Caught in the Bulimic Trap:
Do Eating Disorders Reflect Addictive Behavior?

Michelle S. Goeree, John Ham, and Daniela Iorio [1]

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Abstract

Eating disorders (ED) are an important and growing health concern, and Bulimia Nervosa (BN) accounts for the largest fraction of ED. BN is characterized by recurrent episodes of "binge-eating" followed by compensatory purging, and is especially serious given its increasingly compulsive nature. However, remarkably little is known about its addictive nature. We use a unique panel data set to examine whether bulimic behavior satisfies the economic definition of addiction. Further, we examine whether BN is a rational addiction in the sense of Becker and Murphy (1988), where both the lead and lag of bulimic behaviors should help explain current behavior after controlling for observed and unobserved heterogeneity. We find there is substantial persistence in BN over time due to state dependence, and thus BN satisfies the economic definition of addictive behavior. Moreover, bulimic behavior is also consistent with a rational addiction. Our results have important implications for public policy. They suggest that: i) treatment for BN should receive the same insurance coverage as treatment of other addictive behaviors such as alcoholism and drug addiction; 2) preventive educational programs that facilitate the detection of BN at an early age for all girls should be coupled with more intense (rehabilitation) treatment for individuals exhibiting addictive behaviors. Finally, surprisingly little is known about the factors determining the incidence of BN, and we fill this gap in the literature. We find that bulimic behavior is decreasing in income and parent's education; moreover when race plays a role, African Americans are more likely to exhibit bulimic behavior. These results stand in stark contrast to the popular conceptions of who is most likely to experience BN, and we offer an explanation for this disparity.

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[1] Michelle S. Goeree is at the University of Southern California and Claremont McKenna College; John Ham is at University of Southern California, the University of Maryland, the Institute for Research on Poverty, and IZA; Daniela Iorio is at Universitat Autonoma de Barcelona. We thank Lynne Casper, Seth Sanders, Duncan Thomas and seminar participants at Alicante for very helpful comments and discussions, and Heonjae Song and Alice Chang for excellent research assistance. We are grateful to the the National Science Foundation, the USC College of Letters, Arts and Sciences, the Claremont McKenna Lowe Institute for Political Economy, the Ministerio de Educación y Ciencia (SEJ2006-00712), and Ministerio de Ciencia y Tecnología (SEJ2006-00538) for financial support. Any opinions, findings, and conclusions or recommendations in this paper are those of the authors and do not necessarily reflect the views of the National Science Foundation. We are responsible for any errors.

1 Introduction

Eating disorders are an important and growing health concern in the US. According to the National Eating Disorders Association, approximately 9 million women in the US struggle with an eating disorder (ED). To put this in perspective, in 2005, approximately 4.5 million people had Alzheimer's disease and about 2.2 million had Schizophrenia. Bulimia nervosa (BN) accounts for the highest number of ED incidents and disproportionately affects women. For example, over the last decade 6 to 8.4% of female adolescents reported purging to lose weight (National Youth Risk Behavior Survey, 2005), and approximately 2.2% of young women were diagnosed with BN in the unique panel data set we use, the National Heart, Lung, and Blood Institute Growth and Health Study (hereafter the NHLBI Growth and Health survey).[2] Furthermore, the incidence of BN in women aged 10 to 39 tripled between 1988 and 1993, while children report suffering from BN at ever younger ages – the average age of onset dropped from 13-17 years old to 9-12 years old over the same time frame (Hoek and van Hoeken, 2003).

Bulimia is characterized by recurrent episodes of "binge-eating" followed by compensatory purging.[3] The serious health consequences of these binge and purge cycles are electrolyte imbalances that can cause irregular heartbeats, heart failure and death, inflammation and possible rupture of the esophagus from frequent vomiting, tooth decay, gastric rupture, muscle weakness, anemia, and malnutrition (American Psychiatric Association, 1993). The impact on adolescents and children is even more pronounced due to irreversible effects on physical development and emotional growth.[4] This disorder is especially serious given that a primary characteristic of BN is the increasingly compulsive nature of the behavior (Heyman, 1996). Individuals suffering from BN report requiring more of the behavior to produce the same effect, parallel to the behavior associated with drug or alcohol addictions (Bulik et al, 1997).

Economists have been increasingly interested in issues of addiction. In this paper we follow in this tradition and use the NHLBI Growth and Health survey to investigate whether bulimic behavior satisfies the economic definition of addiction as presented in Becker and Murphy (1988) and further developed in Becker, Grossman and Murphy (1994). The crucial distinction for isolating addictive behavior is persistence in the behavior, i.e. lagged behavior matters after controlling for observed and unobserved differences across individuals. Thus to identify behavior as addictive, one must separate the roles of observed and unobserved heterogeneity from that of state dependence in the persistence (Heckman, 1981). Persistence could arise if once an individual engages in bulimic behavior, it becomes more attractive to do so in the future (state dependence), but on the other hand, repeated bulimic

[2] As we describe in detail below, these data contain an assessment by a panel of medical experts on ED and BN behaviors for each respondent.

[3] Binge-eating is the consumption of an unusually large amount of food (by social comparison) in a two-hour period accompanied by a loss of control over the eating process. Compensatory behavior includes self-induced vomiting, misuse of laxatives, diuretics, or other medications, fasting, or excessive exercise. BN is identified with frequent weight fluctuations.

[4] Irreversible risks include pubertal delay or arrest and impaired acquisition of peak bone mass resulting in growth retardation and increased risk of osteoporosis (Society for Adolescent Medicine, 2003).

episodes may simply be due to differences across individuals leading to different propensities to engage in BN (individual heterogeneity). For example, certain women may have strong permanent tastes for bingeing and purging, the propensity to engage repeatedly in bulimic activities could be due to these differences and in this case one would not describe BN as reflecting addictive behavior. We investigate whether state dependence plays an important role in the persistence of BN over time. Furthermore, if there is evidence of addiction it is worthwhile to investigate whether bulimic behavior is a rational addiction in the sense of Becker and Murphy (1988). Under rational addiction both the lead and lag of bulimic behavior should help explain current behavior, after controlling for individual differences. We investigate whether BN is consistent with a rational addiction under somewhat stronger stochastic assumptions.

The importance of studying BN in an economic (as opposed to epidemiologic) framework is manifold. First, as noted above, BN is comparable to alcoholism and drug addiction, and economists have made substantial theoretical and empirical contributions to the study of addiction. Second, economic models allow us to address how (and when) state dependence can be separated from individual heterogeneity. Third, economists can contribute to the literature on the relationship between BN and observed individual characteristics. The epidemiological literature often suffers from one or more of the following problems: i) focuses only univariate correlations; ii) uses select samples, or iii) does not attempt to distinguish between correlations and the casual factors behind BN. For example, popular culture portrays BN as affecting relatively affluent, White women who are highly educated, or come from highly educated family backgrounds. To our knowledge, no empirical evidence exists to confirm or deny this assertion.[5] Furthermore, since race, family income and parents' education are highly correlated, even if this assertion is true, it is not clear which of these factors is most strongly associated with BN.

The issue of whether bulimic behavior is addictive has important policy implications. If state dependence is the most important cause of persistence in BN, then it is reasonable to instruct a wide range of young women on what constitutes addictive behavior, and urge them to get help if they persistently binge and purge. On the other hand, if individual heterogeneity is the driving force behind BN, then programs focused more narrowly on high risk individuals will probably be most effective.[6] Further, whether BN represents addictive behavior has important implications for financial support for treatment. Currently, BN is considered a disorder, not an addiction, and this leads to limited insurance coverage for treatment as compared to alcoholism and drug addictions (NEDA, 2008). Because the latter are considered addictive diseases, patients are eligible to receive federal, state, and local funds to help with recovery, while insurance companies and employment benefits packages are required to

[5] This popular view may reflect that fact that more whites are diagnosed with an ED. In a companion paper using data from ADD Health (Goeree, Ham and Iorio, 2008A), we find that while whites from high income families are more likely to be diagnosed with an ED, relative to blacks and asians, purging and bingeing behavior is not more likely among high income whites. This finding sugggests that whites may be more likely to seek treatment (perhaps due to access to more resources) and hence more likely to be diagnosed.

[6] Treatment for individuals with BN is most effective if given early in the illness. The recovery rate is close to 80% if treated within the first 5 years, the rate falls to 20% if treatment is delayed until until after 15 years (Reas, et al 2000).

provide payment for treatment.[7]

The outline of the paper is as follows. In section 2 we present a brief review of the eating disorder literature and discuss the economics' addiction literature. In section 3 we describe the data and present basic statistics on the incidence and persistence of BN. We outline our methodology for studying the incidence of BN and present our static results in section 4. In section 5 we present our methodology and results for the dynamic models of BN. Our empirical findings contain several results of interest. First, we find that BN behavior is decreasing in income and parent's education; moreover when race plays a role African Americans are more likely to exhibit BN behavior. Note that these results stand in stark contrast to the popular conceptions about BN discussed above. Second, there is substantial persistence in BN over time. Third, under exogeneity assumptions that we believe are reasonable in the current context, we find that unobserved heterogeneity plays an important role in this persistence, but that as much as half the persistence in the behavior is due to true state dependence after we control for unobserved heterogeneity. Thus bulimic behavior reflects an addiction. Finally, we find that BN satisfies the Becker and Murphy (1988) definition of rational addiction. Our results are robust across econometric specifications. We conclude in section 6.

2 Literature Review

In April of 2006, the Senate Committee of Appropriations expressed concern about the "growing incidence and health consequences of eating disorders among the population" (Department of Health and Human Services, 2006). The extent of the problem, while estimated by several long-term outcome studies as being high, remains unknown. Further, while previous studies in the US have demonstrated differences in education and socioeconomic status for the prevalence of obesity (Lauderdale, 2000; Reeder et al, 1997; Robinson et al, 2001), consistent estimation of the multivariate relationship between factors such as education, social class, and race for the prevalence of BN is relatively rare. The medical literature provides a chemical/biological foundation for the potentially addictive nature of BN but does not address the issue directly.

Hudson et al.(2007) examine the distribution of individual characteristics among four groups with different eating disorders from the National Comorbidity Survey Replication data; by excluding those who do not have an eating disorder, their results suffer from an obvious form of selection bias. Furthermore, their data do not allow them to consider the role of socioeconomic variables on ED. To the best of our knowledge, Reagan and Hersch (2005) is the only study to estimate the multivariate effects of socioeconomic factors on ED behavior. Specifically they investigate the frequency of binge eating (but not purging) using data from the Detroit metropolitan area. They find that there are no race and age effects on bingeing behavior, and that marital status, neighborhood, depressive symptoms, and

[7] As noted by the National Eating Disorders Association, families frequently have to fight to get the appropriate and necessary treatment. It is not uncommon for families to spend thousands of dollars out of pocket to pay for their daughters to receive the necessary counseling and drugs to help to combat the disorder. In adolescents, BN treatment typically involves a combination of individual therapy, family therapy, behavior modification, nutritional rehabilitation and antidepressants (American Psychiatric Association, 2000).

income play a role among women. Our work differs from theirs along many dimensions: i) we focus on BN (both binge eating and purging), ii) have additional cross-section variables such as parent's education, iii) consider nonlinear estimators appropriate for limited dependent variables, fixed effects estimators, and dynamic models, iv) have somewhat wider geographic variation, and v) consider the potentially addictive nature of eating disorders behaviors.

The increasingly compulsive nature of eating disorders behaviors suggests that BN may represent an addiction. The ED literature suggests that there is biological support for an addictive interpretation of BN and some studies have found that addictive genetic factors may play a role in BN incidence (Lilenfeld et al, 1998; Bulik et al, 2003). Specifically, the auto-addiction-opioid theory posits that ED is an addiction to the body's production of opioids. Starving, bingeing, purging, and exercise increase the body's $\beta-$endorphin levels resulting in the same chemical effect as that delivered by opiates. Medical research provides further support of this hypothesis. For instance, Bencherif et al (2005) compare women with BN to healthy women of the same age and weight. Their brains were scanned using positron emission tomography (PET) after injection with a radioactive compound that binds to opioid receptors in the brain. The opioid receptor binding in bulimic women was lower than in healthy women in the area of the brain involved in processing taste, as well as the anticipation and reward of eating. This reaction has been found in other studies of addictive behavioral disorders, including drug addiction and gambling. Finally, some studies in the biological literature suggest there may be a genetic component to BN beyond the production of opioids.[8]

Furthermore, bulimics appear to persist in their behaviors. For example, 35% of individuals who engaged in bulimic episodes in the past continue to do so (Keel, et al, 2005), and only about half of the patients diagnosed with BN fully recover, many experiencing bulimic episodes for decades. The seminal papers of Stigler and Becker (1977) and Becker and Murphy (1988) (hereafter BM) showed that addiction can be consistent with forward-looking, rational utility maximizing behavior. Becker, Grossman and Murphy (1994) (hereafter BGM) used the framework of BM to examine whether addiction to cigarettes is rational, i.e. whether individuals consider that, due to the addictive nature of the behavior, their actions today will affect their future behavior and utility. For addiction to be rational, BM and BGM show that both leads and lags of the behavior should (positively) affect current behavior after controlling for unobserved heterogeneity. Moreover they show that, after controlling for unobserved heterogeneity, the coefficient on the lag of the behavior should generally be larger than that on the lead behavior, and as the ratio of the lead coefficient to the lag coefficient approaches one, the implied discount rate approaches zero.[9] As noted earlier, the previous literature does not control for unobserved heterogeneity when examining persistence in BN behaviors.

A number of papers have empirically tested the rational addiction model.[10] This literature has

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[8] See for instance, Bulik et al, 2003; Steiger, et al, 2004; and Frank, et al, 2004.

[9] BGM find evidence of rational addiction in their analysis of smoking behavior. Dockner and Feichtinger (1993) extend the BM model to allow for a more general addiction process where the addictive good accumulates to two different stocks of consumption capital.

[10] See Chaloupka and Warner (2000) for a detailed overview of the empirical rational addiction literature.

focused mainly on addictive behaviors in tobacco use (Chaloupka, 1991; Keeler et al, 1993; Becker, Grossman, and Murphy, 1994; Jones, 1994; Douglas, 1998; Gilleski and Strumpf, 2000; Choo, 2000; Baltagi and Griffin, 2001) and alcohol consumption (Walters and Sloan, 1995; Grossman, Chaloupka, and Sirtalan, 1998; Baltagi and Griffin, 2002; Arcidiancono et al, 2007). Results from these papers suggest that addictions to alcohol and to cigarettes have rational forward looking elements. A few studies have examined addiction to hard drugs (Bretteville-Jensen 1999) and caffeine (Olekalns and Bardsley 1996). Bretteville-Jensen found that individuals who actively use heroin and amphetamines have a higher discount rate than non-users. Finally, with respect to caffeine addiction, Olekalns and Bardsle find that the BM model fits well.[11] There is also a small literature examining whether addiction to food elements may be a contributing factor to the rise in obesity. Cawley (2001) is concerned with addictive elements of caloric intake; Richards, et al (2007) of food nutrients; and Rashad (2006) of caloric intake, smoking, and exercise. These papers find evidence of a forward looking addiction to calories (Cawley, 2001) and to carbohydrates (Richard, et al, 2007). The large and growing literature on obesity is related to our work in the broad sense that it pertains to food consumption, but otherwise is unrelated given that women suffering from BN are characterized by average body weight (Department of Health and Human Services, 2006).

3 Data

As noted above, we use the NHLBI Growth and Health survey, which involves girls from schools in Richmond, California and in Cincinnati, Ohio, and families enrolled in a health maintenance organization in the Washington, DC area.[12] The samples were also chosen to have equal numbers of African Americans and Whites, and to have approximately equal representation across different income groups for African Americans and Whites (page 2, Kimm, et al.(2002). Thus it is not a nationally representative sample, and is stratified by race and income. In our view neither of these are problematic. First, if model coefficients are constant across the country the fact that it is not nationally representative is not an issue; if coefficients differ, say across urban and rural locations, it is probably more informative to run separate equations on the urban and rural data, and our results from the NHLBI Growth and Health survey can be thought of as estimating the urban coefficients. Since we treat race and family

[11] As with our study, the majority of the papers follow the approach of Becker, Grossman, and Murphy (1994) who analyse the first order condition for prices and quantities. Some of these papers use aggregated data, while others use micro data. No study using micro data takes into account the fact that many observations involve zero consumption of the substance in question, and we address this issue. A few papers (Gilleskie and Strumpf, 2004; Choo, 2000; and Arcidiacono, et al, 2007) estimate dynamic structural models, which do account for the limited dependent variable nature of the data.

[12] Unfortunately, because of confidentiality concerns, the data do not indicate in which of these three sites an individual lives. Selection of potential schools was based on census tract data that showed approximately equal fractions of African American and White children, and the least disparity in income and education between the respondents of the two ethnic groups. The majority of the cohort, selected via the Health Maintenance Organization (HMO), was randomly drawn from a membership list of potentially eligible families with nine (or ten) year-old girls. A small percentage was recruited from a Girl Scout troop located in the same geographical area as the HMO population.

income as exogenous, there is no bias from stratifying the sample on these variables.[13]

The NHLBI Growth and Health survey was conducted annually for ten years, and began in 1988 when the girls were aged 9-10.[14] It contains substantial demographic and socioeconomic information such as age, race, parental education, initial family structure, and initial family income. The data also contain a number of time-varying psychological or personality indices (reflecting potential for personality disorders). These indices play an important role in our analysis, particularly in helping to control for unobserved individual heterogeneity.

A notable aspect of the data is that all individuals were asked a number of questions about their bingeing and purging behavior. For each respondent the data contain an Eating Disorders Inventory index developed by a panel of medical experts, which was designed to assess the psychological characteristics relevant to bulimia (Garner et al, 1983). Thus a major advantage of these data is that all sample participants are evaluated regarding BN behaviors and a BN eating disorder index is developed for each participant, independent of any diagnoses or treatment they have received. This stands in contrast to many data, where often a measure of ED or BN behavior is only available if the respondent had been diagnosed with, or was being treated for, an ED. However, if individuals from certain income or racial groups are more likely to seek treatment for an ED, results based on data from diagnosed individuals can present a very misleading picture of the incidence of EDs. Indeed we present evidence below that suggests this is a very real problem, not just a potential one.

To the best of our knowledge the NHLBI Growth and Health survey has not been used previously in economics, so we now describe the data and variable construction in some detail. The data consist of ten waves of 2379 girls. Starting in 1990, the survey contained questions on BN behavior approximately every other year (in waves 3, 5, 7, 9, and 10). The BN questions were developed by a panel of medical experts who were experienced in treating BN patients and familiar with the literature on the disorder (Garner et al, 1983). The questions were formulated to be consistent with the clinical definition of BN.[15] Respondents' answers were categorized and the survey reports an Eating Disorders Inventory Bulimia subscale (hereafter the ED-BN index), which measures degrees of behavior associated with BN. The ED-BN index is constructed based on the subjects responses ("always"=1, "usually"=2, "often"=3, "sometimes"=4, "rarely"=5, and "never"=6) to seven items: 1) I eat when I am upset, 2) I stuff myself with food, 3) I have gone on eating binges where I felt that I could not stop, 4) I think about bingeing (overeating), 5) I eat moderately in front of others and stuff myself when they are gone, 6) I have the thought of trying to vomit in order to lose weight, and 7) I eat or drink in secrecy. A response of 4-6 on a given question contributes zero points to the ED-BN index; a response of 3 contributes 1 point; a response of 2 contributes 2 points; and a response of 1 contributes 3 points.

[13] Of course, if coefficients differ across the population, stratifying on exogenous variables will change the coefficients, since there is a different local approximation to the index function, but it probably does not make sense to describe the results from the stratified sample as 'biased.'

[14] The attrition rate after ten years was 11%.

[15] Clinical criteria for BN, according to the Diagnostic and Statistical Manual of Mental Disorders fourth edition (DSM-IV), requires the cycle of binge-eating and compensatory behaviors occur at least two times a week for three months or more and that the individual feel a lack of control during the eating episodes.

The ED-BN index is the sum of the contributing points and ranges from 0 to 21 in our data. A higher score is indicative of more BN related problems (characterized by uncontrollable eating episodes that may be followed by the desire to self-induce vomiting). According to the team of medical experts that developed the index (Garner et al, 1983), a score higher than 10 indicates that the girl is very likely to have a clinical case of BN.[16]

The NHLBI Growth and Health survey also contains questions used to construct four other indices based on psychological criteria. Again, these indices were developed by a panel of medical experts (Garner et al, 1983). The four additional indices measure a respondent's potential for personality disorders, and below we refer to these indices collectively as the "personality indices." The first index is a measure of each girl's dissatisfaction with her body. This index is reported every year and, given the importance body image may play in the incidence of BN behaviors, we describe its construction in detail here. It is a sum of respondents answers to nine items intended to assess satisfaction with size and shape of specific parts of the body. Specifically, the statements are: 1) I think that my stomach is too big, 2) I think that my thighs are too large, 3) I think that my stomach is just the right size, 4) I feel satisfied with the shape of my body, 5) I like the shape of my buttocks, 6) I think my hips are too big, 7) I think that my thighs are just the right size, 8) I think that my buttocks are too large, 9) I think my hips are just the right size. It also is constructed based on the subjects responses ("always", "usually", "often", "sometimes", "rarely", and "never"), and each answer is scored using the point system used to construct the ED-BN index.[17] This index ranges from 0 to 27, and again a higher score indicates more dissatisfaction. Hereafter we refer to it as the Body Image index.

We also use three additional indices that are based on psychological criteria, measuring tendencies toward: i) perfectionism (hereafter the Perfectionism index) ii) feelings of ineffectiveness (hereafter the Ineffectiveness index), and interpersonal distrust (hereafter the Distrust index). These indices are available in waves 3, 5, 9, and 10 and thus overlap with the ED-BN index availability, with the exception that the ED-BN index is also available in wave 7. The Perfectionism index is based on subject responses to six items: 1) In my family everyone has to do things like a superstar; 2) I try very hard to do what my parents and teachers want; 3) I hate being less than best at things; 4) My parents expect me to be the best; 5) I have to do things perfectly or not to do them at all; 6) I want to do very well. The subjects are offered the same responses, and the responses are scored in the same way, as in the ED-BN index and the Body Image index. The Distrust and Ineffectiveness indices were constructed analogously. For ease of exposition, we provide details on the questions used to form the Ineffectiveness and Distrust indices in Appendix A. In all cases a higher score indicates a higher level of personality disorder.

[16] The index is an aggregation of qualitative numbers. The quantitative interpretation in terms of who is perceived to be suffering from clinical BN (ie a score higher than 10) is motivated by results from surveys among women diagnosed with BN (by the DSM criteria): the average EDI-BN index among this subsample was 10.8. See Garner et al. (1983) for a description of the development and validation of the ED-BN index.

[17] The scoring rule is as follows: "always"=6, "usually"=5, "often"=4, "sometimes"=3, "rarely"=2, and "never"=1 in questions 1, 2, 6, 7, and 8; and "always"=1, "usually"=2, "often"=3, "sometimes"=4, "rarely"=5, and "never"=6 in questions 3, 4, 5, and 9.

We report variable means, standard deviations, and standard errors for the means of the NHLBI Growth and Health sample in Table 1. Since we have multiple observations on the same respondent for all but the specific year entries, we cluster the observations by individuals when calculating standard errors for the mean values. Approximately 2.2% of the girls have a case of clinical BN, which is close to the national average reported from other sources, while the mean of the ED-BN index is 1.2. The average age of the girls over the sample is approximately 14 years, and as expected given the sample design, it is approximately equally distributed across race, income, and parent's education level.[18]

Table 2 illustrates the univariate relationship between the demographic variables , the ED-BN index and the incidence of BN. Specifically in the upper panel columns 1-3 we present the mean, standard deviation, and standard error of the ED-BN index for the given demographic group. Columns 4-6 presents the mean of the incidence of BN, as well as the other statistics, for each group. Again, in each case we cluster the standard errors for the means. Note first that as the girls age, both the index and the incidence of BN fall. Interestingly, compared to White girls, at standard confidence levels African American girls have a statistically significant higher ED-BN index and a statistically significant higher incidence of BN.[19] The ED-BN index and the incidence of clinical BN both decrease as both parental education and family income increase, and again these differences are statistically significant at standard confidence levels. These results suggest that EDs are more problematic among African American girls, girls from low income families, and girls from families with lower parental education, and thus stand in contrast to popular wisdom about the incidence of EDs. One possibility is that these univariate results will disappear once we condition on the personality indices, and that some will disappear once we condition on the other demographic variables. However, the results in the next section indicate that most of these demographic differences persist in a multivariate setting with or without conditioning on the personality characteristics indices. Below we discuss why our results are at odds with popular wisdom. Finally, in the lower panel of Table 2 we present the univariate correlations between each of the personality indices with both the ED-BN index and the incidence of clinical BN. In all cases these correlations are positive and statistically significant.

Finally, we present summary statistics on the persistence in the ED-BN index and the incidence of clinical BN to motivate our estimation of dynamic models. To look at persistence in the ED-BN index we consider four categories of the ED-BN index: equal to 0, in the range $1-5$, in the range $6-10$, and greater than 10. Table 3 provides the transition rates across two year intervals for these categories.[20]
Note first that the higher ED-BN category, the lower the probability of having an index value of 0 at time $t+2$. Second, the higher the category for the index in t, the more likely the ED-BN index

[18] In almost 20% of the individual-wave observations, the girls report being depressed (they were asked about their problems with depression in waves 7 and 9). Those who are depressed have statistically significant higher ED-BN indices and incidence of clinical BN. The high comoribity of depression and ED behaviors is well-documented (see Department of Health and Human Services, 2006). We do not include depression as an explanatory variable in our analysis due to problems associated with reverse causality from BN to depression, for which we do not have an adequate instrument. The issue of reverse causality from BN to depression does not seem to have been recognized in the previous literature.

[19] By construction the sample contains only African Americans and Whites.

[20] Recall that the ED-BN index is only available approximately every two years.

lies between 6 and 10 in $t+2$. Finally the higher the ED index in t, the more likely is the woman to be in the 11+ category at $t+2$, i.e. the more likely she is to have clinical bulimia. If we simply look at the correlation between the index in t and the index in$t+2$, we find 0.476 (at 1% significance level). Finally, the conditional probability of having clinical BN in $t+2$ given that a girl has in t is 0.37, while the same probability for someone who does not have clinical BN in t is 0.01. We draw two conclusions from these results. First, there is substantial persistence in the ED-BN index and the incidence of clinical BN, motivating our use of dynamic models. Second, the first set of transition rates indicates that a value of the ED-BN index between 0 and 10 is important for predicting the incidence of clinical BN in $t+2$, and that simply aggregating the ED-BN index into an incidence of clinical BN would discard valuable information. Indeed our results presented below show that coefficients are of the same sign when we analyze the ED-BN index and the incidence of clinical BN, but the former are much more precisely estimated than the latter.

4 Econometric Specification and Results: Static Models of Bulimia

We consider results from five model specifications: i) a linear regression structure that treats a zero value of the ED-BN index as lying on the regression line, ii) a Tobit structure for the ED-BN index, iii) a potentially more flexible (than the Tobit model) Ordered Probit structure based on the intervals for the ED-BN index we used in Table 3[21] , iv) a linear probability model for the incidence of clinical BN (i.e. a value for the ED-BN index greater than 10),[22] and v) standard Probit model for the incidence of clinical BN. We first use these models to examine the relationship between outcomes and the socioeconomic status (SES) of the respondent. We then augment these models to study the relationship between outcomes and personality indices. We then allow for the possibility that the results are biased by a person-specific, time-invariant effect. In the linear models we address this by first-differencing while in the nonlinear models we use the Chamberlain (1984)/Woldridge (2005) (hereafter C/W) approach.

To begin we estimate the linear projection of the latent variable underlying ED-BN index

$$y_{it} = \beta_0 + \beta_1 X_{it} + a_t + \delta_i + v_{it}, \qquad (1)$$

where X_{it} is a vector of explanatory variables (demographics, the personality characteristics indices described above) for individual i at time t, a_t is a time dummy (which we sometimes drop), δ_i is an individual-specific effect and v_{it} is a contemporaneous shock.[23] To begin with we treat δ_i as uncorrelated with the explanatory variables, and cluster the standard errors by individual to control

[21] As noted above the Ordered Probit model is based on the categories for the ED-BN index equal to 0; $1-5$; $6-10$ and greater than 10.We estimate the limit points in the Ordered Probit and thus this model is potentially more flexible than the Tobit model.

[22] In a study consisting of women diagnosed with BN by the formal DSM criteria (Garner et al 1983), the average ED-BN index was 10.8. These results motivate the classification of values higher than 10 on the ED-BN index being consistent with a clinical case of BN.

[23] Given this notation, an intuitive statement of strict exogeneity conditional on the fixed effect is $E(v_{it}X_{it}|\delta_i) = 0$.

for correlation across time due to individual components and the induced heteroskedacticity in the linear models.

For the Tobit estimates, we assume that the latent variable underlying ED-BN index takes the form

$$y_{it}^{*} = \varphi_0 + \varphi_1 X_{it} + b_t + \mu_i + e_{it}, \tag{2}$$

where the change in notation is obvious. The observed value, y_{it} of the ED-BN index is given by

$$y_{it} = \begin{cases} 0 \text{ if } y_{it}^{*} \leq 0 \\ y_{it}^{*} \text{ otherwise.} \end{cases} \tag{3}$$

We begin by assuming that μ_i is an independently and identically distributed $N(0, \sigma_\mu^2)$ individual-specific random effect and that e_{it} is i.i.d. $N(0, \sigma_e^2)$ (over time and individuals). We then estimate the model by forming a quasi-likelihood of the period by period observations where standard errors are clustered by individual.[24] Below we compare the regression coefficients to the partial effects for the Tobit model, which give very similar results.

Note that in estimating the Tobit and regression models, we treat the sum of the answers to the ED-BN index questions as a quantitative variable for which the difference between the values of 2 and 3, say, is the same as the difference between values of 7 and 8. Since this assumption may be too strong, we could alternatively consider a model where the ED-BN index takes on 24 ordinal values determined by

$$y_{it} = \begin{cases} 0 \text{ if } y_{it}^{*} \leq 0 \\ 1 \text{ if } 0 < y_{it}^{*} \leq \alpha_1 \\ k \text{ if } \alpha_{k-1} < y_{it}^{*} \leq \alpha_k \qquad k = 2, ., 22 \\ 23 \text{ if } \alpha_{22} < y_{it}^{*}. \end{cases} \tag{4}$$

While (4) is very flexible, it also involves estimating the twenty-two α parameters, in addition to the parameters in (1), which we felt would be too many to identify using our data. Instead we estimated an Ordered Probit model as a specification test, where the observed dependent variable, $z_{it} = 0$ if the ED-BN index equals 0, $z_{it} = 1$ if the index is in $[1, 5]$, $z_{it} = 2$ if the index is in $[6, 10]$, and $z_{it} = 3$ if the index is greater than 10. Our statistical model is

$$z_{it}^{*} = \gamma_0 + \gamma_1 X_{it} + \widetilde{b}_t + \mu_i + e_{it}, \tag{5}$$

[24] Of course we cannot allow for heteroskedacticity when clustering, since Tobit estimates are inconsistent unless we have homoskedactic errors. We also estimated random effects Tobit models, which offer an efficiency gain at the cost of making the assumption that the correlation across time periods is constant. This gave us results very similar to the ones reported in the paper.

where $(\sigma_\mu^2 + \sigma_e^2)$ is normalized to 1, and

$$z_{it} = \begin{cases} 0 \text{ if } z_{it}^* \leq 0 \\ 1 \text{ if } 0 < z_{it}^* \leq \delta_{L2} \\ 2 \text{ if } \delta_{L2} < z_{it}^* \leq \delta_{U2} \\ 3 \text{ if } z_{it}^* > \delta_{U2}. \end{cases} \tag{6}$$

In this approach we estimate the parameters in (5) and the two δ cutoff terms. Note that if the Tobit model is strictly true, we could replace the Ordered Probit model in (5) by one where[25]

$$z_{it}^* = \varphi_0 + \varphi_1 X_{it} + b_t + \mu_i + e_{it}, \tag{7}$$

and

$$z_{it} = \begin{cases} 0 \text{ if } z_{it}^* \leq 0 \\ 1 \text{ if } 0 < z_{it}^* \leq 5.5 \\ 2 \text{ if } 5.5 < z_{it}^* \leq 10.5 \\ 3 \text{ if } z_{it}^* > 10.5. \end{cases} \tag{8}$$

We again maximize the the quasi-likelihood for the Ordered Probit model based on the period-by-period likelihood function. We compare the sign and significance of the Tobit estimates and the Ordered Probit estimates as an informal specification test; the coefficients are not directly comparable because the variance must be normalized to 1 for the Ordered Probit model with estimated limit points.[26]

Next we consider a linear probability model for the incidence of clinical BN (i.e., our dependent variable is $w_{it} = 0$ if the ED-BN index is less than or equal to 10 and $w_{it} = 1$ if the ED index is greater than 10); we cluster the standard errors to allow for heteroskedacity and correlation across individuals. Finally, we estimate a Probit model by maximizing the quasi-likelihood and clustering the standard errors.

We discussed in section 3 the possibility that the personality characteristics may be driven by genetic factors. If this is the case the individual effect μ_i will be correlated with the independent variables, and the coefficients on the independent variables will not have a casual interpretation. To allow for this possibility in the regression and linear probability model we simply first-difference. Of

[25] Of course, here we are assuming that it is appropriate to use the midpoint of the interval.

[26] We cannot use a Hausman test to compare the coefficients even if we account for the variance normalization because, even if Tobit structure is valid, estimates based on the quasi-likelihood are not efficient.

course, only the coefficients on the time-changing independent variables can be estimated.[27] Also, as in any fixed effect model, to estimate these equations consistently we need to assume that the personality indices are strictly exogenous, conditional on the fixed effect (see, e.g., Woldridge 2002, p. 253, equation (10.14). In other words, we require that

$$E[v_{is}X_{il}|\delta_i] = 0$$

for all s and l. In particular, this rules out feedback from current values of the error term to future values of the explanatory variables. The strict exogeneity assumption may be a more reasonable for the perfectionism, ineffectiveness and distrust indices than for the body image index, since a shock to ED behavior today may affect one's body image tomorrow. Thus we also estimate models where we only include these personality indices and exclude the body image index.

In the nonlinear models, we use the C/W fixed effects estimators, where again we need to assume strict exogeneity. Specifically, for the Tobit model we assume that $\mu_i = \pi_1\bar{X}_i + u_i$ where $\bar{X}_i$ is the vector of means of the explanatory variables and $u_i \sim iid\ N(0, \sigma_u^2)$. For example, substituting for μ_i in (2) yields

$$y_{it}^* = \varphi_0 + \varphi_1 X_{it} + b_t + \pi_1\bar{X}_i + u_i + e_{it}.$$

In Table 4 we present the estimates from five estimators. The top panel gives results where we use only the demographic characteristics of the respondent as explanatory variables. The corresponding estimates with time dummies are in the lower panel. For the Tobit and Probit models we report partial effects, while for the Ordered Probit we present the coefficients as the partial effects are not as straightforward to interpret. The X_{it} term is a vector containing the respondent's age, dummy variable for race is White , two dummy variables for parent's education (some college and four year college degree or more) and two dummy variables for initial family income (between \$20,000 and \$40,000 and over \$40,000; both in 1988\$). Thus the base case is an African American girl with parent's education of high school or less with a family income under \$20,000. As noted above standard errors are clustered by individual.

The coefficients for the linear model and the partial effects for the Tobit model are very similar in terms of size and significance, so we discuss only the former. They show that the effect of being White , holding the other variables constant, is significantly negative, contrary to popular opinion. Further, the ED-BN index is significantly decreasing in age, family income and parent's education. Being White decreases the ED-BN index by approximately 0.2, while having the highest parental education is predicted to lower the index by approximately 0.3 as compared to those with the lowest

[27] Chamberlain (1984) suggested controlling for the fixed effect by making it a linear function of all the values of the explanatory variable, while Woldridge (2005) suggested the more parsimonious approach of making the fixed effect the means of the independent variables. We follow Woldridge's approach since it makes our estimates more comparable to our dynamic fixed effects estimates.

parental education. Finally, being in the highest family income category lowers the index by about 0.5 as compared to having the lowest category of family income. Recall that the mean for the ED-BN index is only 1.2; hence the estimated partial effects are not small.

The results for race and income stand in contrast to popular opinion, and, as discussed below, the findings remain even after we condition on personality characteristics. This raises the question of why popular opinion is at odds with our results. We believe the explanation is straightforward: popular opinion appears to be based on who has been diagnosed with an eating disorder, not (the potentially larger group) of those who exhibit behavior consistent with an ED. For instance, in a companion paper (Goeree, Ham and Iorio, 2008A) we consider two groups of women: those who are diagnosed with an ED and those who are not necessarily diagnosed but engage in bingeing and purging behavior. We find that the incidence of diagnosis is more likely among high-income Whites (consistent with popular opinion), but bingeing and purging behavior is more prevalent among women with demographics consistent with the results from this study.[28] The difference would appear to arise because girls who are African American and/or come from low income families are much less likely to be diagnosed with an ED conditional on having an ED. These results illustrate the importance of having objective information on behavior rather than relying solely on data on diagnoses.

The results from the Ordered Probit model are very similar to those from the Tobit in terms of the signs and significance of the coefficients, but as one would expect the Tobit coefficients are significant at higher confidence levels (since they are based on less-aggregated data). Finally, the Probit partial effects and LPM results (in the last two columns) are relatively similar (to each other), and have the same sign as the Tobit and Ordered Probit results. However fewer estimated coefficients are statistically significant, and the significance is at lower confidence levels. The fact that we have substantially fewer significant coefficients in the Probit and LPM estimates is again expected, since they use much less information per person than the other methods. Indeed, our estimates illustrate the importance of not simply focusing on whether an individual is diagnosed with ED-BN for understanding the determinants of this disease.

When we include time dummies (the lower panel of Table 4) only the coefficients for age are affected, and these coefficients are noisily estimated. This latter result is not surprising given we do not have much variation in age at the start of the sample, so the girls in our sample tend to act like a single cohort, and it is well known that one cannot estimate vintage and time effects for a single cohort.

We next look at the effect of the personality characteristics indices on the ED-BN index, holding constant the demographic variables. It is well known in the medical literature that patients diagnosed with BN are likely to suffer from other psychiatric disorders.[29] The most common comorbidities include depression, anxiety, substance abuse, and personality traits such as high tendencies toward

[28] In Goeree, Ham and Iorio (2008A) we use data from ADD Health to address different issues than those considered in this study. Most importantly, the ADD Health data are not a long enough panel to allow us to estimate dynamic models needed to address the addictive nature of BN behaviors that we consider in this paper.

[29] For an overview of the medical literature see the papers discussed in Department of Health and Human Services (2006).

perfectionism, poor body image, feelings of ineffectiveness and interpersonal distrust issues. The source of the high comorbidities is not known, but some studies suggest that common familial or genetic factors may be responsible (Walters et al.1992; Wade et al, 2000; Mangweth et al, 2003). Further, it is plausible that for body image concerns, the causality may be reversed - high levels of the ED-BN index, i.e. abusing food, may lead to a poor body image. This possibility does not seem to have been noted previously in the literature.

Table 5 contains the results for the linear model where personality indices are included as explanatory variables; in all specifications we cluster the observations by individuals when calculating the standard errors. We begin by estimating the model in levels. Column (1) presents results with the distrust, ineffectiveness and perfectionism indices. We exclude the body image index from column (1) since it may be more susceptible to reverse causality issues than the other personality indices. In column (2) we include all personality characteristics indices, and in column (3) we include only the body image index. Note first that race, age and family income, but not parental education, are still statistically significant when we condition on personality characteristics, independent of which ones we condition on. Second, the ineffectiveness, perfectionism and body image indices, but not the distrust index, significantly affect the ED-BN index in the direction expected. Third, the effects of increases in the personality characteristics are not trivial. A five point increase in the ineffectiveness index or the perfectionism index, increases the ED-BN index by about one point, while a five point increase in the poor body image index increases the ED-BN index by about 0.2. Columns (4)-(6) report the first difference estimates of the equation, which allow for common unobserved familial or genetic factors that affect both the personality indices and the ED-BN index. These results are very similar to those from the level estimates except that now distrust is statistically significant and has a negative sign, while we would have expected that if significant, it would have had the opposite sign. (The demographic variables are only measured at the start of the survey and thus drop out of the first difference model.) The results are reassuringly similar to the first difference estimates. Columns (7)-(9) present the results with Chamberlain/Wooldridge type fixed effects, where again the signs and significance of the estimates are similar to the first difference estimates. These columns are useful to facilitate comparison with the results from the nonlinear models where we cannot first difference.

Table 6 contains the partial effects for the Tobit model when we include the personality characteristics as explanatory variables. The results are virtually identical to those from the linear model except that the distrust variable has a significant positive coefficient in the levels equation and an insignificant coefficient in the fixed effect specification. The Ordered Probit estimates in Table 7 are very similar in sign and significance to the Tobit estimates. The LPM and Probit partial effects for clinical BN (i.e. ED-BN index greater than 10) estimates are given in Tables 8 and 9, respectively; they are also similar to the Tobit model estimates in terms of the impact of personality characteristics, which are very significant even though we are only exploiting zero-one information on the outcome variable.

5 Persistence of Bulimia: The Role of State Dependence and Unobserved Heterogeneity

In this section we consider dynamic models of addiction. We use the same five estimation methods as in the previous section. Our goal is to study the degree of persistence in bulimic behavior, and to decompose this persistence into that due to state dependence (i.e., BN behavior in the past has a casual effect on BN behavior this period) and that due to unobserved heterogeneity (i.e., some girls have persistent traits that makes them more prone to bulimic behavior.)

5.1 Standard Models of Addiction

We begin with the most basic model

$$y_{it} = \beta_0 + \beta_1 y_{it-1} + a_t + \delta_i + v_{it}, \tag{9}$$

where y_{it} is the linear projection of the observed variable underlying the ED-BN index. The least squares estimate of β_1 will reflect both unobserved heterogeneity and state dependence unless δ_i drops out and v_{it} is not correlated over time. To reduce the role of heterogeneity we include current explanatory variables (X_{it}) :

$$y_{it} = \beta_0 + \beta_1 y_{it-1} + \beta_2 X_{it} + a_t + \delta_i + v_{it}.. \tag{10}$$

Conditioning on X_{it} diminishes the role of δ_i and makes it less likely that v_{it} is correlated over time. However if δ_i is part of the error term the least squares estimate of β_1 will continue to reflect, in part, unobserved heterogeneity. To allow for the presence of an individual-specific term δ_i which is uncorrelated with X_{it} and its lags, we consider 2SLS estimates of (10) where X_{it-1} are instrumental variables (IV). Given our assumption that δ_i is uncorrelated with X_{it} and its lags the estimate of β_1 encompasses only state dependence.[30] However, if δ_i is correlated with X_{it} and its lags then (following Arellano and Bond, 1991) we can first difference (10) to obtain

$$\Delta y_{it} = \beta_0 + \beta_1 \Delta y_{it-1} + \beta_2 \Delta X_{it} + \Delta a_t + \Delta v_{it} \tag{11}$$

and estimate the parameters by 2SLS with X_{it}, X_{it-1}, X_{it-2}, and y_{it-2} as IV.[31] This allows us to obtain a structural estimate of β_1 that reflects only state dependence.

For the Tobit model, we consider the latent variable equation

$$y^*_{it} = \varphi_0 + \varphi_1 y_{it-1} + \varphi_2 X_{it} + \alpha_t + \mu_i + e_{it}, \tag{12}$$

[30] In theory we could use additional lags of the explanatory variables as IV but this would reduce our sample size considerably.

[31] In practice adding the two period lagged dependent variable to the instruments has very little effect on the 2SLS estimates. As we mentioned previously, the only personality characteristic for which we can use a two period lag is body image; including a two period lag for the other personality characteristics would result in too many lost observations. Thus we only use one lag of the other personality indices as instruments.

where μ_i are (unobserved) individual-specific random effects and e_{it} is an uncorrelated (over time) error term, both of which are normally distributed. Again we want to estimate φ_1 as a structural parameter representing state dependence. However, the estimate of φ_1 will capture both heterogeneity and state dependence unless μ_i drops out of the index function. To address this issue, first we add explanatory variables X_{it} to diminish the role of μ_i. Then we treat μ_i as a fixed effect (in addition to including X_{it}) using the the Woldridge (2005) fixed effect estimator for the dynamic Tobit model. In this approach μ_i is a function of the mean values of the explanatory variables ($\overline{X}$) and the initial condition (y_{i0}). Substituting for μ_i yields

$$y^*_{it} = \varphi_0 + \varphi_1 y_{it-1} + \varphi_2 X_{it} + \varphi_3 \overline{X}_i + \varphi_4 y_{i0} + \alpha_t + e_{it}.$$

where the estimate of φ_1 reflects only state dependence.

We also estimate a dynamic Ordered Probit model as an informal specification check. Recall that $z_{it} = 0$ if the ED-BN index equals 0, $z_{it} = 1$ if the ED-BN index is in $[1, 5]$, $z_{it} = 2$ if the ED-BN index is in $[6, 10]$, and $z_{it} = 3$ if the ED-BN index is greater than 10. Let $\widetilde{z}_{it-1}$ be a 4-dimensional column vector equal to: $(1, 0, 0, 0)$ if $z_{it-1} = 0$; $(0, 1, 0, 0)$ if $z_{it-1} = 1$; $(0, 0, 1, 0)$ if $z_{it-1} = 2$ and $(0, 0, 0, 1)$ if $z_{it-1} = 3$. The dynamic index function is given by

$$z^*_{it} = \gamma_0 + \gamma_1 X_{it} + \gamma_2 \widetilde{z}_{it-1} + \widetilde{\alpha}_t + \theta_i + u_{it}. \tag{13}$$

We estimate the parameters and the limit points of (13). Again we start by ignoring the correlation between $\widetilde{z}_{it-1}$ and θ_i and obtain an estimate of γ_2 that reflects both heterogeneity and state dependence. Next we add the explanatory variables, and finally we use the Woldridge (2005) procedure to obtain an estimate of γ_2 that only reflects state dependence. Persistence in this model is described by the 4 by 4 transition matrix with elements given by $\Pr(z_{it} = k \mid z_{it-1} = j \text{ for } k, j = 0, .., 3)$

For the dynamic (standard) Probit model of clinical BN (an ED-BN index greater than 10) we consider

$$w^*_{it} = \gamma_0 + \gamma_1 w_{it-1} + \gamma_2 X_{it} + \alpha_t + \mu_i + e_{it}. \tag{14}$$

We can obtain an estimate of γ_1 that only encompasses state dependence by using Woldridge (2005). If we consider the LPM version of this equation

$$w_{it} = \gamma_0 + \gamma_1 w_{it-1} + \gamma_2 X_{it} + \alpha_t + \mu_i + e_{it}, \tag{15}$$

all of the estimation methods available with the linear estimator can be used to estimate the LPM.

Table 10 contains our parameter estimates for the linear model. Column (1) presents estimates of the model where the only explanatory variable is the (assumed to be exogenous) lagged dependent variable; not surprisingly it is very statistically significant and positive. In column (2) we add the demographic variables. The coefficient and standard error for the lag (y_{it-1}) hardly change, where the only demographic variables that are statistically significant are income and age. (If we add time dummies the only real change is that age becomes very insignificant.) When we add the personality characteristics indices the lag coefficient drops substantially (columns (3) and (4)). Distrust is insignificant but the other three indices are significant and have the expected sign. In columns (5)-(7) we estimate the levels equation by 2SLS, and find a highly significant lag coefficient of around 0.2. The other coefficients have the expected sign, except that now distrust again has a negative, statistically significant, coefficient. Note that the estimates are consistent if the individual effect is uncorrelated with the explanatory variables. To correct for potential correlation, we present the Arellano-Bond approach of differencing before using 2SLS and present the results in column (8). We are only able to use the body image index (lagged two periods) as an IV because the other personality indices are missing in wave 7. We also use the dependent variable (ED-BN index) lagged two periods as an IV. We find a lag coefficient estimate of 0.22, where the coefficient is ten times as large as its standard error. The body image index has the expected positive sign and is statistically significant. These results provide consistent evidence that bulimic behavior is an addiction. Indeed, the results suggest that roughly half the persistence in the behavior is due to true state dependence, given that the lag coefficient in column (6) is about half of the size of the coefficient in column (1).

The Tobit partial effect estimates are given in Table 11. The lag coefficient decreases as we condition on explanatory variables, but the estimates are substantially larger than those from the linear models, and suggest that about three quarters of the persistence is due to state dependence. Moreover, the distrust variable is no longer statistically significant. The Ordered Probit estimates in Table 12 tell a similar story to the Tobit model in terms of sign and significance, which is reassuring. (Recall that it is not helpful to calculate partial effects for this model so the results are not comparable in terms of magnitude to those in Table 11.) The LPM model estimates for clinical Bulimia are in Table 13. They also show a reduction in the lag coefficients as we add explanatory variables. However, when we use 2SLS the lag coefficient is only significant when we first difference the data (column 8).

5.2 Models of Rational Addiction

Finally we estimate the rational addiction model of BG and BGM. As noted above, to estimate this model we include both the lead and the lag of the dependent variable. We consider only the linear estimates because i) the Wooldridge (2005) procedure has not been extended to include lead dependent variables and ii) the LPM coefficients are very noisy, indicating that the model is too rich if we use only binary information of who has clinical BN. Thus we consider the model

$$y_{it} = \rho_0 + \rho_1 y_{it-1} + \rho_2 y_{it+1} + \rho_3 X_{it} + \alpha_t + \mu_i + e_{it}, \tag{16}$$

where we anticipate that $\rho_1 > 0$ and $\rho_2 > 0$. Further, if the implied interest rate equals zero then $\rho_1 = \rho_2$; while it is positive if $\rho_2 < \rho_1$, where the difference in the coefficients grows as the discount rate grows. We estimate the model by 2SLS, and we use one lag and one lead of the body image index as IV (that are excluded from the structural equation) for the case where we assume μ_i is uncorrelated with the body image index. (We cannot use leads and lags of the other personality disorders since these are not available in wave 5.) Finally, to allow for correlation between μ_i and body image, we first difference (16) to obtain

$$\Delta y_{it} = \rho_0 + \rho_1 \Delta y_{it-1} + \rho_2 \Delta y_{it+1} + \rho_3 \Delta X_{it} + \Delta \alpha_t + \Delta e_{it}, \quad (17)$$

where we use the lead and second lag of the body image index as IV (that are excluded from the structural equation). Note that we only have one observation per person with which to estimate 17.

Column (1) of Table 15 presents the benchmark case where only the lag and lead (treated as exogenous) are included as explanatory variables. Not surprisingly, they are both highly positive and significant. Columns (2) and (3) present the results when the lag and lead of the dependent variable are treated as exogenous, where all personality characteristics and only body image are included as explanatory variables, respectively. The lead and lag of the dependent variable continue to be very significant, although the magnitude is somewhat lower. The corresponding 2SLS estimates (treating the lag and lead as endogenous) are in columns (4) and (5). The 2SLS estimates were obtained using the lead and lag of body image as instruments. Note the magnitude of the lead and lag coefficients has fallen by about half, and both coefficients are positive as predicted by theory. The lead coefficient is slightly bigger than the lag coefficient, and thus at the point estimates we implicitly are estimating suggest a slightly negative discount rate. However the confidence interval for $(\rho_1 - \rho_2)$ is $[-0.278, 0.237]$ in column (4) and $[-0.239, 0.214]$ in (5), which includes many positive values of the discount rate. This wide confidence interval would seem to be another example of the difficulty in precisely estimating discount rates.

6 Conclusions

We use a unique dataset to examine the addictive nature of BN among teenage girls. This dataset has the advantage first that it is panel data, and second that bulimic behavior is based on observable behavior for the entire sample as interpreted by ED experts. We find that BN satisfies the economic definition of addiction, i.e. lagged bulimic behavior matters once one controls for individual heterogeneity. Further, we find that BN is a rational addiction in the sense of Becker and Murphy (1988), since both the lead and lag of bulimic behaviors help explain current behavior after controlling for individual heterogeneity. Our results have important implications for public policy, since it suggests the importance of discouraging and diagnosing bulimic behavior at an early age for all girls. They also suggest that treatment for BN should receive the same insurance coverage as treatment of alcoholism and drug addiciton.

Second, suprisingly little is known about the factors determining the incidence of BN, and we fill this gap in the literature. We find that BN behavior is decreasing in income and parent's education; moreover when race plays a role, African Americans are more likely to exhibit bulimic behavior. These results stand in stark contrast to the popular conceptions about BN. Based on evidence here and in Goeree, Ham and Iorio (2008a), we argue that this disparity occurs because affluent white teenage girls are much more likely to be diagnosed with BN conditional on having it.

7 Tables

Table 1: Descriptive Statistics

	Mean	Std. Dev.	Clustered Std Er. (Mean)	Number of Waves
ED-BN Index	1.279	2.682	0.039	3,5,7,9,10
Clinical Bulimia	0.022	0.145	0.002	3,5,7,9,10
Age	14.363	2.991	0.014	All 10
White	0.480	0.499	0.01	All 10
Parents High School or Less	0.250	0.433	0.009	All 10
Parents Some College	0.396	0.489	0.01	All 10
Parents Bachelor Degree or More	0.354	0.478	0.01	All 10
Income less than $20,000 (in 1988$)	0.316	0.465	0.01	All 10
Income in [20000, 40000] (in 1988$)	0.311	0.463	0.01	All 10
Income more than $40,000 (in 1988$)	0.373	0.484	0.01	All 10
Body Image *	8.039	7.554	0.131	3,5,7,9,10
Distrust **	3.589	3.492	0.056	3,5,9,10
Ineffectiveness ***	2.752	3.915	0.063	3,5,9,10
Perfectionism ****	6.468	3.290	0.052	3,5,9,10

Notes: * ranges from 0 to 27 (maximal dissatisfaction); ** ranges from 0 to 21 (maximal distrust);
*** ranges from 0 to 29 (maximal ineffectiveness); **** ranges from 0 to 18 (maximal perfectionism)

Table 2: Mean of ED-BN Index and Incidence of Clinical Bulimia by Characteristics

Variable (% of sample)	ED-BN Index			Clinical Bulimia		
	Mean	Std Dev.	Clustered Std. Error	Mean	Std Dev.	Clustered Std. Error
Years:						
1989 (21.65)	1.814	3.287	0.07	0.038	0.191	0.004
1991 (19.81)	1.61	3.021	0.067	0.033	0.178	0.004
1993 (18.51)	1.098	2.342	0.054	0.014	0.117	0.003
1995 (19.65)	0.86	2.054	0.046	0.008	0.092	0.002
1996 (20.40)	0.955	2.279	0.05	0.013	0.113	0.002
White (48.10)	1.042	2.437	0.051	0.017	0.13	0.002
Black (51.90)	1.498	2.873	0.058	0.026	0.158	0.003
Parents High School or Less (24.60)	1.648	3.136	0.096	0.033	0.178	0.005
Parents Some College (39.73)	1.325	2.682	0.06	0.02	0.141	0.003
Parents Bachelor Degree or More (35.68)	0.973	2.278	0.055	0.015	0.122	0.002
Household Income (in 1988$):						
Income less than $20,000 (29.56)	1.721	3.146	0.086	0.033	0.179	0.004
Income in [$20000, $40000] (29.47)	1.198	2.633	0.072	0.021	0.144	0.003
Income more than $40,000 (35.49)	0.982	2.245	0.053	0.013	0.112	0.002

Correlations of ED-BN and Clinical Bulimia with Personality Characteristics

Personality Index	ED-BN Index	Clinical Bulimia
Poor Body Image	0.221	0.114
Distrust	0.213	0.107
Ineffectiveness	0.439	0.274
Perfectionism	0.229	0.145

Notes: The top panel reports clustered standard errors of the mean. All correlations in the bottom panel are significant at the 1% level.

Table 3: ED-BN Index Transition Probabilities

	t+2			
t	0	[1,5]	[6,10]	>10
0	80.16	17.9	1.5	0.43
[1,5]	51.92	39.8	6.47	1.82
[6,10]	31.38	42.86	17.8	7.96
>10	21.93	37.97	20.32	19.79
Marginal Probability of ED-BN at t+2	68.57	25.59	4.17	1.67

Table 4: Partial Effects with Demographic Characteristics

	ED-BN Index			Clinical Bulimia	
	Linear Probability	Tobit	Ordered Probit	Probit	Linear Probability
White	-0.243***	-0.676***	-0.108***	-0.073	-0.004
	(0.088)	(0.240)	(0.041)	(0.083)	(0.004)
Age	-0.132***	-0.318***	-0.051***	-0.083***	-0.004***
	(0.011)	(0.029)	(0.005)	(0.012)	(0.001)
Parents Some College	-0.198*	-0.321	-0.042	-0.150*	-0.010*
	(0.113)	(0.280)	(0.047)	(0.082)	(0.005)
Parents Bachelor Degree	-0.313***	-0.703**	-0.100*	-0.120	-0.008
or More	(0.116)	(0.316)	(0.053)	(0.097)	(0.005)
Income in [$20000, $40000]	-0.377***	-1.029***	-0.174***	-0.132	-0.009*
	(0.112)	(0.287)	(0.048)	(0.089)	(0.005)
Income more than $40,000	-0.488***	-1.278***	-0.209***	-0.318***	-0.016***
	(0.107)	(0.295)	(0.050)	(0.096)	(0.005)
Constant	3.975***	3.871***		-0.483**	0.106***
	(0.227)	(0.518)		(0.201)	(0.013)
Year Dummies Included					
White	-0.227***	-0.629***	-0.100**	-0.073	-0.004
	(0.088)	(0.240)	(0.041)	(0.083)	(0.004)
Age	0.010	0.122	0.024	-0.084	-0.005*
	(0.060)	(0.174)	(0.030)	(0.054)	(0.003)
Parents Some College	-0.193*	-0.311	-0.040	-0.150*	-0.009*
	(0.113)	(0.279)	(0.047)	(0.082)	(0.005)
Parents Bachelor Degree	-0.299***	-0.657**	-0.093*	-0.121	-0.008
or More	(0.116)	(0.316)	(0.053)	(0.098)	(0.005)
Income in [$20000, $40000]	-0.384***	-1.050***	-0.178***	-0.132	-0.009
	(0.112)	(0.286)	(0.048)	(0.089)	(0.005)
Income more than $40,000	-0.500***	-1.314***	-0.216***	-0.322***	-0.016***
	(0.106)	(0.294)	(0.050)	(0.095)	(0.005)
Constant	1.362	-4.348		-0.336	0.118**
	(1.169)	(3.355)		(1.036)	(0.050)
Sample Size	9591	9591	9591	9591	9591

Notes: Standard errors robust to both heteroskedasticity and intra-group correlation are in in parenthesis in columns (1) and (5). Standard errors robust to intra-group correlation are in parenthesis in (2),(3),(4). * indicates significant at 10%; ** at 5%; *** at 1%.

Table 5: Linear Model Estimates for ED-BN Index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
White	-0.178**	-0.238**	-0.406***						
	(0.090)	(0.088)	(0.081)						
Age	-0.068**	-0.087**	-0.163***						
	(0.012)	(0.013)	(0.011)						
Parents Some College	-0.086	-0.083	-0.153						
	(0.110)	(0.110)	(0.108)						
Parents Bachelor Degree or More	-0.162	-0.143	-0.193*						
	(0.119)	(0.119)	(0.111)						
Income in [20000, 40000]	-0.219*	-0.232**	-0.375***						
	(0.112)	(0.112)	(0.108)						
Income more than $40,000	-0.233**	-0.253**	-0.466***						
	(0.109)	(0.109)	(0.102)						
Distrust	0.010	0.008		-0.053**	-0.060***		-0.031**	-0.035***	
	(0.013)	(0.013)		(0.016)	(0.016)		(0.013)	(0.013)	
Ineffectiveness	0.287***	0.260***		0.215***	0.194***		0.234***	0.214***	
	(0.018)	(0.018)		(0.014)	(0.015)		(0.011)	(0.012)	
Perfectionism	0.136***	0.134***		0.134***	0.130***		0.135***	0.133***	
	(0.014)	(0.014)		(0.016)	(0.016)		(0.012)	(0.012)	
Body Image		0.040***	0.088***		0.047***	0.067***		0.045***	0.081***
		(0.006)	(0.006)		(0.009)	(0.005)		(0.007)	(0.005)
Constant	1.063***	1.179***	3.759***	-0.046	-0.106*	-0.290**	1.035***	1.224***	3.799***
	(0.243)	(0.241)	(0.219)	(0.056)	(0.057)	(0.031)	(0.232)	(0.237)	(0.167)
First Difference	No	No	No	Yes	Yes	Yes	No	No	No
Chamberlain/Wooldridge Fixed Effects	No	No	No	No	No	No	Yes	Yes	Yes
Sample size	6308	6291	9549	2639	2624	7756	6308	6291	9549

Notes: Standard errors robust to both heteroskedasticity and intra-group correlation are reported in parenthesis.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6: Tobit Partial Effects for ED-BN Index

	(1)	(2)	(3)	(4)	(5)	(6)
White	-0.178**	-0.248***	-0.374***			
	(0.076)	(0.073)	(0.070)			
Age	-0.051***	-0.075***	-0.132***			
	(0.010)	(0.010)	(0.009)			
Parents Some College	-0.022	-0.019	-0.073			
	(0.086)	(0.085)	(0.084)			
Parents Bachelor Degree or More	-0.120	-0.105	-0.141			
	(0.009)	(0.098)	(0.093)			
Income in $[20000, $40000]	-0.224***	-0.242***	-0.323***			
	(0.085)	(0.083)	(0.080)			
Income more than $40,000	-0.206**	-0.235***	-0.385***			
	(0.090)	(0.089)	(0.083)			
Distrust	0.022**	0.020**		-0.007	-0.011	
	(0.009)	(0.009)		(0.010)	(0.011)	
Ineffectiveness	0.181***	0.150***		0.140***	0.117***	
	(0.010)	(0.009)		(0.010)	(0.010)	
Perfectionism	0.096***	0.093***		0.098***	0.096***	
	(0.010)	(0.009)		(0.011)	(0.011)	
Body Image		0.044***	0.078***		0.045***	0.077***
		(0.004)	(0.004)		(0.006)	(0.005)
Chamberlain/Wooldridge Fixed Effects	No	No	No	Yes	Yes	Yes
Sample Size	6308	6291	9549	6308	6291	9549

Notes: Standard errors robust to intra-group correlation are reported in parenthesis.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 7: Ordered Probit Estimates for ED-BN Index

	(1)	(2)	(3)	(4)	(5)	(6)
White	-0.098**	-0.143***	-0.204***			
	(0.044)	(0.044)	(0.040)			
Age	-0.026***	-0.042***	-0.072***			
	(0.006)	(0.006)	(0.005)			
Parents Some College	-0.006	-0.003	-0.029			
	(0.050)	(0.050)	(0.048)			
Parents Bachelor Degree or More	-0.051	-0.039	-0.061			
	(0.058)	(0.059)	(0.054)			
Income in [$20000, $40000]	-0.133**	-0.149***	-0.189***			
	(0.052)	(0.052)	(0.049)			
Income more than $40000	-0.115**	-0.135**	-0.215***			
	(0.054)	(0.055)	(0.050)			
Distrust	0.013**	0.012**		-0.001	-0.005	
	(0.005)	(0.005)		(0.008)	(0.008)	
Ineffectiveness	0.103***	0.085***		0.091***	0.077***	
	(0.005)	(0.005)		(0.007)	(0.007)	
Perfectionism	0.053***	0.053***		0.066***	0.067***	
	(0.005)	(0.006)		(0.008)	(0.008)	
Body Image		0.026***	0.044***		0.032***	0.049***
		(0.003)	(0.002)		(0.004)	(0.003)
Constant				0.600***	0.477***	-0.794***
				(0.139)	(0.143)	(0.103)
Chamberlain/Wooldridge Fixed Effects	No	No	No	Yes	Yes	Yes
Sample Size	6291	6291	9549	6291	6291	9549

Notes: Standard errors are in parenthesis. Standard errors in columns (1) to (3) are robust to intragroup correlation.
* indicates significant at 10%; ** significant at 5%; *** significant at 1%.

Table 8: Linear Probability Model Estimates for Clinical Bulimia

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
White	-0.004	-0.005	-0.008**						
	(0.005)	(0.005)	(0.004)						
Age	-0.002***	-0.003***	-0.005***						
	(0.001)	(0.001)	(0.001)						
Parents Some College	-0.005	-0.005	-0.008						
	(0.006)	(0.006)	(0.005)						
Parents Bachelor Degree or More	-0.001	-0.000	-0.004						
	(0.007)	(0.007)	(0.005)						
Income in [20000, 40000]	-0.001	-0.001	-0.009*						
	(0.006)	(0.006)	(0.005)						
Income more than $40,000	-0.008	-0.008	-0.015***						
	(0.006)	(0.006)	(0.005)						
Distrust	-0.001	-0.001		-0.002	-0.002*		-0.002**	-0.002**	
	(0.001)	(0.001)		(0.001)	(0.001)		(0.001)	(0.001)	
Ineffectiveness	0.010***	0.010***		0.010***	0.009***		0.009***	0.008***	
	(0.001)	(0.001)		(0.002)	(0.002)		(0.001)	(0.001)	
Perfectionism	0.005***	0.005***		0.005***	0.005***		0.004***	0.004***	
	(0.001)	(0.001)		(0.002)	(0.002)		(0.001)	(0.001)	
Body Image		0.001**	0.002***		0.002*	0.002***		0.001***	0.002***
		(0.000)	(0.000)		(0.001)	(0.000)		(0.000)	(0.000)
Constant	0.008	0.011	0.099***	-0.000	-0.002	-0.008***	0.000	0.006	0.099***
	(0.014)	(0.014)	(0.013)	(0.004)	(0.004)	(0.001)	(0.014)	(0.014)	(0.010)
First Difference	No	No	No	Yes	Yes	Yes	No	No	No
Chamberlain/Wooldridge Fixed Effects	No	No	No	No	No	No	Yes	Yes	Yes
Sample size	6308	6291	9549	2639	2624	7756	6308	6291	9549

Notes: Standard errors are robust to heteroskedasticity and intra-group correlation and are reported in parenthesis.
* indicates significant at 10%; ** significant at 5%; *** significant at 1%.

Table 9: Probit Partial Effects for Clinical Bulimia

	(1)	(2)	(3)	(4)	(5)	(6)
White	-0.0054*	-0.0065**	-0.0069***			
	(0.0030)	(0.0027)	(0.0027)			
Age	-0.0016***	-0.0019***	-0.0035***			
	(0.0005)	(0.0004)	(0.0004)			
Parents Some College	-0.0030	-0.0029	-0.0041			
	(0.0028)	(0.0026)	(0.0026)			
Parents Bachelor Degree or More	-0.0010	-0.0009	-0.0019			
	(0.0035)	(0.0033)	(0.0032)			
Income in [$20000, $40000]	-0.0001	-0.0004	-0.0045*			
	(0.0031)	(0.0029)	(0.0026)			
Income more than $40,000	-0.0046	-0.0047	-0.0100***			
	(0.0032)	(0.0030)	(0.0028)			
Distrust	-0.0000	-0.0000		-0.0003	-0.0003	
	(0.0003)	(0.0003)		(0.0002)	(0.0002)	
Ineffectiveness	0.0028***	0.0023***		0.0004***	0.0008***	
	(0.0003)	(0.0003)		(0.0002)	(0.0002)	
Perfectionism	0.002***	0.0018***		0.0008***	0.0007***	
	(0.0003)	(0.0003)		(0.0002)	(0.0002)	
Body Image		0.0006***	0.0015***		0.0003***	0.0005***
		(0.0001)	(0.0002)		(0.0001)	(0.0001)
Chamberlain/Wooldridge Fixed Effects	No	No	No	Yes	Yes	Yes
Sample size	6308	6291	9549	6308	6291	9549

Notes: Standard errors robust to intra-group correlation are reported in parenthesis.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 10: Persistence of ED-BN Index: Linear Model Estimates

Variables					Two Stage Least Squares			Arellano-
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	Bond
Lag ED-BN Index	0.444***	0.436***	0.355***	0.349***	0.214***	0.215***	0.175***	0.223***
	(0.028)	(0.030)	(0.027)	(0.027)	(0.046)	(0.044)	(0.053)	(0.027)
White		-0.005	-0.038	-0.081	-0.088	-0.158	-0.238***	
		(0.084)	(0.085)	(0.084)	(0.129)	(0.128)	(0.086)	
Age		-0.074***	-0.051***	-0.063***	-0.026	-0.036*	-0.117***	-0.474
		(0.016)	(0.016)	(0.016)	(0.021)	(0.021)	(0.015)	(0.081)
Parents Some College		0.048	0.073	0.073	0.032	-0.003	-0.101	
		(0.107)	(0.101)	(0.101)	(0.152)	(0.151)	(0.102)	
Parents Bachelor Degree		0.107	0.122	0.131	0.032	0.018	-0.029	
or More		(0.114)	(0.110)	(0.110)	(0.175)	(0.174)	(0.118)	
Income in [20000, 40000]		-0.264**	-0.236**	-0.238**	-0.539***	-0.536***	-0.306***	
		(0.109)	(0.102)	(0.102)	(0.155)	(0.154)	(0.105)	
Income more than $40,000		-0.277**	-0.207**	-0.221**	-0.475***	-0.485***	-0.409***	
		(0.109)	(0.104)	(0.103)	(0.168)	(0.167)	(0.114)	
Distrust			-0.019	-0.018	-0.043**	-0.046***		
			(0.014)	(0.014)	(0.017)	(0.017)		
Ineffectiveness			0.205***	0.188***	0.237***	0.216***		
			(0.020)	(0.020)	(0.016)	(0.017)		
Perfectionism			0.097***	0.095***	0.129***	0.124***		
			(0.013)	(0.013)	(0.016)	(0.016)		
Body Image				0.027***		0.038***	0.065***	0.058***
				(0.005)		(0.008)	(0.005)	(0.009)
Constant	0.597***	1.957***	0.592*	0.657**	0.581	0.613*	2.724***	0.598
	(0.037)	(0.302)	(0.304)	(0.303)	(0.368)	(0.365)	(0.335)	(0.134)
Sample Size	4151	3938	3938	3928	2293	2280	6841	4623

Notes: Columns from (1) to (4) report estimates of the equation in levels. Standard errors robust to both heteroskedasticity and intra-group correlation are reported in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 11: Tobit Partial Effects for ED-BN Index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lag ED-BN Index	0.270***	0.260***	0.200***	0.191***	0.190***	0.180***	0.177***
	(0.013)	(0.014)	(0.012)	(0.011)	(0.013)	(0.013)	(0.008)
White		-0.038	-0.077	-0.135**			
		(0.075)	(0.070)	(0.069)			
Age		-0.060***	-0.041***	-0.058***			
		(0.014)	(0.013)	(0.013)			
Parents Some College		0.087	0.096	0.092			
		(0.090)	(0.083)	(0.081)			
Parents Bachelor Degree		0.124	0.127	0.130			
or More		(0.103)	(0.095)	(0.095)			
Income in [$20000, $40000]		-0.248***	-0.224***	-0.230**			
		(0.082)	(0.076)	(0.075)			
Income more than $40,000		-0.238***	-0.169**	-0.193**			
		(0.091)	(0.086)	(0.084)			
Distrust			-0.007	-0.006	-0.015	-0.015	
			(0.010)	(0.009)	(0.012)	(0.012)	
Ineffectiveness			0.123***	0.098***	0.114***	0.099***	
			(0.010)	(0.009)	(0.011)	(0.011)	
Perfectionism			0.066***	0.064***	0.092***	0.044***	
			(0.009)	(0.009)	(0.013)	(0.018)	
Body Image				0.033***		0.033***	0.055***
				(0.004)		(0.007)	(0.005)
Chamberlain/Wooldridge Fixed Effects	No	No	No	No	Yes	Yes	Yes
Sample Size	4151	3938	3938	3928	3938	3928	6870

Notes: Standard errors robust to intra-group correlation are reported in parenthesis.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 12: Persistence of ED-BN Index: Ordered Probit Estimates

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lag ED-BN Index [1,5]	0.838***	0.848***	0.781***	0.755***	0.716***	0.697***	0.454***
	(0.045)	(0.047)	(0.048)	(0.048)	(0.062)	(0.062)	(0.049)
Lag ED-BN Index [6,10]	1.436***	1.415***	1.202***	1.174***	1.068***	1.036***	0.797***
	(0.084)	(0.088)	(0.091)	(0.092)	(0.114)	(0.114)	(0.084)
Lag ED-BN Index >10	1.920***	1.855***	1.590***	1.554***	1.458***	1.414***	1.012***
	(0.118)	(0.121)	(0.116)	(0.116)	(0.163)	(0.164)	(0.120)
White		-0.016	-0.034	-0.077			
		(0.048)	(0.051)	(0.051)			
Age		-0.042***	-0.033***	-0.046***			
		(0.009)	(0.010)	(0.010)			
Parents Some College		0.037	0.052	0.052			
		(0.058)	(0.059)	(0.060)			
Parents Bachelor Degree		0.090	0.103	0.107			
or More		(0.065)	(0.067)	(0.068)			
Income in [$20000, $40000]		-0.167***	-0.164***	-0.173***			
		(0.058)	(0.060)	(0.060)			
Income more than $40,000		-0.163***	-0.129**	-0.148**			
		(0.061)	(0.063)	(0.064)			
Distrust			-0.003	-0.003	-0.005	-0.006	
			(0.007)	(0.007)	(0.010)	(0.010)	
Ineffectiveness			0.084***	0.069***	0.083***	0.072***	
			(0.006)	(0.007)	(0.009)	(0.010)	
Perfectionism			0.050***	0.049***	0.074***	0.072***	
			(0.007)	(0.007)	(0.074)	(0.010)	
Body Image				0.023***		0.029***	0.045***
				(0.003)		(0.006)	(0.004)
Constant					0.597***	0.484**	-0.074
					(0.198)	(0.203)	(0.153)
Chamberlain/Wooldridge Fixed Effects	No	No	No	No	Yes	Yes	Yes
Sample Size	4151	3938	3938	3928	3938	3928	6870

Notes: Standard errors are reported in parenthesis. They are robust to intra-group correlation in columns (1)-(4)
* indicates significant at 10%; ** significant at 5%; *** significant at 1%.

Table 13: Persistence of Clinial Bulimia: Linear Probability Model Estimates

Variables					Two Stage Least Squares			Arellano-
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	Bond
Lag Clinical Bulimia	0.196***	0.181***	0.150***	0.149***	0.068	0.066	0.037	0.075**
	(0.043)	(0.043)	(0.041)	(0.041)	(0.085)	(0.081)	(0.103)	(0.037)
White		-0.003	-0.005	-0.005	-0.007	-0.008	-0.006	
		(0.005)	(0.005)	(0.005)	(0.008)	(0.008)	(0.004)	
Age		-0.004***	-0.002**	-0.003**	-0.002	-0.002	-0.004***	-0.021
		(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.005)
Parents Some College		-0.000	0.001	0.001	-0.003	-0.003	-0.007	
		(0.006)	(0.006)	(0.006)	(0.010)	(0.010)	(0.005)	
Parents Bachelor Degree		0.004	0.006	0.006	0.004	0.004	-0.001	
or More		(0.007)	(0.007)	(0.007)	(0.011)	(0.011)	(0.006)	
Income in [$20000, $40000]		-0.009	-0.007	-0.007	-0.010	-0.010	-0.010*	
		(0.007)	(0.007)	(0.007)	(0.010)	(0.010)	(0.005)	
Income more than $40,000		-0.012**	-0.009	-0.009	-0.010	-0.010	-0.015**	
		(0.006)	(0.006)	(0.006)	(0.011)	(0.011)	(0.006)	
Distrust			-0.001	-0.001	-0.002**	-0.002**		
			(0.001)	(0.001)	(0.001)	(0.001)		
Ineffectiveness			0.008***	0.008***	0.010***	0.009***		
			(0.001)	(0.002)	(0.001)	(0.001)		
Perfectionism			0.003***	0.003***	0.005***	0.005***		
			(0.001)	(0.001)	(0.001)	(0.001)		
Body Image				0.001		0.001**	0.002***	0.001***
				(0.000)		(0.001)	(0.000)	(0.000)
Constant	0.016***	0.084***	0.023	0.024	0.010	0.010	0.086***	0.029
	(0.002)	(0.019)	(0.020)	(0.020)	(0.025)	(0.025)	(0.019)	(0.008)
Sample Size	4151	3938	3938	3928	2293	2280	6841	4623

Notes: Standard errors are robust to heteroskedasticity and intra-group correlation and are reported in parenthesis.
* indicates significant at 10%; ** significant at 5%; *** significant at 1%.

Table 14: Probit Partial Effects of Clinical Bulimia

	(1)	(2)	(3)	(4)
Lag Clinical Bulimia	0.196***	0.148***	0.061***	0.056***
	(0.043)	(0.040)	(0.023)	(0.022)
White		-0.002	-0.005	-0.006**
		(0.004)	(0.003)	(0.003)
Age		-0.003***	-0.002**	-0.002***
		(0.001)	(0.001)	(0.000)
Parents Some College		-0.000	0.000	0.000
		(0.005)	(0.003)	(0.003)
Parents Bachelor Degree		0.003	0.003	0.003
or More		(0.006)	(0.004)	(0.004)
Income in [$20000, $40000]		-0.006	-0.004	-0.004
		(0.004)	(0.003)	(0.003)
Income more than $40,000		-0.009**	-0.004	-0.004
		(0.005)	(0.003)	(0.003)
Distrust			-0.000	-0.000
			(0.000)	(0.000)
Ineffectiveness			0.002***	0.002***
			(0.000)	(0.000)
Perfectionism			0.001***	0.001***
			(0.000)	(0.000)
Body Image				0.000
				(0.000)
Chamberlain/Wooldridge Fixed Effects	No	No	No	No
Sample Size	4151	3938	3938	3928

Notes: Standard errors robust to intra-group correlation are reported in parenthesis.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 15: Linear Probability Model Estimates for Rational Addiction

Variables				2 Stage Least Squares	
	(1)	(2)	(3)	(4)	(5)
Lag ED-BN Index	0.292***	0.261***	0.272***	0.148**	0.176***
	(0.015)	(0.023)	(0.016)	(0.061)	(0.056)
Lead ED-BN Index	0.409***	0.335***	0.394***	0.169*	0.188**
	(0.025)	(0.031)	(0.026)	(0.097)	(0.089)
White		-0.049	-0.137***	-0.124	-0.247***
		(0.083)	(0.048)	(0.095)	(0.078)
Age		-0.101***	-0.122***	-0.118***	-0.149***
		(0.018)	(0.017)	(0.019)	(0.020)
Parents Some College		0.022	-0.087	-0.053	-0.166*
		(0.102)	(0.065)	(0.109)	(0.088)
Parents Bachelor Degree or More		0.020	-0.038	-0.066	-0.112
		(0.109)	(0.068)	(0.126)	(0.101)
Income in [$20000,$40000]		-0.208**	-0.187***	-0.262**	-0.262***
		(0.102)	(0.064)	(0.111)	(0.092)
Income more than $40,000		-0.194*	-0.255***	-0.250**	-0.348***
		(0.104)	(0.063)	(0.120)	(0.100)
Distrust		-0.021		-0.012	
		(0.015)		(0.013)	
Ineffectiveness		0.144***		0.183***	
		(0.019)		(0.017)	
Perfectionism		0.097***		0.115***	
		(0.014)		(0.013)	
Body Image		0.018***	0.040***	0.026***	0.059***
		(0.005)	(0.004)	(0.006)	(0.007)
Constant	0.360***	1.213***	2.288***	1.641***	3.066***
	(0.029)	(0.309)	(0.285)	(0.346)	(0.383)
Sample Size	5198	3280	4897	3249	4855

Notes: Standard errors are in parenthesis. In columns (1)-(3) standard errors are robust to heteroskedasticity and intra-group correlation.* indicates significant at 10%; ** at 5%; *** 1%. Instruments for 2SLS estimates are lag and lead of Body Image.

Appendix

A Data

The correspondence with the NHLBI project office helped us to identify the items that make up the indices used in our analysis. We describe the construction of the ED-BN index, Body Image, and Perfectionism indices in the main text of the paper. The Distrust Index is based on the subjects responses ("always"=1, "usually"=2, "often"=3, "sometimes"=4, "rarely"=5, and "never"=6) to seven items: 1) I tell people about my feelings; 2) I trust people; 3) I can talk to other people easily; 4). I have close friends; 5) I have trouble telling other people how I feel; 6) I don't want people to get to know me very well; and 7) I can talk about my private thoughts or feelings. Scoring is as follows: a response of 1=3 points, 2=2 points, 3=1 point, 4 or more=0 points. The index is a sum of all contributing points.

The Ineffectiveness index is based on the subjects responses ("always"=1, "usually"=2, "often"=3, "sometimes"=4, "rarely"=5, and "never"=6) to ten items: 1) I feel I can't do things very well; 2) I feel very alone; 3) I feel I can't handle things in my life; 4) I wish I were someone else; 5) I don't think I am as good as other kids; 6) I feel good about myself; 7) I don't like myself very much; 8) I feel I can do whatever I try to do; 9) I feel I am a good person; 10) I feel empty inside. Scoring is as follows: a response of 1=3 points, 2=2 points, 3=1 point, 4 or more=0 points. The index is a sum of all contributing points.

Table A.1: Variable Definitions

Variable	Description	Coding	Waves
ED-BN Index*	EDI-bulimia	categorical variable: 0-21	3,5,7,9,10
Clinical Bulimia	Clinical BN	1 if EDI-Bulimia¿10	3,5,7,9,10
Body Image	Body Dissatisfaction Index	categorical variable: 0-27	3,5,7,9,10
Perfectionism	Driveness for Perfection Index	categorical variable:0-18	3,5,9,10
Ineffectiveness	Ineffectiveness Index	categorical variable:0-29	3,5,9,10
Distrust	Distrust Index	categorical variable:0-21	3,5,9,10
Age	Respondent age		All
White	Respondent race	1 if ethnic group is white; 0 if black	All
Education*	Highest parental education	1=HS or less, 2=1-3 years post HS, 3=College Grad +	All
Parents HighSchool or Less		1 if highest education is High School degree or less	
Parents Some College		1 if highest education is some college	
Parents Bachelor Degree or More		1 if highest education is college degree or higher	
Income*	Household income (in 1988$)	1=0 - $19,999, 2=$20,000 - $39,999, 3=$40,000+	All
Income less than $20,000		1 if household income is less than $20,000	
Income in [$20000, $40000]		1 if household income is in range [$20,000,$40,000]	
Income more than $40,000		1 if household income is higher than $40,000	

Notes: * indicates thse are original variables that we used to construct our dummies.

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