An Analysis of the Exposure to Poor Food Environments and Diet-Related Health

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ABSTRACT: As obesity and diet related disease continue to grow, policy attention is turning to how the food environment—the location and availability of food retailers and restaurants, food prices, and other factors—may impact these health outcomes. This research utilizes a long-term panel data set matched with information on the density of supermarkets and other large food stores, convenience and other food retailers, and quick service restaurants to understand the impact of the food environment on Body Mass Index (BMI), overweight, obesity, general health status, diabetes and high blood pressure. We find little evidence that the availability of these food retailers and restaurants affects diet related health outcomes, with one exception. We find that the availability of supermarkets is negatively associated with the probability of having diabetes. This effect is driven by individuals who live in near urban and rural areas and is not found among urban residents. Overall, these results suggest that individual factors have a greater impact on diet-related health outcomes than food environment factors.

PRELIMINARY RESULTS: Please do not quote or cite.

Background and Conceptual Framework

High rates of obesity, diabetes, and other indicators of poor diet quality in some parts of the U.S. and with some populations that cannot be explained by observed individual level characteristics have led to questions about how environmental factors may contribute to poor dietary health. The dearth of healthy food options in some neighborhoods along with an overabundance of options for less healthy food has led to much research and some policy proposals to improve the food environment. The Healthy Food Finance Initiative dedicated about $314 million in 2013 and was allocated another $125 million with the 2014 Farm Bill to fund improvements to the food environment through a variety of interventions.[1] Some cities and states have initiated funding for similar projects (Policy Link, 2015).

The food environment—the availability and proximity of food retailers and restaurants, the characteristics and prices of these food retailers, and community characteristics—is hypothesized to interact with individual characteristics such as household resources, education and preferences to influence the food choices, diet quality, and ultimately, the dietary health outcomes of individuals. Access to retailers that sell a range of food options including foods such as fruits, vegetables, and whole grains has been particularly singled out as a potential cause of poor dietary health. The availability and proximity of retailers selling healthy food choices is hypothesized to influence the choice set of households with less access to a broad set of retailers by either limiting the types of foods that can be purchased nearby or increasing the travel and time costs and perhaps frequency of food shopping. A limited choice set could mean that the prices paid for food are greater because there is less competition among stores or because low-

[1] The federal Healthy Food Financing Initiative is modeled after Pennsylvania's Fresh Food Financing Initiative, a public-private partnership to develop supermarkets in underserved areas.

cost food sellers, such as supercenters and large supermarkets are not nearby. It is also hypothesized that because retailers selling less-healthy food options are almost everywhere, households that lack access to healthy food retailers may instead consume a greater share of food with less nutritional value. A limited choice set could also mean that diet quality suffers because healthy foods are not available nearby, while options for less healthy food are plentiful. The proximity of food retailers may be alleviated for families with resources such as vehicles or income that can overcome proximity barriers, but those with few such resources may be more affected.

The literature examining the effects of the food environment and particularly, the lack of access to healthy food sources, upon which we are focused, is mixed. There is substantial, although not complete agreement that there is some correlation between the lack of access to healthy food sources and poor diet and dietary health. Larson et al., (2009) review much of this literature. Recent cross-sectional studies also show that greater availability of grocery stores and supermarkets was associated with lower BMI and lower blood pressure (Dubowitz, et al., 2012).

While there is fairly consistent evidence that poor access to supermarkets is correlated with poorer diets, the causal evidence is less clear. A number of studies have attempted to go beyond cross-sectional correlations, usually using longitudinal data to control for time invariant characteristics that may explain diet and dietary outcomes. In a 15 year longitudinal study of young adults, Boone-Heinonen, et al., (2011) found that supermarket availability was not associated with diet quality or fruit and vegetable intake but fast food restaurant availability was positively associated with fast food consumption. Handbury et al. (2015) use proprietary data that measure household food purchases over time along with the locations of food stores to study how changes in the retail environment are correlated with where households shop and the dietary quality of their purchases. While they find that the dietary quality of food purchases is lower in lower-income and lower education households, they find that changes in the food retail environment do not have a large impact on changes in diet quality for such households. Evidence from two experimental studies of low-income, food desert neighborhoods where a new supermarket opened also show that a change in the food environment—in both cases an improvement in the food environment—did not have a large impact on dietary choices. Dubowitz et al. (2015) found that some measures of diet quality improved after a new store opened, while others did not and that improvements did not seem to be associated with the opening of the new store. Cummins et al. (2015) found that residents' perceptions of food accessibility in the neighborhood with a new store improved relative to the control neighborhood, but consumption of fruits and vegetables did not improve and that most people in the neighborhood where a new store was opened did not shop at the new store.

Evidence of the effects of the retail environment on body weight and healthy outcomes is similarly weak. Block, et al. (2011) used longitudinal data covering 30 years of a cohort from Massachusetts to study the effects of store proximity on Body Mass Index (BMI) and did not find a consistent relationship between proximity to a supermarket nor a fast food restaurant and BMI. Laraia et al. (2015) used unique longitudinal data from a California health insurance company's diabetes registry to examine supermarket proximity and density on weight change. They found a statistically significant relationship between a poor food environment and weight gain over 5 years, but the size of the effect was very small. Powell and Chaloupka (2009) used longitudinal data on children from the Child Development Supplement of the Panel Study of Income Dynamics (PSID) to study how the food retail environment affects child BMI. This study did not find an effect of supermarket or convenience store availability on body weight.

And finally, Lee (2012) use longitudinal data on a nationally representative cohort of kindergartners to study the effects of retail access on obesity. This study found that variation in retail outlet availability was not associated with body weight.

Much of the policy attention has focused on the spatial effects of grocery and other food-at-home retailers, but there is some literature that addresses spatial aspects of restaurants, particularly fast food restaurants are related to diet and health outcomes. From the above studies, Boone-Heinonen et al. (2011) find that the availability of fast food restaurants is associated with greater consumption of fast food. Block et al. (2011) found a negative relationship between fast food proximity and body weight, but Chen et al. (2010) find that a positive but small increase in BMI was associated with greater proximity to fast food restaurants experienced slight increases in BMI. Two other studies show mixed results with respect to fast food restaurant availability and obesity (Anderson and Matsa, 2011; Currie et al., 2010).

These longitudinal and experimental studies are an advancement over the cross-sectional estimates of the effects of the food environment because unobserved factors may be correlated with both the food environment and dietary health and because households are not randomly assigned to a food environment, but rather, make a choice about where to live based on budget constraints, preferences and many potential amenities of a neighborhood. Our work builds upon their work, but takes a slightly different tack. First, unlike the previous longitudinal studies which each cover somewhat select samples, we use national data on adults to examine the effects of food store access. We use longitudinal data on individuals combined with longitudinal data on a household's food environment. These data allow us to estimate the effect of changes in access to healthy food retailers and less healthy food retailers, such as convenience stores and quick service restaurants, on changes in diet quality at a neighborhood level. First we estimate the cross-sectional relationship between access and diet/health. We then use multiple years of data on food access, population characteristics, obesity rates and other health outcomes and fixed effects estimators to measure the effect that changes in food access has on changes in obesity rates and health outcomes.

In short, we find that once controlling for time invariant individual characteristics, the food environment has little effect on body weight and diet related health outcomes. There are two exceptions, we find that the availability of supermarkets is negatively associated with the probability of having diabetes. This effect is concentrated in near urban and rural areas. We also find that the availability of convenience and other stores is negatively associated with BMI and the probability of obesity.

Data and Methods

To estimate the relationship between the food environment and body weight and health measures using data from the 1999 to 2011 PSID by the Survey Research Center at the University of Michigan. The PSID originated in 1968 as a nationally representative longitudinal study of 5,000 families, after which, the individuals in these families and their descendants have been interviewed annually through 1997, and after that, every two years. These original families were drawn from two independent samples, one that oversampled low-income families and one that was nationally representative. Since 1968, the survey has twice added a random sample to reflect changes in the U.S. population—a Latino sample in 1990, and then a recent immigrant sample in 1997. A reduction in the sample was also conducted in 1997. Details on the PSID sample structure and rules for following family members are provided in PSID Main Interview

User Manual (2015). To merge in census tract level data on the food environment, we received access to the PSID Restricted Access Sample.

Since 1985, the PSID survey asked heads of families and their wives a question about their self-assessed general health where respondents could rate their health as excellent, very good, good, fair or poor. Beginning in 1999, heads and wives were also asked to report their weight and height, and whether a doctor had ever told the respondent that they had diabetes or high blood pressure. These measures are the dependent variables in our analysis. Since we only have these data for heads and wives from 1999 on, we limit our sample to individuals who were a head or a wife in the years 1999, 2001, 2003, 2005, 2007, 2009 and 2011. We also limit our sample to adults between the ages of 18 to 70. Over these seven years and five health outcomes and accounting for those with missing data, we have an average of 10,433 sample members.

Health Outcome Measures

We estimate the relationship between the tract level measures of the food environment and several different individual measures of health outcomes over time. The health outcomes are the individual's body mass index (BMI), whether or not the individual is overweight (with BMI of 25 or higher), is obese (BMI of 30 of higher), has diabetes, has high blood pressure, and an individual's self-assessed health status. PSID heads and wives were asked to report their height and weight and from these, we calculate BMI. We use responses to the question about general health status to classify heads and wives into those who report that their general health is very good or excellent compared with those who report good, fair or poor health. Heads and wives were also asked if a doctor had ever told them they had diabetes or high blood pressure and we use responses to these questions to assess how the food environment affects these two diet-related conditions.

Food Environment Measures

Measures of the local food environments are from the USDA's Store Authorization and Redemption System (STARS) database and NPD's ReCount data. Both data sets have geocoded information on the location of specific food retailers from 1999 to 2011. The STARS data contain all stores authorized to accept benefits from the Supplemental Nutrition Assistance Program (SNAP). For STARS stores, we classify food at home stores into two categories: supermarkets, supercenters and large grocery stores; and convenience stores, combo stores, and dollar stores. We also used TDLinx data, which is another geo coded data series on food at home retailers when we were unable to classify STARS stores into grocery stores or convenience combo stores. When we were not able to match to TDLinx data to identify a store type, we also did internet searches on store names and location. Once each store was classified, we counted the number of each of these stores within a set radius from the population weighted centroid of each tract. The distance of the radius used to calculate store counts is based on the urban rural makeup of the tract. For tracts that are entirely urban, we count the number of each store type within a 5 mile radius. For tracts that are mix of urban and rural, the radius is expanded to 10 miles. For completely rural tracts, we count the total number of store types within a 20 mile radius[2]. For each year, we divide the total number of stores by the tract's total population and take the natural log.

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[2] We verified the suitability of our 3 radii by examining distance measures in USDA's National Household Food Acquisition and Purchase Survey (FoodAPS), which contains distance measures to each household's primary food at home store as well as the distance traveled to each food-at home and away from home event over a one week period.

We use essentially the same approach to characterize each household's food away from home environment. Using data from NPD ReCount, we count the number of quick service restaurants (QSRs) that are within the same set radius of each tract's population weighted centroid. Fast food and fast casual restaurants both fall within the QSR category. QSRs typically offer limited table service and prices are lower compared to full service restaurants (FSR). ,

Figures 1 and 2 show these measures (before transforming to the log) in 1999 and in 2011 for one state, Minnesota, which we choose as an example, not because any PSID household members live there. The darker colored tracts are those that have a greater number of supermarkets (figure 1) or quick-service restaurants (figure 2). Changes in patterns over the beginning and end of our sample period can be seen across the two sets of figures.

Covariates

We control for other individual and family characteristics, as well as other census tract level characteristics that are hypothesized to be associated with dietary health. Individual characteristics include, age, sex, race (black, other race, and white), Hispanic ethnicity, education level (high school dropout, high school or GED, some college and at least a Bachelor's degree), employment status (employed, unemployed and not in the labor force), family size, number of children, total family income, whether the family owns its own home, whether or not the family owns or leases a vehicle, and whether or not anyone in the family received food stamps in the previous year.

We also include a measure of the child poverty rate of the census tract. For these poverty estimates, we use 2000 Decennial Census data for the 1999 data. For the years 2007, 2009 and 2011, we use the 5-year American Community Survey estimates of census tract child poverty, using the 2005-2009 estimates for 2007, the 2007-2011 estimates for 2009, and the 2009-2013 estimates for 2011. For the years between 1999 and 2007, we impute tract level child using county level estimates of child poverty from the Census Bureau's Small Area Income and Poverty Estimates (SAIPE) program. These interpolations are based on calculating the ratio of tract actual poverty rates to SAIPE county averages for years in which both are available, and interpolating that ratio over time. We recognize that the child poverty rate at the tract may not be a perfect measure of the tract poverty rate for all people in the tract. Future work will explore alternative ways to interpolate the overall tract poverty rate.

Models

We estimate the relationship between the food environment and dietary health using a reduced form empirical:

$$H_{ist} = \beta_0 + \beta_1 SM_{st} + \beta_2 CO_{st} + \beta_3 QSR_{st} + \beta_4 X_{it} + \beta_5 Year_t + \mu_{ist} \qquad (1)$$

where H_{ist} are the dietary health outcomes (BMI, overweight, obese, diabetes, and high blood pressure) for individual *i*, in census tract *s* at time *t*. $SM_{s,}$ CO_{st}, and QSR_{st} are the measures of large stores (supermarkets, supercenters and large grocery stores), convenience and other stores and quick service restaurants as defined above; X_{it}.is the vector of covariates described above; and μ_{ist} is the error term. We estimate this basic ordinary least squares (OLS) model using the PSID individual longitudinal weights and clustering on individuals.

Treating these observations as cross-sectional data could bias estimates of our parameters and underestimate standard error estimates if there is unobserved heterogeneity of individuals, so that $\mu_{ist} = v_i + w_{ist}$ where v_i is an error term specific to the individual and w_{ist} is standard error term. Substituting for Equation (1), we estimate the following fixed effect (FE) model:

$$H_{ist} = \beta_0 + \beta_1 SM_{st} + \beta_2 CO_{st} + \beta_3 QSR_{st} + \beta_4 X_{it} + \beta_5 Year_t + v_i + w_{ist} \qquad (2)$$

The FE estimates allow us to control for unobserved time-invariant characteristics of individuals that may be correlated with dietary outcomes. We estimate robust standard errors and conduct Hausman tests to see if the v_i is uncorrelated with other covariates.

Results

Descriptive Statistics

Table 1 shows the full sample means, weighted by the individual longitudinal weights. Dependent variables are shown first, then our measures of the food environment, and finally our control variables.

The mean BMI in our sample is 27.4, while 63 percent of individuals are overweight and 26 percent are obese. The mean BMI is pretty close to measures for 2005-2006 from the National Health and Nutrition Examination Survey (NHANES), the midpoint of our period of study (Flegal et al., 2016). However, we show slightly lower prevalence of overweight—65% in NHANES data and quite a bit lower than the prevalence of obesity--34% in NHANES data (Ogden et al., 2007). This may mean there is underreporting of body weight in PSID, especially among those who are more likely to be on the upper end of the BMI scale. The share rating their health as very good or excellent is 57 percent. Eight percent of our sample has been diagnosed as diabetic and 23 percent with high blood pressure.

Our key food environment measures are the log number of supermarkets per 1000 people, the log number of convenience and other small food retailers per 1,000 people, and the log number of quick service restaurants per 1,000 people (all within the distance bands of the population weighted tract centroid as described above). These data show that not surprisingly, quick service restaurants are more prevalent in the census tracts of our sample members, followed by convenience/other stores and then finally supermarkets. Although not reported, this pattern was true for each of our three census tract typologies of urban, near urban and rural. Other tract level contextual variables include the children poverty rate average of 17.3 percent and a break down of our tract typology as 25 percent near urban, 11 percent rural, and the remaining 64 percent urban.

For our control variables, we note the average age is just over 44 years. Our sample is 32 percent Hispanic, which is greater than national estimates. Other control variables look reasonable.

BMI, Overweight and Obese

Table 2 contains OLS and fixed effect estimates of the relationship between our food environment and other census tract contextual variables on BMI, and the probability of being overweight and obese. For overweight and obesity, estimated coefficients are reported first and then odds ratios are reported. For all three outcomes, we first regress the outcomes as a function of only the food environment and census tract contextual variables, then add individual and family-level controls, then finally fixed effects estimates.[3] In each of our models of all 6 outcomes, Hausman tests reject the null hypothesis that coefficient estimates of fixed and random effects are the same.

For all three outcomes, the log number of supermarkets per 1,000 people is positively associated with BMI and the probably of overweight and obesity in the basic OLS regression. However, when individual control variables are added, the estimate is not different from zero for the probability of overweight and obese, and is smaller for BMI, although still significant. However, when individual fixed effects are included, this variable is no longer significant for

[3] Control variable coefficient and standard error estimates are not reported here.

either of the three body weight outcomes. The lack of an effect in the number of supermarkets in the fixed effects is consistent with most previous work that has not found an effect of supermarkets on body weight outcomes.

The relationship between the number of convenience and other stores in the individual's area and these body weight outcomes follows a somewhat similar pattern as the number of supermarkets, however, there are some exceptions. For the OLS estimates, the number of other stores is positively associated with BMI. But in the fixed effects estimates, the number is actually negative and significant, although quite small in size. A 1 percent increase in the number of other stores per 1,000 people is associated with a 0.08 point increase in BMI. OLS estimates show a positive relationship between the number of other stores and the probability of being overweight. These results hold when individual controls are included. However, in the individual fixed effects model, the coefficient estimate is not different from zero. For the probability of obesity, both OLS estimates show that a positive and significant effect of the number of other stores, however, in fixed effects estimates, the sign reverses and is significant. A 1 percent increase in the number of other stores per 1000 people is associated with 11 percent lower odds of being obese. In general, the OLS estimates here are as expected—showing a positive relationship between the availability of convenience and other stores and greater BMI, overweight and obesity. However, the reversal of the sign in the fixed effects estimates for BMI and the probability of obesity is surprising. These results suggest that behaviors that contribute to body weight are not affected by the availability of these smaller stores—for example, if an individual usually does not shop at these stores, increases in the availability of these stores will not affect their shopping behavior (and hence weight outcomes) and may even be consistent with behavior that reduces body weight.

Basic estimates that treat our sample as pooled observations, both with only contextual controls and with the addition of individual controls show that the number of quick service restaurants is negatively associated with BMI, the probability of overweight and obesity. In fixed effect estimates, these effects are not statistically different from zero for all three outcomes. Once time-invariant individual characteristics are controlled, the changes in the availability of quick-service restaurants does not impact BMI or overweight and obesity.

The tract's child poverty rate is positively associated with BMI and the probability of overweight and obesity in the cross-sectional estimates. However, these coefficients are no longer statistically significant in the fixed effects estimates. Indicators of the urbanicity of the census tract are generally not important predictors of these body weight outcomes.

Health Outcomes

Table 3 shows estimates of the relationship between the food environment variables and health outcomes. Again, we report estimates that control only for the food environment and tract contextual variables first, then include individual and family level control variables, and finally estimate fixed effect models.

Results with respect to the estimates of how the availability of supermarkets is associated with the probability of very good or excellent health and for the likelihood of having a diagnosis or high blood pressure look quite similar to the body weight estimates. There is a surprising and negative effect of the availability of supermarkets on the likelihood of very good or excellent health. The story is similar for the high blood pressure estimates, except that when individual and family controls are included, there is not association between having high blood pressure and the availability of supermarkets. For the probability of having diabetes, fixed effects estimates show a negative relationship, which is fairly large, although significant at only the 10 percent level. A 1 percent change in supermarkets per 1,000 people is associated with a 29 percent lower odds of having diabetes.

The relationship between the availability of convenience and other stores and these health outcomes fit a similar pattern, where the basic pooled estimates show a relationship (positive for the probabilities of diabetes and high blood pressure, and negative for the probability of very good or excellent health). However, these results are not statistically different from zero in fixed effects estimates.

Finally, turning to the counts quick service restaurants, we see a pattern similar to that of the number of supermarkets. For both the general health question and high blood pressure diagnosis, the count of quick service restaurants is significant in the pooled estimates (and the signs are opposite of what we would expect), but is not in the fixed effect models. For diabetes, in the fixed effects estimates, a 1 percent increase in the number of quick service restaurants per 1,000 people is associated with a 1.43 percent increase in diabetes.

Poverty rates in the tract are also associated with the health outcomes in the direction we expect (negatively for very good or excellent health and positively for diabetes and high blood pressure). However, in fixed effects estimates, these coefficients are no longer significant. The urbanicity of the tract was not associated with the health outcomes, except those in near urban areas were less likely to have high blood pressure than those in urban areas in the fixed effects models.

Alternative Specifications

Tables 2 and 3 present results using an unbalanced panel. Table 4 presents the results of the pooled estimates with individual and family level controls and the fixed effects estimates using only those observations we observe in each time period. Again, we exclude the coefficient estimates of control variables. Results in the balanced panel are similar to those in tables 2 and 3. For each outcome, fixed effect estimates for food environment variables are insignificant.

Accounting for population density in creating our food environment measures was a difficult task. For these estimations, we used distance bands that varied across tracts based on whether the tracts were urban, near urban or rural. We re-estimated these models separately for individuals in urban tracts and for individuals in near urban and rural tracts. These results are in Table 5 (body weight outcomes) and 6 (health outcomes) with the top panel showing the estimates for urban tracts and the bottom panel for near urban and rural tracts.

For the body weight outcomes, the results are largely the same for urban and non-urban tracts as they are for the full sample. In both cases, the availability of supermarkets and of quick service restaurants are not associated with body weight in fixed effects estimates. For convenience and other stores, there is some divergence by urbanicity. In urban areas, the availability of these stores is associated with lower BMI and lower probability of overweight and obesity. In nonurban areas, the availability of these stores is associated with a greater probability of overweight status, although not of BMI or the probability of obesity.

For the health outcomes, table 6 shows that some of the results found in the full sample are concentrated in near urban and rural areas. In these areas, fixed effects estimates show that the availability of supermarkets is negatively associated with the probability of diabetes and the availability of quick service restaurants is positively associated with the probability of diabetes. In urban areas, there are no effects of any of the food environment variables on diabetes. In urban areas, the availability of quick service restaurants is positively associated with the probability of very good or excellent health. But otherwise, the food environment variables are not associated with health outcomes in the fixed effects models.

Conclusions and Future Work

While are results are preliminary, they are suggestive of broad trends. First, with a couple of exception, we find that once individual time invariant factors are controlled in our fixed effect estimates, our measures of the food environment have little impact on body weight and health outcomes. The main exceptions are that the availability of supermarkets is negatively associated with the probability of diabetes and the availability of quick service restaurants is positively associated with diabetes. Upon further investigation, this effect is concentrated in near urban and rural areas. We also find that the availability of convenience and other stores is associated with lower BMI and probability of obesity.

Future iterations will explore alternative measures of the food environment. One weakness of our SNAP store list is that some stores that exist may not accept SNAP benefits and thus, not be in our data set. From the years 2006 going forward, we also have data on stores from TDLinx, a proprietary data set and can match these data to STARS data to get a more complete picture of store availability. We also will be able to match in 3 years of ERS's low-income and low-access measures, which are measures of whether census tracts have a significant number or share of people or households that have low access to a supermarket.

Our food environment measures thus far do not include food prices, which are likely to impact food choices and thus, diet related health outcomes. We will explore sources of data on local prices.

The lack of a relationship between the food environment and body weight is overall, suggests that individual food habits, not food environmental factors seem to be more important in explaining BMI and obesity.

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Figure 1 Supermarkets and large grocery stores per 1,000 people in Minnesota, 1999 & 2011

1999 2011

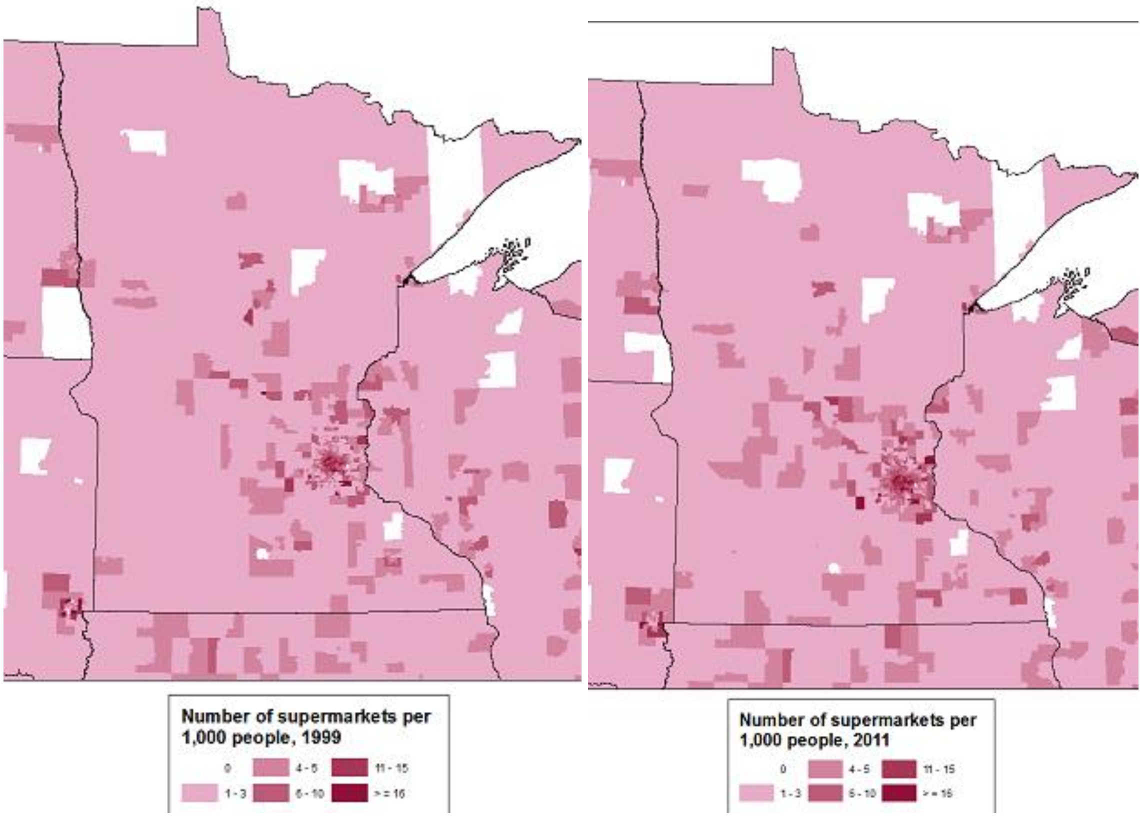

Figure 2 Quick service restaurants per 1000 people, Minnesota 1999 and 2011

1999 2011

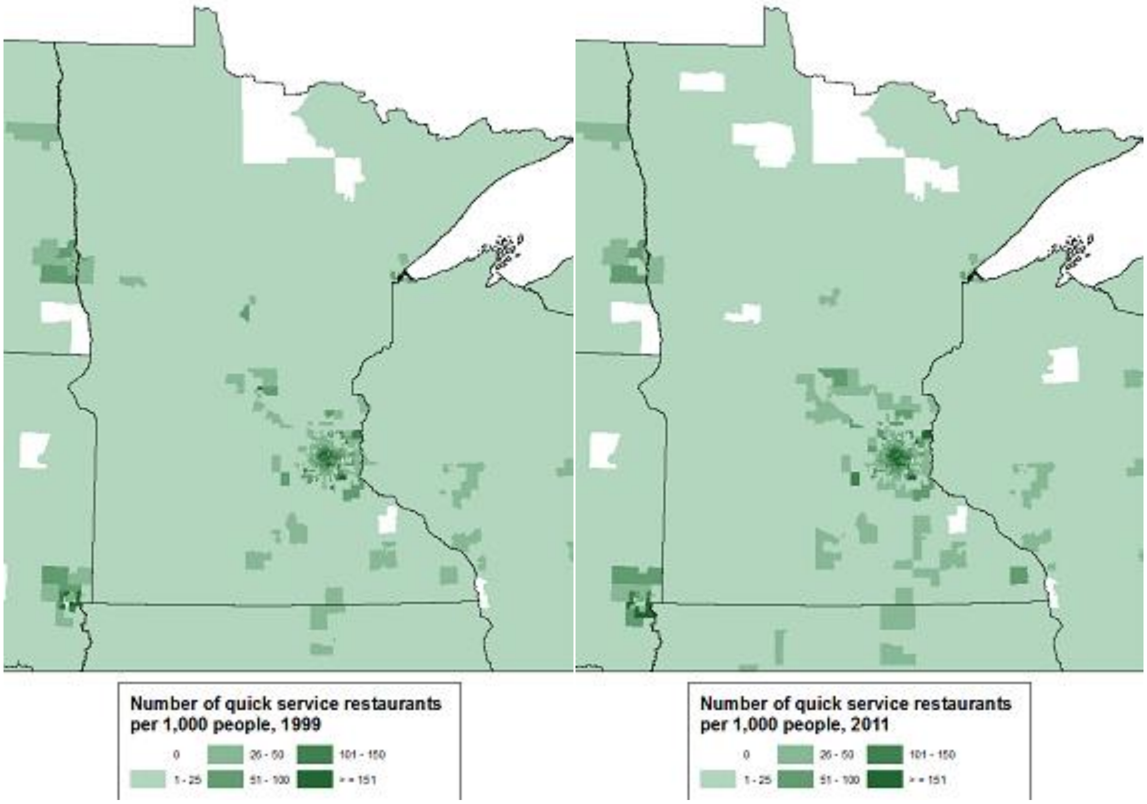

Table 1 Sample descriptives

VARIABLES	sample means
bmi	27.40
	(0.07)
share overweight	0.63
	(0.01)
share obese	0.26
	(0.01)
share in very good or excellent health	0.57
	(0.01)
share with diabetes	0.08
	(0.00)
share with high blood pressure	0.23
	(0.00)
log # of supermarkets per 1,000 people	1.32
	(0.01)
log # CS,CO stores per 1,000 people	2.03
	(0.02)
log # of quick service restaurants per 1000 people	3.40
	(0.02)
tract child poverty rate	17.13
	(0.17)
Tract is near urban	0.25
	(0.01)
Tract is rural	0.11
	(0.00)
Share female	0.52
	(0.01)
Age	44.31
	(0.15)
Share Hispanic	0.32
	(0.00)
Share black	0.13
	(0.00)
Share other race	0.07
	(0.00)
Share never married	0.19
	(0.00)
Share separated, divorced or widowed	0.18
	(0.00)
Family size	2.71
	(0.02)

Number of children	0.78
	(0.01)
Share high school dropout	0.11
	(0.00)
Share with some college	0.25
	(0.01)
Share with Bachelor's or more	0.30
	(0.01)
Share currently working	0.75
	(0.00)
Share unemployed	0.06
	(0.00)
Share who own their own home	0.68
	(0.01)
Share who own at least one vehicle	0.88
	(0.00)
Total family income (in constant $2011)/1000	90.32
	(1.50)
Share receiving SNAP benefits	0.07
	(0.00)
Observations	72,135

Means are weighted by PSID individual longitudinal weights. Robust standard errors in parentheses.

Table 2 BMI, Overweight and Obese Status, OLS and Fixed Effect Estimates

	BMI			Probability of Overweight (BMI>25)						Probability Obese (BMI > 30)					
	BMIOLS w/tract controls	BMIOLS w/individual controls	BMI Fixed Effects	With tract level controls		With tract and individual controls		Fixed Effects		With tract level controls		With tract and individual controls		Fixed Effects	
				Coeff	OddsRatio	Coeff	OddsRatic	Coeff	OddsRatio	Coeff	OddsRatio	Coeff	OddsRatio	Coeff	OddsRatio
Supermarkets/	0.43***	0.24*	0.02	0.12***	1.12***	0.06	1.06	0.02	1.02	0.10**	1.10**	0.04	1.04	-0.01	0.99
1,000 (log)	(0.13)	(0.13)	(0.06)	(0.04)	(0.05)	(0.05)	(0.05)	(0.08)	(0.09)	(0.05)	(0.05)	(0.05)	(0.05)	(0.10)	-0.09
Other stores /	0.58***	0.23***	-0.08**	0.16***	1.18***	0.08***	1.08***	-0.00	1.00	0.20***	1.22***	0.07***	1.07***	-0.11**	0.89**
1,000 (log)	(0.06)	(0.06)	(0.03)	(0.02)	(0.03)	(0.02)	(0.02)	(0.05)	(0.05)	(0.02)	(0.03)	(0.03)	(0.03)	(0.05)	-0.05
restaurants/1000	-0.99***	-0.55***	-0.01	-0.27***	0.76***	-0.16***	0.85***	-0.02	0.98	-0.29***	0.74***	-0.14***	0.87***	0.04	1.04
(log)	(0.12)	(0.11)	(0.06)	(0.04)	(0.03)	(0.04)	(0.04)	(0.08)	(0.08)	(0.04)	(0.03)	(0.04)	(0.04)	(0.09)	-0.09
	0.03***	0.01***	-0.00	0.01***	1.01***	0.00***	1.00***	-0.00	1.00	0.01***	1.01***	0.00**	1.00**	-0.00	1.00
tractcpov	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	0.00
	-0.01	0.05	0.06	-0.00	1.00	0.00	1.00	0.06	1.07	0.03	1.03	0.05	1.05	0.13	1.14
nearurban	(0.11)	(0.11)	(0.06)	(0.04)	(0.04)	(0.04)	(0.04)	(0.08)	(0.08)	(0.04)	(0.04)	(0.04)	(0.04)	(0.09)	-0.1
	-0.29*	-0.05	0.04	-0.08	0.92	-0.03	0.97	0.09	1.10	-0.05	0.95	0.02	1.02	0.05	1.05
rural	(0.16)	(0.16)	(0.10)	(0.05)	(0.05)	(0.06)	(0.06)	(0.13)	(0.14)	(0.06)	(0.06)	(0.06)	(0.06)	(0.15)	-0.15
Observations	72135			72135						72135					
R-squared	0.03	0.082	0.074												

Robust standard errors in parentheses. Individual controls include, sex, age, race, hispanic ethnicity, education, marital status, family income, vehicle ownership, home ownership, & year.

*** p<0.01, ** p<0.05, * p<0.1

Table 3 General Health Status, Diabetes, High Blood Pressure, Logit and Fixed Effect Estimates

	Probability of self-reported very good or excellent health						Probability of diabetes diagnosis						Probabilty of high blood pressure diagnosis					
	Logit with tract level variables		Logit with tract + individual		Fixed Effects		Logit with tract level variables		Logit with tract + individual		Fixed Effects		Logit with tract level variables		Logit with tract + individual		Fixed Effects	
	Coeff	OddsR	Coeff	OddsR	Coeff	OddsR	Coeff	OddsR	Coeff	OddsR	Coeff	OddsR	Coeff	OddsR	Coeff	OddsR	Coeff	OddsR
Supermarkets /	-0.18***	0.84***	-0.09**	0.92**	-0.04	0.96	0.11	1.12	0.01	1.01	-0.34*	0.71*	0.11**	1.12**	0.02	1.02	-0.05	0.95
1000 people (Log)	(0.04)	(0.03)	(0.04)	(0.04)	(0.06)	(0.06)	(0.08)	(0.09)	(0.08)	(0.08)	(0.20)	(0.14)	(0.05)	(0.06)	(0.05)	(0.05)	(0.10)	(0.10)
Other store / 1000	-0.24***	0.79***	-0.11***	0.89***	-0.01	0.99	0.26***	1.29***	0.16***	1.17***	0.12	1.12	0.17***	1.18***	0.07***	1.07***	0.03	1.03
people (log)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.04)	(0.06)	(0.05)	(0.06)	(0.10)	(0.11)	(0.03)	(0.03)	(0.03)	(0.03)	(0.06)	(0.06)
Quick service /	0.39***	1.48***	0.22***	1.25***	0.10	1.10	-0.34***	0.71***	-0.19**	0.83**	0.36**	1.43**	-0.26***	0.77***	-0.13***	0.88***	-0.05	0.95
1000 people (log)	(0.03)	(0.05)	(0.03)	(0.04)	(0.06)	(0.07)	(0.07)	(0.05)	(0.07)	(0.06)	(0.18)	(0.26)	(0.04)	(0.03)	(0.05)	(0.04)	(0.10)	(0.09)
	-0.01***	0.99***	-0.00***	1.00***	-0.00	1.00	0.01***	1.01***	0.00	1.00	-0.00	1.00	0.01***	1.01***	0.00**	1.00**	0.00	1.00
child poverty rate	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	-0.01	0.99	0.01	1.01	-0.06	0.94	0.01	1.01	-0.05	0.95	-0.05	0.95	0.05	1.05	0.03	1.03	-0.24**	0.79**
near urban	(0.03)	(0.03)	(0.03)	(0.03)	(0.06)	(0.05)	(0.07)	(0.07)	(0.08)	(0.07)	(0.17)	(0.16)	(0.04)	(0.04)	(0.05)	(0.05)	(0.10)	(0.08)
	0.02	1.02	0.00	1.00	-0.01	0.99	-0.19*	0.83*	-0.24**	0.78**	-0.27	0.76	0.08	1.08	0.10	1.11	-0.02	0.98
rural	(0.05)	(0.05)	(0.05)	(0.05)	(0.10)	(0.10)	(0.10)	(0.08)	(0.11)	(0.08)	(0.30)	(0.23)	(0.06)	(0.06)	(0.07)	(0.07)	(0.16)	(0.16)
Observations	72,135						72,135						72,135					

Robust standard errors in parentheses. Individual controls include, sex, age, race, hispanic ethnicity, education, marital status, family income, vehicle ownership, home ownership, & year.

*** p<0.01, ** p<0.05, * p<0.1

Table 4 Body weight and health outcomes by store and restaurant density, balanced panel estimates

	BMI OLS w/controls	BMIFe	Probability of Overweight Coeff	OR	Coeff	OR	Probability of Obese Coeff	OR	Coeff	OR
Supermarkets/	0.32*	0.02	0.13*	1.14*	-0.04	0.95	0.04	1.04	0.01	1.01
1000 people (log)	(0.20)	(0.08)	(0.07)	(0.08)	(0.12)	(0.11)	(0.07)	(0.08)	(0.13)	(0.13)
Other store / 1000	0.29***	-0.05	0.11***	1.12***	-0.01	1.00	0.08**	1.09**	-0.03	0.97
people (log)	(0.09)	(0.04)	(0.03)	(0.04)	(0.06)	(0.06)	(0.04)	(0.04)	(0.07)	(0.07)
Quick service /	-0.70***	-0.00	-0.24***	0.78***	0.09	1.10	-0.16**	0.85**	-0.09	0.92
1,000 people (log)	(0.17)	(0.08)	(0.06)	(0.05)	(0.11)	(0.12)	(0.07)	(0.06)	(0.12)	(0.11)
Tract child poverty	0.01	-0.00	0.00**	1.00**	0.00	1.00	0.00	1.00	-0.00	1.00
rate	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Observations	37,266		37,266				37,266			
R-squared	0.094	0.083								

Robust standard errors in parentheses. All estimates include same controls from Tables 2 &3.
*** p<0.01, ** p<0.05, * p<0.1

	Prob(Very good or excellent health) Coeff	OR	Coeff	OR	Probability of Diabetes Coeff	OR	Coeff	OR	Probability of High Blood Pressure Coeff	OR	Coeff	OR
Supermarkets/	-0.09	0.91	-0.06	0.94	0.03	1.03	-0.23	0.79	0.09	1.10	-0.01	0.99
1000 people (log)	(0.06)	(0.05)	(0.08)	(0.08)	(0.11)	(0.11)	(0.24)	(0.19)	(0.08)	(0.08)	(0.14)	(0.14)
Other store / 1000	-0.11***	0.90***	0.03	1.04	0.16**	1.17**	-0.00	1.00	0.11***	1.11***	0.03	1.03
people (log)	(0.03)	(0.03)	(0.05)	(0.05)	(0.06)	(0.07)	(0.12)	(0.12)	(0.04)	(0.04)	(0.07)	(0.08)
Quick service /	0.22***	1.24***	0.05	1.05	-0.21**	0.81**	0.33	1.39	-0.21***	0.81***	-0.10	0.90
1,000 people (log)	(0.05)	(0.06)	(0.08)	(0.08)	(0.10)	(0.08)	(0.21)	(0.30)	(0.07)	(0.05)	(0.13)	(0.11)
Tract child poverty	-0.00***	1.00***	-0.00	1.00	0.00*	1.00*	0.00	1.00	0.00	1.00	0.00	1.00
rate	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Observations	40,181				40,140				40,120			

Robust standard errors in parentheses. All estimates include same controls from Tables 2 &3.
*** p<0.01, ** p<0.05, * p<0.1

Table 5 BMI, Overweight and Obesity Separately by Urban and other tracts

Urban	BMI		Prob of Overweight: Logit with ind + tract controls		Prob of Overweight: Fixed Effects		Prob of Obese: Logit with ind + tract controls		Prob of Obese: Fixed Effects	
	BMIOLS	BMIFe	Coeff	OR	Coeff	OR	Coeff	OR	Coeff	OR
Supermarkets/ 1000	0.22	0.06	0.05	1.05	0.10	1.11	0.01	1.01	0.05	1.06
people (log)	(0.17)	(0.09)	(0.06)	(0.06)	(0.12)	(0.14)	(0.06)	(0.07)	(0.13)	(0.14)
Other store / 1000	0.24***	-0.10**	0.08***	1.08***	-0.12*	0.89*	0.08***	1.09***	-0.14**	0.87**
people (log)	(0.08)	(0.04)	(0.03)	(0.03)	(0.06)	(0.05)	(0.03)	(0.03)	(0.07)	(0.06)
Quick service / 1,000	-0.66***	-0.05	-0.19***	0.82***	0.02	1.02	-0.16***	0.85***	-0.01	0.99
people (log)	(0.16)	(0.09)	(0.06)	(0.05)	(0.12)	(0.12)	(0.06)	(0.05)	(0.13)	(0.13)
Tract child poverty	0.01***	-0.00	0.00***	1.00***	-0.00	1.00	0.00**	1.00**	-0.00	1.00
rate	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Observations	46,627		46,627				46,627			

Near Urban & Rural	BMI		Prob of Overweight: Logit with ind + tract controls		Prob of Overweight: Fixed Effects		Prob of Obese: Logit with ind + tract controls		Prob of Obese: Fixed Effects	
	BMIOLS	BMIFe	Coeff	OR	Coeff	OR	Coeff	OR	Coeff	OR
Supermarkets/ 1000	0.30	-0.06	0.09	1.10	-0.12	0.88	0.09	1.09	-0.09	0.92
people (log)	(0.18)	(0.11)	(0.07)	(0.07)	(0.15)	(0.13)	(0.07)	(0.08)	(0.16)	(0.15)
Other store / 1000	0.26**	-0.01	0.08**	1.09**	0.21**	1.24**	0.07*	1.07*	-0.01	0.99
people (log)	(0.11)	(0.06)	(0.04)	(0.04)	(0.09)	(0.11)	(0.04)	(0.05)	(0.11)	(0.11)
Quick service / 1,000	-0.39**	0.02	-0.12**	0.89**	0.00	1.00	-0.11**	0.89**	0.05	1.06
people (log)	(0.16)	(0.09)	(0.06)	(0.05)	(0.13)	(0.13)	(0.06)	(0.05)	(0.15)	(0.16)
Tract child poverty	0.02***	0.00	0.01**	1.01**	0.01	1.01	0.00*	1.00*	0.01*	1.01*
rate	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Observations	25,508		25,508				25,508			

Robust standard errors in parentheses. All estimates include same controls from Tables 2 &3.
*** p<0.01, ** p<0.05, * p<0.1

Table 6 Probability of Very Good or Excellent Health, Diabetes or High Blood Pressure, Separately by Urban and Other Tracts

Urban	Prob of Very Good or Excellent Health				Probability of Diabetes				Prob of High Blood Pressure			
	Logit with ind + tract controls		Fixed Effects		Logit with ind + tract controls		Fixed Effects		Logit with ind + tract controls		Fixed Effects	
	Coeff	OR	Coeff	OR	Coeff	OR	Coeff	OR	Coeff	OR	Coeff	OR
Supermarkets/	-0.10*	0.91*	-0.09	0.92	0.00	1.00	-0.44	0.65	-0.04	0.96	-0.10	0.91
1000 people (log)	(0.05)	(0.05)	(0.09)	(0.08)	(0.11)	(0.11)	(0.27)	(0.18)	(0.07)	(0.07)	(0.15)	(0.14)
Other store / 1000	-0.11***	0.89***	-0.03	0.97	0.16***	1.17***	0.06	1.06	0.05	1.05	-0.01	0.99
people (log)	(0.02)	(0.02)	(0.05)	(0.04)	(0.06)	(0.07)	(0.13)	(0.14)	(0.03)	(0.04)	(0.07)	(0.07)
Quick service /	0.24***	1.27***	0.16*	1.17*	-0.20*	0.82*	0.39	1.48	-0.08	0.92	0.03	1.03
1,000 people (log)	(0.05)	(0.06)	(0.09)	(0.11)	(0.11)	(0.09)	(0.26)	(0.38)	(0.07)	(0.06)	(0.15)	(0.15)
Tract child poverty	-0.00***	1.00***	-0.00*	1.00*	0.00	1.00	-0.00	1.00	0.00*	1.00*	0.00*	1.00*
rate	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Observations	25,508				25,508				25,508			

Near Urban & Rural	Prob of Very Good or Excellent Health				Probability of Diabetes				Prob of High Blood Pressure			
	Logit with ind + tract controls		Fixed Effects		Logit with ind + tract controls		Fixed Effects		Logit with ind + tract controls		Fixed Effects	
	Coeff	OR	Coeff	OR	Coeff	OR	Coeff	OR	Coeff	OR	Coeff	OR
Supermarkets/	-0.05	0.95	0.05	1.05	-0.02	0.98	-0.72**	0.49**	0.11	1.12	0.23	1.26
1000 people (log)	(0.06)	(0.05)	(0.11)	(0.11)	(0.12)	(0.12)	(0.36)	(0.17)	(0.08)	(0.08)	(0.18)	(0.22)
Other store / 1000	-0.13***	0.88***	0.05	1.06	0.16**	1.17**	0.15	1.16	0.13***	1.13***	0.07	1.07
people (log)	(0.03)	(0.03)	(0.07)	(0.07)	(0.08)	(0.09)	(0.22)	(0.26)	(0.05)	(0.05)	(0.11)	(0.12)
Quick service /	0.19***	1.21***	0.02	1.02	-0.12	0.89	0.76**	2.14**	-0.22***	0.81***	-0.25	0.78
1,000 people (log)	(0.05)	(0.06)	(0.10)	(0.10)	(0.10)	(0.09)	(0.32)	(0.69)	(0.06)	(0.05)	(0.17)	(0.13)
Tract child poverty	-0.00	1.00	-0.00	1.00	0.01	1.01	-0.01	0.99	0.00	1.00	-0.01	0.99
rate	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
Observations	25,508				25,508				25,508			

Robust standard errors in parentheses. All estimates include same controls from Tables 2 &3.

*** p<0.01, ** p<0.05, * p<0.1