In better and worse

In sickness and health

In stable and unstable financial times?

The effect of a change in household income on the probability of divorce

Master Economics of Management and Organisation

Master thesis

Abstract

This research tries to measure the effect of a household income shock on the probability of divorce, using data from the annual LISS panel. A linear probability model and a cox proportional hazard model are used to measure this effect. The results of the linear probability model suggest that having experienced a household income shock of at least 10 percent increases the likelihood of being divorced. A negative household income shock has the strongest positive effect on the probability of being divorced. This relationship becomes stronger as the threshold increases. The results of the cox proportional hazard analyses showed that there are 2.5 times more divorced individuals that have experienced a household income shock of at least 10 percent relative to not divorced individuals. There are 9.6 times more divorced individuals that experienced a negative household income shock of at least 50 percent relative to not divorced individuals. Implying that the probability of divorce, when experiencing such a household income shock, increases with 4.24%. The results also showed that a longer duration of marriage increases the probability of divorce if someone experienced a household income shock.

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1. INTRODUCTION

Marriage, for some people the most important thing and for others a big liability. Spouses promise each other to stay together in sickness and in health, to love and cherish each other. Will they also keep their promise in unstable financial situations?

The economic crisis of 2008 caused a lot of financial troubles. Not only companies and governments were victim, households also felt the effects of the crisis. People lost their job and the purchasing power went down due to a decrease in household income. This could led to problems in marriages, but could it also lead to a divorce? The number of divorces in the Netherlands is increasing since 2008 (CBS, 2015)[1]. This trend is not only present in the Netherlands but also in European countries like Spain, Italy and Germany and in the United States of America (CDC, 2016)[2].

For most people, marriage and getting married is an important event in their life. It makes them more satisfied with life and it increases their over-all well-being. People that decide to get married are happier than compared to people that decide to stay single or unmarried. Married individuals are easier satisfied with their life compared to the unmarried life they had and are on average healthier (Stutzer and Frey, 2006). Divorce is with marriage also an important event in one's life. People see divorce as a life changing moment and need time to processed the fact of being divorced (Zwimmermann and Easterlin, 2006).

Since the divorce rate is increasing over time, academic researches pay also attention on investigating the causes and the effects of a divorce. There is a huge body of literature that focuses on the effects of a divorce. For instance, Cherlin (1991) conducted a longitudinal study that measured the effect of divorce on children in Great Britain and the United States. Chase- Landsdale (2008) investigated the effect of a divorce on the mental health of young adults and Grossbard-Shechtman (1993) looked at the effect of divorce on labour participation. The literature that investigates the causes of divorces is small compared to the literature that investigates the effect of a divorce.

Becker (1974) introduced a theoretical model that explained that changes in personal characteristics, like income, can lead to divorce due to positive assortative mating. Weiss and Willis (1997) investigated the role of surprises in marital dissolution. Surprises consists of changes in the predicted earnings capacity of either spouse. They found that unexpected changes in earning capacity strongly influence the probability of divorce. In line with those findings Milosch (2014) and Becker, Landes and Micheal (1977) find that decreases in predicted permanent income increases the probability of divorce.

[1] Appendix – Graph A
[2] Appendix – Graph B

Compared to these studies I do not predict permanent income or earning capacity. I make use of data that reports yearly household income. Doing this allows me to investigate whether economic outcomes can influence divorce decisions. More specific, in addition to previous studies, I try to answer the following research question:

What is the effect of a change in household income on the probability of divorce?

In order to answer this research question I used data of the Longitudinal Internet Studies for the Social Sciences Panel (LISS panel forwards). It consists on average of 5000 households, comprising 8000 individuals. The panel consists of questions about lifestyle, personality, religion, income, work, family, education and immigration. I used data from 2009 to 2015. This dataset allows me to measure the effect of household income shocks on the probability of divorce.

There are two research methods used to find this effect. The first research method is a linear probability model. It measures the relationship between an experienced household income shock and being divorced. I include demographic control variables that might have an influence on the relationship between a dependent and independent variable. The results show that experiencing a household income shock of at least 10 percent increases the likelihood of being divorced. Experiencing negative household income shocks has the strongest positive effect on the likelihood of being divorced. There is no significant relationship between experiencing a positive income shock and the probability of divorce. The robustness check, where a household income shock is defined as an increase or decrease of the household income with at least 30 percent relative to one year before, shows the same results.

The second research method consist of a survival analysis that estimates the effect of an income shock on the probability of divorce. I use a Cox Proportional Hazard Model. The key advantage of using the Cox Proportional Hazard Model is that the explanatory variables may be time-varying. This implies that using this research method allows me to know whether the duration of marriage has an effect on the probability of being divorce. For example it allows me to know whether someone who experienced a household income shock and is married for five years has a higher probability of being divorced compared to someone who is married for three year. The results of the analysis show that a marriage with a longer duration has a higher probability of divorce given that an household income shock is experienced. The results of the Cox Proportional Hazard Model show that the hazard ratio is significant positive for a household income shock of 10 percent. This implies that there are more divorced individuals that experienced a household income shock than not divorced individuals. The probability of divorce increases with 0.661% when one experienced a household income shock. The highest significant hazard ratio is reported for a negative income shock of least 50 percent. There are 9.65

times more divorced individuals that experienced a negative household income shock of at least 50 percent than not divorced individuals. The probability of being divorced increases to 4.24%.

Both research models showed that the relationship between a household income shock and the probability of being divorced is positive. Implying that experiencing a household income shock might increase the probability of divorce. Experiencing a negative household income shock has the strongest positive effect on the probability of divorce.

Although I investigate whether changes in income influences the probability of divorce, it is important to note that there might be reversed causal relationship. People that get divorced have on average a worse health and are less satisfied. This could lead to productivity problems at work. If those problems are great enough this will lead to a decline in income.

In the remainder of this paper a theoretical model is presented and previous studies are discussed. I carefully explain the data and the empirical strategy. From the results of the analyses I discuss the findings and interpretations. I end with a conclusion and some final comments.

2. THEORETICAL ANALYSIS

Following Becker, Landes and Micheal (1977) and Weiss and Willis (1997), I will present a simply theoretic model that emphasizes the roll of uncertainty about marriage and economic outcome in the process of divorce.

The analysis starts with assuming that each person in a household maximizes his or hers full wealth. Full wealth does not equal money wealth alone but also takes account of nonmarket products like happiness or health. Marriage is a voluntary partnership, formed to allows the coordination of consumption and production activities, like the production of children and the production of staying together. The expected gains from marriage depend on the traits of each spouse. Assuming that there is an efficient market, the interaction between personal characteristics such as, education, height, intelligence, physical attractiveness, etc. induces assortative mating. With assortative mating is meant that people will attract other people with the same characteristics. A high-quality person will be matched with high-quality person and a low-quality person will be matched with a low-quality person. This is also called positive assortative mating(Becker, 1974). At the time of marriage, the two spouses have only limited information on the determinants of the gains from marriage. As time passes, new information on the success of their commitment and on the alternative option of each partner is revealed. The couple decides whether to dissolve the commitment or the continue the marriage. Divorce occurs when the gain of the outside option exceeds the gain of staying married.

The gain from marriage can be specified with the aid of a household production function. The household production in each period depends on the characteristics of the two persons like education level, family background or income. But also on the quality of their match (which is usually unobserved) and the accumulation of marital capital like, children and common property. Each partner has alternatives outside their particular marriage, as a single person. The value of being single state includes the option value of becoming remarried. Assume that the value of an outside option is a linear function of the characteristics of each partner. Once a marriage is formed, dissolving it is costly. Because there are legal costs associated with the divorce process. Think of a lawyer or the division of property. Also, marriage-specific capital like your knowledge about one's spouse is lost and lastly, there are unobserved costs in the future like, an inefficient level of child care expenditures. A last component that has an influence on marital decisions are unexpected shocks. Unexpected shocks include situations that were not count on at the time of marriage. Situations like unexpected death, income shocks, family problems or problems with the children.

So a couple will stay married at any point in time if the value of marriage exceeds the sum of the outside opportunities at the time of marriage, that is, if

$$household\ function + postive\ unexpected\ shocks - negative\ unexpected\ shock > Outside\ alternative_{wife} + Outside\ alternative_{husband} - costs\ of\ divorce$$

and divorce otherwise.

It is less obvious how an unexpected change in personal attributes, such as income, influences divorce. An increase (decrease) in the income of a spouse influences both his or her contribution to the current marriage and his or her outside opportunities. Since the partners were matched on the basis of assortative mating and therefore were matched on personal characteristics, they were also matched on their earning capacity or income at the time of marriage. Any surprise leading to an unexpected rise or decline in income can cause a divorce. The income of both spouses together form the household income. Changes in household income can therefore lead also to divorce. They give more importance to household income once a couple is together and find personal income more important when they separated (Becker et al. 1977). If the gains from marriage are sufficient large enough, small shocks will not lead to divorce. The probability of divorce will be lower for couples who are well matched.

The theoretic model discussed above is too simplistic for reality. It takes the decision of marriage to be the only dynamic decision in a human lifetime. It ignores all other investment activities. But it gives a theoretical basis to know how changes in income (household income) could lead to a divorce.

3. RELATED LITERATURE

After the discussion of a theoretical model that explains how unexpected income changes can lead to divorce, this section pays attention to earlier studies that tried to find the forces that causes divorces.

Although the divorce rate increased over the past ten years there are just few studies that investigate the role of income in the decision of divorce. Becker, Landes and Michael (1977) developed a theoretical analysis of marital dissolution, incorporating uncertainty about outcomes of marital decisions into a framework of utility maximization and the marriage market. They also explored implications of the theoretical analysis with cross-sectional data but this did not allow them to see what happens over time. They found that an increase in the expected earnings of men reduces the probability of divorce, raises the speed and probability of remarriage if the first marriage failed, and reduces the probability of divorce on second or higher-order marriages. An increase in the expected earnings of women has the opposite effects. It raises the probability of divorce and reduces the propensity to remarry. They also found that unanticipated events, whether favourable or unfavourable, tend to destabilize marriage. Examples of unanticipated events are either unexpectedly high or low levels of earnings of men or women or unexpectedly losing a job. Those unanticipated events appear to raise the probability of divorce.

Most studies compare the effect of male earnings to the effect of female earnings on marital instability. For instance, Oppenheimer (2003) showed that men earnings positively affect the entry into a marital contract. Once the men were in cohabiting unions, earnings had little effect on the odds of marrying. Sweeney (2002) and Oppenheimer, Kalmijn and Lim (1997) both show that men's earnings are positively related to marriage. Men that earn on average more are more inclined to marry faster. Becker (1977) and Hoffman (1995) investigated the relationship between male earnings, and a woman's wage rate, on the probability of marital dissolution. They found that the probability of divorce is lower for marriages in which the husband's labour income is higher. They did not found any evidence that rising wages of women increases marital instability.

However, other studies found a relationship between female labour income and marital instability. Ruggles (1997) investigated the effect of long-term changes in employment patterns of males and females on divorce and separation. He used logistic regressions to measure the probability of being divorced, separated, or married-spouse. The key variables of interest were about male and female labour participation. Sweeney and Cancian (2004) used the same research method as Ruggles (1997) but they looked at the effect of women's earnings on the probability of failing the first marriage. Sweeney (2002) investigated the relationship between women's earnings and marital issues. In contrast with the previous studies, he used a multivariate linear regression analyses, with dependent

variable the wife's labour market position. Independent of the research method all studies found that the rise of female labour-force participation and the increase in employment are closely associated with the growth of divorce and separation. A higher female labour-force participation among women and lower economic opportunities for men may account for marital instability. When women's earnings increases, the partner feels more insecure and therefore marriage instability increases (Cancian, 2004). They also find some evidence that women's economic characteristics may be more important for the decision of marrying in the first place(Sweeney, 2002). But in contrast with those finding White and Rogers (2000) suggests that women's earnings have a positive influence on marriage. It is associated with more marriage, less divorce, more marital happiness, and greater child well-being.

Other studies focused on the effect of a change in the labour income on the probability of divorce. For instance, Weiss and Willis (1997) investigated the role of surprises in marital dissolution. Surprises consists of changes in the predicted earnings capacity of either spouse. During the early stages of the work career, current earnings provide little information about their long run income. On the other hand, by the end of the sample period most respondents are well established in their work careers, and their incomes reflect their earning capacity. Although the future level of income is not known at the time of marriage, one may form an expectation of long-run earning capacity based on information available at that time. In order to measure the relationship between surprises in the expected income and the probability of divorce, the authors used a survival analyzes. The results of the hazard ratio analyses showed that an unexpected increase in the wife's earning capacity raises the divorce hazard rate. Implying that unexpected changes in earning capacity strongly influence the probability of divorce. The divorce hazard rate increases with the duration of marriage and the presence of children. In addition to this research Milosch (2014) conducted the same study with another dataset. She found that decreases in predicted permanent income of the husband increases the hazard ratio. Unpredicted decreases in predicted permanent income for the wife have no direct effect on the probability of marriage instability, unless they switch into unemployment. Nunley and Seals (2010) extended the literature on the effects of earnings shocks on divorce by identifying separately the effects of transitory and permanent household income shocks and by allowing the shocks to have asymmetric effects across education and racial groups. They did this with a model that takes the probit functional form. The estimations showed that a negative household income shock increases the probability of divorce and a positive household income shock does not influences the this probability.

There are other personal characteristics that affect marriage and the decision of divorce. Those factors include experienced situation in childhood, cultural factors, occupation, age and family structure. Many studies have found that divorce is more likely when couples marry at a young age. For instance,

Bumpass and Sweet (1972) showed for the first time, using national data on white ever-married women under forty-five, that marriage instability is more likely for couples that married at a younger age. Teachman (2002) examines the stability of the effects of a wide range of divorce factors using a pooled sample of data taken from five rounds of the National Survey of Family Growth. The main finding was that the effect of age on marriage stability is constant over time. It does not vary by historical periods.

A large body of literature indicates that adults whose parents are divorced in their childhood are more likely to divorce, like McLanagan & Bumpass (1988) and Bumpass, Martin & Sweet (1991). Amato (1996) tries to explain the intergenerational transmission of divorce. He shows that parental divorce is associated with an increased risk of future divorce of their children. Other researches (e.g. Thronton (1991)) found that adults that experienced a parental divorce in their childhood, rather cohabit with their partner than marrying them. In addition to these finding Clarkberg (1999) showed that both men and women who are economically unstable are likely to cohabit. This implies that cohabitation may provide an alternative for those who are in a relationship but lack the economic well-being required for marriage or lack the occupational stability that would make them attractive candidates for a marriage. Amato and Rogers (1997) conducted a longitudinal study that investigated the extent to which reports of marital problems predicts divorce. Marital problems involving infidelity, spending money foolishly, drinking or drugs use, jealousy, moodiness and irritating habits are the strongest predictions of a possible future divorce.

4. DATA

In order to investigate the effect of an income shock on the probability of divorce, I use data from the Longitudinal Internet Studies for the Social Sciences Panel (LISS panel forwards). The LISS panel is the principal component of the Measurement and Experimentation in the Social Sciences, the MESS project. This project is devoted to enabling researchers to benefit from exiting data, to carry out their own survey or to design a special experiment. The data is special available for policy makers and academic researchers. It is an unbalanced panel, containing yearly and monthly survey data. The panel consists of questions about lifestyle, personality, religion, income, work, family, education and immigration. The first wave was conducted in 2008. For this study data from 2009 till 2015 is used. The reason that I did not include the data from 2008 is that there are too much missing variables. The LISS study covers on average 5000 households, comprising 8000 individuals[3]. In order to answer the research question I combine two important parts of the LISS survey. The background variables and the variables of the income core study. The background variables are derived from a monthly survey consisting of questions about age, family situation, household income, personal income and work. The income core study variables are derived from a yearly survey consisting of questions about the financial situation of a respondent. For this research I use a selection of variables. After selecting for respondents that filled in the survey at least three years, the final dataset consist of 3214 respondents with 18312 observations over seven years. The dataset does not allow me to know when an individual is married. Therefore I make the following important assumption in order to answer the research question:

Assumption: *The marriages of all individuals began in 2009.*

The key variables of interest are questions on stated civil status and household income. Respondents indicated their civil status by the question: "What is your civil status?". The response is measured on five categories married, separated, divorced, widow/widower and never been married. Because this research aims to investigate the effect of an income shock on the probability of divorce I selected only respondents that are married, separated or divorced. I treat the people that are separated and divorced as equal because of two reasons. The first reason is that the number of separations after marriage is sufficient small. The second reason is that the data shows that separation always leads to divorce after 1 one year. Over seven years there were 118 divorces in the dataset.

Earlier studies like Becker, Landes and Michael (1977) and Milosch (2014) tried to investigate what effect of changes in predicted income has on marital decisions. They both focused on personal income and not on household income. In contrast to those studies, I try to find the relationship between

[3] Detailed information about the LISS panel can be found at www.lisspanel.nl

household income shocks and marriage outcomes. The main reason why this study looks at household income instead of personal income is because following Becker's theoretical model, both incomes are important in a marriage. Changes in personal income automatically leads to changes in household income. Matched based on assortative matching can fail when personal characterises, like household income, changes. When one of the two experiences an income shock, this can have an influence on both in a marriage. Therefore I investigate the effect of a household income on the probability of divorce.

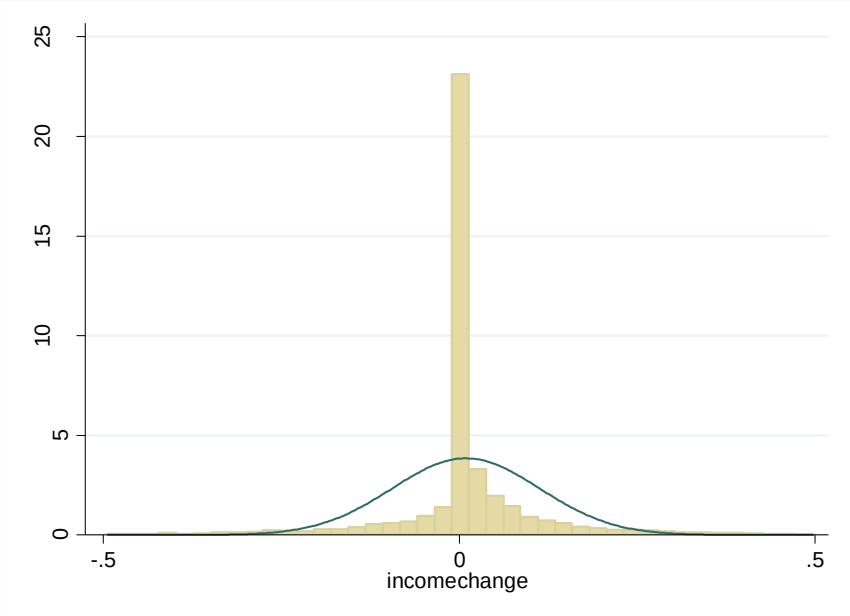
I measured a household income change by the responses to the question: *"What is the total net income of your household in Euros?".* The change in household income is measured on the basis of the background variables. Because the survey is monthly, I take the household income of June on a yearly basis to measure the income change. The household change is measured with the following formula:

$$Household\ income\ change\ in\ percentage = \frac{household\ income_t - Household\ income_{t-1}}{Household\ income_{t-1}}$$

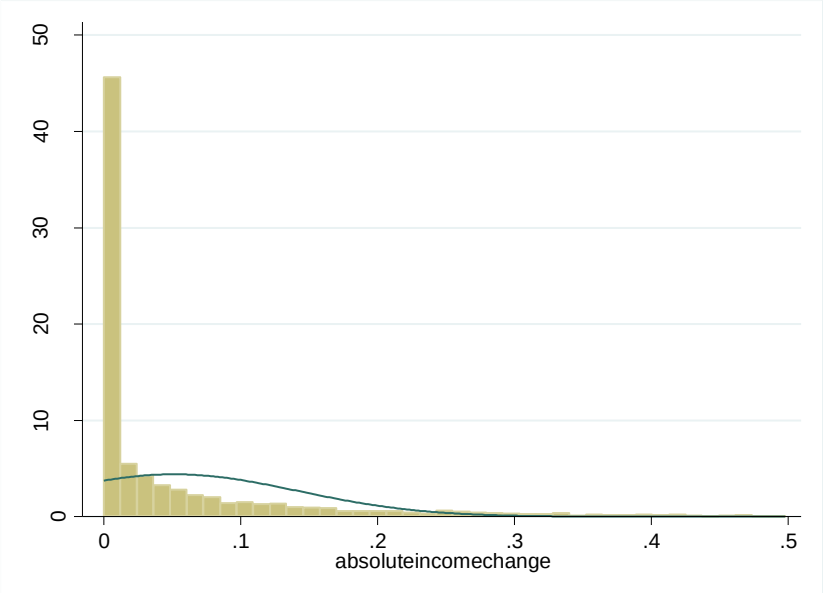
The household income change is positive when the household income increased in one year and is negative when it decreased.

Graph 1 shows the distribution of the income change of the sample. *Graph 2* shows the distribution of the absolute value of the income change. The average absolute value of a change in the household income of the sample was 6.19%.

Graph 1 – Distribution of change in household income



Graph 2 – Distribution of change in the absolute value of household income



I define a household income shock as a dummy variable that takes a value of 1 when the household income increases or decreases with at least 10 percent relative to the household income of one year before in June. I make a difference between negative and positive income shock in order to know which of them has a greater influences on the probability of divorce. A negative income shock appears when the household income has decreased with at least 10 percent relative to the household income of one year before. A positive household income shock appears when the household income has increased with at least 10 percent relative to one year before. To check the models on robustness I increase the threshold to 30, 40, 50 up to 90 percent.

I include demographics like age, gender, education and position in household. Education is measured on a seven point scale. It goes from lowest to highest education level. I include education as a dummy variable in the regression analysis, with baseline primary school. Position in household measures whether someone is the household head, wedded partner, unwedded partner, parent, child (older than 21), housemate or family member. I categorize this demographic variable in four categories. Household head, wedded partner, unwedded partner and others. I include position in household in the regressions as a dummy variable, with baseline others.

Table 1 shows the descriptive statistics of the sample. It shows the mean of the variables over the observations per individual. Because this research aims to gain knowledge about the relationship between a household income shock and the probability of divorce, the summary statistics are broken down into two groups. The first group, the ever divorced group forwards, consists of respondents that experienced a divorce or separation between 2009 and 2015. After experiencing a divorce an individual

Table 1 *Descriptive Statistics*

	Total	Ever divorced	Never divorced
Experienced a divorce			
Mean	0.006	1	0
Standard deviation	0.004	0	0
Experienced household income shock			
Mean	0.167	0.458	0.166
Standard deviation	0.038	0.050	0.037
Household income (euros)			
Mean	3162.99	2278.77**	3168.72**
Standard deviation	1566.05	1072.44	1477.71
Age (years)			
Mean	55.7	49.5***	55.7***
Standard deviation	12.2	11.3	12.1
Gender (female)			
Mean	0.751	0.750	0.750
Standard deviation	0.250	0.250	0.250
Education			
1. Primary school			
Mean	0.075	0.008***	0.076***
Standard deviation	0.026	0.009	0.026
2. VMBO			
Mean	0.294	0.237	0.294
Standard deviation	0.045	0.043	0.046
3. HAVO/VWO			
Mean	0.078	0.093	0.077
Standard deviation	0.026	0.029	0.026
4. MBO			
Mean	0.246	0.364***	0.246***
Standard deviation	0.043	0.048	0.043
5. HBO			
Mean	0.230	0.254	0.231
Standard deviation	0.042	0.043	0.042
6. University			
Mean	0.075	0.034*	0.074*
Standard deviation	0.026	0.018	0.026
Position in household			
1. Household head			
Mean	0.540	0.780***	0.538***
Standard deviation	0.498	0.418	0.495
2. Wedded partner			
Mean	0.426	0.076***	0.429***
Standard deviation	0.285	0.026	0.259
3. Unwedded partner			
Mean	0.024	0.118***	0.024***

	Standard deviation	0.015	0.032	0.015
4.	Others			
	Mean	0.008	0.025*	0.009*
	Standard deviation	0.009	0.015	0.008
Observation		18312	118	18194

Notes: . *, ** and *** indicate whether the differences of means of the ever divorced and never divorced group are significant different from zero, at the 0.10, 0.05 and 0.01 levels, respectively.

does not appear in the dataset anymore. The reason behind this is to overcome that an income shock happens after divorce. The second group, never divorced group forwards, consists of respondents that did not experience a divorce or separation. In the total sample, 65.7% of the households experienced an household income shock of 10% between 2009 and 2015. Respondents in the ever divorced group, experienced significant more income shocks compared to respondents in the never divorced group. The average monthly income of a household is 3162.99 Euros. The summary statistics show that respondents in the ever divorced group are significant younger, earn less and have a higher education level compared to the never divorced group. The individuals in the ever divorced group are more often a household head or a wedded partner. All means are statistical significant different from each other on a ten percent significance level, except the variable gender. This implies that the male/female ratio is the same in the two groups.

Table 2 shows correlations between the dependent and the independent variables. Experienced a divorce shows a positive correlation with experienced an income shock. Also age, household income and education are significant correlated with the dependent variable. Age shows also a significant positive correlation with the dummy for whether a household experienced an income shock, implying that respondents with a higher age are more likely to experience a income shock. The significant positive correlation between education and whether someone experienced a household income shock implies that more people with a higher education level experienced a household income shock. Because those variables correlate with the dependent variable and independent variables it is important to include them as control variables in the main analysis.

Table 2 Correlation table

	1	2	3	4	5	6
1.Experienced divorce	1					
2.Experienced income shock	0.0626***	1				
3.Household income	-0.015**	0.012**	1			
4.Age	-0.041***	-0.039***	-0.035***	1		
5.Gender	0.006	0.002	-0.009	-0.097***	1	
6.Education	0.013*	0.044***	0.092***	-0.208***	-0.127***	1

Notes: Correlations are calculated using 18312 observations *, ** and *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.

5. EMPERICAL STRATEGY

To answer the research question of this paper, two parts of investigation will be implemented. First, I use a Linear Probability Model to estimate the probability that an individual, given whether he or she experienced an income shock, also experienced a divorce. The second investigation consists of a survival analysis to estimate the effect of an income shock on the probability of divorce.

4.1 Linear Probability Model

A linear probability model predicts the probability that the outcome variable equals one, given the independent variables. It is simply the application of ordinary least squares (OLS) to binary outcomes instead of continuous outcomes. Using a Linear Probability Model allows me to know the linear relationship between experiencing an income shock and the probability of divorce. The linear time fixed effect regression specification is:

$$\Pr(dummy_{divorce} = 1) = \alpha_i + \rho * dummy_{income\ shock\ it} + \delta * X_{it}{}' + \varepsilon_i$$

Where the outcome variable $\Pr(dummy_{divorce})$, is the probability that an individual experienced a divorce. This is based on a dummy variable that equals 1 if an individual experienced a divorce and 0 otherwise. The α_i, captures all time-invariant effects. The key explanatory variable, $dummy_{income\ shock_i}$, is a dummy variable that equals 1 if an individual experienced an income shock over the years and 0 otherwise. The vector x' contains all control variables like age, gender, education level and position in household. In line with previous findings I expect that ρ is positive, implying experiencing an income shock leads to a higher probability of divorce. In addition to this analysis I conduct an analysis that makes a difference between negative and positive income shock. It allows to investigate the relationship between a negative or positive household income shock and the probability of divorce. In line with the findings of previous studies, like Milosch (2014) and Nunley and Seals (2010), I expect that there is a stronger positive relationship between a negative household income shock and the probability of divorce, compared to the relationship between a positive household income shock and the probability of divorce. Using a fixed effect regression specification allows me to control for time effects. To check the results of the linear probability model on robustness I increase the threshold of the household income shock to 30, 40, 50 up to 90 percent.

4.1 Cox Proportional Hazard Model

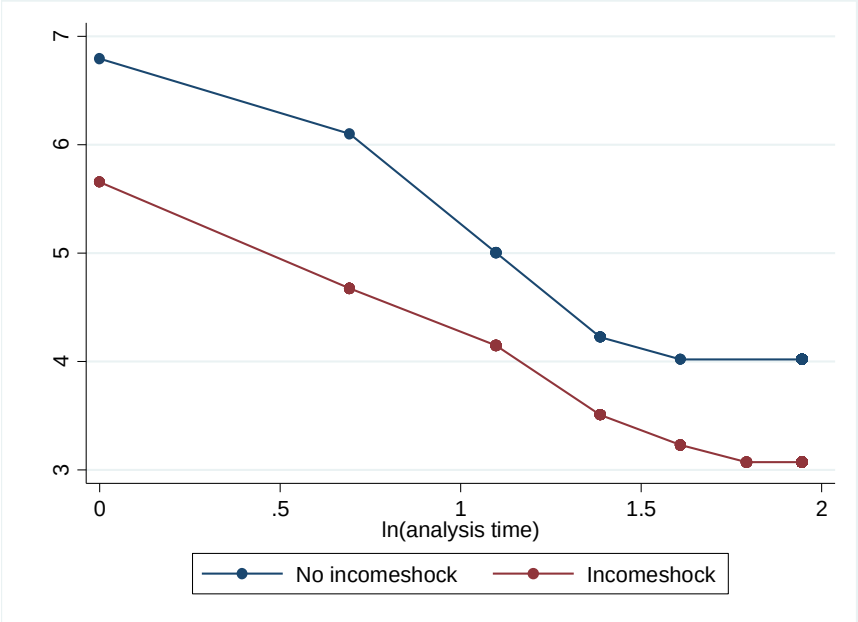
After knowing the relationship between experiencing an income shock and experiencing a household income shock, it is interesting to know the causal effect of an income shock on the probability of divorce. In order to estimate this effect I use a Cox Proportional Hazard Model. Like other survival models, the Cox PH Model relates the time that passes before some event occurs to one or more

explanatory variables that may be associated with the quantity of time. The time before some event occurs is called the survival time. In this research the survival time is measured by the time that an individual did not experience a divorce. Simply stated, the time an individual is still married is called the survival time. For example if an individual is still married in 2012, there is a survival time of 3 years, because the individual did not experienced a divorce in three years. In order to use this research method I need to assume that all marriages started in 2009. The main reason behind this assumption is that the data does not allow me to know when the marriage started of the individuals. The key advantage of using the Cox Proportional Hazard Model is that the explanatory variables may be time-varying. This allows me to know the effect of the duration of a marriage on the probability of divorce, given a particular household income shock. I use the traditional model of a Cox Hazard Model where the hazard ratio is only measured based on one explanatory variable, the key variable of interest, a household income shock. A general proportional hazards regression specification is:

$$h_i\,(t) = \; h_0(t) * e^{\beta_1 X_{i1} + \cdots + \beta_p X_{ip}}$$

The regression consists of two elements. The first element, $h_0(t)$, is the underlying baseline Hazard function. The second element are the effect parameters, describing how the hazard changes in response of the explanatory covariates. This model is based on a key assumption, proportional hazards. This implies that the hazard for any individual is a fixed proportion of the hazards of any other individual. In other words, the probability that a divorce will happen after a household income shock is independent of time. It does not matter whether the divorce happens in the second years of the analysis or in the fifth year. Checking for this assumption is crucial.

Graph 3 *- log-log survival graph*



I check this assumption by using the proportional-hazards assumption test based on Schoenfeld residuals, the ph-test. Schoenfeld residuals are defined as the covariate value for individuals that failed, divorced, minus its expected value of the covariate. The Schoenfeld Residuals Test tests whether the slope of those residuals are equal to zero. If they are not equal to zero, the proportional hazard assumption has been violated (Rodriguez, 2010). From the results of this test (p-value>0.0.5) I do not reject the null-hypothesis that the hazards are in fact proportional. Another way I tested this key assumption is plotting a log-log survival graph. This plot allows to check whether the proportional hazards assumption is met. *Graph 3* shows that the red line, the treatment group, and the blue line, the control group, are almost parallel. This means that the proportional hazards assumption is satisfied. To check the results of the survival analysis on robustness I conduct a robustness check where I define the household income shock as a dummy variable that takes a value of 1 when the household income increases or decreases with at least 20, 30, 40 and 50 percent.

6. RESULTS

In this section I present the results of the two research methods. In the first part I discuss the results of the linear probability model followed by the second part where I present the results of the Cox Proportional Hazard Model.

5.1 Linear Probability Model

Table 3 reports the results of the linear probability model using the full sample. The linear probability model is used to estimate the effects of a household income shock on the probability of divorce. The coefficient estimates show the change in the decimal probability of being divorce instead of being not divorce, given a unit change in the independent variable. In all regressions I report robust standard errors that are clustered on the identical respondent ID number as each person appears in the data multiple times.

The first column shows the estimation results without taking up any control variables as well without allowing for a difference between negative and positive household income shocks. The estimation result show that the likelihood that an individual is divorced is increasing in an experienced household income shock. This effect is positive and significant (p-value < 0.01). Having experienced a household income shock of at least 10 percent increases the likelihood that an individual is divorced by 1.33 percent points. In the second column I control for demographics like age, gender, education level and position in household. The estimation result, after including the control variables, shows that the likelihood that an individual is divorced increases by 1.25 percent points after experiencing a household income shock of at least 10 percent. Age has a significant negative influences on the likelihood that an individual is divorced. Education has an overall positive influences on the likelihood of being divorced. Individuals that completed only VMBO have the highest change of being divorced[4]. There is a significant negative relationship between the likelihood of being divorced and being the household head or a wedded partner. This could be explained by the fact that a household head or a wedded partner feel more responsible for a marriage compared to other position in a household.

The third column show the estimation results of the linear probability models where I made a difference between a positive household income shock and a negative household income shock. A positive household income shock implies that the household income increased with at least 10 percent relative to a year before. A negative household income shock implies that the household income decreased with at least 10 percent relative to a year before. The variable is still a dummy variable that takes a value of 1 if a household experienced such an income shock and a value of 0 otherwise.

[4] After attending primary education, children in the Netherlands go directly to high school (VMBO, HAVO or VWO).

Table 3 *Results of the linear probability model (full sample)*

	Dependent variable : dummy divorced		
	(1)	*(2)*	*(3)*
Experienced income shock	*0.0133****	*0.0125****	
	(0.0023)	*(0.0018)*	
Experienced positive income shock			0.0027
			(0.0022)
Experienced negative income shock			*0.0265****
			(0.0025)
Age		*-0.0106****	*-0.0105****
		(0.0035)	*(0.0027)*
Gender		*-0.0035*	*-0.0016*
		(0.0084)	*(0.0840)*
Education			
1. VMBO		*0.0451****	*0.0482***
		(0.0111)	*(0.0212)*
2. HAVO/VWO		*0.0067****	*0.0068****
		(0.0026)	*(0.0026)*
3. MBO		*0.0093****	*0.0094***
		(0.0036)	*(0.0034)*
4. HBO		*0.0061***	*0.0061***
		(0.0023)	*(0.0024)*
5. University		*0.0018**	*0.0020*
		(0.0016)	*(0.0016)*
Position in household			
1. Unwedded partner		*0.0136*	*0.0137*
		(0.0404)	*(0.0400)*
2. Wedded partner		*-0.0181****	*-0.0185****
		(0.0031)	*(0.0031)*
3. Household head		*-0.0252***	*-0.0238***
		(0.0123)	*(0.1191)*
Intercept	*0.0044****	*0.0771****	*0.0768****
	0.0009	*(0.0020)*	*(0.0097)*
Time fixed effects	*No*	*Yes*	*Yes*

R^2	*0.0039*	*0.0095*	*0.0158*
Observations	*18312*	*18312*	*183112*

*Notes: the robust standard errors are in parentheses, clustered by person ID. *, ** and *** indicate significance based on a two-sided test at the 0.10, 0.05 and 0.01 levels, respectively.*

The estimation results show that there is no significant relationship between being divorced and having experienced an positive income shock, on all significance levels.[5] There is a significant relationship between a negative household income shock and the probability of divorce. The results show that the relationship is significant and positive. This implies that having experienced a negative income shock of at least 10 percent, increases the likelihood of being divorce by 2.64 percentage points[6]. The control variables have almost the same influences as in the second column.

To check the results of the linear probability model on robustness I conducted the same analysis with a higher threshold. For the robustness check I define a household income shock as a dummy variable that takes a value of 1 if the household income has changed with at least 30 percent relative to one year before and 0 otherwise. *Table 4* reports the results of the linear probability model using a threshold of 30 percent. In all regression I report robust standard errors that are clustered on the identical respondent ID number. The first column shows the estimation results without taking up any control variables as well without allowing for a difference between negative and positive household income shocks. The results show that there is a significant positive relationship between the dependent and independent variable. This implies that, experiencing a household income shock of at least 30 percent increases the likelihood of being divorced by 0.85 percent point. Including the control variables, the likelihood increases to 3.61 percent point. This result is in line with the result of the analysis with a 10 percent threshold. There is no significant relationship between experiencing a positive household income shock and the probability of divorce, like with a threshold of 10 percent. The relationship between a negative income shock and the probability of divorce is significant on all significance levels and positive. Experiencing a negative household income shock of at least 30 percent increases the likelihood of being divorced by 8.25 percent points. This relationship is much stronger with a 30 percent threshold than with a 10 percent threshold.

The results of the linear probability analyses and the robustness check, show that experiencing a negative income shock increases the likelihood of being divorced. When the threshold increases the

[5] The relationship between the dependent variable and having experienced a positive income shock is insignificant on all significance levels without including any control variable.
[6] The relationship between the probability of divorce and having experienced a negative income shock is significant negative on all significance levels without including any control variable.

Table 4 *Results of the linear probability model – Threshold 30%*

	Dependent variable : dummy divorced		
	(1)	*(2)*	*(3)*
Experienced income shock	*0.0085****	*0.0361****	
	(0.0019)	*(0.0030)*	
Experienced positive income shock			-0.0003
			(0.0033)
Experienced negative income shock			*0.0825****
			(0.0048)
Age		*-0.0111****	*-0.0108****
		(0.0027)	*(0.0027)*
Gender		*-0.0013*	*-0.0012*
		(0.0011)	*(0.0840)*
Education			
1. VMBO		*0.0050****	*0.0051***
		(0.0022)	*(0.0022)*
2. HAVO/VWO		*0.0069***	*0.0065***
		(0.0025)	*(0.0027)*
3. MBO		*0.0097****	*0.0095****
		(0.0035)	*(0.0045)*
4. HBO		*0.0064****	*0.0067****
		(0.0024)	*(0.0023)*
5. University		*0.0022**	*0.0024**
		(0.0016)	*(0.0016)*
Position in household			
1. Unwedded partner		*0.0815*	*0.0795****
		(0.0084)	*(0.0080)*
2. Wedded partner		*-0.1125****	*-0.1057****
		(0.0058)	*(0.0025)*
3. Household head		*-0.0653***	*-0.0525****
		(0.0232)	*(0.0054)*
Intercept	*0.0044****	*0.0746****	*0.0718****
	0.0009	*(0.0022)*	*(0.0097)*
Time fixed effects	*No*	*Yes*	*Yes*

R^2	*0.0039*	*0.0120*	*0.0248*
Observations	*18312*	*18312*	*18312*

*Notes: the robust standard errors are in parentheses, clustered by person ID. *, ** and *** indicate significance based on a two-sided test at the 0.10, 0.05 and 0.01 levels, respectively.*

likelihood also increases. To prove whether this holds for higher thresholds, I conducted the linear probability analyses with different higher thresholds. *Table 5* reports the results of the analyses that measured the effect of a negative household income shock on the probability of divorce[7]. I report robust standard errors that are clustered on the identical respondent ID number. The controls variables are included in all regressions. All coefficients are significant on all significance levels. The results show that the likelihood of being divorced, given that a household experienced a household income shock, increases when the threshold increases. There is a maximum to where it increases. After 60 percent, the likelihood of being divorced decreases. This implies that an increase of 70 percent or more of the household income relative to one year before still increases the likelihood of being divorced, but less. *Graph 4* shows that the returning point lies between 60 and 70 percent. It also shows that after 70 percent the likelihood decreases with great extent.

5.2 Cox Proportional Hazard Model

The results of the linear probability model showed the relationship between experiencing an income shock and the likelihood of being divorce. I used a Cox Proportional Hazard Model to estimate the effect of a household income shock on the probability of divorce. *Table 6* reports the results of the Cox Proportional Hazard analyses. In all regressions I report robust standard errors that are clustered on the identical respondent ID number. The main analysis is conducted with a threshold of 10 percent. The first column shows that the hazard ratio estimation results without taking up any control variables. The results shows that the hazard ratio is positive and significant on all significance levels. A hazard ratio of 1.4581 implies that at any time, 1.46 more divorce individuals have experienced a household income shock compared to not divorced individuals. Experiencing a household income shock of at least 10 percent relative to one year before, increases the probability to be divorced. In the second column I include demographic control variables. The estimation results show that the hazard ratio is positive and significant. There are 2.57 times more divorced individuals that experienced a household income shock compared to not divorced individuals.

In third column I make a difference between a positive and negative household income shock. The results show that the hazard ratio for a positive household income shock is positive but insignificant.

[7] The relationship between a positive household shock and the probability of divorce is insignificant for all higher thresholds on all significant levels.

Table 5 *Results of the linear probability model – different thresholds*

	Dependent variable : dummy divorced					
	40%	*50%*	*60%*	*70%*	*80%*	*90%*
Experienced negative income shock	*0.1548****	*0.1944****	*0.2342****	*0.2317****	*0.1203****	*0.0167****
	(0.0345)	*(0.0546)*	*(0.0784)*	*(0.0900)*	*(0.0451)*	*(0.0074)*
Controls	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Intercept	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
R^2	*0.0042*	*0.0028*	*0.0093*	*0.0105*	*0.0138*	*0.0091*
Observations	*18312*	*18312*	*18312*	*18312*	*18312*	*18312*
Observations income shock	*180*	*69*	*39*	*11*	*9*	*6*

*Notes: the robust standard errors are in parentheses, clustered by person ID. *, ** and *** indicate significance based on a two-sided test at the 0.10, 0.05 and 0.01 levels, respectively.*

Graph 4 - *Results of the linear probability model – different thresholds*

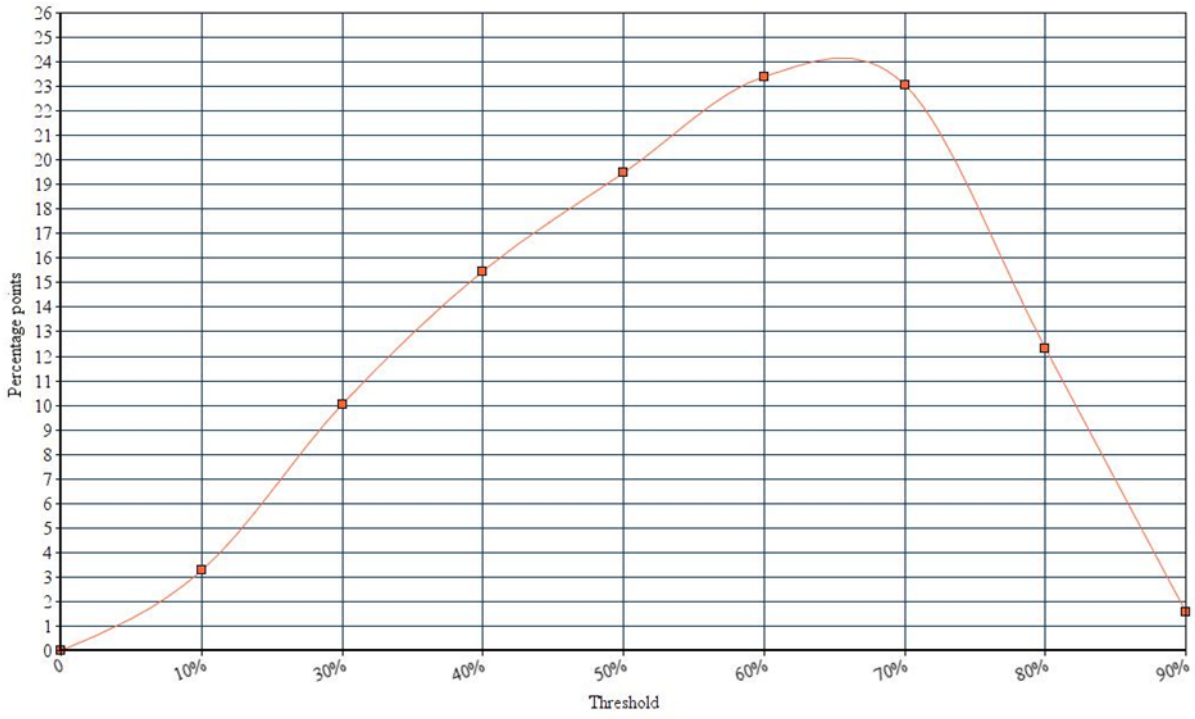


Table 6 *Results of the Cox Proportional Hazards Analysis – 10%*

Dependent variable : dummy divorced			
		Hazard rate	
	(1)	*(2)*	*(3)*
10% income shock	*1.4581****	*2.5653****	
	(0.3003)	*(0.7030)*	
10% positive income shock			*1.2048*
			(0.2485)
10% negative income shock			*3.6628****
			(0.8081)
Age		*0.9733****	*.9567**
		(0.0099)	*(0.0100)*
Gender		*0.9345*	*2.843*
		(0.0859)	*(0.6979)*
Education			
1. VMBO		*1.5993**	*2.5330***
		(0.5985)	*(1.8806)*
2. HAVO/VWO		*1.3306*	*2.0522**
		(2.6190)	*(1.7218)*
3. MBO		*2.4615****	*3.3597****
		(1.3368)	*(2.4680)*
4. HBO		*2.2596***	*2.7586**
		(1.0258)	*(2.0398)*
5. University		*1.0682*	*0.96740*
		(0.9978)	*(0.8857)*
Position in household			
1. Unwedded partner		*1.7638*	*2.4917*
		(1.3769)	*(1.9668)*
2. Wedded partner		*0.1116****	*0.11389****
		(0.0873)	*(0.0893)*
3. Household head		*1.6360***	*1.4339***
		(0.4572)	*(1.0501)*
Observations	*15696*	*15696*	*15325*

The hazard ratio for a negative household income shock is positive and significant on all significance levels. There are 3.66 times more divorced individuals that experienced a negative household income shock of at least 10 percent compared to the individuals that are not divorced. This result holds for any point in time of the research time. The hazard ratio is the strongest for a negative household income shock. This implies that experiencing the negative household income shock has the strongest influence on the probability of being divorce. This results is in line with the results of the linear probability model. Both models showed that experiencing a household income shock of at least 10 percent increases the probability of being divorced. Also, experiencing a negative income shock has a stronger effect.

All control variables have a positive hazard ratio. The interpretation is not the same as in the linear probability model. In line with the findings of the linear probability model, there are more divorced household heads and wedded partners that experienced a household income shock. The findings for education are slightly different. The highest hazard ratio is reported for the MBO education level[8].

Graph 5 show the relationship between the survival time, duration of the marriage, and the probability of divorce separated for individuals that have experienced a household income shock of at least 10 percent and individuals that have not experienced a household income shock. The graph shows two important things. The first observation is that a longer duration of marriage increases the probability of divorce despite the fact someone has experienced a household income shock. The second observation is that the increase over time in the probability of divorce is stronger for individuals that experienced a household income shock. The red line decreases much more, increases the probability of divorce, than the blue line.

To check the results of the cox proportional hazard analyses on robustness I conducted the same analyses for higher thresholds. *Table 7* reports the results of the analyses for higher thresholds. It shows that increasing the threshold increases the hazard ratio. This implies that a higher household income shock leads to a higher probability of being divorced. Experiencing a household income shock of 40 percent leads to the highest hazard ratio. There are 3.79 times more divorced individuals that experienced a household income shock of at least 40 percent relative to individuals that are not divorced. In the next analyses I made a difference between a positive and negative household income shock. The results show that a positive household income shock leads to insignificant hazard ratios for all thresholds. This implies that a positive household income shock does not have a significant influence on the probability of being divorced. In line with the results of the linear probability model, a negative household income shock leads to a significant positive hazard ratio for all thresholds.

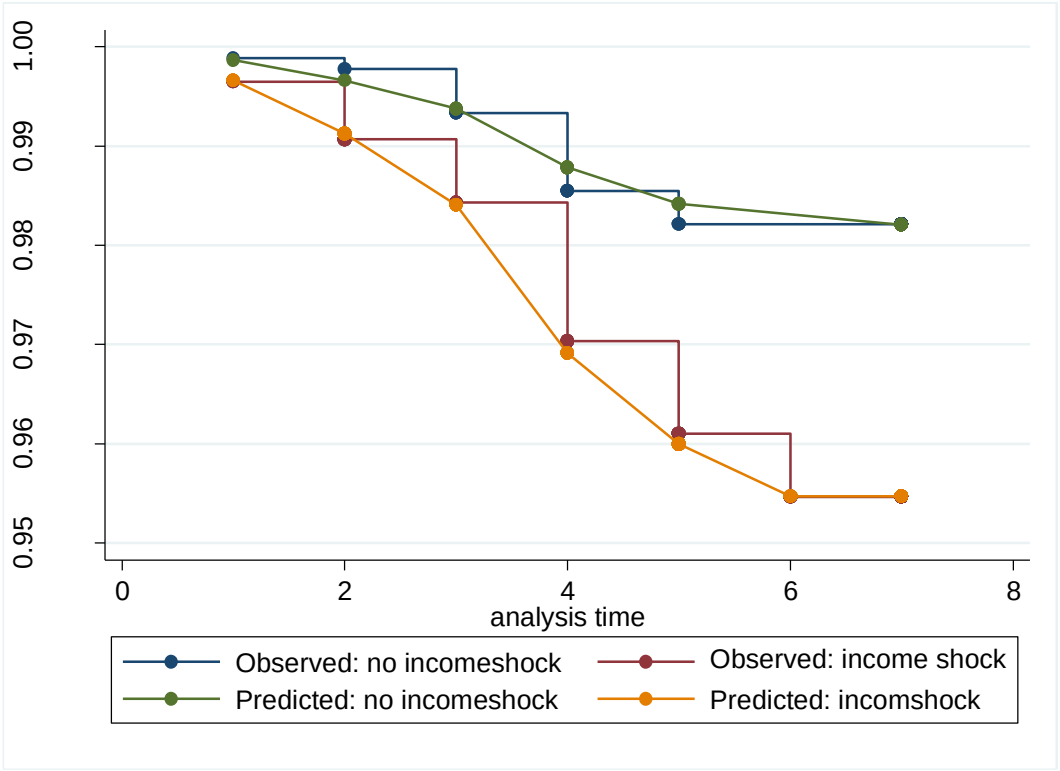
[8] After attending high school, students choose to go to higher education (MBO, HBO or University).

Table 7 *Results of the Cox Proportional Hazards Analysis*

	Hazard Ratios		
Threshold	***Household Income Shock***	***Positive Household Income Shock***	***Negative Household Income Shock***
10%	*2.5653****	*1.2048*	*3.6628****
	(0.7030)	*(0.2485)*	*(0.8081)*
20%	*2.3461****	*1.0834*	*4.0097****
	(0.5000)	*(0.2412)*	*(0.8247)*
30%	*3.0532****	*1.0402*	*5.2611****
	(0.6266)	*(0.2853)*	*(1.0962)*
40%	*3.7880****	*1.1965*	*7.4894****
	(0.7888)	*(0.3841)*	*(1.5981)*
50%	*3.5510****	*1.0935*	*9.6494****
	(0.8446)	*(0.4658)*	*(2.4580)*
Controls	*Yes*	*Yes*	*Yes*

*Notes: the robust standard errors are in parentheses, clustered by person ID. *, ** and *** indicate significance based on a two-sided test at the 0.10, 0.05 and 0.01 levels, respectively.*

Graph 5 *– Survival time and probability of divorce*



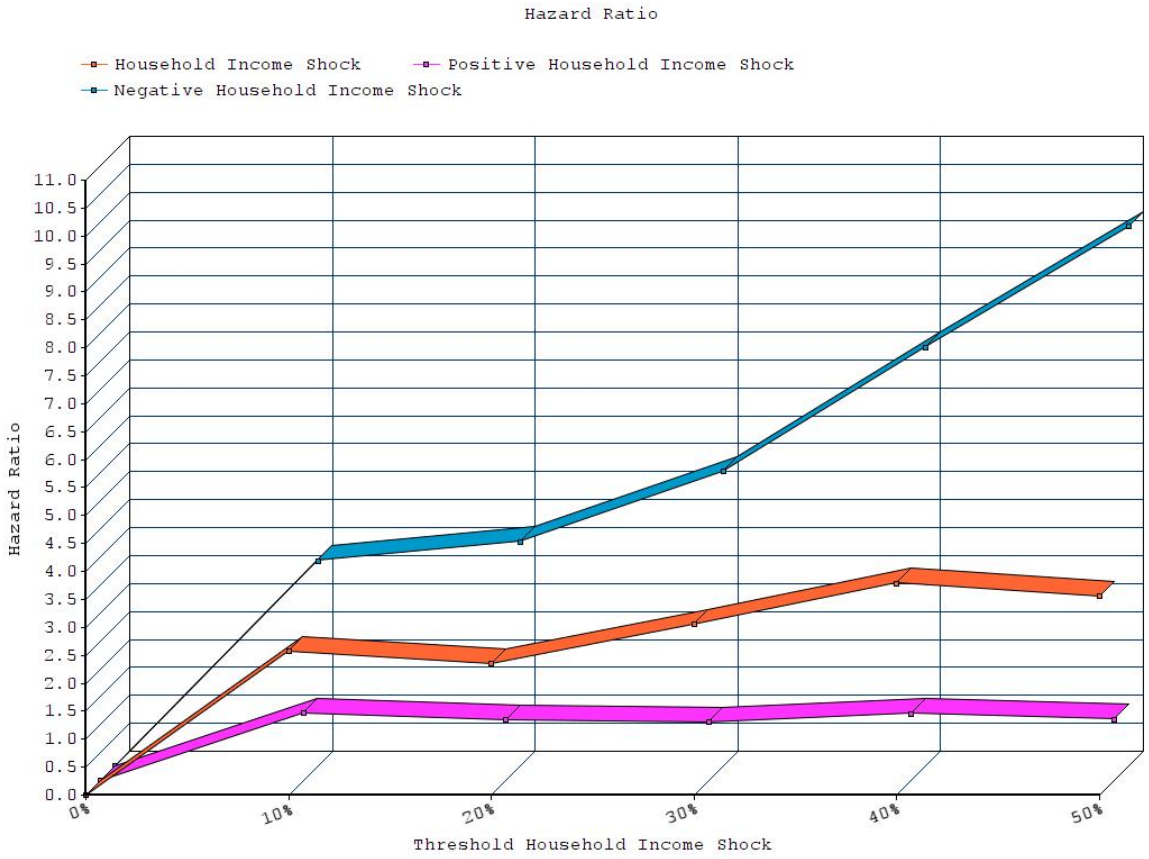
The hazard ratio is increasing in an increasing threshold, implying that greater negative income shocks lead to a higher probability of being divorced. There are 5.26 times more divorced individuals that experienced a negative household income shock of at least 30 percent than individuals that are not divorced. The highest hazard ratio is reported with a threshold of 50 percent. There are 9.64 times more divorced individuals that experienced a negative household income shock of at least 50 percent relative to individuals that are not divorced. This implies that experiencing a negative household income shock leads to a higher probability of being divorced.

Graph 6 shows the development of the hazard ratio when the threshold increases. The different lines stand for a household income shock, a positive household income shock and a negative household income shock. The graph shows that the line of the negative household income shock increases when the threshold increases. The line of the positive shock is stable and it does not change when the threshold increases, implying that experiencing a positive income shock does not change the probability of being divorced. Experiencing an income shock, independent of whether it is positive or negative, increases the hazard ratio. This implies that more and more people that are divorced have experienced a household income shock. *Graph 7* shows the relationship between the survival time and the probability of divorce, for a negative household income shock of at least 50 percent[9]. The difference in the red, experienced a household income shock, and blue line increased compared to graph 5. This implies that experiencing a negative household income shock increases the probability of divorce.

To give more realistic view of the effect of the income shock on the probability of divorce. *Table 8* reports failure rates given a particular income shock. The results show that experiencing a household income shock of at least 10% increases the probability of divorce with 0.661 percentage point. Experiencing an income shock of at least 50% increases this probability to 1.532%. The probability of divorce increases the most when a negative household income shock of at least 50% is experienced. It increases to 4.235%.

[9] The highest hazard ratio is reported with a threshold of 50 percent. Lower thresholds show the weaker relationship between the survival time and the probability of divorce.

Graph 6 *Hazard Ratios*



Graph 7 *– Survival time and probability of divorce – Negative shock of 50%*

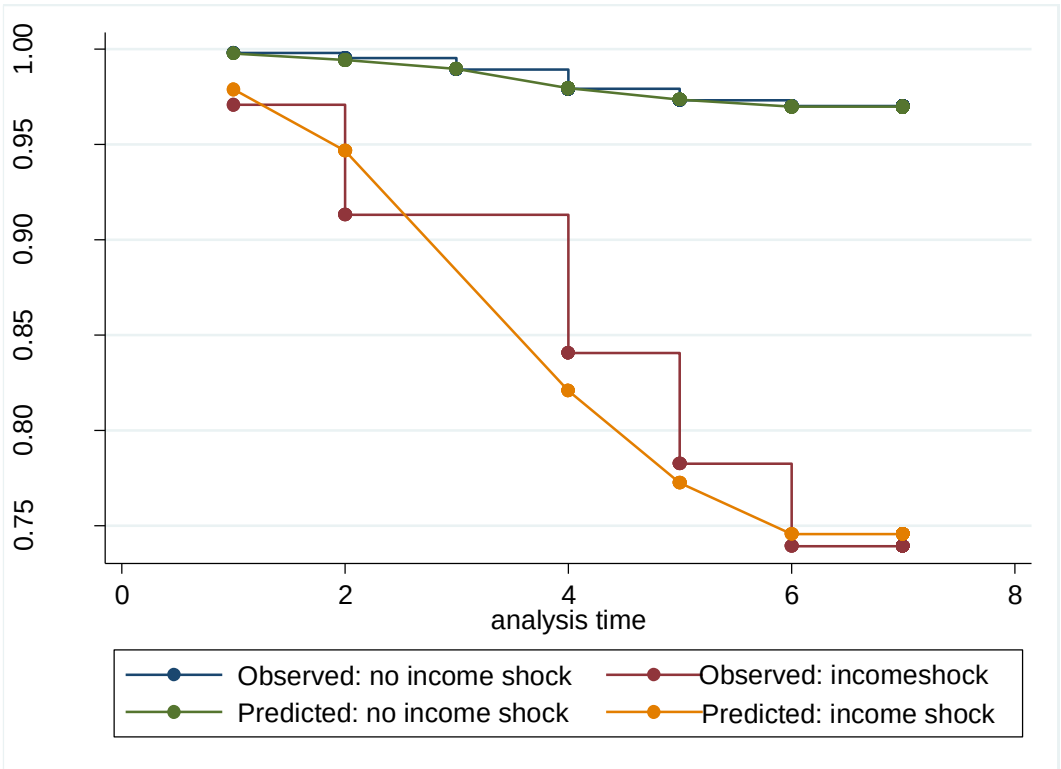


Table 8 *Table of failure rates*

	Failure Rates		
Threshold	***Household Income Shock***	***Positive Household Income Shock***	***Negative Household Income Shock***
10%	*0.661%*	*0.510%*	*0.967%*
20%	*0.784%*	*0.520%*	*1.261%*
30%	*1.061%*	*0.510%*	*1.835%*
40%	*1.396%*	*0.516%*	*2.789%*
50%	*1.532%*	*0.564%*	*4.235%*

7. Conclusion

I have studied how a household income shock effects marital outcomes, using a linear probability model and a cox proportional hazard model. The results of the linear probability model show that there is positive relationship between experiencing a household income shock of at least 10 percent and being divorced. This relationship is the strongest with a negative household income shock. To check the results of the linear probability model on robustness, I conducted the same analyses with a threshold of 30 percent. The results were in line with the main analyses. A additional analysis showed that the relationship between a negative income shock and the probability of being divorced increases in the threshold. This implies that a bigger income shock increases the probability of being divorced. Experiencing a negative income shock of 60 percent has the strongest positive effect, it is increases the likelihood of being divorced with 23.4 percentage point.

The results of the cox proportional hazard analyses showed that there are 2.5 times more divorced individuals that have experienced a household income shock of at least 10 percent relative to not divorced individuals. The probability of divorce increases with 0.661% when one experienced a household income shock. There are 9.6 times more divorced individuals that experienced a negative household income shock of at least 50 percent relative to not divorced individuals. In other words, the probability that you divorce when experiencing a household income shock of at least 50 percent increases with 4.24%. This findings imply that experiencing a household income shock, more specified a negative household income shock, increases the probability of divorce. The results also showed that a longer survival time, duration of marriage, increases the probability of divorce. The higher the threshold, the stronger this effect occurs.

8. Final Remarks

There are some important points to notice of this research. The dataset did not allow me to make a distinguish between people that experienced a household income shock ones and people that experienced this multiple times. For future research it might be interesting to know whether the number of experienced shock matters for the results. As mentioned earlier, the problem of reversed causality might arise. Experiencing a divorce could lead to a change in income. There might be omitted variables when trying to know the effect of income change on the probability of divorce. An example of a omitted variable could be working years. When someone becomes more experienced it could lead to more responsibility on the job. More responsibility can leads to more working hours and to less time for family and one's marriage. This might leads to marriage problems and any future divorce. The real causes of the divorce is less time for family due to more responsibility on the job and not the increase in income. Another concern that might create a problem is the division of divorced and not divorced individuals. The treatment group, with 118 divorces in seven years, is much smaller than the control group. This is a quit unbalanced. It would be interesting to know whether the results would change when there is a more balanced dataset. So for future research it might be important to look for data specified on divorced and not divorced individuals, so that the division is more equal. The last concern I want to address is about the assumption I make in this research. I assume that all marriages began in 2009, in order to know one's survival time. It would be interesting to know what would happen to the outcome of this study if the real survival time could be measured. In order to know the real survival time it is required to know when a marriage is started.

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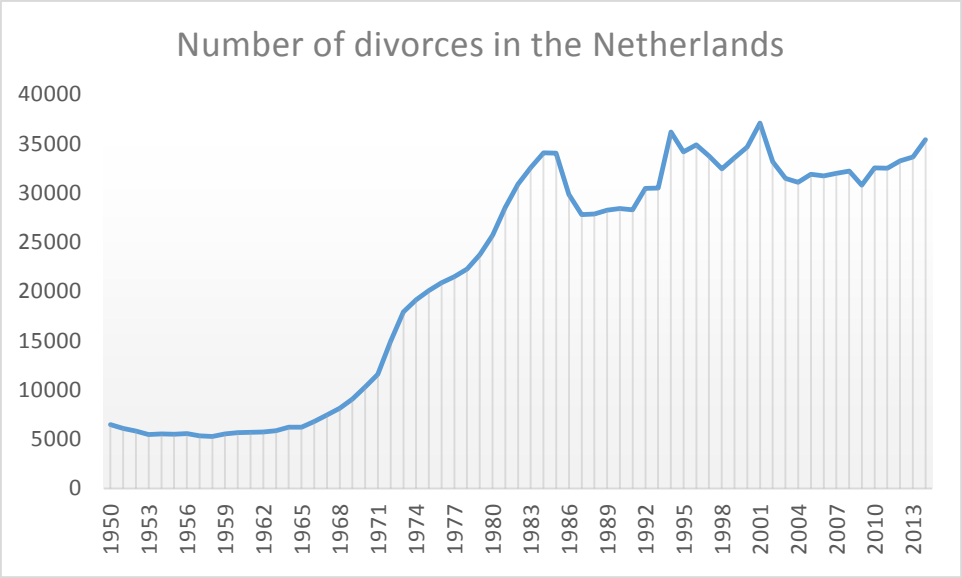
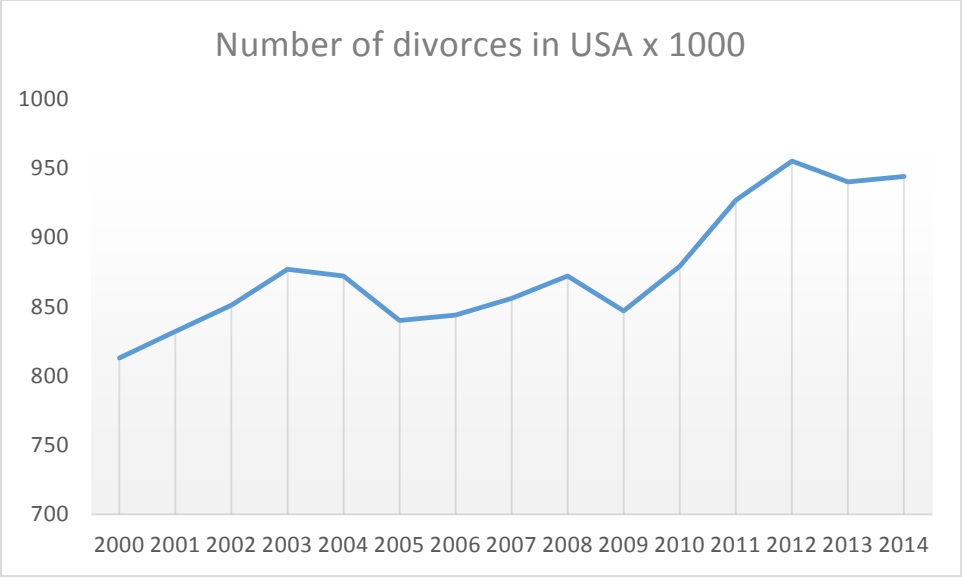
10. Appendix

Graph A



Source: Central Agency of Statistics The Netherlands

Graph B



Source: U.S. Data and Statistics