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Is there a daily discount rate? Evidence from the food stamp nutrition cycle

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Abstract

Quasi-hyperbolic discounting predicts impatience over short-run tradeoffs. I present a direct non-laboratory test of this implication using data on the nutritional intake of food stamp recipients. Caloric intake declines by 10 to 15 percent over the food stamp month, implying a significant preference for immediate consumption. These findings constitute a rejection of the permanent income hypothesis and are extremely difficult to reconcile with exponential discounting. The data support an explanation based on time preference and reject several alternative explanations, including highly elastic intertemporal substitution. I explore implications for the optimal timing of transfer payments under alternative assumptions about preferences.

JEL classification: D91; E21; I38
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1. Introduction

Consider a consumer who discounts tomorrow's utility by a factor of 0.996. Such an individual has a daily discount factor of 0.996, and if she is an exponential discounter her annual discount *factor* will be about 0.23 (corresponding to an annual discount *rate* of about 146 percent). She would, therefore, discount utility 5 years from now by a factor of 0.0007.

As these calculations illustrate, an exponential discounter who is reasonably patient in the long-run must be almost perfectly patient in the short-run. Even small amounts of daily

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discounting translate into enormous amounts of annual discounting in the exponential model. By contrast, the quasi-hyperbolic model of discounting (Laibson, 1997) severs the link between short- and long-run time preference, and predicts significant present-bias even in short-run trade-offs.

In this paper, I test for the presence of short-run impatience using data on the caloric intake of food stamp recipients. I find that the average caloric intake of members of recipient households declines by 10 to 15 percent over the food stamp month. A calibration exercise shows that, to be resolved with exponential discounting, these facts require an annual discount factor of about 0.23 or an extremely high elasticity of intertemporal substitution. Survey evidence on household financial circumstances reveals rising desperation over the course of the food stamp month, which suggests that a high elasticity of intertemporal substitution is not a likely explanation. Additionally, estimates of the responsiveness of caloric intake to food prices show elasticities far too small to resolve the observed consumption patterns with sensible exponential discount rates. Finally, households with more short-run impatience (as estimated from hypothetical intertemporal choices) are more likely to run out of food sometime during the month, consistent with an explanation based on time preference.

The data can reject a number of alternative hypotheses. Households that shop for food more frequently do not display a smaller decline in intake over the month, casting doubt on explanations based on the depreciation of the household's food stock. Individuals in single-person households experience no less of a decline in caloric intake over the month than individuals in multi-person households, indicating that competition for resources within the household is not a likely explanation for my findings. Survey respondents are not more likely to eat in another person's home toward the end of the month, suggesting that resource transfers between households are not driving the consumption cycle. Extramarginal households for whom food stamps cover the entire monthly food budget do not experience a significantly smaller nutrition cycle, casting doubt on the view that the cycle results from households' confusion about the value of their food stamps. Finally, the data show no evidence of learning over time, which seems difficult to resolve with explanations based on over-optimism about how long food stamps will last.

This paper makes several contributions. First, my findings constitute direct field evidence for short-run impatience. While quasi-hyperbolic discounting has been applied to a wide range of economic issues (see, e.g., Angeletos et al., 2001; Cutler et al., 2003; Gruber and Koszegi, 2001; O'Donoghue and Rabin, 2001), evidence on short-run discounting has derived mainly from the laboratory (Frederick et al., 2002)[1]. Having reliable, real-world values for short-run time preference parameters is essential to conducting simulations of savings policy experiments (Laibson et al., 1998). Although food stamp recipients may have different intertemporal preferences from the overall population, they constitute an important group for policy analysis and one for which short-run impatience may be especially relevant.

[1] Exceptions include DellaVigna and Paserman (2001), DellaVigna and Malmendier (2002), Laibson et al. (2003a,b), which infer hyperbolic preferences from job search behavior, health club plan choice, and life cycle consumption and savings facts, respectively.

Second, in showing that the timing of consumption is sensitive to the timing of payments, these results constitute a rejection of the Permanent Income Hypothesis (PIH). The rejection is especially striking, given that households must solve the same problem each month for a series of months. Although other research has argued that the PIH is violated at monthly frequencies (Stephens, 2002, 2003), such work has tended to use data on expenditures, rather than actual consumption, to test the PIH. The difference between food purchases and food intake may be especially important at high frequencies, where the durability of purchases is more likely to be a concern. As the PIH has important implications for the evaluation of fiscal policy (Poterba, 1988), it is important to study whether existing rejections result from data deficiencies of this sort.

Finally, the food stamp program is of interest in its own right (Currie, 2003). The economic literature on food stamps has investigated labor supply effects (Fraker and Moffitt, 1988) and the effects of cash-out (Moffitt, 1989; Whitmore, 2002), and has put relatively little emphasis on the timing of benefit use.[2] My findings indicate that the timing of payments may impact the welfare of recipients. To the extent that my results tell us something about underlying time preference parameters, these policy implications may generalize to other government transfer programs.

The rest of the paper is organized as follows. Section 2 describes the data on caloric intake, as well as other supporting datasets used in the paper. Section 3 presents the basic evidence on the behavior of caloric intake over the month. Section 4 calibrates an exponential model of intertemporal choice and discusses evidence on the elasticity of intertemporal substitution. Section 5 presents direct evidence on the relationship between time preference and food intake, and shows results rejecting a number of alternative hypotheses. Section 6 calibrates a quasi-hyperbolic model of the allocation of the food budget, and discusses the consistency of the quasi-hyperbolic model with the observed facts. Section 7 discusses policy implications. Section 8 concludes.

2. Data

In a typical month in 2001, some 17 million Americans received food stamps, with the average household getting roughly $160 per month in benefits. This average household had $620 in gross income and contained 2.3 individuals.[3] I will make use of three datasets in my analysis, each appropriate for studying different aspects of the behavior of food stamp recipients.

The best available data on the consumption patterns of food stamp recipients comes from the Continuing Survey of Food Intake by Individuals, 1989–91 (CSFII), conducted by the US Department of Agriculture (USDA). The CSFII is based on a nationally representative sample of households and collects 3 days of dietary intake data for each household member. The first day of data is collected by 24-h recall: the respondent is

[2] See Wilde and Ranney (1997, 2000) for notable recent exceptions.

[3] For a review of the characteristics of food stamp participants and participant households, see US Department of Agriculture (2002).

asked to list everything she ate on the previous day, with interviewer prompts designed to help respondents fill in frequently omitted items. The second 2 days of data come from intake diaries completed by respondents over the next 48 h[4]. USDA staff process the data to produce aggregate measures of nutrition, such as total daily caloric intake. Along with fairly rich demographic and health data, the CSFII contains information on whether respondents are receiving food stamps and, if so, the exact date of the last benefit payment. From this variable I construct a measure of the number of days since receipt of food stamps.[5]

For some purposes it will be convenient to know the market value as well as the nutritional characteristics of food eaten. The Nationwide Food Consumption Survey 1987–88 (NFCS) contains detailed information on the quantity, price, and characteristics of food used in the home over a 7-day period for a representative sample of households. Participating households were contacted at the beginning of the diary period and asked to keep a record of all foods used in the home over the next 7 days. This information was then collected by an interviewer at the end of the 7-day period. For food eaten out of the home, total expenditure is recorded.[6]

I will also make some use of the Evaluation of the EBT Expansion in Maryland, a survey conducted in 1992 and 1993 to document the effects of Maryland's statewide adoption of the Electronic Benefit Transfer (EBT) system.[7] The survey was conducted in two waves, the first prior to the implementation of EBT, the second after its implementation. I will be using data from the pre-implementation wave of the survey, as this corresponds more nearly with the time period of the CSFII. It covers a random sample of 1298 food stamp households residing in Maryland. In addition to basic demographics, respondents were asked a variety of questions about their use of food stamps, including a rich battery of questions on the costs associated with using food stamps.[8]

3. Monthly patterns in food intake

Table 1 presents regressions of the log of total caloric intake on the number of days since the household's last receipt of food stamps using data from the CSFII. Since this dataset contains at most 3 days of intake records per person, there is insufficient power to estimate this relationship with individual fixed effects. I therefore adopt the identifying

[4] Enns et al. (1997) offer further discussion of survey methodology and a descriptive analysis of time trends in food consumption.

[5] Because the question about the date of last benefit payment is asked only on the first survey day, it is possible that a household at the beginning of its benefit month could be coded as being at the very end of its month. Since virtually no states vary the benefit date systematically by month, I correct for this problem by assuming that the day of the month of the next benefit payment will be the same as the day of the month of the previous benefit payment.

[6] See Huang and Lin (2000) for a further description of the dataset.

[7] See Wilde and Andrews (2000) for a further description of the data and an analysis of the use of different sources of income over the month.

[8] An appendix, including summary statistics on variables of interest from the CSFII, the NFCS and the EBT dataset, is available on request from the author.

Table 1
Monthly patterns in food intake

Dependent variable	(1) log(caloric intake)	(2) log(caloric intake)	(3) caloric intake	(4) log(food value)
Days since receipt of food stamps	− 0.0045	− 0.0040	− 7.9439	− 0.0073
	(0.0021)	(0.0019)	(3.1772)	(0.0038)
Demographics?	No	Yes	No	Yes
Dataset	CSFII	CSFII	CSFII	NFCS
Number of observations	6652	6652	6652	309
R^2	0.0796	0.1895	0.0966	0.6013

In regressions using the CSFII, each observation describes one household member on one survey day (out of three total days). In regressions using the NFCS, each observation describes one household on 1 week. Regressions (1)–(3) include dummies for survey day, day of week, year, month, and calendar date. Regression (2) includes dummies for gender, race, 10-year age categories, and the log of height in inches (with a dummy for missing data on height). Regression (4) includes dummies for Census division, household size, interview month, interview year, and day of the calendar month (at the beginning of the sample period). In regressions (1)–(3), standard errors in parentheses are adjusted for correlation within households. Survey weights used as recommended by data providers.

assumption that the difference between the interview date and the date of last food stamp benefit receipt is distributed randomly across households in the sample. This allows me to recover the relationship between caloric intake and time since receipt of food stamps using cross-sectional variation.[9]

In all specifications, I use dummy variables to control for the year, month, day of the week, day of the calendar month, and day of the survey. All reported standard errors have been adjusted for possible within-household correlation in the error structure. In these and all subsequent regressions, I use the survey weights recommended by the data providers to adjust for nonresponse.

Column (1) of Table 1 reports results with no demographic controls. Caloric intake declines by a statistically significant 0.45 percent per day after receipt of stamps. Column (2) includes dummies for gender, race, 10-year age categories, and the log of height in inches (with a dummy for missing data on height). Adding these controls increases the fit of the model considerably but has only a tiny effect on the coefficient of interest, moving it to a 0.40 percent daily decline.

One potential problem with these estimates is that survey measures of energy intake are subject to severe underreporting (Livingstone and Black, 2003). This will not bias my estimates provided that the misreporting of log caloric intake is uncorrelated with time since receipt of food stamps. However, if underreporting is additive—if each respondent reports true intake less a constant—specifications using the log of caloric intake as the dependent variable will yield inconsistent estimates of underlying parameters.

[9] A regression of time since receipt of food stamps on a set of demographic variables related to caloric intake (gender, race, log of height, and dummies for 10-year age categories) supports this assumption. None of the demographic characteristics is statistically significantly related to time since receipt of food stamps, and an F-test fails to reject the null that all coefficients in this regression are equal to zero. (Results available on request from the author.)

Column (3) of Table 1 therefore repeats the specification reported in column (1) using the level of caloric intake in place of the log of intake. The estimated daily decline is strongly statistically significant. When divided by the mean of caloric intake of roughly 2500 kilocalories per day for the US population in 1989 (US Department of Agriculture, 2000), the estimate gives a daily decline of 0.32 percent.[10] This result is quite similar to the coefficients reported in columns (1) and (2), suggesting that imperfect measurement of caloric intake is not likely to be introducing significant bias into my estimates.

Since the quality of food can vary quite independently of its quantity, it may be inappropriate to use energy content as a summary measure of food intake. The NFCS reports a household-level measure of the market value of food consumed over a 7-day period, which can serve as a rough measure of food quality. Column (4) presents results from a regression of the log of this quantity on the number of days since receipt of food stamps as of the first day of the sample period.[11] This regression includes dummies for Census division, household size, interview month, interview year and day of the calendar month (at the beginning of the sample period). Results are weighted as recommended by the data providers.

As column (4) shows, the market value of food consumed declines significantly over the food stamp month. The percentage daily decline in food value of 0.73 is larger than that observed for caloric intake, reflecting substitution towards lower-cost foods over the month. The fact that two datasets with completely independent samples—the NFCS and CSFII—both reveal a statistically significant decline in food consumption over the month demonstrates the statistical reliability of the monthly nutrition cycle.

4. Calibration of the exponential model

Towards a calibration of an exponential discounting model, consider a consumer who maximizes utility over calories C given by

$$U = \sum_{t=0}^{T} \delta^t u(C_t) \tag{1}$$

where $u(.)$ is increasing and everywhere strictly concave and t indexes days in a month of length T.[12] Suppose that the consumer cannot borrow against future income and is, therefore, given a fixed stock W to spend over the month. Within the month, the consumer

[10] Section 2 of the appendix (available on request) discusses formally the issues surrounding the functional form of underreporting, and shows that in the case of additive measurement error these estimates of the percentage daily decline will be consistent for the true slope parameter.

[11] Well-known survey fatigue effects make it likely that the total value of food consumed reflects food consumed at the beginning of the sample period more closely than food consumed at the end. Using the number of days since receipt of food stamps averaged over the entire 7-day period reduces statistical precision, but gives qualitatively similar results.

[12] Note here that I am assuming perfect certainty. As Section 5 of the appendix (available on request) shows, this is a conservative assumption, in that it will tend to bias any calibration toward a discount rate that is too low.

faces a gross interest rate R and a deterministic stream of prices P_t. The budget constraint is, therefore, given by

$$W = \sum_{t=0}^{T} \frac{P_t C_t}{R^t}. \tag{2}$$

This model yields a standard Euler equation:

$$u'(C_t) = \frac{P_t}{P_{t+1}} \delta R u'(C_{t+1}). \tag{3}$$

In the special case of isoelastic utility in which $u'(C_t) = C_t^{-\rho}$ for all t, equation (3) can be written as

$$\Delta c_{t+1} = \frac{r - \gamma}{\rho} - \frac{\Delta p_{t+1}}{\rho}. \tag{4}$$

Here, lowercase letters denote logs, Δ denotes changes, and $\gamma = -\log \delta$. From the evidence in Section 3, we know that Δc_{t+1} is roughly -0.0040 for the average household. In order to translate this into an estimate of the daily discount rate γ, we must first pin down values for r and ρ (assuming within-month variation in prices is zero on average). While food stamps and food in the pantry do not accumulate interest, it is possible that food depreciation could create a motive for early eating. I investigate and reject this possibility in Section 5.2, and therefore assume that $r = 0$.

It remains, then, to establish whether there exist reasonable values of both γ and ρ that can fit the facts. As equation (4) shows, ρ is equal to the inverse of the intertemporal elasticity of demand for calories, sometimes called the elasticity of intertemporal substitution. A one percent increase in the price of calories tomorrow relative to today will lead to an increase in relative caloric intake of $1/\rho$ percent.

Suppose an annual discount factor of 0.8, which is well below recent estimates based on the life cycle profile of consumption, even for low-income groups.[13] This corresponds to a daily discount rate γ of about 0.0006. In order for this to be consistent with my finding of a 0.40 percent daily decline in caloric intake, ρ would have to be on about 0.15, corresponding to an elasticity of intertemporal substitution of about 6.7. In other words, if the price of a calorie becomes 10 percent lower on Tuesday relative to Monday, the caloric intake on Tuesday of a typical food stamp recipient would have to increase by 67 percent relative to Monday. This would seem to imply an enormous ability to substitute calories across days.

If we instead assume $\rho = 1$, which corresponds to log utility, the implied elasticities seem far more sensible: a 10 percent decrease in relative prices will correspond to a 10

[13] Laibson et al. (2003a,b) calibrate the discount rate to the mid-life wealth-income ratio and find a discount factor of 0.91 for the least patient group (high school dropouts). Gourinchas and Parker (2002) use the method of simulated moments to fit a dynamic model of consumption to the life-cycle profile and find discount factors consistently above 0.93 for several occupation/education categories.

percent increase in relative intake. In addition to its intuitive plausibility, an elasticity of about unity is consistent with evidence presented below (in Section 4.2) on the response of caloric intake to price changes. Given log utility, the daily discount rate implied by my estimate of the drop in consumption over the month is about 0.0040. This corresponds to an annual discount factor of about 0.23, far below what would seem to be the reasonable range of values.

In the next two subsections, I present the available evidence on elasticities of intertemporal substitution, and argue that high willingness to substitute calories across days is not responsible for the monthly food intake pattern.

4.1. Evidence on the time path of marginal utility

Inferring time preference from a declining consumption path relies crucially on the assumption of diminishing marginal utility from food. If calories today that are very good substitutes for calories tomorrow, then even a tiny amount of time preference could lead to rapidly diminishing food intake over the month.[14]

Similarly, if households' preferences are non-convex over certain regions, then standard models of intertemporal choice may lead to false conclusions about preference parameters. In particular, suppose that households like to have a few feast days each month and a number of days with relatively less intake, rather than having the same amount of intake on all days. In this case, even slightly impatient households might well have all of their feasts at the beginning of the month, since the cost of feasting is presumably constant over the month. This type of model could therefore, produce a steep decline in caloric intake over the month without unusually present-biased preferences.

Models of this kind can produce declining *total* utility over the month. However, even if there are regions over which marginal utility is non-diminishing, an optimizing agent will generally consume in a region of diminishing marginal utility (Becker, 1971). Moreover, if such an agent is patient in the short run, her marginal utility will not rise over the month, otherwise there would be an opportunity to increase total utility at the margin by reallocating consumption towards later days.

The central prediction of these models is therefore that the *marginal* utility of food (or the marginal utility of money to buy food) does not rise significantly over the month, even though the amount of food eaten declines. Evidence of rising marginal utility over the month would reject the models discussed above and provide additional support for a model based on time preference.

Respondents to the Maryland EBT survey were asked the following question:

> Suppose you had a choice between getting $50 in cash one month from today, or getting *less* than $50 today. Would you take less than $50 to get the money today?

[14] To illustrate, consider the extreme case of linear utility, which corresponds to infinitely elastic intertemporal substitution (or $\rho = 0$). With no impatience, the agent will be indifferent between consuming 2000 calories today and 2000 calories tomorrow, or 4000 calories today and zero calories tomorrow. However, any arbitrarily small amount of impatience will lead the agent to strictly prefer 4000 calories today and zero calories tomorrow over any other allocation with the same total number of calories.

The 20 percent of respondents who answered affirmatively were then asked:

> What is the smallest amount of cash you would take today rather than getting the $50 1-month from today?

The mean imputed monthly 'discount factor' for the sample of respondents is 0.93. While the usual caveats about hypothetical choice data apply (Wallis and Firedman, 1942), the answer to this question will likely capture both time preference and the extent of the household's need for cash. Respondents who are impatient, or who find themselves in difficult financial circumstances, are likely to reply that they would accept less than $50 today in exchange for $50 in a month. Since the time preference component is presumably stable over the month, any relationship between the preferences expressed in response to this question and the number of days since receipt of food stamps would strongly suggest changes in the marginal utility of money over the month.

As Table 2 illustrates, the data reveal a striking monthly cycle in households' willingness to accept a smaller immediate payment in exchange for a larger future payment. Column (1) shows the results of a probit regression in which the dependent variable is a dummy for whether the household would accept less than 50 dollars today in exchange for 50 dollars in 4 weeks. The estimates indicate that the share of households willing to make this trade increases by 0.35 percentage points per day. Column (2) adds additional demographic controls, including dummies for age categories, gender, race, and whether the respondent is a high school graduate, leaving the results essentially unchanged. Columns (3) and (4) repeat the specifications of columns (1) and (2), using as a dependent variable the log of the 'discount rate' implied by the respondent's reply to the hypothetical choice question. The results indicate that this 'discount rate' increases by 0.24 percent per day over the course of the food stamp month.

These findings suggest that food stamp households find themselves in increasingly dire straits as the food stamp month progresses. This observation contrasts sharply with a model in which a calorie today is just as good as a calorie tomorrow. It is also difficult to reconcile with explanations based on rotting food or other forms of depreciation. It is, however, quite consistent with an explanation based on time preference: impatient consumers will allow

Table 2
Monthly patterns in the need for cash

Dependent variable	(1) Pr(would accept less than $50)	(2) Pr(would accept less than $50)	(3) log(willingness to accept)	(4) log(willingness to accept)
Days since receipt of food stamps	0.0035	0.0033	−0.0024	−0.0024
	(0.0014)	(0.0014)	(0.0011)	(0.0011)
Demographics?	No	Yes	No	Yes
Model	Probit	Probit	OLS	OLS
Number of observations	1100	1100	1100	1100
(Pseudo-)R^2	0.0058	0.0178	0.0040	0.0132

Data from Maryland EBT study. Each observation describes one respondent. Probit coefficients reported as marginal effects. Demographic controls include dummies for 10-year age categories, sex, race, and high school graduation status of household head. Dummies for missing data are included for all controls.

their marginal utility of consumption to increase over the month, because they are unwilling to sacrifice consumption today in order to prevent a shortage tomorrow.

Though suggestive, however, the above evidence is not conclusive. One important concern is that if food stamp recipients are aware that their consumption follows a 'sawtooth' pattern, then they should realize that the marginal utility of money 1 month from today will, in expectation, be about equal to the marginal utility of money today. Even though marginal utility is high at the end of the month, it will also be high at the end of the next month, so willingness to pay for a 1-month loan need not rise as food intake falls.

The fact that demand for a 1-month loan *does* rise over the food stamp month may imply that respondents are not aware of their consumption patterns, or that they are interpreting the question somewhat non-literally as asking 'how useful would 50 dollars be right now?' However, since it is unclear how respondents interpreted the survey question, it will be useful to circumvent this concern by examining evidence on attitudes toward shorter-term trade-offs.

Those respondents who indicated a willingness to accept the 1-month trade-off were subsequently asked:

> Now suppose you had a choice between getting $50 in cash 1 *week* from today, or getting less than $50 today. Would you take less than $50 to get the money today?

The 44 percent of respondents who answered 'yes' were then asked:

> What is the smallest amount of cash you would take today rather than getting the $50 1 week from today?

The view that marginal utility is rising significantly over the food stamp month would predict that respondents would be most inclined to accept such a trade-off in the final 7 days of the food stamp month, because the 50 dollars would then be sacrificed in the first week of the next food stamp month–a relatively low marginal utility time–and the smaller sum would be received now, in the time of greatest need.

Table 3 presents tests of that hypothesis under several alternative specifications. Columns (1) and (2) show regressions with and without demographic controls for only those respondents who were asked about the 1-week trade-off. In both cases, the willingness to accept less than $50 today in exchange for 50 dollars in 1 week is greater in the final 7 days of the food stamp month. In the specification with demographic controls, the relationship is statistically significant; in the specification without controls, it is marginally significant (significant at the 10 percent level).

One difficulty in interpreting these results is that only respondents who indicated a willingness to accept a $50 loan at a 1-month horizon were asked about their attitudes toward the 1-week trade-off. To address this concern, columns (3) and (4) repeat the specifications of columns (1) and (2) on the whole sample, assuming that respondents who indicated they would not accept less than 50 dollars today in exchange for 50 dollars in 1 month would also reject the trade-off at the 1-week horizon. The effect of being in the final 7 days of the food stamp month is statistically significant and positive both with and without controls.

Table 3
Monthly patterns in the need for cash: 1-week horizon dependent var.: Pr(would accept less than $50 now in exchange for $50 in 1 week)

	(1)	(2)	(3)	(4)
Last 7 days of food stamp month	0.1208	0.1551	0.0646	0.0658
	(0.0697)	(0.0719)	(0.0226)	(0.0223)
Demographics?	No	Yes	No	Yes
Sample	Non-imputed only		All	
Number of observations	225	225	1100	1100
(Pseudo-)R^2	0.0097	0.0650	0.0137	0.0235

Data from Maryland EBT study. Each observation describes one respondent. Probit coefficients reported as marginal effects. Demographic controls include dummies for 10-year age categories, sex, race, and high school graduation status of household head. Dummies for missing data are included for all controls.

4.2. Evidence on the price elasticity of caloric intake

As equation (4) suggests, a regression of log (caloric intake) on log(price per calorie) will recover the elasticity of intertemporal substitution, $1/\rho$, as the coefficient on price, provided that price is uncorrelated with the error term. Given high-frequency price variation that is plausibly exogenous to taste shocks, it is therefore possible to pin down the curvature of the utility for calories and thus the discount rate implied by the nutrition cycle.

To implement this estimation strategy, for each household in the NFCS I calculate the price per calorie consumed during the survey week by dividing the market value of food consumed by the caloric content of food consumed. I then regress log(calories consumed) on log(price per calorie). In order to overcome the 'division bias' arising from the fact that caloric intake appears as the denominator in price per calorie, I instrument for each household's log(price per calorie) using the log of the average price per calorie of all *other* households in the same Census region and survey week.[15]

This approach has two principle limitations. First, the variation in price per calorie may not be driven entirely by supply-side factors. Note, however, that if shocks to the demand for cheap calories are driving the price movements, this will tend to bias upward my estimates of the elasticity of intertemporal substitution, and thus bias downward my estimates of the discount rate.

Second, by necessity, the prices used reflect the price of purchasing food, not the price of eating it as would be required by the model. Whether or not this approach is reasonable depends on the nature of household inventory behavior. The more often the household shops for food, the closer current market prices will be to the cost of replacing food eaten this week. I will therefore need to check the robustness of my findings across samples of households with different shopping frequencies.

With these caveats in mind, Table 4 presents the results of OLS and two-stage least squares (2SLS) regressions of log(caloric intake) on log(price per calorie). The models shown have been estimated on the entire sample of respondent households, as regressions

[15] Finer geographic detail (Census division) is available in the NFCS, but sample size limitations make Census region the smallest level at which it is still possible to calculate weekly average prices.

Table 4
Estimating the price elasticity of weekly caloric intake dependent variable: log(total household caloric intake in survey week)

	(1)	(2)	(3)	(4)
log(price per calorie)	−0.8705	−0.6201	−0.4328	−0.7873
	(0.0371)	(0.2445)	(0.1768)	(0.4717)
Household size dummies?	No	No	Yes	Yes
Region dummies?	No	No	No	Yes
Linear time trend?	No	No	No	Yes
Model	OLS	2SLS	2SLS	2SLS
Number of observations	4393	4393	4393	4393
R^2	0.1870	–	–	–

Data from NFCS. Each observation describes one household on 1 week. Survey weights used as recommended by data providers. Sample includes both food stamp and non-food stamp households.

using only the sample of 309 food stamp households yield estimates too imprecise to be useful.

Column (1) presents the results of a simple OLS regression with no instrument. A 1 percent increase in the price per calorie reduces weekly caloric intake by a statistically significant 0.87 percent. This figure, however, is biased away from zero, since the independent variable is a function of the dependent variable. Column (2) therefore repeats the specification of column (1), instrumenting for log(price per calorie) with the log of the average price per calorie of all *other* households in the same Census region and survey week. As predicted, the estimated coefficient on price falls in absolute value (though it remains statistically significant), now implying that a 1 percent price increase will lead to a 0.62 percent decline in caloric intake.

The specification in column (3) adds dummies for household size, an obvious determinant of total household food intake, leading to a statistically significant elasticity of −0.43. The model in column (4) includes dummies for Census region and a linear control for survey week in addition to dummies for household size, and yields a marginally statistically significant price elasticity of −0.79.

Though the estimated weekly price elasticities are somewhat sensitive to the specification used, in no case does the point estimate suggest anything greater than unit elasticity. Indeed, adopting the estimate in column (1)—the point estimate greatest in absolute magnitude—implies a curvature parameter ρ equal to approximately 1.15. Combining this estimate with the observed weekly decline in caloric intake of roughly 2.8 percent yields an estimated annual discount factor of about 0.19. This is below the discount factor of 0.23 suggested in the calibration exercise.[16]

[16] As the above discussion indicates, if households shop very infrequently, prevailing market prices will tend to be poor proxies for the true cost of eating. I have, therefore, re-estimated the models in columns (1)–(4), restricting the sample to households who report making a major shopping trip at least once per week (results not shown). The estimated elasticities fall slightly in absolute value, suggesting that infrequent shopping is not causing a bias in toward low elasticities of intertemporal subsitution.

Thus, the estimated price elasticities suggest, if anything, that assuming the log utility case of $\rho = 1$ will lead to a bias towards inferring too much patience, rather than too little. Although this exercise is not conclusive, taken together with the above evidence on rising marginal utility throughout the month, it argues strongly against an interpretation of the nutrition cycle based on highly elastic intertemporal substitution.

5. Robustness

Given the magnitude of the decline in caloric intake and the evidence presented above on the elasticity of intertemporal substitution, it is extremely difficult to fit an exponential model to the data with reasonable time-preference parameters. In this section, I will show direct evidence linking time preference to the food stamp nutrition cycle. I will also present evidence rejecting a broad set of alternative explanations for the cycle.

5.1. Direct evidence on the role of time preference

The most direct test of the role of time preference would be to estimate the effect of cross-sectional differences in the discount rate on the magnitude of the monthly decline in caloric intake. Unfortunately, the CSFII and NFCS do not contain any direct measures of time preference. I therefore take an alternative approach, which is to use evidence from the Maryland EBT survey's hypothetical choice between receiving 50 dollars in 4 weeks or less than 50 dollars today. This survey question, discussed in greater detail in Section 4.1, provides a useful estimate (or at least a correlate) of the true rate of time preference.

The Maryland EBT survey data do not contain information on caloric intake. However, the survey does contain some questions related to the variability of spending and food availability over the month, making it possible to ask whether more patient individuals smooth more effectively. For example, respondents were asked.

In the previous calendar month, did anyone in your household skip any meals because there wasn't enough food, money, or food stamps to buy food?

Nine percent of respondents answered 'yes' to this question. Column (1) of Table 5 shows the results of a probit regression of the answer to this 'food insufficiency' question on a dummy variable for whether the respondent would accept less than $50 today in exchange for $50 in 1 month. Individuals who would accept less than $50 today are seven percentage points more likely to report having run out of food in the previous month. As column (2) shows, this finding is robust to the inclusion of a set of demographic controls, including dummies for age categories, gender, race, and whether the respondent is a high school graduate.[17]

Though suggestive of an effect of time preference on households' ability to smooth food consumption, these regressions raise concerns of reverse causality. Households that are having a bad month—in the sense that they have run out of food—may be more

[17] Very similar results can be obtained using a number of alternative dependent variables, including the number of days in the previous month on which the respondent worried about having enough food.

Table 5
Time preference and food insufficiency, dependent variable: Pr(skipped a meal last month)

	(1)	(2)	(3)	(4)
Would accept less than $50 today in exchange for $50 in 4 weeks	0.0655 (0.0249)	0.0578 (0.0236)	0.0616 (0.0244)	0.0522 (0.0230)
Amount of food stamps currently remaining ($100)			− 0.0371 (0.0155)	− 0.0389 (0.0149)
Demographics?	No	Yes	No	Yes
Number of observations	1106	1106	1100	1100
Pseudo-R^2	0.0128	0.0346	0.0224	0.0456

Data from Maryland EBT study. Each observation describes one respondent. Coefficients are marginal effects from a probit regression. Demographic controls include dummies for 10-year age categories, sex, race, and high school graduation status of household head. Dummies for missing data are included for all controls.

willing to accept less than $50 today in exchange for $50 in 1 month. Although the food insufficiency question asks about the previous month, households that experienced food insufficiency last month are presumably more likely to be experiencing it now. Food insufficiency might therefore be causing high estimated impatience, rather than impatience causing food insufficiency.

To address this issue, columns (3) and (4) re-estimate the specifications of columns (1) and (2) controlling for the amount of food stamps remaining out of the household's most recent allotment. Coefficients on this control have the expected negative sign. The coefficients on the impatience dummy do fall slightly, but they remain statistically and economically significant.

Overall, then, the evidence indicates that time preference plays an important role in households' smoothing of food consumption over the month. However, there are alternative models that could potentially explain the monthly pattern in nutritional intake. In the next subsections I evaluate several of these models and find that none is consistent with the available data.

5.2. Shopping and depreciation

Possibly the simplest explanation for the consumption decline is that food rots. Suppose that a household were to do most of its major grocery shopping on the day on which it receives food stamp benefits. If stored food loses some percent of its value for each day it goes uneaten, then even a perfectly patient household would display a consumption decline over the month.

The CSFII data contains a survey question on shopping frequency. Respondents were asked how often someone does a major shopping for the household, and were able to answer either more than once a week, once a week, once every 2 weeks, once a month or less, or never. Table 6 repeats the baseline specification of Table 1 on four shopping frequency categories.[18] If anything, the evidence suggests that households with frequent shopping have more of a decline in consumption than households with infrequent shopping.

[18] Households that report never doing a major shopping trip are omitted from the analysis.

Table 6
Shopping frequency and caloric intake dependent variable: log(caloric intake)

Shopping frequency	(1) More than once a week	(2) Once a week	(3) Once every 2 weeks	(4) Once a month or less
Days since receipt of food stamps	−0.0104	−0.0087	0.0021	−0.0029
	(0.0035)	(0.0033)	(0.0028)	(0.0031)
Number of observations	655	1394	1895	2687
R^2	0.2496	0.2374	0.1135	0.1130

Data from CSFII. Each observation describes one household member on one survey day (out of three total days). Regressions include dummies for survey day, day of week, year, month, and calendar date. Standard errors in parentheses are adjusted for correlation within households. Survey weights used as recommended by data providers.

The variation in consumption patterns across shopping frequencies could certainly be due to other differences between households.[19] Nevertheless, the results in Table 4 show that even households shopping on average once or more each week display a significant decline in caloric intake over the month. Evidently, the food stamp nutrition cycle is not caused by infrequent shopping and food depreciation.

5.3. Strategic motives

If individuals can extract resources from one another, either through transfers or through outright theft, then food stamp participants may effectively face negative interest rates. The more wealth I consume today, the less will be available tomorrow to be stolen or transferred to others, and the more I can credibly demand from those who care about me in order to prevent my own starvation.[20]

The most straightforward effect in this class of models is direct theft. If each dollar of wealth carries with it a per-period probability of theft, this hazard rate will tend to make a declining consumption profile optimal. Respondents to the Maryland EBT survey were asked whether any food stamps were lost or stolen in the previous 2 months, and if so for the unrecovered amount.[21] Using information on the amount of food stamp benefits received, I have converted this amount into a daily rate of loss. The average daily rate of loss is 0.0001, a figure is far too small to contribute significantly to the observed consumption decline.

A scramble for resources within the household could potentially generate a downward-sloping consumption path. In such a model, when benefits arrive, each household member tries to eat what she can to capture as much of the available resources as possible. One simple test of the importance of this theory is to compare single-person households to households with multiple individuals. Only 8 percent of

[19] It is also possible that households with greater short-run impatience try to commit themselves to consuming less in early weeks by buying only a little food at a time.

[20] This is similar to Becker's (1998) observation that we may sometimes prefer to cross the street in order to avoid feeling obligated to donate to a beggar.

[21] Since some of food stamp recipients' wealth is held as food rather than food stamps, it would be desirable to know the rate of theft or loss of food. Unfortunately, this information is not available, although the probability of theft of food would have to be quite considerable to alter my conclusions.

the observations in the CSFII are from individuals in single-person households, making precise comparisons difficult, but it is still possible to ask whether the results are driven by large households.

Table 7 addresses this issue. Column (1) presents the baseline specification of Table 1, interacting the number of days since receipt of food stamps with the number of individuals in the household (top-coded at 6). While individuals in larger households do appear to experience a larger decline in consumption, the difference is statistically insignificant and quantitatively quite small. Adding an additional household member increases the rate of consumption decline by 0.02 percent. And as column (2) shows, for respondents in single-person households the point estimate of the daily decline in caloric intake is similar to that estimated for the average respondent in Table 1. Though the estimate is quite imprecise, it does not suggest an important role for within-household competition in determining the time path of consumption.

An alternative approach to examining consumption behavior directly is to ask whether, in the Maryland EBT survey, individuals living in larger households tend to report skipping meals more often than respondents in multi-person households. Columns (3) and (4) of Table 7 address this question in a probit framework. Column (3) presents a univariate analysis of the relationship between household size and self-reported food insufficiency. There is no appreciable effect, and if anything the estimates suggest that individuals living in smaller households are more likely to have run out of food in the past

Table 7
The effect of household size

Dependent variable	(1) log(caloric intake)	(2) log(caloric intake)	(3) Pr(skipped a meal)	(4) Pr(skipped a meal)
Days since receipt × household size	−0.0002			
	(0.0013)			
Days since receipt of food stamps	−0.0034	−0.0037		
	(0.0048)	(0.0046)		
Household size	0.0183		−0.0087	0.0017
	(0.0228)		(0.0060)	(0.0081)
Demographics?	No	No	No	Yes
Sample	All	Single-person household	All	All
Model	OLS	OLS	Probit	Probit
Dataset	CSFII	CSFII	EBT	EBT
Number of observations	6652	519	1106	1103
(Pseudo-)R^2	0.0814	0.3523	0.0032	0.0442

In regressions using the CSFII, each observation describes one household member on one survey day (out of three total days). In regressions using EBT data, each observation describes one respondent. Regressions (1) and (2) include dummies for survey day, day of week, year, month, and calendar date. In regressions (1) and (2), standard errors in parentheses are adjusted for correlation within households. Demographic controls in column (4) include dummies for 10-year age categories, sex, race, and high school graduation status of household head, as well as total value of food stamps received in previous month. Dummies for missing data are included for all controls. Probit coefficients reported as marginal effects. Survey weights used as recommended by data providers.

Table 8
Inter-household transfers over the month

Dependent variable	(1) Pr(Ate in other home)	(2) Pr(Ate in other home)	(3) Calories received	(4) Calories received
Days since receipt of food stamps	0.0001		0.4753	
	(0.0003)		(0.4072)	
Short on cash		− 0.0066		− 0.8644
		(0.0150)		(16.9869)
Model	Probit	Probit	OLS	OLS
Number of observations	6671	6683	6671	6683
(Pseudo-)R^2	0.1014	0.1017	0.0266	0.0273

Data from CSFII. Each observation describes one household member on one survey day (out of three total days). All specifications include dummies for survey day, day of week, year, month, and calendar date. Standard errors in parentheses are adjusted for correlation within households. Probit coefficients reported as marginal effects. Survey weights used as recommended by data providers.

month. Column (4) adds demographic controls to the model; the coefficient on household size is now positive but extremely small.[22]

Even if within-household competition is not an important factor, transfers of resources *between* households may play a role. If I know that the less money I save the less I will be expected to contribute to others, and the more I will be able to credibly demand from friends, my consumption may decline over the month even if I am perfectly patient.

Since in most states, different households receive benefits on different days of the month, the transfers model predicts that food stamp recipients will be net donors of food (or other resources) earlier in their food stamp month (when their wealth exceeds the community average) and net recipients later on. These implications are testable, since the CSFII records whether a respondent's meal is eaten at another person's home.

Table 8 explores the relationship between time of month and eating in the home of friends or relatives. As column (1) shows, there is no correlation between the probability of eating at another person's home and the number of days since receipt of food stamps. This is not simply a matter of lack of statistical precision: the probit model can reject positive effects as small as 0.07 percentage points per day. In column (2), I examine the relationship between the probability of eating in another person's home and whether the respondent indicates being short on cash on the survey date. There is no evidence that food eaten out of the home buffers stocks experienced by the household. Column (3) uses the number of calories obtained in others' homes as the dependent variable. Although the amount of food transferred increases over the month, the effect is tiny and statistically insignificant. Column (4) repeats this specification using a dummy for whether the respondent was short on cash as the independent variable and suggests the same conclusion.

On the whole, then, the data reject explanations for the decline based on strategic considerations. While these concerns may be present, they are not quantitatively strong

[22] Results are similar using a dummy variable for single-person households rather than a continuous measure of household size.

enough to show up in the data and therefore, seem unlikely to be the driving force behind the food stamp nutrition cycle.

5.4. Confusion about the value of food stamps

Liebman and Zeckhauser (2003) have recently suggested that recipients are confused about the value of their food stamps. A household that must supplement its food stamps with cash may think early in the month that food stamps are worth less than their face value equivalent in cash, leading the household to overconsume food early on in the month. Later, when food is being purchased with cash, the household will correctly value the food and will consume less. As a test of this hypothesis, which Liebman and Zeckhauser have colorfully dubbed 'Schmeduling', I have compared households for whom food stamps cover all household food expenditures to households that spend more on food than they receive in food stamps. The results indicate a small and statistically insignificant reduction in the monthly nutrition cycle for households that use only food stamps for food (regression not shown). It does not seem that confusion can account for the monthly decline in caloric intake.

5.5. Over-optimism

A final possibility is that food stamp recipients over-estimate how long their food stamps will last. They spend too much at the beginning of the food stamp month and find they do not have the resources to maintain the same level of food intake as they get closer to month's end. This explanation is related to the 'Schmeduling' hypothesis in that both posit that the nutrition cycle results from a cognitive error, rather than optimizing behavior subject to short-run impatience.

Table 9
Tests for experience effects

Dependent variable	(1) Pr(skipped a meal)	(2) Pr(skipped a meal)	(3) Share of benefits exhausted in first week	(4) Share of benefits exhausted in first week
Months since first received food stamps	0.0055 (0.0043)	0.0053 (0.0041)	0.0053 (0.0034)	0.0013 (0.0033)
Demographics?	No	Yes	No	Yes
Model	Probit	Probit	OLS	OLS
Number of observations	1099	1099	1099	1099
(Pseudo-)R^2	0.0027	0.0259	0.0022	0.0702

Data from EBT. Each observation describes one household. Demographic controls in columns (2) and (4) include dummies for 10-year age categories, sex, race, and high school graduation status of household head. Dummies for missing data are included for all controls. Probit coefficients reported as marginal effects. Share of benefits exhausted in first week is coded from the response to the survey question "One week after you receive your food stamps do you usually have (1) no coupons left, (2) less than half of the coupons left, (3) about half of the coupons left, or (4) more than half of the coupons left." The share exhausted in the first week is coded as 1, 0.75, 0.5, or 0.25, respectively. Results are not sensitive to the details of this coding scheme.

If we assume that learning takes place even among naive agents, this suggests a straightforward test of the over-optimism hypothesis: the food stamp nutrition cycle should lessen with experience. As a test of this prediction, Table 9 shows the relationship between various measures of the nutrition cycle and time since first receipt of food stamps. Neither the propensity to skip meals nor the share of food stamps exhausted in the first week seems to decrease with the number of months the household has been on the food stamp program. In fact, results generally suggest a small *increase* in the propensity to skip meals and rapidly exhaust benefits as time in the program rises. The estimates are quite robust to the inclusion of a broad set of demographic controls, suggesting that omitted household characteristics are not driving these results.

Although it is possible that households are persistently overconfident about how long their food stamps will last, it does not seem plausible that such effects would remain constant over time. As the data show no evidence of learning, they would seem to support a story based on preferences rather than cognitive error.

6. Calibration of the quasi-hyperbolic model

Having shown that the weight of the evidence strongly supports a time preference-based explanation of my findings, it remains to compare the exponential and quasi-hyperbolic discounting models in terms of their ability to replicate the observed consumption patterns. In Section 4, I argued that it is not possible to construct a sensible calibration of a standard exponential discounting model to explain my quantitative results. In this section, I present and calibrate a quasi-hyperbolic model of intertemporal choice that is consistent both with survey evidence on the time preferences of food stamp recipients and with the existing literature on non-exponential discounting.

Quasi-hyperbolic discounting posits that an individual at time t discounts utility from a future period $t+j$ by the factor $\beta\delta^j$. In other words, tomorrow's utility is $\beta\delta$ less important than today's utility, and utility two days from now is δ less important than utility tomorrow. With a high δ and a low β, an agent will be simultaneously patient over long-term choices and impatient over short-term ones. With $\beta = 1$ hyperbolic discounting reduces to standard exponential discounting.

To fix ideas, consider our T-period consumption problem in which we abstract away from uncertainty, interest, and variation in prices. As before, let utility be isoelastic with parameter ρ. Then the hyperbolic Euler equation (Harris and Laibson, in press) at time t is given by:

$$C_t^{-\rho} = [C'(W_{t+1})\beta\delta + (1 - C'(W_{t+1}))\delta]C_{t+1}^{-\rho} \tag{5}$$

where $C(\cdot)$ is the consumption function. Since the model incorporates conflicts between the present self and the future self, the lower is the tomorrow self's marginal propensity to consume out of wealth, the more this condition will approach the standard exponential Euler equation.

In the isoelastic case, consumption is proportional to wealth, so we can write

$$C(W_t) = \alpha_t W_t \tag{6}$$

where $\alpha_T = 1$ and

$$\alpha_t = \frac{\alpha_{t+1}}{\alpha_{t+1} + (\delta(1-(1-\beta)\alpha_{t+1}))^{\frac{1}{\rho}}} \tag{7}$$

for $t < T$. This provides a simple recursive method for solving the equilibrium consumption path.[23]

If we assume log utility, an intuitively reasonable calibration and one in line with the evidence on price elasticities presented in Section 4.2, then the quasi-hyperbolic model can fit the consumption decline with a β of 0.96. This is within the range suggested by experimental evidence (Frederick et al., 2002), and is just above the range of estimates reported by Laibson et al. (2003a,b), who estimate the annual time preference parameters of a hyperbolic discounter solving a life cycle consumption problem. It is also very similar to the average monthly discount factor of 0.93 imputed from the hypothetical choice evidence discussed in Section 4.

It is thus possible to replicate the key features of the food stamp nutrition cycle using a parametrization consistent with life cycle facts, survey evidence and experimental results on quasi-hyperbolic discounting. Although the existing literature does not relate specifically to the food stamp population, it is comforting that estimates from the nutrition cycle are in the vicinity of extant evidence on quasi-hyperbolic discounting.

7. Policy implications

In the quasi-hyperbolic model, the equilibrium consumption path is suboptimal in the sense that the consumer would be willing to pay for a commitment technology that would force her not to over-consume in early periods. This begs the question of whether there might be a policy tool for reducing the monthly consumption decline. Since the introduction of EBT, which drastically reduced the cost of delivering benefits, some have suggested increasing the frequency of payments (Wilde and Ranney, 2000).

This is not an unrealistic proposal: in several states (including Massachusetts, Michigan, New Hampshire, New York and Rhode Island), Temporary Assistance to Needy Families (TANF) benefits are already paid out twice each month. And in a focus group conducted in 1990, some participants suggested breaking benefits down into smaller amounts delivered more frequently (Ohls et al., 1992):

> Break it [benefit check] down with a check on the 1st and a check on the 15th like they used to do [for AFDC]. If you're spending most of your money in the first few days of the month with one check, if you spend most of it on the 1st, you know [with two checks] you got that other money coming through so you're stringing it out.

[23] See section 5 of the appendix (available on request) for a proof that this is the solution.

> Give it to us in two installments. At the end of the month I'm dying [for money]. If you got it on the 1st and 15th, or whatever, it would be so much better. Checks or coupons, it doesn't matter, either way, but it does not last a month. The second part of the month is always a struggle.

It is important to note, however, that the magnitude of the realized welfare loss depends crucially on assumptions about the elasticity of intertemporal substitution. For the benchmark case of log utility ($\rho = 1$), a consumer whose 'true' optimal consumption path is constant over the month but whose actual consumption declines by 0.4 percent per day suffers losses equivalent to 0.06 percent of her total monthly food expenditures, or about 15 cents per month for the typical food stamp household.[24] (On the other hand, if the marginal utility from food were very rapidly diminishing, say with $\rho = 40$, then the losses would be more substantial: 2.1 percent of monthly food outlays or 5.25 dollars per month.)

These potential gains must be evaluated against the increased administrative and other costs associated with more frequent benefit issuance. While obtaining a precise estimate of these costs is beyond the scope of this paper, it is possible to determine some bounds. Detailed cost estimates are available for Maryland in 1993, at which time total food stamp program costs per case month were about $3.92 in contemporaneous dollars (Logan et al., 1994). These costs can be divided into five broad categories: authorizing benefits ($0.76 per case month), delivering benefits ($2.52), redeeming and reconciling benefits ($0.53), investigating and prosecuting fraud ($0.07), and managing benefit funds ($0.04). Of these, only the first two categories—authorizing and delivering benefits—are likely to be significantly affected by changes in issuance frequency. Within these two categories, only three subcategories—creating and posting benefit records ($0.23), processing transactions ($0.87), and resolving transaction problems ($0.62)—would likely change if payments were made more often during the month.

Consider a possible change to a twice-monthly rather than once-monthly issuance scheme. In the most costly scenario, the costs of creating and posting benefit records would roughly double, and recipient households would double their transaction frequency. Total additional costs per case month in this scenario would be roughly $1.72, which would require a ρ of at least 12.4 to justify the policy change. In the least costly scenario, costs of creating and posting benefit records would double but transaction frequency would be unchanged, corresponding to a cost of $0.23. In this case, ρ would need to be at least 1.7 to justify the change.[25]

Thus, even if doubling the issuance frequency could completely eliminate the nutrition cycle, for the benchmark case of $\rho = 1$ the benefits would not justify the likely costs. This is consistent with Cochrane's (1989) observation that the welfare effects of deviations from the optimal consumption path tend to be small in practice.

[24] These calculations assume that a typical food stamp household spends $250 monthly on food, roughly the median of reported spending in the CSFII. See Section 6 of the appendix (available on request) for the formal model underlying the welfare calculations.

[25] The discussion of program costs draws heavily on conversations with Chris Logan on April 8, 2004.

8. Conclusions

The evidence presented in this paper challenges the PIH, and exponential discounting more generally, as descriptions of the intertemporal choices of food stamp households. In contrast, the quasi-hyperbolic model is consistent with my findings, and has potentially very different implications for the expected impact of fiscal policy and the optimal timing of benefit payments. Whether my results generalize to other populations is an important topic for future research. Data on nutritional intake of the sort I have employed here are likely to be an important tool for future studies, because they allow direct observation of consumption at the daily level. Such a high level of detail is especially important for testing theories, such as quasi-hyperbolic discounting, that focus on trade-offs made over the very short run.

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