ESSAYS ON DISABILITY, FOOD INSECURITY, ASSISTANCE PROGRAMS, AND EMPLOYMENT

A Dissertation

by

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ABSTRACT

Populations with disabilities are at higher risks of food insecurity and low employment than those without a disability which can lead to poor nutritional outcomes and decreased quality of life. The objective of this dissertation is to examine the effects of participation in assistance programs for households with disabled members and to analyze the effects of policy changes that designed to improve employment outcomes for people with disabilities. This dissertation consists of three essays and in the analyses, we consider three programs that include the Supplemental Security Income (SSI) and Supplemental Nutrition Assistance Program (SNAP) in the U.S. and the Employment Quota System (EQS) in South Korea.

The objective of the first essay is to understand the underlying relationships between food insecurity and various disability characteristics of household members and look at how the relationship is affected by participation in assistance programs. Using data from the 2011–2016 National Health Interview Survey and by applying ordered probit and local polynomial regression models, we find that food insecurity is not only affected by type, severity, and multiplicity of disability of a household member but also affected by who in the household has a disability. Results suggest that participation in assistance programs may shield food security from a household member's disability.

The objective of the second essay is to examine the effects of SNAP participation and the 2013 SNAP benefit changes on food insecurity for households with disabled members. We make use of the public- and restricted-access National Health Interview

Survey (NHIS) 2011–2015, in which two different indicators of disability are used: the presence of member(s) with disabilities and who in the household has a disability. To obtain more efficient and consistent estimates, copula distribution functions are incorporated into in the maximum likelihood function of the switching regression model in which state-specific SNAP policy variables serve as instrumental variables to satisfy exclusion restrictions. Main results suggest that SNAP is more effective in reducing food insecurity for households with disabled members than for those without disabled members, and the effects of SNAP vary with a household head's, spouse/partner's and children's disabilities. Additionally, we find that the decrease in SNAP benefits that occurred in 2013 weakens the program's effectiveness.

The objective of the third essay is to examine a set of changes in the employment quota system for people with disabilities that was implemented in 2010 in South Korea. Using data from the Panel Survey of Employment of the Disabled (PSED) from South Korea and ordered probit models with sample selection, we estimate the extent to which these exogenous policy changes have desired employment outcomes for people with disabilities. Results suggest that policy changes bring about improved employment for only men with disabilities; for women with disabilities, no improved employment outcomes are found, and that they are significantly disadvantaged in the labor-market.

DEDICATION

To my family

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1. INTRODUCTION

Disability can lead to food insecurity and preclude employment, and result in decreased quality of life (Huang, Guo, and Kim 2010; Coleman-Jensen and Nord 2013; Hotchkiss 2013; Baker et al. 2018). Efforts have been made to reduce economic vulnerability for populations with disabilities by providing various types of social services and supports and implementing employment policies. In the U.S. the Supplemental Nutrition Assistance Program (SNAP) and Supplemental Security Income (SSI) play important roles in helping people with disabilities to be more food and economically secure. In South Korea, the Employment Quota System (EQS), which is a widely used employment policy among non-U.S. countries, has been implemented that requires private firms and/or public firms to integrate a certain number or portion of people with disabilities into the workplace. Thus, looking at the roles of the programs and policies and evaluating whether the implemented changes resulted in the desired outcomes for the intended target populations is important in improving the understandings of policy/program's effectiveness. The objective of this dissertation is to examine the effects of participation in assistance programs for households with disabled members and to analyze the effects of policy changes that designed to improve employment outcomes for people with disabilities by focusing on SNAP and SSI in the U.S. and the EQS in South Korea.

Although there is no universal definition of disability (Palmer and Harley 2012), disability characteristics of an individual can be assessed based on type, severity, and

multiplicity of disability. In a household, who has a disability among household members can also be implicative. Using these various indicators of disability, the objective of the first essay is to investigate how the various disability characteristics are related to food insecurity, by doing so, how the relationships between food insecurity and a household member's disability vary with participation in SSI and/or SNAP is examined.

Households with disabled members are more likely to participate in SNAP and at the same time, these households are less likely to be food secure than those without disabled members (Coleman-Jensen and Nord 2013). Thus, to what extent SNAP participation reduces food insecurity for these households may be different from that for households without disabled members, which also may vary by household members' disability status. The objective of the second essay in this dissertation is to examine the effects of SNAP participation on reducing food insecurity for households with disabled members using different indicators of disability: (1) the presence of member(s) with disabilities and (2) who has a disability among household members, i.e. a household head, spouse/partner, and/or children. Additionally, we estimate the change in the program's effectiveness due to the 2013 SNAP benefit decreases, caused by the expiration of the American Recovery and Reinvestment Act (ARRA) of 2009, for households with and without disabled members.

A variety policies and programs have been implemented and enacted in an effort to close the employment gaps between individuals with disability and without disability. For example, in the U.S., the Americans with Disabilities Act (ADA) that went into

effect in 1992 which prohibits discrimination on the basis of disability in hiring. However, it is understood that the ADA has brought unintended consequences by leading to negative effects on the employment outcomes for the disabled (DeLeire 2000; Acemoglu and Angrist 2001), or no effect (Hotchkiss, 2003). Unlike the US, more than third of OECD countries implement the Employment Quota System (EQS) that requires private and/or public firms to integrate a certain number or proportion of people with disabilities into a workplace. On the other hand, EQS instruments a monetary penalty/compensation scheme that imposes a levy if firms do not meet the quota but are subsidized if they employ disabled workers beyond the quota. In this context, looking at how other countries implement employment policies to provide better and secure employment for people with disabilities may be of particular interest. South Korea is one of the countries have the EQS, and recently there have been a set of policy changes in the EQS: (1) the quota increases for both public and private firms, (2) the implementation of the double count system for people with severe disabilities that regards the employment of an employee with severe disabilities as the employment of two employees with disabilities, and (3) the change in the grant policy for firms attained the quota. The objective of the third essay in this dissertation is to investigate whether these policy changes bring about enhanced employment outcomes for people with disabilities, with specific attentions paid to severity of disability and gender of employees and the employment status of unemployment, part-time, and full-time.

2. UNDERSTANDING THE RELATIONSHIP BETWEEN FOOD INSECURITY AND DISABILITY OF HOUSEHOLD MEMBERS

2.1. Introduction

Food insecurity is one of the major public health concerns in the United States (Gundersen and Ziliak 2018). While most U.S. households have consistent access to enough food to maintain healthy and active lives, the prevalence of food insecurity in the U.S. is not negligible. In 2017, 11.8 percent of U.S. households (15.0 million households) were food insecure, including 5.8 million very low food secure households (Food Security Statistics, USDA 2018), which refers to the absence of adequate food access because of financial resource constraints.

Previous studies on food insecurity have been devoted to finding its determinants, which encompass households' socio-demographic characteristics, household income or income-related attributes. Not surprisingly, the likelihood of food insecurity declines as a household's income rises (Gundersen, Kreider, and Pepper 2011). Huang, Guo, and Kim (2010) further found that households' economic or financial resources such as net worth, liquid assets, and home-ownership are related to food insecurity. In contrast, Coleman-Jensen et al. (2016) argued that in 2015 about 6 percent of households with annual income at or above 185 percent of the Federal Poverty Level (FPL) were food insecure, and about 38 percent of households with income below 100 percent of the FPL were food insecure. They also found that the prevalence of food insecurity is associated with household demographics such as

household members' race and gender and household composition. While the demographic factors and household resources found in the current literature are significantly associated with food insecurity, disability can be one of the important factors that can also affect food insecurity of households.

It is generally agreed that households with disabled members are more likely to be food insecure than those without disabled members (Coleman-Jensen and Nord 2013; Huang, Guo, and Kim 2010). This may be because of decreased disposable income (Mitra and Sambamoorthi 2006; Nord 2008; Huang, Guo, and Kim 2010; Ghosh and Parish 2013) and household members' physical or mental limitations on food-related issues: meal planning, grocery shopping, and cooking (She and Livermore 2007; Webber and Dollahite 2007; Huang et al. 2012). They are more likely to participate in assistance programs, by which food insecurity status of their households may be alleviated to some extent. For example, it is well-documented that participation in Supplemental Security Income (SSI) and Supplemental Nutrition Assistance Program (SNAP) is more common among households with disabled members than those without disabled members (Coleman-Jensen and Nord 2013; SSI Annual Statistical Report 2017). Taken together, it could be suggested that household member(s)' disabilities and program participation can be good predictors of food insecurity of households.

The objectives of this essay are to examine how various disability characteristics of household members are related to food insecurity. First, little is known about whose disability among household members impinges more on food insecurity than other members' disabilities. Although household heads' disabilities are predictive of increased

food insecurity, in this context, other household members' disabilities may have different effects on food insecurity. We take into account household heads', spouse/partners' and children's disabilities and examine their effects on food insecurity.

Second, we examine how specific types of disabilities and severity and multiplicity of these disabilities are related to food insecurity as comprehensive empirical evidence on this issue is lacking. We expect that households with a member with a severe disability are more likely to be food insecure than those with the non-severe disability because of over-extraction of household resources, and the relationship may differ by which type of disability he/she has. Multiple impairments of a household member may be positively associated with the higher likelihood of food insecurity.

Third, given the positive relationship between food insecurity and severity of disability, for a certain disability type, the degree of limitation of a household member may have a nonlinear rather than additive effect on the level of food insecurity, and this non-linearity may vary with household resources: income or participation in assistance programs. We take into account SSI and SNAP and examine how the non-linear relationships between food insecurity and a specific type of disability of a household member varies by participation in the assistance programs.

2.2. Related Literature

Research on the relationships between food insecurity and disability characteristics of household members has focused on household members' specific types of disabilities. Coleman-Jensen and Nord (2013) looked at a household member's hearing, vision, mental, physical, self-care, and going-outside-home disabilities and found that

households with a working-age adult with vision, mental, and physical disabilities are more likely to be food insecure than those without a disability. More recently, Brucker (2016) has looked at young adults' (age 18–25) mental disabilities, which are measured using the Kessler index of psychological distress, and six different types of disabilities: ambulatory, cognitive, hearing, vision, independent living, and self-care. She found that adults with mental disabilities or with one of the six limitations are more likely to be living in a food insecure household than their respective counterparts. Further, Brucker and Nord (2016) found that individuals with intellectual or developmental disabilities are more likely to be food insecure than those without a disability. Different household members' disabilities may have different effects on food insecurity, and among them household heads' disabilities may have the greatest negative effects on food security as they are usually a primary income earner. In this context, other household member's disabilities may have different effects on food insecurity. However, in the current literature, little attention has been paid to this issue except for Huang, Guo, and Kim's (2010) study. They found that household head's disabilities are related to increased food insecurity, but the variable for household heads' disabilities turned out to be insignificant when a spouse/partner's disability status is controlled for in the model.

Much of the research on food insecurity and participation in safety-net programs, such as SNAP, the National School Lunch Program (NSLP), Temporary Assistance for Needy Families (TANF), and SSI, has estimated the programs' effectiveness in reducing food insecurity with controlling for individuals' or households' self-selected program participation. A great deal of work found that SNAP participation

reduces food insecurity to some extent (Borjas 2004; Bartfeld and Dunifon 2006; Yen et al. 2008; Depolt, Moffitt, and Ribar 2009; Mykerezi and Mills 2010; Ratcliffe, McKernan, and Zhang 2011; Gundersen, Kreider, and Pepper 2017; Zhang and Yen 2017; Gundersen, Kreider, and Pepper 2018). Schmidt, Shore-Sheppard, and Watson (2016) found that the receipts of SSI and TANF reduces food insecurity. Gundersen, Kreider, and Pepper (2017), Artega and Heflin (2014), and Miller (2016) found that the NSLP decreased food insecurity of NSLP participating children.

2.3. Data and Measure

The data used come from 2011 through 2016 National Health Interview Survey (NHIS). The NHIS provides a rich set of information about household members' demographic characteristics, disability, and household characteristics such as food insecurity and participation in assistance programs. We use the "Person," "Family," "Sample Adult," and "Adult Functioning and Disability" cores of the NHIS in the analysis.

2.3.1. Food Insecurity

The United States Department of Agriculture (USDA) utilizes the 18-item Food Security Survey Module (FSSM) to assort a household's food security status in the last 12 months into one of these four categories: high food secure, marginal food secure, low food secure, and very low food secure, of which the items 1 through 10 refer to adult[1] food security. The "Family" core of the NHIS contains 30-day-based[2] adult food security questions, which are analogous to the questions in the USDA-FSSM. In table A-1, the

[1] The last 8 items refer to child-referenced food insecurity

[2] An experience of food insecurity in the last 30-day prior to interview.

10-item food security questions are listed (10-item food security questions, "Family" core of the NHIS 2011–2016). The first three questions are answered by the ordinal scale that responses of "often true" and "sometimes true" are coded as affirmative; the following five questions are answered by the yes/no format; and the answers to two occurrence frequency questions are considered as affirmative if numerical answers[3] are greater than or equal to three days. Based on the sum of affirmative responses scaled from 0 to 10, an ordered food security status of adults in a household is classified into 0 for "high food secure", 1-2 for "marginal food secure", 3-5 for "low food secure", and 6-10 for "very low food secure". A binary food security is defined by classifying "high food secure" and "marginal food secure" into "food secure" and "low food secure" and "very low food secure" into "food insecure". We use these ordered and binary food security measures for analyses. Additionally, we index a continuous food insecurity scale score to use more information from the variously scaled responses to the food security questions. To this end, we deal with three variables: (1) aggregate score from the first three questions (out of 6), (2) aggregate score from the five binary format questions (out of 5), and (3) aggregate score from the two frequency occurrence questions (out of 60). We apply the Principal Component Analysis (PCA) to these three variables in order to extract a major component with the largest eigen-value and standardize the major component with zero mean and unit variance.

[3] In the first stage, households with affirmative responses to "often true" or "sometimes true" to one or more items of the first three questions are asked to answer four yes/no questions and a frequency question in the second stage. Households with non-affirmative answer to the first three questions are regarded as non-affirmative to remaining all the seven questions. If households affirmatively answer to the one or more four yes/no questions, they are asked a binary question and a frequency question in the last stage. Similarly, non-affirmative households to the four binary questions are recorded as non-affirmative to the two questions in the last stage.

2.3.2. Disability

Although there is no universal measure of type and severity of disability, commonly used indicators are six questions included in the federal household surveys. For example, the American Community Survey (ACS) and Current Population Survey (CPS) utilize survey respondents' self-reported answers to the 6 Question Sequence (6QS): limitations on ambulatory, cognitive, hearing, vision, independent living, and self-care. Another disability measure often used is the Kessler index for assessing an individual's psychological wellness using standardized and validated six (K6) or ten (K10) items.

Each core and supplement of the NHIS asks survey respondents' health conditions and information about disability differently. In this essay, household members' disabilities are measured in two different ways. First, using "Adult Functioning and Disability (AFD)[4]" supplement, six disability types of a randomly selected adult (hereafter, adult) in each household are taken into account: vision, hearing, physical, cognitive, communicative, and self-care disability. As degree of these disabilities are assessed as "no difficulty," "some difficulty," "a lot of difficulty," and "cannot do at all", we classify "no difficulty" into "no limitation", "some difficulty" and "a lot of difficulty" into "non-severe disability", and "cannot do at all" into "severe disability". Additionally, to capture an adult's multiple disabilities, we count number of their disabilities regardless of severity: 0–6. Using a household identifier, a family relationship variable, and a question in the "Person" core asking whether an individual

[4] The AFD is a sub-file of the "Sample Adult" core. About a half (2011, 2013–2016) and a quarter (2012) of all the sample adults are randomly selected to be surveyed for the file.

has “any limitation-for all condition”, household heads[5]’ disability status are measured dichotomously, and if a spouse/partner or children are present, their disability status are measured by sets of dummy variables.

Second, an adult’s psychological distress is measured by using the six-item Kessler index (K6) from the “Sample Adult” Core. The Kessler psychological distress scale is well-known in that it utilizes a short screening device to evaluate the level of distress associated with non-specific psychological symptoms in the general population (Kessler et al. 2002; Anderson et al. 2011). It is comprised of six questions asking adults’ degree of psychological distress; how often they have felt in past 30 days: (1) so sad nothing to cheer up, (2) felt nervous, (3) felt restless or fidgety, (4) felt hopeless, (5) felt everything was an effort, and (6) how often felt worthless. Severity of each domain is scored by the five-pointwise scale: 4-all of the time, 3-most of the time, 2-some of the time, 1-a little of the time, and 0-none of the time, which makes the sum of scores 0–24. Based on this raw score with specific cut-off points, previous studies specified an ordered or a binary status with respect to severity of psychological distress (Furukawa et al. 2003; Brucker 2016). To elicit a non-linear relationship between food insecurity and the degree of psychological distress of an adult, we index a standardized continuous psychological distress scale score using the PCA. Additionally, we use a binary index for severe psychological distress of an adult which is coded as 1 if the sum of raw score is greater than or equal to 13 as Brucker (2016) and Furukawa et al. (2003) used.

[5] The NHIS does not provide information about who is a household head among household members but define a household reference person as the person who owns or rents the housing unit, we regard the household reference person as the household head.

2.3.3. Participation in Assistance Program(s)

As noted, we focus on SSI and SNAP as they are major public assistance programs for low-income households with disabled members. Information about households' participation in these programs come from the "Family" core in which participation is coded affirmatively if a household received benefits from each of the programs in the last 12 months prior to the survey. For program eligibility, a gross-income threshold of SNAP receipt is 130 percent of the FPL. However, in some states, the Broad-based Categorical Eligibility[6] (BBCE) increases the income threshold to 200 percent of the FPL. Although there is no specific cut-off in the gross-income eligibility for SSI, the monthly basis income limit for SSI for an adult is nearly 110 percent of the FPL, and that for children due to a disability is nearly 200 percent of the FPL. Accordingly, we focus on households with annual income below 200 percent of the FPL for our analyses on the basis of programs eligibility.

To examine variations in the relationship between food insecurity and an adult's psychological distress by participation in assistance programs, we assign the number of assistance programs that households participated: 0 for non-participation, 1 for participation in any of the programs, and 2 for participation in both programs.

2.4. Methodology

Because we have multiple interests on the relationship between food insecurity and differently measured household members' disabilities and need to sidestep overfitting

[6] By the BBCE, households may become eligible for SNAP if they quality the TANF or benefits from State Maintenance-of-Effort.

problems that arises from multicollinearity between the different disability measures, three respective parametric models are estimated based on: an adult's type and severity of disability (Model 1), disability status of a household head, spouse/partner, and children (Model 2) if the spouse/partner and children are present, and multiplicity of disability of an adult (Model 3). To examine a non-linear relationship between an adult's psychological distress and food insecurity, we employ a nonparametric estimation model (Model 4).

2.4.1. Parametric Framework

We apply an ordered Probit model to Models 1 through 3;

(1) $$FS_i^* = \beta_0 + \beta_1 X_i + \beta_2 D_i + \varepsilon_i, \quad i = 1, \dots, N$$

where FS_i is the observed ordered food security status of a household i in the last 30 days from the survey which is governed by a latent variable FS_i^*, where

(2) $$FS_i = \begin{cases} 0 \;\; if \;\; FS_i^* \leq (-\infty, \; \mu_1] \\ 1 \;\; if \;\; FS_i^* \in (\mu_1, \mu_2] \\ 2 \;\; if \;\; FS_i^* \in (\mu_2, \mu_3] \\ 3 \;\; if \;\; FS_i^* > (\mu_3, \; \infty] \end{cases}$$

Values of FS_i, 0 to 3, correspond to the status of high food secure, marginal food secure, low food secure, and very low food secure. μ_1, μ_2, and μ_3 are estimable cutoff points. X_i controls for a household head's socio-demographic characteristics: age, gender, race, marital status, educational background, and employment status, as well as household characteristics such as home-ownership, number of kids, gross-income, and household size. D_i represents information about type, severity, and multiplicity of

disability of an adult, as well as, a household head's, spouse/partner's, and children's disabilities. ε_i is an error term with zero mean and constant variance σ_ε^2.

2.4.2. Nonparametric Framework

We employ Fan and Gijbels (1996)'s kernel-weighted local polynomial regression model with a smooth, continuous, and unknown function $m(\cdot)$ as specifies;

(3) $$Y_i = m(X_i) + \epsilon_i$$

where X_i is the level of psychological distress of an adult in a household i: standardized psychological distress scale score, and Y_i is the standardized food insecurity scale score. ϵ_i is a symmetric disturbance. Without imposing any assumptions, we aim to estimate $m(x_0) = E(Y|X = x_0)$. Using a Taylor expansion for some x in the neighborhood of x_0, $m(x_0)$ can be estimated as the constant of a regression of Y_i on the p-th order polynomial terms. By incorporating a kernel function $K(\cdot)$ that is a density function symmetric at zero and a bandwidth h and defining $\beta_j = m^{(j)}(x_0)/j!$ for $j = 0, \dots, p$, $\hat{\beta}_0 = \hat{m}(x_0)$ is obtained by minimizing in β_0 such that

(4) $$\sum_{i=1}^{n}\{Y_i - \sum_{j=0}^{p}\beta_j(X_i - x_0)^j\}^2 K_h(X_i - x_0)$$

where $K_h(a) = h^{-1}K(a/h)$. The bandwidth is obtained by using Fan and Gijbels (1996)'s Rule of Thumb (ROT) method which minimizes the conditional weighted mean integrated squared error. The resultant ROT bandwidth is computed as follows:

(5) $$\hat{h} = C_{0,p}(K)\left[\frac{\hat{\sigma}^2 \int w_0(x)dx}{n\int\{\hat{m}^{(p+1)}(x)\}^2 w_0(x)f(x)dx}\right]^{1/(2p+3)}$$

where $C_{0,p}(K)$ is a constant depends on the kernel function $K(\cdot)$ and the degree of polynomial p. $w_0(x)$ is selected to be an indicator function on the interval

$[min_X + 0.05 \times range_X, max_X - 0.05 \times range_X]$ where min_X, max_X, and $range_X$ is minimum, maximum, and the range of x. $\hat{\sigma}^2$ is estimated as a standardized residual sum of squares from fitting a polynomial in x of order $(p + 3)$ to Y_i. In this specification, the 3rd degree polynomial smoothing function with the Epanechnikov kernel is used.

2.4.3. Analytical Sample

A full sample for ordered Probit models includes 78,214 households in all income levels. For nonparametric analyses, we use subsamples by income and number of program participation because of a lack of variables controlling for endogeneity issues that arise from self-selected program entries into SSI and SNAP. By doing so, we examine how non-linear relationships between food insecurity and an adult's psychological distress vary with income and program participation, rather than estimating causal effects of program participation.

First, the full sample is divided into three subsamples: low-income households below 200 percent of the FPL (N=28,561), middle-income between 200 and 400 percent of the FPL (N=22,526), and high-income above 400 percent of the FPL (N=27,127). Second, low-income households eligible for program participation are further divided into three subsamples: low-income households participating in any one of the programs (N=9,478), in both programs (N=2,519), and non-participants (N=16,564), respectively. We use sampling weights to account for population representativeness in all the analyses.

2.5. Results

2.5.1. Descriptive Statistics

Descriptive statistics of our full sample by ordered food security status are presented in table A-2. Households are predominantly comprised of as high food secure (82 percent). Overall, household heads of low and very low food secure households are more likely to be non-Hispanic Black, less educated, unmarried/widowed/divorced/separated, and unemployed. Additionally, low and very low food secure households are more likely to be in low-income and rented.

As expected, food insecurity and household heads' disabilities are positively related. That is, about a half (52 percent) of very low food secure households are headed by a person with disabilities. On the contrary, 9 percent of low food secure and 11 percent of very low food secure households are populated by spouses/partners with disabilities. It appears that children's disabilities are least relevant with the prevalence of food insecurity; 9 percent of low and very low food secure households have children with disabilities. We can see that household resources are strongly related to food insecurity. Low-income households are more likely to be food insecure, and as more food insecure, the households tend to participate in SSI, SNAP, or both programs. Descriptive statistics for the nonparametric specifications are presented in table A-3. We find that low-income households are more likely to have an adult with severe psychological distress, and households with an adult with severe psychological distress are more likely to participate in assistance programs.

2.5.2. Ordered Probit Models

Given parameter estimates of the three ordered Probit models reported in tables A-4 through A-6, we estimate the average partial effects (APEs) of covariates on the ordered food security status. The APEs of Model 1 are presented in table A-7. We find that adults' specific types and severity of disabilities are closely related to food insecurity. Households with an adult with severe vision, hearing, physical, or cognitive disability are more likely to be low and very low food secure than those with the adult without a disability. Households with an adult with all the types of non-severe disabilities are more likely to be low and very low food secure than those with the adult without a disability. For each of six disability types, we test whether severe disability has different effects on low and very low food security compared to non-severe disability using Wald tests. These test results are presented in table A-8 and suggest that severe hearing, cognitive, and self-care disabilities do not have significantly different effects on low food security compared to each respective non-severe disability. Similarly, severe hearing and self-care disabilities do not have significantly different effects on very low food security compared to each respective non-severe disability.

For the six disability types, in terms of magnitude, severe physical disability has the greatest effects on increased low food security (2.9 percent points) and very low food security (3.3 percent points) compared to the other types of severe disabilities. However, Wald test results in table A-9 suggest that the effects of severe physical disability of an adult on low and very low food security are not significantly different from those of

severe vision and cognitive disabilities but greater than those of hearing, communicative, and self-care disabilities.

The presence of an adult with all the types of non-severe disabilities are related to increased low and very low food security. Compared to households with an adult without a disability, households with the adult with non-severe physical disability are more likely to be low and very low food secure by 2.0 and 2.2 percent points, respectively. Similarly, households with an adult with non-severe cognitive and vision disabilities are more likely to be low food secure by 2.0 and 1.8 percent points and very low food secure by 2.1 and 1.9 percent points than those with the adult without a disability, respectively. We test whether non-severe physical disability has significantly different effect on low and very low food security compared to other types of non-severe disabilities. According to the Wald test results in table A-10, the effects of non-severe physical disability of an adult on low and very low food security are not significantly different from those of non-severe vision and cognitive disabilities but greater than those of non-severe hearing, communicative, and self-care disabilities.

Turning to the APEs from Model 2 in table A-11, the results are consistent with the findings from the descriptive statistics in that food security is most affected by a household head's disabilities than the other members' disabilities. We suppress the APEs of the other covariates for brevity and due to similarity of those of Model 1. Households headed by a person with disabilities are more likely to be low and very food secure by 4.4 and 4.9 percent points than those headed by a person without a disability, respectively. Households headed by a person with a spouse/partner without a disability

are less likely to be low and very low food secure by 1.4 percent points than those without a spouse/partner. On the contrary, households headed by a person with a spouse/partner with disabilities are more likely to be low and very low food secure by 1.4 and 1.5 percent points than those without a spouse/partner, respectively. We test these different effects of the presence of a spouse/partner and children with and without disabilities on food insecurity, the results from which are reported in table A-11. We find that the presence of a spouse/partner and children with disabilities have significantly greater effects on decreased low and very food security than the presence of a spouse/partner and children without a disability.

Children's disabilities are significant predictors of low and very low food security as well. Households with children without a disability are less likely to be low and very low food secure by 0.5 and 0.6 percentage points than those without children, respectively. On the contrary, households with children with disabilities are more likely to be low and very low food secure by 0.9 and 1.0 percent points than those without children, respectively. Wald test results reported in table A-12 are supportive of the different effects of the presence of children with and without disabilities on low and very low food security.

Lastly, we find that multiple disabilities are related to food insecurity. It can be inferred from the results from Model 3 in table A-13 that as adults have multiple impairments, households are more likely to be low and very low food secure. Wald test results in table A-14 reject the hypotheses of equal effects of different numbers of disabilities on low and very low food security.

2.5.3. Nonparametric Specifications.

The first principal component with the largest eigenvalue, 2.34, generates the standardized food insecurity scale score ranging from –0.33 to 9.88 with zero mean and unit variance. Similarly, the standardized psychological distress scale score ranges from –0.63 to 5.51 with zero mean and unit variance that is generated by the first principal component with the largest eigenvalue, 3.63. Note that the horizontal and vertical axes in figure D-1 describe the standardized food insecurity and psychological distress scale scores, respectively.

First, for the low-income households below 200 percent of the FPL, we find a positive relationship between food insecurity and adults' psychological distress. Food insecurity linearly increases as the psychological distress scale score reaches 4.0, and then a drastic curve is seen. For the high-income households above 400 percent of the FPL, we obtain a markedly different result from that of the low-income households; the food insecurity scale score moderately rises with a lower slope over the domain of the psychological distress scale score. For the middle-income households between 200 and 400 percent of the FPL, food insecurity gradually increases with the psychological distress scale score up to near 3.8, and then an inverse U-curve appears.

Second, we find that the relationships between food insecurity and adults' psychological distress vary with households' participation in assistance programs. The low-income non-participating households experience gradually increasing food insecurity with adults' aggravated psychological distress. In contrast, for households participating in any one of the programs, food insecurity substantially increases at high

levels of psychological distress, which is similar with that of the low-income households. Food insecurity of households participating in both programs turned out to have a moderate pattern of increase with the adults' psychological distress, which is analogous to that of the low-income non-participants.

2.6. Discussion and Conclusions

Although we used data from the NHIS with slightly different measures of disability from the 6QS categorization, the findings from the parametric specifications are consistent with Coleman-Jensen and Nord's results (2013) that the presence of a working-age adult with vision, physical, or mental disability is positively related to increased food insecurity. In addition, our results suggest that hearing disability is related to increased food insecurity as well.

We find that the disability status of household members is a significant predictor of food insecurity. Whereas the presence of a spouse/partner and children with disabilities are positively associated with food insecurity, the presence of those without a disability are negatively associated with food insecurity. These results mainly differ from Huang, Guo, and Kim (2010)'s findings that the indicator of the household head's disability loses its statistical significance when spouse's disability is controlled for in the analysis.

The results from the nonparametric specifications confirm that the relationships between adults' psychological distress and food insecurity differ by household income level and participation in assistance programs. At any level of adults' psychological distress, food insecurity of high-income households is lower than that of middle and

low-income households. In contrast, for middle-income households, we observe an inverse U-relationship between food insecurity and high levels of psychological distress, which might be due to uncontrolled household attributes which are associated with both food insecurity and psychological distress. For low-income households, food insecurity almost uniformly grows over low to mid-level of psychological distress and then drastically increases at the very high level of psychological distress. Taken altogether, it can be concluded that households' high-income may shield food security from adults' aggravated psychological distress. The results from the restricted samples are supportive of these findings; compared to households participating in both SSI and SNAP, food insecurity of households participating in only one program is more sensitive to adults' aggravated psychological distress. Additionally, we can see that the regression curve for households participating in both programs are somewhat similar with that for the low-income non-participating households. This implies that resources from the benefit programs may help the low-income households to be more food secure, similar with the low-income non-participants who are not eligible for program entry due to moderate amounts of assets or are not necessary to participate.

It should be noted that there are limitations in the nonparametric specifications. We could not adequately control for potential endogeneity but bypass the issue by utilizing restricted samples. Thus, non-parametric regression results on the effect of participation in assistance programs on reducing food insecurity should be interpreted with caution. Future studies would need to revisit and test the results by using other econometric methods with the endogeneity control.

Our overall results suggest that household members' various disability characteristics are strongly linked to food insecurity. To protect those who are suffering from food-related hardships among population with disabilities, by means of meeting the intensity of their needs through a channel of public assistance, figuring how disability and food insecurity is related and understanding the role of program participation would be matters of importance. Using data from the NHIS, we add empirical evidence to existing literature help to understand the underlying relationship between disability and food insecurity.

3. THE EFFECTS OF SNAP PARTICIPATION AND THE 2013 SNAP BENEFIT DECREASES ON FOOD INSECURITY FOR HOUSEHOLDS WITH DISABLED MEMBERS

3.1. Introduction

Although most households in the United States have stable access to adequate food for a healthy lifestyle, food insecurity is still a major health concern. In 2017, 11.8 percent (15.0 million) of U.S. households were food insecure at times, including 4.5 percent (5.8 million) of households with very low food security (USDA-ERS Food Security Statistics 2018), which means that their access to adequate food was limited by a lack of money and other resources (Coleman-Jensen et al. 2016).

Individuals with disabilities and households with disabled members are more likely to be food insecure or living in food insecure households than those without a disability or those without disabled members (Coleman-Jensen and Nord 2013; Huang, Guo, and Kim 2010; Brucker 2016; Brucker and Nord 2016; Burke et al. 2016; Sonik et al. 2016). This gap in food security might be because of limited economic resources, high disability-related expenses, and limited work opportunities, as well as, limitations on food preparation such as meal planning, grocery shopping, and cooking (Kemmer 1999; Mitra and Sambamoorthi 2006; Webber, Sobal, and Dollahite 2007; She and Livermore 2007; Parish, Rose, and Andrews 2009; Huang, Guo, and Kim 2010; Huang et al. 2012; Ghosh and Parish 2013).

The United States has implemented a variety of food assistance programs[7] that provide benefits for food-at-home spending or in-kind support for eligible low-income households or individuals. The Supplemental Nutrition Assistance Program (SNAP) is one of such programs designed to mitigate food insecurity and improve nutritional well-being of participants. SNAP is the largest food assistance program in the United States; program costs of SNAP in 2017 amounted to $68 billion, with an average monthly SNAP benefit of about $127 per person (USDA-FNS SNAP Data and Statistics 2018).

Vulnerable segments of the populations comprise a large portion of SNAP participants. In 2016, about 20 percent of SNAP participating households had no cash income and nearly two-thirds of those households had children, elderly, or at least one member with disabilities (Lauffer 2017). Coleman-Jensen and Nord (2013) found that in 2009–2010 47 percent of households with income below 185 percent of the Federal Poverty Level (FPL) that also had a member who is unable to work due to a disability participated in SNAP, compared to 27 percent of similar households with no working-age adults with a disability. Thus, households with disabled members may be distinct in terms of SNAP participation and food insecurity compared to those without disabled members, accordingly SNAP may have different effects on food insecurity for households with disabled members compared to those without disabled members.

Beginning in April 2009, the American Recovery and Reinvestment Act of 2009 (ARRA) raised SNAP benefits by 13.6 percent at a maximum, and as a result food

[7] Well-known food assistance programs operated by USDA are the Emergency Food Assistance Program (TEFAP), National School Lunch Program (NSLP), Supplemental Nutrition Assistance Programs (SNAP), the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), and School Breakfast Program (SBP).

insecurity of households below with income 130 percent of the FPL decreased by 2.2 percentage points from 2008 to 2009 (Nord and Prell 2011). Additionally, Nord (2013) found that the SNAP benefit increases reduced the number of SNAP participating households with very low food security by about 34 percent. In November 2013, on the other hand, the temporary SNAP benefit boost expired and the average monthly benefits decreased[8] by about 5 percent on average.

The objective of this essay is to examine how the effects of SNAP participation on food insecurity differ by: (1) the presence of disabled individuals and (2) who among household members, a household head, spouse/partner and/or children, have disability, which are less understood in the current literature on food insecurity and SNAP. Additionally, we estimate the changes in the effectiveness of SNAP due to the 2013 SNAP benefit decreases for households with and without disabled members, thereby compare the changes in the effectiveness between these two cohorts.

3.2. Related Literature

Previous studies on SNAP and food insecurity found either positive associations of SNAP with food insecurity (Jensen 2002; Ribar and Hamrick 2003; Wilde and Nord 2005; Huang, Guo, and Kim 2010) or no significant relationships (Gundersen and Oliveira 2001; Huffman and Jensen 2008).

More recent studies have found that SNAP participation reduces food insecurity with specific attentions paid on controlling for self-selection; food insecure households are more likely to enroll in SNAP due to various observed and unobserved household

[8] Except for Hawaii: no major change in SNAP benefits.

characteristics compared to food secure households. Borjas (2004) instruments the 1996 welfare reform legislation as an exogenous SNAP benefit change to control for endogenous SNAP participation and found that SNAP participation reduces the probability of food insecurity among SNAP participating non-immigrant households by 2 percent points. Bartfeld and Dunifon (2006) utilized hierarchical modeling to control for unobserved household characteristics related to SNAP participation and found that households in the states with higher SNAP participation rates are less likely to be food insecure.

A series of studies utilized instrumental variables (IVs) approach to identify a food insecurity equation that include an endogenous variable for SNAP participation. Yen et al. (2008), Mykerezi and Mills (2010), Ratcliffe, McKernan, and Zhang (2011), and Zhang and Yen (2017) made use of IVs for state-specific SNAP policy or other SNAP-related individuals' characteristics such as stigma, which are highly correlated with SNAP participation but not correlated with food insecurity. Using different estimation techniques, based on the framework of a treatment effect model, with the IVs, they found that SNAP participation reduces food insecurity to some extent.

Very recently, there have been efforts to estimate the treatment effects of SNAP participation on food insecurity without imposing exclusion restrictions controlling for the endogeneity issue. Gundersen, Kreider, and Pepper (2017) used partial identification methods to estimate lower and upper bounds on the average treatment effects of SNAP on food insecurity, rather than obtaining the point estimates. They found that SNAP decreases the rate of food-insufficient households with children by six to eleven percent

points. Gundersen, Kreider, and Pepper (2018) utilized a survey question from the Current Population Survey (CPS) that asks how much money the respondents would need to be food secure. They defined these amounts of money as the resource gap and found that a $42 increase in weekly SNAP benefits for SNAP participating households brings about a 62 percent reduction in food insecurity.

Little is known about the relationship between food insecurity and the 2013 SNAP benefit decreases. One study in the literature, Katare and Kim (2017) used difference in differences approach with an assumption that only food insecurity of SNAP participating households was affected by the SNAP benefit decreases. They found that the 2013 SNAP benefit decreases resulted in 3.7 percentage point increase in the prevalence of food insecurity among SNAP participating households compared to non-SNAP households.

3.3. Data and Measures

Individual and household-level data come from the National Health Interview Survey (NHIS) 2011–2015, a cross-sectional annual survey of households that collects information on the health status and various socio-economic and demographic characteristics of the non-institutionalized population of the U.S. We use both public- and restricted-access NHIS data. The former is comprised of information about household members' socio-economic and demographic characteristics, disability, households' participation in assistance programs, and 30-day-based[9] adult food security. The restricted-access data includes a state-level identifier, by which state-specific SNAP

[9] An experience of food insecurity in the last 30-day prior to the survey.

policy variables are merged into the public-access NHIS data set. The SNAP policy variables come from the policy database available from the Economic Research Service (ERS), USDA (USDA-ERS SNAP Policy Data Sets 2018). We obtained geographic data on household location through a data sharing agreement with the National Center for Health Statistics (NCHS) and gained access to confidential NCHS data under Special Sworn Status. As these data are made accessible through the Texas Research Data Center (TXRDC) at Texas A&M University, all the analyses were conducted at the TXRDC.

3.3.1. Food Security and SNAP Participation

In this essay, we use the binary food security measure which is based on the sum of affirmative responses to the 10-item adult food security questions: food secure for 0–2 affirmatives and food insecure for 3 or more affirmatives. Information about households' participation in SNAP are taken from two questions about households' enrollment in SNAP that ask whether any family member has received SNAP benefits and number of months received in the last year. To link current food security to current SNAP participation, households participated in SNAP during the previous 12 months are assumed to be participating in SNAP in the 30 days prior to the survey.

3.3.2. Disability

The NHIS not only provides detailed information about household members' self-reported physical and mental conditions but also includes comprehensive assessments of household members' disability status. First, we utilize a binary question: "Is any family member limited in any way?" to capture the presence of member(s) with disabilities.

Second, to capture disability status of a household head[10], spouse/partner, and children[11] in a household, we identify each person in the household according to their relation to the household reference person and use indicators of "any limitation, for all conditions" to identify disability. Although these measures on disability status may have limitations on capturing diverse dimensions of disabilities e.g. type or severity, they cover all the gradients of disabilities comprehensively without omission, and similar ones were utilized in other studies on disability (Burkhauser, Haveman, and Wolf 1993; DeLeire 2000; Acemoglu and Angrist 2001; Hotchkiss 2003; Nazarov, Kang, and Schrader 2015).

3.3.3. Control Variables and Analytical Sample

Control variables consisting of socio-economic and demographic characteristics of households include household head's age, gender, race, education attainment, marital status, employment status, U.S. citizenship status, and home-ownership. Household characteristics such as household size and participation in the Supplemental Security Income (SSI), Medicaid, and Temporary Assistance for Needy Families (TANF) are included as well. Given that food security is based on households' experience in the last 30-day from the survey, to fully detect the effects of SNAP benefit decreases on food

[10] The NHIS does not contain information about who is a household head in the household but describes a household reference person as the person age 18 or older who owns or rents the household. We identify the household head with the household reference person.

[11] Based on this information, we set a set of binary variables for a spouse/partner's and children's disabilities. Households headed by a person with a spouse/partner without a disability and households headed by a person without a spouse/partner comprises a reference group compared to those with a spouse/partner with disabilities, so does children's disabilities.

insecurity, the dummy variable for the post-SNAP benefit decrease period is coded as 1 if a household was interviewed in December 2013[12] or thereafter.

Although a gross monthly income limit for SNAP eligibility is 130 percent of the FPL, the Broad-Based Categorical Eligibility (BBCE) rule can raise the threshold in some states, and no state has the gross income limit above 200 percent of the FPL (USDA-FNS Broad-Based Categorial Eligibility Chart 2018). Accordingly, the primary analytical sample includes households below 200 percent of the FPL. Since multifamily households may share SNAP benefits within the household that may produce imprecise program effects, these households are excluded from the sample (1,939 households).

Summary statistics of our analytical sample (N = 64,209), classified by households' SNAP participation and binary food security status, are reported in table B-1; eligible non-SNAP participant households represent 71 percent of our sample. A higher rate of food insecurity (36 percent) is observed among SNAP participating households compared to non-SNAP households (22 percent), implying that there may exist adverse self-selection into SNAP.

As for the presence of disabled members, food insecure SNAP participating households are more likely to have disabled members (68 percent) than food secure SNAP households (48 percent). As for household members' disabilities, food insecure SNAP participating households are more likely to have a household head (54 percent), spouse/partner (10 percent), or children (14 percent) with disabilities than food secure SNAP households (35, 6, and 11 percent, respectively).

[12] One-month forwarded from the month of the SNAP benefit decreases.

Food insecure non-SNAP households are more likely to have member(s) with disabilities (49 percent) than food secure non-SNAP households (32 percent). As for household members' disabilities, food insecure non-SNAP households are more likely to have a household head (38 percent), spouse/partner (8 percent), or children (8 percent) with disabilities than food secure non-SNAP households (23, 6, and 5 percent, respectively). Overall, our analytical sample shows that households with disabled members are more likely to be food insecure and more likely to participate in SNAP.

3.4. Econometric Analysis

3.4.1. Endogenous Switching Regression

SNAP-eligible households can choose to participate in SNAP, and this decision can be driven by observed and unobserved household characteristics. As Gregory and Coleman-Jensen (2013) pointed out, some previous research using a framework of a treatment effect model (Yen et al. 2008; Ratcliffe, Mckernan, and Zhang 2011) assumed that the effects of the observables on food insecurity are the same for SNAP and non-SNAP households. In this essay, we relax this strong assumption and posit that the effects of the presence of disabled members or household members' disabilities on food insecurity would differ for SNAP and non-SNAP participating households. Accordingly, we use a framework of an endogenous switching regression model (ESR, hereafter) (Maddala 1983) and a system of equations are defined as follows:

$$SNAP_i^* = \alpha_0 + \alpha_1 X_i + \alpha_2 Z_i + \alpha_3 \mu_i + \alpha_4 \lambda_i + \varepsilon_{si} \tag{6}$$

$$FI_{1i}^* = \beta_1 + \beta_{11} X_i + \beta_{21} \mu_i + \beta_{31} \lambda_i + \varepsilon_{1i} \tag{7}$$

$$FI_{0i}^* = \beta_0 + \beta_{10} X_i + \beta_{20} \mu_i + \beta_{30} \lambda_i + \varepsilon_{0i} \tag{8}$$

where *i* indexes a household. $SNAP_i^*$ is a latent SNAP participation dummy and $SNAP_i$ is a binary variable indicating households SNAP participation with $SNAP_i =$ 1 if $SNAP_i^* > 0$, $SNAP_i = 0$ otherwise. Similarly, FI_{1i}^* and FI_{0i}^* are latent variables of food insecurity status of SNAP and non-SNAP participating households, with $FI_{si} =$ 1 if $FI_{si}^* > 0$, $FI_{si} = 0$ otherwise, for *s* = 0,1. X_i includes households' socio-economic/demographic characteristics and information about household members' disabilities. Z_i denotes a set of instruments. μ_i and λ_i are year and state dummy variables, respectively.

We have two research questions about the effects of SNAP participation on reducing food insecurity by (a) the presence of member(s) disabilities and (b) the distribution or composition of household members' disabilities in a household, and an additional question about (c) the change in the program effectiveness of SNAP due to the 2013 SNAP benefit decreases for households with and without disabled members. Because an inclusion of the disability indicators of both (a) and (b) in the covariates may lead to overfitting problems due to multicollinearity, two respective models are estimated centering on each of the disability indicators. Model 1 estimates a system of equations with a binary variable indicative of the presence of any household member with disabilities. The structure of Model 2 is equivalent to Model 1 except replacing the binary disability variable with a set of dummy variables for a household head's and spouse/partner's, and children's disability status. The structure of Model 3 is equivalent with that of Model 1 except for replacing the year dummies with a dummy variable for

pre- and post-SNAP benefit decreases. Household sampling weights are applied to all the analyses to provide results nationally-representative.

3.4.2. Identification

We apply a Full Information Maximum Likelihood (FIML) procedure to the ESR model, in which dependence structures of the error terms are incorporated into the maximum likelihood function. To help model identification that stems from the non-linearity of the jointly distributed error terms, we utilize exclusion restrictions, which requires at least one variable which is highly correlated with SNAP participation but uncorrelated with food security enters into the SNAP equation. To this end, as in equation (6), we use a set of instrumental variables (IVs), Z_i, which refers to state-specific SNAP rules; since households interviewed are randomly drawn from primary sampling units in each state, arguably specific policies for SNAP eligibility rules are not correlated with food insecurity but highly correlated with households' SNAP participation which variates geographically. The set of the IVs is comprised of the variables for the BBCE, vehicle exemptions for SNAP asset test, and the use of combined application process for SNAP and SSI (USDA SNAP policy data sets 2018). Detailed variable explanations are as follows;

(a) The BBCE rule confers categorical eligibility for SNAP if households are eligible for the non-cash TANF or State Maintenance of Effort (MOE) funded benefit.

(b) Some states may exclude the value of all vehicles, at least one vehicle, or only the first vehicle above a fair market value from household assets. The fair market value

differs by state and year. Among three policies on the vehicle restrictions, we make use of the exclusion of all vehicles for SNAP asset test.

(c) The combined application process for SNAP enables SSI recipients to be automatically eligible for SNAP by simplifying a SNAP application paper-work without visiting a SNAP office.

Each of these variables is coded as 1 if the state implements the policy and 0 otherwise and may vary from state to state and by month and year. For brevity, summary statistics of the variables by state, averaged over 60 months (January 2011 to December 2015) are provided in table B-2 and summary statistics of the variables for each year averaged over the states are shown in table B-3.

Second, as is apparent from the arguments of existing literature, obtaining consistent estimates of the standard ESR model rests on the joint normality of the error terms ($\varepsilon_{si},\ \varepsilon_{1i}$) and ($\varepsilon_{si},\ \varepsilon_{0i}$) (Smith 2003; Luechinger, Stutzer, and Winkelmann 2010; Yen, Bruce, and Jahns 2012; Hasebe 2013). However, when the true distribution is not normal, estimating a system via the FIML yields inconsistent estimates, even worse an iteration process may fail to find an optimum that satisfies the convergence criteria of the maximizing function. Thus, the accommodation of a flexible distribution structure in lieu of the joint normal distribution could be an alternative, and a copula distribution function can be a good candidate to do that.

Copula approach provides a way to generate non-normal dependence structures of random variables by specifying margins and a copula function that links the margins together (Smith 2003). For this reason, when we have limited information on the true

distribution of random variables as a priori, the copula approach could put more choices on model specifications as Luechinger, Stutzer, and Winkelmann's (2010) and Yen, Bruce, and Jahns (2012)'s studies. We incorporate the copula joint distribution function into the maximum likelihood function of the ESR model, and then estimate the system of equations.

3.4.3. Maximum Likelihood Estimation using Copulas

Consider two random variables x_1 and x_2 are given. Let $u_i = F_i(x_i)$ be a marginal distribution function for $i = 1, 2$ and let $F(x_1, x_2)$ denotes a bivariate joint distribution function. By Sklar's theorem (Sklar 1959), there exist a copula, $C : [0,1]^2 \rightarrow [0,1]$, function such that

$$F(x_1, x_2) = C\{F_1(x_1), F_2(x_2); \theta\} = C(u_1, u_2; \theta) \tag{9}$$

where θ is an estimable dependence parameter. Using the copula joint distribution function in lieu of $F(x_1, x_2)$, we can write the maximum likelihood function as

$$\begin{aligned} L = \prod_{i=1}^{N} \{ & [C(F_{si}, F_{\varepsilon i}; \theta)]^{y_i=0} \times [F_{si} - C(F_{si}, F_{\varepsilon i}; \theta)]^{y_i=1} \}^{s_i=0} \\ & \times \{ [F_{\varepsilon i} - C(F_{si}, F_{\varepsilon i}; \theta)]^{y_i=0} \times [1 - F_{\varepsilon i} - F_{si} + C(F_{si}, F_{\varepsilon i}; \theta)]^{y_i=1} \}^{s_i=1} \end{aligned} \tag{10}$$

where $F_{\varepsilon i} = F_{\varepsilon i}(-x_i\beta)$ and $F_s = F_{si}(-z_i\gamma)$. x_i refers to all the covariates in the food security equations, and z_i refers to the covariates and instruments in the SNAP participation equation. s_i and y_i denote SNAP participation and binary food insecurity status, which equals 1 for participation in SNAP and food insecurity and 0 vice versa, respectively. We apply a Probit marginal distribution to F_{si}, $F_{\varepsilon 0i}$, and $F_{\varepsilon 1i}$ but a selection of the copulas is important since each copula portrays a different dependence structure between random variables. In this essay, candidate copulas for the analyses are

Gaussian, Ali-Mikhail-Haq (AMH), Farlie-Gumbel-Morgenstern (FGM), Frank, and Plackett copulas. See Nelson (2010) and Hasebe (2013) for functional forms of these copulas.

To determine the best-fitting copula for the underlying distribution of the error terms, in general, the Akaike or Bayesian Information Criterion (AIC/BIC) is used. Alternatively, under a given specification on the margins and parameters, a selection of copulas with the largest log-likelihood value is equivalent to those with the smallest information criteria (Hasebe 2013; Winkelmann 2012).

3.4.4. Measures for Dependence and Program Effects

A copula function includes a dependence parameter, θ, which measures the degree of dependence between random variables. The dependence parameter of a copula, however, cannot be compared to the one of the other copulas (Hasebe 2013) since each θ is distributed on a different range. Instead of θ, Kendall's τ allows universal comparisons to the degrees of dependence of random variables. It is defined as;

$$\tau = 4 \int \int C(u_1, u_2; \theta) dC(u_1, u_2; \theta) - 1 \quad (11)$$

The Kendall's τ provides an overall measure of dependence not only for elliptically[13] but also non-elliptically distributed random variables (Embrechts, Lindskog, and Mcneil 2003), which is preferred to a standard linear correlation coefficient that only provides a partial measure of dependence if the dependence structure is non-elliptical (Carmona 2004).

[13] The elliptical distribution generalizes a multivariate normal distribution.

The Average Treatment Effect (ATE) and the Average Treatment Effect on the Treated (ATET) are frequently used terms measuring program effects. Whereas the ATE measures the program effect on randomly drawn households from the entire sample, the ATET evaluates that on the program participants, and thus could be more policy-relevant. We estimate the ATET for SNAP participating households. It is written as

$$E\{P(y_1 = 1|x, S = 1) - P(y_0 = 1|x, S = 1)\} \quad (12)$$

The first expression in the square bracket is the predicted probability of food insecurity of SNAP participating households. The second term is the predicted probability of food insecurity of SNAP households if they had not been participated, which is an estimable counterfactual in the ESR model. The terms in the square bracket are averaged over SNAP participating households. Additionally, we estimate the conditional ATETs (CATETs) for SNAP participating households, which are conditioned on the indicators of disabilities. These CATETs refer to the ATETs in various subpopulations (Abrevaya, Hsu, and P.Leili 2015) and are defined as;

$$E\{P(y_1 = 1|X = x_1, S = 1) - P(y_0 = 1|X = x_1, S = 1)\} \quad (13)$$

3.5. Estimation Results

3.5.1. Model Specification and Tests for Instruments

For each of the three models, we conduct 25 estimations[14] using each pair of copulas among Gaussian, AMH, FGM, Frank, and Plackett, and then compare the log-likelihood values. We obtain marginally more efficient results with the AMH–Plackett copula,

[14] There are two joint distribution functions in the ESR model, and for each one, five copulas are available. Thus, total 25 estimations are conducted for each model.

which have the largest log-likelihood value for all of the Model 1(–59,670.02), Model 2(–59,559.36), and Model 3(–59,720.86). What follows is the Wald test[15] for testing joint dependence of the error terms: (ε_{si}, ε_{1i}) and (ε_{si}, ε_{0i}). The test results reject the hypothesis of independence of the error terms for all the models (test statistics=35.50, 35.98, and 38.15 with $p<0.01$ for Models 1 through 3, respectively), meaning that the error terms are jointly dependent. Further, the test results imply that SNAP and non-SNAP households are distinct with regard to food insecurity, and the ESR model would be preferred to a standard treatment effect model that assumes observed household characteristics of SNAP and non-SNAP households are the same with regard to food insecurity (Gregory and Coleman-Jensen 2013).

Two types of tests for the validity of our instruments are conducted for all the models. First, we test the instrument relevance using Staiger and Stock (1997)'s weak instrument test. This involves estimating a Probit model for SNAP participation on covariates and instruments to verify whether coefficients of the instruments are close to zero and test joint significance of the instruments. For all the models, each of the instruments has a positive sign as expected and only the combined application process is statistically significant ($p<0.01$), though the Wald test results indicate that the set of the instruments is jointly statistically significant ($p<0.01$) with test statistics above the rule of thumb level ($\chi^2(3)$=26.10, 25.68, and 26.35 for Models 1 through 3, respectively). Second, to test overidentification, we estimate Probit models for the food insecurity

[15] We applied sampling weights (probability weights) to estimations, so pseudo-likelihoods were computed. In this case, the likelihood ratio test is not valid but the Wald test is applicable.

equation on the covariates, instruments, and SNAP participation variable, and then conduct joint tests for the instruments. This test procedure is analogous to Rashad and Kaestner's (2004), Kan's (2006), and Yen, Bruce, and Jahns's (2012). The Wald test results indicate that the instruments are not jointly significant for all of the models (p=0.15 with $\chi^2(3)$=5.35 for Model 1, p=0.15 with $\chi^2(3)$=5.34 for Model 2, and p=0.11 with $\chi^2(3)$=6.06 for Model 3). Taken together, exclusion restrictions are satisfied for all the models.

3.5.2. Parameter Estimates and Average Partial Effects

Using the best preferred combinations of the copulas for each model and the IVs, we estimate three ERS models, Models 1 through 3, and their results are presented in tables B-4 through B-6, respectively. For all the models, we can see a positive and statistically significant τ_0, implying that for non-SNAP participating households, unobservables that increase the probability of food insecurity are likely to occur with unobservables in the SNAP participation. For all the models, the ancillary θ[16] has a negative sign and significant only for Model 2. This implies that for SNAP households, unobservables that decrease the probability of food insecurity are likely to occur with unobservables that increase SNAP participation

Based on the parameter estimates of Model 1, the average partial effects (APEs) of the covariates on the probabilities of SNAP participation and food insecurity by

[16] The ancillary dependence parameter of a copula, generated by the maximum likelihood routine, spreads θ on a different range, and its distribution is independent of θ. Since τ for the Plackett copula cannot be calculated via a closed form expression, we can detect an inherent sign of dependence using that of the ancillary θ.

SNAP participation are calculated and presented in table B-7. For the equation for SNAP participation, we can see that households headed by a person who is female, widowed/divorced/separated, U.S. citizen, unemployed, renter, less-educated, and Non-Hispanic Black are more likely to participate in SNAP than their respective counterparts. Household size and the receipts of SSI, Medicaid, and TANF are positively associated with SNAP participation.

Turning to the APEs in the food insecurity equation for the non-SNAP households, the presence of household member(s) with disabilities leads to the probability increase in food insecurity by 15.8 percent points. We find that households with a household head who is female, renter, U.S. citizen, non-Hispanic Black, widowed/divorced/separated, and unemployed are more likely to be food insecure than their respective counterparts. The participation in other assistance programs is positively associated with the probability of food insecurity and household size is inversely associated with food insecurity.

For the SNAP participating households, the presence of household member(s) with disabilities leads to the probability increase in food insecurity by 14.8 percentage points. Households with a household head who is female, non-U.S. citizen, unemployed are more likely to be food insecure than their respective reference groups. Household size is inversely related to the probability of food insecurity as those of non-SNAP households, but Medicaid enrollment is inversely related to food insecurity, which is contrary to those of non-SNAP households. The rest of the covariates are not statistically significant but still retain expected signs as those of non-SNAP households.

The APEs in Model 2 are presented in table B-8. We mainly focus on the APEs of the variables for household members' disabilities since all the other APEs are analogous to those in Model 1. For non-SNAP participating households, household with a household head with disabilities are more likely to be food insecure by 17.1 percent points than those without a disability. Households with a household head with a spouse/partner with disabilities are more likely to be food insecure by 9.9 percent points than households with a household head with a spouse/partner without a disability or households with a household head without a spouse/partner. Households with children with disabilities are more likely to be food insecure by 5.8 percent points than households with children without a disability or households without children.

For SNAP participating households, household with a household head with disabilities are more likely to be food insecure by 14.1 percent points than those without a disability. Households with a household head with a spouse/partner with disabilities are more likely to be food insecure by 13.2 percent points than households with a household head with a spouse/partner without a disability or households with a household head without a spouse/partner. Households with children with disabilities are more likely to be food insecure by 6.1 percent points than households with children without a disability or households without children.

The APEs of Model 3 are presented in table B-9. As our main interests lie in the magnitude and statistical significance of the indicator of the 2013 SNAP benefit decreases, we focus on these estimates for both food insecurity equations by SNAP participation. The significant, negative 0.037 coefficient on that variable in the food

insecurity equation for non-SNAP households can be interpreted as non-SNAP households are less likely to have been food insecure by 3.7 percentage points since November 2013 due to unobserved secular trends. On the contrary, the secular trends have no significant effect on food insecurity of SNAP households; the negative 0.014 coefficient is not statistically significant.

3.5.3. Program Effects

In this essay, the unconditional ATETs measure the program effect of SNAP for all SNAP households. The CATETs measure the program effects of SNAP households for various subpopulations of interests in terms of disability: (a) SNAP households with and without disabled members, (b) SNAP households with a household head with and without disabilities, SNAP households with a household head with a spouse/partner with disabilities and those without disabilities or without a spouse/partner, and SNAP households with children with disabilities and those without disabilities or without children, and (c) SNAP households before and after the 2013 SNAP benefit decreases and SNAP households with and without disabled members before and after the benefit decreases. All these results are provided in table B-10, in which standard errors of the ATETs are obtained via the bootstrap method with 50 replications[17] in order to account for both the sampling variability of parameter estimates and the variability of stochastic covariates.

[17] Normal-approximation confidence intervals and standard errors of the ATETs are obtained using a nonparametric bootstrap method as Terza (2016) proposed. In this case, 50–200 replications are adequate to use (Stata manual for bootstrap 2018), and we used 50 replications because of computational burdens. The default is 50 in Stata.

For all the models, we find that all the ATETs have negative signs and statistically significant at the 1 percent level of statistical significance, of which the unconditional ATET in Model 1 suggests that SNAP participation reduces the probability of food insecurity by 13.2 percent points for all SNAP participating households. More importantly, SNAP reduces the probability of food insecurity by 15.3 and 11.4 percent points for SNAP households with and without disabled members, respectively.

For Model 2, there seem to be little difference in the magnitudes of the program effects for all SNAP participating households compared to those in Model 1. To what extent SNAP reduces food insecurity varies according to who in the household has disabilities. While SNAP reduces the probability of food insecurity by 11.9 percentage points for SNAP participating households with a household head without a disability, for SNAP households with a household head with disabilities, the program's effect amounts to 17 percent points. The ATETs also differ by spouse/partners' disabilities. SNAP reduces the probability of food insecurity for SNAP households with a spouse/partner with disabilities by 11.5 percent points, whereas it reduces the probability of food insecurity for SNAP households headed by a person without a spouse/partner or those with a spouse/partner without a disability by 13.9 percent points. Lastly, it seems to be little difference in the magnitudes of the effects of SNAP on food insecurity by children's disability status. SNAP reduces the probability of food insecurity for SNAP participating households with children with disabilities by 14.3 percent points, while it reduces the probability of food insecurity by 13.6 percent points for SNAP households with children without a disability or those without children.

Turning to the ATETs in Model 3, whereas the unconditional ATET has still the same magnitude as in Model 2, a notable difference is found in the magnitudes of the effectiveness of SNAP between two different cohorts with respect to the SNAP benefit decreases. That is, whereas SNAP reduces the probability of food insecurity by 15.3 percent points for all SNAP participating households before the benefit decreases, its effectiveness decreases to 11.6 percent points for SNAP households after the benefit decreases, which results in the reduced program's effect by 3.7 percentage points for all SNAP households. Very little difference in the magnitudes of the decreased program effects is found between households with and without disabled members. For households with disabled members, the change in the program effects due to the SNAP benefit decreases amounts to 3.7 percent points. For SNAP households without disabled members, the reduced program effects run to 3.9 percent points.

3.6. Robustness

To check the robustness of the results, we primarily estimate all the three models with different sets of the copulas, and then calculate the unconditional ATETs, by which to a certain extent the results are sensitive to the selection of copulas is investigated. In these specifications, no convergence problem occurred, and iteration procedures find an optimum in less than 50 iterations.

First, we estimate all the models with AMH–Frank copula that is the second best-preferred set of copulas with the second largest[18] log-likelihood values. Additionally,

[18] For model 1–3, –59670.78, –59559.55, and –59721.10, respectively.

we estimate all the models with Gaussian–Gaussian copula[19] that is the most commonly used for postulating underlying distribution between random variables as a priori. All these estimates are presented in table B-11. We can see that there are no differences in the magnitudes of unconditional ATETs between the specifications with AMH–Plackett and AMH–Frank copula for all the models. On the contrary, Gaussian-Gaussian copula models yield the slightly decreased program effects compared to AMH–Plackett copula models.

Second, one may have an interest in whether the models fit well without the instruments and how much the results vary accordingly. To check this, we estimate Model 1 without the instruments and with each of 25 combinations of the copulas, which result in AMH–Plackett and AMH–Frank copulas as the first and second best-fitting combinations of copulas, respectively. We calculate the unconditional ATETs for these models and a Gaussian–Gaussian copula model. The results show that there seem to be little differences in the magnitudes of the unconditional ATETs compared to each of the ATETs in Model 1 with instruments. Put together, we find out that the program effects depend more on the distributional assumption rather than the validity of exclusion restrictions.

3.7. Discussion and Conclusions

SNAP played an important role in increasing food security in SNAP participating households with disabled members compared to those without disabled members and all

[19] The Gaussian copula is reduced to a joint normal distribution if the margins are Probit (Hasebe 2013).

households. SNAP reduces the probability of food insecurity for SNAP participating households headed by disabled—most likely to be at higher risk of food-related hardships partly due to a substantial loss in earnings—by 17.0 percent points, which is relatively greater than those of spouse/partner's (11.5 percent points) and children's disabilities (14.3 percent points). One noteworthy finding is that SNAP is more effective in reducing the probability of food insecurity for SNAP households headed by a person with a spouse/partner without a disability than those with disabilities or households headed by a person without a spouse/partner, that is 2.4 percent points difference. The policy implication of these findings is that who has a disability among different household members and the presence of disabled members can be good predictors to look at the program's potential effectiveness; to what extent specific groups of populations with disabilities are expected to reduce the odds of food insecurity when SNAP benefits are given.

We find that due to the decrease in SNAP benefit, the effectiveness of SNAP decreased by 3.7 percentage points for SNAP participating households, which is supportive of Katare and Kim (2017)'s findings that the SNAP benefit reductions led to an increase in the prevalence of food insecurity among SNAP participant households. Further, the reductions in the program effects are largely the same among all SNAP participating households and SNAP households with and without disabled members, implying that a 5 percent reduction on average in SNAP benefits was somewhat small to make notable differences in the program effects.

To better understand the program effects of SNAP participation, specifically for disadvantaged populations with disabilities, this essay provides quantifiable evidence about the impacts of SNAP participation in reducing food insecurity for these cohorts. Further research is needed in developing and extending the empirical models of this essay using other data and accounting for diverse measures of household members' disabilities and improved estimation methods.

4. THE EFFECTS OF CHANGES IN DISABILITY EMPLOYMENT POLICIES ON THE EMPLOYMENT OUTCOMES OF THE DISABLED — EVIDENCE FROM SOUTH KOREA

4.1. Introduction

It is generally recognized that people with disabilities are economically disadvantaged and prone to achieve poor employment outcomes compared to those without a disability. Moreover, people with disabilities are more likely to be employed in a part-time position and at a higher risk of dismissal than non-disabled counterparts (Choe and Baldwin 2016; Erickson, Lee, and Schrader 2008; Bjelland et al. 2008; Schur 2003; Yelin and Trupin 2003; Baldwin and Schumacher 2002).

A variety of policies and programs have been implemented and enacted in an effort to close the employment gaps between individuals with and without disabilities. For example, the U.S. passed the Americans with Disabilities Act (ADA)[20] in July 1990, which ensures equal opportunity and non-discrimination in employment for people with disabilities. The ADA requires employers to offer accommodation of workers with disabilities in the workplaces without discrimination in wage, hiring, and firing (Acemoglu and Angrist 2001) and enables employees with disabilities to take legal actions if unreasonably discriminated. However, previous research found that the ADA has brought about unintended negative effects on the employment for the disabled that can be attributable to accommodation costs and the potential burdens of legal actions

[20] The ADA took effect in July 1992.

against labor disputes of employees with disabilities (DeLeire 2000; Acemoglu and Angrist 2001). On the contrary, Hotchkiss (2003) pointed out that the ADA had no effects on the employment outcomes for labor-force participants with disabilities.

Unlike the U.S., more than a third of OECD countries[21], including South Korea (Korea, hereafter), have implemented the employment quota system (EQS) that requires private firms and/or public firms to integrate a certain number or portion of people with disabilities. Although the size of the quota and the establishment size of targeted firms may differ from country to country, the EQS usually instruments the monetary penalty/compensation scheme that imposes a levy if firms do not meet the quota and subsidize if they employ disabled workers beyond the quota. Thus, to what extent the EQS brings about improved employment outcomes for people with disabilities has aroused scholarly interests among policymakers across countries.

4.2. The Employment Quota System for the Disabled in Korea

The employment rate of people with disabilities in Korea is far below those of the overall population. In 2017, only 36.1 percent of people with disabilities aged 15 or more were employed, which is considerably lower than those for the overall population, 61 percent, and below the average employment rate of people with disabilities in the E.U., 47.3 percent (Disability Statistics at a Glance 2018, Korea Employment Agency for the Disabled). In response to this disparity, the Employment Promotion Act for the Disabled of Korea (EPAD), which includes a clause for the levy/grant-based EQS for people with disabilities was signed in 1990, and then came into effect in 1991.

[21] Includes South Korea, Japan, Austria, France, Spain, Germany, Italy, and Russia.

Beginning in 1991, the EQS for people with disabilities obligated a 2 percent quota to public and private firms with 300 or more employees, but since 2004 the quota has started to target firms with 50 or more employees. Although the 50-employee threshold is still in effect to date and is stipulated in the EPAD, an additional clause of the EPAD exempts the levy for firms with 50–99 employees even if they did not achieve the quota (Act. 33, Sec. 1, EPAD 2017). Therefore, practically, the EQS targets firms with 100 or more employees. The 2 percent, 50-employee quota rule had persisted up to 2009, but in 2010 there were momentous changes in the levy/grant-based EQS in Korea.

There have been two major changes and one minor change in the EQS since January 2010. First, the quota to private firms increased to 2.3 percent in 2010, and gradually increased to 2.5 in 2012, 2.7 in 2014, and 2.9 percent in 2018. The quota to public firms increased to 3 percent from 2 percent in 2010, remains unchanged until 2016, and then increased to 3.2 percent in 2017. Second, in 2010 the double count system, which regards the employment of an employee with severe disabilities as the employment of two employees with disabilities, was implemented. The one minor change in 2010 is related to the grant policy for firms with employees with disabilities beyond the quota. The calculation criteria for the grants until March 2010 are shown in table C-1. Under this system, firms which have achieved the quota but with less than or at 30 percent of employees with disabilities to total employees could receive $300 per month for each male employee with non-severe disabilities over the quota. If a firm has attained the quota and integrates more than 30 percent of employees with disabilities to total employees, the firm could receive $400 per month for an excess male employee

with non-severe disabilities. In this context, the unit-grant differs by gender and severity of disability of an excess employee with disabilities. Since April 2010, the grant calculation criteria have been modified, which are shown in table C-2. We can see that the unit-grant in reward for employing an excess employee with non-severe disabilities decreases with the employee's employment periods but is uniform for those with severe disabilities regardless of their employment periods. The unit-grant for employing an excess female employee with disabilities is greater than that for employing a male employee with disabilities. Taken together, it might be said that the new policy was intended to ensure long-term employment for women with disabilities and/or people with severe disabilities. Additionally, calculation criteria for the levy in 2017 that have been unchanged since 2005 are presented in table C-3, in which stepwise increases in the unit-levy that is proportional to a shortfall in the quota are found. Overall, the policy changes in the EQS in Korea were intended to protect more vulnerable population with disabilities.

The objective of this essay is to examine the effects of a combination of the three policy changes in the EQS on the employment outcomes of people with disabilities in Korea, with specific attentions paid to two unaddressed issues in the previous research on the ADA and EQS. First, to understand how the policy changes affected quality not just quantity of the employment outcomes, we look at whether the position is part-time or full-time as people with disabilities are more likely to be employed part-time. Second, since the policy changes put more weight on the employment outcomes of people with severe disabilities, severity of disability is taken into account as well. Additionally, we

examine how the policy changes affects the employment outcomes for men and women with disabilities.

While the quota increase may bring about an increase in the employment of people with disabilities, it is possible that under the double count system, an employer may have an incentive to hire or retain people with severe disabilities or women with disabilities instead of those with non-severe disabilities to meet the quota and/or receive more grants. At the same time, an employer, as a rational economic agent, is more likely to demand for employees with non-severe disabilities due to their higher productivity in comparison to those with severe disabilities. Moreover, although the quota increases since 2010 may induce improved employment outcomes among people with disabilities, to what extent employees with disabilities or severe disabilities take a full-time position is uncertain. Taken altogether, the total effects of the policy changes on the employment of people with disabilities or severe disabilities and men or women with disabilities are open to conjecture and in need of empirical examinations.

4.3. Related Literature

Using different data from different countries, researchers have examined the effects of the EQS in each country on the employment outcomes for the disabled. Mori and Sakamoto (2018) used data from the 2008 firms' employment of people with disabilities of Japan and found that the levy/grant-based EQS, which requires a 1.8 percent quota for private firms with more than 300 employees, helps to increase the number of disabled workers among firms in the manufacturing industries. Using data from the Austrian Social Security Database and Austrian Federal Welfare Office, Lalive et al. (2013)

looked at the quota policy in Austria, which requires firms to integrate an employee with disabilities per 25 non-disabled employees and found that firms with 25 non-disabled workers from 2009 to 2011 accommodated about 12 percent more disabled workers because of the levy. On the contrary, Wagner, Schnabel, and Kolling (2001) utilized data from the 1993 to 1998 IAB (Institute for Employment Research of the Federal Labor Services in Germany) establishment panel and conclude that the EQS in Germany that requires private firms with 15 employees or more to employ six percent of disabled workers had no effect.

In the case of Korea, Nazarov, Kang, and Schrader (2015) used data from the Korean Labor and Income Panel Study (KLIPS) and found that the expansion of establishment size under the EQS from 300 to 50 or more employees in 2004 led to an increase in labor-force participation but had no effect on the employment of the labor-force participants with disabilities. Recently, Jeong and Ko (2014) have utilized administrative longitudinal data from the current implementation status of the mandatory employment for the disabled in Korea and found that the double count system in 2010 led to an increase in the number of workers with severe disabilities by 0.12.

4.4. Data and Measure for Analyses

We utilize data from the first wave[22] of the Panel Survey of Employment of the Disabled (PSED) in Korea 2008–2015, which is provided by the Employment Development Institute under the sponsorship of the Korea Employment Agency for the

[22] The PSED is comprised of two waves, of which the first wave covers 2008–2015 and the second one covers until current year.

Disabled. The PSED is a nationally representative yearly panel survey[23] targeting randomly selected 5,000 people with disabilities since 2008. The PSED is well-suited to this essay in that it includes various information about demographic characteristics, disability, and employment of people with disabilities in Korea. More importantly, in comparison with many other surveys in Korea and other countries, the PSED targets people with disabilities registered as disabled by the Ministry of Health and Welfare of Korea via determinations of medical institutions, accordingly survey participants' disability status is most likely measurement-error free.

As the PSED surveys individuals registered as disabled at the interview point, assessing whether respondents are disabled is not necessary. The respondents' degree of disability is more implicative. In Korea, types[24] of disabilities are assorted into 15 types, and each type is rated as 1-7 degree, of which the 1st degree refers to the most severe status and the 7th refers to the least one. Based on the type, degree, and multiplicity of disabilities, medical institutions determine a person's disability status as severe or non-severe (Act. 2, EPAD 2017), and respondents are asked to provide information on their severity of disability.

The PSED provides respondents' employment status as follows. Respondents are asked whether they are employed or not within one week prior to interview, of whom the employed are grouped into: salaried, self-employed, and unpaid family employee. The salaried employees are asked their detailed job information: part-time or full-time, rank,

[23] Surveyed in May to October in 2008 and May to August thereafter.
[24] Physical, brain lesions, vision, hearing, communicative, cognitive, and mental disability and epilepsy, kidney, heart, and liver defect and facial nerve disorder, autism, bowel syndrome, and respiratory disorder.

industry, and establishment size. Unemployed respondents are asked whether they are inactive or job-seeking in the last week from the survey. Using these classifications, we classify respondents' employment status as employed, self-employed (including unpaid family employee), unemployed-but-active, and inactive, which is a standard classification of work-force in the labor market. Because the self-employed with disabilities may not be directly affected by the policy changes, to estimate the policy effects more precisely, we classify respondents employed or unemployed-but-active as salaried labor-force participants and self-employed or inactive as non-salaried labor-force participants. Accordingly, the salaried labor-force participants' employment outcomes can be defined ordinally as 1 for unemployed-but-active, 2 for part-time, and 3 for full-time employed. The non-salaried labor-force participants are treated as a non-selected sample.

To design an analytical sample, a selection of eligible labor-force participants and non-participants is important as people at certain ages have strong labor-force attachment. Because college-education[25] is common in Korea, and Koreans usually graduate from college around age 25 and become eligible for the national pension at age 60, we restrict the respondents to aged 25–60 in 2008 that comprise 3,370 people with disabilities. As these respondents are repeatedly surveyed year by year, over the survey period 2008–2015, there are 24,735 observations that constitute a pooled-panel, which is a primary analytical sample[26] in this essay. Summary statistics of the sample

[25] In 2008, the college entrance rate was nearly 84 percent (Statistics from Korean educational development institute).
[26] Observations with missing data and panel drop outs are excluded.

(N=24,735) by salaried labor-force participation and employment outcomes are presented in table C-4, in which respondents' various demographic information at the individual and household levels are included: age, educational attainment, marital status, gender, self-assessed health status, disability, home-ownership, non-labor financial income, province of residence, and respondents' father's job status when the respondents are at age 14.

The sample is comprised of 31 percent salaried labor-force participants and 69 percent non-participants. Of the non-participants, 75 percent are out of the labor-force and 25 percent are self-employed. Of the participants, about 91 percent are employed. People with severe disabilities are less likely to participate in the salaried labor-force and participants with severe disabilities are more likely to have poor employment outcomes.

4.5. Methodology

We employ a standard ordered Probit model with sample selection[27] following Green and Hensher's (2009) and Luca and Perotti's models (2011). Consider a model of employment outcomes with selection into salaried labor-force participation. For notional simplicity, subscripts for indexing an individual are dropped.

-Participation equation:

(14) $S_i^* = \alpha' z_i + u_i$ with $S_i = 1\ if\ S_i^* > 0$ and $S_i = 0$ otherwise.

-Employment outcome equation:

(15) $E_i^* = \beta' x_i + \varepsilon_i$ with $E_i = j$ if $\mu_{j-1} < y^* \leq \mu_j$ and $j = 1, 2,$ or 3 for each i.

[27] Similarly, Hotchkiss (2003) and Nazarov, Kang, and Schrader (2015) used a Probit model with sample selection for a binary employment outcome. We apply their methods to an ordered employment outcome.

-Participation mechanism:

(16) E_i and x_i are observed when $S_i = 1$

where, S_i is an individual *i*'s observed salaried labor-force participation, which equals 1 if participate. E_i is a participant's employment outcome, equals 3 if employed full-time, 2 if employed part-time, and 1 if unemployed-but-job-seeking. α' and β' are conformable parameters. μ_1 and μ_2 are estimable cutoff points, and μ_0 and μ_3 are taken as $-\infty$ and $+\infty$, respectively. x_i and z_i include a respondent's demographic characteristics, an indicator of severe disability (equals 1 if severely disabled and 0 otherwise), year dummy variables (2009–2015, 2008 base), and interaction terms between the year dummy variables and the indicator of severe disability. Additionally, to control for unobserved heterogeneity that may affect employment outcomes and participation in the salaried labor-force, such as recovery from the 2008 recession, provincial dummies and variables for provincial unemployment and economic growth rates of each year 2008–2015 are included. An intercept term in the employment outcome equation is normalized to zero for identification. $u_i$and ε_i are jointly normally distributed error terms with zero means, unit variances, and correlation, ρ.

Identification of the model follows nonlinearity of the error terms. However, estimation performance solely relying on the nonlinearity tends to be poor and the model may be failed to converge. To obtain precise estimates, we impose exclusion restrictions that require at least one variable, highly correlate with the participation equation but not correlated with the employment outcome equation under control for sample-selection, to enter into the participation equation. To this end, we include two more variables in the

participation equation. The first variable represents a respondent's nonlabor financial income[28], which is used in Hotchkiss's (2003) and Nazarov, Kang, and Schrader's (2015) models. Arguably, nonlabor financial income is negatively correlated with participation in salaried labor-force since it could incentivize being self-employed but demotivate individuals' job hunting. The second one included pertains to a respondent father's job status: salaried, self-employed, unemployed-but-job-seeking, or inactive when the respondent was 14 years old, which is coded as 1 if the father was a salaried employee and 0 otherwise. We expect that respondents who has a salaried-father in their adolescence are more likely to participate in the salaried labor-force.

The equations (14) and (15) is estimated by a full information maximum likelihood (FIML) method, the log-likelihood function of which is written as Green and Hensher's (2009)'s specification;

(17) $$\log L = \sum_{S=0} \log \Phi(-\alpha' w) + \sum_{S=1} \sum_{j=0}^{J} m_{ij} \log\left[\Phi_2(\mu_j - \beta' x, \alpha' w, \rho) - \Phi_2(\mu_{j-1} - \beta' x, \alpha' w, \rho)\right]$$

,where $m_{ij} = 1$ if $E_i = j$. Φ denotes the standard normal distribution function and Φ_2 denotes the joint normal distribution function. The first term in the right-hand side refers to an individual *i*'s log-likelihood contribution to the overall log-likelihood value which is governed by the selection mechanism, and the second term refers to the log-likelihood contribution of participant *i* to the overall log-likelihood value with regard to one of the employment outcomes: unemployment, part-time, and full-time. Based on the

[28] Unit of ten million won. 1,000 won≈1 USD.

parameter estimates, we calculate the Average Partial Effects (APEs) of the covariates on the employment outcome and salaried labor-force participation. To compute the APEs of the interaction terms, as Karaca-Mandic, Norton, and Dowd (2012) proposed, we compute the differences in the probabilities of the employment outcomes and participation by severity of disability, evaluate these differences at each year 2008–2015, and average them over observations. Since we deal with repeated observations year by year, robust standard errors of the estimates are clustered at the individual level.

4.6. Results

4.6.1. Results from the Full-Sample Model

Based on the parameter estimates reported in table C-5, we compute the APEs shown in table C-6. For people with disabilities, positive and significant factors related to participation in the salaried labor-force include being younger and married and having higher education, home-ownership, and good-health, in addition to gender (male) and living in a larger household. More importantly, people with severe disabilities are less likely to participate in the salaried labor-force by 21.4 percent points than those with non-severe disabilities, and overall no notable variations in this tendency are found with respect to year-control 2008–2015. The time dummies for every year except 2009 are not statistically significant, implying that no notable changes are observed in participation rates among people with disabilities over time. Additionally, we find that the variables for exclusion restrictions are statistically significant and have expected signs. That is, people with disabilities with a salaried father when they were 14 years old are more likely to participate in the salaried labor-force, and as non-labor financial

income increase, they are less likely to participate. The statistically significant correlation coefficient in table C-5, 0.9, implies that unobservables that make it more likely to participate are positively correlated with better employment outcomes.

Turning to the estimates of the employment outcomes, among salaried labor-force participants, those who are younger, male, married, high school or college educated, in good health, and homeowners are more likely to be part-time or full-time; thus, they are less likely to be unemployed. Among participants, the severely disabled are less likely to be employed part-time by 8.8 percent points than the non-severely disabled, and an overall decrease in this tendency is found over the period 2010–2015; differences in the probabilities of part-time employment between the non-severely and severely disabled salaried labor-force participants get smaller. Similarly, this tendency is found in the probabilities of unemployment and full-time employment as well.

Turning to the year dummies in the employment outcomes, we find that all of them except for 2009 and 2010 are significant and have signs that are supportive of enhanced employment outcomes of participants with disabilities, meaning that the policy changes began to take into effect in 2011. However, no decreasing or increasing trends are found in the magnitudes of the year-dummy estimates across all the employment outcomes.

4.6.2. Results from the Sub-Sample Analyses by Gender

Women with disabilities may have less attachment to the labor-force than men with disabilities, and even women with severe disabilities are more likely to attain substantially poor employment outcomes than men with severe disabilities. In this section, we iterate the analysis using subsamples by gender to investigate which cohorts are far more influenced by the changes in the employment policies for people with disabilities. To test gender-equivalence that based on all the parameter, a Wald test for sample-split by gender is carried out. The test statistics reject the null hypothesis of equal coefficients ($\chi^2(79)$=310.78, p<0.001), meaning that on the basis of observed individual characteristics, men and women with disabilities differ in both employment outcomes and participation in the salaried labor-force.

Given the parameter estimates for a sample of males in table C-7, the APEs are computed, which are shown in table C-8. On the whole, the signs and statistical significances of the APEs are analogous to those of the full sample model. Men with severe disabilities are less likely to participate in the salaried labor-force. The male participants with severe disabilities are more likely to be unemployed with an overall decreasing trend from 2010 to 2015, less likely to be part-time employed with a decreasing trend from 2010 to 2013, and less likely to be full-time employed with an overall decreasing trend from 2010 to 2015 than male participants with non-severe disabilities.

The year dummies 2011–2015 are statistically significant and have the same sign as those of the full model. On the other hand, an increasing trend appears in the probabilities of part-time employment from 2011 to 2015; male participants with

disabilities are more likely to be employed part-time year by year, which is not found in the full-sample model. Two instruments are statistically significant at the 10 percent level of significance and have expected signs as those of the full model.

The APEs that based on the parameter estimates in table C-9 are shown in table C-10. Among women with disabilities, those who are older, in bad health, and severely impaired are less likely to participate in the salaried labor-force than their respective counterparts. Women with disabilities with college degree or more are more likely to participate in the salaried labor-force than those who have not completed high-school.

However, for each employment outcome, all of the variables for demographic characteristics of female participants with disabilities turned out to be statistically insignificant. Furthermore, all the year dummies in the employment outcomes appear to be statistically insignificant, meaning that the employment policy changes since 2010 have no effects on the employment outcomes of female participants with disabilities. In contrast, we can see that beginning in 2011 female participants with severe disabilities rather than with non-severe disabilities are more likely to have a full-time job and less likely to be unemployed. As for the instruments, only the variable for non-labor financial income is significant at the 10 percent level of significance.

The results from the gender analyses suggest that on the whole women with disabilities are substantially disadvantaged in the labor market. First, we did see that all of the demographic factors of the female participants with disabilities are not predictive of their employment outcomes at all. This can be attributable to their substantial vulnerability in the labor market; to such an extent that their individual characteristics

such as higher education or good-health, which could be related to improved employment outcomes, have no effects on the employment outcomes positively. Second, the employment policies for people with disabilities do not have significant effects on the employment outcomes of female participants with disabilities, which contrast sharply to those for male participants with disabilities. Although female participants with severe disabilities are more likely to be full-timers and less likely to be unemployed than those with non-severe disabilities, which can be attributable to the reformation of the grant policy that put more weight on protecting long-term employments of women with severe disabilities, in an overall sense, employment of the female participants with disabilities are not affected by the policy changes. Eventually, the significant policy effects are most likely to be stemmed from the improved employment outcomes among the male participants with disabilities.

4.7. Robustness

One could argue that the time dummies and their interactions with the indicator of severe disability in both equations may reflect not only changes in the employment policies for people with disabilities, but also unobservable secular trends associated with each of the dependent variables, which could result in faulty analyses. To examine this possibility, we conduct robustness checks by estimating the models (the full model and the gender models) with a linear trend variable that interacted with the indicator of severe disability ("trend variable" for short). The trend variable controls for unobservable trends related to both the dependent variables for the non-severely and severely disabled. In this specification, to fully obviate multicollinearity, 2008–2010 are treated as a base group of

the time dummies. This test is analogous to a specification performed by Acemoglu and Angrist (2001). Parameter estimates of the full-model and the corresponding APEs are presented in table C-11 and C-12, respectively. In table C-12, we can see that the trend variable in each of employment outcomes and participation is not statistically significant, meaning that it rarely related to unobservable secular trends in employment outcomes and participation. For the employment outcomes, the indicator for severe disability and its year controls are still significant and have same signs as those of the main model. Moreover, most of the year dummies have expected signs and are statistically significant, though some of them for 2014 and 2015 turned out to be statistically insignificant. For participation, however, the indicator of severe disability and its year controls changed their signs. Similarly, most of the year dummies change their signs but turned out to be statistically significant, which might be due to multicollinearity between the trend variable and the indicator of severe disability, and/or the trend variable and the year dummies.

Similarly, we apply the specification to the sample of males and females with disabilities, and resultant parameter estimates and the APEs are presented in tables C-13 through C-16. In table C-14, we can see that for the sample of males, the trend variables are not significant in all the employment outcomes and participation. Moreover, the indicator of severe disability with its year controls are all significant and have expected signs in the employment outcomes, but changes their signs in participation, and all the year dummies in the part-time employment turned out to be statistically insignificant. For the sample of females, the results in table C-16 indicate that the trend variables in

the employment outcomes and participation are not significant, and the indicators of severe disability and its year controls change their signs, but most of the year dummies are statistically insignificant.

Taken altogether, the results we obtained in the specifications of the robustness checks suggest that the trend variables in all the models hardly contribute to capture omitted variables reflecting unobserved secular trends related to both employment of the participants with severe and non-severe disabilities.

4.8. Discussion and Conclusions

This essay seeks to find empirical evidence on the policy effectiveness; how the changes in employment policies for the disabled in Korea affect employment outcomes of people with disabilities. Our results suggest that starting in 2011 the policy changes lead to enhanced employment outcomes of men with disabilities participating in the salaried labor-force. Additionally, we find that the policy changes contribute to promote better employment outcomes for male participants with severe disabilities in that overall disparities in the probabilities of enhanced employment outcomes between the non-severely and severely disabled male participants narrowed over the period 2010–2015. Note that since the three policy changes were implemented in early 2010, we could not figure out how much each policy affects employment outcomes of the participants with severe and non-severe disabilities. However, we find that a combination of the policies is an effective way to promote employment outcomes of male participants with disabilities. What we need to scrutinize is that for men with disabilities, no marked changes in the predicted probabilities of participation and employment outcomes occur in 2010, though

the policies have changed since January 2010, but some changes in the predicted probabilities in the employment outcomes are observed at least in 2011. This policy-lag can be attributable to the survey period of the PSED. As the 2010 PSED was conducted from May to August, it is possible that firms during that period might not fully adjust their employment plans to meet the required quota.

On the contrary, our findings suggest that female participants' employment is not affected by the changes in the employment policies; even they appear to be substantially disadvantaged in the labor market. To promote and secure their employment, it is desirable to program other employment policies which could be more effective to encompass those vulnerable cohorts into the workplaces. For example, a double count system that regards employment of one woman with disabilities as employment of two employees with disabilities may yield different employment outcomes of women with disabilities. Our results contribute to provide empirical evidence that the combination of the changes in the employment policies for the disabled can play a significant role for integrating more of disabled workers in the workplaces at least for men with disabilities and can be used as a reference to design employment policies for people with disabilities in other countries or to revise them in Korea.

5. CONCLUSIONS

A variety of assistance programs and policies not only in the U.S. but in other countries play important roles to provide safety nets for people with disabilities and understanding their roles and to what extent their desired outcomes are achieved are important for designing a better policy. The overall objective of this dissertation is to provide a better understanding of the effects of program participation and policy changes on the economic well-being of the populations with disabilities by; (1) analyzing the relationships between food insecurity and various disability characteristics of a household member and looking at how the relationship varies with participation in assistance programs; (2) examining the effects of SNAP participation on food insecurity for households with disabled members; (3) estimating the attenuated program effectiveness of SNAP due to the 2013 SNAP benefit changes; and (4) analyzing the effects of the changes in the disability employment policies on the employment outcomes for people with disabilities.

In the first essay, we identify a household member's six types—vision, hearing, physical, cognitive, communicative, and self-care—of disabilities, severity and multiplicity of these disabilities, severity of mental disorder based on the 6-item Kessler index, and who in a household has a disability among a household head, spouse/partner, and children. Using these indicators of disability and ordered Probit models, we find that each of the indicators of disability of a household member is highly predictive of food insecurity. Results from the nonparametric specification suggest that participation in

assistance programs may shield food security from a household member's aggravated psychological distress.

In the second essay, we focus on SNAP and examine how SNAP participation reduces food insecurity for households with disabled members using indicators of the presence of member(s) with disabilities and who in the household has a disability. To obtain more efficient estimation results, we apply copula joint distribution functions to switching regression models with a set of valid instruments representing state-specific SNAP policies. Estimation results suggest that SNAP participation is more effective in reducing food insecurity for households disabled members than those without disabled members, and the effectiveness differs by the presence of a spouse/partner and children with and without disabilities. Additionally, we find that the 2013 SNAP benefit decreases attenuated the program effectiveness of SNAP, and the results highlight an importance of a distributional assumption of the switching regression model, which is decisive on the estimated treatment effects.

The third essay in this dissertation turns to the set of policy changes in the employment quota system for people with disabilities in South Korea, which have not been operated in the U.S. We employ ordered Probit models with sample selection in order to endogenize salaried-labor force participation and differentiate an employment outcome into unemployment, part-time, and full-time. Survey respondents' severity of disability and gender are modelled since the policy changes put more weights on protecting secure employments of people with severe disabilities and/or women with disabilities. The results suggest that the policy changes bring about enhanced

employment outcomes for only men with disabilities participating in the salaried labor-force.

This dissertation demonstrates the roles, importance, and effectiveness of assistance programs in the U.S. and employment policies in Korea that aim to protect vulnerable population with disabilities. SNAP participation and the disability employment policies have significant effects on the desired outcomes of interests for population with disabilities. As SNAP has not administered in Korea and the EQS has not in operation in the U.S., this dissertation contributes to provide implications for mapping out prospective policies for people with disabilities in each country in a cross-reference to the empirical evidence of another one.

At the same time, there are some limitations in the analyses. In the first essay, due to the lack of valid instrumental variables related to participation in both SSI and SNAP, we could not directly control for potential endogeneity and use sub-sample analyses to partially address the problem. In the second essay, we utilize five copula joint distribution functions that widely used in the literature but other copulas are also available that may produce more efficient estimates than the best-preferred copula model. In the third essay, as for the ordered Probit model with sample selection, we assume the distribution of the error terms of the participation equation and outcome equation are jointly distributed. Since this assumption is too strong, applications of other distributions e.g. copula or Johnson's Su-distribution could be good alternatives to yield more efficient estimates. All of these are left for future exploration.

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APPENDIX A

TABLES FOR SECTION 2

Table A-1. 30-Day Scale 10-Item (Adult) Food Security Questions in the NHIS

Item	Question	Response Format	Coding
1	"I/We worried whether my/our food would run out before I/we got money to buy more."	Often true, sometimes true, or never true	Affirmative if often true or sometimes true
2	"The food that I/we bought just didn't last, and I/we didn't have money to get more."	Often true, sometimes true, or never true	Affirmative if often true or sometimes true
3	"I/We couldn't afford to eat balanced meals."	Often true, sometimes true, or never true	Affirmative if often true or sometimes true
4	Did you/you or other adults in your family ever cut the size of your meals or skip meals because there wasn't enough money for food?	Yes/No	Affirmative if yes
5	How many days did this happen?	0–30 Continuum	Affirmative if 3 or more
6	Did you ever eat less than you felt you should because there wasn't enough money for food?	Yes/No	Affirmative if yes
7	Were you ever hungry but didn't eat because there wasn't enough money for food?	Yes/No	Affirmative if yes
8	Did you lose weight because there wasn't enough money for food?	Yes/No	Affirmative if yes
9	Did you/you or other adults in your family ever not eat for a whole day because there wasn't enough money for food?	Yes/No	Affirmative if yes
10	How many days did this happen?	0–30 Continuum	Affirmative if 3 or more

Source: Author's tabulation based on 10-item food security questions in the "Family" core of the NHIS 2011–2016.

Table A-2. Descriptive Statistics by Ordered Food Security Status

Household Demographics	High Food Secure (82.15%)	Marginal Food Secure (7.10%)	Low Food Secure (6.34%)	Very Low Food Secure (4.42%)
Household head characteristics				
Age	51.862±0.139	46.396±0.276	46.996±0.264	47.419±0.282
Gender				
Male	48.571	39.006	36.720	37.170
Female	51.429	60.995	63.280	62.830
Marital status				
Married or have a partner	57.485	47.957	42.891	33.896
Unmarried/widowed/divorced/separated	42.515	52.043	57.109	66.104
Race				
Hispanic	10.297	19.881	22.792	15.872
Non-Hispanic White	74.302	55.791	51.369	56.564
Non-Hispanic Black	9.720	19.427	21.492	23.150
Non-Hispanic Asian	4.944	3.304	2.792	1.780
Non-Hispanic all other race groups	0.736	1.598	1.556	2.633
Education				
Less than high school	9.664	21.911	26.584	25.007
High school or GED	22.291	28.381	29.289	29.466
Some college no degree	18.734	22.216	22.051	23.082
College degree or associate degree	34.757	22.741	18.878	19.935
Higher than college	14.553	4.751	3.198	2.510
Employment status				
Employed (family business included)	60.983	54.319	45.824	37.994
Unemployed	39.017	45.681	54.176	62.006
Adults' types and severity of disability				
Vision disability				
Without-	86.675	80.782	73.303	65.605
Non-severe-	12.009	16.700	22.882	28.616
Severe-	1.316	2.519	3.815	5.780
Hearing disability				
Without-	83.106	82.729	80.460	76.010
Non-severe-	15.055	15.207	16.474	20.595
Severe-	1.839	2.064	3.066	3.395
Physical disability				
Without-	84.171	76.676	68.287	59.268
Non-severe-	10.798	15.045	19.151	22.229
Severe-	5.032	8.279	12.562	18.503
Cognitive disability				
Without-	86.849	79.384	73.355	63.553
Non-severe-	11.747	18.077	22.425	28.029
Severe-	1.404	2.539	4.220	8.418
Communicative disability				
Without-	96.533	93.144	91.297	87.882
Non-severe-	2.955	5.732	7.295	10.446
Severe-	0.511	1.124	1.407	1.672
Self-care disability				
Without-	96.990	95.246	91.647	87.524
Non-severe-	2.341	3.636	6.417	9.430
Severe-	0.669	1.118	1.936	3.046
Household members' disabilities				
Household head				
With disabilities	15.442	25.247	35.590	51.534
Without a disability	84.558	74.753	64.410	48.466
Spouse/Partner				
With disabilities	5.567	7.210	8.847	11.299

Without a disability	50.463	39.416	32.422	20.877
Without S/P	43.970	53.375	58.731	67.825
Children				
With disabilities	3.438	7.618	8.963	9.257
Without a disability	24.888	34.379	32.422	22.116
Without children	71.674	58.002	58.615	68.627
Multiple disabilities				
0	61.712	51.947	42.633	32.832
1	21.778	23.426	24.127	23.006
2	9.500	12.776	15.492	17.354
3	4.240	6.506	9.015	12.408
4	1.868	3.661	5.301	8.292
5	0.706	1.205	2.304	4.601
6	0.196	0.479	1.128	1.508
Household characteristics				
Household size	2.313±0.009	2.648±0.026	2.599±0.027	2.232±0.030
Number of kids	0.522±0.006	0.853±0.018	0.838±0.021	0.605±0.020
0	71.674	58.002	58.615	68.627
1~2	22.904	30.110	29.862	23.961
≥3	5.422	11.888	11.523	7.412
Home-ownership				
Own	68.952	42.869	37.070	32.375
Not own	31.048	57.131	62.930	67.625
Federal Poverty Level				
0~0.99	9.719	28.667	37.485	45.251
>1.99	15.708	32.850	34.837	34.020
≥2.00	74.574	38.483	27.679	20.730
Multiple programs participation (SSI and SNAP)				
None	90.181	64.305	54.804	46.868
Any one of	8.250	29.069	35.341	38.100
Both	1.570	6.626	9.855	15.032
N=78,214				

Note: For age, household size, and number of kids, the figures refer to sample mean ± SEs. All the rest are percentage in each category.

Table A-3. Descriptive Statistics for Sub-Samples

Samples	Food Security		Psychological Distress	
	Food Secure (89.24%)	Food Insecure (10.76%)	Non-severe (96.31%)	Severe (3.69%)
Household Income				
Below 200% of the FPL (low) (N=28,561)	28.296	75.175	32.045	67.096
200% to 400% of the FPL (middle) (N=22,526)	30.072	19.979	29.279	21.358
Above 400% of the FPL (high) (N=27,127)	41.632	4.846	38.677	11.546
Program Participation, below 200% of the FPL				
None (N=16,564)	65.702	40.416	61.387	36.904
Any one of (N=9,478)	27.971	44.331	30.925	44.577
Both (N=2,519)	6.327	15.253	7.687	18.519

Table A-4. Parameter Estimates for Model 1: Type and Severity of Disability

Variables	Estimate	SE
Household head characteristics		
Age	0.066***	0.002
Age square	–0.001***	0.000
Male	–0.085***	0.013
Married/have a partner	–0.151***	0.016
Home-ownership: own	–0.328***	0.015
Non-Hispanic Black (Base)		
Hispanic	–0.121***	0.020
Non-Hispanic White	–0.265***	0.018
Non-Hispanic Asian	–0.452***	0.034
Non-Hispanic all other race groups	0.110**	0.055
Less than high school (Base)		
High school or GED	–0.106***	0.019
Some college no degree	–0.127***	0.021
College degree or associate degree	–0.308***	0.021
Higher than college	–0.551***	0.032
Unemployed	0.205***	0.015
Household characteristics		
Low Income (FPL<2.00)	0.702***	0.016
Household size	0.058***	0.008
Number of kids: 0 (Base)		
Number of kids: 1~2	–0.082***	0.021
Number of kids: ≥3	–0.175***	0.038
Adults' types and severity of disability		
Non-severe vision	0.236***	0.018
Severe vision	0.340***	0.043
Non-severe hearing	0.071***	0.019
Severe hearing	0.103**	0.046
Non-severe physical	0.270***	0.020
Severe physical	0.372***	0.029
Non-severe communicative	0.139***	0.030
Severe communicative	–0.015	0.065
Non-severe cognitive	0.262***	0.019
Severe cognitive	0.329***	0.041
Non-severe self-care	0.077**	0.035
Severe self-care	0.047	0.064
Year (2011 Base)		
2012	–0.088***	0.025
2013	–0.212***	0.020
2014	–0.177***	0.020
2015	–0.222***	0.022
2016	–0.157***	0.020
Cutoff point 1	1.899***	0.064
Cutoff point 2	2.310***	0.064
Cutoff point 3	2.902***	0.065
N=78,214		

Note: Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Robust standard errors are suppressed for brevity.

Table A-5. Parameter Estimates for Model 2: Household Member's Disabilities

Variables	Estimate	SE
Household head characteristics		
Age	0.061***	0.002
Age square	–0.001***	0.000
Male	–0.104***	0.013
Home-ownership: own	–0.323***	0.015
Non-Hispanic Black (Base)		
Hispanic	–0.100***	0.020
Non-Hispanic White	–0.264***	0.017
Non-Hispanic Asian	–0.414***	0.034
Non-Hispanic all other race groups	0.135**	0.056
Less than high school (Base)		
High school or GED	–0.119***	0.019
Some college no degree	–0.147***	0.021
College degree or associate degree	–0.327***	0.021
Higher than college	–0.574***	0.032
Unemployed	0.134***	0.016
Household characteristics		
Low Income (FPL<2.00)	0.678***	0.016
Household size	0.045***	0.007
Household members' disabilities		
Household head's disabilities	0.549***	0.018
Without spouse/partner (Base)		
Spouse/partner without a disability	–0.200***	0.017
Spouse/partner with disabilities	0.185***	0.027
Without children (Base)		
Children without a disability	–0.079***	0.022
Children with disabilities	0.127***	0.033
Year (2011 Base)		
2012	–0.069***	0.025
2013	–0.172***	0.020
2014	–0.151***	0.020
2015	–0.203***	0.022
2016	–0.155***	0.020
Cutoff point 1	1.684***	0.064
Cutoff point 2	2.094***	0.064
Cutoff point 3	2.684***	0.065
N=78,214		

Note: Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Robust standard errors are suppressed for brevity.

Table A-6. Parameter Estimates for Model 3: Multiple Disabilities

Variables	Estimate	SE
Household head characteristics		
Age	0.067***	0.002
Age square	–0.001***	0.000
Male	–0.091***	0.013
Married/have a partner	–0.154***	0.016
Home-ownership: own	–0.333***	0.015
Non-Hispanic Black (Base)		
Hispanic	–0.126***	0.020
Non-Hispanic White	–0.273***	0.017
Non-Hispanic Asian	–0.459***	0.034
Non-Hispanic all other race groups	0.112**	0.055
Less than high school (Base)		
High school or GED	–0.110***	0.019
Some college no degree	–0.131***	0.021
College degree or associate degree	–0.312***	0.021
Higher than college	–0.557***	0.032
Unemployed	0.214***	0.015
Household characteristics		
Low Income (FPL<2.00)	0.709***	0.016
Household size	0.058***	0.008
Number of kids: 0 (Base)		
Number of kids: 1~2	–0.082***	0.021
Number of kids: ≥3	–0.179***	0.038
Multiple disabilities (0 base)		
1	0.296***	0.016
2	0.501***	0.021
3	0.668***	0.027
4	0.800***	0.035
5	0.916***	0.052
6	1.081***	0.080
Year (2011 Base)		
2012	–0.094***	0.025
2013	–0.216***	0.020
2014	–0.189***	0.020
2015	–0.226***	0.022
2016	–0.164***	0.020
Cutoff point 1	1.919***	0.064
Cutoff point 2	2.330***	0.064
Cutoff point 3	2.919***	0.065
N=78,214		

Note: Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Robust standard errors are suppressed for brevity.

Table A-7. Average Partial Effects for Model 1: Adults' Type and Severity of Disability on Food Insecurity

Variables	Food Security Status			
	High Food Secure	Marginal Food Secure	Low Food Secure	Very Low Food Secure
Household head characteristics				
Age	0.002***	–0.001***	–0.001***	–0.001***
Male	0.017***	–0.005***	–0.006***	–0.006***
Married/have a partner	0.031***	–0.009***	–0.011***	–0.011***
Home-ownership: own	0.070***	–0.021***	–0.025***	–0.024***
Non-Hispanic Black (Base)				
Hispanic	0.024***	–0.007***	–0.008***	–0.008***
Non-Hispanic White	0.056***	–0.017***	–0.020***	–0.020***
Non-Hispanic Asian	0.078***	–0.026***	–0.027***	–0.025***
Non-Hispanic all other race groups	–0.023*	0.007**	0.008*	0.009*
Less than high school (Base)				
High school or GED	0.021***	–0.006***	–0.007***	–0.007***
Some college no degree	0.025***	–0.007***	–0.009***	–0.009***
College degree or associate degree	0.061***	–0.019***	–0.021***	–0.020***
Higher than college	0.095***	–0.032***	–0.034***	–0.029***
Unemployed	–0.043***	0.013***	0.015***	0.015***
Household characteristics				
Low Income (FPL<2.00)	–0.162***	0.052***	0.059***	0.051***
Household size	–0.012***	0.003***	0.004***	0.004***
Number of kids: 0 (base)				
Number of kids: 1~2	0.016***	–0.005***	–0.006***	–0.006***
Number of kids: ≥3	0.033***	–0.010***	–0.012***	–0.012***
Adults' types and severity of disability				
Non-severe vision	–0.051***	0.015***	0.018***	0.019***
Severe vision	–0.077***	0.021***	0.026***	0.030***
Non-severe hearing	–0.015***	0.004***	0.005***	0.005***
Severe hearing	–0.022**	0.006**	0.007**	0.008**
Non-severe physical	–0.059***	0.017***	0.020***	0.022***
Severe physical	–0.085***	0.023***	0.029***	0.033***
Non-severe cognitive	–0.057***	0.016***	0.020***	0.021***
Severe cognitive	–0.075***	0.020***	0.025***	0.029***
Non-severe communicative	–0.030***	0.008***	0.010***	0.011***
Severe communicative	0.003	–0.001	–0.001	–0.001
Non-severe self-care	–0.016**	0.005**	0.005**	0.006**
Severe self-care	–0.010	0.003	0.003	0.004
Year (2011 Base)				
2012	0.019***	–0.005***	–0.007***	–0.007***
2013	0.044***	–0.013***	–0.015***	–0.016***
2014	0.037***	–0.011***	–0.013***	–0.014***
2015	0.046***	–0.013***	–0.016***	–0.017***
2016	0.034***	–0.010***	–0.011***	–0.012***
N=78,214				

Note: Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Robust standard errors are suppressed for brevity.

Table A-8. Wald Test Results for the Differences in the Effects of Disabilities by Severity of Disability (Model 1)

Severe vs non-severe disabilities	High food secure	Marginal food secure	Low food secure	Very low food secure
Vision disability	$\chi^2(1)$ = 5.62, p=0.018	$\chi^2(1)$ = 5.27, p=0.022	$\chi^2(1)$ = 5.45, p=0.020	$\chi^2(1)$ = 5.93, p=0.0149
Hearing disability	$\chi^2(1)$ = 0.46, p=0.496	$\chi^2(1)$ = 0.46, p=0.498	$\chi^2(1)$ = 0.46, p=0.498	$\chi^2(1)$ = 0.47, p=0.4943
Physical disability	$\chi^2(1)$ = 12.30, p<0.001	$\chi^2(1)$ = 11.91, p=0.006	$\chi^2(1)$ = 12.19, p<0.001	$\chi^2(1)$ = 12.52, p<0.001
Cognitive disability	$\chi^2(1)$ = 2.85, p=0.091	$\chi^2(1)$ = 2.42, p=0.120	$\chi^2(1)$ = 2.67, p=0.102	$\chi^2(1)$ = 3.26, p=0.079
Communicative disability	$\chi^2(1)$ = 5.46, p=0.019	$\chi^2(1)$ = 5.19, p=0.022	$\chi^2(1)$ = 5.41, p=0.020	$\chi^2(1)$ = 5.72, p=0.017
Self-care disability	$\chi^2(1)$ = 0.20, p=0.653	$\chi^2(1)$ = 0.20, p=0.656	$\chi^2(1)$ = 0.20, p=0.655	$\chi^2(1)$ = 0.20, p=0.655

Table A-9. Wald Test Results for the Differences in the Effects of Disabilities between Severe Physical Disability and the Other Severe Disabilities (Model 1)

	High food secure	Marginal food secure	Low food secure	Very low food secure
Severe vision disability	$\chi^2(1)$ = 0.34, p=0.557	$\chi^2(1)$ = 0.49, p=0.485	$\chi^2(1)$ = 0.41, p=0.521	$\chi^2(1)$ = 0.23, p=0.630
Severe hearing disability	$\chi^2(1)$ = 24.48, p<0.001	$\chi^2(1)$ = 23.64, p<0.001	$\chi^2(1)$ = 24.49, p<0.001	$\chi^2(1)$ = 24.68, p<0.001
Severe cognitive disability	$\chi^2(1)$ = 0.64, p=0.423	$\chi^2(1)$ = 0.81, p=0.369	$\chi^2(1)$ = 0.72, p=0.397	$\chi^2(1)$ = 0.51, p=0.472
Severe communicative disability	$\chi^2(1)$ = 33.40, p=0.741	$\chi^2(1)$ = 29.97, p<0.001	$\chi^2(1)$ = 32.70, p<0.001	$\chi^2(1)$ = 35.96, p<0.001
Severe self-care disability	$\chi^2(1)$ = 19.54, p<0.001	$\chi^2(1)$ = 18.18, p<0.001	$\chi^2(1)$ = 19.34, p<0.001	$\chi^2(1)$ = 20.49, p<0.001

Table A-10. Wald Test Results for the Differences in the Effects of Disabilities between Non-Severe Physical Disability and the Other Non-Severe Disabilities (Model 1)

	High food secure	Marginal food secure	Low food secure	Very low food secure
Non-severe vision disability	$\chi^2(1)$ = 1.50, p=0.221	$\chi^2(1)$ = 1.38, p=0.2407	$\chi^2(1)$ = 1.44, p=0.2305	$\chi^2(1)$ = 1.64, p=0.2005
Non-severe hearing disability	$\chi^2(1)$ = 47.63, p<0.001	$\chi^2(1)$ = 47.80, p<0.001	$\chi^2(1)$ = 47.35, p<0.001	$\chi^2(1)$ = 46.69, p<0.001
Non-severe cognitive disability	$\chi^2(1)$ = 0.08, p=0.783	$\chi^2(1)$ = 0.05, p=0.818	$\chi^2(1)$ = 0.06, p=0.804	$\chi^2(1)$ = 0.11, p=0.741
Non-severe communicative disability	$\chi^2(1)$ = 12.30, p<0.001	$\chi^2(1)$ = 12.56, p<0.001	$\chi^2(1)$ = 12.37, p<0.001	$\chi^2(1)$ = 11.99, p<0.001
Non-severe self-care disability	$\chi^2(1)$ = 21.85, p<0.001	$\chi^2(1)$ = 21.46, p<0.001	$\chi^2(1)$ = 21.77, p<0.001	$\chi^2(1)$ = 21.98, p<0.001

Table A-11. Average Partial Effects for Model 2: Household Members' Disabilities on Food Insecurity

Household Members' Disabilities	Food Security Status			
	High Food Secure	Marginal Food Secure	Low Food Secure	Very Low Food Secure
Household head				
With disabilities	–0.128***	0.035***	0.044***	0.049***
Without a disability				
Spouse/Partner				
Without S/P				
Without a disability	0.041***	–0.012***	–0.014***	–0.014***
With disabilities	–0.040***	0.011***	0.014***	0.015***
Children				
Without children				
Without a disability	0.016***	–0.005***	–0.005***	–0.006***
With disabilities	–0.027***	0.008***	0.009***	0.010***
N=78,214				

Note: Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Robust standard errors are suppressed for brevity.

Table A-12. Wald Test Results for the Comparison between the Effects of Spouse/Partner with and without Disabilities and Children with and without Disabilities on Food Insecurity (Model 2)

	High Food Secure	Marginal Food Secure	Low Food Secure	Very Low Food Secure
Spouse/Partners with vs. without disabilities	$\chi^2(1)$ = 179.39, p<0.001	$\chi^2(1)$ = 195.53, p<0.001	$\chi^2(1)$ = 180.23, p<0.001	$\chi^2(1)$ = 153.01, p<0.001
Children with vs. without disabilities	$\chi^2(1)$ = 46.58, p<0.001	$\chi^2(1)$ = 53.05, p<0.001	$\chi^2(1)$ = 50.06, p<0.001	$\chi^2(1)$ = 45.48, p<0.001

Table A-13. Average Partial Effects for Model 3: Multiple Disabilities of Adults on Food Insecurity

	Food Security Status			
	High Food Secure	Marginal Food Secure	Low Food Secure	Very Low Food Secure
Number of Disabilities				
0 (base)				
1	–0.064***	0.018***	0.022***	0.024***
2	–0.117***	0.030***	0.039***	0.047***
3	–0.165***	0.040***	0.054***	0.071***
4	–0.206***	0.046***	0.066***	0.093***
5	–0.242***	0.051***	0.075***	0.116***
6	–0.294***	0.056***	0.089***	0.150***
N=78,214				

Note: Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Robust standard errors are suppressed for brevity.

Table A-14. Wald Test Results for the Effects of Multiple Disabilities of Adults on Food Insecurity (Model 3)

	High Food Secure	Marginal Food Secure	Low Food Secure	Very Low Food Secure
1 vs 2	$\chi^2(1) = 89.92$, p<0.001	$\chi^2(1) = 85.89$, p<0.001	$\chi^2(1) = 88.74$, p<0.001	$\chi^2(1) = 89.11$, p<0.001
2 vs 3	$\chi^2(1) = 32.15$, p<0.001	$\chi^2(1) = 29.00$, p<0.001	$\chi^2(1) = 31.33$, p<0.001	$\chi^2(1) = 33.40$, p<0.001
3 vs 4	$\chi^2(1) = 11.08$, p<0.001	$\chi^2(1) = 9.56$, p=0.002	$\chi^2(1) = 10.55$, p=0.001	$\chi^2(1) = 11.77$, p<0.001
4 vs 5	$\chi^2(1) = 3.81$, p=0.051	$\chi^2(1) = 3.17$, p=0.075	$\chi^2(1) = 3.56$, p=0.060	$\chi^2(1) = 4.08$, p=0.044
5 vs 6	$\chi^2(1) = 3.09$, p=0.079	$\chi^2(1) = 3.04$, p=0.081	$\chi^2(1) = 3.04$, p=0.081	$\chi^2(1) = 3.09$, p=0.079

APPENDIX B

TABLES FOR SECTION 3

Table B-1. Summary Statistics by SNAP Participation and Food Insecurity

Variables	SNAP (N= 18,620, 28.999%)		Non-SNAP (N=45,589, 71.001%)	
	Food secure (63.942%)	Food insecure (36.058%)	Food secure (78.420%)	Food insecure (21.580%)
Household head characteristics				
Age	46.445	46.952	50.257	46.282
Gender				
Male	28.257	27.205	41.718	36.923
Female	71.743	72.795	58.282	63.077
Marital status				
Married or have a partner	35.470	32.366	42.400	39.052
Single	28.689	28.017	22.834	23.439
Widowed/Divorced/Separated	35.841	39.617	34.767	37.509
Citizenship				
Citizen	88.829	90.091	87.604	87.069
Not citizen	11.171	9.909	12.396	12.931
Race				
Hispanic	22.930	21.291	19.054	22.707
Non-Hispanic White	45.327	46.975	61.073	50.721
Non-Hispanic Black	27.155	27.821	13.513	22.236
Non-Hispanic Asian	2.842	1.934	5.338	2.794
Non-Hispanic All others	1.747	1.978	1.023	1.542
Education				
Less than high school	34.639	36.774	21.711	26.581
High school or GED	33.337	30.722	31.514	29.753
Some college, no degree	17.888	19.184	21.544	23.524
College degree or associates	12.791	12.346	21.285	18.156
Higher than college	1.344	0.975	3.946	1.986
Employment status				
Employed (family business included)	33.789	25.082	47.145	44.960
Unemployed	66.211	74.918	52.855	55.040
Home ownership				
Own	25.629	24.382	47.591	34.259
Not own	74.371	75.618	52.409	65.741
Region				
Northeast	20.419	17.832	14.711	12.434
Midwest	22.657	23.534	22.855	20.029
South	40.664	41.658	39.589	43.228
West	16.261	16.976	22.845	24.309
Household members' disabilities				
Household head				
With disabilities	34.898	53.667	22.845	37.795
Without a disability	65.102	46.333	77.155	62.205
Spouse/Partner				
With disabilities	5.943	10.437	6.054	8.407
Without a disability or without S/P	94.057	89.563	93.946	91.593

Children				
With disabilities	9.623	12.403	4.014	7.184
Without a disability or without children	90.377	87.597	95.986	92.816
Presence of member(s) with disabilities				
One or more members with disabilities	48.329	67.603	31.561	48.815
Without disabled members	51.671	32.397	68.440	51.185
Household characteristics				
Household size	3.006	2.775	2.377	2.498
Receipt of SSI				
Received	23.572	32.028	5.472	11.032
Not received	76.428	67.972	94.528	88.968
Receipt of Medicaid				
Received	75.991	75.743	26.534	37.764
Not received	24.009	24.257	73.466	62.236
Receipt of TANF				
Received	12.108	14.674	1.480	3.443
Not received	87.892	85.327	98.520	96.557
Survey year				
2011	17.901	18.862	19.605	23.626
2012	18.763	20.044	19.549	21.238
2013	21.098	20.586	19.481	19.327
2014	21.461	21.021	21.421	19.414
2015	20.777	19.487	19.945	16.395
SNAP benefit decreases				
Pre-	56.280	58.189	57.562	62.918
Post-	43.720	41.811	42.438	37.082
Instruments				
BBCE	0.875	0.873	0.860	0.879
Combined application process	0.551	0.546	0.497	0.510
Exclusion of all vehicles	0.841	0.836	0.832	0.829
N=64,209				

Note: For age, household size, and instruments, figures are mean value and all the other figures are percentage in each category.

Table B-2. Summary Statistics for Instruments by State, Averaged over 60 Months

State	BBCE	Excl. of all vehicles	Combined appl. process
Alabama	1.000	1.000	0.000
Alaska	0.000	0.000	0.000
Arizona	1.000	1.000	1.000
Arkansas	0.000	0.000	0.000
California	1.000	1.000	0.000
Colorado	0.967	1.000	0.000
Connecticut	1.000	1.000	0.000
Delaware	1.000	1.000	0.000
District of Columbia	1.000	1.000	0.000
Florida	1.000	1.000	1.000
Georgia	1.000	1.000	0.000
Hawaii	1.000	1.000	0.000
Idaho	1.000	0.086	0.000
Illinois	1.000	1.000	0.000
Indiana	0.000	1.000	0.000
Iowa	1.000	1.000	0.000
Kansas	0.000	1.000	0.000
Kentucky	1.000	1.000	1.000
Louisiana	0.717	1.000	1.000
Maine	1.000	1.000	0.000
Maryland	1.000	1.000	1.000
Massachusetts	1.000	1.000	1.000
Michigan	1.000	0.155	1.000
Minnesota	1.000	1.000	0.000
Mississippi	1.000	1.000	1.000
Missouri	0.000	1.000	0.000
Montana	1.000	1.000	0.000
Nebraska	0.850	0.000	0.000
Nevada	1.000	1.000	0.000
New Hampshire	1.000	1.000	0.000
New Jersey	1.000	1.000	1.000
New Mexico	1.000	1.000	0.633
New York	1.000	1.000	1.000
North Carolina	1.000	1.000	1.000
North Dakota	1.000	1.000	0.000
Ohio	1.000	1.000	0.000
Oklahoma	1.000	1.000	0.000
Oregon	1.000	1.000	0.000
Pennsylvania	1.000	0.397	1.000
Rhode Island	1.000	1.000	0.000
South Carolina	1.000	1.000	1.000
South Dakota	0.000	0.000	1.000
Tennessee	0.000	1.000	0.000
Texas	1.000	0.000	1.000
Utah	0.000	1.000	0.000

Vermont	1.000	1.000	0.000
Virginia	0.000	1.000	1.000
Washington	1.000	1.000	1.000
West Virginia	1.000	1.000	0.000
Wisconsin	1.000	1.000	0.000
Wyoming	0.000	0.845	0.000

Note: Each policy variable is coded as 1 if the states have the policies, and 0 otherwise. Source: Author's calculation based on USDA SNAP policy data sets 2011–2015.

Table B-3. Summary Statistics for Instruments by Year, Averaged over States

	2011	2012	2013	2014	2015
BBCE	0.786	0.804	0.804	0.796	0.784
Excl. of all vehicles	0.871	0.851	0.843	0.843	0.855
Combined appl. process	0.353	0.353	0.353	0.337	0.333

Source: Author's calculation based on USDA SNAP policy data sets 2011–2015.

Table B-4. Parameter Estimates for Model 1 with AMH–Plackett Copula

Variables	SNAP		FI (SNAP)		FI (Non-SNAP)	
	Estimate	SE	Estimate	SE	Estimate	SE
Age	0.035***	0.002	0.059***	0.006	0.076***	0.003
Age square	0.000***	0.000	–0.001***	0.000	–0.001***	0.000
Male	–0.155***	0.016	–0.063**	0.030	–0.129***	0.018
(Ref.:widowed/divorced/separated)						
Married/Have a partner	–0.298***	0.020	0.042	0.040	–0.204***	0.025
Single	0.029	0.022	–0.044	0.032	–0.141***	0.026
Citizen	0.171***	0.023	–0.086**	0.042	0.104***	0.027
Unemployed	0.346***	0.016	0.089**	0.040	0.196***	0.021
Home owned	–0.394***	0.017	–0.002	0.043	–0.313***	0.022
(Ref.: Less than high school)						
High school or GED	–0.164***	0.019	–0.066**	0.032	–0.170***	0.023
Some college, no degree	–0.291***	0.022	0.036	0.042	–0.166***	0.027
College degree or associates	–0.384***	0.024	–0.026	0.051	–0.294***	0.029
Higher than college	–0.555***	0.056	–0.128	0.124	–0.492***	0.057
(Ref.: Non-Hispanic Black)						
Hispanic	–0.082***	0.023	0.017	0.037	–0.160***	0.029
Non-Hispanic White	–0.236***	0.020	0.011	0.037	–0.312***	0.024
Non-Hispanic Asians	–0.333***	0.039	–0.073	0.082	–0.498***	0.045
Non-Hispanic All others	–0.034	0.069	0.003	0.096	–0.074	0.078
Household size	0.093***	0.005	–0.057***	0.010	–0.022***	0.007
SSI receipt	0.387***	0.022	0.025	0.045	0.143***	0.040
Medicaid receipt	0.896***	0.016	–0.156**	0.077	0.207***	0.035
TANF receipt	0.845***	0.033	0.047	0.074	0.428***	0.072
Presence of member(s) with dis.	0.224***	0.017	0.396***	0.037	0.525***	0.021
(Ref.:2011)						
2012	0.051**	0.022	–0.014	0.036	–0.055	0.025
2013	0.137***	0.023	–0.065*	0.037	–0.109	0.026
2014	0.086***	0.023	–0.052	0.037	–0.153	0.025
2015	0.095***	0.023	–0.073**	0.037	–0.228	0.027
BBCE	0.071	0.115				
Combined application process	0.566***	0.144				
Exclusion of all vehicles	0.018	0.072				
Constant	–2.332***	0.143	–1.151***	0.358	–1.580***	0.108
Ancillary θ_0	0.763***	0.196				
Ancillary θ_1	–0.616	0.411				
τ_0	0.175***	0.040				
Log likelihood	–59670.56					
Wald test of independence	Test statistic=35.501 with P-value<0.01					
N=64,209						

Note: *Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Estimates for state-dummy are suppressed for brevity.

Table B-5. Parameter Estimates for Model 2 with AMH–Plackett Copula

Variables	SNAP		FI (SNAP)		FI (Non-SNAP)	
	Estimate	SE	Estimate	SE	Estimate	SE
Age	0.034***	0.002	0.056***	0.006	0.075***	0.003
Age square	0.000***	0.000	–0.001***	0.000	–0.001***	0.000
Male	–0.159***	0.016	–0.061*	0.031	–0.137***	0.018
(Ref.:widowed/divorced/separated)						
Married/Have a partner	–0.325***	0.021	–0.044	0.046	–0.259***	0.027
Single	0.027	0.022	–0.054*	0.032	–0.145***	0.026
Citizen	0.172***	0.023	–0.097**	0.042	0.106***	0.027
Unemployed	0.329***	0.017	0.045	0.042	0.160***	0.022
Home owned	–0.388***	0.017	0.021	0.044	–0.303***	0.022
(Ref.: Less than high school)						
High school or GED	–0.162***	0.019	–0.061*	0.032	–0.168***	0.024
Some college, no degree	–0.289***	0.022	0.050	0.042	–0.167***	0.028
College degree or associates	–0.380***	0.024	–0.013	0.053	–0.286***	0.029
Higher than college	–0.552***	0.056	–0.110	0.126	–0.484***	0.058
(Ref.: Non-Hispanic Black)						
Hispanic	–0.081***	0.023	0.023	0.037	–0.159***	0.029
Non-Hispanic White	–0.237***	0.020	0.013	0.037	–0.314***	0.024
Non-Hispanic Asians	–0.330***	0.039	–0.061	0.082	–0.493***	0.045
Non-Hispanic All others	–0.034	0.069	0.002	0.095	–0.081	0.078
Household size	0.103***	0.006	–0.043***	0.011	0.003	0.008
SSI receipt	0.395***	0.022	0.014	0.047	0.168***	0.041
Medicaid receipt	0.896***	0.016	–0.187**	0.081	0.212***	0.036
TANF receipt	0.842***	0.033	0.016	0.078	0.420***	0.072
HH head's disabilities	0.236***	0.019	0.372***	0.042	0.558***	0.024
Spouse/partner's disabilities	0.144***	0.031	0.349***	0.053	0.329***	0.036
Children's disabilities	0.068**	0.029	0.161***	0.039	0.195***	0.038
(Ref.:2011)						
2012	0.052**	0.022	–0.014	0.036	–0.050**	0.025
2013	0.138***	0.023	–0.067*	0.037	–0.107***	0.026
2014	0.086***	0.023	–0.050	0.037	–0.152***	0.025
2015	0.095***	0.023	–0.070*	0.037	–0.227***	0.027
BBCE	0.066	0.115				
Combined application process	0.557***	0.143				
Exclusion of all vehicles	0.019	0.071				
Constant	–2.312***	0.142	–0.953**	0.384	–1.551***	0.109
Ancillary θ_0	0.776***	0.207				
Ancillary θ_1	–0.754*	0.443				
τ_0	0.177***	0.041				
Log likelihood	–59559.36					
Wald test of independence	Test statistic=35.979 with P-value< 0.01					
N=64,209						

Note: *Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Estimates for state-dummy are suppressed for brevity.

Table B-6. Parameter Estimates for Model 3 with AMH–Plackett Copula

Variables	SNAP		FI (SNAP)		FI (Non-SNAP)	
	Estimate	SE	Estimate	SE	Estimate	SE
Age	0.035***	0.002	0.059***	0.006	0.076***	0.003
Age square	0.000***	0.000	–0.001***	0.000	–0.001***	0.000
Male	–0.156***	0.016	–0.062**	0.030	–0.128***	0.018
(Ref.:widowed/divorced/separated)						
Married/Have a partner	–0.298***	0.020	0.042	0.040	–0.204***	0.025
Single	0.030	0.022	–0.045	0.032	–0.140***	0.026
Citizen	0.172***	0.023	–0.087**	0.042	0.105***	0.027
Unemployed	0.344***	0.016	0.089**	0.040	0.198***	0.021
Home owned	–0.394***	0.017	–0.001	0.043	–0.313***	0.022
(Ref.: Less than high school)						
High school or GED	–0.162***	0.019	–0.065**	0.032	–0.173***	0.023
Some college, no degree	–0.290***	0.022	0.037	0.042	–0.170***	0.027
College degree or associates	–0.381***	0.024	–0.026	0.051	–0.298***	0.029
Higher than college	–0.553***	0.056	–0.129	0.124	–0.496***	0.057
(Ref.: Non-Hispanic Black)						
Hispanic	–0.081***	0.023	0.016	0.037	–0.160***	0.029
Non-Hispanic White	–0.237***	0.020	0.012	0.036	–0.310***	0.024
Non-Hispanic Asians	–0.335***	0.039	–0.072	0.082	–0.498***	0.045
Non-Hispanic All others	–0.035	0.069	0.001	0.095	–0.075	0.078
Household size	0.092***	0.005	–0.057***	0.010	–0.021***	0.007
SSI receipt	0.388***	0.022	0.024	0.044	0.145***	0.040
Medicaid receipt	0.896***	0.016	–0.158**	0.076	0.208***	0.035
TANF receipt	0.840***	0.033	0.047	0.073	0.437***	0.072
Presence of member(s) with dis.	0.225***	0.017	0.394***	0.037	0.524***	0.021
Post-SNAP benefit decreases	0.032**	0.015	–0.037	0.023	–0.128***	0.017
BBCE	0.088	0.114				
Combined application process	0.574***	0.143				
Exclusion of all vehicles	–0.059	0.070				
Constant	–2.284***	0.142	–1.166***	0.352	–1.634***	0.107
Ancillary θ_0	0.782***	0.198				
Ancillary θ_1	–0.628	0.408				
τ_0	0.179	0.039				
Log likelihood	–59720.89					
Wald test of independence	Test statistic= 38.148 with P-value< 0.01					
N=64,209						

Note: *Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Estimates for state-dummy are suppressed for brevity.

Table B-7. Average Partial Effects for Model 1 with AMH–Plackett Copula

Variables	SNAP		FI (SNAP)		FI (Non-SNAP)	
	Estimate	SE	Estimate	SE	Estimate	SE
Age	0.000	0.000	–0.001***	0.000	–0.002***	0.000
Male	–0.037***	0.004	–0.023**	0.011	–0.037***	0.005
(Ref: widowed/divorced/separated)						
Married/Have a partner	–0.071***	0.005	0.015	0.015	–0.058***	0.007
Single	0.007	0.005	–0.016	0.012	–0.039***	0.007
Citizen	0.040***	0.005	–0.032**	0.016	0.029***	0.007
Unemployed	0.083***	0.004	0.033**	0.014	0.056***	0.006
Home owned	–0.094***	0.004	–0.001	0.016	–0.089***	0.006
(Ref.: Less than high school)						
High school or GED	–0.039***	0.004	–0.024**	0.011	–0.048***	0.007
Some college, no degree	–0.067***	0.005	0.013	0.016	–0.046***	0.008
College degree or associates	–0.087***	0.005	–0.009	0.019	–0.080***	0.008
Higher than college	–0.116***	0.010	–0.047	0.044	–0.123***	0.013
(Ref.: Non-Hispanic Black)						
Hispanic	–0.019***	0.005	0.006	0.014	–0.044***	0.008
Non-Hispanic White	–0.057***	0.005	0.004	0.014	–0.090***	0.007
Non-Hispanic Asians	–0.074***	0.008	–0.027	0.029	–0.125***	0.010
Non-Hispanic All others	–0.008	0.016	0.001	0.035	–0.021	0.021
Household size	0.022***	0.001	–0.021***	0.004	–0.006***	0.002
SSI receipt	0.101***	0.006	0.009	0.016	0.042***	0.012
Medicaid receipt	0.246***	0.005	–0.057*	0.031	0.060***	0.011
TANF receipt	0.236***	0.010	0.017	0.027	0.133***	0.024
Presence of member(s) with dis.	0.055***	0.004	0.148***	0.011	0.158***	0.007
(Ref.:2011)						
2012	0.012**	0.005	–0.005	0.013	–0.016**	0.007
2013	0.033***	0.005	–0.024*	0.014	–0.032***	0.007
2014	0.020***	0.005	–0.019	0.014	–0.045***	0.007
2015	0.022***	0.005	–0.027*	0.014	–0.065***	0.008
BBCE	0.017	0.033				
Combined application process	0.134***	0.027				
Exclusion of all vehicles	0.004	0.017				
N=64,209						

Note: *Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Estimates for state-dummy are suppressed for brevity.

Table B-8. Average Partial Effects for Model 2 with AMH–Plackett Copula

Variables	SNAP		FI (SNAP)		FI (Non-SNAP)	
	Estimate	SE	Estimate	SE	Estimate	SE
Age	0.000	0.000	–0.002***	0.000	–0.002***	0.000
Male	–0.038***	0.004	–0.023**	0.011	–0.039***	0.005
(Ref.:widowed/divorced/separated)						
Married/Have a partner	–0.077***	0.005	–0.016	0.017	–0.073***	0.008
Single	0.007	0.005	–0.020*	0.012	–0.040***	0.007
Citizen	0.040***	0.005	–0.036**	0.016	0.030***	0.007
Unemployed	0.079***	0.004	0.017	0.015	0.046***	0.006
Home owned	–0.093***	0.004	0.008	0.017	–0.086***	0.007
(Ref.: Less than high school)						
High school or GED	–0.038***	0.004	–0.023*	0.012	–0.047***	0.007
Some college, no degree	–0.066***	0.005	0.019	0.016	–0.046***	0.008
College degree or associates	–0.086***	0.005	–0.005	0.020	–0.078***	0.008
Higher than college	–0.115***	0.010	–0.041	0.045	–0.121***	0.013
(Ref.: Non-Hispanic Black)						
Hispanic	–0.019***	0.005	0.009	0.014	–0.044***	0.008
Non-Hispanic White	–0.057***	0.005	0.005	0.014	–0.090***	0.007
Non-Hispanic Asians	–0.073***	0.008	–0.023	0.030	–0.124***	0.010
Non-Hispanic All others	–0.008	0.016	0.001	0.036	–0.022	0.021
Household size	0.025***	0.001	–0.016***	0.005	0.001	0.002
SSI receipt	0.103***	0.006	0.005	0.018	0.049***	0.013
Medicaid receipt	0.245***	0.005	–0.070**	0.033	0.062***	0.011
TANF receipt	0.235***	0.010	0.006	0.029	0.130***	0.024
HH head's disabilities	0.058***	0.005	0.141***	0.014	0.171***	0.008
Spouse/partner's disabilities	0.035***	0.008	0.132***	0.020	0.099***	0.011
Children's disabilities	0.016**	0.007	0.061***	0.014	0.058***	0.012
(Ref.:2011)						
2012	0.012**	0.005	–0.005	0.013	–0.015**	0.007
2013	0.033***	0.005	–0.025*	0.014	–0.031***	0.007
2014	0.020***	0.005	–0.019	0.014	–0.044***	0.007
2015	0.022***	0.005	–0.026*	0.014	–0.065***	0.008
BBCE	0.016	0.027				
Combined application process	0.131***	0.033				
Exclusion of all vehicles	0.005	0.017				
N=64,209						

Note: *Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Estimates for state-dummy are suppressed for brevity.

Table B-9. Average Partial Effects for Model 3 with AMH–Plackett Copula

Variables	SNAP		FI (SNAP)		FI (Non-SNAP)	
	Estimate	SE	Estimate	SE	Estimate	SE
Age	0.000	0.000	–0.001***	0.000	–0.002***	0.000
Male	–0.037***	0.004	–0.023**	0.011	–0.036***	0.005
(Ref.:widowed/divorced/separated)						
Married/Have a partner	–0.070***	0.005	0.016	0.015	–0.058***	0.007
Single	0.007	0.005	–0.017	0.012	–0.039***	0.007
Citizen	0.040***	0.005	–0.032**	0.016	0.030***	0.007
Unemployed	0.083***	0.004	0.033**	0.014	0.057***	0.006
Home owned	–0.094***	0.004	0.000	0.016	–0.089***	0.007
(Ref.: Less than high school)						
High school or GED	–0.038***	0.004	–0.024**	0.011	–0.049***	0.007
Some college, no degree	–0.067***	0.005	0.014	0.016	–0.047***	0.008
College degree or associates	–0.086***	0.005	–0.010	0.018	–0.082***	0.008
Higher than college	–0.115***	0.010	–0.047	0.044	–0.124***	0.013
(Ref.: Non-Hispanic Black)						
Hispanic	–0.019***	0.005	0.006	0.014	–0.045***	0.008
Non-Hispanic White	–0.058***	0.005	0.004	0.014	–0.090***	0.007
Non-Hispanic Asians	–0.074***	0.008	–0.026	0.029	–0.125***	0.010
Non-Hispanic All others	–0.008	0.016	0.001	0.035	–0.021	0.021
Household size	0.022***	0.001	–0.021***	0.004	–0.006***	0.002
SSI receipt	0.102***	0.006	0.009	0.016	0.043***	0.012
Medicaid receipt	0.246***	0.005	–0.058*	0.030	0.061***	0.011
TANF receipt	0.235***	0.010	0.017	0.027	0.136***	0.024
Presence of member(s) with dis.	0.055***	0.004	0.148***	0.011	0.158***	0.007
Post-SNAP benefit decreases	0.008**	0.004	–0.014	0.009	–0.037***	0.005
BBCE	0.021	0.027				
Combined application process	0.136***	0.033				
Exclusion of all vehicles	–0.014	0.017				
N=64,209						

Note: *Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Estimates for state-dummy are suppressed for brevity.

Table B-10. Estimates for the Average Treatment Effects on the Treated

	ATET	
	Estimate	SE
Model 1		
Unconditional	–0.132***	0.030
Presence of member(s) with disabilities	–0.153***	0.035
Without disabled members	–0.114***	0.028
Model 2		
Unconditional	–0.137***	0.030
HH head with disabilities	–0.170***	0.039
HH head without a disability	–0.119***	0.035
S/P with disabilities	–0.115***	0.042
S/P without a disability or without S/P	–0.139***	0.035
Children with disabilities	–0.143***	0.041
Children without a disability or without children	–0.136***	0.035
Model 3		
Unconditional	–0.137***	0.032
Pre-SNAP benefit decreases	–0.153***	0.034
Post-SNAP benefit decreases	–0.116***	0.029
Presence of member(s) with disabilities	–0.158***	0.029
Without disabled members	–0.119***	0.025
Pre- and presence of member(s) with disabilities	–0.174***	0.039
Pre- and without disabled members	–0.136***	0.036
Post- and presence of member(s) with disabilities	–0.137***	0.039
Post- and without disabled members	–0.097***	0.026

Note: *** sig at≤ 1% level of significance. Standard errors are calculated using bootstrap methods with 50 replications.

Table B-11. Robustness check

	Unconditional ATET	
	Estimate	SE
Model 1 with IVs		
AMH–Plackett	–0.132***	0.030
AMH–Frank	–0.132***	0.033
Gaussian–Gaussian	–0.111***	0.040
Model 1 without IVs		
AMH–Plackett	–0.132***	0.035
AMH–Frank	–0.133***	0.023
Gaussian–Gaussian	–0.112***	0.033
Model 2 with IVs		
AMH–Plackett	–0.137***	0.030
AMH–Frank	–0.137***	0.026
Gaussian–Gaussian	–0.122***	0.039
Model 3 with IVs		
AMH–Plackett	–0.137***	0.032
AMH–Frank	–0.137***	0.035
Gaussian–Gaussian	–0.121***	0.040

Note: **Statistically significant at≤ 5%, and *** sig at≤ 1% level of significance. Standard errors are calculated using bootstrap methods with 50 replications.

APPENDIX C

TABLES FOR SECTION 4

Table C-1. Monthly-Grant per Excess by Severity of Disability, Gender, and the Employment Rate of Disabled Employees until March 2010

	Male, non-severe	Female, non-severe	Male, severe	Female, severe
Less than or at 30%	$300	$375	$375	$450
Above 30%	$400	$500	$500	$600

Source: Employment Promotion Act for the Disabled of Korea.

Table C-2. Monthly-Grant per Excess by Severity of Disability, Gender, and Employment Period since April 2010

	Non-severe disability		Severe disability	
	Male	Female	Male	Female
Less than 3 years	$300	$400	$400	$500
3 years to less than 5 years	$210	$280	$400	$500
More than 5 years	$150	$200	$400	$500

Note: An employee with 6th grade disability (very minor) is considered as an excess only for 4 years of employment period. Source: Employment Promotion Act for the Disabled of Korea.

Table C-3. Monthly-Levy per Shortfall by Disability Employment Rate to Quota in 2017

Disability Employment Rate to Quota				
3/4~1	1/2~3/4	1/4~1/2	Less than 1/4	No employment
$945	$1,001	$1,134	$1,323	$1,573

Source: Employment Promotion Act for the Disabled of Korea.

Table C-4. Summery Statistics

Variables	Non-participants (17,157, 69.36%)			Salaried labor-force participants (7,578, 30.64%)			
	Inactive (75.28%)	Self-employed (24.72%)	Non-participants all	Unemployed (9.37%)	Part-time (55.08%)	Full-time (35.55%)	Participants all
Age	51.80	53.49	52.22	48.04	50.73	46.94	49.13
Gender							
Male	0.54	0.78	0.60	0.75	0.68	0.82	0.74
Female	0.46	0.22	0.40	0.25	0.32	0.18	0.26
Marital status							
Married/have a partner	0.47	0.81	0.56	0.48	0.63	0.74	0.65
Single	0.53	0.19	0.44	0.52	0.37	0.26	0.35
Education							
Less than high school	0.61	0.62	0.61	0.46	0.56	0.26	0.44
High school	0.33	0.31	0.32	0.41	0.36	0.45	0.40
College or more	0.06	0.07	0.06	0.13	0.09	0.29	0.16
Household size	2.48	2.94	2.60	2.82	2.96	3.28	3.06
Health condition							
Bad	0.74	0.54	0.69	0.50	0.47	0.31	0.41
Good	0.26	0.46	0.31	0.50	0.53	0.69	0.59
Disability Status							
Severe	0.59	0.25	0.51	0.35	0.28	0.21	0.26
Non-severe	0.41	0.75	0.49	0.65	0.72	0.79	0.74
Home-ownership							
Own	0.36	0.72	0.45	0.43	0.50	0.63	0.54
Rent	0.64	0.28	0.55	0.57	0.50	0.37	0.46
Father's job status at age 14							
Salaried	0.27	0.15	0.24	0.35	0.25	0.30	0.72
The rest	0.73	0.85	0.76	0.65	0.75	0.70	0.28
Non-labor financial income	4.25	6.22	4.74	0.35	1.88	8.79	4.19
Observation	12,915	4,242	17,157	710	4,174	2,694	7,578

Note: For age, household size, and non-labor financial income, the figures refer to sample mean. All the rest are percentage in each category.

Table C-5. Parameter Estimates for a Full Sample Model

Variables	Employment Outcome		Salaried Labor Force Participation	
	Estimate	SE	Estimate	SE
Age	–0.020***	0.004	–0.020***	0.003
Male	0.310***	0.057	0.305***	0.049
Married	0.294***	0.072	0.115**	0.055
High school	0.200***	0.068	0.472***	0.092
College degree or more	0.693***	0.110	0.097*	0.058
Household size	0.022	0.026	0.050**	0.022
Bad health	–0.438***	0.046	–0.469***	0.040
Home-ownership	0.207***	0.061	0.091*	0.049
Severely disabled	–0.613***	0.071	–0.591***	0.058
Severely disabled *Year				
Severely disabled*2009	–0.011	0.058	–0.017	0.047
Severely disabled*2010	0.033	0.073	–0.039	0.053
Severely disabled*2011	–0.038	0.093	–0.108*	0.065
Severely disabled*2012	–0.007	0.078	–0.102*	0.059
Severely disabled*2013	0.113	0.086	–0.054	0.063
Severely disabled*2014	0.125	0.088	–0.053	0.066
Severely disabled*2015	0.173*	0.100	–0.077	0.066
Year				
2009	0.018	0.039	–0.060*	0.033
2010	0.057	0.051	–0.038	0.042
2011	0.208***	0.052	0.075*	0.040
2012	0.246***	0.040	0.033	0.037
2013	0.173***	0.044	0.020	0.040
2014	0.157***	0.051	0.002	0.046
2015	0.163***	0.056	0.065	0.047
Father salaried at age 14			0.076**	0.038
Financial income/1000			–0.585**	0.236
Province economic growth rate	0.005	0.006	0.000	0.004
Province unemployment rate	0.031	0.039	0.057*	0.032
Cutoff point 1			–0.345	0.303
Cutoff point 2			0.771	0.282
Constant			0.356	0.227
Correlation coefficient			0.901***	0.078
Log-likelihood	–22,159.654			
N=24,735				

Note: *Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Estimates for province dummies are suppressed. Standard errors are clustered at the individual level. The intercept of the outcome equation is normalized to zero.

Table C-6. Average Partial Effects for a Full Sample Model

Variables	Employment outcome						Salaried Labor Force Participation	
	Unemployed		Part-time		Full-time			
	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Age	0.006***	0.001	–0.003***	0.001	–0.004***	0.001	–0.006***	0.001
Male	–0.104***	0.020	0.047***	0.010	0.057***	0.010	0.099***	0.016
Married	–0.099***	0.025	0.043***	0.012	0.055***	0.013	0.032*	0.019
High school	–0.067***	0.023	0.028***	0.010	0.039***	0.014	0.037**	0.018
College degree or more	–0.233***	0.033	0.065***	0.008	0.168***	0.033	0.161***	0.032
Household size	–0.007	0.008	0.003	0.004	0.004	0.005	0.016**	0.007
Bad health	0.151***	0.015	–0.065***	0.007	–0.086***	0.009	–0.159***	0.014
Home-ownership	–0.069***	0.021	0.030***	0.009	0.040***	0.012	0.029*	0.016
Severely disabled	0.192***	0.021	–0.088***	0.011	–0.104***	0.011	–0.214***	0.016
-2008	0.203***	0.024	–0.106***	0.016	–0.097***	0.010	–0.196***	0.019
-2009	0.207***	0.023	–0.107***	0.015	–0.100***	0.011	–0.197***	0.018
-2010	0.195***	0.023	–0.096***	0.013	–0.099***	0.012	–0.205***	0.018
-2011	0.223***	0.032	–0.098***	0.017	–0.125***	0.017	–0.233***	0.023
-2012	0.213***	0.026	–0.089***	0.013	–0.125***	0.014	–0.228***	0.019
-2013	0.172***	0.028	–0.073***	0.014	–0.099***	0.015	–0.213***	0.020
-2014	0.169***	0.029	–0.072***	0.014	–0.096***	0.015	–0.212***	0.020
-2015	0.153***	0.033	–0.063***	0.016	–0.089***	0.018	–0.223***	0.021
Year								
2009	–0.004	0.011	0.002	0.006	0.003	0.006	–0.021**	0.009
2010	–0.023	0.017	0.011	0.008	0.011	0.009	–0.017	0.012
2011	–0.063***	0.017	0.026***	0.009	0.037***	0.009	0.011	0.011
2012	–0.080***	0.015	0.034***	0.008	0.046***	0.008	–0.002	0.010
2013	–0.072***	0.016	0.034***	0.009	0.038***	0.008	0.000	0.011
2014	–0.068***	0.019	0.033***	0.010	0.035***	0.010	–0.006	0.013
2015	–0.077***	0.020	0.038***	0.011	0.040***	0.010	0.012	0.014
Father salaried at age 14							0.025**	0.012
Financial income/1000							–0.190**	0.076
Province economic growth rate	–0.002	0.002	0.001	0.001	0.001	0.001	0.000	0.001
Province unemployment rate	–0.010	0.013	0.004	0.005	0.006	0.008	0.019*	0.010
N=24,735								

Note: *Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Estimates for province dummies are suppressed. Standard errors are clustered at the individual level.

Table C-7. Parameter Estimates for a Male Sample Model

Variables	Employment Outcome		Salaried Labor Force Participation	
	Estimate	SE	Estimate	SE
Age	–0.024***	0.005	–0.022***	0.004
Married	0.485***	0.093	0.165**	0.075
High school	0.237***	0.082	0.089	0.064
College degree or more	0.718***	0.118	0.447***	0.100
Household size	0.017	0.031	0.062**	0.027
Bad health	–0.451***	0.058	–0.502***	0.048
Home-ownership	0.258***	0.075	0.101*	0.058
Severely disabled	–0.529***	0.090	–0.537***	0.070
Severely disabled *Year				
Severely disabled*2009	0.019	0.070	–0.023	0.056
Severely disabled*2010	0.039	0.088	–0.060	0.063
Severely disabled*2011	0.012	0.113	–0.044	0.078
Severely disabled*2012	0.022	0.091	–0.078	0.070
Severely disabled*2013	0.183*	0.104	–0.040	0.075
Severely disabled*2014	0.222**	0.102	–0.016	0.077
Severely disabled*2015	0.269**	0.113	–0.019	0.079
Year				
2009	0.020	0.048	–0.035	0.039
2010	0.044	0.067	–0.022	0.050
2011	0.179***	0.062	0.049	0.048
2012	0.270***	0.050	0.039	0.045
2013	0.178***	0.056	0.025	0.047
2014	0.202***	0.065	0.024	0.055
2015	0.193***	0.072	0.084	0.057
Father salaried at age 14			0.090*	0.051
Financial income/1000			–0.506*	0.274
Province economic growth rate	0.006	0.007	–0.001	0.005
Province unemployment rate	0.014	0.050	0.032	0.037
Cutoff point 1			–0.891	0.366
Cutoff point 2			0.355	0.345
Constant			0.781***	0.266
Correlation coefficient			0.810***	0.114
Log-likelihood	–16,193.000			
N=15,862				

Note: *Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Estimates for province dummies are suppressed. Standard errors are clustered at the individual level. The intercept of the outcome equation is normalized to zero.

Table C-8. Average Partial Effects for a Male Sample Model

Variables	Employment outcome						Salaried Labor Force Participation	
	Unemployed		Part-time		Full-time			
	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Age	0.008***	0.002	–0.002***	0.001	–0.006***	0.001	–0.007***	0.001
Married	–0.165***	0.030	0.058***	0.013	0.107***	0.022	0.056**	0.026
High school	–0.079***	0.026	0.024***	0.008	0.055***	0.020	0.030	0.022
College degree or more	–0.225***	0.031	0.026	0.028	0.199***	0.040	0.156***	0.035
Household size	–0.005	0.010	0.002	0.003	0.004	0.007	0.021**	0.009
Bad health	0.154***	0.024	–0.049***	0.015	–0.105***	0.013	–0.177***	0.017
Home-ownership	–0.087***	0.024	0.028***	0.008	0.059***	0.018	0.034*	0.020
Severely disabled	0.148***	0.033	–0.052***	0.018	–0.096***	0.017	–0.198***	0.020
-2008	0.182***	0.030	–0.081***	0.017	–0.101***	0.015	–0.186***	0.023
-2009	0.176***	0.033	–0.076***	0.019	–0.100***	0.016	–0.192***	0.023
-2010	0.169***	0.035	–0.070***	0.019	–0.099***	0.017	–0.204***	0.023
-2011	0.176***	0.047	–0.061**	0.025	–0.116***	0.025	–0.202***	0.029
-2012	0.171***	0.039	–0.048**	0.023	–0.122***	0.020	–0.212***	0.024
-2013	0.117***	0.042	–0.034*	0.020	–0.083***	0.024	–0.200***	0.025
-2014	0.103**	0.041	–0.027	0.018	–0.076***	0.025	–0.192***	0.025
-2015	0.087**	0.044	–0.022	0.017	–0.065**	0.028	–0.195***	0.027
Year								
2009	–0.009	0.014	0.004	0.006	0.005	0.009	–0.015	0.011
2010	–0.020	0.022	0.009	0.009	0.011	0.013	–0.015	0.015
2011	–0.061***	0.020	0.022**	0.009	0.039***	0.013	0.011	0.013
2012	–0.092***	0.016	0.030***	0.007	0.061***	0.012	0.003	0.013
2013	–0.085***	0.018	0.034***	0.007	0.051***	0.013	0.003	0.014
2014	–0.098***	0.021	0.039***	0.008	0.060***	0.015	0.006	0.016
2015	–0.102***	0.022	0.041***	0.008	0.061***	0.016	0.026	0.017
Father salaried at age 14							0.031*	0.018
Financial income/1000							–0.172*	0.093
Province economic growth rate	–0.002	0.002	0.001	0.001	0.001	0.002	0.000	0.002
Province unemployment rate	–0.005	0.017	0.001	0.005	0.003	0.012	0.011	0.012
N=15,862								

Note: *Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Estimates for province dummies are suppressed. Standard errors are clustered at the individual level.

Table C-9. Parameter Estimates for a Female Sample Model

Variables	Employment Outcome		Salaried Labor Force Participation	
	Estimate	SE	Estimate	SE
Age	0.011	0.007	–0.017***	0.006
Married	0.007	0.108	–0.025	0.093
High school	0.014	0.104	0.160*	0.097
College degree or more	0.237	0.200	0.356**	0.165
Household size	–0.028	0.045	0.024	0.037
Bad health	0.116	0.099	–0.404***	0.071
Home-ownership	0.040	0.095	0.077	0.086
Severely disabled	0.211	0.216	–0.658***	0.111
Severely disabled *Year				
Severely disabled*2009	–0.089	0.188	–0.015	0.096
Severely disabled*2010	0.017	0.191	–0.005	0.103
Severely disabled*2011	0.215	0.191	–0.272**	0.117
Severely disabled*2012	0.257	0.192	–0.182	0.111
Severely disabled*2013	0.179	0.188	–0.117	0.115
Severely disabled*2014	0.200	0.223	–0.159	0.129
Severely disabled*2015	0.388*	0.223	–0.259**	0.127
Year				
2009	0.146	0.096	–0.097	0.064
2010	0.118	0.111	–0.064	0.078
2011	0.098	0.112	0.115*	0.067
2012	0.094	0.099	0.043	0.067
2013	0.062	0.096	0.033	0.073
2014	0.033	0.106	–0.021	0.082
2015	–0.002	0.115	0.058	0.089
Father salaried at age 14			0.090	0.078
Financial income/1000			–3.421*	1.794
Province economic growth rate	0.004	0.011	0.002	0.007
Province unemployment rate	–0.063	0.083	0.119*	0.063
Cutoff point 1			–1.447	0.569
Cutoff point 2			–0.029	0.541
Constant			0.132	0.424
Correlation coefficient			–0.918***	0.079
Log-likelihood	–5,747.433			
N=8,873				

Note: *Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Estimates for province dummies are suppressed. Standard errors are clustered at the individual level. The intercept of the outcome equation is normalized to zero.

Table C-10. Average Partial Effects for a Female Sample Model

Variables	Employment outcome						Salaried Labor Force Participation	
	Unemployed		Part-time		Full-time			
	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Age	–0.001	0.000	–0.003	0.002	0.004	0.002	–0.005***	0.002
Married	0.000	0.006	–0.002	0.029	0.002	0.035	–0.007	0.027
High school	–0.001	0.006	–0.004	0.028	0.005	0.033	0.047	0.029
College degree or more	–0.011	0.008	–0.060	0.054	0.071	0.061	0.111**	0.054
Household size	0.002	0.003	0.007	0.012	–0.009	0.015	0.007	0.011
Bad health	–0.007	0.005	–0.031	0.024	0.038	0.030	–0.123***	0.022
Home-ownership	–0.002	0.005	–0.010	0.026	0.013	0.031	0.022	0.025
Severely disabled	–0.018**	0.008	–0.096***	0.032	0.114***	0.039	–0.229***	0.024
-2008	–0.014	0.013	–0.059	0.055	0.073	0.068	–0.199***	0.031
-2009	–0.007	0.013	–0.033	0.068	0.040	0.081	–0.191***	0.029
-2010	–0.012	0.009	–0.062	0.044	0.074	0.052	–0.193***	0.028
-2011	–0.020**	0.009	–0.111***	0.041	0.131***	0.050	–0.275***	0.035
-2012	–0.021***	0.007	–0.121***	0.034	0.142***	0.040	–0.245***	0.030
-2013	–0.020***	0.008	–0.104***	0.035	0.125***	0.042	–0.230***	0.031
-2014	–0.022**	0.010	–0.110**	0.050	0.133**	0.059	–0.232***	0.031
-2015	–0.029***	0.008	–0.156***	0.037	0.185***	0.042	–0.264***	0.031
Year								
2009	–0.007	0.006	–0.029	0.026	0.036	0.032	–0.030*	0.016
2010	–0.008	0.007	–0.035	0.032	0.042	0.039	–0.020	0.020
2011	–0.010	0.008	–0.052	0.038	0.062	0.045	0.005	0.018
2012	–0.010	0.007	–0.056	0.036	0.066	0.043	–0.007	0.017
2013	–0.008	0.007	–0.039	0.033	0.046	0.039	–0.003	0.019
2014	–0.006	0.007	–0.033	0.035	0.040	0.042	–0.023	0.022
2015	–0.007	0.008	–0.045	0.041	0.052	0.049	–0.010	0.024
Father salaried at age 14							0.027	0.023
Financial income/1000							–0.993*	0.522
Province economic growth rate	0.000	0.001	–0.001	0.003	0.001	0.004	0.000	0.002
Province unemployment rate	0.003	0.005	0.017	0.022	–0.020	0.027	0.034*	0.018
N=8,873								

Note: *Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Estimates for province dummies are suppressed. Standard errors are clustered at the individual level.

Table C-11. Robustness: Parameter Estimates for a Full Sample Model

Variables	Employment Outcome		Salaried Labor Force Participation	
	Estimate	SE	Estimate	SE
Age	–0.019***	0.004	–0.020***	0.003
Male	0.310***	0.058	0.304***	0.049
Married	0.296***	0.071	0.097*	0.058
High school	0.202***	0.068	0.113**	0.055
College degree or more	0.697***	0.110	0.470***	0.091
Household size	0.022	0.026	0.050**	0.022
Bad health	–0.437***	0.046	–0.469***	0.040
Home-ownership	0.208***	0.061	0.090*	0.048
Severely disabled	–72.264	71.145	73.323	45.858
Severely disabled *Year				
Severely disabled*2011	–0.113	0.095	–0.019	0.066
Severely disabled*2012	–0.117	0.113	0.023	0.076
Severely disabled*2013	–0.032	0.147	0.108	0.099
Severely disabled*2014	–0.056	0.180	0.146	0.121
Severely disabled*2015	–0.042	0.215	0.158	0.147
Year				
2011	0.183***	0.044	0.110***	0.034
2012	0.227***	0.032	0.068**	0.029
2013	0.152***	0.037	0.053	0.033
2014	0.130***	0.039	0.040	0.034
2015	0.137***	0.045	0.105***	0.037
Severely disabled*Linear trend	0.036	0.035	–0.037	0.023
Father salaried at age 14			0.076**	0.038
Financial income/1000			–0.586**	0.238
Province economic growth rate	0.009***	0.003	0.001	0.003
Province unemployment rate	0.041	0.035	0.044	0.028
Cutoff point 1			–0.323	0.295
Cutoff point 2			0.806	0.273
Constant			0.378*	0.221
Correlation coefficient			0.894***	0.079
Log-likelihood	–22,162.096			
N=24,735				

Note: *Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Estimates for province dummies are suppressed. Standard errors are clustered at the individual level. The intercept of the outcome equation is normalized to zero.

Table C-12. Robustness: Average Partial Effects for a Full Sample Model

Variables	Employment outcome						Salaried Labor Force Participation	
	Unemployed		Part-time		Full-time			
	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Age	0.006***	0.001	–0.003***	0.001	–0.004***	0.001	–0.006***	0.001
Male	–0.104***	0.020	0.047***	0.010	0.057***	0.010	0.099***	0.016
Married	–0.100***	0.025	0.044***	0.012	0.056***	0.013	0.032*	0.019
High school	–0.068***	0.023	0.028***	0.010	0.040***	0.014	0.037**	0.018
College degree or more	–0.234***	0.032	0.065***	0.008	0.169***	0.033	0.160***	0.032
Household size	–0.007	0.008	0.003	0.004	0.004	0.005	0.016**	0.007
Bad health	0.151***	0.016	–0.065***	0.007	–0.086***	0.009	–0.159***	0.014
Home-ownership	–0.070***	0.021	0.030***	0.009	0.040***	0.012	0.029*	0.016
Severely disabled	0.609***	0.013	–0.097***	0.011	–0.512***	0.005	0.405***	0.008
-2008–2010	0.596***	0.017	–0.096***	0.013	–0.501***	0.007	0.403***	0.010
-2011	0.623***	0.018	–0.100***	0.012	–0.523***	0.009	0.391***	0.011
-2012	0.626***	0.014	–0.099***	0.009	–0.527***	0.007	0.400***	0.009
-2013	0.610***	0.016	–0.095***	0.011	–0.515***	0.007	0.412***	0.010
-2014	0.612***	0.020	–0.097***	0.014	–0.515***	0.008	0.417***	0.012
-2015	0.611***	0.023	–0.096***	0.015	–0.515***	0.010	0.414***	0.015
Year								
2011	–0.045***	0.015	0.016**	0.008	0.029***	0.008	0.033***	0.010
2012	–0.060***	0.017	0.022**	0.010	0.038***	0.008	0.025**	0.011
2013	–0.046**	0.022	0.019	0.012	0.027***	0.010	0.030**	0.014
2014	–0.036	0.024	0.014	0.015	0.022**	0.010	0.030**	0.015
2015	–0.040	0.029	0.016	0.017	0.024*	0.012	0.054***	0.019
Severely disabled*Linear trend	–0.012	0.012	0.005	0.005	0.007	0.007	–0.012	0.007
Father salaried at age 14							0.025**	0.013
Financial income/1000							–0.190**	0.077
Province economic growth rate	–0.003***	0.001	0.001***	0.000	0.002***	0.001	0.000	0.001
Province unemployment rate	–0.014	0.011	0.006	0.005	0.008	0.007	0.014	0.009
N=24,735								

Note: *Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Estimates for province dummies are suppressed. Standard errors are clustered at the individual level.

Table C-13. Robustness: Parameter Estimates for a Male Sample Model

Variables	Employment Outcome		Salaried Labor Force Participation	
	Estimate	SE	Estimate	SE
Age	–0.024***	0.005	–0.022***	0.004
Married	0.486***	0.093	0.165**	0.075
High school	0.238***	0.082	0.089	0.064
College degree or more	0.720***	0.118	0.446***	0.099
Household size	0.016	0.031	0.062**	0.027
Bad health	–0.450***	0.059	–0.502***	0.048
Home-ownership	0.259***	0.074	0.100*	0.058
Severely disabled	–69.659	86.203	80.420	54.123
Severely disabled *Year				
Severely disabled*2011	–0.074	0.119	0.062	0.074
Severely disabled*2012	–0.099	0.142	0.069	0.089
Severely disabled*2013	0.029	0.185	0.147	0.118
Severely disabled*2014	0.033	0.222	0.211	0.145
Severely disabled*2015	0.046	0.270	0.248	0.176
Year				
2011	0.158***	0.053	0.068*	0.040
2012	0.253***	0.041	0.058	0.036
2013	0.160***	0.048	0.043	0.040
2014	0.179***	0.050	0.046	0.042
2015	0.169***	0.059	0.107**	0.046
Severely disabled*Linear trend	0.034	0.043	–0.040	0.027
Father salaried at age 14			0.090*	0.052
Financial income/1000			–0.506*	0.275
Province economic growth rate	0.009**	0.004	0.000	0.003
Province unemployment rate	0.025	0.044	0.024	0.033
Cutoff point 1			–0.865	0.353
Cutoff point 2			0.389	0.330
Constant			0.794***	0.259
Correlation coefficient			0.805***	0.114
Log-likelihood	–16,193.639			
N=15,862				

Note: *Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Estimates for province dummies are suppressed. Standard errors are clustered at the individual level. The intercept of the outcome equation is normalized to zero.

Table C-14. Robustness: Average Partial Effects for a Male Sample Model

Variables	Employment outcome						Salaried Labor Force Participation	
	Unemployed		Part-time		Full-time			
	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Age	0.008***	0.002	–0.002***	0.001	–0.006***	0.001	–0.007***	0.001
Married	–0.165***	0.030	0.058***	0.013	0.107***	0.022	0.056**	0.026
High school	–0.079***	0.026	0.024***	0.008	0.055***	0.020	0.030	0.022
College degree or more	–0.225***	0.031	0.025	0.029	0.200***	0.040	0.156***	0.035
Household size	–0.005	0.010	0.002	0.003	0.004	0.007	0.021**	0.009
Bad health	0.154***	0.024	–0.049***	0.016	–0.105***	0.013	–0.177***	0.017
Home-ownership	–0.087***	0.024	0.027***	0.008	0.059***	0.018	0.034*	0.020
Severely disabled	0.615***	0.013	–0.103***	0.007	–0.512***	0.008	0.404***	0.010
-2008–2010	0.609***	0.020	–0.107***	0.012	–0.501***	0.010	0.397***	0.012
-2011	0.627***	0.021	–0.106***	0.010	–0.521***	0.013	0.398***	0.014
-2012	0.634***	0.014	–0.101***	0.007	–0.533***	0.010	0.400***	0.012
-2013	0.612***	0.018	–0.098***	0.009	–0.514***	0.011	0.411***	0.013
-2014	0.612***	0.022	–0.097***	0.010	–0.516***	0.013	0.420***	0.015
-2015	0.610***	0.028	–0.096***	0.013	–0.514***	0.017	0.420***	0.019
Year								
2011	–0.042**	0.019	0.012	0.009	0.030***	0.012	0.031**	0.012
2012	–0.069***	0.022	0.018	0.012	0.051***	0.012	0.028**	0.014
2013	–0.057**	0.029	0.019	0.015	0.038**	0.015	0.033*	0.017
2014	–0.064***	0.032	0.021	0.017	0.043***	0.017	0.042**	0.020
2015	–0.063*	0.038	0.021	0.020	0.042**	0.020	0.068***	0.024
Severely disabled*Linear trend	–0.011	0.014	0.003	0.004	0.008	0.010	–0.014	0.010
Father salaried at age 14							0.031*	0.018
Financial income/1000							–0.172*	0.093
Province economic growth rate	–0.003**	0.001	0.001**	0.000	0.002**	0.001	0.000	0.001
Province unemployment rate	–0.008	0.014	0.002	0.004	0.006	0.010	0.008	0.011
N=15,862								

Note: *Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Estimates for province dummies are suppressed. Standard errors are clustered at the individual level.

Table C-15. Robustness Check: Parameter Estimates for a Female Sample Model

Variables	Employment Outcome		Salaried Labor Force Participation	
	Estimate	SE	Estimate	SE
Age	0.011	0.007	–0.017***	0.006
Married	0.004	0.107	–0.025	0.093
High school	0.014	0.104	0.160*	0.096
College degree or more	0.232	0.197	0.356**	0.165
Household size	–0.027	0.045	0.024	0.037
Bad health	0.118	0.098	–0.402***	0.070
Home-ownership	0.037	0.094	0.077	0.086
Severely disabled	–120.018	175.814	61.305	91.569
Severely disabled *Year				
Severely disabled*2011	0.129	0.219	–0.211	0.131
Severely disabled*2012	0.112	0.267	–0.090	0.150
Severely disabled*2013	–0.025	0.331	0.006	0.191
Severely disabled*2014	–0.063	0.419	–0.006	0.229
Severely disabled*2015	0.063	0.506	–0.075	0.284
Year				
2011	0.000	0.087	0.173***	0.052
2012	0.002	0.072	0.100*	0.051
2013	–0.029	0.071	0.087	0.057
2014	–0.070	0.070	0.041	0.058
2015	–0.108	0.081	0.124*	0.065
Severely disabled*Linear trend	0.060	0.087	–0.031	0.046
Father salaried at age 14			0.091	0.077
Financial income/1000			–3.441*	1.777
Province economic growth rate	0.004	0.008	0.005	0.005
Province unemployment rate	–0.031	0.076	0.096*	0.056
Cutoff point 1			–1.390	0.556
Cutoff point 2			0.018	0.529
Constant			0.165	0.413
Correlation coefficient			–0.922***	0.073
Log-likelihood	–5,748.889			
N=8,873				

Note: *Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Estimates for province dummies are suppressed. Standard errors are clustered at the individual level. The intercept coefficient of the outcome equation is normalized to zero.

Table C-16. Robustness: Average Partial Effects for a Female Sample Model

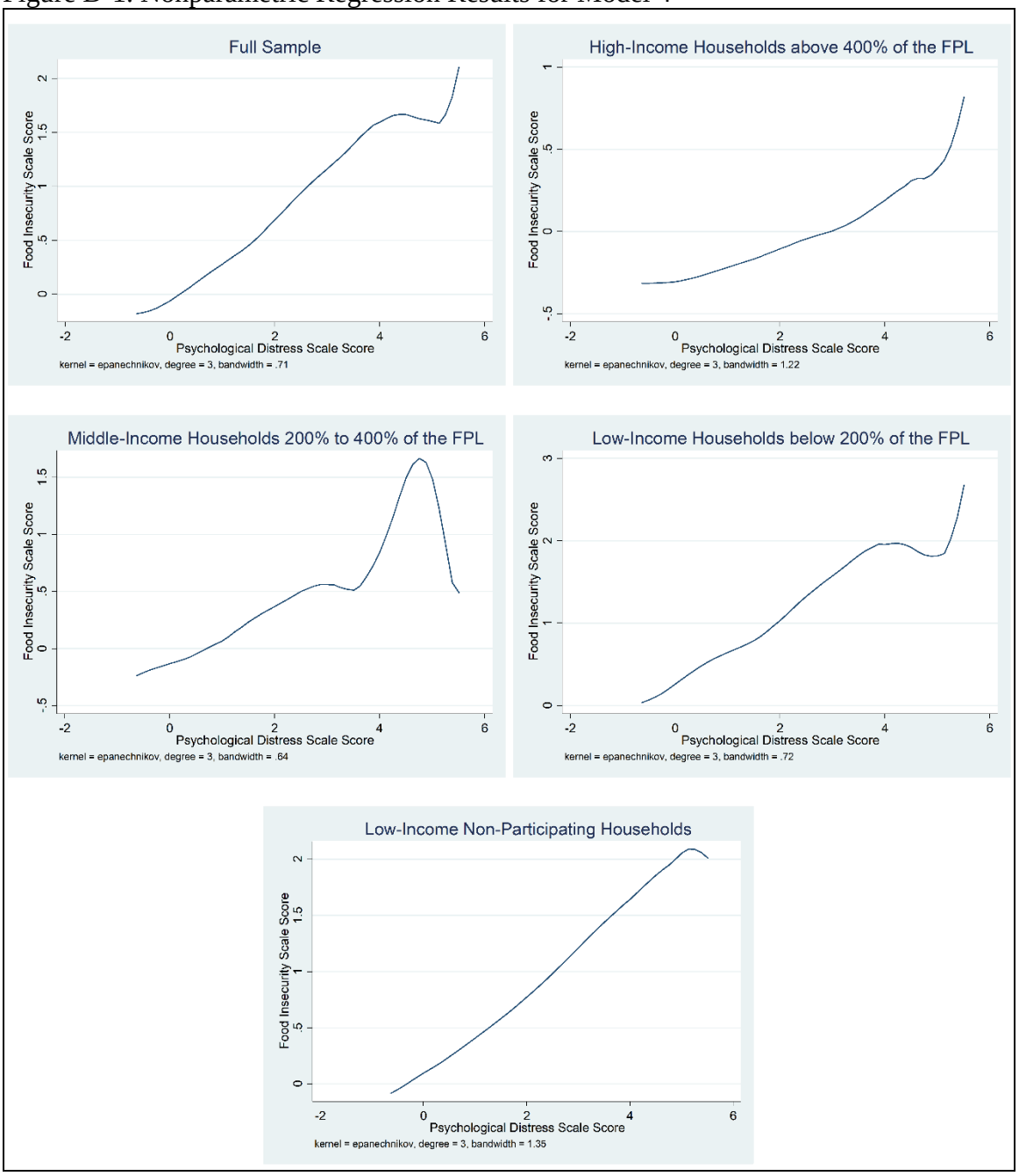
Variables	Employment outcome						Salaried Labor Force Participation	
	Unemployed		Part-time		Full-time			
	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Age	–0.001	0.000	–0.003	0.002	0.004	0.002	–0.005***	0.002
Married	0.000	0.006	–0.001	0.028	0.001	0.034	–0.007	0.027
High school	–0.001	0.006	–0.004	0.027	0.004	0.033	0.047	0.029
College degree or more	–0.011	0.007	–0.059	0.052	0.069	0.059	0.111**	0.054
Household size	0.001	0.002	0.007	0.012	-0.008	0.015	0.007	0.011
Bad health	–0.007	0.005	–0.031	0.024	0.038	0.029	–0.122***	0.022
Home-ownership	–0.002	0.005	–0.010	0.025	0.012	0.030	0.022	0.025
Severely disabled	0.528***	0.004	–0.060***	0.013	–0.467***	0.016	0.411***	0.012
-2008–2010	0.529***	0.004	–0.056**	0.027	–0.473***	0.030	0.421***	0.016
-2011	0.527***	0.004	–0.070***	0.019	–0.457***	0.022	0.385***	0.018
-2012	0.527***	0.004	–0.068***	0.016	–0.459***	0.020	0.404***	0.015
-2013	0.529***	0.005	–0.054**	0.021	–0.474***	0.027	0.415***	0.016
-2014	0.529***	0.008	–0.051	0.034	–0.478***	0.042	0.417***	0.019
-2015	0.525***	0.008	–0.067*	0.038	–0.458***	0.046	0.403***	0.023
Year								
2011	–0.002	0.005	–0.014	0.030	0.016	0.035	0.029*	0.016
2012	–0.002	0.005	–0.013	0.033	0.015	0.039	0.020	0.019
2013	0.002	0.007	0.011	0.040	–0.013	0.046	0.026	0.023
2014	0.005	0.009	0.026	0.050	–0.031	0.060	0.011	0.025
2015	0.005	0.010	0.021	0.059	–0.026	0.069	0.028	0.031
Severely disabled*Linear trend	–0.003	0.005	–0.016	0.023	0.019	0.029	–0.009	0.013
Father salaried at age 14							0.027	0.023
Financial income/1000							–0.999*	0.517
Province economic growth rate	0.000	0.000	–0.001	0.002	0.001	0.002	0.001	0.001
Province unemployment rate	0.002	0.004	0.008	0.020	–0.010	0.024	0.028*	0.016
N=8,873								

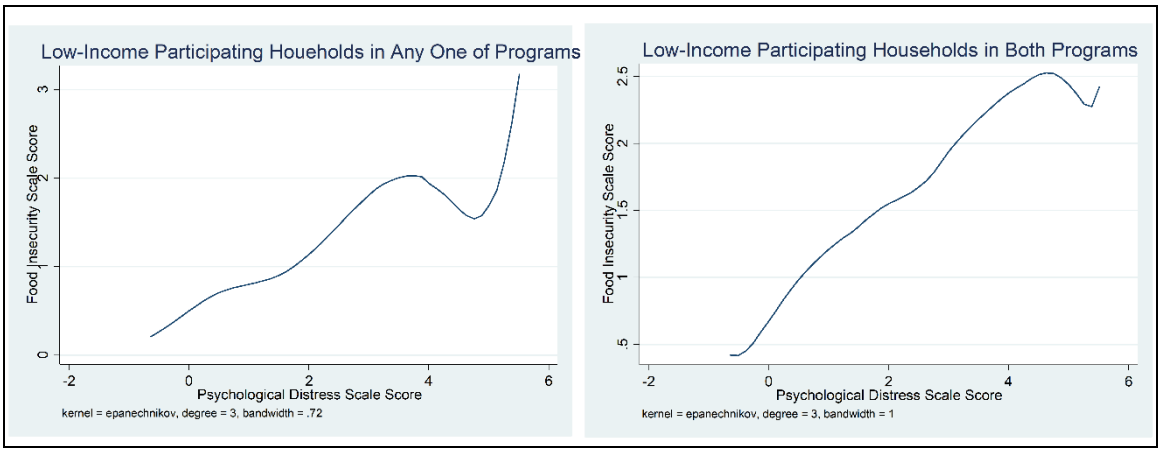
Note: *Statistically significant at≤ 10%, **sig at≤ 5%, and *** sig at≤ 1% level of significance. Estimates for province dummies are suppressed. Standard errors are clustered at the individual level.

APPENDIX D

FIGURES FOR SECTION 2

Figure D-1. Nonparametric Regression Results for Model 4




Low-Income Participating Houeholds in Any One of Programs
Food Insecurity Scale Score
0
1
2
3
-2
0
2
4
6
Psychological Distress Scale Score
kernel = epanechnikov, degree = 3, bandwidth = .72
Low-Income Participating Households in Both Programs
Food Insecurity Scale Score
.5
1
1.5
2
2.5
-2
0
2
4
6
Psychological Distress Scale Score
kernel = epanechnikov, degree = 3, bandwidth = 1