J Fam Econ Iss (2014) 35:499–515
DOI 10.1007/s10834-013-9382-z

ORIGINAL PAPER

Household Finance and Food Insecurity

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Published online: 10 December 2013

Abstract Despite repeated expansions of federal food assistance, food insecurity and hunger continue to affect many Americans. While job loss and poverty are among major contributors, theoretical and empirical literature suggest that households' ability to borrow and save might provide a buffer protecting from food insecurity. Using data from the Panel Study of Income Dynamics, we tested whether liquidity constraint, asset inadequacy, and insolvency risk defined based on financial ratios could predict household food insecurity separately from the effects of income and program participation. Results showed that a household's liquidity constraint and asset inadequacy were linked with increased risk of food insecurity at all income levels, although the association was strongest among poor households and those with incomes slightly above the federal food assistance eligibility threshold. Unlike indications from qualitative literature, financial constraint appeared to be an exogenous determinant of household food insecurity. Implications for financial practitioners and policymakers are discussed.

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Keywords Food insecurity · Financial strain · Liquidity constraint · Asset poverty · SNAP

Introduction

According to the 2011 report from the Economic Research Service (ERS) of the United States Department of Agriculture (USDA), 14.9 % of American households were food insecure, meaning that they lacked access to enough food to maintain an active and healthy lifestyle sometime during the year. Furthermore, 5.7 % of American households had to cut their amount of food intake at times or had disrupted eating patterns, a situation labeled "very low food security" by the USDA (Coleman-Jensen et al. 2012).

Not only does food insecurity persist in America, but household food insecurity has also grown over the years despite continuous expansion of federal food assistance programs. In 1998, the food insecurity and very low food security rates were 11.8 and 3.7 %, respectively—considerably lower than the current numbers (Andrews and Nord 2009; LeBlanc et al. 2005). The increase was viewed as being due in part to the recession (Andrews and Nord 2009; LeBlanc et al. 2005).

While job loss and low income have been found to be among the strongest contributors to food insecurity (Loopstra and Tarasuk 2013), income alone cannot explain why some households are food secure and others are not. More than half (58.9 %) of the households whose incomes were below poverty were in fact food secure, while there were as many as 7 % of American households who made more than 185 % of the poverty line but were food insecure (Coleman-Jensen et al. 2012). A significant reason for this mismatch may be explained by differences in living costs and local food environment (Bartfeld and Dunifon 2006),

but it may also be due to households' ability to cope financially and maintain consistency in food consumption when they are faced with income shortage or instability.

This study investigates whether households' adequate asset holdings can provide an additional "cushion" to help avoid food insecurity and hunger. We expect assets and debts to play an important role in explaining food insecurity because research suggested that low-income households that have more assets relative to debt are better able to cope with unforeseen expenditures or financial difficulties than households that are in financially ill-prepared (Guo 2011; Mills et al. 2000; US Department of Health and Human Services 1999). Specifically, we examine whether household financial strain, asset inadequacy, and risk of insolvency increase food insecurity, while holding income, program participation, and other socioeconomic characteristics constant.

Research regarding the role of household financial strain other than income in explaining food insecurity is sparse. Some previous research that studied household assets as a factor of food security in addition to income focused on ownership of several types of assets such as home, vehicle, savings, and risky assets (Gundersen and Gruber 2001; Guo 2011; Olson et al. 1996; Ribar and Hamrick 2003; West and Price 1976). However, asset ownership may not depict the financial situation of households fully if households have substantial liabilities to offset. This study looked at the relationship between household debt burden and food insecurity, which has not been studied previously. Increased supply of consumer credit for low-income families in the past decades enabled low-income households to utilize financial credit but also put them under heavy debt burden and greater hardship (Fellowes and Mabanta 2007). The debt level of those in the bottom income quartile has increased by 308 % between 1989 and 2004 (Fellowes and Mabanta 2007), which might partially explain the increase in food insecurity rates in the US.

Given the importance of assets as well as increased availability of financial credit for low-income households, using concrete financial guidelines could help us to better understand wealth and food insecurity. By using financial ratios instead of linear measures of assets and debts, this study offers specific implications for financial counselors and shows that maintaining the recommended saving minimum and staying within the borrowing limit can help a household avoid food shortages at times of income interruptions.

Another contribution of this study is that it attempts to extricate the asset-hunger relationship for subgroups based on income levels commonly used as income eligibility cutoffs for food assistance programs. Not only does this approach further isolate the role of household finance from closely related factors such as income and program participation, it also sheds light on the current policy debate of whether asset tests in food assistance eligibility determination are needed. With greater emphasis on asset-building among low-income families, many states have allowed greater flexibility in asset-based eligibility standards such as vehicle and other asset ownerships (Klerman and Danielson 2011; Rosenbaum 2002). We discuss how our findings relate to this policy change.

Review of Literature

Food security is a concept of "consistent, dependable access to enough food for active, healthy living" (Coleman-Jensen et al. 2012, p. 2). Households are considered food insecure if their "access to adequate food is limited by lack of money and other resources" sometime during the year (p. 2). The inter-temporal consumption model hypothesizes the risk of food insecurity increases upon negative income shocks if the household is liquidity-constrained, that is, if the household lacks sufficient liquid assets and/or has difficulty borrowing.

Analyses of household expenditures have consistently found that food expenditure increases with assets. In his seminal work on the theory of permanent income, Friedman (1957) hypothesized and empirically showed that household food expenditures increased as assets increased, holding income constant. Another study also found that, overall, a $10,000 increase in asset holdings resulted in a $4 increase in monthly food spending, although the asset effect depended on race (West and Price 1976). Although it is possible that the positive association between assets and food expenditures at the mean simply reflected the income effect on high-priced food items, other studies more directly showed that households borrowed and saved to meet food consumption needs when they were faced with income volatility (Ogaki and Atkeson 1997; Zimmerman and Carter 2003). Some others suggested that access to credit might help households avoid food insecurity (Gundersen and Gruber 2001; Ribar and Hamrick 2003).

Assessment of the relationship between household assets and food security is sparse at least in the quantitative literature. Most previous studies about the determinants of food insecurity have only used income, homeownership, and vehicle ownership as indicators of financial resources (Gundersen and Gruber 2001; Ribar and Hamrick 2003; West and Price 1976). Only a handful of studies have examined the role of owning other types of assets to explain food security. For example, in their study of Michigan welfare recipients, Heflin et al. (2007) found that mental health and low financial resources were associated with food insecurity, where income instead of assets represented households' financial resources.

Homeownership has been viewed as a proxy for assets or wealth (Rose et al. 1998). At least two separate studies (Cristofar and Basiotis 1992; Rose et al. 1998) found homeownership to be negatively associated with food insecurity. In a similar vein, other research found that past homelessness was positively associated with food insecurity among low-income households (Furness et al. 2004). A study that used a survey of Oregon residents also reported that not only the lack of homeownership but also the high burden for housing payment (>30 % of income) were positively associated with food insecurity (De Marco and Thorburn 2008). Another study demonstrated that vehicle ownership reduced food insecurity, possibly through improved access to food (Fitzpatrick and Ver Ploeg 2010).

In a qualitative study based on women's open-ended interview responses, unusual spending needs such as longstanding health problems, persistent income deficiency, and accumulated debts were identified as conditions that precipitated food shortages (Tarasuk 2001). Another interview-based study found that lack of savings was correlated with significantly higher risk of food insecurity among rural households (Olson et al. 1996). A Finnish study also reported that controlling for current income and recent employment status, food insecurity was positively associated with the household's long-term economic problems (Sarlio-Lähteenkorva and Lahelma 2001).

To our knowledge, there is only one quantitative study that directly examined the association between financial asset ownership and food insecurity (Guo 2011). In addition to home and vehicle ownerships, Guo expanded the value of total savings and ownership of mutual funds/stocks to understand food insecurity using the 2002 Survey of Program Dynamics. Guo (2011) found that the values of households' savings, mutual funds, and stocks were negatively associated with the risk of food insecurity, controlling for income. Guo also argued that especially among low-income households it was assets (especially savings), and not income, that mattered. Whereas Guo's study provided evidence of negative correlations between financial asset holdings and food insecurity at the mean, it neither considered the role of household debts nor provided specific information on whether following certain financial ratio-based guidelines would help avoid food insecurity. We expand from Guo's study and investigate how failure to maintain the recommended minimum level of savings, or borrowing beyond the suggested maximum, may put a household in danger of food insecurity.

Financial Status Measures

In household finance literature, several asset-based concepts and measurements have been used to describe the financial status of a household. Some studies have used the total asset value or net worth as a measure of accumulated wealth available for emergency or for retirement (Guo 2011; West and Price 1976). However, given the highly skewed distribution of household wealth, total household asset holdings measured at the mean may not be very useful in describing the problems experienced by financially-constrained households in meeting their basic consumption needs such as food.

Other studies used financial ratios to evaluate a household's emergency cash reserves, liquidity constraint, and debt burden. A number of studies in household finance literature have developed and tested financial ratios as asset-based concepts that assess households' financial conditions and well-being (Bi and Montalto 2004; Choi et al. 2001; DeVaney 1994, 2002; Grafova 2011; Greninger et al. 1996; Harness et al. 2009a, b; Hong and Kao 1997; Huston and Chang 1997; Johnson and Widdows 1985). The Griffith (1985) study was the first scientific attempt to use financial ratios to represent financial well-being of households. DeVaney (1994) found that financial ratios were important indicators for predicting household indebtedness and delinquency. The study by Greninger et al. (1996) further established the application of several financial ratios related to debt, liquidity, emergency fund holdings, and savings that have been used ever since in numerous subsequent studies for analyzing financial well-being of households.

Compared to total asset holdings or net worth, which summarize the value of an accumulated stock of funds available for emergency or for retirement, financial ratios gauge a household's liquidity constraint by evaluating the adequacy of emergency cash reserves or debt burden (Choi et al. 2001; Grafova 2011). These ratios examine whether the households maintained readily-available financial resources to sustain normal or minimal consumption levels when income flow was interrupted (Hayashi 1985; Jappelli 1990; Zeldes 1989). As most credit denials in the US are related to income and asset, use of these ratios may be based on the notion that asset-to-income ratios proxy the household's ability to borrow (Jappelli 1990; Leete and Bania 2010). In other words, borrowing may be out of the reach of financially strained households as their poor financial shape may make it either impossible or very expensive to borrow, and financial ratios might better reflect current and future borrowing of households. Also, unlike the amount of asset holdings or the raw values of financial ratios that may merely reflect the household's permanent income and economic status, binary measures of asset readiness or adequacy determined by the recommended levels of financial ratios can be interpreted as the product of sound financial management practices at any income and wealth levels.

In sum, the search for economic causes of food insecurity has focused on the relationship between household income dynamics and food insecurity, and very few empirical studies have examined how food insecurity is related to healthy financial management practices of households. This study investigates how household food insecurity is related to several alternative measures of household financial ratios that reflect liquidity constraint, asset inadequacy, and insolvency separately from the effect of income, program participation, and other known adverse contributors. To further isolate the role of household finance from program eligibility and other socioeconomic correlates, we also estimate the regression for subgroups defined on the basis of income levels.

Methods

Assuming that Y was the latent variable of food insecurity, we hypothesized Y to be a function of household finance and other household characteristics. Since the extant literature suggests that prevalence of food insecurity varied substantially from state to state, even within the same region, due to the variations across states in terms of accessibility of federal nutrition programs, income support for the poor, and socioeconomic characteristics (Bartfeld and Dunifon 2006; Coleman-Jensen et al. 2012), the omission of state fixed effects would result in state-level clustering of the regression residuals. To overcome this problem, we modeled the likelihood of food insecurity of household i living in state s as:

$$Y_{is} = X'_{is}\mathrm{B} + Fin'_{is}\Gamma + \pi_s + \varepsilon_i$$

where $\boldsymbol{X}$ was a vector of demographic controls, $\boldsymbol{Fin}$ was a vector of the financial strain variables, $\boldsymbol{\pi}$ was a vector of state-specific intercepts, ε was the error term with $\varepsilon \sim N(0,1)$. A household was considered food insecure if Y exceeded a certain threshold Y^*, and the probability that household i was food insecure could be written as:

$$\Pr(Y_{is} > Y^* | X_{is}, Fin_{is}) = \Phi(X'_{is}\mathrm{B} + Fin'_{is}\Gamma + \pi_s)$$

where $\Phi(\cdot)$ as the standard normal distribution. The parameters were estimated in maximum likelihood Probit.

Dependent Variable

The USDA ERS developed the core food security survey module, which has been adopted by several nation-wide household surveys. The module comprised 18 questionnaire items, which described conditions and behaviors that characterized households having difficulty meeting basic food needs (Coleman-Jensen et al. 2012). Three of the 18 items were at the household level, seven were for adult household members, and eight were for children if the household had any. Households were asked whether their experiences during the last 12 months matched any of these items. The number of affirmative responses could range between 0 and 18 for households with children and between 0 and 10 for households without children, based on which each household was categorized into one of four food security levels: high food security, marginal food security, low food security, and very low food security (Coleman-Jensen et al. 2012). The USDA classified the latter two categories as "food insecure." Following the convention in the food insecurity literature, we used the binary measure of food insecurity, where 1 meant food insecurity and 0 meant food security. In essence, "food insecure" meant that the household reported experiencing at least three conditions or behaviors characterizing food insufficiency during the last 12 months.

The binary measure of "food insecurity" has been more widely used in the literature than the raw score or the four categorical levels. The raw score was unusable because the range of scores was not equal across the sample (i.e., households without children were asked only 10 questions as opposed to 18). Use of the four levels of food security was also problematic because "very low food security" appeared so infrequently that in practice the ordered Probit often reduced to binary Probit. Binary measures of food insecurity also can yield more direct policy implications considering most official government statistics (Coleman-Jensen et al. 2012) cited the rate of food insecurity more frequently than the severity of it.

Variables Representing Household Financial Status

In this study we used five asset-based measures. Our first variable was based on the household liquidity ratio. This measure assesses whether the household has readily-available financial resources to maintain its consumption in case the normal income flow is temporarily interrupted by job loss, illness, death, or any other negative income shocks. Specifically, following Grafova (2011) and DeVaney (2003), we determined whether a ratio of liquid assets to annual household income was less than 0.25, that is, whether the household's liquid assets amounted to less than 3 months' income. Liquid assets included funds in checking and saving accounts, money market funds, certificates of deposit, government bonds, and treasury bills.

Our second measure was based on the ratio of non-pension financial assets to income. Non-pension financial assets included liquid assets plus equity in stock, mutual funds, and investment trusts, and also other liquid assets such as bond funds, cash value in a life insurance policy, valuable collection for investment purposes, and rights in a trust or estate. Following the literature (DeVaney 2003),

we considered the ratio of non-pension financial assets to annual income of less than 0.5 as financially constrained. Compared to the first measure addressing the household's emergency funds and immediate coping capability, the second measure assessed the household's ability to maintain the current level of consumption during longer periods (6 months) of income interruptions. Both the first and the second measures can be interpreted to represent liquidity constraint based on the notion that asset-to-income ratios were a proxy for the household's ability to borrow (Jappelli 1990; Leete and Bania 2010).

The third and fourth measures we used were related to the concept of asset poverty. In the poverty measurement arena, asset-based measures have been suggested as an indicator of economic hardship alternative to the official income-based poverty measure (Brandolini et al. 2010; Haveman and Wolff 2004). Following the suggestions of Haveman and Wolff (2004), we defined a household to be asset poor if its non-housing net worth was less than 25 % of the poverty line or three times the monthly poverty level. Alternatively, a household could be defined as asset poor if its non-pension financial assets were less than 25 % of the poverty line or three times the monthly poverty level. In both cases, the poverty line was defined household-specifically. That is, we applied the Census Bureau's poverty threshold based on each household's family size, number of persons under age 18, and age of the householder. We also accounted for changes in family composition in the previous year.

The fifth measure used the debt-to-equity ratio, which equaled the total outstanding debt other than mortgage on the primary residence or vehicle loans, divided by net worth excluding housing equity (DeVaney and Lytton 1995). Because the amount of debt may be positively correlated with the household's ability to borrow, this measure may be less likely than the above four measures to represent liquidity constraint. However, a high debt-to-equity ratio might indicate that a household's financial burden resulted from significant expenditures from the past, and is likely to limit the present availability of financial resources. Based on the literature, we interpreted a ratio greater than one to be an indicator of insolvency.

Because these five measures shared either denominators or numerators with one another, using all five measures in one regression would make regression coefficients intuitively uninteresting. For example, the asset-to-income ratios and asset-to-poverty ratios share the same numerator, therefore asset-to-poverty ratios controlling for asset-to-income ratios would essentially reflect nothing more than income relative to poverty, which is not of our main interest. Therefore, we explored three regression specifications: one regression with the two "asset to income"-based measures only, another regression with the two "asset to poverty"-based measures only, and lastly another regression with the "debt to equity"-based measure only.

Demographic and Other Controls

Repeatedly noted determinants of food insecurity in the US included labor market variables such as income and employment; socioeconomic variables such as education; demographic variables such as age, race, and family composition; program participation such as food stamps (Gundersen and Kreider 2008; Mykerezi and Mills 2010; Ratcliffe et al. 2011; Yen et al. 2008) and other welfare programs (Borjas 2004); behavioral variables such as smoking (Armour et al. 2008); social capital (Martin et al. 2004); and environmental variables such as urban/rural residence and local food accessibility (Garasky et al. 2006).

The life-cycle income hypothesis models an individual's asset holding as a function of his or her initial wealth, rate of return on investment, and age. Empirical literature generally confirmed theoretical predictions and also showed that income, education, financial literacy, health, male gender, being white, and marriage increased household net worth and decreased the risk of asset poverty (Caner and Wolff 2004; Cobb-Clark and Hildebrand 2006; Deere and Doss 2006; Lusardi and Mitchell 2007; Lyons and Yilmazer 2005; Shorrocks 1975; Smith 1995; Venti and Wise 1998).

Therefore, our regression models controlled for age, age squared, gender, race, marital status, number of children, education, income, as well as participation in Temporary Assistance for Needy Families (TANF), participation in Supplemental Nutrition Assistance Program (SNAP), participation in Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), and participations in National School Breakfast and Lunch Program (NSBP and NSLP). Income was measured as the total household income before tax including social security and other transfer incomes, and was transformed to natural log in regressions. We also controlled for standard metropolitan statistical area (SMSA), urban, and rural residence, and the four US regions.[1] As there may be seasonal variations in food security (Nord and Kantor 2006; Nord and Romig

[1] PSID offers Beale Rural–Urban Code, which is a 10-point ordinal scale with lower numbers signifying greater urbanization. However, our preliminary analysis showed that food insecurity was not a linear function on the urban–rural continuum, and was relatively high in very urban and very rural areas compared to areas that were somewhat urbanized. This discouraged us from using the continuous scale of urbanization. Alternatively, using ten dummies created based on Beale codes would result in problems due to some small cell sizes and hurt model efficiency. The decision to group the sample to three categories—rural, urban (omitted category), and metropolitan—was a choice based on this technical consideration as well as to follow the convention in the existing food insecurity literature.

2006), a dummy indicating the interview was conducted in summer months—June through September—was also controlled for. As the previous literature suggested, homeownership and vehicle ownership were also important correlates of food insecurity (Fitzpatrick and Ver Ploeg 2010; Guo 2011), so we included them also.

Food Assistance Program Participation

Participation in food assistance programs, such as SNAP, may be a variable that mediated the finance-food correlation. There were at least two reasons for that. First, because food assistance programs such as SNAP explicitly aimed to lessen household food insecurity (Gundersen et al. 2011), the correlation between a household's poor financial status and the likelihood of food insecurity could be minimized if it received food assistance at times of need (Robinson 2013; Ver Ploeg 2009). Second, poor financial status and program participation may be simultaneously determined. Federal food assistance programs such as SNAP included an asset eligibility test, which required recipients to prove their asset levels were sufficiently low.[2] This implied that asset hardship must be closely correlated with SNAP participation because the financial variables themselves represented SNAP eligibility.

Although our regression model controlled for participation in TANF, SNAP, WIC, NSLP, and NSBP as household-level covariates, we needed a more methodical approach to account for the intervening role of food assistance programs. We estimated additional regressions for income subgroups: the households whose household incomes were below 100 % of the federal poverty line, those whose incomes were between 100 and 130 % of the poverty line, those whose incomes were between 130 and 185 % of the poverty line, and those with incomes above 185 % of the poverty threshold. The poverty thresholds came from the Census Bureau's needs assessment based on family size and age composition. The 130 and 185 % cutoffs were chosen because, while there remained a cross-state variability of food assistance program generosity, many states used 130 % of the poverty line as the food assistance program eligibility threshold, and households whose incomes were above 185 % of the poverty threshold were unlikely to be eligible for public food and other assistance programs. Also, the USDA reported that the income below 185 % of poverty was a highly significant predictor of low food security (Coleman-Jensen et al. 2012). For each income group, the exact same regression specifications were applied, except that the five financial ratio variables were entered one at a time. Also, due to small cell sizes, regressions by income groups were estimated without state fixed effects.

Data

We used the 2003 Panel Study of Income Dynamics (PSID). The PSID is a longitudinal survey that began in 1968 with a nationally representative sample of over 5,000 US households. Since 1984, the PSID has collected detailed household wealth data consisting of reported or imputed values of specific components of net worth. The PSID was one of a few national surveys that had incorporated the USDA's core food security module and at the same time had detailed information on household assets. The most recent survey year for which the PSID included the food security questions was 2003. Inclusion of both the asset data and the food security module makes the 2003 PSID ideal for our study.

We excluded households with heads aged 65 or older because interpretation of post-retirement wealth should be different. We also deleted 39 households whose incomes were not greater than zero. Non-positive incomes typically result from losses in business or farm (Grafova 2011). After deleting observations with missing values, our final sample for analysis consisted of 6,244 households.

Table 1 summarizes the characteristics of the sample. All estimates were adjusted with the sampling weights provided by the PSID so that the data would resemble the population as closely as possible and be free of potential sampling bias. Only 7.8 % of our weighted sample was food insecure, which was substantially lower than the report based on Current Population Survey for the same year, 2003 (11.2 %). This may be due to our exclusion of older households, for whom the food insecurity rate was high (Coleman-Jensen et al. 2012). The average household head in the sample was a 43 year-old non-Hispanic white man. The majority of the sample was married-couple households. At the median, household heads had some but less than 4 years of college education. The mean annual household income was $67,353, considerably higher than the Census Bureau's report, also likely due to exclusion of households with heads over 65 years of age. Roughly 5.7 % of the sample reported receiving food stamps, which was close to the participation rate reported by the Census Bureau for that year. The vast majority lived in metropolitan areas defined by the Beale rural–urban code. The sample fairly represented all four major US regions.

Table 2 summarizes asset-related variables. 64 % of the sample was homeowners. 87 % of the households owned at least one vehicle. The weighted mean values of liquid

[2] The federal SNAP eligibility rules require that receiving households have assets of $2,000 or less, although states vary in handling of asset eligibility tests (http://www.fns.usda.gov/snap/applicant_recipients/eligibility.htm).

Table 1 Sample characteristics ($n = 6,244$)

	Mean	Std. dev.
Food insecure	0.078	0.268
Age (years)[a]	42.8	11.6
Female	0.253	0.435
Race: white	0.766	0.424
Race: black	0.126	0.332
Race: Latino	0.063	0.242
Race: other	0.024	0.154
Marital status: married	0.521	0.500
Marital status: never married	0.226	0.418
Marital status: widowed	0.023	0.149
Marital status: divorced	0.230	0.421
Number of children[a]	0.8	1.1
Education: less than high school	0.154	0.361
Education: high school	0.314	0.464
Education: some college	0.247	0.431
Education: college	0.174	0.379
Education: graduate school	0.111	0.314
Annual household income ($)[a]	67,353	94,439
TANF	0.011	0.105
SNAP	0.057	0.233
WIC	0.047	0.212
School lunch	0.022	0.147
School breakfast	0.071	0.257
SMSA	0.773	0.419
Urban	0.198	0.398
Rural	0.031	0.172
Region: Northeast	0.179	0.383
Region: North Central	0.236	0.425
Region: South	0.360	0.480
Region: West	0.222	0.415
Summer months	0.363	0.481

The sample consisted of households with heads under 65 years of age that reported positive incomes in the 2003 PSID. All estimates were adjusted for sampling weights

[a] Dummy variables except marked

asset, non-pension financial asset, non-equity net worth, and debt were $15,696, $54,395, $156,681, and $8,204, respectively. The respective median values were $1,400, $2,000, $11,000 and $800. The median net worth of $11,000 was close to the $10,500 reported by the Census Bureau for the same year (Gottschalck 2003).

Table 3 summarizes pairwise correlation coefficients among financial variables. All five binary measures had significant positive correlations with one another. Correlations were particularly strong for pairs of variables derived from the ratios that shared either the denominator or the numerator, which justifies our decision not to include them altogether in regressions. The weakest correlation was observed between whether the financial assets were less than 3 months' poverty and whether the debt exceeded the net worth ($r = 0.031$, $p < 0.05$).

Table 2 Descriptive statistics of household assets ($n = 6,244$)

	Mean	Std. dev.	Median
Own a home[a]	0.637	0.481	–
Own a car[a]	0.869	0.337	–
Liquid assets ($)	15,696	60,872	1,400
Financial assets ($)	54,395	512,251	2,000
Net worth ($)	156,681	858,971	11,000
Debt ($)	8,204	22,132	800
Liquid asset <3 × monthly income	0.827	0.378	
Financial asset <6 × monthly income	0.775	0.417	
Net worth <3 × monthly poverty line	0.301	0.459	
Financial asset <3 × monthly poverty line	0.479	0.500	
Debt to asset ratio >1	0.073	0.259	

The sample consisted of households with heads under 65 years of age that reported positive incomes in the 2003 PSID. Means and standard deviations were adjusted for sampling weights. Values of assets, debt, and net worth are reported in 2003 US dollars

[a] Dummy variables

Results

Table 4 presents marginal effects from probit regressions of food insecurity. Regressions were estimated with survey weights. The results showed strong support for the importance of adequate household assets in meeting basic food needs of the family.

Households that did not have liquid assets totaling at least 3 months' worth of their income were about three percentage points more likely to be food insecure than households that did. In addition, households that did not have non-pension financial assets totaling at least 6 months' income were 1.6 percentage points more likely to be food insecure (columns 1 and 2). The coefficients for financial variables were not much affected by the introduction of state fixed effects.

Asset poverty was another significant predictor of food insecurity. Holding income and other household characteristics constant, households with non-housing net worth less than 3 months' family-specific poverty line were 1.6–1.7 percentage points more likely to be food insecure. Those whose financial assets fell below 3 months' family-specific poverty line were an additional 4 percentage points more likely to be food insecure (columns 3 and 4). Again, state fixed effects did not make much difference.

Table 3 Correlation among asset variables ($n = 6{,}244$)

	Liquid asset <3 × monthly income	Financial asset <6 × monthly income	Net worth <3 × monthly poverty line	Financial asset <3 × monthly poverty line	Debt to asset ratio >1
Liquid asset <3 × monthly income	1.000				
Financial asset <6 × monthly income	0.563***	1.000			
Net worth <3 × monthly poverty line	0.282***	0.333***	1.000		
Financial asset <3 × monthly poverty line	0.433***	0.516***	0.526***	1.000	
Debt to asset ratio >1	0.057***	0.075***	0.072***	0.031*	1.000

The sample consisted of households with heads under 65 years of age that reported positive incomes in the 2003 PSID. Pairwise correlation coefficients are reported

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

The debt-to-equity ratio was not significantly related to food insecurity (columns 5 and 6). While the above four measures represented a household's lack of emergency funds or manifested its level of credit constraint, the debt ratio had different connotations. A high debt ratio could imply greater financial burden or insolvency, but it could also be an indication that the household had little liquidity constraint and was able to borrow (Grafova 2011). Our finding—that debt was not a significant predictor of food insecurity—went with the latter argument and implied that a high debt ratio did not significantly affect the households' ability to borrow.

Homeownership and vehicle ownership were consistently negative determinants of food insecurity. Homeowners were 1–2 percentage points less likely to be food insecure. Owning at least one vehicle was associated with a further 1–2 percentage-point reduction in the likelihood of food insecurity. Controlling for other demographic and economic characteristics, African Americans and those of "other race" were less likely to be food insecure than non-Hispanic white Americans. "Other race" included Asians, Native Americans, and those who identified themselves as of other race. This contradicted the higher prevalence of food insecurity among racial/ethnic minorities relative to non-Hispanic Whites (Coleman-Jensen et al. 2012), but was consistent with some previous regression-based estimates (Gundersen and Garasky 2012; Guo 2011; Leete and Bania 2010). Less-than-high-school education of the household head was associated with an increased likelihood of food insecurity, whereas those with college degrees or graduate education were less likely to be food insecure than high school graduates. A one-percent increase in income was associated with a 1.8–2.8 percentage-point reduction in the likelihood of food insecurity. Participation in a cash assistance program such as TANF was negatively associated with food insecurity, while participation in food assistance programs such as SNAP, WIC, NSBP and NSLP was positively associated with food insecurity. The positive association of food assistance programs with food insecurity could be due to endogenous selection (Borjas 2004). Among the four US regions, the Northeast region appeared to be associated with the lowest rate of food insecurity, after accounting for demographic and socioeconomic factors. Gender and marital status of the household head were not found to be significant. Coefficients on age and age squared were not significant, suggesting there is little life-cycle effect on food insecurity at least before retirement age. Unlike previous research findings (Nord and Kantor 2006; Nord and Romig 2006), the summer survey months ranging from June through September were not significantly associated with food insecurity. The reason for the lack of seasonal effect was probably that we excluded the retired households from our study. Seasonal effects have been associated with the food insecurity of retired households in previous studies.

Some state intercepts were highly significant, supporting our assumption that there may be state-level clustering of the unexplained variation in food insecurity. However, comparison of coefficients between the models with state fixed effects and those without revealed very little significant difference (Test statistics of differences in coefficients are available upon request). Therefore, the regressions by income subgroups were estimated without the state fixed effects to improve model efficiency and to avoid cell-size issues.

Effects by Income Levels

Since the association between liquidity constraint and food insecurity was expected to be stronger for low-income households, we estimated the regression models for four different income groups: those below the federal poverty threshold, households with incomes equal to 100–130 % of the poverty threshold, and household with incomes equal to 130–185 % of the poverty threshold, and households with incomes above 185 % of the poverty threshold. As explained in the methods section, the 130 and 185 % cut-offs were chosen based on the commonly used income eligibility thresholds for SNAP.

Table 4 Effects of household finance on the probability of food insecurity: marginal effects from Probit

	(1)	(2)	(3)	(4)	(5)	(6)
Liquid asset <3 × monthly income	0.0307***	0.0289***				
	(0.0039)	(0.0037)				
Financial asset <6 × monthly income	0.0164**	0.0156**				
	(0.0055)	(0.0052)				
Net worth <3 × monthly poverty line			0.0174**	0.0158**		
			(0.0059)	(0.0054)		
Financial asset <3 × monthly poverty line			0.0399***	0.0393***		
			(0.0063)	(0.0059)		
Debt to asset ratio >1					0.0122	0.0126
					(0.0105)	(0.0101)
Own a home	−0.0161**	−0.0151**	−0.0108*	−0.0100*	−0.0227***	−0.0218***
	(0.0051)	(0.0048)	(0.0049)	(0.0045)	(0.0063)	(0.0060)
Own a vehicle	−0.0125†	−0.0123†	−0.0070	−0.0073	−0.0200*	−0.0199*
	(0.0067)	(0.0063)	(0.0063)	(0.0059)	(0.0087)	(0.0083)
Age	0.0013	0.0013	0.0014	0.0013	0.0017	0.0018
	(0.0013)	(0.0012)	(0.0013)	(0.0012)	(0.0015)	(0.0014)
Age squared	−1.8E−05	−1.8E−05	−1.8E−05	−1.7E−05	−2.5E−05	−2.5E−05
	(1.6E−05)	(1.5E−05)	(1.6E−05)	(1.4E−05)	(1.8E−05)	(1.7E−05)
Female	0.0054	0.0049	0.0054	0.0049	0.0062	0.0058
	(0.0054)	(0.0050)	(0.0054)	(0.0050)	(0.0066)	(0.0061)
Race: black	−0.0109**	−0.0091*	−0.0110**	−0.0094*	−0.0117*	−0.0090†
	(0.0039)	(0.0040)	(0.0039)	(0.0039)	(0.0051)	(0.0052)
Race: Latino	0.0042	−0.0020	0.0028	−0.0032	0.0069	−0.0001
	(0.0083)	(0.0068)	(0.0079)	(0.0064)	(0.0104)	(0.0090)
Race: other	−0.0168**	−0.0171***	−0.0168**	−0.0169***	−0.0199**	−0.0204**
	(0.0056)	(0.0048)	(0.0053)	(0.0044)	(0.0075)	(0.0065)
Marital status: never married	0.0058	0.0057	0.0075	0.0072	0.0069	0.0065
	(0.0066)	(0.0062)	(0.0068)	(0.0064)	(0.0079)	(0.0074)
Marital status: widowed	−0.0096	−0.0088	−0.0110	−0.0102	−0.0113	−0.0105
	(0.0084)	(0.0077)	(0.0076)	(0.0070)	(0.0103)	(0.0096)
Marital status: divorced	0.0073	0.0078	0.0062	0.0067	0.0100	0.0103
	(0.0061)	(0.0059)	(0.0060)	(0.0058)	(0.0075)	(0.0071)
Number of children	−0.0017	−0.0017	−0.0031	−0.0030	−0.0024	−0.0024
	(0.0021)	(0.0019)	(0.0021)	(0.0019)	(0.0026)	(0.0024)
Education: less than high school	0.0188**	0.0180**	0.0181*	0.0174**	0.0264**	0.0254**
	(0.0072)	(0.0067)	(0.0071)	(0.0066)	(0.0087)	(0.0082)
Education: some college	−0.0041	−0.0034	−0.0033	−0.0025	−0.0072	−0.0062
	(0.0046)	(0.0043)	(0.0047)	(0.0044)	(0.0055)	(0.0051)
Education: college	−0.0117*	−0.0106*	−0.0092	−0.0078	−0.0190**	−0.0174**
	(0.0054)	(0.0051)	(0.0059)	(0.0056)	(0.0061)	(0.0058)
Education: graduate school	−0.0219***	−0.0214***	−0.0196***	−0.0191***	−0.0309***	−0.0301***
	(0.0048)	(0.0042)	(0.0053)	(0.0046)	(0.0049)	(0.0043)
Ln (income)	−0.0245***	−0.0231***	−0.0186***	−0.0175***	−0.0278***	−0.0265***
	(0.0032)	(0.0030)	(0.0027)	(0.0026)	(0.0033)	(0.0031)
TANF	−0.0165**	−0.0155**	−0.0152**	−0.0140**	−0.0205**	−0.0194**
	(0.0052)	(0.0049)	(0.0054)	(0.0052)	(0.0066)	(0.0063)
SNAP	0.0171†	0.0174†	0.0128	0.0131	0.0259*	0.0262*
	(0.0098)	(0.0095)	(0.0088)	(0.0084)	(0.0126)	(0.0122)

Table 4 continued

	(1)	(2)	(3)	(4)	(5)	(6)
WIC	0.0153	0.0157†	0.0147	0.0150†	0.0188†	0.0193†
	(0.0094)	(0.0092)	(0.0090)	(0.0088)	(0.0112)	(0.0110)
School lunch	0.1088*	0.1089**	0.1036**	0.1030**	0.1340***	0.1330***
	(0.0332)	(0.0327)	(0.0330)	(0.0325)	(0.0384)	(0.0379)
School breakfast	0.0517*	0.0476**	0.0478**	0.0440**	0.0654***	0.0604***
	(0.0153)	(0.0144)	(0.0149)	(0.0140)	(0.0180)	(0.0172)
SMSA	−0.0039	−0.0053	−0.0034	−0.0052	−0.0058	−0.0074
	(0.0049)	(0.0050)	(0.0048)	(0.0050)	(0.0060)	(0.0062)
Rural	−0.0105	−0.0090	−0.0110	−0.0089	−0.0142†	−0.0117
	(0.0072)	(0.0075)	(0.0070)	(0.0073)	(0.0085)	(0.0091)
Region: Northeast	−0.0170***	−0.0238***	−0.0161***	−0.0243***	−0.0215***	−0.0287**
	(0.0043)	(0.0067)	(0.0044)	(0.0065)	(0.0053)	(0.0085)
Region: South	−0.0061	−0.0419*	−0.0062	−0.0447*	−0.0076	−0.0475*
	(0.0045)	(0.0197)	(0.0045)	(0.0200)	(0.0055)	(0.0237)
Region: West	0.0001	−0.0248	−0.0008	−0.0320*	−0.0011	−0.0358
	(0.0056)	(0.0197)	(0.0055)	(0.0160)	(0.0067)	(0.0219)
Summer months	0.0058	0.0046	0.0050	0.0035	0.0082	0.0066
	(0.0042)	(0.0038)	(0.0041)	(0.0037)	(0.0051)	(0.0047)
State fixed effects	No	Yes	No	Yes	No	Yes
n	6,244	6,244	6,244	6,244	6,244	6,244
F	18.92***	8.70***	19.31***	9.09***	21.52***	9.64***
Predicted P	0.0249	0.0229	0.0244	0.0223	0.0320	0.0297

The sample consisted of households with heads under 65 years of age that reported positive incomes in the 2003 PSID. All estimates were adjusted for sampling weights. Marginal effects at the mean; or for dummy variables, upon changes from 0 to 1. Standard errors are in parentheses. Omitted categories were male, non-Hispanic white, married, high school, urban, and North Central. In state fixed effects, ten state dummies that could cause perfect collinearity were excluded

† <0.10; * <0.05; ** <0.01; *** <0.001

Table 5 presents the marginal effects of family finance variables as predictors of food insecurity. Unlike with the entire sample, we estimated probit regressions on one financial ratio variable at a time, along with demographic controls. With fewer and more homogenous observations, inclusion of multiple financial ratio variables together would likely create multicollinearity problems.

Our analysis showed that financial strain and liquidity constraint increased food insecurity at all income levels. For those in poverty (income <100 % of the poverty line), liquidity constraint—defined by inadequate reserves of liquid assets, inadequate reserves of financial assets, and low net worth—increased the likelihood of food insecurity by 21–27 percentage points. For households with income below poverty, the debt-to-equity ratio neither increased nor decreased food insecurity. Interestingly, asset vulnerability hardly affected food insecurity among the near poor (100–130 % of the poverty line), except for a weak positive association between the low financial asset-to-needs ratio and food insecurity. For households with income between 130 and 185 % of the poverty line, savings in liquid assets totaling less than 3 months' income increased the likelihood of food insecurity by 16.5 percentage points, while non-pension financial assets less than 6 months' income had no clear implication on food insecurity. For this income group, asset poverty was associated with a 10–12 percentage-point increase in the likelihood of food insecurity.

What may be the most alarming finding was that even for households with income greater than 185 % of the poverty line, all five financial variables were significantly correlated with food insecurity. Although the magnitude of the marginal effects was modest (between 1.2 and 2.2 percentage points increase in the likelihood of food insecurity), statistically the marginal effects were highly significant for all four measures of liquidity constraint and asset inadequacy. Also, this income group was the only case where the excessive borrowing was significantly associated with increased food insecurity. For those with income above 185 % of poverty, if the debt-to-equity ratio—also referred to as the insolvency ratio—exceeded one, the likelihood of food insecurity increased by 1.4 percentage points.

Endogeneity Check

In our analysis, we interpreted the marginal effects as if assets or liquidity constraints were pre-existing conditions exogenous to household food insufficiency. However, some qualitative observations in the literature argued that might not be the case. Earlier discussion of measurement of food insecurity in the US considered that borrowing money or buying food on extended credit frequently served as a hunger coping strategy, and borrowing money for food could be a sign of food insecurity in itself (Maxwell 1996). Maxwell (1996, p. 259) wrote, "… borrowing money for food can lead to permanent indebtedness, and is an example of how a short-term coping strategy can put a household in a more vulnerable position…" Another study used Canadian data and reported that many food insecure households delayed paying bills, borrowed money, sold or pawned possessions, and bought food on credit to prevent food shortage (Rainville and Brink 2001; Tarasuk 2001), possibly suggesting a simultaneous asset-hunger interaction. If this applied to our financial status variables, the parameter estimates would be subject to endogeneity and would not indicate a cause and effect.

We checked for endogeneity of financial variables with the Durbin-Wu-Hausman test (Davidson and MacKinnon 1993). In the first stage regression, we instrumented financial variables with factors that were likely correlated with the financial status of the household but not with food security. The PSID included questions about whether the households recently received a large sum of inheritance or gift, whether they used computers to manage finances, whether they experienced difficulty managing household finances, and whether they itemized taxes. Also, we included a state-level instrument that indicated whether the household lived in a state where payday lending was banned. Although the F-tests of the instruments from the first-stage regressions were highly significant with F-statistics ranging from 45 to 257, suggesting that these variables provide sufficient instrumental power, a series of Durbin–Wu–Hausman tests accepted the null hypotheses and we found no evidence of endogeneity in any of the family finance variables used in this study. We also checked for endogeneity for income subgroups, which all turned out nil. Estimates are available upon request.

Financial Ratios and Participation in Food Assistance Programs

The above findings by income groups (Table 5) suggest that a household's asset inadequacy or asset poverty might have different effects on food insecurity depending on its income-based program eligibility status. In order to verify whether this relatively weak asset-hunger correlation for the households that were only slightly above the poverty threshold signifies a substitution between household savings and program participation, we estimated additional regressions. In these regressions, the dependent variable was whether the household participated in any of the food

Table 5 Effects of household finance on the probability of food insecurity by income levels: marginal effects from Probit

	Income below 100 % of poverty line	Income 100–130 % of poverty line	Income 130–185 % of poverty line	Income above 185 % of poverty line
Liquid asset <3 × monthly income	0.216***		0.165***	0.013***
	(0.059)		(0.027)	(0.0023)
Financial asset <6 × monthly income	0.240***	0.052	0.051	0.011***
	(0.058)	(0.112)	(0.065)	(0.0025)
Net worth <3 × monthly poverty line	0.231***	−0.006	0.119**	0.012**
	(0.058)	(0.069)	(0.042)	(0.0045)
Financial asset <3 × monthly poverty line	0.273***	0.143†	0.104*	0.021***
	(0.048)	(0.076)	(0.043)	(0.0042)
Debt to asset ratio >1	−0.051	−0.131	−0.022	0.013†
	(0.174)	(0.084)	(0.067)	(0.007)
n	706	330	597	4,602
% Food insecure	31.6	25.3	19.9	3.0

The sample consisted of households with heads under 65 years of age that reported positive incomes in the 2003 PSID. All estimates were adjusted for sampling weights. Marginal effects at the mean; or for dummy variables, upon changes from 0 to 1. Standard errors are in parentheses. Each regression was run on one financial variable at a time, to avoid cell sizes becoming too small. Regressors also included homeownership, vehicle ownership, age, age squared, female, race, marital status, number of children, education, log income, TANF, SNAP, WIC, NSLP, NSBP, SMSA, rural, region, and seasonal dummy. State fixed effects were not included to avoid cell sizes becoming too small. The variable *liquid asset <3 × monthly income* was dropped for those whose incomes were 100–130 % of poverty due to perfect correlation with the dependent variable

† < 0.10; * < 0.05; ** < 0.01; *** < 0.001

Table 6 Effects of household finance on the probability of participating in food assistance programs by income levels: marginal effects from Probit

	Income below 100 % of poverty line	Income 100–130 % of poverty line	Income 130–185 % of poverty line	Income above 185 % of poverty line
Liquid asset <3 × monthly income	0.394***	0.397***	0.121	0.003
	(0.087)	(0.108)	(0.086)	(0.003)
Financial asset <6 × monthly income	0.455***	0.223	0.176**	0.005†
	(0.066)	(0.159)	(0.067)	(0.003)
Net worth <3 × monthly poverty line	0.428***	0.141	0.162**	0.006†
	(0.065)	(0.099)	(0.056)	(0.003)
Financial asset <3 × monthly poverty line	0.505***	0.271*	0.185**	0.008**
	(0.054)	(0.125)	(0.060)	(0.003)
Debt to asset ratio >1	−0.225†	−0.173	−0.110	0.000
	(0.014)	(0.172)	(0.067)	(0.003)
n	706	330	597	4,602
% Participation	51.6	49.3	38.3	6.1

Dependent variable is participation in any food assistance programs including SNAP, WIC, NSLP, and NSBP. The sample consisted of households with heads under 65 years of age that reported positive incomes in the 2003 PSID. All estimates were adjusted for sampling weights. Marginal effects at the mean; or for dummy variables, upon changes from 0 to 1. Standard errors are in parentheses. Each regression was run on one financial variable at a time, to avoid cell sizes becoming too small. Regressors also included homeownership, vehicle ownership, age, age squared, female, race, marital status, number of children, education, log income, TANF, rural, region, and seasonal dummy. State fixed effects were not included to avoid cell sizes becoming too small. The variable *liquid asset <3 × monthly income* was dropped for those whose incomes were 100–130 % of poverty due to perfect correlation with the dependent variable

† <0.10, * <0.05, ** <0.01, *** <0.001

assistance programs—SNAP, WIC, NSLP, or NSBP. Explanatory variables included one of the five financial ratio variables. The regressions were run on the same set of controls as in the above food insecurity regressions. Table 6 reports marginal effects and standard errors from weighted Probit.

The results showed that, for those under poverty, all measures of inadequacy of financial assets were positively associated with participation in food assistance programs. Among households with incomes above poverty but no more than 130 % of the poverty threshold, those whose liquid assets were below 3 months' income or those whose financial assets were not enough to pay for 3 months' of subsistence-level living had increased likelihood of participating in food assistance programs compared to those that were not financially strained. To our surprise, this was true also for higher income groups. Even for those with incomes over 130 % of the poverty line, asset poverty or the lack of sufficient financial assets to cover 6 months' income interruptions led to modest but consistently higher participation than those that were not financially strained, controlling for other socioeconomic factors.

The positive correlation between liquidity constraint and food program participation has several possible explanations. It may simply mean that asset inadequacy and food program participation both reflect the household's overall economic destitution. Part of it may also be a natural result of asset test under the federal food program eligibility rules. Or, it might suggest that some households actually use food assistance programs as a substitute for own savings. How significant the third explanation is, or whether it means that generous food assistance programs would discourage saving behavior, remain undetermined at this point. However, our regressions of food assistance program participation offer some insight that the federal food assistance programs may act as an alternative safety net for liquidity-constrained families to maintain access to food.

Discussion

The present study found that households that were financially strained or liquidity-constrained were significantly more likely to experience food insecurity holding other factors constant. The detrimental effects of household liquidity constraint, asset poverty, and risk of insolvency upon food insecurity were separate from the effect of current-period income. This suggests that a household's financial strain leads to inability to liquidate its assets or to borrow in order to maintain adequate levels of food expenditures upon income interruptions. Despite the suggestions from several qualitative studies, we found little indication of simultaneous determination of a household's food insufficiency and its financial problems. Financial constraint measures that we employed appeared to be exogenous determinants of household food insecurity.

Our findings by income groups provide added insights as to why some poor families are not food secure and why some non-poor families are food insecure. Liquidity constraint increased the likelihood of food insecurity by more than 20 percentage points among households with below-poverty income even though they would most likely meet the federal food assistance eligibility criteria. Households that earned substantially more than the poverty thresholds were also susceptible to food insecurity if they had low asset-to-income ratios or were asset poor. Even the households that made more than 185 % of the poverty line experienced increased risk of food insecurity if they had high debt-to-equity ratios.

Interestingly, the effect of household finance on food insecurity was weakest among households that were slightly above the poverty line. This resulted in interesting non-linearity of the income-asset interaction in determining food insecurity. That is, the extent to which household financial issues determine food insecurity does not continuously decrease with income. Instead, the association between financial strain and food insecurity decreases as income increases among the poor and near poor, and increases as income increases among those that are not near poverty. We speculate it may be related to the income-eligibility standards of most public food assistance programs such as SNAP. Our study found that, for families whose incomes were above the poverty threshold but low enough to meet food assistance program eligibility, liquidity constraint and asset inadequacy were not very likely to put the families' food security at risk. This could suggest potential substitution between food assistance program participation and savings. Our additional analyses on food assistance program participation found that this inconsistency could be explained by the role of food assistance programs as a safety net against food insecurity for financially strained households. Conversely, families whose incomes were well beyond the food assistance eligibility cutoff would not have such a safety net and be vulnerable to food insecurity if they were financially strained or struggled with other existing financial obligations.

In summary, the present study contributes to the literature by utilizing financial ratios to better understand the role of liquidity constraint in household food insecurity. Financial ratios may gauge household financial strain, asset adequacy, and credit constraint better than income or asset ownership. This is particularly important as asset building among low- to moderate-income households has been recognized as a critical policy concern, the debt level of households has increased, and food insecurity has increased among different groups. Additional analyses by income groups showed potential buffering effects of government food assistance programs on food insecurity among financially distressed households.

Implications

This study offers implications for practitioners and policy makers and calls for additional research on financial strain ratios and food security across different time periods and economic cycles. This study suggests that personal finance counseling and education for low- to moderate-income households may improve food security of households. Although it remains uncertain whether the identified effect of household finance on food insecurity was due to individual financial management practices or it was mostly attributable to external factors such as financial market performances, it shed light to how food insecurity could be avoided or alleviated through interventions in personal finance. The negative association between financial management skills and the likelihood of food insecurity has been recently shown (Gundersen and Garasky 2012), and our study confirms it using some of the outcome measures of effective financial management practices and a much bigger sample. While the current study confirms the importance of saving and having an emergency cash reserve in order to maintain adequate food consumption, avoid hunger, and not depend on food assistance programs, financial education opportunities for the low- to moderate-income households are limited (Birkenmaier and Curley 2009). One also needs to note that some of the financial ratios—except for asset poverty measures—were primarily developed as financial management guidelines for middle- and higher-income households. There might be a need for financial standards developed and tested specifically for low- to moderate-income households.

Moreover, in contrast with existing knowledge that greater amounts of assets lead to the lower risk of food insecurity (Guo 2011), our findings indicate that it is the ability for the assets to readily pay for 3–6 months' living expenses that substantially lowers the risk of food insecurity and promotes steady access to food needed for families' active and healthy living. We believe, therefore, our findings expand upon existing knowledge by offering a more concrete and realistic financial target for families of limited means.

This study also implies that promotion of better personal financial management at the household level could save societal resources needed to deal with consequences of food insecurity. Food insecurity has been found to be a strong predictor of obesity (Matheson et al. 2002; Sarlio-Lähteenkorva and Lahelma 2001). Food insecurity has also been associated with subsequent problematic behavior among children (Kainz et al. 2012). According to our findings, these costly consequences might be avoided or prevented by subsidizing or incentivizing financial counseling and education efforts. Policies that promote community-based asset building and community support for

low-asset families may also help in alleviating food insecurity (Sano et al. 2011). Also, this study suggests that macro-level changes affecting household finance such as regulation and deregulation of the consumer credit industry may affect food insecurity in the US.

In addition to promotion of financial counseling and education programs for the poor, our findings indicate that policies and programs supporting asset building among low-income households and communities can play an important role in reducing household food insecurity. A recent study by Pikauskas et al. (2012) noted that the short-term nature of public transfer programs such as TANF provides a temporary relief, but does not necessarily provide a long-term solution to financial hardship. Anti-poverty policies and programs that can result in longer-term financial resiliency would improve food security, which in turn can impact health.

This study offers an important implication for food assistance programs. To simplify and streamline the certification processes of the federal food assistance programs, especially SNAP, in recent years many states have virtually eliminated the asset test and increasingly taken advantage of an option known as "categorical eligibility" that depends on income tests alone (Klerman and Danielson 2011). Our findings suggest that asset-based measures of financial hardship are strong predictors of food insecurity in addition to income-based measures, and therefore may need to remain as a significant and feasible criterion in federal food assistance program eligibility. In the era of complex financial market with widespread credit, food insecurity may increase due to liquidity constraints and high debt obligations among households.

Limitations and Suggestions for Future Studies

First, our data came from 2003, which was prior to the collapse of subprime lending and global financial crisis as well as recent changes in government assistance programs. The Great Recession stripped most American households' wealth but the impact was disproportionately high for poor households. Whereas this may raise a doubt for the usefulness of nearly decade-old data, it was inevitable because the PSID, which collects a rich set of financial variables, stopped including food insecurity questions after 2003. It would have been possible to assess what the consequences of the Great Recession on household finance had to do with the recent increase in food insecurity if we had more recent data. However, we believe the evidence from the 2003 PSID is still valuable, considering that the last decade witnessed increases in both household financial problems as well as food insecurity rates in the population, despite expansions of SNAP eligibility and benefits (Andrews and Smallwood 2012; Klerman and Danielson 2011). Future research could investigate the roles of recent economic crisis, market conditions, and policy changes in determining household financials and food insecurity when appropriate data become available.

Second, the concept of stocks and flows suggests asset inadequacy and debt burden may arise for a number of reasons, which this study could not distinguish. Asset inadequacy and debt burden can result not only from poor money management practices but also can be a consequence of interruptions of income flow or decline in the value of financial commodities due to market performance. While discernment of different causes of financial strain is outside the scope of this study, our findings' implication for personal finance should be discussed with caution.

Third, there may have been other determinants of household food insecurity such as social insurance, human and social capital, community resources, and home production that we did not consider in this study. While some researchers found the role of human and social capital factors including social support networks in food insecurity (Dean et al. 2011; De Marco and Thorburn 2008), others found that food banks and community-based charities made little difference for the food insecure (Dachner and Tarasuk 2002; Tarasuk and Beaton 1999). In any case, we believe bias resulting from omitting these factors might be quite modest considering that our sample excluded older Americans who were most likely to receive social security and also given little empirical evidence of these omitted determinants being significantly correlated with asset and debt holdings. Future research could explore the roles of these factors in explaining the relationship between household finance and food insecurity.

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