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Abstract

Although the Food Stamp Program is the largest entitlement program remaining in the social safety net, comparatively little is known about the potential benefits that the program may confer on recipients. In this paper we examine an important dimension of well being, mental health, and the extent to which participation in the Food Stamp Program may attenuate the effect of food insufficiency on levels of emotional distress. Using longitudinal data from a nationally representative sample of families in the Panel Study of Income Dynamics (PSID) we model emotional distress as a function of food insufficiency and other known risk factors for poor mental health. We allow participation in the Food Stamp Program to have a direct impact on mental health, and then test whether food stamp participation mediates the effect of food insufficiency on emotional distress. To conduct our tests we use a first-difference instrumental variables estimator to control for unobserved heterogeneity in emotional distress and possible measurement error in Food Stamp Program participation. We find that food insufficiency has a sizable deleterious effect on the level of emotional distress, as does participation in the Food Stamp Program. However, we also find that participation in the Food Stamp Program among food insufficient households nearly eliminates the deleterious effect of food insufficiency on emotional health, suggesting that the program is well targeted to those in need of food assistance and improved mental health. This research provides the first evidence that the Food Stamp Program has an important positive spill-over effect on mental health through its mediation of household food insufficiency.

Key Words: Emotional Distress, Food Assistance, Instrumental Variables

Mental health problems are of great social, economic, and policy concern. A recent review estimated that every year, five to six million workers in the United States lose, fail to seek, or fail to obtain employment because of psychiatric disorders; in addition, mental illness decreases annual income by $3500-$6000 (Marcotte and Wilcox-Gok, 2001). Psychiatric disorders such as depression and anxiety are higher in women than men, lower in blacks and higher in Hispanics compared to whites, and are inversely related to educational level and income (Kessler et al. 1994). High rates of food insecurity, food insufficiency, and hunger are also a significant problem in the United States (Alaimo et al., 1998; Nord et al., 2005). It is currently estimated that more than 38.2 million people lived in food insecure households, meaning that at some time during the previous year, they were unable to acquire or were uncertain of having enough food to meet basic needs due to inadequate household resources (Nord et al., 2005). Rates of food insecurity are substantially higher among those in households with incomes below the poverty line (36.8%) and in households with children headed by a single woman (33.0%).

While there has been some research on the links between food insufficiency and mental health (Campbell 1991; Corcoran, Heflin and Siefert 1999; Olsen 1999; Siefert et al. 2000, 2001, 2002), none to date has been conducted on the general population and none has examined the impact of policy interventions on the relationship between food insufficiency and mental health.[1] The latter omission is particularly surprising in light of the fundamental changes to the social safety net over the past decade. As part of the 1996 Welfare Reform Act the primary cash assistance program for low-income families, Aid to Families with Dependent Children, was abolished and replaced by the Temporary Assistance for Needy Families Program (TANF).

[1] We use the term "food insufficiency" here in the narrow sense to distinguish restricted household food stores or too little food intake among adults or children in the household. "Food insecurity" includes those who are food insufficient in addition to those who are anxious about meeting their household's food consumption through culturally normalized means, along with various attempts to limit, augment, or stretch the food supply (Scott and Wehler, 1998).

TANF, which provides time limited cash assistance for single mothers who fulfill work requirements, is funded as a block grant to states and is no longer an entitlement. The Food Stamp Program, which provides food assistance to low-income and low-asset families and individuals, was also affected by the 1996 welfare reforms—access was limited for recent immigrants to the United States and for able-bodied adults without children. While the Food Stamp Program largely retained its entitlement status, the U.S. Congress has in recent years considered converting the program to a block grant to states much like TANF. These changes in the safety net are being made without the aid of research to suggest what the possible unintended consequences of reforming the programs might be on many dimensions of well being, including mental health (Blank 2003).

In this paper we begin to fill this gap in the literature by examining the extent to which participation in the Food Stamp Program mediates the relationship between food insufficiency and mental health. The Food Stamp Program, which in fiscal year 2003 had over 21 million participants and appropriations over $21 billion, may improve health outcomes by allowing low-income populations to purchase a larger (and potentially improved) bundle of food, thereby reducing unmet food need and in turn improving mental health. Using longitudinal data from the 2001 and 2003 waves of the Panel Study of Income Dynamics, we test whether and to what extent participation in the Food Stamp Program attenuates the effect of food insufficiency on emotional distress, controlling for other known risk factors for poor mental health. A key advantage of the PSID is that to our knowledge this is the first analysis of its kind to examine the effect of food insufficiency on mental health using data from a representative sample of the U.S. population, and the first analysis to examine the interaction of public policy on the links between unmet food need and mental distress.

Using a first-difference instrumental variables estimator to address unmeasured heterogeneity and measurement error, we find that food insufficiency has a strong and deleterious effect on mental health, as does participation in the Food Stamp Program. However, we also find that Food Stamp Program participation among food insufficient households nearly eliminates the deleterious effect of food insufficiency on emotional health, suggesting that the program is well targeted to those in need of food assistance and improved mental health. This research provides the first evidence that the Food Stamp Program has an important positive spill-over effect on mental health through its mediation of household food insufficiency.

II. Links Between Food Insufficiency and Mental Health

There are several potential pathways whereby household food insufficiency could have a detrimental effect on the mental health of the household head. We draw on two main theoretical traditions. The first is sometimes termed the neomaterial view. Here, food insufficiency could have a negative impact on mental health through a direct effect of nutritional shortfalls or reductions in positive health behaviors (Bhattacharya, Currie, and Haider 2004; Lynch et al. 2000). For example, research has documented that even the early stages of nutrient deficiency can have adverse effects on behavior and mental performance. In an experimental study of 1,081 young men in good health, Heseker and his colleagues (1992) found that reduced vitamin intake over a two-month period was associated with negative changes in psychological disposition and functioning. Specifically, inadequate vitamin intake was associated with increased irritability, nervousness, depression, feelings of fear and decreased well-being, and memory and reaction performance. Importantly, providing the subjects with vitamin supplements reversed several of these adverse effects. Bhattacharya, Currie, and Haider (2004), using data from the National Health and Nutrition Examination Survey III, find that heightened food insecurity does

exacerbate nutritional shortfalls among adults, but conditional on poverty status, does not help predict nutrition amongst children.

The second potential causal pathway is the psychosocial environment interpretation. Proponents of this view suggest that awareness of disadvantage in regard to relative social positioning creates feelings of shame and distrust that have negative biological consequences through the psycho-neuro-endocrine chain and through stress-induced behaviors such as smoking (Lynch et al. 2000). This reasoning is supported by research indicating that an individual's sense of mastery is largely a consequence of experiencing oneself as efficacious (Gecas and Schwalbe 1983), as well as by research that shows that exposure to stressful life experiences can erode one's sense of mastery (Krause and Tran 1989). Likewise, the association between cumulative or persistent stressful life events or conditions and the onset or chronicity of mental illness, particularly depression among single mothers with low self-esteem and lack of support, is well documented (Brown and Harris 1978; Costello 1982; Brown and Moran 1997).

Drawing on theories of the social production of health and disease (Krieger et al., 1993; Kreiger and Zierler, 1995; Link and Phelan, 1995; Williams, 1997; Williams et al., 1997; Denton and Walters, 1999), Siefert, Heflin, Corcoran and Williams (2001) hypothesized that household food insufficiency could be a contributor to poor health and mental health among welfare recipients. In a cross-sectional analysis using the Women's Employment Study, a longitudinal survey of women on welfare in a Michigan urban county, that controlled for a wide range of other factors known to influence women's health and well-being, food insufficiency remained a significant predictor of self-rated health, limitations in physical functioning, and major depression, but did not predict generalized anxiety disorder. The authors then analyzed the relationship between household food insufficiency and women's health in the same sample at

two points in time: fall 1997 and approximately one year later (Siefert et al., 2002). Controlling for common risk factors, the authors found that women who reported food insufficiency at both times were significantly less likely to report a high sense of mastery over their lives. Food insufficiency at wave 2 only was significantly associated with meeting the diagnostic screening criteria for recent major depression, as well as with a lower sense of mastery. Finally, Heflin et al. (2005) used three waves of data and fixed effect models to examine the relationship between a change in food insufficiency and a change in mental health, controlling for a number of covariates and time invariant unobserved heterogeneity. The authors found that a change in household food insufficiency status was positively correlated with a change in depression status, but not mastery.

The research to date has provided compelling evidence that food insufficiency is linked to worse mental health among specialized populations. However, research is lacking on the general population of American families, or even the broader population of low-income families that are simultaneously at greater risk of food insufficiency and poor mental health, and more likely to participate in transfer programs such as food stamps.

III. The Food Stamp Program as Mediator

The Food Stamp Program is an integral component of the social safety net in the United States. This cornerstone of food assistance programs works under the principle that everyone has a right to food for themselves and their families and, hence, with few exceptions, the program is available to all citizens who meet income and asset tests. Most participants receive an Electronic Benefit Transfer (EBT) card for the purchase of food in authorized, privately run retail food outlets. Subject to passing the income and asset limits, which vary with family size, the program is an entitlement to needy families, and participation moves counter-cyclically with the state of

the macroeconomy (Ziliak, Gundersen, and Figlio 2003). At its peak in 1994 over 27 million people received food stamp benefits at an expense of $25 billion to the federal government. In some states with low TANF benefit levels, food stamp benefits can constitute more than 50 percent of the disposable income of TANF recipients.

Households have to meet three financial criteria to qualify for the Food Stamp Program: the gross income, net income, and asset tests. A household's gross income before taxes in the previous month must be at or below 130 percent of the poverty line. Households with disabled persons or headed by someone over the age of 60 are exempt from this test (although they must pass the net income test). After passing the gross income test, a household must have a net monthly income at or below the poverty line. Net income is obtained by applying a standard deduction and then itemized deductions for part of labor earnings, for child care and/or care for disabled dependents, medical expenses, and excessive shelter expenses. Finally, net-income-eligible households must meet a liquid-asset test ($2,000 if the head is under 60 years old) and vehicle-value test ($4,650 in 2001, though certain exemptions are allowed such as a car for work-related purposes). The amount of food stamps a family receives is equal to the maximum food stamp benefit level minus 0.3 times its net income. So a family with zero net income will receive the maximum benefit level. Food stamp recipients must occasionally recertify their continuing eligibility and the proper amount of benefits. The frequency of recertification depends on the state of residence and the source of a household's income.

Relative to the TANF program, and its predecessor AFDC, there is comparatively little research on the Food Stamp Program (Currie 2003). Much of the research has focused on the effect of food stamps on food spending, the results of which tend to indicate that the typical food stamp recipient is *infra-marginal*, implying that they spend more on food than their food stamp

allotment, and that the marginal propensity to consume is higher out of a dollar of food stamps than out of cash (Fraker 1990; Breunig et al. 2001). In more recent years with the introduction of the food sufficiency and food security scale questions to major social surveys such as the Current Population Survey, the PSID, and the Survey of Income and Program Participation, there has been a flurry of research on unmet food need and various measures of well being. Much of the work indicates that food stamp recipients have higher rates of food insufficiency than eligible non-recipients, though recent research that allows for the possibility of self selection into food stamps find mixed evidence on the links between food insufficiency and food stamp use (Gundersen and Oliveria 2001; Jensen 2002). Likewise, whereas much research indicates that food stamp receipt is positively associated with nutrient intake, Butler and Raymond (1996) find that conditional on self selection into the Food Stamp Program, the nutrition of the elderly is not improved by receipt of food stamps. Though the evidence is mixed, we expect that participation in the Food Stamp Program will be associated with declines in food insufficiency and in turn with improved mental health. However, our model will clearly need to confront endogeneity issues between food stamp participation and health addressed in some of the recent literature.

IV. Data

To test whether and to what extent the Food Stamp Program mediates the link between food insufficiency and mental health we use data from the Panel Study of Income Dynamics (PSID). The PSID is a longitudinal study of a representative sample of U.S. men and women drawn in 1968. While there has been considerable attrition out of the PSID since its inception, the fact that it follows children over time out of the original 5,000 families and that it refreshes the sample with “births”, means that the PSID continues to be representative and thus an excellent source of data for social science research (Fitzgerald, Gottschalk, and Moffitt 1998).

The PSID emphasizes the dynamic aspects of economic and demographic behavior, but its content is broad, including sociological and psychological measures.

The PSID has several characteristics that make it a good choice for this project. First, beginning in 2001, and again in 2003, the PSID includes a measure of 30-day emotional distress from the National Health Interview Survey. Kessler et al. (2003) indicates that the scale provides a reliable measure of serious mental illness, defined as meeting criteria for at least one of the mental health diagnoses other than a substance use disorder contained within the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, and a Global Assessment of Functioning score of less than 60, indicating the person has at least moderate symptoms with or moderate difficulty in social, occupational, or school functioning. Second, the PSID includes the single item food insufficiency measure in 1999, 2001, and 2003. The item asks households about the availability of food in the prior calendar year. Respondents who indicate they "sometime" or "often" did not have enough to eat are coded as food insufficient. Third, in every survey year the PSID includes very detailed demographic, income, and transfer program information, including the Food Stamp Program. Fourth, because the PSID follows the same family over time it is possible to utilize estimation methods that control for time invariant unmeasured characteristics. Finally, the PSID is nationally representative and results from the 2001-2003 PSID will be broadly generalizable to the current policy environment.

The focal sample of our analysis is prime aged adult men and women between the ages of 18 and 65 who are present in the PSID as family heads in 2001, and 2003. As food insufficiency is only recorded at the family level in the PSID we direct our focus on household heads. While we are interested in understanding whether and how much participation in the Food Stamp Program mediates the impact of food insufficiency on emotional distress in the general

population, previous research suggests that families at greatest risk for food insufficiency and emotional distress are single female heads and/or family heads with low education attainment. Likewise, program rules dictate that incomes must be low in order to qualify for food stamps, and because of the strong links between income and education attainment, we view one relevant risk set for food stamp use as the low-education population. Consequently, in addition to a sample of the general population we also examine a sub-sample selected on having attained a high school diploma or less. Because the dependent variable in our model is a measure of mental health, and income and mental health may be simultaneously determined (Smith 1999), the low-education subsample is likely to be more robust and free of endogeneity bias than would a low-income subsample.[2] In addition, the case for samples split by education is stronger relative to low-income splits in light of the fact that participation in the Food Stamp Program is income tested.

Additionally, we present analysis for a subsample of single female heads. We do this because female headed households are a special population of interest. Female headed households have rates of food insecurity that are over three times the national average (Nord et al 2005). Thus, consequences of food insufficiency and possible mediators are of special relevance for this population. Additionally, female heads are two to three times more likely to participate in the Food Stamp Program than family heads as a whole. Moreover, prior work on the effect of food insufficiency on mental health has mostly used samples of female heads from specialized populations (Heflin et al. 2005). By comparing our results with this female head subsample with prior work, we can begin to understand the robustness of the relationship between food insufficiency and mental health to general data sources and modeling strategies.

[2] For this reason as well, we do not include income as an explanatory variable in the main models for mental health. However, in results not tabulated, we find that results presented here are robust to the inclusion of income in the model.

[Table 1 here]

Our measure of mental health, which is the dependent variable in our empirical model described below, records how often a respondent experienced certain symptoms of psychological distress during the past 30 days. These symptoms include feelings of sadness, nervousness, restlessness, hopelessness, worthlessness, and that everything was an effort. Table 1 details the exact wording of this question and the six symptoms that are assessed. The response codes (0-4) of the six items are summed for each person to yield a scale with a 0-24 range. The average score out of 24 was 3.2 for the general population, 3.6 for the low education sample, and 4.1 for female heads.

Many studies reduce the emotional distress scale to a binary dependent variable by defining a value of 13 or more as serious psychological distress (Kessler et al. 2003; National Center for Health Statistics, 2003). In the full sample, 3.0 percent of the sample meets the criteria for high emotional distress. This is comparable to the population estimates produced by the Center for Disease Control based on the same measure in the National Health Interview Survey. In the low-education sample the prevalence rises to 4.0 percent. The comparable figure for the female headed sample is 5.3 percent. This pattern is consistent with earlier evidence that severe emotional distress is more prevalent among disadvantaged populations, especially single female-headed families (Kessler et al. 1994).

Instead of using the dichotomous measure of severe emotional distress, we chose to use the full 24-item scale in our analysis. Figure 1 depicts a histogram of the relative frequency of outcomes on the emotional distress scale pooled across 2001 and 2003. The figure reveals that a substantial fraction of the population have scores between 0 and 10, but the dichotomous dependent variable treats all observations with scores under 13 the same and thus suppresses

important variation in the dependent variable. Moreover, some of our estimation techniques exploit changes over time in emotional distress, and over 70 percent of the sample report changes in emotional distress between 2001 and 2003; however, only 4 percent of the sample falls into or out of the severe emotional distress category. Consequently, given the low prevalence of severe emotional distress in the general population, using the full scale allows us to model small changes in emotional health that may not rise to the level of changing a categorization of "severe emotional distress".[3]

[Figure 1 here]

Table 2 presents descriptive statistics (means and standard deviations) for selected outcomes and demographics across the three separate samples for the pooled data from 2001 and 2003. *Food insufficiency* is a dummy variable if the household head indicated that they "sometimes" or "often" did not have enough food to eat in the previous year. This measure has been demonstrated to be related to food expenditures and nutrient in-take (Basiotis 1992; Cristofar and Basiotis 1992). *Food stamp participation* is a dummy variable equaling one if the family received food stamps in the previous year. *Female head* is dummy variable indicating if the household head is female. Education level is captured at four levels: *less than high school*, *high school graduates, some college, 4 year degree or more.* Marital status is grouped into three categories: *married, ever married* indicating that the head is currently divorced, widowed or separated, and *never married*. Race of the head is measured with a series of dummy variables as *white* if the head self-identified themselves as white; *black* indicates that the head self-identified

[3] Recognizing the concentration of zeros and the limited scale of outcomes, as alternatives to the linear estimators reported below, we also considered cross-section and random effects Tobit estimators, zero-inflated negative binomial estimators, and fixed and random effect negative binomial estimators. The qualitative pattern of results is unchanged from those reported here. We also treated the dependent variable as a dichotomous variable and estimated the model with several methods, including linear probability and probit estimators. As discussed in the text the reduced variation in the latter case hampered identification of the policy impact of food stamps on unmet food need and emotional distress.

themselves as having a primary racial identify of black; and *other* indicates that the household identified themselves as American Indian, Asian, Latino or some other combination. *Age* represents the age in years of the household head and has a range from 18 to 65. *Number of children* indicates the total number of children in the household under age 18. *Age of youngest child* indicates the age of the youngest children in the household under age 18.

[Table 2 here]

Rates of food insufficiency are on the order of 1.9 percent in the general population, but they are closer to 3 percent among low educated and female headed families. Likewise, food stamp participation rates are 6.7 percent overall, but upwards of 11.2 percent among families whose head has a high school education or less and 19.8 percent among families with a female head. Examining the other variables in the table the pattern of results is quite consistent: female-headed and low-educated families are less likely to be married, less likely to be white, more likely to never have been married, and have more children.

V. Empirical Analysis

We are interested in formally modeling the relationship between emotional distress and food insufficiency, and the attendant role of public policy through the Food Stamp Program to possibly attenuate the links between unmet food need and mental health. The basic model specification for family head *i, i=1,…N* in time period *t, t=2001, 2003* is:

(1) $Y_{it} = \alpha + \beta * FDINSUF_{it-1} + \mu * FSP_{it-1} + \delta * (FDINSUF_{it-1} * FSP_{it-1}) + X_{it}\gamma + \varepsilon_{it}$,

where Y_{it} is the continuous measure of mental health based upon the 30-day emotional distress scale, $FDINSUF_{it-1}$ is an indicator variable equaling 1 if the household was food insufficient in the previous year, FSP_{it-1} is an indicator variable equaling 1 if the household participated in the Food Stamp Program in the past year, $FDINSUF_{it-1} * FSP_{it-1}$ captures the possible mediating

effect of food stamps on mental health via reductions in food insufficiency, X_{it} is a vector of observed time-varying and time-invariant demographics such as sex, race, age, education level, and family structure that may affect mental health, and ε_{it} is an error term.

Several comments on the model in equation (1) require further explanation. First, it is important to recall that the dependent variable reflects emotional health over the past 30 days whereas both food insufficiency and food stamp participation refer to the previous year, which accounts for the lag operator in the equation. This timing difference likely eliminates any direct simultaneity between emotional distress, unmet food need, and food stamp use (i.e. the possibility that distress leads to food insufficiency), but does not rule out possible shared unobserved heterogeneity as explored in detail below. Second, previous research in more limited samples suggests a positive link between food insufficiency and severe emotional distress; thus, we hypothesize that $\beta > 0$. Third, it is possible that participation in the Food Stamp Program may have a direct effect on mental distress, i.e. $\mu \neq 0$. Studies of food stamp non-participation among eligible individuals often list factors such as stigma and 'too many hassles' as reasons for non-participation (Daponte, Sanders, and Taylor 1999). It is possible that by revealed preference actual participants have lower levels of these concerns, but if limited office hours, frequent recertification, and/or negative stereotypes feed into higher distress it may be the case that $\mu > 0$. Fourth, if food stamps are effective at mitigating the potential deleterious effects of food insufficiency on mental health, then we expect $\delta < 0$; that is, the covariance between food stamps and food insufficiency has the effect of reducing emotional distress. In the program evaluation literature this parameter identifies the impact of "treatment" (i.e. food stamp use) on the treated. This is the key parameter of interest.

A. Cross Sectional Results

We begin our analysis under the classical assumptions of linear least squares, namely, the assumption of a zero conditional mean between the error term in equation (1) and the regressors, i.e. $E[\varepsilon_{it} \mid X_{it,} FDINSUF_{it}, FSP_{it}] = 0$. This standard assumption means that both pooled OLS (i.e. pooling the 2001 and 2003 data into a large cross section) and the so-called between-groups estimator are consistent estimators of the model parameters. The between groups estimator is a cross-sectional estimator using individuals' time-means of the variables

$$(2) \qquad \overline{Y}_i = \alpha + \beta \overline{FDINSUF}_i + \mu \overline{FSP}_i + \delta \overline{FDINSUF * FSP}_i + \overline{X}_i \gamma + \overline{\varepsilon}_i$$

where $\overline{Y}_i = \frac{1}{T} \sum_{t=1}^{T} Y_{it}$ and other variables are similarly defined. A potential advantage of the between-groups estimator is that measurement-error induced attenuation bias in estimated coefficients may be reduced because averaging smoothes the data generating process.

[Table 3 here]

In columns (1)–(4) of Table 3 we record the estimates from the between-groups and pooled OLS estimators for each of the three samples. For each specification we report results first for models suppressing the Food Stamp Program and then for models allowing food stamps to have a direct effect on emotional distress and an interactive effect with food insufficiency. As each model has additional controls for age, education, race, marital status, number of children, age of youngest child, and a year dummy variable for 2003, we report the full set of estimates in Appendix Tables 1-3.

The between groups model estimates for all families in column (1) of Table 3 imply a strong positive effect of food insufficiency on emotional distress. Family heads who experience food insufficiency report 5.25 more conditions than those who are not food insufficient, which

when added to the baseline emotional distress score of 3 implies levels of distress 2.75 times the baseline. This finding broadens earlier results by Siefert et al. (2001) of a cross-sectional relationship between food insufficiency and mental health in a sample of women on welfare to the general U.S. population. We find similarly sized coefficients for both the subsamples of low-educated heads and female heads, though the total effect is not as great given the higher baseline emotional distress scores for these groups.

In column (2) we add food stamp participation and its interaction with food insufficiency to the model. The direct effect of food insufficiency remains and there is also a strong positive direct effect of food stamp participation on emotional distress, which is mostly likely due to stigma and the hassles of obtaining benefits. The typical food stamp participant has an emotional distress score about 2.5 points above baseline. However, the interaction term is large, negative, and significant. This suggests that families with unmet food need who chose to participate in the Food Stamp Program cut the direct impact of food insufficiency on emotional distress by about half (5.38-2.57). This mediating effect is most strong among the female-head sample who are at greatest risk of both emotional distress and food insufficiency where the effect is cut by about two-thirds. The between-groups estimates suggest that the Food Stamp Program has a direct, positive spillover effect on mental health by reducing food insufficiency.

Columns (3) and (4) of Table 3 contain the parallel estimates from pooled OLS. Recall that under standard assumptions for linear least squares both the between groups and pooled OLS estimators yield consistently estimated parameters. While the qualitative pattern of estimates is identical across the two estimators, the estimated coefficients from pooled OLS are significantly attenuated relative to the between groups estimates, especially the interactive effect of food insufficiency and food stamps. At first blush this is puzzling given that both estimators yield

consistent estimates under the stated model assumptions, but there are at least two sources for the divergence in parameter estimates, one being possible unobserved heterogeneity that we have failed to account for and the other possibility is that food insufficiency and food stamp participation are measured with error. While there is scant evidence in the literature on the quality of measures of food insufficiency, Bollinger and David (1997, 2001) do provide compelling evidence of that food stamp usage is frequently misreported in the Survey of Income Program Participation (SIPP). We explore both possibilities in the following sections.

B. Accounting for Unobserved Heterogeneity

As discussed previously because emotional distress, food insufficiency, and food stamp participation are measured at different times we do not expect direct feedback of emotional distress on food insufficiency or food stamp use. This does not rule out the possibility of shared, but unmeasured heterogeneity across these three outcomes. Specifically, it is possible that those family heads that have a latent (to researchers) propensity to experience emotional distress may also have a latent propensity to suffer from unmet food need and/or to participate in food assistance programs. To admit this possibility we rewrite the error term in equation (1) as the standard error-components for panel data models $\varepsilon_{it} = \phi_i + \eta_{it}$, where ϕ_i captures person-specific and time-invariant unobserved heterogeneity and η_{it} is an independently and identically distributed random error term.

Under this composite error structure we consider two cases, one where ϕ_i is distributed randomly in the population and assumed to be uncorrelated with the other regressors (i.e. the "random-effects" estimator), and the other where ϕ_i is assumed to be correlated with all regressors yielding the so-called fixed-effects estimator. The implication of random effects is that selection into food stamps and/or food insufficiency on the basis of an unobserved

propensity to experience emotional distress is purely random across the population. Although both the pooled least squares and between-groups estimators remain consistent in the presence of random heterogeneity, the random-effects estimator will be more efficient because it accounts for person-specific autocorrelation in the health process. If selection into food stamps, for example, is not random with respect to unobserved heterogeneity then the between-groups, pooled OLS, and random effects estimators are all inconsistent.

In columns (5)-(8) of Table 3 we record random-effects and fixed effects estimates of the effect of food insufficiency and food stamps on emotional distress for our three samples of families in the PSID. Compared to the between-groups estimates the effect of food insufficiency on emotional distress is reduced by about 30 percent when controlling for random effects and by about half when the unobserved heterogeneity is treated as correlated, although in both cases the effect is still positive and strongly significant. Moreover, in the fixed effects models both the direct effect of food stamps and the mediating effect of food stamps on emotional distress are reduced to zero statistically (and the interaction term even changes sign). While the random effects models still indicate a direct effect of food stamps on emotional distress, as with our fixed effects models, there is no longer any evidence that the Food Stamp Program mediates the deleterious effect of food insufficiency on mental health. Relative to pooled OLS, the random effects and fixed effects estimates are attenuated. For all samples, Hausman tests soundly reject the null hypothesis that the unobserved heterogeneity is randomly distributed with p-values < 0.00, which indicates that the fixed effects estimates are preferred.

Taken at face value the fixed effect estimates suggest that there is no programmatic effect—direct or indirect—of food stamps on mental distress and that the between-groups estimates are spurious because they neglect non-random selection of those who are emotionally

distressed into the Food Stamp Program. This somewhat negative result, while consistent with Gundersen and Olivera's (2001) result that the link between food stamps and food insufficiency is purely selection and not causal, may be premature because of possible measurement error in food stamps that can attenuate the coefficients. Indeed, Griliches and Hausman (1986) show that fixed effects estimators frequently exacerbate measurement error-in-variables relative to cross-sectional estimators because the first-difference and within transformations often reduce the signal to noise in socioeconomic data. Given that pooled OLS estimates are attenuated compared to between groups, and both random and fixed effects are attenuated further, and that Bollinger and David (1997, 2001) find that food stamp use is often misreported in the SIPP, we cannot rule out that the negative fixed effect results are due to measurement error.

C. Accounting for Measurement Error

Measurement error in food insufficiency and/or food stamps implies that the model's error term no longer satisfies the conditional mean independence assumption assumed in the cross-sectional and panel-data estimates in Table 3, i.e. $E[\eta_{it} \mid FDINSUF_{it-1}, FSP_{it-1}] \neq 0$. For the ensuing analysis we rely on the first-difference estimator to control for unobserved heterogeneity rather than the 'within' fixed-effects estimator. It is well known that when $T = 2$, as is the case in this paper, the estimates from the within and first-difference estimators are identical. However, the first difference estimator is preferred in instrumental variables applications because the first-difference estimator is more robust to alternative instrument sets compared to the within estimator (Griliches and Hausman 1986). The choice of instruments depends on the assumed error properties of the measurement error, η_{it}, and the number of time periods available.

Consider our model in first difference form

$$\Delta Y_{it} = \beta(\Delta FDINSUF_{it-1}) + \mu(\Delta FSP_{it-1}) + \delta(\Delta FSP * FDINSUF_{it-1}) + \Delta X_{it}\gamma + \Delta\eta_{it} \quad , \tag{3}$$

where ' Δ ' refers to the two-year difference operator such that $\Delta Y_{it} = Y_{i2003} - Y_{i2001}$ for our measure of emotional distress and because food insufficiency refers to use in the previous year $\Delta FDINSUF_{it-1} = FDINSUF_{i2002} - FDINSUF_{i2000}$. Griliches and Hausman (1986 Table 2) demonstrate that under fairly general conditions $FDINSUF_{i2001}$ is a valid instrument for $\Delta FDINSUF_{it-1}$, FSP_{i2001} is a valid instrument for ΔFSP_{it-1}, and $FSP * FDINSUF_{i2001}$ is a valid instrument for $\Delta FSP * FDINSUF_{it-1}$. These conditions for instrument validity include situations when the error term η_{it} is stationary but possibly correlated up to an MA(3) process, and cases when η_{it} is non-stationary but with no correlation. Given that these conditions are likely satisfied in this application the challenge then is obtaining adjacent measures of food stamps and food insufficiency.

Fortunately, in each survey of the PSID (usually conducted in March or April of the survey year) they ask both whether or not the family is *currently* using food stamps and whether or not they used food stamps in the *previous year*. Hence in the 2001 survey we know both whether or not $FSP_{i2001} = 1$ and $FSP_{i2000} = 1$. The latter is used in construction of the regressor and the former is used as an instrument. However, we do not possess a similar second measure of food insufficiency in the PSID differentiating current from past year unmet food need. The best instrument for the 2000 to 2002 change in food insufficiency is $FDINSUF_{i2000}$.[4] In the Griliches and Hausman (1986) framework this instrument is valid only if measurement error in food insufficiency is not serially correlated. We will maintain this assumption, though we recognize that there is no research to guide us on the validity of the assumption of no serial correlation in

[4] We also experimented with using the food insufficiency and food stamp participation measures from the 1999 wave of the PSID. These instruments were considerably weaker than the instruments described in the text, which is not surprising given that the level of food insufficiency in 1998 is likely to be weakly correlated with the change between 2000 and 2002.

the measurement error of food insufficiency. It follows then that for the first-difference of the interaction term we will use $FSP_{i2001} * FDINSUF_{i2000}$ as an instrument. Our base-case IV models are just identified, but we will also present results with an expanded instrument set where we include state-by-year variables commonly used in the food stamp caseload literature (e.g. Ziliak, et al. 2003) such as state unemployment rates, political party of the Governor, the maximum AFDC and food stamp benefit level, and the error rate in the food stamp determination process.[5]

[Table 4 here]

Because we lack strong priors as to whether or not reports of food insufficiency are measured with error, and that the evidence to date on food stamps comes from a single data source (SIPP), it is instructive to first test whether or not measurement-error induced endogeneity is present. To conduct these tests we use a regression-based alternative to a Hausman test known generally in the literature as variable addition tests (Davidson and MacKinnon 1993; Wooldridge 2002). We first estimate the reduced-form prediction equations for each of the potentially mismeasured (and thus endogenous) regressors:

(4) $\Delta Z_{i,t} = \pi Z_{i,t-1} + \Delta X_{it}\theta + \nu_{it}, Z = FDINSUF, FSP, FSP * FDINSF$

where $Z_{i,t-1}$ is the lagged value of the head's food insufficiency, the lagged alternative measure of food stamp participation, or the lagged level of the interaction term, ΔX_{it} are the exogenous regressors in equation (3), and ν_{it} is a random error term. For each of the three reduced-form regressions we save the fitted residuals, $\hat{\nu}_{it}^{FDINSUF}, \hat{\nu}_{it}^{FSP}, \hat{\nu}_{it}^{FSP*FDINSF}$, and append them to equation (3) and run OLS on

[5] Black, Berger, and Scott (2000) propose an alternative method of accounting for measurement error in binary regressors in a cross sectional setting. Their approach exploits the presence of multiple measures of the same noisy variable to improve the bounds between OLS and standard IV estimators. It is not known whether such methods dominate the approach of Griliches and Hausman (1986) adopted here in the context of panel data.

$$\Delta Y_{it} = \beta(\Delta FDINSUF_{it-1}) + \mu(\Delta FSP_{it-1}) + \delta(\Delta FSP * FDINSUF_{it-1}) + \Delta X_{it}\gamma + \rho_1 \hat{v}_{it}^{FDINSF} + \rho_2 \hat{v}_{it}^{FSP} + \rho_3 \hat{v}_{it}^{FSP*FDINSF} + \Delta \eta_{it}. \quad (5)$$

The test of exogeneity (no measurement error) is a simple t-test that each of the $\rho_k, k = 1,2,3$ are zero, or one may wish to jointly test the null hypothesis that $\rho_1 = \rho_2 = \rho_3 = 0$ with a Wald test.

In Table 4 we record our tests of no measurement error for the just identified model both singly and jointly for all three samples. For transparency we simply report the coefficients on the $\rho_k, k = 1,2,3,$ but for completeness we report the full set of first-stage reduced-form estimates in Appendix Tables 4–6. The first-stage predicts well and the power of the lagged regressors in predicting food stamp participation and food insufficiency is quite strong. The simple t-tests in Table 4 indicate that we cannot reject the null hypothesis of exogeneity of food insufficiency, indicating that measurement error is not likely to be problematic for this variable. We do, however, find strong evidence of measurement-error induced endogeneity in both food stamps and the interaction term in both the full sample and the sample of low educated heads, and as a consequence the joint test rejects the null of exogeneity for those two samples. This suggests that instrumental variables estimation is necessary for consistent estimates of model parameters. The exception here is with the female-headed sample, where there is no evidence of measurement error. While the standard errors do rise because of smaller sample sizes, the coefficients fall in absolute value more relative to the rise in standard errors. This result is consistent with Bollinger and David (1997) who show that single females are significantly less likely to misreport food stamp use relative to men, and with the general result that women less frequently misreport in surveys relative to men (Bound et al. 2002). However, for completeness we will pursue the instrumental variables analysis for all three samples.

[Table 5 here]

In Table 5 we present instrumental variables estimates of the effects of food insufficiency, food stamps, and the interaction of food stamps with food insufficiency on emotional distress. The standard errors are robust to heteroskedasticity of unknown form. We show four sets of results for each of the three samples, one set where we treat food insufficiency as exogenous as suggested by the endogeneity tests in Table 4, one set where all three variables are treated as endogenous, and for each of the latter two we use a just identified set of instruments of lagged food stamps and food insufficiency and an expanded set that includes state economic and policy factors. We focus our discussion on the preferred model treating food stamps and the interaction term as endogenous but food insufficiency as exogenous.

Compared to the least squares fixed effects estimates in Table 3 the first difference IV estimates in Table 5 significantly reduce the attenuation bias in the least squares estimates. Food insufficiency continues to have a strong deleterious effect on emotional health, even after accounting for unobserved heterogeneity and measurement error, and the IV estimate is about 75 percent higher than the least squares fixed effect estimate. The reduced attenuation is most apparent for the coefficients on food stamps and the interaction between food stamps and food insufficiency. In the preferred base case where food insufficiency is treated as exogeneous the IV estimate suggests that food stamps has a direct effect of increasing emotional distress by about 4 points, which is about double the base level for a non food stamp recipient, and this effect is statistically significant with a two-tailed p-value of 0.078. Importantly, though, is that among the sample of food insufficient households, food stamp participation nearly eliminates the direct effect of food insufficiency on emotional distress (0.495=3.962-3.467 in the just identified model of all families). Given our one-sided null hypothesis that $\delta < 0$, the mediating effect of food stamps on food insufficiency is statistically significant with a one-tailed p-value of 0.031 (and at

the 0.037 level in the over-identified model in column 2). The qualitative magnitudes of the coefficients are the similarly sized in both the samples of low-educated families and female-headed families, though with the smaller samples the statistical significance is reduced somewhat with a one-sided p-value of 0.045 for the low education sample.

D. Simulations of the Role of Food Stamps as Mediator

In Table 6 we quantify the extent to which food stamp participation attenuates the impact of food insufficiency on the level of emotional distress. The base score is calculated by estimating the mean value of the emotional distress scale when all the variables in the equation are evaluated at their mean, except for food insufficiency and food stamp participation which are set to zero, using results from our preferred model—the IV results treating food insufficiency as exogenous and using lagged values of food stamp participation and the interaction as instruments. Working from that base, we then add the effect of being food insufficient alone to arrive at the second row of results. For the third row, we estimate the emotional distress score for households that are both food insufficient and also participate in the Food Stamp Program including the interaction term. Finally, we estimate the emotional distress score without the mediation effect of participation in the Food Stamp Program for food insufficient households in the last row. Superscripts provide results for two sample t-tests assuming unequal variance for each row's mean when compared to the prior row.

[Table 6 here]

The pattern of results is consistent across the three samples: While the base score of the emotional distress scale is quite modest, ranging from 2.98 in the full sample to 3.70 in the female headed sample, being food insufficient alone substantially increases the emotional distress score to a range from 10.6 in the full sample and low education samples and to 12.5 in

the female headed sample, an increase from 230 to 257 percent. Recall that the cut-off for meeting the criteria for severe emotional distress is 13 and note that the female headed sample gets quite close to the cut-off with the presence of this single risk factor. Participating in the Food Stamp Program and being food insufficient after adjusting for the mediating effect by including the interaction term results in marginally higher levels of emotional distress than being food insufficient alone. In fact, t-statistics indicate that the null of no difference in average emotional distress scores of being food insufficient alone or food insufficient and receiving food stamp participation cannot be rejected in any of the three samples. That is, among food insufficient households, the Food Stamp Program confers little additional cost in terms of emotional distress. In fact, among female headed households, the level of predicted emotional distress is lower among households that receive food stamps than those who do not, although again, these results are not statistically different.

The last row of Table 6 demonstrates that the joint effect of being food insufficient and participating in the Food Stamp Program is much less than the additive affect of the two main effects. If we ignore the interaction term and estimate the emotional distress score for households that are food insufficient and participate in the Food Stamp Program, we find that levels of emotional distress rise by approximately 30 percent in each sample. Even with the small sample sizes used for these simulations, these comparisons are highly statistically significant. Across all three samples we find that among those who are both food insufficient and participate in the Food Stamp Program, ignoring the mediation effect of food stamps on food insufficiency would result in predicted levels of emotional distress that would rise above the cut-off for severe emotional distress, indicating the presence of a mental health disorder and some functional difficulties. In short, while participation in the Food Stamp Program in general raises the

emotional distress levels of clients, it also provides critical support to those family heads that are food insufficient and under emotional distress.

VI. Conclusion

The federal safety net for the poor is in transition in the United States. Cash welfare has already undergone a large and, some would argue, overdue reform. Provisions in the reauthorization of welfare calling for the block granting of the Food Stamp Program to a number of states on a provisional basis suggest that attention may be focusing next on food and nutrition programs. Other proposed legislation aims to end the categorical eligibility of women on the TANF caseload for the Food Stamp Program. Yet, surprisingly there has been little direct empirical evidence on the possible spill-over effects of food programs on the health and mental health of the populations they are designed to serve.

Using data from the Panel Study for Income Dynamics and methods that address both unobserved heterogeneity and measurement error, this research provides the first evidence supporting the contention that the Food Stamp Program has important positive spill-over effects on mental health through its mediation of household food insufficiency in a nationally representative dataset. We find clear and convincing evidence that food insufficiency is positively correlated with emotional distress, with scores on the Emotional Distress Scale of 10.6 to 12.5, which is over three times the levels found among the majority of the population who are neither food insufficient nor on food stamps. At the same time, we find evidence that participation in the Food Stamp Program also has a deleterious effect on emotional health that is of comparable magnitude to the effect of food insufficiency. However, among those who are food insufficient the results suggest that food stamp participation nearly eliminates the negative effect of food insufficiency on mental health. Simulations suggest that failure to account for the

mediating effect of food stamps on food insufficiency results in an upward-bias of emotional distress scores of about 30 percent. We interpret this reduction as the mediating effect of Food Stamp Program participation on emotional distress among food insufficient individuals.

There are several implications for our results. One is that any reforms undertaken in the Food Stamp Program need to keep in mind the important spillover effects of this program on mental health. In order to do this, reformers will need to expand their focus beyond the labor supply and food consumption effects of food stamps. Second, as we find that participation in the Food Stamp Program imparts a sizable direct cost on emotional health, policy makers should redouble efforts to reduce the hassle and stigma effects of food stamp use. Introduction of the EBT in the late 1990s and increasing recertification periods from 3 months to 6 months as part of the 2001 Farm Act are steps in this direction, though additional reforms to make the application and recertification process more transparent are likely to improve the emotional health of participants. Third, given our finding that food stamp participation has the greatest mediating effect on the relationship between food insufficiency and emotional distress within female headed populations, it is important to protect the categorical eligibility of TANF recipients for the Food Stamp Program. Finally, given the growing body of evidence regarding deleterious effects of food insufficiency, it is important to continue research into the determinants and correlates of food insufficiency.

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Figure 1: Relative Frequency of Emotional Distress Scores

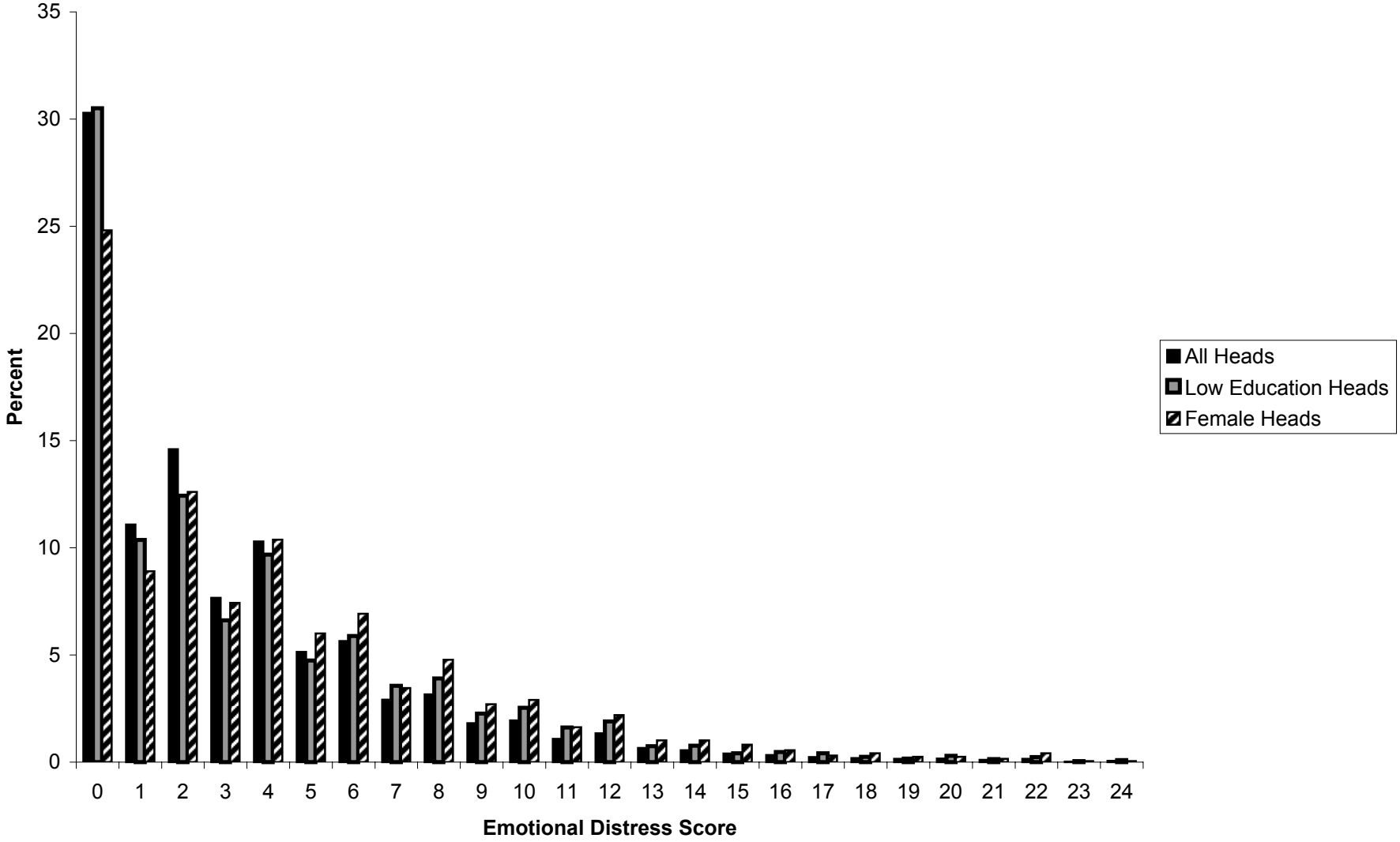

Table 1. Description of the 30-Day Emotional Distress Scale

In the past 30 days how often did you feel…	Full Sample	Low Education	Female Head
. . . So sad nothing could cheer you up?			
(0) none of the time	70.48	64.87	59.05
(1) a little of the time	15.03	16.47	19.99
(2) some of the time	11.46	14.49	16.23
(3) most of the time	2.11	2.80	3.20
(4) all of the time	0.92	1.38	1.53
. . . Nervous?			
(0) none of the time	55.41	57.31	53.05
(1) a little of the time	22.23	19.31	21.36
(2) some of the time	18.53	18.50	19.79
(3) most of the time	2.26	2.75	3.41
(4) all of the time	1.57	2.12	2.39
. . . Restless or fidgety?			
(0) none of the time	51.05	52.46	46.95
(1) a little of the time	20.62	17.51	20.09
(2) some of the time	22.41	22.65	25.03
(3) most of the time	3.26	3.54	4.58
(4) all of the time	2.66	3.84	3.36
. . . Hopeless?			
(0) none of the time	86.17	83.66	79.15
(1) a little of the time	6.51	6.90	8.85
(2) some of the time	5.58	6.97	8.80
(3) most of the time	1.02	1.38	1.93
(4) all of the time	0.72	1.08	1.27
. . . That everything was an effort?			
(0) none of the time	62.47	59.54	51.93
(1) a little of the time	13.94	12.45	14.19
(2) some of the time	15.45	16.76	20.09
(3) most of the time	3.96	5.30	6.61
(4) all of the time	4.18	5.93	7.17
. . . Worthless?			
(0) none of the time	89.32	86.69	84.13
(1) a little of the time	5.01	5.57	6.77
(2) some of the time	4.26	5.55	6.82
(3) most of the time	0.68	1.04	1.07
(4) all of the time	0.74	1.15	1.22
Average Emotional Distress	3.22	3.61	4.15
High emotional distress (>13)	3.01	3.99	5.29
Person Years	8,836	4,432	1,966

Table 2. Selected Summary Statistics

	Full Sample	Low Education	Female Head
Food Insufficient	0.019	0.031	0.030
	(0.137)	(0.174)	(0.169)
Food Stamp Participation	0.068	0.112	0.198
	(0.251)	(0.315)	(0.399)
Female Head	0.222	0.259	1.000
	(0.416)	(0.438)	(0.000)
Less than high school	0.179	0.357	0.246
	(0.384)	(0.479)	(0.431)
High school graduate	0.322	0.643	0.338
	(0.467)	(0.479)	(0.473)
Some college	0.253		0.273
	(0.435)		(0.445)
College or more	0.246		0.143
	(0.431)		(0.351)
Married	0.599	0.551	
	(0.490)	(0.497)	
Ever Married	0.219	0.239	0.552
	(0.414)	(0.427)	(0.497)
Never Married	0.177	0.203	0.447
	(0.382)	(0.402)	(0.497)
White	0.616	0.511	0.369
	(0.486)	(0.450)	(0.483)
Black	0.305	0.392	0.578
	(0.460)	(0.488)	(0.494)
Other	0.079	0.097	0.053
	(0.269)	(0.295)	(0.224)
Age	43.209	42.492	42.360
	(10.178)	(10.190)	(10.605)
Number of children	1.014	1.114	1.080
	(1.210)	(1.296)	(1.313)
Age of youngest child	4.055	4.224	4.356
	(5.347)	(5.345)	(5.416)

Table 3. OLS Cross-Section and Panel Data Estimates of the Effect of Food Insufficiency and Food Stamp Program Participation on Emotional Distress

	Between Groups Estimator		Pooled OLS Estimator		Random Effects Estimator		Fixed Effects Estimator	
Full Sample								
Food Insufficiency	5.245	5.381	4.294	4.167	3.667	3.397	2.839	2.266
	(0.447)	(0.572)	(0.455)	(0.560)	(0.438)	(0.535)	(0.580)	(0.686)
Food Stamps		2.455		1.993		1.538		0.386
		(0.248)		(0.230)		(0.235)		(0.350)
Food Insufficiency * Food Stamps		–2.574		–0.866		0.172		1.618
		(0.952)		(0.965)		(0.873)		(1.096)
Low Education Sample								
Food Insufficiency	5.198	5.296	4.199	4.093	3.563	3.369	2.707	2.245
	(0.547)	(0.713)	(0.519)	(0.656)	(0.496)	(0.625)	(0.656)	(0.802)
Food Stamps		2.762		2.238		1.748		0.499
		(0.309)		(0.266)		(0.268)		(0.387)
Food Insufficiency * Food Stamps		–2.631		–0.980		–0.038		1.309
		(1.153)		(1.077)		(0.965)		(1.183)
Female Head Sample								
Food Insufficiency	5.299	6.867	4.287	5.299	3.436	4.036	2.487	2.505
	(0.882)	(1.311)	(0.717)	(1.005)	(0.653)	(0.916)	(0.857)	(1.130)
Food Stamps		2.263		1.757		1.174		0.213
		(0.401)		(0.304)		(0.311)		(0.452)
Food Insufficiency * Food Stamps		–4.431		–2.660		–1.359		–0.026
		(1.796)		(1.415)		(1.259)		(1.578)

NOTE: There are 8,836 observations in the full sample (4,418 heads over two years), 4,432 in the low education sample (2,216 heads), 1,966 (983 heads) in the female-head sample. All models include controls for age, education, race, marital status, number of children, age of youngest child, and a year dummy variable for 2003. Standard errors for the pooled OLS, random effects, and fixed effects are robust to heteroskedasticity of unknown form.

Table 4. Variable Addition Tests of Exogeneity of Food Insufficiency and Food Stamp Participation

	Full Sample	Low Education	Female Head
1st Stage Residual on Food Insufficient	–0.4005 (1.3139	–1.0477 (1.5352)	1.2676 (1.8814)
1st Stage Residual on Food Stamp Participation	–3.7379 (2.1573)	–3.8657 (2.5620)	–2.5576 (2.8219)
1st Stage Residual on Interaction	5.5520 (2.2393)	5.9089 (2.4810)	1.6744 (2.5376)
P-value on Joint Test of Significance of Food Insufficiency, Food Stamp Participation, and Interaction	0.0126	0.0288	0.3461

NOTE: There are 8,836 observations in the full sample (4,418 heads over two years), 4,432 in the low education sample (2,216 heads), 1,966 (983 heads) in the female-head sample. All models include controls for food insufficiency, food stamp use, the interaction between food stamps and food insufficiency, age, education, race, marital status, number of children, age of youngest child, and a year dummy variable for 2003. Standard errors are robust to heteroskedasticity of unknown form.

Table 5. Instrumental Variables Estimates of the Effect of Food Insufficiency and Food Stamp Participation on Emotional Distress

	Food Insufficiency Exogenous		Food Insufficiency Endogenous	
	Just Identified	Over Identified	Just Identified	Over Identified
Full Sample				
Food Insufficiency	3.962	3.902	3.005	2.875
	(0.938)	(0.934)	(1.189)	(1.172)
Food Stamps	3.996	3.775	3.908	3.713
	(2.264)	(2.018)	(2.277)	(2.018)
Food Insufficiency * Food Stamps	–3.467	–3.281	–2.379	–2.126
	(1.856)	(1.829)	(1.925)	(1.874)
Low Education Sample				
Food Insufficiency	4.082	4.024	3.456	3.230
	(1.135)	(1.132)	(1.398)	(1.368)
Food Stamps	4.214	3.556	4.141	3.513
	(2.688)	(2.145)	(2.721)	(2.155)
Food Insufficiency * Food Stamps	–3.898	–3.736	–3.168	–2.804
	(2.299)	(2.263)	(2.290)	(2.218)
Female Head Sample				
Food Insufficiency	4.290	4.808	2.178	2.633
	(1.848)	(1.855)	(1.646)	(1.615)
Food Stamps	2.801	2.766	2.658	2.731
	(2.867)	(2.358)	(2.882)	(2.373)
Food Insufficiency * Food Stamps	–3.343	–4.332	–1.083	–1.800
	(2.739)	(2.755)	(2.376)	(2.350)

NOTE: There are 8,836 observations in the full sample (4,418 heads over two years), 4,432 in the low education sample (2,216 heads), 1,966 (983 heads) in the female-head sample. All models include controls for age, education, race, marital status, number of children, age of youngest child, and a year dummy variable for 2003. Standard errors are robust to heteroskedasticity of unknown form. The just identified models includes lagged levels of the endogenous regressors as instruments, while the over-identified models include a dummy variable for whether the worker was unemployed at some time in the previous year, state unemployment rates, political party of the Governor, the maximum AFDC and food stamp benefit level, and the error rate in the food stamp determination process.

Table 6. Simulations of How Food Stamp Participation Mediates the Effect of Food Insufficiency on the Emotional Distress Score

	Full Sample	Low Education	Female Headed Sample
Base Level of Emotional Distress	2.988	3.237	3.699
Food Insufficient Only	10.662[a]	10.688[d]	12.531[g]
Food Insufficient with Food Stamp Participation (with mediation effect)	11.776[b]	11.874[e]	11.161[h]
Food Insufficiency and Food Stamp Participation (no mediation effect)	15.244[c]	15.772[f]	14.504[i]

[a] indicates that t=16.446 for a two sample t-test with unequal variance between the base level of emotional distress and food insufficient only
[b] indicates that t=1.398 for a two sample t-test with unequal variance between the simulation of food insufficiency only and joint food insufficiency and food stamp participation
[c] indicates that |t|=3.791 for a two sample t-test with unequal variance between the simulation of joint food insufficiency and food stamp participation with and without the mediation effect
[d] indicates that t=13.789 for a two sample t-test with unequal variance between the base level of emotional distress and food insufficient only
[e] indicates that t=1.310 for a two sample t-test with unequal variance between the simulation of food insufficiency only and joint food insufficiency and food stamp participation
[f] indicates that |t|=3.787 for a two sample t-test with unequal variance between the simulation of joint food insufficiency and food stamp participation with and without the mediation effect
[g] indicates that t=8.346 for a two sample t-test with unequal variance between the base level of emotional distress and food insufficient only
[h] indicates that t=0.989 for a two sample t-test with unequal variance between the simulation of food insufficiency only and joint food insufficiency and food stamp participation
[i] indicates that |t|=2.631 for a two sample t-test with unequal variance between the simulation of joint food insufficiency and food stamp participation with and without the mediation effect

Appendix 1: Full Results for all Models (Full Sample N=8836)

	Pooled OLS	Between Effects	Fixed Effects	Random Effects	Food Insufficiency Exogenous		Food Insufficiency Endogenous	
					Just Identified	Over Identified	Just Identified	Over Identified
Food Insufficient	4.167	5.381	2.266	3.397	3.962	3.902	3.005	2.875
	(0.560)	(0.572)	(0.686)	(0.535)	(0.938)	(0.934)	(1.189)	(1.172)
Food Stamp Participation	1.993	2.455	0.386	1.538	3.996	3.775	3.908	3.713
	(0.230)	(0.248)	(0.350)	(0.235)	(2.264)	(2.018)	(2.277)	(2.018)
Food Insufficiency * Food Stamps	–0.866	–2.574	1.618	0.172	–3.467	–3.281	–2.379	–2.126
	(0.965)	(0.952)	(1.096)	(0.873)	(1.856)	(1.829)	(1.925)	(1.874)
Less than high school	0.932	0.847		1.012				
	(0.128)	(0.137)		(0.157)				
High school graduate	0.241	0.225		0.255				
	(0.085)	(0.107)		(0.104)				
Married	–0.829	–0.818	–0.545	–0.821	–0.430	–0.436	–0.448	–0.455
	(0.107)	(0.126)	(0.413)	(0.125)	(0.427)	(0.426)	(0.428)	(0.427)
Never Married	–0.117	–0.116	–1.051	–0.133	–1.025	–1.025	–1.026	–1.026
	(0.142)	(0.159)	(0.644)	(0.168)	(0.732)	(0.726)	(0.727)	(0.722)
Age	–0.025	–0.025	0.086	–0.026	0.113	0.112	0.106	0.105
	(0.004)	(0.005)	(0.129)	(0.005)	(0.139)	(0.138)	(0.138)	(0.137)
Number of children	–0.045	–0.052	–0.154	–0.046	–0.236	–0.231	–0.230	–0.226
	(0.042)	(0.052)	(0.101)	(0.048)	(0.114)	(0.112)	(0.114)	(0.112)
Age of youngest child	0.002	0.001	0.011	0.003	0.010	0.010	0.010	0.010
	(0.008)	(0.011)	(0.015)	(0.009)	(0.016)	(0.016)	(0.016)	(0.016)
Black	–0.352	–0.402		–0.293				
	(0.099)	(0.115)		(0.120)				
Other Race	–0.524	–0.540		–0.510				
	(0.163)	(0.183)		(0.204)				
Yr03	–0.140		–0.375	–0.136				
	(0.077)		(0.269)	(0.056)				
Intercept	4.623	4.527	0.223	4.661	–0.461	–0.457	–0.448	–0.443
	(0.222)	(0.274)	(5.476)	(0.267)	(0.293)	(0.290)	(0.292)	(0.289)

Appendix 2: Full Results for all Models (Low Education Sample N=4432)

	Pooled OLS	Between Effects	Fixed Effects	Random Effects	Food Insufficiency Exogenous Just Identified	Food Insufficiency Exogenous Over Identified	Food Insufficiency Endogenous Just Identified	Food Insufficiency Endogenous Over Identified
Food Insufficient	4.093	5.296	2.245	3.369	4.082	4.024	3.456	3.230
	(0.656)	(0.713)	(0.802)	(0.625)	(1.135)	(1.132)	(1.398)	(1.368)
Food Stamp Participation	2.238	2.762	0.499	1.748	4.214	3.556	4.141	3.513
	(0.266)	(0.309)	(0.387)	(0.268)	(2.688)	(2.145)	(2.721)	(2.155)
Food Insufficiency * Food Stamps	–0.980	–2.631	1.309	–0.038	–3.898	–3.736	–3.168	–2.804
	(1.077)	(1.153)	(1.183)	(0.965)	(2.299)	(2.263)	(2.290)	(2.218)
Less than high school	0.692	0.623		6.054				
	(0.140)	(0.160)		(0.430)				
High school graduate								
Married	–0.905	–0.876	–0.634	–0.917	–0.444	–0.460	–0.466	–0.486
	(0.156)	(0.189)	(0.585)	(0.181)	(0.606)	(0.601)	(0.609)	(0.604)
Never Married	–0.272	–0.264	–1.782	–0.298	–1.864	–1.817	–1.878	–1.840
	(0.205)	(0.235)	(1.105)	(0.243)	(1.314)	(1.278)	(1.307)	(1.271)
Age	–0.029	–0.028	0.118	–0.030	0.176	0.173	0.163	0.157
	(0.006)	(0.008)	(0.191)	(0.008)	(0.218)	(0.212)	(0.217)	(0.210)
Number of children	–0.075	–0.097	–0.165	–0.061	–0.252	–0.237	–0.248	–0.232
	(0.061)	(0.073)	(0.145)	(0.070)	(0.158)	(0.155)	(0.158)	(0.155)
Age of youngest child	–0.016	–0.015	–0.013	–0.017	–0.018	–0.017	–0.018	–0.017
	(0.012)	(0.017)	(0.021)	(0.013)	(0.023)	(0.222)	(0.023)	(0.022)
Black	–0.484	–0.554		–0.409				
	(0.139)	(0.170)		(0.168)				
Other Race	–0.672	–0.698		–0.653				
	(0.246)	(0.268)		(0.306)				
Yr03	–0.158		–0.459	–0.151				
	(0.120)		(0.398)	(0.089)				
Intercept	5.245	5.126	0.389	5.298	–0.631	–0.615	–0.606	–0.583
	(0.334)	(0.410)	(7.961)	(0.401)	(0.458)	(0.442)	(0.458)	(0.441)

Appendix 3: Full Results for all Models (Female Head Sample N=1966)

	Pooled OLS	Between Effects	Fixed Effects	Random Effects	Food Insufficiency Exogenous Just Identified	Food Insufficiency Exogenous Over Identified	Food Insufficiency Endogenous Just Identified	Food Insufficiency Endogenous Over Identified
Food Insufficient	5.299	6.867	2.505	4.036	4.290	4.808	2.178	2.633
	(1.005)	(1.311)	(1.130)	(0.916)	(1.848)	(1.855)	(1.646)	(1.615)
Food Stamp Participation	1.757	2.263	0.213	1.174	2.801	2.766	2.658	2.731
	(0.304)	(0.401)	(0.452)	(0.311)	(2.867)	(2.358)	(2.882)	(2.373)
Food Insufficiency * Food Stamps	–2.660	–4.431	–0.026	–1.359	–3.343	–4.332	–1.083	–1.800
	(1.415)	(1.796)	(1.578)	(1.259)	(2.739)	(2.755)	(2.376)	(2.350)
Less than high school	1.317	1.208		1.447				
	(0.276)	(0.321)		(0.341)				
High school graduate	0.310	0.281		0.344				
	(0.216)	(0.277)		(0.264)				
Married								
Never Married	–0.483	–0.534	2.530	–0.404	5.123	5.089	4.978	5.051
	(0.218)	(0.274)	(1.591)	(0.264)	(3.280)	(2.839)	(3.294)	(2.853)
Age	–0.043	–0.044	0.220	–0.041	0.292	0.295	0.289	0.292
	(0.010)	(0.013)	(0.354)	(0.013)	(0.372)	(0.369)	(0.371)	(0.369)
Number of children	–0.182	–0.246	0.004	–0.110	–0.087	–0.082	–0.093	–0.093
	(0.092)	(0.120)	(0.233)	(0.113)	(0.257)	(0.250)	(0.256)	(0.249)
Age of youngest child	–0.004	–0.001	0.002	–0.005	–0.004	–0.005	–0.002	–0.003
	(0.019)	(0.026)	(0.032)	(0.021)	(0.034)	(0.034)	(0.034)	(0.034)
Black	–0.763	–0.790		–0.737				
	(0.217)	(0.277)		(0.271)				
Other Race	0.151	0.111		0.191				
	(0.475)	(0.553)		(0.630)				
Yr03	–0.206		–0.715	–0.203	–0.901	–0.907	–0.904	–0.912
	(0.190)		(0.736)	(0.131)	(0.789)	(0.777)	(0.786)	(0.776)
Intercept	6.036	6.001	–6.087	5.918				
	(0.549)	(0.704)	(14.681)	(0.676)				

Appendix Table 4: First Stage Estimates (Full Sample N=4418)

	Δ Food Insufficiency		Δ Food Stamp Participation		Δ Food Insufficiency * Food Stamp Participation	
	Just Identified	Over Identified	Just Identified	Over Identified	Just Identified	Over Identified
Food Insufficiency lag	–0.772	–0.773	0.090	0.089	–0.052	–0.052
	(0.055)	(0.056)	(0.062)	(0.062)	(0.044)	(0.045)
Food Stamp Participation lag	0.0441	0.039	–0.148	–0.163	0.036	0.037
	(0.015)	(0.015)	(0.030)	(0.031)	(0.012)	(0.012)
Food Insufficiency*Food Stamp Participation lag	–0.082	–0.078	–0.096	–0.089	–0.700	–0.700
	(0.089)	(0.089)	(0.107)	(0.107)	(0.089)	(0.089)
State Unemployment Rate lag (x100)		–0.049		–0.245		–0.242
		(0.239)		(0.400)		(0.164)
Unemployed lag (x100)		1.116		0.331		–0.362
		(1.004)		(2.012)		(0.562)
Error Rate lag (x100)		–0.027		0.099		0.006
		(0.084)		(0.122)		(0.052)
Democratic Governor lag (x100)		–0.007		1.110		0.303
		(0.475)		(0.817)		(0.323)
AFDC/FSP Benefit lag (x1000)		–0.003		–0.021		–0.001
		(0.015)		(0.026)		(0.013)
Age lag (x100)		–0.015		–0.047		0.009
		(0.020)		(0.037)		(0.014)
Number of Children lag (x100)		0.222		0.982		0.025
		(0.250)		(0.404)		(0.145)
Δ Age (x100)	–0.114	–0.120	–0.563	–0.643	0.330	0.339
	(0.349)	(0.347)	(1.078)	(1.086)	(0.208)	(0.210)
Δ Married	–0.017	–0.016	–0.017	–0.016	0.001	0.000
	(0.014)	(0.014)	(0.021)	(0.022)	(0.012)	(0.012)
Δ Never Married	0.016	0.017	0.021	0.023	0.019	0.017
	(0.021)	(0.021)	(0.053)	(0.055)	(0.020)	(0.020)
Δ Age youngest child (x100)	–0.011	–0.027	0.030	–0.033	–0.041	–0.039
	(0.051)	(0.055)	(0.073)	(0.075)	(0.038)	(0.040)
Δ Number of Children	0.004	0.005	0.022	0.028	0.003	0.003
	(0.004)	(0.005)	(0.007)	(0.008)	(0.003)	(0.003)
Constant	0.013	0.023	0.027	0.055	–0.005	0.002
	(0.007)	(0.020)	(0.022)	(0.041)	(0.004)	(0.012)

Appendix Table 5: First Stage Estimates (Low Education Sample N=2216)

	Δ Food Insufficiency		Δ Food Stamp Participation		Δ Food Insufficiency * Food Stamp Participation	
	Just Identified	Over Identified	Just Identified	Over Identified	Just Identified	Over Identified
Food Insufficiency lag	–0.792	–0.794	0.099	0.096	–0.065	–0.064
	(0.060)	(0.060)	(0.075)	(0.074)	(0.053)	(0.054)
Food Stamp Participation lag	0.049	0.042	–0.143	–0.163	0.043	0.043
	(0.018)	(0.018)	(0.034)	(0.035)	(0.015)	(0.015)
Food Insufficiency*Food Stamp Participation lag	–0.059	–0.054	–0.050	–0.043	–0.660	–0.660
	(0.099)	(0.100)	(0.119)	(0.120)	(0.104)	(0.104)
State Unemployment Rate lag		–0.140		–0.180		–0.319
		(0.391)		(0.701)		(0.285)
Unemployed lag (x100)		1.413		2.254		–0.609
		(1.451)		(2.809)		(0.855)
Error Rate lag (x100)		0.007		0.182		0.039
		(0.155)		(0.216)		(0.103)
Democratic Governor lag (x100)		–0.635		3.104		0.185
		(0.764)		(1.397)		(0.561)
AFDC/FSP Benefit lag (x1000)		–0.005		–0.031		0.000
		(0.027)		(0.045)		(0.025)
Age lag (x100)		0.006		–0.111		0.016
		(0.035)		(0.001)		(0.026)
Number of Children lag (x100)		0.396		1.071		0.054
		(0.430)		(0.006)		(0.248)
Δ Age (x100)	–0.531	–0.514	–0.781	–0.890	0.677	0.697
	(0.647)	(0.642)	(2.067)	(2.099)	(0.407)	(0.410)
Δ Married	–0.017	–0.018	–0.014	–0.011	0.015	0.015
	(0.022)	(0.022)	(0.031)	(0.032)	(0.017)	(0.018)
Δ Never Married	0.042	0.042	0.089	0.100	0.055	0.052
	(0.040)	(0.040)	(0.101)	(0.103)	(0.039)	(0.040)
Δ Age youngest child (x100)	–0.064	–0.087	0.122	0.047	–0.097	–0.093
	(0.091)	(0.096)	(0.128)	(0.129)	(0.067)	(0.068)
Δ Number of Children	0.004	0.007	0.019	0.025	0.002	0.002
	(0.006)	(0.007)	(0.011)	(0.012)	(0.004)	(0.005)
Constant	0.028	0.032	0.042	0.086	–0.010	–0.005
	(0.014)	(0.030)	(0.042)	(0.071)	(0.008)	(0.023)

Appendix Table 6: First Stage Estimates (Female Head Sample N=983)

	Δ Food Insufficiency		Δ Food Stamp Participation		Δ Food Insufficiency * Food Stamp Participation	
	Just Identified	Over Identified	Just Identified	Over Identified	Just Identified	Over Identified
Food Insufficiency lag	–0.772	–0.772	0.087	0.077	–0.117	–0.118
	(0.103)	(0.103)	(0.113)	(0.111)	(0.079)	(0.079)
Food Stamp Participation lag	0.037	0.035	–0.146	–0.189	0.039	0.035
	(0.017)	(0.016)	(0.036)	(0.043)	(0.015)	(0.014)
Food Insufficiency*Food Stamp Participation lag	–0.021	–0.021	–0.033	–0.014	–0.621	–0.617
	(0.142)	(0.143)	(0.147)	(0.148)	(0.130)	(0.129)
State Unemployment Rate lag (x100)		–0.102		0.299		–0.070
		(0.592)		(1.279)		(0.482)
Unemployed lag (x100)		–1.379		2.875		–0.143
		(1.450)		(4.758)		(1.496)
Error Rate lag (x100)		0.081		0.082		–0.150
		(0.188)		(0.393)		(0.131)
Democratic Governor lag (x100)		0.446		0.229		–0.108
		(1.035)		(2.546)		(0.793)
AFDC/FSP Benefit lag (x1000)		–0.048		0.022		–0.029
		(0.034)		(0.083)		(0.033)
Age lag (x100)		–0.017		–0.169		0.030
		(0.037)		(0.109)		(0.029)
Number of Children lag (x100)		0.247		2.049		0.474
		(0.432)		(1.154)		(0.366)
Δ Age (x100)	0.222	0.305	–3.147	–3.046	0.361	0.544
	(0.294)	(0.337)	(2.754)	(2.767)	(0.301)	(0.343)
Δ Married						
Δ Never Married	–0.010	–0.011	–0.948	–0.911	–0.013	–0.010
	(0.015)	(0.018)	(0.041)	(0.044)	(0.009)	(0.013)
Δ Age youngest child (x100)	–0.094	–0.112	0.187	0.061	–0.150	–0.163
	(0.116)	(0.114)	(0.241)	(0.244)	(0.112)	(0.110)
Δ Number of Children	–0.003	–0.002	0.034	0.045	0.007	0.010
	(0.012)	(0.013)	(0.021)	(0.024)	(0.009)	(0.010)
Constant	0.002	0.038	0.102	0.116	–0.007	0.009
	(0.007)	(0.039)	(0.057)	(0.116)	(0.006)	(0.035)