Does Food Consumption Away From Home Make You Happier? An Empirical Investigation of the Elderly in Taiwan

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Abstract

Due to the increased share of food consumption away from (FAFH) on overall household food expenditure, a considerable body of literature has examined the impacts of FAFH on diet quality and physical health. A conventional wisdom is that FAFH is associated with poor diet quality, and it also increases the likelihood of being overweight. However, not much attention has been paid to the association between FAFH and mental health of the individual. Since mental health is as important as physical health, a better understanding of the effect of FAFH on mental health is crucial for policy making. This study contributes to this knowledge gap by assessing the causal effect of FAFH on elderly depression using a national representative dataset of elderly in Taiwan. Results indicate that elderly who consumed food away from home is more likely to be depressed by 34% compared to their counterparts of FAFH non-participants, after controlling for socio-demographic characteristics and other factors.

Keywords: Food Consumption Away From Home (FAFH); Depression; Elderly, Taiwan.

Introduction

The rising trend of the share of food away from home consumption (FAFH) to overall household food expenditures has been observed in many countries. In the U.S. for example, the share of FAFH expenditure has increased rapidly since the 1970's and climbed to an all-time high today. The total expenditure on FAFH by all families was $433.5 billion in 2010 (41 percent of total food expenditure), and it was up from 32 percent in 1980 (USDA-ERS 2011). Similar findings are found in Asian countries: the share of FAFH increased from 26 percent in 1970 to 47 percent in 1999 among Korean households. In Taiwan, the share of household food expenditure spent on FAFH increased more than fourfold from 6 percent in 1983 to 26 percent in 2000 (Keng and Lin 2005).

Given the increased share of FAFH on overall household food expenditure, a considerable body of literature has devoted to the impacts of the FAFH on diet quality (e.g., Mancino, Todd, and Lin 2009). A common wisdom is that FAFH results in poor diet quality. For instance, Lin and Guthrie (2012) found that FAFH constitutes 32% of the total calorie intakes among American. Compared to food consumption at home (FAH), FAFH is higher in saturated fat, sodium, and cholesterol and lower in dietary fiber than FAH. Some other studies focused on the effects of FAFH on health, with obesity in particular. Given the rapidly growing rates of obesity in the world, the link

between food consumption (especially the FAFH) and overweight has been paid special attention by the policy makers. Empirical evidence has pointed to a positive association between FAFH and the likelihood of being overweight. For instance, Kyureghian et al. (2007) used data from National Eating Trends in the U.S to examine the relationship between number of foods consumed and obesity by service type and meal occasion. Their results suggest that FAFH consumption is positively related to body weight and that foods consumed from quick service restaurants affect body weight more than foods from full service restaurants. Using a state-level panel dataset and a random effect model in the U.S., Cai et al. (2008) also found that FAFH expenditures are positively related to the likelihood of being obese. Similar evidence has been revealed in European countries as well. Drichoutis, Nayga, and Lazaridis (2012) examined the effect of FAFH on obesity for elderly in Europe, and found that FAFH has a significant effect on BMI of older females.

Although enormous evidence has been provided on the association between FAFH and physical health (such as obesity), little is known about the extent to which FAFH may affect subjective wellbeing or individual mental health. Addressing the association between individual mental health and FAFH has particular policy implication since the prevalence of mental illness problems has been dramatically increased in recent years, especially for elderly population. It is estimated that

depression is a serious illness affecting approximately 15 out of every 100 adults over age 65 in the U.S. In Taiwan, the prevalence of the elderly with mental illness is approximately 30–35% nationwide (Lyu and Lin 2000). Therefore, how to prevent the depressive symptom among the elderly population has become one of the important public policy issues for many countries in the world.

Research focusing on individual's subjective wellbeing has received great attention recently, and the use of subjective wellbeing indicator to evaluate the effectiveness of the public programs has received increasing attention by economists. Among these studies, most of them focused on the examination of the factors associated with adult's mental health. However, not much attention has been paid on the association between FAFH and mental health. This study aims to fulfill the knowledge gap of the existing studies by examining the causal effect of FAFH on elderly depression.

A unique dataset of 1,184 individuals aged 65 and older was drawn from the National Health and Nutrition Survey in 2008 in Taiwan. A bariate probit model was estimated to capture the potential endogeneity between FAFH and depression of the elderly. After controlling for individual socio-demographic characteristics, our results point to a positive effect of FAFH on elderly depression. Compared to the elderly who did not consume food away from home, FAFH participants have more likelihood of

being depressed by 34.7%. Since FAFH is believed to have more fat, calorie, and less vitamin intakes, our finding is not inconsistent with scientific evidence which documented a positive (negative) association between fat/energy (vitamin) intakes and depressive symptoms.

Data

Data used in this study are drawn from the Nutrition and Health Survey in Taiwan (NHAST) for the elderly age >=65 in 2008. This dataset was an island-wide survey of residents age 65 and above in Taiwan conducted by the Department of Health in Taiwan through a face-to-face interview in 2008. The survey adopted a three-stage (townships, blocks and individuals) stratified sample design using the Taiwan Household Register system, so the sample is representative of the population aged 65 and older in Taiwan. In total, 1,184 respondents were included, and detailed information of family background and socio-demographic characteristics was recorded. In addition, food consumption and general health conditions are also included.

A serious of questions related to food consumption were documented based on a 7-day recall of the food consumption. Each respondent was asked "*how many days during last week you have consumed food away from home for breakfast/lunch/dinner/night snack?*" According to this information, a measure of

food consumption away from home can be defined by summing up the answers into a simple scale ranged from 0 to 28. In our data, we observe that the zero values of this aggregated measure account for 64% of the total respondents. That is, only 36% of the elderly in our sample ever consumed food away from home for at least one meal in a week. Therefore, this measure is not appropriate to capture the level of food away from home consumption. As an alternative, we define a binary indicator to measure whether the elderly consumed food away from home in a week. This dummy variable for FAFH then captures the extensive margin of FAFH of the elderly in Taiwan.

The way that the NHAST survey used to evaluate general health condition of the elderly relies on the SF-36 questionnaires. With respect to the measure of the depressive symptom of the respondents, we defined a binary variable to measure whether the elderly is depressed, generated from responses to a series of questions in the Taiwanese SF-36 (the 36-item Short Form Health Survey).[1] A general mental health index can be derived from five questions related to mental conditions, and a higher score indicates better mental health (the score point is from 0-100). This is also known as the Mental Component Score (Lu, Tseng, and Tsai 2002).[2] Following McCall et al. (2002) and Baumeister and Morar (2008), a binary indicator for

[1] Details of the English version SF-36 can be found in Ware (1993). The contents of the Taiwanese version SF-36 survey can be found in Lu, Tseng, and Tsai (2002), and Tseng, Lu, and Gendek (2003).

[2] The descriptions of each question used to conduct these two indexes are summarized in the appendix.

depression is defined if the Mental Component Score is below 42 score point.

Built on the findings of the previous studies on food away from home (e.g., Binkley et al., 2006; Byrne, Capps, and Saha, 1996; Jensen and Yen, 1996; Mancino, Todd, and Lin, 2009) and depression (e.g., Campolieti 2000; Cassidy et al. 2004; Chatterji et al. 2007; Lee and Shinkai 2005) among the elderly, several socio-economic and demographic characteristics are also specified. Individual characteristics include a continuous variable for age and five dummy variables for individual education level: illiterate (reference group), elementary school, junior high school, senior high school, and college or higher. A dummy variable for gender is also included to capture gender difference. Since it has been documented that employment and marital status are important predictors for elderly mental health, we define a dummy variable to indicate if the respondent is married and a dummy variable for current employment status. Four dummy variables are also specified for personal monthly income. Following Smith (1999) and Chang and Yen (2012), a continuous variable which reflects presence of chronic health conditions among twelve common chronic symptoms among the elderly, such as diabetes, cancer, heart disease, chronic lung diseases and stroke is defined. Presence of each symptom is coded as one and the sum of scores for all symptoms, which ranges from 0 to 12, is used as an indicator for chronic disease condition. This variable is defined from historical records and does

not necessarily reflect current health conditions. With respect to the house characteristics, a dummy variable is specified to indicate whether the respondent lives in the apartment with elevators. Finally, four variables of the geographic regions that each respondent resident are specified to reflect unobserved regional differences in food consumption and health condition of the elderly. Sample statistics of the selected variables are presented in Table 1.

As exhibited in Table 1, only 36 % (428/1184=0.36) of the respondents consumed food away from home at least one meal in a week. Those who consumed food away from home also have lower likelihood for being depressed compared to their counterparts of the elderly who did not eat out for any meal (0.15 vs. 0.18). However, this result may not explore too much useful information in that it fails to control for the differences in socio-demographic characteristics and other factors between the FAFH participants and non-participants. Differences in socio-demographic characteristics and other factors are also found between these two groups of elderly. FAFH participants appear to be slightly younger (72.63 vs. 73.31), male (0.60 vs. 0.47), and higher educated. The differences in personal monthly income between FAFH participants and non-participants are also revealed. For instance, 24% of the FAFH participants have monthly income $\geq$NT$ 10,000, while there is only 15% among the FAFH non-participants. Interestingly, house

characteristics also differ among these two groups of respondents. Elderly who consumed food away from home tend to be more likely to live in a house with elevators compared to their counterparts of the FAFH non-participants (0.14 vs. 0.10).

Econometric Analysis

To identify the effect of FAFH on elderly depression, one important econometric issue has to be addressed. FAFH is likely to be endogenous to the depression symptom of the elderly due to some unobserved common factors. A considerable body of literature has highlighted the importance to deal with the endogeneity issue when it comes to the examination of the effects of food consumption on health condition (e.g., Drichoutis, Nayga, and Lazaridis 2012). These studies conclude that failing to correct for endogeneity issue will lead to inconsistent estimators of the causal effects. In this study, the instrumental variable method (IV) is used to address the endogeneity bias of FAFH on elderly depression .

Following the standard framework of the IV method, we specify a two-equation simultaneous equation system:

(1) $$Y_i^* = \beta_1 \times FAFH_i + \beta_2 ' X_i + \varepsilon_{1i}$$

(2) $$FAFH_i^* = \alpha_1 \times Z_i + \alpha_2 ' X_i + \varepsilon_{2i}$$

$$FAFH_i = 1 \text{ if } FAFH_i^* \geq 0; \; FAFH_i = 0 \text{ otherwise,}$$

$$Y_i = 1 \text{ if } Y_i^* \geq 0; \; Y_i = 0 \text{ otherwise.}$$

where Eq. (1) and (2) is the depression and FAFH equation, respectively. Y_i* is the latent variable of depression for the i^{th} respondent, $FAFH_i$ is a binary indicator if the i^{th} respondent consumed food away from home. X_i is the vector of the explanatory variables that are associated with elderly depression and the decision for FAFH consumption. ($\alpha_1, \alpha_2, \beta_1, \beta_2$) are parameters to be estimated and ($\varepsilon_1, \varepsilon_2$) are random errors of these two equation, respectively.

The variable Z_i is the instrumental variable which will affect elderly FAFH decision directly, but it has an indirect effect on elderly depression. In this study, a dummy variable to indicate whether the old adult lives in an apartment with elevators is used as instrument (the variable *House_elevator* in Table 1). We hypothesize that living arrangement is crucial for the elderly to eat out, and this situation is more pronounced for elderly given that they are less mobile physically compared to other age groups. Therefore, elderly who live in a place with elevators would feel more comfortable and convenient to eat out than their counterparts of the elderly who live in a place without elevators. In the empirical analysis, we have conducted a serious of statistical tests to check the robustness of our selected instrument.

It is of note that a direct estimation using the two-stage least square (2SLS) commonly used in the standard linear IV method to Eqs. (1) and (2) is not appropriate in that the dependent variables (Y_i* and $FAFH_i$*) are binary variables rather than

continuous variables. To deal with the discrete nature of the dependent variables, we estimate a bivariate probit model. Assume that ($\varepsilon_1, \varepsilon_2$) follow a bivariate normal distribution with zero mean, unity variance, and correlation coefficient (ρ), the four possible regions that can be realized from the outcomes can be derived as (Greene, 2010):

$$(3)\quad P_{11} = \Pr(Y_i = 1, FAFH_i = 1) = \Phi_2(\beta_1 \times FAFH_i + \beta_2 ' x_i, \alpha_1 \times Z_i + \alpha_2 ' x_i, \rho)$$

$$P_{10} = \Pr(Y_i = 1, FAFH_i = 0) = \Phi_2(\beta_1 \times FAFH_i + \beta_2 ' x_i, -\alpha_1 \times Z_i - \alpha_2 ' x_i, -\rho)$$

$$P_{01} = \Pr(Y_i = 0, FAFH_i = 1) = \Phi_2(-\beta_1 \times FAFH_i - \beta_2 ' x_i, \alpha_1 \times Z_i + \alpha_2 ' x_i, -\rho)$$

$$P_{00} = \Pr(Y_i = 0, FAFH_i = 0) = \Phi_2(-\beta_1 \times FAFH_i - \beta_2 ' x_i, -\alpha_1 \times Z_i - \alpha_2 ' x_i, \rho)$$

where P_{11}, P_{10}, P_{01} and P_{00} indicate the probability in the region (1,1), (1,0), (0,1) and (0,0) respectively. $\Phi_2(.)$ is the joint cumulative density function of the bivariate normal distribution. The consistent estimates of the parameters can be estimated using the full information maximum likelihood estimation method on the following log-likelihood function (Greene, 2010).

$$(4)\quad \ln L = \sum_{i=1}^{N} [Y_i \times FAFH_i * \ln P_{11} + Y_i \times (1 - FAFH_i) \times \ln P_{10} + (1 - Y_1) \times FAFH_i * \ln P_{01} + (1 - Y_i) \times (1 - FAFH_i) * \ln P_{00}]$$

Note that if the correlation parameter ρ degenerates to zero, Eq. (4) is equivalent to the product of the log-likelihood functions of a two binary probit model. Therefore, testing the hypothesis that the parameter ρ is statistically equal to zero provides the justification if the bivariate probit model is specified appropriately. In the empirical

analysis, we conducted a likelihood ratio test (LR) to test the null hypothesis H^0: ρ=0.

Since the outcome variables are not continuous, the effects of the FAFH on elderly depression are not fully revealed from the estimated coefficients. We calculate the average treatment effects on the entire sample (ATE) and the average treatment effect on the treated (ATT) (i.e. FAFH participants) as (Chiburis et al., 2012):

(5) $$ATE = \Phi(\beta_1 + \beta'_2 \bar{x}) - \Phi(\beta'_2 \bar{x})$$

$$ATT = \Pr(Z=0) \times \frac{\Phi_2(\beta_1 + \beta_2 'x, \alpha_2 'x, \rho) - \Phi_2(\beta_2 'x, \alpha_2 'x, -\rho)}{\Phi(\alpha_2 'x)}$$
$$+ \Pr(Z=1) \times \frac{\Phi_2(\beta_1 + \beta_2 'x, \alpha_1 + \alpha_2 'x, \rho) - \Phi_2(\beta_2 'x, \alpha_1 + \alpha_2 'x, -\rho)}{\Phi(\alpha_1 + \alpha_2 'x)}$$

We also calculate the marginal effect for other explanatory variables. Marginal effect evaluates an additional change in the determinant on the likelihood of the joint outcomes (the formula of these marginal effects for each regime can be found in Greene (2010)). The standard errors of the marginal effect are derived based on the delta method.

Results

Our empirical results are presented in three tables. Table 2 reports the estimation results of the bivariate probit model, and the associated marginal effects of the explanatory variables in four possible regions are presented in Tables 3. Table 4 reports the statistical results to show the validation of our empirical model.

Effects of FAFH on Elderly Depression

We begin our discussion of the results in the bivariate probit model by looking at the effect of the FAFH on the depression of the elderly. As presented in Table 2, the estimated error correlation coefficient (ρ) is 0.724 which is statistically significant at the 1% level. This significant correlation coefficients justifies the use of the bivariate probit model, and it confirms our hypothesis that the risk of being depressed and FAFH are simultaneously determined due to some unobserved common factors. Therefore, it is necessary to estimate the two different types of outcomes simultaneously because failure to control for the endogeneity would cause statistical inefficiency.

With respect to the effect of FAFH on the likelihood of depression, the estimated coefficient of the variable *FAFH* in the depression equation is 1.135 which is statistically significant at the 1% level. This results show that FAFH has a direct and positive effect on elderly depression. In terms of the magnitudes of the effect, the estimated ATE are ATE are 0.347 and 0.146 respectively (see the bottom of Table 2). That is, compared to FAFH non-participants, elderly who consumed food away home have a higher probability of being depressed by 34.7 % evaluated on the entire sample. Moreover, the magnitude of the effect is less pronounced when it is evaluated on the subgroup of FAFH participants only. Among the FAFH participants, the estimated ATT effect is 0.146. Although there are several reasons that may cause the positive

effect of FAFH on elderly depression, the possible mechanisms of this positive association can be explained from the existing evidence from nutrition studies. Several studies in the field of nutrition science has looked at the association between food consumption or nutrient intakes and mental health condition. One of the agreements from these studies is that food consumption and nutrient intakes are significantly associated with mental illness. For instance, Woo et al. (2006) found that consuming more vegetables can improve mental health. In contrast, fat and energy intakes are positively associated with mental illness. Moreover, vitamin supplements contribute to better mental health. Since it is generally believed that FAFH is associated with less vegetables consumption and less vitamin-contented food, therefore, our findings of the positive effect of FAFH on elderly depression are consistent with the existing evidence revealed in nutrient science studies. The scientific evidence may help to explain our primary finding of a positive effect of FAFH on elderly depression.

Marginal Effects of the Explanatory Variables

As discussed in the earlier section, the magnitude of the effects of the explanatory variables can be better understood by looking at the marginal effects. Results of the marginal effects, which capture the change of an additional in one unit of the explanatory variables on the probability of the possible four regimes, are

presented in Table 3. Since the discussions of the other explanatory variables on FAFH and depression are not the primary focus of this study, and many of the findings are consistent with the findings of the previous studies, we only briefly summarize the effects of these explanatory variables that are associated with elderly depression and FAFH in this section.

Socio-demographic characteristics of the respondents are significantly associated with the FAFH decision and the likelihood of being depressed of the elderly. Age is negatively associated with FAFH decision. It is evident that an additional year in age would decrease the probability of FAFH consumption and being depressed (Pr(FAFH=1 & Depression=1)) by 0.7%. Gender differences in FAFH and depression of the elderly is also evident. Male respondents are more likely to be consume food away from home and being depressed by 8.2%, and 9.7% without food consumption away from home. Consistent with the findings of the previous studies, education is positively associated with FAFH and negatively correlated with the propensity of being depressed. Taking the marginal effect on those who are depressed and without FAFH consumption for instance, those who have junior high and senior high school education have higher probability by 17.8% and 12.8%, respectively compared to elderly who are illiterate. The positive effect of education on the likelihood of FAFH and depression may be reinforced by personal income. Results indicate that compared

to elderly who have monthly income ≥NT$ 10,000, those who have income between NT$5,000 - 10,000 are less likely to consume FAFH and being depressed by 10.7%.

It is also not a surprise to see that married person are less likely to consume food away from home: the marginal effect of the marital status on the Pr (FAFH=1, Depression=1) is -12.2%. Finally, the chronic disease of the elderly is also positively associated with the likelihood of depression. It is evident that an additional unit increase in chronic disease score would increase the likelihood by 9.7% on those who are depressed and did not eat out (i.e. Pr(FAFH=0, Depression=1)).

Validation of the Empirical Specification

To show the robustness of our results, we conduct three statistical tests related to the selected instrument and the critical assumption imposed on the bivariate probit model. These statistical tests are displayed in Table 4. The results of these tests are encouraging. We start our discussion by justifying the imposed normality assumption on the bivariate probit model. The score test for normality assumption imposed on the bivariate probit model proposed by Chiburis et al. (2012) is applied and the test statics is 7.99, which is corresponding to the p-value 0.668. Therefore, the null hypothesis that the normality assumption of the bivariate probit model is appropriate cannot be rejected by our data.

The second test we conduct is related to the weak instrument. Several evidence

of our empirical findings point out that our selected instrument (the variable *house_elevator*) is not statistically weak. First, a significant effect of the variable *house_elevator* is found in the FAFH equation in Table 3. Results show that elderly who live in a house with elevators are more likely to consume FAFH. This finding echoes our expectation in that elevators can increase physical mobility of the elderly and also increase the chance to eat out. Since we are not aware of any literature which conduct the weak instrument test in a non-linear model or a simultaneous equation system, we estimate a linear probability model for FAFH and uses the F test to see if the variable *house_elevator* is statistically weak. The result of the F test is 16.06, which is larger than the standard cutoff of 10 proposed by Staiger and Stock (1997). Therefore, we have some confidence that the instrument is not statistically weak.

The third test we conduct is related to the endogeneity between FAFH and depression. There are two ways to check the endogeneity bias. First, the significance of the correlation coefficient (ρ) in Table 2 provides a snapshot. In Table 2, the estimated ρ is 0.724 which is significant at the 1% level. To provide a formal evidence, a likelihood ratio test (LR test) is conducted under the null hypothesis that ρ is equal to zero. The result of the LR test is 8.46 with the corresponding p-value 0.003. Therefore, the null hypothesis of exogeneity is rejected by our data and this indicates that the FAFH and depression is endogenous.

Conclusions

Depression is a significant contributor to the global burden of disease and it affects people in all communities across the world. Depression is estimated to affect 350 million people, and every 1 in 20 people reported having an episode of depression in 2011. Moreover, the prevalence of depressive symptoms is more pronounced among the elderly population (WHO, 2012). This study contributes to this important issue by examining the role of food consumption away from home on the likelihood of elderly depression using a national representative dataset in Taiwan as an illustration. After controlling for the socio-demographic characteristics, regional heterogeneity, and other factors that may be associated with food consumption away from home and depression, a positive effect of food consumption away from home on depression is evident. Results of the average treatment effect shows that the effect of food consumption away from home on the likelihood of depression is 34.7%. In addition, the effect is small for elderly who have food consumption away from home (14.6%). With respect to the potential mechanisms, our finding is consistent with scientific evidence of a positive (negative) association between fat, energy (vitamin) intakes on depressive symptoms. That is, food away from home consumption is more likely to result in higher fat and energy intakes and lower vitamin intakes. As a result, it may have increase the likelihood of depression among the elderly.

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Table 1: Sample Statistics

		Full sample		FAFH=1		FAFH=0	
		1,184		428 (36%)		756 (64%)	
Variable	Definition	Mean	SD	Mean	SD	Mean	SD
Depression	If depressed (=1).	0.17	0.37	0.15	0.36	0.18	0.38
Age	Age of the respondents (year)	73.06	5.86	72.63	5.60	73.31	5.99
Male	If male (=1).	0.52	0.50	0.60	0.49	0.47	0.50
Illiterate	If no education (=1).	0.29	0.45	0.22	0.41	0.33	0.47
Elementary	If finished elementary school (=1).	0.46	0.50	0.45	0.50	0.46	0.50
Junior	If finished junior high school (=1).	0.09	0.28	0.11	0.31	0.08	0.26
Senior	If finished senior high school (=1).	0.09	0.29	0.14	0.34	0.07	0.26
College	If has college degree or higher (=1).	0.07	0.26	0.09	0.28	0.07	0.25
Married	If married (=1).	0.65	0.48	0.63	0.48	0.66	0.47
Employment	If working with a full-time job (=1).	0.12	0.33	0.12	0.32	0.12	0.33
Income1	If no personal income (=1).	0.14	0.35	0.15	0.36	0.13	0.34
Income2	If monthly income <NT$5,000(=1).	0.43	0.49	0.39	0.49	0.45	0.50
Income3	If monthly income NT$5,000-10,000 (=1).	0.24	0.43	0.21	0.41	0.26	0.44
Income4	If monthly income >NT$10,000(=1).	0.19	0.39	0.24	0.43	0.15	0.36
Chronic	Number of chronic disease	1.48	1.30	1.58	1.37	1.42	1.25
North	If living in northern part (=1).	0.33	0.47	0.33	0.47	0.33	0.47
Center	If living in the central part (=1).	0.20	0.40	0.20	0.40	0.20	0.40
South	If living in the southern part (=1).	0.31	0.46	0.32	0.47	0.31	0.46
East	If living in eastern part (=1).	0.16	0.36	0.14	0.35	0.17	0.37
House_elevator	If living in a house with elevator (=1).	0.12	0.32	0.14	0.34	0.10	0.31

Table 2: Estimation results of the bivariate probit model

	FAFH		Depression	
Variable	Coefficient	SE	Coefficient	SE
FAFH			1.135 **	0.546
House_elevator	0.150 ***	0.031		
Age	-0.017 **	0.007	-0.003	0.009
Male	0.274 ***	0.089	-0.053	0.108
Elementary	0.197 **	0.096	-0.207 **	0.099
Junior	0.336 **	0.153	-0.220	0.169
Senior	0.455 ***	0.153	-0.464 ***	0.173
College	0.209	0.172	-0.426 **	0.196
Married	-0.323 ***	0.086	-0.032	0.117
Employment	-0.076	0.121	-0.103	0.134
Income1	-0.090	0.136	-0.058	0.155
Income2	-0.227 **	0.117	0.057	0.131
Income3	-0.285 **	0.126	-0.036	0.149
Chronic	0.037	0.030	0.073 *	0.040
Center	0.042	0.109	0.113	0.119
South	0.124	0.097	-0.011	0.106
East	-0.100	0.120	0.306 **	0.124
Constant	0.870	0.535	-0.979	0.694
Rho	0.724 ***	0.188		
Log-likelihood		-1259.848		
Treatment Effects				
ATE	0.347 **	0.162		
ATT	0.146 **	0.078		

Note: ATT is the average treatment effect; ATT is the average treatment effect on the treated.

***, **, * indicate the significance at the 1%, 5%, and 10% level.

Table 3: Estimation of the marginal effects

	Pr (FAFH=1, Depression=1)		Pr (FAFH=1, Depression=0)		Pr (FAFH=0, Depression=1)	
Variable	Marginal Effect	SE	Marginal Effect	SE	Marginal Effect	SE
Age	-0.007 ***	0.003	0.000	0.002	-0.006 **	0.003
Male	0.082 **	0.034	-0.020	0.027	0.097 ***	0.032
Elementary	0.016	0.034	-0.058 **	0.028	0.074 **	0.035
Junior	0.070	0.059	-0.060	0.040	0.128 **	0.058
Senior	0.067	0.060	-0.110 ***	0.041	0.178 ***	0.060
College	-0.019	0.064	-0.099 **	0.040	0.084	0.067
Married	-0.122 ***	0.031	0.000	0.026	-0.113 ***	0.034
Employment	-0.053	0.044	-0.025	0.034	-0.025	0.043
Income1	-0.046	0.048	-0.013	0.039	-0.030	0.048
Income2	-0.064 *	0.040	0.020	0.035	-0.080 *	0.043
Income3	-0.107 **	0.043	-0.004	0.037	-0.097 **	0.044
Chronic	0.032 ***	0.011	0.018 **	0.008	0.011	0.011
Center	0.045	0.039	0.029	0.033	0.012	0.039
South	0.041	0.035	-0.006	0.028	0.044	0.036
East	0.051	0.042	0.088 **	0.039	-0.043	0.041

***, **, * indicate the significance at the 1%, 5%, and 10% level.

Table 4: statistical test results

	test value	p-value
Normality test		
H^0: Normality is appropriate	7.99	0.668
Weak IV test[#]		
H^0: *House_elevator* is a weak IV	16.06	
Endogeneity test		
H^0: FAFH is exogeneity	8.46	0.003

the critical value is 10.