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Prudence and Prevention – Empirical Evidence

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Prudence and Prevention – Empirical Evidence

Abstract

Theoretical papers show that optimal prevention decisions in the sense of selfprotection (i.e., primary prevention) depend not only on the level of (second-order) risk aversion but also on higher-order risk preferences such as prudence (third-order risk aversion). We study empirically whether these theoretical results hold and whether prudent individuals show less preventive (self-protection) effort than non-prudent individuals. We use a unique dataset that combines data on higher-order risk preferences and various measures of observed real-world prevention behavior. We find that prudent individuals indeed invest less in self-protection as measured by influenza vaccination. This result is driven by high risk individuals such as individuals >60 years of age or chronically ill. We do not find a clear empirical relationship between risk-preferences and prevention in the sense of self-insurance (i.e. secondary prevention). Neither risk aversion nor prudence is related to cancer screenings such as mammograms, Pap smears or X-rays of the lung.

JEL-Code: D12, D81, I12

Keywords: Prudence; risk preferences; prevention; vaccination; screening

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1 Thomas Mayrhofer: Stralsund University of Applied Sciences, Stralsund, and Harvard University, Boston, USA; Hendrik Schmitz: Paderborn University, RWI, and Leibniz Science Campus Ruhr (LSCR). *– We thank Alexander Haering, Timo Heinrich, Richard Peter, Bernt-Peter Robra, Harald Tauchmann and participants of the Health Economics Workshop Stralsund, the annual workshop of the Association of German Health Economists (DGGÖ, Hamburg), the Health Economic committee of the Verein für Socialpolitik (Hohenheim), and the research seminar at RWI Essen for helpful comments and discussion. In this paper we make use of data of the LISS (Longitudinal Internet Studies for the Social sciences) panel administered by CentERdata (Tilburg University, The Netherlands).* *- All correspondence to: Hendrik Schmitz, Department of Economics, Paderborn University, Warburger Str. 100, 33098 Paderborn, Germany, e-mail: hendrik.schmitz@uni-paderborn.de*

1 Introduction

Most economic models assume that individuals prefer more money over less money and less risky situations over more risky situations. In this case individuals are risk-averse. In expected utility theory (EUT) this corresponds to a positive first derivative and a negative second derivative of the utility function. By now, the concept of risk aversion is well established as central to analyzing decisions under uncertainty. However, over the course of the last decades it turned out that risk preferences of individuals are only captured partially by this concept. Higher-order risk preferences such as prudence also impact decisions made by individuals when facing uncertainty. Under EUT, prudent behavior is equivalent to a positive third-order derivative of the utility function (see Eeckhoudt et al., 1995, 1996). Prudence is, therefore, also known as third-order risk aversion or downside risk aversion (Menezes et al., 1980). Most of the commonly used utility functions (e.g. $ln(x)$ and $x^{0.5}$) imply "mixed risk aversion," which means that the derivatives of the utility functions exhibit alternating signs (see Brockett and Golden, 1987, Caballé and Pomansky, 1996). Therefore, these utility functions assume second-order risk aversion ($U^{II} < 0$), as well as higher-order risk preferences, such as prudence ($U^{III} > 0$).

However, the concept of prudence does not depend on the EUT framework. Eeckhoudt and Schlesinger (2006) define prudence as a preference over particular classes of lottery pairs, where a prudent individual prefers to disaggregate a sure loss from an additional zero-mean background risk. This model-free definition does not require as far reaching assumptions as EUT and lends itself to experimental investigations. Deck and Schlesinger (2010, 2014, 2018), Ebert and Wiesen (2011, 2014), Haering et al. (2020), Heinrich and Mayrhofer (2018), Heinrich and Shachat (2018), Krieger and Mayrhofer (2012, 2017), Maier and Rüger (2012), and Noussair et al. (2014) conduct economic experiments and find that a majority of aggregate choices is in line with prudence.[1]

Many theoretical papers show the importance of prudence preferences on decision making in various fields. For instance, prudence preferences are important for intertemporal consumption decisions, i.e. precautionary savings. Prudent individuals save more money today when the risk of the future income increases (Leland, 1968, Sandmo, 1970, and Kimball, 1990). In the health domain prudence preferences are important for test and treatment decisions. Felder and Mayrhofer (2014, 2017) show that prudent individuals test and treat earlier, i.e. at lower pre-test probabilities of illness, than non-prudent individuals when facing a comorbidity risk (background risk). Furthermore, prudence preferences are important for prevention decisions. Eeckhoudt

[1] For an overview of the experimental evidence of higher-order risk preferences see Trautmann and van de Kuilen (2018).

and Gollier (2005) and Courbage and Rey (2006) analyze the impact of prudence preferences on preventive efforts. They distinguish between prevention in the sense of self-protection (primary prevention), i.e. prevention lowers the probability of the occurrence of a loss (while the size of the loss is exogenous) and self-insurance (secondary prevention), an effort aimed at reducing the size of a loss (while the probability of occurrence is exogenous) (see Ehrlich and Becker, 1972). (Second order) risk aversion unambiguously leads individuals to choose higher levels of prevention in the sense of self-insurance. In the case of self-protection, however, risk-aversion is not sufficient to determine the optimal preventive effort (see Dionne and Eeckhoudt, 1985, Briys and Schlesinger, 1990). Eeckhoudt and Gollier (2005) and Courbage and Rey (2006) show that prudent individuals will expend less preventive effort than risk-neutral (and thus prudent-neutral) ones.

So far, there is no empirical evidence with real-world data that tests this theoretical relationship. It is our contribution to the literature to fill this gap. This paper studies empirically whether these theoretical results hold and prudent individuals show less preventive effort (in the sense of self-protection) than non-prudent individuals. We use a unique dataset on higher-order risk preference that was compiled by Noussair et al. (2014) and is available as a subsample of the LISS (Longitudinal Internet Studies for the Social sciences) panel which is a representative sample of the Dutch population. The data combine experimentally elicited risk preferences with real-world prevention behavior and, thus, arguably have both high internal and external validity. We use different measures of prevention. In the main analysis, we look at influenza vaccination as a measure for prevention in the sense of self-protection (see McLean et al., 2014, for evidence from the medical literature). Later, we use screening tests such as mammograms, Pap smear tests, and x-rays of the lung as a measure for prevention in the sense of self-insurance.

We find that for high risk individuals such as individuals >60 years of age, prudence is significantly negative related to the likelihood of undergoing flu vaccination. We find no such effects for screening methods, i.e. prevention in the sense of self-insurance. These results are robust to different measures of vaccination and screening and similar across gender.

In the next section we describe the theoretical findings of the literature regarding the relationship between prudence and prevention and some experimental results. Section 3 gives an overview of the data and descriptive statistics. Section 4 shows empirical specifications and results regarding prudence and prevention in the sense of self-protection. Section 5 studies the relationship between prudence and prevention in the sense of self-insurance and Section 6 concludes.

2 Prudence and prevention – Theoretical and experimental findings

In 1972, Isaac Ehrlich and Gary S. Becker developed a theory of demand for insurance by studying the interaction between market insurance and prevention. In their paper, prevention can be categorized into two different types: i) prevention in the sense of *self-protection* and ii) prevention in the sense of *self-insurance*. While self-protection lowers the probability of the occurrence of a loss (while the size of the loss is exogenous), self-insurance is an effort aimed at reducing the size of a loss, the probability of which is exogenous. Therefore, self-protection is also known as loss prevention and self-insurance as loss reduction. In the clinical (medical) context, self-protection is equivalent to primary prevention – i.e. trying to prevent oneself from getting a disease, e.g. by undergoing influenza vaccination (flu shots) – and self-insurance to secondary prevention – i.e. trying to detect a disease early and prevent it from getting worse, e.g. by undergoing a screening test. Ehrlich and Becker (1972) showed that market insurance and self-insurance are substitutes while market insurance and self-protection can be complements.

This distinction matters because theoretical models provide different predictions for the relationship between risk aversion and prevention: (Second-order) risk aversion unambiguously leads individuals to choose higher levels of prevention in the sense of self-insurance. In the case of self-protection, however, risk-aversion is not sufficient to determine the optimal preventive effort (see Dionne and Eeckhoudt, 1985, Briys and Schlesinger, 1990). Third-order risk aversion, i.e. prudence, also affects the optimal level of prevention: Eeckhoudt and Gollier (2005) showed that a prudent individual will expend less preventive effort than a risk-neutral one (under certain assumptions on the distribution of risks). While this appears counter-intuitive at first, they reason that lowering the preventive effort does not affect the amount of risk an individual faces at the margin (which is why second-order risk preferences are not a clear determinant of self-protection), but it favors the accumulation of wealth he requires to address future risks. In other words: "prudence raises the marginal level of wealth, thereby reducing the willingness to consume wealth in order to finance prevention" (p. 992). Courbage and Rey (2006) took this analysis into the health context: Using a bivariate utility function with arguments for wealth and health, they distinguished between the utility of wealth in different states of health and define "fear of sickness" as the psychological cost of future illness. They showed that fear of sickness (analogous to risk-aversion) is not a sufficient condition to determine the optimal level of health prevention, but that prudence is required as well. In this model, too, prudence leads to lower optimal prevention (because for prudent individuals the marginal cost of the preventive effort is higher and the marginal benefit lower).

Menegatti (2009) extended the original one-period models to two-periods. He argued that in many prevention situations, the preventive effort precedes its effect on the probability. In contrast to the results of one-period models, he found that in the case of two-period models, prudence leads to more prevention. However, Peter (2017) showed that once saving decisions are incorporated (i.e. they are endogenous), results of the one-period models are restored, i.e. prudence leads to less prevention in the sense of self-protection. This is due to a substitution effect between saving and prevention (Menegatti and Rebessi, 2011, and Hofmann and Peter, 2016). Assuming that individuals are able to optimize both, their savings (and, thus, also consumption) and prevention decisions, the two-period model is reduced – in a technical sense – to the one-period world.

Finally, Peter (2019) generalizes the benchmark case of the risk-neutral individual as used in Eeckhoudt and Gollier (2005). Going away from risk-neutrality, for small probabilities of a loss (smaller than 0.5), an increase in risk aversion together with a decrease in prudence leads to more prevention, while a decrease in risk aversion together with an increase in prudence leads to less prevention. Thus, the negative relationship between prudence and prevention is also derived here. Peter (2020) also finds a negative effect of downside risk aversion on prevention.

There are only a few experimental studies and no empirical study with observational data that provide real-world evidence on the role of prudence on prevention behavior. Krieger and Mayrhofer (2017) conducted an economic laboratory experiment to study the relationship between prudence and prevention in the sense of self-protection in general decision situations. They find risk-averse and prudent behavior among their subjects. Moreover, in line with theoretical results, they find that prudent subjects chose significantly less prevention than non-prudent subjects. Interestingly, in their setting, risk aversion is a non-significant predictor for prevention decisions. Masuda and Lee (2019) also conducted an economic laboratory experiment. However, in contrast to Krieger and Mayrhofer (2017) they explicitly studied the impact of prudence on prevention behavior (in a self-protection context) under different timings of loss, i.e. they tested whether prudence will decrease the likelihood to prevent when the loss may occur in the same period – thus following the theoretical results of one-period models such as in Eeckhoudt and Gollier (2005) – and whether prudence will increase the likelihood to prevent when the loss may occur in the future – thus following the theoretical results of two-period models such as in Menegatti (2009). Masuda and Lee (2019) find that prudent subjects exert less effort than risk neutral players regardless of the timing of loss.

3 Data and descriptive statistics

In this paper we make use of data of the LISS (Longitudinal Internet Studies for the Social sciences) panel administered by CentERdata (Tilburg University, The Netherlands). The LISS panel is a representative sample of 4,500 Dutch households and about 7,000 individuals who participate in monthly Internet surveys. The panel is based on a true probability sample of households drawn from the population register. Households that could not otherwise participate are provided with a computer and Internet connection. A longitudinal survey is fielded in the panel every year, covering a large variety of domains including work, education, income, housing, time use, political views, values and personality. More information about the LISS panel can be found at www.lissdata.nl or in Scherpenzeel and Das (2010). For this, study we make use of a couple of subsamples of the panel.

Measures of risk preferences

The measures of risk preferences are taken from the subsample "Measuring Higher Order Risk Attitudes of the General Population", which was carried out by Noussair et al. (2014) as a single wave study in December 2009. It is based on a random selection of members of the LISS panel of 16 years of age and older. The incentivized experiment consisted of 17 lottery tasks which were designed to measure the degree of risk aversion, prudence, and temperance. To measure risk aversion, individuals were asked to choose between a risky option of receiving either 5 or 65 Euros with equal probability or a save payment. In the five questions regarding risk aversion, the save payment varied between 20, 25, 30, 35, and 40 Euros. These options are listed in Table 1, where $[x\_y]$ indicates an equiprobable lottery to receive either x or y. Following Noussair et al. (2014), we measure the degree of individual risk aversion by the number of safe choices (left lottery chosen) made.

There were also five tasks to measure prudence. Again, individuals decided between two options which are listed in Table 1. All options now included a background risk realized by a second lottery. As an example, the left lottery of *Prudence 1* means that, with 50 per cent probability, individuals receive a payoff of 60. With 25 per cent probability, they receive a payoff of 110 (90+20) and with another 25 per cent probability a payoff of 70 (90-20). Choosing the left lottery in Table 1 indicates prudence. Again in line with Noussair et al. (2014), we measure prudence by the number of prudent choices in the five choice situations. Thus, both *risk aversion* and *prudence* are variables ranging from 0 to 5 with higher values implying higher risk aversion or prudence.

In total, 3,547 individuals from the LISS panel participated in the experiment. While 1,386 attended the real experiment, 2,161 played a hypothetical game. Noussair et al.

Table 1: List of choice tasks

	Left lottery	Right lottery
Risk aversion 1	20	[65_5]
Risk aversion 2	25	[65_5]
Risk aversion 3	30	[65_5]
Risk aversion 4	35	[65_5]
Risk aversion 5	40	[65_5]
Prudence 1	[(90+[20_-20])_60]	[90_(60+[20_-20])]
Prudence 2	[(90+[10_-10])_60]	[90_(60+[10_-10])]
Prudence 3	[(90+[40_-40])_60]	[90_(60+[40_-40])]
Prudence 4	[(135+[30_-30])_90]	[135_(90+[30_-30])]
Prudence 5	[(65+[20_-20])_35]	[65_(35+[20_-20])]

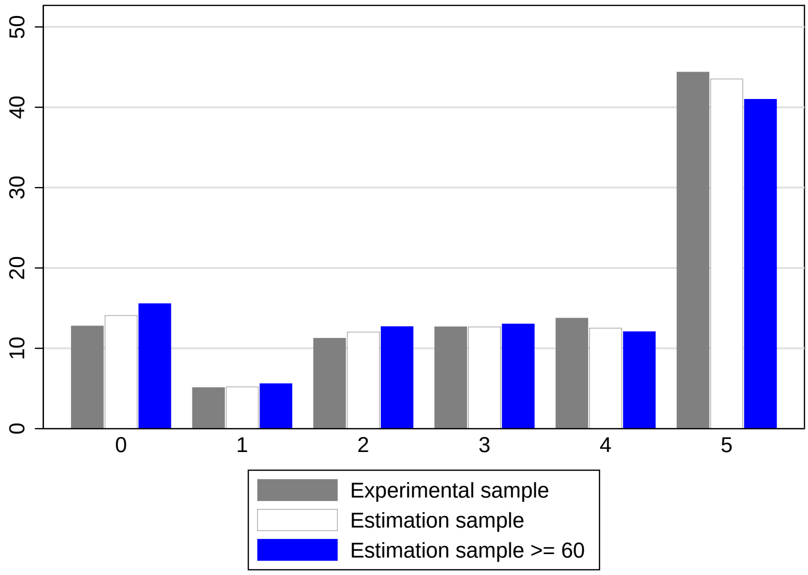
Notes: Taken from Noussair et al. (2014). $[x\_y]$ indicates an equiprobable lottery to receive either x or y; choice of the left lottery indicates risk aversion, and prudence, respectively. We do not report the tasks for temperance as this is not relevant for our study.

(2014) show that it does not make a difference for their findings whether individuals played the real or hypothetical game. In the regressions below we control for these differences. Figure 1 shows the distribution of prudence both among the 3,547 individuals as well as in our final estimation sample with around 2,000 individuals. Our estimation sample is smaller because not all control variables are observed for each individual (around 300 cases) and, more importantly, because we restrict the sample to individuals above the age of 40 (see below). Apparently, the distribution is not affected at all by any age restrictions, even if we restrict the sample to individuals 60+. In contrast to well-known findings with regard to risk aversion (Dohmen et al., 2011), there does not seem to be an age gradient in prudence.[2] Around 45% of all individuals choose the prudent option in all five lotteries while the remaining subjects are distributed fairly equal across the other choice options.

Theoretically, prudent individuals are expected to choose all five prudent options while imprudent ones are expected to choose no prudent option at all. This gives rise to a binary measure of "unambiguous prudence", taking on the value 1 for those who opted five times for the prudent lottery and 0 for those who never opted for it. To allow for minor inconsistencies (and increase sample size) we define a binary measure *Prudence 4/5 vs. 0/1* for further analyses. When we use this indicator below, individuals with realizations of 2 or 3 in the raw prudence measure are excluded. The definition of *Prudence 4/5* seems arbitrary but the conclusions drawn below also hold for other measures such as *Prudence 3/4/5* or *Prudence 5* where the results are even more pronounced.

[2] This can also be seen in Figure A1 in the Appendix that graphs average prudence by age.

Figure 1: Distribution of prudence



Notes: The graph shows relative frequencies of the six possible values of prudence in the three samples. Experimental sample is the sample of all 3,547 individuals that participated in the experiment on risk preferences by Noussair et al. (2014). Estimation sample are the 2,038 individuals that enter the main regression in Table 2, 944 of them are age 60+.

The risk preferences we utilize are measured in the financial domain while we are mainly interested in the health domain. Dohmen et al. (2011) show that self-reported willingness to take risks in the two domains financial risks and health risks are strongly correlated. They also share the same primary determinants such as age, gender, body height and parental education. Decker and Schmitz (2016) find that health shocks have a significant effect on general risk preferences. Attema et al. (2019), in their experimental study, classify individuals as risk-averse and prudent according to the two domains wealth (as the financial domain) and longevity (as the health domain). They do not report correlations in individual classifications, that is, whether individuals who are prudent in the financial domain are also prudent in the health domain. However, descriptive statistics and, in general, their findings are very similar for both domains. This allows the tentative conclusion that information on risk preferences in the financial domain also help to infer risk preferences in the health domain, subject to measurement error, of course.

Measures of prevention

The main dependent variable in this study is a binary variable indicating an influenza vaccination in the previous 12 months. This is a measure of self-protection in the sense that it reduces the likelihood to get influenza, thus, it reduces the probability of a loss. In contrast, self-insurance reduces the size of a loss (Ehrlich and Becker, 1972). Examples of self-insurance are cancer screenings that, if cancer is detected in an early stage, might reduce mortality due to this type of cancer.

Information on flu vaccination is taken from the *health* module which is part of the core study and available as a panel. To match the timing of the experiment on risk preferences we use wave 3, sampled in November 2009. Thus, all our analyses will only make use of cross-sectional information. This module also contains information on screening measures such as mammogram or Pap smear.

Other modules of the LISS such as *disease prevention* from 2008 or *health prevention* from 2010 also include information on influenza vaccination and screening. Table A1 in the Appendix shows which measures are available in the different data sets. Some of the questions are exactly the same (Did you have a flu vaccination over the past 12 months?) as the one we use in our main specification, others are different (How many times did you have a flu shot in the past 5 years? How many times have you had a flu shot in the last 6 years?). Regression results below and in the Appendix also reveal that the findings are robust to the choice of subsample/flu shot measure. We mainly use the flu shot variable from the *health* module because it has the largest number of respondents. To keep the sample homogeneous throughout specifications, however, we restrict it to individuals older than 40 in the regression analysis as some prevention measures are only available for this age group.[3]

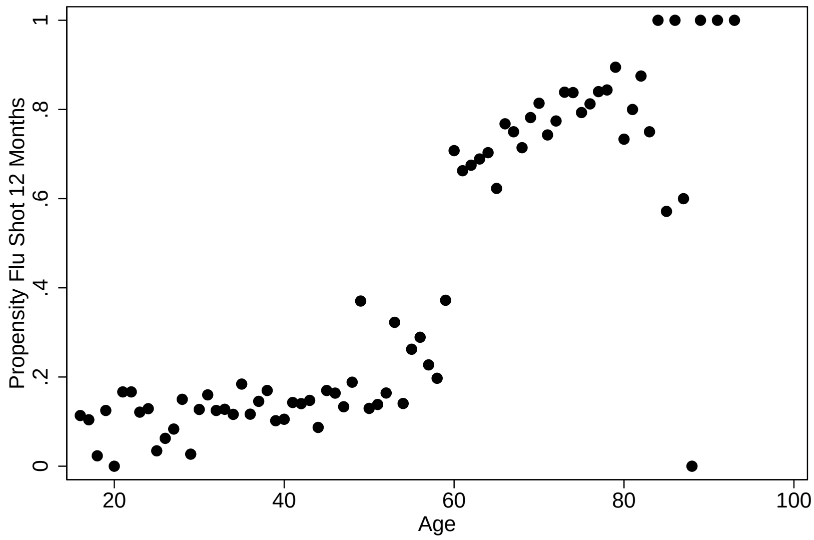
Figure 2 shows average vaccination rates by age. At values of 10-20 per cent, the rates are low for individuals below the age of 50. Afterwards, there is a slight increase in age until 59 and a sharp discontinuity between 59 and 60, followed by a further increase in age. On average, 70 per cent of the 60 year olds get a flu shot, and this number converges to around 100 per cent for those older than 80. The jump by 30 percentage points between 59 and 60 is clearly driven by guidelines in the Dutch health care system. Influenza vaccinations are free of charge and recommended by physicians for "high risk groups". These are individuals who have a higher risk of becoming seriously ill after contracting influenza: individuals with certain diseases like cardiovascular disease, lung diseases, or diabetes, and individuals above the age of 60.[4]

The bivariate relationship between prudence and self-protection can be seen in the following statistics (not shown in a table). Those with prudence of 0 or 1 have a 39.3 per cent probability to get a flu vaccination while those with prudence of 4 or 5 have a 32.5 per cent probability. These unconditional figures point to the negative relationship outlined in Section 2 but will be needed to be corroborated in regressions controlling for demographic characteristics in the next section.

[3]This does not affect the results. Effects are only found for those age 60+. Absence of effects for those younger than 60 is not affected by including the 20-39 year olds.

[4]See e.g. Ministry of Health, Welfare and Sport: https://www.government.nl/topics/vaccinations/question-and-answer/where-can-i-get-the-free-flu-jab

Figure 2: Flu shots by age groups



Notes: The graph shows unconditional sample means of flu shots in the previous 12 month by age in years.

The data set includes information on screening for cancer and other diseases that can be used as self-insurance device. Specifically, we exploit information on mammograms in the previous two years (yes/no), Pap smear in the previous 5 years (yes/no), the number of x-rays of the lung to detect a chronic lung disease in the previous 10 years as well as the number of non-invasive tests for cancer in a hospital in the past 10 years. Mammogram and Pap smear are only relevant for women while all individuals are asked the other two questions.

Figure 3 reports the distribution of screening variables. Again, guidelines are clearly visible for mammograms which are almost exclusively carried out between 50 and 70 and Pap smear which is relevant between the age 30 and 50. No clear pattern is visible for x-rays of the lungs and non-invasive cancer screening.

Other controls

In the regressions below we add control variables that might be correlated with both prudence and prevention. These are the socio-economic variables such as age, gender, wealth, or gross income which have also been used by Noussair et al. (2014). We follow Schmitz and Wübker (2011) in also accounting for indicators of high-risk, namely the diagnoses angina pectoris, heart disease, stroke, diabetes, lung disease, asthma, and arthritis. We also include the self-rated health status on a five-point scale. Sample means and descriptions of all variables are reported in Table 2.

Figure 3: Screening measures by age groups

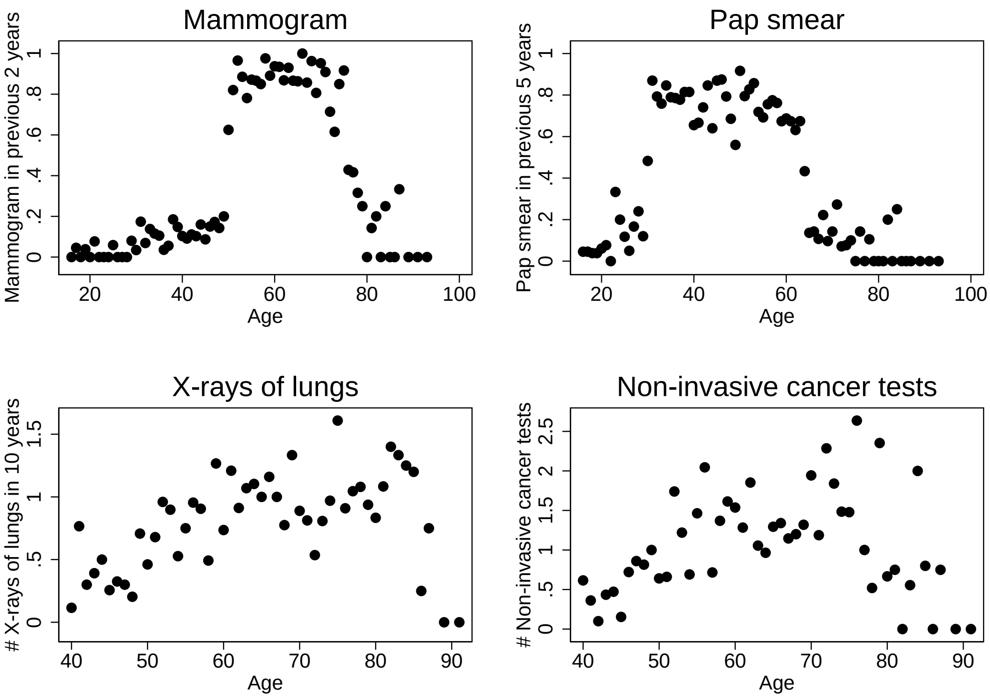


Table 2: Variable description and statistics

Variable name	Description	Mean	SD	Min	Max
Dependent variables:					
Flu shot binary	Did you have a flu vaccination over the past 12 months?	0.45	0.50	0	1
Number of flu shots	How many times have you had a flu shot in the last 6 years?	1.50	2.46	0	11
Mammogram	Have you had an X-ray taken of one or both breasts. over the past two years?	0.64	0.48	0	1
Pap smear	Have you had a smear test taken over the past five years?	0.56	0.50	0	1
X-ray lungs	How many times in the past 10 years did you have a chest X-ray to detect a chronic lung disease?	0.86	2.13	0	20
Non-invasive cancer screening	How many times in the past 10 years did you do any non-invasive test for cancer in a hospital?	1.13	2.62	0	20
Risk preferences:					
Prudence		3.35	1.83	0	5
Prudence 4/5 vs. 0/1	Binary: 1 if prudence = 4 or 5, 0 if prudence = 0 or 1	0.74	0.44	0	1
Risk aversion		3.37	1.72	0	5
Temperance		3.02	1.86	0	5
Socio-economic controls:					
Female		0.51	0.50	0	1
Age/10	Age divided by 10	5.89	1.08	4.1	9.3
Age/10 squared		35.83	13.12	16.81	86.49
Married		0.70	0.46	0	1
Divorced		0.11	0.32	0	1
Number of Kids		0.57	0.98	0	6
Homeowner		0.73	0.45	0	1
Education: high		0.30	0.46	0	1
Health status:					
Angina Pectoris	Has a physician told you this last year that you suffer from one of the following diseases / problems? More than one answer possible: angina, pain in the chest	0.05	0.23	0	1
Heart Attack	Has a physician... a heart attack including infarction or coronary thrombosis or another heart problem including heart failure	0.03	0.16	0	1
Stroke	Has a physician... a stroke or brain infarction or a disease affecting the blood vessels in the brain	0.01	0.10	0	1
Diabetes	Has a physician... diabetes or a too high blood sugar level	0.07	0.25	0	1
Lung disease	Has a physician... chronic lung disease such as chronic bronchitis or emphysema	0.04	0.21	0	1
Asthma	Has a physician... asthma	0.04	0.19	0	1
Arthritis	Has a physician... arthritis, including osteoarthritis, or rheumatism, bone decalcification or osteoporosis	0.11	0.32	0	1
Self-assessed health	How would you describe your health. generally speaking? 1 = poor; 5 = excellent	3.03	0.73	1	5
GP visits	Number of GP visits in past 12 months	2.58	3.13	0	48
Hospital visit	Any hospital visit in past 12 months (binary)	0.11	0.32	0	1
Controls for treatments:					
Hyponorm	Hypothetical treatment: normal stakes	0.30	0.46	0	1
Hypohigh	Hypothetical treatment: highl stakes	0.29	0.45	0	1
Reallow	Real treatment: low stakes	0.10	0.30	0	1
(reference category:)	Real treatment: normal stakes				
Counter 1		0.51	0.50	0	1
Counter 2		0.48	0.50	0	1
Counter 3		0.51	0.50	0	1

Notes: Number of observations 2,038. Except for some screening measures which are only available for women.

4 Regression results: self-protection

We run probit regressions of the prevention indicators on risk preferences, the other mentioned controls, as well as control variables of the different treatments in the experiment, see Table 2 for a complete list. We start with results on self-protection (influenza vaccination) and show results on self-insurance in Section 5. Table 3 reports marginal effects of nine separate regressions in the nine columns. Full estimation results are shown in Table A2 in the Appendix. In columns (1)-(3) all age groups are pooled (that is ages 41 and older), results for age group 41-59 are shown in columns (4)-(6) while those for age group 60 and older are in columns (7)-(9). For all three groups we report results with prudence as the only measure of risk preferences (columns (1), (4), (7)) and also accounting for other risk preferences such as risk aversion and temperance (columns (2), (5), (8)).[5] We also report results with the binary measure of unambiguous prudence.

Table 3: Regression results: Flu vaccination (marginal effects)

Sample:	All			Age 41-59			Age 60+		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Prudence	-0.012*	-0.012		-0.001	0.003		-0.014*	-0.016*	
	(0.007)	(0.008)		(0.007)	(0.007)		(0.008)	(0.009)	
Prudence 4/5 vs. 0/1			-0.063*			0.003			-0.075*
			(0.036)			(0.032)			(0.043)
Risk aversion		0.002	-0.001		0.008	0.013		-0.009	-0.021*
		(0.008)	(0.009)		(0.008)	(0.009)		(0.009)	(0.011)
Sample mean of dep. variable	0.453	0.453	0.453	0.205	0.205	0.204	0.742	0.742	0.750
Observations	2,038	2,038	1,535	1,094	1,094	834	944	944	701

Robust standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Each column presents marginal effects from separate probit regressions regressions. Marginal effects are evaluated at sample averages. All regressions include gender, age and treatment as well as socio-economic controls and health indicators. Full estimation results in Table A2 in the Appendix.

Starting with the pooled results for all age groups, we find a negative relationship between prudence and prevention. An increase in the prudence measure by one unit goes along with a decreased probability to get vaccination by 1.2 percentage points (column 1). This effect is marginally significant at the 10 per cent level. Also accounting for risk aversion does not change the marginal effect but increases the standard errors

[5] In the regression tables we only report the most interesting variables. As temperance is not part of the theoretical models we do not separately report its effects in the main text for sake of brevity. Yet, full regression results for all variables can be found in the Appendix.

(column 2). Risk aversion itself is not related to prevention which is in line with Krieger and Mayrhofer (2017).[6] The results using the binary prudence measure in column 3 almost perfectly reflect the raw differences found in Section 3 with an effect of 6.3 percentage points. This gives rise to the assumption that prudence is an exogenous character trait which is not correlated with other variables that at the same time affect prevention.

Nevertheless, the relationship between prudence and prevention might be heterogeneous for different individuals. The columns 4-9 reveal that the relationship is completely driven by the high-risk individuals above the age of 60. Given the low vaccination rates of the younger individuals, this finding does not come as a surprise. For individuals with a high loss in case of illness (the high risk individuals) prudence is negatively related to prevention in the sense of self-protection. Thus, we find empirical confirmation of the theoretically derived results by Courbage and Rey (2006) and Peter (2017, 2019). Yet, this only holds for prudence. Empirically, we do not observe the positive relationship between risk aversion and prevention as theoretically described by Peter (2019).

The notion of the high-risk group driving the results is corroborated in Table 4 where, in the first two columns, we only include those individuals from the age group 41-59 that we can clearly identify as being high risk. That is, we only keep those with at least one of the illnesses we control for or those with a poor self-rated health status. These are 197 individuals with an average probability of an influenza vaccination of 52 per cent. In this group we find an even stronger relationship between prudence and self-protection than in the one of individuals above 60 years of age. An increase in the prudence measure by one unit goes along with a decreased likelihood of getting a flu shot by 4.3 percentage points. Particularly strong are the differences between the unambiguously prudent and imprudent. The prudent high-risk individuals have a 22.6 percentage points lower probability to get vaccination than the imprudent ones.

In the next step we change the dependent variable to the number of influenza vaccinations in the previous 6 years. While 69 per cent in the full sample report to have had no vaccination, 18 per cent had a vaccination in each of the six years. 13 per cent report a number between 1 and 5.[7] For this outcome, we report results from linear regressions in the last two columns of Table 4 and omit the effects for the binary prudence measure for sake of brevity. These go into the same direction. The results are not affected by this change in outcome variable. In the group of individuals 60 years and older, one more unit of prudence goes along with a decreased expected number of flu shots

[6]Note that the findings for risk aversion do not change when a binary indicator is used instead of the variable ranging from 0 to 5.

[7]We drop five individuals who state to have had more than six flu shots in the previous six years.

within 6 years of 0.118. Table A3 in the Appendix reports results of two other measures of influenza vaccination. The pattern observed so far holds there, too.

Table 4: Results: Alternative specifications

	Flu shot binary		Number of flu shots	
	Age 41-59 high risk	Age 41-59 high risk	Age 41-59	Age 60+
Prudence	-0.043*		-0.008	-0.118**
	(0.024)		(0.029)	(0.058)
Prudence 4/5 vs. 0/1		-0.226*		
		(0.120)		
Risk aversion	-0.005	0.005	0.015	-0.022
	(0.026)	(0.032)	(0.030)	(0.054)
Sample mean of dep. variable	0.518	0.497	0.642	2.529
Observations	197	153	879	695

Robust standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. All regressions include gender, age and treatment as well as socio-economic controls and health indicators. Columns 1 and 2 use the same outcome variable as before and report marginal effects after probit regressions. Columns 3 and 4 use the number of flu shots in the previous six years as an alternative outcome variable and report coefficients of ordinary least squares regressions.

Table 5 reports results separately by gender. While we lose statistical significance, the effect sizes remain unchanged and there is no notable difference between men and women. We also report results for subgroups of risk averse and risk loving individuals as classified by Noussair et al. (2014). The finding of a negative relationship between prudence and self-protection is found in both groups, even with stronger effects sizes. The coefficient is less precise for the risk loving due to a strongly reduced number of observations. We do not report the results for the risk-neutral where the coefficient of prudence is virtually zero.

5 Self-insurance

Finally, we study the relationship between prudence and prevention in the sense of self-insurance. We use the baseline sample of the previous section but change the outcome variable. As outlined in Section 3, we now look at mammograms, Pap smears, X-rays of the lung and non-invasive cancer screenings. In the first two measures, only women are affected and thus included in our analysis.

Table 5: Regression results by gender and risk aversion

Sample:	Age 41-59		Age 60+		Age 60+	
	Females	Males	Females	Males	Risk Averse	Risk Loving
Prudence	0.005	0.000	-0.014	-0.017	-0.023**	-0.025
	(0.010)	(0.009)	(0.013)	(0.013)	(0.011)	(0.027)
Risk aversion	0.009	0.007	0.003	-0.016		
	(0.012)	(0.010)	(0.013)	(0.013)		
Sample mean of dep. variable	0.215	0.188	0.742	0.753	0.738	0.727
Observations	576	515	454	484	732	105

Robust standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Each column presents marginal effects from separate probit regressions regressions. Marginal effects are evaluated at sample averages. All regressions include age and treatment as well as socio-economic controls and health indicators. In the regressions for the subgroups "risk averse" and "risk loving" we do not further control for the degree of risk aversion.

We report regression results in Table 6. All in all, the results are much weaker than before. Apart from mammograms for the group of individuals above 60, there is no correlation between prudence and self-insurance. This is in line with theoretical results that predict a (positive) relationship between risk aversion and self-insurance but no impact of prudence. Interestingly, however, we also do not find a significant positive relationship between risk aversion and prevention in the sense of self-insurance. It is even negative for mammograms among the younger women but we do not want to interpret this single significant coefficient as evidence that might also be a result of a multiple testing problem. Note that the implications do not change if we group the individuals differently (e.g. < 50, 50-70, > 70), as reported in Table A4 in the Appendix. The findings also do not differ when we use the binary measure of unambiguous prudence which is not reported here for sake of brevity. Thus, we conclude that we find an expected result for the relationship between prudence and self-insurance (namely no relationship) while we cannot provide empirical evidence for the theoretically expected relationship with risk aversion.

6 Conclusion

In this paper, we analyze the empirical relationship between prudence and prevention. We link experimentally elicited measures of prudence with real-world behavior on prevention. We discriminate two types of prevention: prevention in the sense of self-protection (proxied by the decision to vaccinate against influenza) and prevention in

Table 6: Regression results: Other Measures (marginal effects)

Sample:	Full sample		Age 41-59		Age 60+	
Mammogram:						
Prudence	0.000	(0.010)	0.010	(0.016)	-0.022*	(0.013)
Risk aversion	-0.015	(0.012)	-0.031*	(0.017)	-0.004	(0.014)
Sample mean of dep. variable	0.641		0.544		0.763	
Observations	1039		579		460	
Pap smear:						
Prudence	0.009	(0.011)	-0.000	(0.011)	0.011	(0.014)
Risk aversion	-0.007	(0.012)	0.005	(0.012)	-0.016	(0.015)
Sample mean of dep. variable	0.557		0.756		0.298	
Observations	1039		561		460	
X-ray lungs:						
Prudence	-0.007	(0.007)	-0.004	(0.009)	-0.011	(0.011)
Risk aversion	0.002	(0.007)	0.006	(0.010)	-0.002	(0.011)
Sample mean of dep. variable	0.855		0.660		1.079	
Observations	1728		902		818	
Non-invasive cancer screening:						
Prudence	0.003	(0.007)	0.012	(0.009)	-0.008	(0.011)
Risk aversion	0.001	(0.007)	0.002	(0.009)	-0.001	(0.011)
Sample mean of dep. variable	1.132		0.950		1.336	
Observations	1727		911		816	

Robust standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

the sense of self-insurance (proxied by the decision to take mammograms, Pap smear, X-rays for lung cancer or non-invasive cancer screening). To the best of our knowledge, we are the first to test the theoretically derived relationships between higher-order risk preferences and health prevention using data outside the lab. In fact, we find evidence as theoretically predicted by Courbage and Rey (2006), Eeckhoudt and Gollier (2005) and Peter (2017, 2019).

The main finding of this paper is that for individuals with a high loss in case of illness (the high risk individuals) prudence is negatively related to prevention in the sense of self-protection. On the one hand, less prevention is – at least in part – not the result of irrational behavior but based on individual (risk) preferences which could be used to argue against a policy intervention. However, on the other hand, these individual risk preferences do not take into account that vaccination will have positive externalities and a higher vaccination rate does not only protect the individual but also other individuals who are likely in the same (high) risk group (e.g. >60 years of age). Thus, externalities may make the case for government intervention.

It is obvious that COVID-19 and influenza are not the same, yet, they do share similarities, in particular when it comes to the definition of high risk groups. Moreover, both may be life-threatening for these groups. Thus, we argue that knowledge about determinants of voluntary influenza vaccinations may also be of help to infer about possible COVID-19-vaccination behavior. Thus, absent knowledge of potential COVID-19 vaccination behavior, findings in this paper might inform policymakers on how to increase COVID-19 vaccination rate once a vaccine is available. In case governments shy away from making vaccination compulsory (and there are good arguments to do this), targeted information on importance of vaccination might help to convince prudent individuals. To identify prudent individuals we, again, go back to Noussair et al. (2014) who study correlations of prudence with socio-demographic characteristics. It turns out that the one predictor of prudence that is significant throughout all specifications is education and cognitive ability. Highly educated individuals are more likely to be prudent. On the one hand, this may help to explain why "vaccination skepticism" (often related to the question of vaccination against measles and other children's diseases) is mainly a phenomenon among highly educated individuals. On the other hand, it might be of help in constructing targeted campaigns for influenza- (and, maybe also COVID-19) vaccination which might address highly educated older individuals in the high risk group. For instance, traditional newspapers might be a more promising channel than, for instance, social media in order to reach this target group.

This paper shows how observational data from outside the laboratory can be used to complement theoretical and experimental research in the field of higher-order risk preferences. Of course, this comes at the cost of some simplifications. For instance, we cannot take time preferences into account which might be relevant in decisions that have implications not only for the present but also for the future. Yet, as influenza vaccination decisions only have short-term implications – they need to be renewed every year – this might not be too problematic in our case. Chapman and Coups (1999) actually show that vaccination decisions are not related to health-based measures of time preferences (although they do correlate with monetary time-preference measures).

References

Attema, A. E., l'Haridon, O., and van de Kuilen, G. (2019). Measuring multivariate risk preferences in the health domain. *Journal of Health Economics*, 64:15 – 24.

Briys, E. and Schlesinger, H. (1990). Risk aversion and the propensities for self-insurance and self-protection. *Southern Economic Journal*, 57:458–467.

Brockett, P. L. and Golden, L. L. (1987). A class of utility functions containing all the common utility functions. *Management Science*, 33(8):955–964.

Caballé, J. and Pomansky, A. (1996). Mixed risk aversion. *Journal of Economic Theory*, 71(2):485–513.

Chapman, G. B. and Coups, E. J. (1999). Time preferences and preventive health behavior: Acceptance of the influenza vaccine. *Medical Decision Making*, 19(3):307–314. PMID: 10424837.

Courbage, C. and Rey, B. (2006). Prudence and optimal prevention for health risks. *Health Economics*, 15(12):1323–1327.

Deck, C. and Schlesinger, H. (2010). Exploring higher order risk effects. *Review of Economic Studies*, 77(4):1403–1420.

Deck, C. and Schlesinger, H. (2014). Consistency of higher order risk preferences. *Econometrica*, 82(5):1913–1943.

Deck, C. and Schlesinger, H. (2018). On the robustness of higher order risk preferences. *Journal of Risk and Insurance*, 85(2):313–333.

Decker, S. and Schmitz, H. (2016). Health shocks and risk aversion. *Journal of Health Economics*, 50(C):156–170.

Dionne, G. and Eeckhoudt, L. (1985). Self-insurance, self-protection and increased risk aversion. *Economics Letters*, 17(1-2):39–42.

Dohmen, T., Falk, A., Huffman, D., Sunde, U., Schupp, J., and Wagner, G. G. (2011). Individual Risk Attitudes: Measurement, Determinants, And Behavioral Consequences. *Journal of the European Economic Association*, 9(3):522–550.

Ebert, S. and Wiesen, D. (2011). Testing for prudence and skewness seeking. *Management Science*, 57(7):1334–1349.

Ebert, S. and Wiesen, D. (2014). Joint measurement of risk aversion, prudence, and temperance. *Journal of Risk and Uncertainty*, 48(3):231–252.

Eeckhoudt, L. and Gollier, C. (2005). The impact of prudence on optimal prevention. *Economic Theory*, 26(4):989–994.

Eeckhoudt, L., Gollier, C., and Schlesinger, H. (1996). Changes in background risk and risk-taking behavior. *Econometrica*, 64(3):683–89.

Eeckhoudt, L., Gollier, C., and Schneider, T. (1995). Risk-aversion, prudence and temperance: A unified approach. *Economics Letters*, 48(3):331 – 336.

Eeckhoudt, L. and Schlesinger, H. (2006). Putting risk in its proper place. *American Economic Review*, 96(1):280–289.

Ehrlich, I. and Becker, G. (1972). Market insurance, self-insurance, and self-protection. *Journal of Political Economy*, 80(4):623–48.

Felder, S. and Mayrhofer, T. (2014). Risk preferences: Consequences for test and treatment thresholds and optimal cutoffs. *Medical Decision Making*, 34(1):33–41.

Felder, S. and Mayrhofer, T. (2017). *Medical Decision Making: A Health Economic Primer*. Springer, Berlin Heidelberg, second edition.

Haering, A., Heinrich, T., and Mayrhofer, T. (2020). Exploring the consistency of higher-order risk preferences. *International Economic Review*, 61(1):283–320.

Heinrich, T. and Mayrhofer, T. (2018). Higher-order risk preferences in social settings. *Experimental Economics*, 21(2):434–456.

Heinrich, T. and Shachat, J. (2018). The development of risk aversion and prudence in chinese children and adolescents. Mpra paper, University Library of Munich, Germany.

Hofmann, A. and Peter, R. (2016). Self-insurance, self-protection, and saving: On consumption smoothing and risk management. *Journal of Risk and Insurance*, 83(3):719–734.

Kimball, M. S. (1990). Precautionary saving in the small and in the large. *Econometrica*, 58(1):53–73.

Krieger, M. and Mayrhofer, T. (2012). Patient preferences and treatment thresholds under diagnostic risk - an economic laboratory experiment. Ruhr Economic Papers 321, RWI - Leibniz-Institut für Wirtschaftsforschung, Ruhr-University Bochum, TU Dortmund University, University of Duisburg-Essen.

Krieger, M. and Mayrhofer, T. (2017). Prudence and prevention: an economic laboratory experiment. *Applied Economics Letters*, 24(1):19–24.

Leland, H. E. (1968). Saving and uncertainty: The precautionary demand for saving. *The Quarterly Journal of Economics*, 82(3):465–473.

Maier, J. and Rüger, M. (2012). Experimental evidence on higher order risk preferences with real monetary losses. *Working Paper, Munich*.

Masuda, T. and Lee, E. (2019). Higher order risk attitudes and prevention under different timings of loss. *Experimental Economics*, 22(1):197–215.

McLean, H. Q., Meece, J. K., and Belongia, E. A. (2014). Influenza vaccination and risk of hospitalization among adults with laboratory confirmed influenza illness. *Vaccine*, 32(4):453 – 457.

Menegatti, M. (2009). Optimal prevention and prudence in a two-period model. *Mathematical Social Sciences*, 58(3):393–397.

Menegatti, M. and Rebessi, F. (2011). On the substitution between saving and prevention. *Mathematical Social Sciences*, 62(3):176–182.

Menezes, C., Geiss, C., and Tressler, J. (1980). Increasing downside risk. *The American Economic Review*, 70(5):921–932.

Noussair, C. N., Trautmann, S. T., and van de Kuilen, G. (2014). Higher Order Risk Attitudes, Demographics, and Financial Decisions. *Review of Economic Studies*, 81(1):325–355.

Peter, R. (2017). Optimal self-protection in two periods: On the role of endogenous saving. *Journal of Economic Behavior & Organization*, 137(C):19–36.

Peter, R. (2019). Who should exert more effort? risk aversion, downside risk aversion and optimal prevention. Technical report, Available at SSRN: https://ssrn.com/abstract=3383853 or http://dx.doi.org/10.2139/ssrn.3383853.

Peter, R. (2020). A fresh look at prevention for health risks. Technical report, mimeo.

Sandmo, A. (1970). The effect of uncertainty on saving decisions. *Review of Economic Studies*, 37(3):353–360.

Scherpenzeel, A. and Das, J. (2010). *'True' longitudinal and probability-based internet panels: Evidence from the Netherlands*, pages 77–103. Taylor & Francis. Pagination: 504.

Schmitz, H. and Wübker, A. (2011). What determines influenza vaccination take-up of elderly europeans? *Health Economics*, 20(11):1281–1297.

Trautmann, S. T. and van de Kuilen, G. (2018). Higher order risk attitudes: A review of experimental evidence. *European Economic Review*, 103:108 – 124.

Appendix

Table A1: Prevention and self-insurance variables

Variable name	Description
Data set: Health (Collection period: 2009-11-02 to 2009-11-25)	
flu_shot_health1	Did you have a flu vaccination over the past 12 months?
pap_smear_health5	Have you had a smear test taken over the past five years?
mammogram_health2	Have you had an X-ray taken of one or both breasts, over the past two years?
Data set: Health prevention (Collection period: 2010-08-02 to 2010-08-31)	
flu_shot5	How many times did you have a flu shot in the past 5 years?
measure_blood_p	How often do you measure your blood pressure?
measure_sugar	How often do you measure the sugar level in the blood?
x_ray_lungs	How many times in the past 10 years did you have a chest X-ray to detect a chronic lung disease?
non_inv_cancer	How many times in the past 10 years did you do any non-invasive test for cancer in a hospital?
self_exam_cancer	How often do you perform a self-examination for any type of cancer?
Data set: Disease prevention (Collection period: 2008-09-04 to 2008-10-07)	
flu_shot1	Have you had a flu shot in the last 12 months?
flu_shot6	How many times have you had a flu shot in the last 6 years?
mammogram2	Have you had a mammogram in the last 2 years?
mammogram6	How many times have you had a mammogram in the last 6 years? If during the (photo)session several photos were taken, count this as 1.
pap_smear5	Have you had a Pap smear in the last 5 years?
pap_smear15	How many times have you had a Pap smear in the last 15 years? Please give your best guess if you do not know the exact answer.

Notes: Own description.

Table A2: Full regression results: Flu shot (coefficients)

Sample:	All			Age 41-59			Age 60+		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Prudence	-0.031*	-0.030		-0.003	0.011		-0.045*	-0.051*	
	(0.017)	(0.019)		(0.026)	(0.027)		(0.025)	(0.030)	
Prudence 4/5 vs. 0/1			-0.160*			0.014			-0.252*
			(0.090)			(0.126)			(0.144)
Risk aversion		0.006	-0.002		0.031	0.054		-0.031	-0.069*
		(0.020)	(0.023)		(0.030)	(0.035)		(0.030)	(0.036)
Temperance		-0.006	-0.010		-0.054*	-0.080***		0.033	0.053
		(0.020)	(0.022)		(0.028)	(0.031)		(0.030)	(0.034)
Female	-0.001	-0.003	0.057	0.068	0.060	0.092	-0.024	-0.017	0.014
	(0.067)	(0.068)	(0.079)	(0.099)	(0.100)	(0.116)	(0.101)	(0.101)	(0.119)
Age/10	1.686***	1.687***	1.832***	0.761	0.653	1.222	1.509	1.513	0.352
	(0.397)	(0.396)	(0.458)	(1.828)	(1.822)	(2.094)	(1.375)	(1.377)	(1.633)
Age/10 squared	-0.084***	-0.084***	-0.096***	-0.043	-0.033	-0.091	-0.094	-0.094	-0.020
	(0.032)	(0.032)	(0.037)	(0.181)	(0.181)	(0.208)	(0.097)	(0.097)	(0.115)
Hyponorm	-0.143*	-0.144*	-0.154	-0.216*	-0.239**	-0.299**	-0.106	-0.117	-0.085
	(0.083)	(0.083)	(0.096)	(0.119)	(0.120)	(0.140)	(0.121)	(0.120)	(0.145)
Hypohigh	-0.141*	-0.143*	-0.135	-0.284**	-0.300**	-0.314**	-0.065	-0.061	-0.005
	(0.083)	(0.083)	(0.096)	(0.123)	(0.124)	(0.143)	(0.120)	(0.120)	(0.140)
Reallow	0.047	0.046	0.129	-0.045	-0.070	-0.097	-0.024	-0.019	0.103
	(0.114)	(0.114)	(0.139)	(0.179)	(0.181)	(0.221)	(0.162)	(0.161)	(0.195)
Counter 1	-0.063	-0.062	-0.026	-0.005	0.002	0.079	-0.110	-0.110	-0.055
	(0.064)	(0.064)	(0.075)	(0.096)	(0.096)	(0.111)	(0.093)	(0.094)	(0.112)
Counter 2	0.059	0.059	0.093	0.012	0.018	0.053	0.036	0.034	0.068
	(0.064)	(0.064)	(0.074)	(0.095)	(0.096)	(0.111)	(0.091)	(0.091)	(0.108)
Counter 3	-0.062	-0.064	-0.037	-0.099	-0.104	-0.063	-0.048	-0.037	0.046
	(0.064)	(0.064)	(0.074)	(0.095)	(0.095)	(0.110)	(0.092)	(0.093)	(0.110)
Married	0.069	0.069	0.102	0.027	0.020	0.127	0.035	0.030	-0.089
	(0.090)	(0.090)	(0.105)	(0.147)	(0.147)	(0.170)	(0.128)	(0.128)	(0.160)
Divorced	-0.274**	-0.272**	-0.306**	-0.310*	-0.302*	-0.340	-0.421**	-0.439**	-0.714***
	(0.126)	(0.126)	(0.147)	(0.181)	(0.181)	(0.224)	(0.188)	(0.189)	(0.227)
Number of Kids	-0.024	-0.025	-0.033	0.001	-0.004	-0.021	-0.082	-0.095	-0.192
	(0.043)	(0.043)	(0.048)	(0.048)	(0.048)	(0.054)	(0.122)	(0.122)	(0.136)
Homeowner	-0.017	-0.017	-0.009	-0.022	-0.010	0.052	-0.005	-0.005	-0.072
	(0.076)	(0.076)	(0.089)	(0.121)	(0.120)	(0.141)	(0.102)	(0.102)	(0.122)
Education: high	-0.019	-0.021	0.089	0.090	0.081	0.175	-0.090	-0.070	0.103
	(0.072)	(0.072)	(0.083)	(0.104)	(0.104)	(0.119)	(0.109)	(0.109)	(0.130)
Angina Pectoris	0.104	0.102	-0.062	0.576**	0.538**	0.225	-0.035	-0.033	-0.017
	(0.178)	(0.178)	(0.198)	(0.240)	(0.237)	(0.275)	(0.210)	(0.210)	(0.244)
Heart Attack	0.237	0.237	-0.051	-0.563	-0.589	-0.939	0.407	0.405	0.035
	(0.219)	(0.219)	(0.245)	(0.534)	(0.523)	(0.589)	(0.279)	(0.279)	(0.336)
Stroke	0.659*	0.667*	0.402	0.501	0.554	0.371	0.666	0.654	0.304
	(0.376)	(0.376)	(0.426)	(0.546)	(0.542)	(0.587)	(0.425)	(0.421)	(0.468)
Diabetes	0.789***	0.788***	0.912***	1.549***	1.546***	1.544***	0.263	0.268	0.422**
	(0.176)	(0.175)	(0.201)	(0.244)	(0.245)	(0.278)	(0.170)	(0.170)	(0.205)
Lung disease	0.533**	0.535**	0.403	1.198***	1.207***	1.482***	0.138	0.126	-0.142
	(0.227)	(0.227)	(0.259)	(0.311)	(0.309)	(0.413)	(0.231)	(0.231)	(0.236)
Asthma	0.681***	0.681***	0.985***	0.929***	0.949***	1.224***	0.284	0.291	0.732**
	(0.224)	(0.224)	(0.257)	(0.272)	(0.274)	(0.290)	(0.278)	(0.279)	(0.349)
Arthritis	-0.189*	-0.188*	-0.250**	-0.057	-0.052	-0.038	-0.186	-0.183	-0.283*
	(0.111)	(0.111)	(0.127)	(0.194)	(0.195)	(0.221)	(0.134)	(0.134)	(0.157)
Self-assessed health	-0.161***	-0.160***	-0.232***	-0.231***	-0.226***	-0.322***	-0.131*	-0.134*	-0.198**
	(0.053)	(0.053)	(0.062)	(0.084)	(0.084)	(0.097)	(0.073)	(0.073)	(0.086)
GP visits	0.080***	0.081***	0.076***	0.062***	0.063***	0.0 57***	0.096***	0.096***	0.103***
	(0.014)	(0.014)	(0.017)	(0.018)	(0.018)	(0.022)	(0.022)	(0.023)	(0.026)
Hospital visit	0.116	0.117	0.132	0.367**	0.385**	0.404**	-0.101	-0.101	-0.030
	(0.113)	(0.113)	(0.131)	(0.156)	(0.157)	(0.179)	(0.145)	(0.146)	(0.177)
Constant	-6.662***	-6.670***	-6.942***	-3.106	-2.821	-4.073	-4.780	-4.765	-0.016
	(1.219)	(1.218)	(1.404)	(4.591)	(4.583)	(5.252)	(4.833)	(4.841)	(5.748)
Observations	2,038	2,038	1,535	1,094	1,094	834	944	944	701

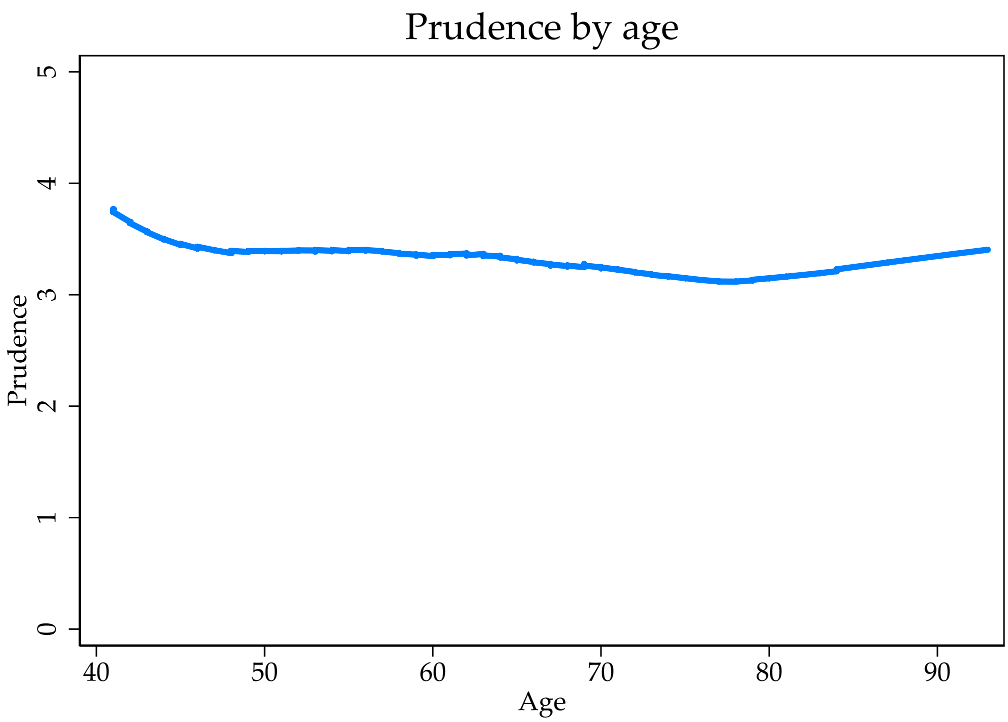
Robust standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Each column presents coefficients from separate probit regressions regressions.

Table A3: Regression results: Other Flu shot measures

	Any flu shot in previous 12 months			Number of flu shots previous 5 years		
Sample:	All (1)	Age 41-59 (2)	Age 60+ (3)	All (4)	Age 41-59 (5)	Age 60+ (6)
Prudence	-0.010	0.002	-0.025*	-0.043*	0.011	-0.097**
	(0.008)	(0.006)	(0.014)	(0.026)	(0.029)	(0.045)
Risk aversion	0.004	0.011*	-0.003	0.008	0.031	-0.010
	(0.008)	(0.006)	(0.013)	(0.027)	(0.030)	(0.045)
Observations	1579	880	699	1731	912	819

Robust standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Columns (1)-(3): marginal effects from separate probit regressions regressions. Columns (4)-(6): Coefficients of linear regressions. All regressions include gender, age and treatment as well as socio-economic controls and health indicators.

Figure A1: Prudence by age



Lowess smoothed means of the prudence indicator (between 0 and 5) in the full sample.

Table A4: Regression results: Other Measures (marginal effects)

Sample:	Full sample		Age <50		Age 50-69		Age 70+	
Mammogram:								
Prudence	0.000	(0.010)	-0.015	(0.012)	0.007	(0.007)	-0.022	(0.030)
Risk aversion	-0.015	(0.012)	-0.044***	(0.013)	-0.005	(0.008)	0.018	(0.035)
Sample mean of dep. variable	0.641		0.142		0.879		0.521	
Observations	1039		240		619		169	
Pap smear:								
Prudence	0.009	(0.011)	0.015	(0.018)	-0.015	(0.014)	0.026**	(0.012)
Risk aversion	-0.007	(0.012)	0.011	(0.021)	0.005	(0.015)	-0.026**	(0.011)
Sample mean of dep. variable	0.557		0.734		0.611		0.097	
Observations	1039		237		619		155	
X-ray lungs:								
Prudence	-0.007	(0.007)	-0.006	(0.011)	-0.008	(0.009)	-0.012	(0.020)
Risk aversion	0.002	(0.007)	-0.013	(0.013)	0.003	(0.009)	0.016	(0.021)
Sample mean of dep. variable	0.855		0.439		0.940		1.079	
Observations	1728		367		1066		292	
Non-invasive cancer screening:								
Prudence	0.003	(0.007)	0.005	(0.010)	-0.002	(0.009)	0.014	(0.019)
Risk aversion	0.001	(0.007)	-0.022*	(0.012)	0.008	(0.009)	-0.002	(0.021)
Sample mean of dep. variable	1.132		0.518		1.253		1.467	
Observations	1727		367		1066		291	

Robust standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.