between the pre-treatment and post-treatment periods. Because the extra variables are received from other surveys which are linked to the existing observations there are less observations when running this regression. This is because not everyone answers all the questions or surveys. The regression model will then look like this:

$$Health_{it} = \beta_0 + \beta_1 * Time_t + \beta_2 * Treated_i + \beta_3 * (Time * Treated) + X_i + \epsilon_{it} \quad (13)$$

Where X_i represents the extra coefficients. Net income is the net income reported by the data set in the aggregated income dataset. Gender is a dummy variable where 1 represents male and 0 represent female. Education is also a dummy variable where 1 represents highly educated and 0 not highly educated. Highly educated are people who have finished an education at the HBO lever or university.

To control for unobserved heterogeneity caused by time invariant characteristics (gender for example) in the same persons group, a fixed effects model is used. By using the fixed effect model, the time invariant characteristics of an individual that influence health are controlled for and therefore this model might produce better estimates. The model here is:

$$Health_{it} = \beta_0 + \beta_1 * time_t + \beta_2 * Treated_i + \beta_3 * (Time * Treated) + \alpha_i + \epsilon_{it} \quad (14)$$

Where α_i is the individuals intercept. This will cancel out in the fixed effects model regression, therefore reducing the error term.

6 Results

6.1 Basic OLS results

A simple OLS regression was conducted first to check whether or not there exists a correlation between health and health in this dataset. With the simple model:

$$Health_i = \beta_0 + \beta_1 * NetWorth_i + \epsilon_i \quad (15)$$

The results of this regression can be seen in table 4. A significant (p ¡ 5%) positive correlation between health and wealth was found as expected. Because health was defined as either healthy of unhealthy the regression tells us something about the chance of being healthy. According to the results a 1000 increase in net wealth corresponds with an increase of $3.77e^{-3}$percentage points to the chance of being healthy. Note that this correlation does not say anything about a possible causal effect.

VARIABLES	Health
Net Wealth	$3.77e^{-08}$**
	$(1.49e^{-08})$
Constant	0.943***
	(0.00416)
Observations	3,864
R-squared	0.002

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: OLS results

6.2 Difference in Differences Analysis

As pointed out before in this paper, endogeneity is a problem when considering the causality the effect of wealth on health. A number of DD analysis have been done to try to find a causal effect in the short-term and the mid-term of wealth on health. The first analyses the short term effects of wealth on health. It uses the waves from 2007 and 2013. The second analysis also analyses the short-term effect by using the 2013 and 2017 waves. The variable of interest is DID. If this variable is significant there is a significant difference in differences and therefore implies a causal effect from wealth to health.

The results from the analyses on the first group, i.e. all the observations, can be seen in table 5. The 2007 – 2013 regression does not have a significant DID. The 2013 – 2017 regression does have a significant (p ¡ 5%) DID coefficient.

In the 2013 – 2017 analysis the time coefficient is -0.0291 which means that between 2013 and 2017 the average health of the tenants decreased by 2.9 percentage points. The DID is 0.0347 which means that the average health of the home owners increased 3.5 percentage points more than the average health of the tenants. The treated coefficient is insignificant indicating that at 2013, the average health of tenants and home owners was not significantly different.

When controlling for the other variables the significance of the DID coefficients that was significant disappears. Net income is however significant (p ¡ 1%) which could imply that the variation in health is caused by net income rather than the change in housing prices caused by the financial crisis. Because the DID coefficient is insignificant in both years, this implies that there is no causal relationship between wealth and health in this group.

The results from the regressions in the second group, so only observations of the same persons pre and post treatment, can be seen in table 6. There are no significant results for the DID variable. Therefore, there is no evidence that there is a causal effect from wealth on health in this group. Even though the error term is smaller in the results of the fixed effects model, they DID coefficient is still not significant.

	2007 - 2013	2013 - 2017	2007 - 2013	2013 - 2017
VARIABLES	health	health	health	health
Time	0.0026	-0.0291***	0.0054	-0.0173
	(0.0096)	(0.0101)	(0.0110)	(0.0113)
Treated	0.0190**	0.0078	0.0173	0.0028
	(0.0096)	(0.0108)	(0.0116)	(0.0123)
DID	-0.0112	0.0347**	-0.0123	0.0234
	(0.0139)	(0.0143)	(0.0155)	(0.0155)
Gender			-0.0124	-0.0110
			(0.0088)	(0.0085)
Education			0.0044	0.0070
			(0.0084)	(0.0082)
Net Income			0.0000**	0.0000***
			(0.0000)	(0.0000)
Constant	0.9487***	0.9513***	0.9426***	0.9450***
	(0.0065)	(0.0076)	(0.0087)	(0.0097)
Observations	3,458	3,864	2,586	2,671
R-squared	0.0013	0.0060	0.0046	0.0085

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Difference in Differences results of the all observations group

	without fixed effects		with fixed effects	
	2007 - 2013	2013 - 2017	2007-2013	2013-2017
VARIABLES	health	health	health	health
DID	-0.0104	0.0167	-0.0204	0.00884
	(0.0197)	(0.0199)	(0.0163)	(0.0149)
time	-0.0130	-0.0155	-0.00803	-0.0102
	(0.0144)	(0.0151)	(0.0116)	(0.0112)
treated	0.0205	0.0243*	0.0441	0.0119
	(0.0139)	(0.0139)	(0.0276)	(0.0258)
Constant	0.9595***	0.9410***	0.947***	0.948***
	(0.0101)	(0.0103)	(0.0153)	(0.0150)
Observations	1,540	1,886	1,540	1,886
persons			770	943
R-squared	0.0040	0.0061	0.011	0.001

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.

Table 6: Difference in Differences results of the same persons group

7 Robustness tests

To test whether the results are valid, several robustness tests have been run. First there is a pre treatment tests to test that the health of the control and treatment group behaved in the same way before the treatment, i.e. to test whether the parallel trends assumption of the difference in difference analysis holds. Secondly, a test has been run to check whether the treatment had the desired effect on the wealth as was assumed, i.e. the net wealth of people with a house reacted in a significantly different way to the change in housing prices than the net wealth of people who rented a house. Thirdly, three tests have been run to see whether or not the characteristics of the group with all observations have changed between before and after the treatment. This is important to tell whether the effects found in the DD analysis of the first group is solely accountable to the wealth difference or that maybe other changes may have played a part.

The way the average health behaves can also be visually inspected. Figure 2 shows the fitted lines of average health throughout the years 1995 to 2006. One assumption of the difference in differences analysis is that the average health of the control and treatment group behave exactly the same and therefore the lines should be parallel (the parallel lines assumption). Otherwise there will be a difference in the differences by simply dividing the observations in different groups. In figure 2 it can be seen that the lines are not perfectly parallel. They do however act in the same way, they are both descending. To test the severity of the violation of the assumption, an DD analysis with a placebo intervention is run to see if the health of both groups differ significantly.

The results of the DD analysis with the placebo intervention can be seen in table 7. Here the pre treatment and post treatment years are respectively 2001 and 2006. The DID coefficient is insignificant which implies that although the lines do not behave in exactly the same way, they do not produce a significant difference. Therefore, even though the parallel lines assumption is not perfectly met, the results are still use able but not as robust as possible.

The results of the mechanism test can be seen in table 8. This test tests whether or not the mechanism had the desired effect on the net wealth. This was also done using a DD analysis but this time with the net worth of a person as the dependent variable. If the financial crisis and the bounce-back had the expected effect on the net worth of both the groups, i.e. more an effect on the net worth of the home owners than the tenants, the DID coefficient should be significant. Also, the DID coefficient should then be negative in the 2007-2013 regression and positive in the 2013-2017 regression.

As can be seen in table 8, in the all-observations group, the DID coefficient is not significant in both periods. this implies that in the all-observations group the treatment did not have the desired effect, i.e., the net wealth of people in the treatment group did not change in a significantly different way than the net wealth of the people in the control group. The coefficients are however correct in them being respectively negative and positive. Since the treatment did not have the desired effect, the results of the all-observations group do not tell us

-1.png -1.png

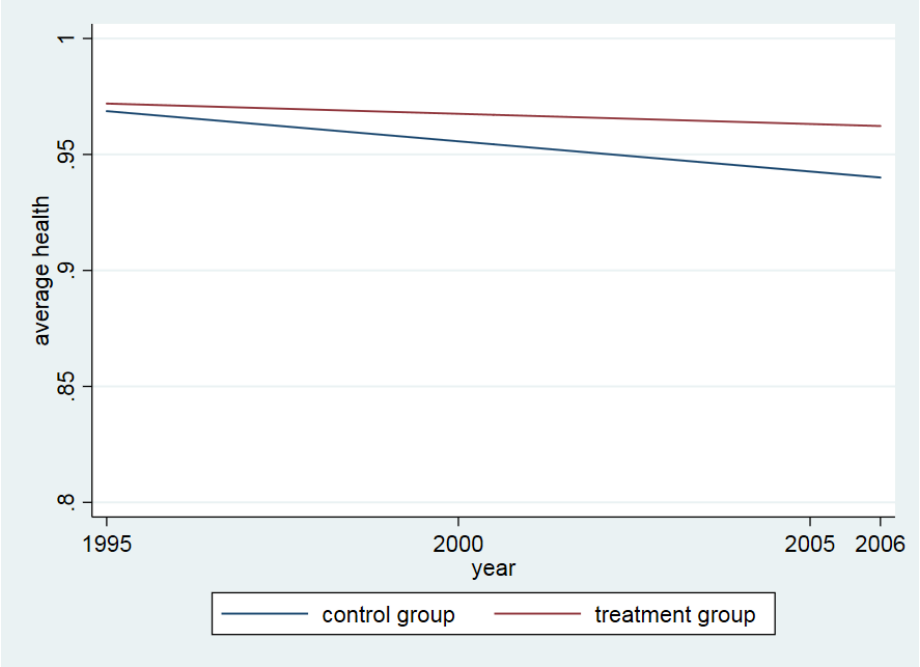

Figure 2: Fitted lines through the average health of the control and treatment group

	2001 - 2006
VARIABLES	Health
time	-0.0182**
	(0.0090)
treated	0.0139
	(0.0102)
DID	0.0061
	(0.0138)
Constant	0.9586***
	(0.0064)
Observations	3,610
R-squared	0.0030

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: Results of the placebo intervention

	All observations		same persons		Same persons with fixed effects	
	2007 - 2013	2013 - 2017	2007 - 2013	2013 - 2017	2007-2013	2013-2017
VARIABLES	netWorth	netWorth	netWorth	netWorth	netWorth	netWorth
DID	-22,284	3,935	-48,247**	25,871	-43,975***	24,245**
	(14,351)	(13,528)	(20,640)	(19,906)	(15,888)	(9,486)
time	3,533	2,597	4,732	-821	4,551	5,274
	(9,902)	(9,606)	(15,015)	(15,110)	(11,331)	(7,131)
treated	249,872***	227,588***	263,253***	243,262***	154,356***	142,737***
	(9,924)	(10,238)	(14,578)	(13,963)	(26,907)	(16,409)
Constant	25,400***	28,933***	25,004**	37,328***	81,574***	92,654***
	(6,743)	(7,162)	(10,507)	(10,359)	(14,969)	(9,571)
Observations	3,458	3,864	1,540	1,886	1,540	1,886
persons			770	943	770	943
R-squared	0.2442	0.2346	0.2619	0.2628	0.048	0.127

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8: Results of the mechanism test

whether wealth does or does not have a significant effect on health.

In the same persons group however, the DID coefficient is significant in the 2007 – 2013 regression without fixed effects and in both the regressions with fixed effects. Since the fixed effects should only increase the accuracy of the estimates, it can be concluded that in the same persons group the financial crisis, the treatment, did have the desired effect on the net wealth on home owners and home renters.

The results of the tests testing whether the characteristics have changed in the "all observations group" can be seen in table 9. Table 9 shows respectively the changes in gender, education and net income. One of the assumptions is that because the treatment should only affect the difference between the control and treatment group, i.e. owning a house or not in this case, the other differences should cancel out before and after the treatment. For this assumption to hold, the DID coefficients need to be insignificant because otherwise health might be explained partly by one or more of the changed characteristics. Because characteristics have remained the same in the group with only observations of repeated repliers, this could only form a problem in the all observations group.

Table 9 shows that there is a significant difference in differences in gender between the control and treatment group in 2013-2017 (p¡10%). Between 2013 and 2017 the percentage of females in the treatment group dropped by 6.4 percentage points more than in the control group. This implies that the effects measured in 2013 – 2017 regressions on health could be explained by gender instead of wealth as was the idea. The other two tested characteristics, education

	2007 - 2013	2013 -2017	2007 - 2013	2013 - 2017	2007 -2013	2013 - 2017
VARIABLES	gender	gender	education	education	net income	net income
time	0.0133	-0.0008	0.0807***	-0.0678**	2,964 ***	-31.3424
	-0.0254	-0.0265	-0.0268	-0.0277	-752	-872
treated	0.3971***	0.3919***	0.2010***	0.1619***	14,764 ***	13,736 ***
	-0.0244	-0.0269	-0.0257	-0.0281	-721	-885
DID	-0.0052	-0.0644*	-0.0392	0.0111	-1,028	1,431
	-0.036	-0.0362	-0.038	-0.0379	-1,065	-1,193
Constant	0.3576***	0.3709***	0.2749***	0.3556***	13,641 ***	16,605 ***
	-0.0171	-0.0192	-0.018	-0.02	-505	-631
Observations	2,586	2,671	2,586	2,671	2,586	2,671
R-squared	0.1584	0.129	0.0395	0.0317	0.2255	0.1855

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9: Results of the characteristics test

and net income, did not significantly change. So the only characteristic that changed significantly is gender in the period of 2013 – 2017. Therefore, some of the variation of the difference in health in the period 2013 – 2017 between the control group and treatment group might be explained by the change in the male to female ratio.

8 Conclusion

This paper used a difference in difference analysis to try and find a causal relationship from wealth to health in the Netherlands. The treatment was the change in housing prices caused by the financial crisis and the subsequent bounce back of the housing prices. Regressions have been done on two groups, one with all observations available and one that only consisted of repeated observed individuals.

In the first group the robustness tests showed that the mechanism did not have the desired effect, i.e., the net wealth of the control and treatment did not react significantly different to the change in housing prices caused by the financial crisis. Therefore, the difference in difference analysis in this group do not give us correct information of whether or not a causal relationship from wealth to health exists.

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9 Discussion

As was pointed out in the introduction, the relationship between wealth and health has three possible directions, wealth could affect health, health could affect wealth and another factor could affect health and wealth in the same direction. As was pointed out in the constitutional section, the effect from health to wealth is not likely to hold in the Netherlands. Since this paper found evidence that the effect from wealth to health is also insignificant, the third option, another factor that affects health and wealth in the same way seems the most likely in the Netherlands. Research should be done to confirm if this is the case.

There are some factors that might have influence on the results of this paper that were out of the scope of the paper to control for. Firstly, the sample used was rather small, especially in the same persons group. This might have increased the error and made the estimates less accurate. Research has a bigger sample might find different results.

Secondly, other factors might have impacted health of the control and treatment group differently between the pre- and posttreatment years. One thing that might have had this effect is the lowering of the mortgage interest deduction between 2013 and 2017 (HomeFinance BV, n.d.) . This may have lowered the income of the of the treatment group and not the control group because the treatment group owns a house and is therefore more likely to have a mortgage. The lowering of the mortgage interest deduction caused a lower net income of the individuals who had a mortgage. This could have caused a worse health, therefore reducing the estimated effect of wealth on health in the 2013 – 2017 analysis.

Another possibility that might have affected the results is that the treatment might have caused some individuals to change from the control to treatment group or vice versa. This could be controlled for in other research. This does however pose less a threat in the short run which this paper analyzed than in the longer run. When this is controlled for, research could be done to investigate whether or not there is a causal effect from wealth to health in the mid to long run.

10 Literature

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