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Abstract:

Organic food markets in developed countries have been rapidly expanding in recent years. Though expected health benefits are a major motive for buying organic food (OF), the health effects of consuming OF are uncertain. This study uses survey data from Germany, 2007, to explore the causal relationship between OF consumption and self-rated health status. While it finds strong and statistically significant relationships between health and indicators of the intensity and duration of OF consumption, these relationships vanish when OF consumption is instrumented by respondents' assessment of the necessity of renewable energy. Since the instrument satisfies usual validity standards, these findings suggest that the OF-health relationship may be spurious due to common unobserved factors, in particular a health-oriented lifestyle.

Keywords: health; food; consumption; organic agriculture

JEL classifications: I12, D12, Q13

1. Introduction

The market for organic food has experienced a rapid expansion in many developed countries over the past decade. In Germany, for instance, sales steadily increased from 2.1 billion Euros in 2000 to 5.9 billion in 2009.[1] Among the strongest motives for consumers to buy organic products are expectations concerning their health effects (Harper and Makatouni 2002, Magnusson et al. 2003, Yiridoe et al. 2005, Wier et al. 2008). Because they are produced without using synthetic fertilizers and pesticides, it is believed that organic products contain less toxic residues, in addition to having more health-promoting compounds, especially anti-oxidative metabolites, such as vitamins.[2] In spite of these expectations, however, conclusive evidence on the human health impacts of organic food is largely lacking (see Dangour et al. 2010 and Huber et al. 2011 for systematic literature reviews).[3]

Studies analyzing the human health effects of organic food can be classified into intervention studies and epidemiological (observational) studies (Huber et al. 2011). In human intervention studies, a group of people is voluntarily brought into a situation in which two subgroups consume either organically or conventionally produced food for a certain period of time. The outcome variable is typically the bioavailability of health-relevant compounds in the consuming organisms. In epidemiological studies, a large group of people is studied using self-reported indicators of organic food consumption as an explanatory variable and self-assessed health status as the outcome variable.

The lack of conclusive evidence on the health impacts of organic food may be seen as the consequence of methodological issues that are characteristic of the respective study types. The advantage of intervention studies is that they permit causal interpretation, as they can

[1] See www.statista.com.

[2] According to a literature review by Worthington (2001) these beliefs tend to be justified, but the causal chain between indicators of nutritional value and health outcomes is ambiguous (Huber et al. 2011). More recently, a comprehensive meta–analysis of existing studies did not find strong evidence that organic foods are more nutritious than conventional alternatives, though consumption of organic foods can reduce the risk of pesticide exposure (Smith-Spangler et al. 2012).

[3] A systematic literature search (Dangour et al. 2010) identified 62 potentially relevant studies published in peer-reviewed journals from January 1958 through March 2010, of which 12 met predefined selection criteria.

control for third factors. However, these studies refer to specific food products (tomatoes, carrots, apples) as parts of an otherwise habitual diet. This begs the problem that effects may be diluted (Huber et al 2011). Moreover, these studies are usually of a relatively short duration (up to a few weeks) and therefore unable to identify possible effects of long-term organic food consumption. Intervention studies typically find no differences in health outcomes between organic and conventional food consumption.[4]

Epidemiological studies, on the other hand, refer to less specific measures of organic diet, but relationships found between organic food and health indicators may be spurious due to inadequate control for third factors. A study by Rembialkowska et al. (2008), for instance, found that consumers of organic food assessed their health status significantly better than consumers of conventional food products, but the study acknowledged that this finding may be due to aspects of consumers' lifestyles (e.g., nutritional patterns, living environments, physical activity) that are correlated with organic food consumption.[5]

Overall, it appears that intervention studies tend to find no relationships between organic food and human health, though they may exist, whereas epidemiological studies tend towards finding such relationships but fail to check whether they are spurious.[6]

The present study seeks to address the spurious correlation problem inherent in epidemiological designs by means of an instrumental variables approach. It uses a unique set of survey data elicited in Germany, 2007, to explore the causal relationship between the consumption of organic food and self-rated health status. While strong and statistically significant relationships are found between health and indicators of the intensity and duration of organic food consumption (controlling for age, income and the education level), these

[4] Controlled trials over 14 to 28 days involving tomatoes, carrots and Golden Delicious apples, respectively, found no significant differences in relevant blood and plasma parameters between organic and conventional exposures (Dangour et al. 2010). See section 3.4 below for a more detailed discussion.
[5] Similarly, relationships between measures of organic food and health outcomes found by Alfven et al. (2006) and Kummeling et al. (2008) may be driven by unobserved common factors. See section 3.4 below for a more detailed discussion.
[6] See section 3.4 for a more detailed discussion.

relationships vanish when the consumption of organic food is instrumented by the degree to which respondents agree to an assertion concerning the necessity of renewable energy. This instrument satisfies common validity checks.[7] The vanishing relationship between organic food and health status in the instrumental variable estimations thus suggests that the relationship found in least squares regressions may be spurious due to common third factors (such as a health-oriented lifestyle).

Though practically all large scale social surveys at national and international levels include items concerning respondents' health, items concerning health-relevant aspects of nutrition are typically lacking in these surveys. An exception is the Health Survey for England, which includes questions on the consumption of fried foods, sweets, and fruit or vegetables. However, no differentiation is provided as to whether these are organic or conventional products. To my knowledge, the database used in the present study is unique in that it covers people's health status and the intensity and duration of organic food consumption jointly with potential control and instrumental variables.[8]

As already mentioned, the instrument used in this study is the degree to which people agree to the assertion that a switch to renewable energy is necessary. The rationale for choosing this variable is the idea that (a) the attitude towards renewable energy is sufficiently correlated with people's preference for organic food while (b) being uncorrelated with unobserved third factors of health like physical activity, smoking, drinking and nutrition patterns other than organic/conventional. Part (a) of this conjecture is supported by first-stage regressions of indicators of organic food consumption on the renewable energy variable, in

[7] A switch from 'complete disagreement' to 'complete agreement' to the renewable energy assertion leads to an increase in the various indicators of organic food consumption by up to 1.4 standard deviations. In addition, this instrument passes the usual weak instrument tests.

[8] The data set that comes closest to the present one is the one used by Rembialkowska et al. (2008), but this study restricts itself to comparing the life styles and health status of organic and conventional consumers within a purely descriptive design.

which the latter turns out to be highly significant and to have strong explanatory power.[9] Part (b) is supported by regressing the health variable on the renewable energy variable and the controls (age, income, education level). In these regressions, the energy variable turns out to be insignificant and to have no explanatory power.

This study differs from existing studies in several ways. First, unlike intervention studies, which typically include a relatively small number of subjects, it involves a cross-section of several hundred persons. Second, unlike the rather specific types of organic vs. conventional food considered in intervention studies (e.g., tomatoes, carrots, apples) this study focuses on food labeled "organic" in general. Third, since the data set includes information not just on the intensity of people's organic food consumption but also on how long (if at all) they have been buying organic food, the study is more likely to capture effects of long-term consumption of organic food, if they exist. Finally, to my knowledge, this is the first epidemiological study which pursues an instrumental variable approach to address the issue of unobserved factors in the relationship between organic food consumption and human health.

The paper is organized as follows. Section 2 describes the methodological framework (data and econometric approach). Section 3 presents and discusses the results. Section 4 concludes.

2. Methodological Framework

2.1 *Empirical Background and Data*

As mentioned in the introduction, the market for organic food in Germany experienced a rapid expansion in recent years. In comparison with traditional distribution channels (direct sale by producers, specialized shops), conventional food shops (including supermarkets and discount shops) have increased the share in the organic food market to more than one third by the

[9] In addition to health considerations, environmental concern is another important motive for organic food consumption (Magnusson et al. 2003). Environmental concern may thus be a common denominator of organic food consumption and the attitude towards renewable energy.

middle of the decade (Hamm et al. 2004). Their marketing campaigns may have contributed to the increase of the organic food market.

This study is based on a survey on several types of pro-environmental consumption, including organic food, which was conducted from July to September 2007 in the region of Hanover, Germany.[10] Because the survey was originally designed to capture a sufficient number of owners of solar heating systems and subscribers to renewable electricity, it was conducted in several stages. Initially, 963 owners of solar heating systems were sent an invitation to participate in the survey. Of these, 190 requested the questionnaire, and 139 completed it. Similarly, 520 subscribers to green electricity were sent an invitation to participate; 150 requested and 122 completed the questionnaire. In addition 233 face-to-face interviews with randomly sampled persons were conducted, using the same questionnaire. Overall, we have 494 valid questionnaires. In the econometric analysis we account for the stratified nature of our sample by weighting the data appropriately.[11]

The survey includes questions on people's pro-environmental behaviors along with their personal characteristics, including their self-assessed health status, and a number of attitude questions. The question concerning organic food (OF) consumption reads as follows: "When shopping food, I buy products labeled as organic … 'always', 'regularly', 'occasionally', 'never'". Responses were coded 'always' = 4, 'regularly' = 3, 'occasionally' = 2, 'never' = 1 and this coding was used to define the variable *OFIntensity* to be employed in the econometric analysis. Alternatively, dummy variables for the four categories were created, labeled *OFAlways* etc. In addition, people responding 'always' or 'regularly' were asked "For how long have you been buying a significant portion of food labeled as organic?" with response options 'less than one year', 'between one and two years', 'between two and five years', 'between five and ten years', 'more than ten years'. For the main analysis, the latter four categories were merged and a dummy variable *OFTime* was created which takes values 0 = 'less than one year', 1 = 'more than one year'.[12] In other words, the dummy variable *OFTime* captures individuals who have been buying organic food at least 'regularly' for at least one year.

The question on the health status reads as follows: "Overall, how would you rate your general health status?", with response options 'very good', 'good', 'average', 'poor', 'very

[10] The region of Hanover has about 1.1 million inhabitants. By the time of the survey, organic food was offered all over the region by food suppliers of various forms (organic food shops, supermarkets, discount shops).
[11] The share of users of solar thermal systems is 2.5 percent and the share of subscribers to green electricity is 12 percent (Clausen 2008).
[12] In addition to the main analysis, experiments with dummy variables for the various categories were carried out, see below.

poor'. The variable *Health* was created by coding the responses 'very good' = 5, … 'very poor' = 1.

The last main variable in the econometric analysis (the instrument for organic food consumption) is built from the degree of agreement/disagreement to/with the assertion "We need a consistent change towards renewable energy", coded 'agree completely' = 4, 'agree' = 3, 'disagree' = 2, 'disagree completely' =1. This variable is denoted as *RenNeeded*.

Additional variables included in the empirical analysis are *Age*, monthly household income (*Income*), and a seven-point indicator of the education level (*Education*).

Table A1 in the Appendix reports the descriptive statistics. As seen, the mean intensity of buying organic food is 2.6 on the four-point scale. About 9 percent of the respondents fall into the *OFAlways* category, but about 58 percent have been buying organic food at least 'regularly' for at least one year (*OFTime*). Table A2 present the correlations of the main variables. *Health* is correlated with *OFIntensity* at r = 0.18 and with *OFAlways* and *OFTime* at r = 0.13. *RenNeeded* is correlated with *OFIntensity*, *OFAlways* and *OFTime* at r = 0.34, r = 0.15 and r = 0.16, respectively and correlated with *Health* at 0.09.

2.2 Econometric Approach

The main specification is of the following form:

$$Health_i = \alpha + \beta\, Food_i + \gamma\, Controls_i + \varepsilon_i \qquad (1)$$

where $Health_i$ is the health status of individual i and $Food_i$ stands for the three indicators *OFIntensity*, *OFAlways* and *OFTime* introduced in the preceding subsection.

Candidates for appropriate control variables ($Controls_i$) are age, sex, income and education.[13] In preliminary checks I regressed health on a quadratic polynomial of age and on sex, income and the level of education. I found age-squared and (somewhat surprisingly) sex

[13] It is well established that there is a positive link between income and health, as higher income may go along with less unhealthy jobs and may allow people to live in healthier places and to buy more expensive medical treatment (see Goldman 2001 for a discussion). The relationship between education and health is more ambiguous (see Braakmann 2012), but I include education in order to err on the right side, if at all.

to be insignificant at any reasonable level of significance. The set of controls thus comprises age, income and the education level.

The instrument used in this study is the degree to which people agree to the assertion that a consistent change towards renewable energy is needed. Choosing this variable as an instrument is based on the idea that the attitude towards renewable energy is sufficiently correlated with people's preference for organic food while being uncorrelated with unobserved health-relevant factors like physical activity, smoking, drinking and nutrition patterns other than organic versus conventional food. The first part of this conjecture reflects the circumstance that environmental concern is another important motive for organic food consumption, in addition to health considerations (Magnusson et al. 2003). Environmental concern may thus be a common denominator of organic food consumption and the attitude towards renewable energy.

The dependent variable in eq. (1) is a five-step ordinal variable. In spite of this, the primary estimation methods will be least squares and two-stage least squares. Complementary results from ordered probit estimations will be presented which suggest that the dependent variable can be treated as cardinal without an appreciable influence on the main results.

3. Results and Discussion

3.1 Correlational Analysis

Columns (1) – (4) in Table 1 present results of OLS *Health* regressions whereas columns (5) – (8) present the ordered probit counterparts. Regression (1) is a benchmark regression without any indicators of organic food consumption. The controls *Age*, *Income* and *Education* have the expected signs and are (at least weakly) significant. They explain 12.6 of the variance in *Health*.

Regression (2) adds *OFIntensity* to the explanatory variables. This raises the explanatory power to 14.3 percent. The coefficients of the controls are not much affected by

the inclusion of *OFIntensity*; only the coefficient of *Education* drops somewhat in magnitude and becomes insignificant. The coefficient on *OFIntensity* is positive and weakly significant (p = 6.9 percent). The coefficient size suggests that a change from 'never' to 'always' buying organic food is associated with an increase by 0.489 (3*0.163) of *Health* on the five-point scale, or about 60 percent of one S.D.

Regression (3) includes *OFAlways* instead of *OFIntensity*. The R^2 is now 16.3 percent. The coefficient on *OFAlways* is positive and highly significant. Buying organic food 'always' (instead of never, occasionally or regularly) is associated with an increase in *Health* by 0.952 or 1.2 S.D.[14]

As seen in regression (4), including a dummy for at least regularly buying organic food for at least one year (*OFTime*) yields a positive but insignificant coefficient for this variable. The explanatory power of this regression is less than in the preceding two regressions.

Columns (5) – (8) report the ordered probit counterparts to (1) – (4). The signs and the significance of coefficients are as in the corresponding least squares regressions. Interestingly, the significance of *OFIntensity* and *OFTime* is now greater than in the previous regressions. With regard to coefficient sizes, the *ratios* of the various coefficients are similar as under least squares. In addition, the distances between cut points 1 and 2 and between cut points 2 and 3 are rather similar. All of this suggests that the five-point ordinal variable *Health* can be treated as a cardinal variable without affecting qualitative results.

These qualitative results are that there exists a strong positive relationship between self-assessed health status and the intensity of buying organic food. This relationship is particularly strong and highly significant at the top of the intensity scale, that is, for the dummy variable *OFAlways*.

[14] I experimented with including, in addition, dummies for buying organic food 'occasionally' and 'regularly' and found them insignificant. This means that it is mainly the difference between buying organic food 'always' and the other degrees of intensity that drives the relationship with the health status.

It is obvious that these correlations might be spurious. Especially, they could be due to unobserved common factors of health and organic food consumption, e.g. a health-oriented lifestyle with organic food consumption being just one of several elements. This issue will now be addressed by using an instrumental variable for organic food consumption which is supposed to be uncorrelated to those third factors.

3.2 Assessing the Instrumental Variable

Columns (1) – (3) in Table 2 present first-stage regressions of the indicators of organic food consumption (*OFIntensity*, *OFAlways*, *OFTime*, respectively) on the prospective instrument, *RenNeeded*, and the controls. *RenNeeded* is significant in all three regressions and its inclusion is the main driver of explanatory power (see R^2 and ΔR^2). In regression (1), a switch in the 4-point *RenNeeded* variable from 'completely disagree' to 'completely agree' is associated with an increase in *OFIntensity* by 3*0.362 = 1.09 or 1.4 standard deviations (S.D.) Strong relationships also exist between *RenNeeded* and *OFAlways* and *OFTime* (3*0.04 = 0.12 or 0.4 S.D., and 3*0.210 = 0.69 or 1.3 S.D, respectively), see regressions (2) and (3). Additionally, the values of the F-statistics generally confirm the absence of weak instrument problems.

A possible exception is the case of *OFAlways*, where the effect size and the F-statistic are smaller than in the other two cases. The relative weakness of the instrument in this case is likely due to the large standard deviation of the dependent variable (which is more than three times the mean, see Table A1). However, as argued by Angrist and Pischke (2009), weak instruments do not need to be a major problem in just identified models like the one used here.

Columns (4) – (7) in Table 2 check whether there is a relationship between *Health* and *RenNeeded*. These regressions are counterparts to the *Health* regressions (1) – (4) in Table 1, which are here augmented by including *RenNeeded*. As seen, inclusion of *RenNeeded* leaves

the respective original *Health* regressions virtually unaffected. In addition, *RenNeeded* is entirely insignificant in regressions (4) – (7) in Table 2. Any relationship between *Health* and *RenNeeded* thus rests on the latter variable's correlation with the organic food variables demonstrated in columns (1) – (3).

3.3 Instrumental Variable Results

Table 3 reports the instrumental variable regressions of *Health* on the various organic food variables. Columns (1) – (3) are the counterparts to columns (2) – (4) in Table 1. Comparing the two tables, it can be noted that the explanatory power of the IV regressions is practically the same as in the corresponding least squares regressions and that the results for the control variables (sign, magnitude and significance of coefficients) are also virtually unchanged.

This is different with respect to the organic food variables. In the first place, the magnitude of the respective coefficients drops. In particular, the coefficient of *OFIntensity* drops by almost one half. In addition, the coefficients of the organic food variables become insignificant, with t-statistics dropping to less than 0.41 and the corresponding p-values rising to more than 0.68.

Though low precision of point estimates is common in IV regressions (Angrist and Pischke 2009), the IV results certainly do not provide much support for a causal relationship between the intensity and duration of organic food consumption and health. Rather, provided that the instrument is valid, they suggest that with probability greater than 68 percent (p-values) the least squares relationships are spurious.

An obvious explanation for this could be that the strong and significant relationships between organic food consumption and health found in least squares regressions reflect common unobserved factors related to both variables, in particular health-oriented behaviors correlated with, yet different from organic food consumption. According to the results

presented here, any health effects of organic food are indistinguishable from the effects of those behaviors.

3.4 Discussion

According to Huber et al. (2011), there are only a few epidemiological studies investigating the health effects on humans of organic compared with conventional foods. Alfven et al. (2006) found that children representing an anthroposophical lifestyle (including biodynamic and organic food) had fewer allergies. Kummeling et al. (2008) found an association of strictly organic dairy products with a reduced risk of eczema in infants. Finally, Rembialkowska et al. (2008) found that consumers of organic food had a significantly better self-assessed health status than consumers of conventional food.

An obvious problem with these previous epidemiological studies is the possibility that the measures of organic food consumption considered in these studies may be correlated with health-relevant aspects of consumers' lifestyles like physical activity, living conditions and nutritional patterns. Indeed, Rembialkowska et al. (2008) found significant differences in these parameters between organic and conventional consumers.[15]

In contrast to epidemiological studies, intervention studies (controlled trials) typically found no significant difference in health outcomes between organic and conventional exposures (Caris-Veyrat et al. 2004, Stracke et al. 2009, 2010). However, these studies refer to specific food products (tomatoes, carrots, Golden Delicious apples, respectively) as parts of an otherwise habitual diet. This begs the problem that effects may have been diluted (Huber et al 2011). In addition, the duration of controlled trials (14-28 days) may be too short to identify any long-term effects, should they exist.

[15] That study limits itself to a set of bivariate relationships between organic/conventional food consumption on the one hand and various characteristics and behaviors of the respondents on the other. No attempt at multivariate or even causal analysis is made.

The present study has focused on food products labeled as organic in general, rather than on specific products. As the cross-sectional data include information on how long people have been buying a sizeable quantity of organic food (if at all), it is in principle possible to detect effects of long-term consumption. In contrast to other epidemiological studies, the present study has addressed the problem of unobserved common factors, especially lifestyles, by means of an instrumental variables approach. Similar as in other epidemiological studies, a significant correlation between health status and organic food consumption was found, but the instrumental variables estimates suggest that these correlations may be spurious.

The instrument used in this exercise was the degree of agreement to the assertion that a consistent switch to renewable energies is needed. This instrument is strongly correlated with organic food consumption because, in addition to health considerations, a strong motive for buying organic food is environmental concern. On the other hand, the instrument is unlikely to be strongly related to behaviors like (non-)smoking, (non-)drinking or (a lack of) physical activity that are characteristic of a health-oriented lifestyle along with organic food consumption.

4. Conclusions

Though expected health benefits are an important determinant of the rapidly expanding consumption of organic food, reliable evidence on the causal relationship between organic food consumption and human health is surprisingly scarce, and results of existing studies are mixed. While human intervention studies typically do not find significant differences in health outcomes between exposures to specific organic vs. conventional food products, some epidemiological studies have yielded significant positive relationships between organic food and indicators of health status. However, the available epidemiological studies either did not focus specifically on organic food (but on more encompassing styles of nutrition) or failed to control for unobserved common factors of health and organic food consumption.

Using a set of survey data from Germany, this study has applied an instrumental variables approach to investigate the causal relationship between indicators of the intensity and duration of buying organic food and self-reported health status. While least-squares regressions yielded a significant positive relationship between the intensity of organic food consumption and self-assessed health, this relationship vanished when the organic food variables were instrumented by the degree of agreement to an assertion on the necessity of a consistent change towards renewable energies. One explanation for this finding is that consumers of organic food may have a healthier lifestyle overall which, being unobserved, leads to a positive but spurious relationship between organic food and health status in least squares regressions.

While this paper seems to be the first to apply instrumental variables techniques to investigating the causal relationship between organic food and human health, limitations to this study are obvious. The first is possible measurement error, given that all variables used are self reports. In particular, people may have different ideas about what constitutes a ‘good’ health status. However, this is a common issue when using subjective data and will not lead to biased results unless measurement error is systematic (non-random). Second, though the instrument used seems to have sufficient power, it is not exogenous. In this regard, a natural experiment design would clearly be desirable, but does not seem to be feasible given available data. Finally, the data used refer to a particular region in Germany. It is not clear if and to what extent they can be generalized to other regions within or outside Germany.

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Appendix

Table A1: Summary Statistics

	Observations	Minimum	Maximum	Mean	Std. Dev.
Health	491	1	5	3.894	0.793
OFIntensity	493	1	4	2.631	0.758
OFAlways	493	0	1	0.091	0288
OFTime	493	0	1	0.578	0.494
RenNeeded	492	1	4	3.398	0.794
Age	492	18	75	46.512	13.652
Income	492	0.000	5.250	3.298	1.637
Education	491	1	7	5.562	1.592

Table A2: Correlations

	Health	OFIntensity	OFAlways	OFTime	RenNeeded
Health	1.0000				
OFIntensity	0.1839	1.0000			
OFAlways	0.1305	0.5779	1.0000		
OFTime	0.1309	0.5707	0.9877	1.0000	
RenNeeded	0.0879	0.3376	0.1519	0.1571	1.0000

Table 1: Least-Squares and Ordered-Probit Results. Dependent Variable: Health

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	3.666 *** (0.269)	3.307*** (0.336)	3.620*** (0.256)	3.644*** (0.268)				
Age	-0.011*** (0.004)	-0.010** (0.004)	-0.011*** (0.004)	-0.011** (0.004)	-0.016*** (0.004)	-0.017*** (0.004)	-0.170*** (0.004)	-0.017*** (0.004)
Income	0.139*** (0.035)	0.135*** (0.035)	0.140*** (0.034)	0.136*** (0.036)	0.096*** (0.036)	0.091** (0.037)	0.100*** (0.037)	0.088** (0.037)
Education	0.063* (0.034)	0.052 (0.034)	0.063** (0.032)	0.053 (0.034)	0.108*** (0.036)	0.086** (0.036)	0.101*** (0.036)	0.088** (0.037)
OFIntensity		0.163* (0.089)				0.217*** (0.081)		
OFAlways			0.952*** (0.209)				0.476** (0.202)	
OFTime				0.194 (0.121)				0.271** (0.111)
Cut Point 1					-1.720*** (0.304)	-1.322*** (0.331)	-1.735*** (0.303)	-1.739*** (0.304)
Cut Point 2					-0.531* (0.295)	-0.135 (0.330)	-0.551* (0.294)	-0.558* (0.294)
Cut Point 3					1.011*** (0.300)	1.429*** (0.339)	1.010*** (0.298)	1.001*** (0.298)
Observations	416	415	415	415	416	415	415	415
R^2/Pseudo R^2	0.126	0.143	0.163	0.135	0.035	0.043	0.041	0.039

Notes. Columns (1) - (4): least squares estimates. Columns (5) - (8): ordered-probit estimates. Heteroskedasticity-consistent standard errors in parentheses. * p<0.10, **p<0.05, ***p<0.01

Table 2: Assessment of Instrument

	(1) OFIntensity	(2) OFAlways	(3) OFTime	(4) Health	(5) Health	(6) Health	(7) Health
RenNeeded	0.362*** (0.075)	0.040** (0.016)	0.210*** (0.047)	0.027 (0.074)	-0.030 (0.081)	-0.008 (0.074)	-0.010 (0.080)
Controls	yes	yes	yes	yes	yes	yes	yes
OFIntensity					0.170* (0.097)		
OFAlways						0.951*** (0.215)	
OFTime							0.192 (0.131)
Observations	416	416	416	415	414	414	414
F-statistic	20.196	3.389	13.866	14.793	13.480	15.820	12.525
Prob (F-stat.)	0.0000	0.0096	0.0000	0.0000	0.0000	0.0000	0.0000
R^2	0.164	0.032	0.119	0.126	0.142	0.162	0.133
ΔR^2	0.128	0.029	0.099	0.000	-0.001	-0.001	-0.002

Notes. Least-squares estimates. Heteroskedasticity-consistent standard errors in parentheses. Controls are Age, Income, Education and a Constant. *p<0.10, **p<0.05, ***p<0.01. ΔR^2 is the increase in R^2 due to inclusion of RenNeeded.

Table 3: Instrumental-Variables Results. Dependent Variable: Health

	(1)	(2)	(3)
Constant	3.526*** (0.534)	3.672*** (0.278)	3.693*** (0.273)
Age	-0.011** (0.004)	-0.011*** (0.004)	-0.011*** (0.004)
Income	0.135*** (0.035)	0.139*** (0.034)	0.136*** (0.036)
Education	0.053 (0.036)	0.060** (0.033)	0.053 (0.037)
OFIntensity	0.084 (0.209)		
OFAlways		0.739 (1.816)	
OFTime			0.142 (0.354)
Observations	414	414	414
R^2	0.136	0.160	0.132

Notes. OFIntensity, OFAlways and OfTime are instrumented by Ren Needed. Heteroskedasticity-consistent standard errors in parentheses.
*p<0.10, **p<0.05, ***p<0.01

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