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Survey Evidence on Habit Formation: Existence, Specification, and Implication

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Abstract

Habit formation is a staple of macroeconomics and finance, but insufficient micro evidence has led to controversies over its existence, specification, and implication. This paper documents new and extensive micro evidence for habit formation, through sur-

"Even with better measurement, there will likely be significant deviations from theory which can direct subsequent theoretical research. This feedback between theory and measurement is the way mature, quantitative sciences advance."

Edward C. Prescott, 1986

1 Introduction

Habit formation refers to the phenomenon of response decrement to repetitive stimulation.[1] Habit formation based on total consumption has been used to explain many important phenomena in, among other areas, asset pricing, business cycles, and economic growth,[2] and has become an integral component of macroeconomic models for policy analysis (Dou et al., 2020).[3] The successes of habit formation models have prompted researchers to investigate the foundations of the models. Some studies provide axiomatic theories for habit formation models (e.g., Rozen, 2010; Tserenjigmid, 2019), while others examine the consistency between the models and microdata (e.g., Dynan, 2000; Crawford, 2010; Ravina, 2019). This latter strand of literature has covered a limited number of aspects of the micro evidence of habit formation and has not reached consensus (see below), giving rise to controversies regarding the existence, specification, and implication of habit formation. Does people's spending behavior exhibit habit formation? Are current habit formation models consistent with people's spending behavior? Can habit formation explain the Easterlin paradox? Employing and extending Barsky et al.'s (1997) method of direct survey measurement of structural preferences, this paper documents new and extensive micro evidence on habit formation, as follows.

First, habit forms both internally and externally. Depending on its source, habit formation can be categorized into internal habit formation (habit based on one's own past consumption)

[1] This definition of habit formation differs from the day-to-day notion of the cue-routine-reward habit, but it is what the current economic models of habit formation are trying to capture and is consistent with the biological literature. This notion of habit formation sets it apart from path dependence, with which it is sometimes confused. It is also worth noting that habit formation is different from desensitization, which would imply reduced responses to s?Tmo8.244(i034Tm290(aETfPd(habit)-250(f)40(or)-20(matio,)-250indec(bases)-250(responses)-250(

and external habit formation (habit based on other people's past consumption). Literature investigating evidence of habit formation has mostly focused on the existence of internal habit formation and suggests that the macro phenomena that habit formation models have been built to explain tend to require more significant evidence for internal habit formation than the current micro evidence suggests (see column 1 of Table 1). The existence of external habit formation has received much less attention, and its scarce micro evidence does not support the popular modeling practice of assuming only external habit formation (column 2 of Table 1).[4] Internal and external habit formation can have dramatically different implications for optimal tax policy and welfare analysis (Ljungqvist and Uhlig, 2000, 2015). Through stated-preference experiments that differentiate between the two types of habit formation, this paper documents micro evidence for the existence of both internal and external habit formation. Few authors have studied the composition of these two types of habit formation, and its only formal estimate in the literature is macrodata-based (column 3 of Table 1). Allowing habit to form both internally and externally as per Grishchenko (2010) and using microdata, this paper estimates that external habit formation accounts for a small portion (about 18%) of habit.

Second, habit depreciates by about 67% per year. Most specifications of habit formation depend on two parameters: habit depreciation rate[5] and habit intensity. Existing research has focused primarily on estimating the habit intensity parameter (column 4 of Table 1)[6] while largely ignored the habit depreciation rate parameter (column 5 of Table 1). A potential reason for the current state of the literature is a lack of recognition of the importance of this parameter. To illustrate its importance, I show that the performance of habit formation models can be very sensitive to the parameter. This paper also provides a microdata-based estimate of the parameter that is aggregated for a representative agent.

Third, neither the additive habit preference nor the multiplicative habit preference is consistent with people's spending behavior (see Table 1 for the preferences). Almost all current habit formation models in the literature assume either of these two habit utility functions (column 6 of Table 1), and the literature has not seen any formal tests of the preferences. The conclusions drawn from these models are, therefore, joint estimates and

[4] For models with only external habit formation, see, e.g., Abel (1990); Campbell and Cochrane (1999); Smets and Wouters (2007); Uhlig (2007); Dou et al. (2020).

[5] This study focuses on the depreciation rate rather than the catch-up rate because the latter varies under different normalizations of habit, whereas the former is invariant to such normalizations. The habit depreciation rate fully pins down the habit catch-up rate for any given normalization of habit.

[6] For a meta-analysis of the literature estimating this parameter, see Havranek et al. (2017).

tests with specifications of unknown validity. In a general utility function naturally nesting these two formulations, this paper proposes and implements four tests of the preference specifications.[7] The tests utilize insights from the linkage between the preferences and the shapes of their indi□erence curves: the indi□erence curves of the additive habit are parallel straight lines, and the nonlinear indi□erence curves of the multiplicative habit become parallel straight lines in the log space. The results of the tests imply that both habit utility functions are rejected with high confidence. Even though these two common specifications are rejected, estimates of the signs of all the elicited utility derivatives in the general preference are consistent with the definition of habit formation,[8] suggesting that habit formation preferences consistent with the micro evidence could be found.[9]

Fourth, the welfare impacts of habit formation and peer e□ect are about the same in size. As two important interdependent preferences, peer e□ect allows interpersonal dependence, while habit formation allows intertemporal dependence (in internal and external habit formation) as well as interpersonal dependence (in external habit formation). Previous researchers have found a strong welfare impact from peer e□ect (Luttmer, 2005; De Giorgi et al., 2020) but have disagreed on the strength of the welfare impact relative to habit formation. Through estimating linearized consumption Euler equations, Alvarez-Cuadrado et al. (2015) find internal habit formation to be as strong as peer e□ect, whereas Ravina (2019) finds internal habit formation to be about 70% stronger than peer e□ect. Allowing both internal and external habit formation, this paper provides an estimate of the relative strength of the welfare impacts of the two phenomena without taking a problematic stance on the specification of the felicity function.

Fifth, combining habit formation with peer e□ect could generate the happiness–income pattern of the Easterlin paradox. Easterlin (1973, 1974) highlighted the tension between the positive cross-sectional correlation and zero time-series correlation of happiness and income and proposed peer e□ect as an explanation in light of its e□ect on averaging happiness across individuals. As happiness data accumulated over time, the literature discovered that the zero time-series correlation tends to hold only in the long run, whereas the short-run correlation is generally positive (Stevenson and Wolfers, 2008; Sacks et al., 2012; Easterlin, 2017).[10]

[7] This is the first time such tests have been done in the literature: the tests not only are new, but also require extending existing methods of preference elicitation for their implementation (see the end of this section for more details).

[8] Specifically, $u_H < 0$ and $u_{CH} > 0$.

[9] I leave this direction to future research.

[10] There is an ongoing debate on whether the long-run gradient is exactly zero or slightly positive. This paper intends not to participate in the debate, because it supplies no new evidence on happiness measures, and

formation models in this direction. Chen and Ludvigson (2009) allow habit to evolve in nonparametric ways and to form either internally or externally but maintain the parametric assumptions of the additive habit and power utility. Crawford (2010) relaxes parametric assumptions for both the felicity function and habit evolution but allows only internal habit formation. Neither of the papers' models nests and therefore neither investigates the common

survey question flipped. I use a statistical model to extract consistent responses from the two survey waves while dealing with response biases and errors not addressed by the design and implementation of the survey experiments. The benchmark estimation uses responses from 359 and 139 U.S. participants of the respective waves. The respondents spread across the U.S. and match the U.S. population on all the demographic characteristics the survey collected. A series of robustness checks are conducted to explore the effects of potential remaining response biases and errors and certain alternative specifications for elicitation and estimation.

While economists generally prefer revealed-preference methods, this paper chooses the stated-preference or hypothetical-choice method because of the severe drawbacks suffered by the former class of methods for providing the extensive micro evidence. Real-world choices tend to be afflicted by identification and data issues (Kimball and Shapiro, 2008). In the context of habit formation, a lack of required variations in real-world choices has confined the literature to mostly studying three, barely touching two more, and completely ignoring the other five of the ten preference parameters this paper estimates, all of which are crucial to the extensive micro evidence of habit formation. Furthermore, real-world choices often come from competitive markets where the price-taking behaviors rule out the possibility of testing the common multiplicative habit. This is because a utility-maximizing agent, taking

extensive micro evidence. The validity of the method rests on the assumption of truthful preference revelation, and response biases and errors can cause deviations from the assumption. Response biases and errors have been carefully studied and dealt with in the literature, and economic studies conducting hypothetical-choice experiments have a long history (Thurstone, 1931) and span many fields: among others, behavioral economics (e.g., Kahneman and Tversky, 1979), public economics (e.g., Kuziemko et al., 2015), environmental economics (e.g., Johnston et al., 2017), and health economics (e.g., Ameriks et al., 2019). This study deals with potential response biases and errors through the design and implementation of the stated-preference experiments, survey, estimation, and robustness checks. The stated-preference evidence is important, not only because it can feasibly shed light on the preference parameters that revealed-preference methods cannot, but also because it complements the revealed-preference evidence for the preference parameters that both the stated- and revealed-preference methods can illuminate. The complementarity derives from the fact that the limitations of the stated-preference method—response biases and errors—tend to be orthogonal to the aforementioned limitations of the revealed-preference methods.

This paper contributes to several strands of the literature. Relative to the literature on the micro evidence of economic models of habit formation (Dynan, 2000; Kapteyn and Teppa, 2003; Crawford, 2010; Ravina, 2019), this paper uses novel micro-level variations from survey experiments to expand the scope of existing micro evidence on habit formation. This expansion also connects this paper to two other lines of research. Relative to the literature on testing general specifications of habit formation models (Chen and Ludvigson, 2009; Crawford, 2010; Grishchenko, 2010), this paper uses, as discussed above, a more general model and proposes and implements the first set of formal tests of additive and multiplicative habits. Relative to the literature on using habit formation to explain the Easterlin paradox (Easterlin, 1995; Clark et al., 2008; Clark, 2016), this paper provides evidence that habit formation joining forces with peer e□ect could explain the paradox and proposes an intuitive analogy for the explanation. Additionally, this paper joins the growing set of studies that conduct hypothetical-choice experiments on MTurk for understanding people's preferences (Kuziemko et al., 2015; Saez and Stantcheva, 2016; Benjamin et al., 2019).

Finally, this paper also contributes to the methods of structural preference elicitation (Barsky et al., 1997; Kimball et al., 2009; Benjamin et al., 2014). Existing research that elicits structural preference parameters has mostly focused on fully parametric preferences.[15]

[15] See, e.g., Kapteyn and Teppa (2003); Sahm (2007); Kimball et al. (2008); Kimball and Shapiro (2008);

To be immune to specification errors, some studies have dispensed with certain parametric assumptions and have used first-order approximations in eliciting semiparametric and non-parametric preferences (Benjamin et al., 2014, 2019). This paper extends the literature by using higher, including the infinitieth, orders of approximations in such preference elicitation. This advancement not only improves the accuracy of preference elicitation, but also enables the elicitation of preference parameters that have not been elicitable: for instance, to elicit (ratios of) the utility derivatives of the second order, as is required to implement the tests of additive and multiplicative habits, approximations of at least the second order are necessary.

This paper proceeds as follows. Section 2 presents the general model and survey design. Section 3 summarizes the data and statistical model. Section 4 contains the elicitation, estimate, and implication of each preference parameter of interest. Section 5 explores the explanation of the Easterlin paradox. Section 6 checks robustness, and Section 7 concludes.[16]

and how habit affects utility.[18] The respondent's utility can depend on other variables (e.g., labor), but because they will be kept constant in the survey, not explicitly listing them as the arguments of the utility function results in no loss of generality. In the discussion of survey questions involving changes in things other than self-spending and habit (e.g., other people's spending), the additional variable(s) of the utility function will be explicitly shown.

Habit evolves according to

$$\dot{H} = \delta(C - H),$$

where δ is the habit depreciation rate. This specification is chosen for two reasons. First, it has been in the literature since at least Houthakker and Taylor (1970) and is the most commonly used habit evolution in the literature. Researchers have used different formulations of the evolution. However, the difference is either a simple rescaling of the unit of habit (e.g., Constantinides, 1990) or disappears in the steady state (e.g., Campbell and Cochrane, 1999). For general habit evolutions that are potentially nonlinear (even in the steady state), I show that they are observationally equivalent to this linear habit evolution under the general habit formation preference.[19] Second, this habit evolution has an intuitive unit, the same as that of consumption. For example, a person who has been spending $5,000 per month for as long as they can remember has a habit of spending $5,000 per month.

Documenting the extensive micro evidence for habit formation requires information on whether habit affects utility and, if it does, the values of the preference parameters governing the effects of habit on the utility: δ, θ, ratios of utility derivatives up to the second order ($\theta\frac{u_H}{u_C}$, $\frac{Hu_{HH}}{u_H}$, $\frac{u_{CH}}{u_{HH}}$, and $\frac{u_{CC}}{u_{HH}}$), external habit mixture coefficient, and strength of habit formation

2.2 Survey Design

To elicit the preference parameters, I design simple stated-preference experiments that identify them while controlling for potential confounding factors and response biases and errors. Because past spending determines habit and habit (potentially) a□ects people's well-being, the basic idea behind the stated-preference experiments is to compare the welfare implications of di□erent spending paths.[21] The exact variations of the spending paths vary from one parameter to another and will be discussed in detail in Section 4. This section sets the stage for that discussion by presenting the survey design.

As discussed earlier, the elicitation of the preference parameters of interest requires placing the comparison of spending paths in stated-preference or hypothetical-choice scenarios. The survey starts with a preamble module that specifies the basic hypothetical environment in which comparisons of spending paths will be performed and instructs the respondents on the format of the core survey questions. Nine core modules follow, each containing specific variations in spending paths that elicit one or two of the preference parameters of interest.

The basic hypothetical situation is designed to be as simple as possible while still allowing elicitation of the parameters of interest and avoiding potential confounding factors that plague real-choice data. In particular, it frees the respondents from worrying about changes to the purchasing power of money, about durable goods, and about changes in preferences. The basic hypothetical situation is the following.

Please answer all survey questions under the following hypothetical situation:

- *There is no inflation, and prices of everything stay the same over time.*
- *You rent the durable goods you consume, including residence, furniture, car, etc.*
- *Things you want don't change over time.*
- *People not mentioned in questions always spend $5,000 per month.*
- *Everything else unmentioned in the questions is and stays the same.*

The survey quizzes the respondents about their understanding of this basic hypothetical situation. Only those who passed the test were able to proceed to the core modules of the survey.

The respondents did not know that the survey is about habit formation. They were only told that the survey was about spending behavior. I did this for two reasons, the first of which was to avoid potential confusion; more likely than not, a typical respondent would not know

what habit formation, as currently modeled in economics, is. The second reason was to avoid potential biases; I cannot prime respondents with habit formation while attempting to test its very existence.

To make the representation of a spending path intuitive and to simplify comparison across several of them, I draw it in a monthly spending graph (Figure 1a). In such graphs, time is on the horizontal axis: past on the left, now in the middle, and future on the right. The bars above the time axis represent monthly spending and are drawn to scale and colored differently to help distinguish time horizons. The spending path of Figure 1a represents spending $7,000 per month in the past until now and $5,000 per month in the future starting now. The respondents went through instructions and were tested on reading the monthly spending graphs before being qualified to answer questions in the core modules.

To alleviate the concern that each person has only one past spending path in reality, I invoke the metaphor of parallel universes, between which everything is the same except for the spending paths. I then ask the respondents which universe brings them a better future experience—how they feel in the future starting now. Figure 1b presents a screenshot of a typical survey question.

The survey is incentive-compatible for truthful preference revelation if the respondents truthfully reveal their preferences regardless of other respondents' choices. The anonymous online implementation of the survey rules out feasible mechanisms through which the respondents could know and influence each other. Due to the fact that the preference elicitation does not rely on, and therefore the survey does not elicit, respondents' exact valuation that is often the object of interest in willingness to pay or accept elicitation, concerns of under- or over-reporting of valuation do not apply, as long as the relative ranking of the (often two) options is truthfully reported. Because of the stated-preference nature of the core survey questions and because none of their options are inherently right or wrong, the only reasons for not revealing true ranking are misunderstanding the survey questions, lack of attention, and protest responses.

To deal with these concerns, the stated-preference experiments and the survey are designed to minimize cognitive load as much as possible, which can be partly seen from the above discussion of the design of the representation of spending paths. To reinforce the idea that the only variation between the universes is in spending, the survey reiterates it at the start of every core module. To help the respondents compare the graphical spending paths, the survey questions also tell them in words in what time horizon the spending differs. To help them distinguish past experience from future experience, they are asked to express

views on both experiences. The survey also repeats the definitions of the experiences of interest and highlight the key words—past or future—to further remind the respondents of which experience a question asks about. To help the respondents avoid clicking on an option di□erent from the one they want to choose, I integrate the spending graphs into clickable options. To help them confirm that they answer as they intend, I darken slightly the background of an option when their mice hover over it and darken completely the background of the option they select. As mentioned above, the survey tests respondents' understanding of the instructions, and only those who pass the tests can enter the sample.

Attention checks spread throughout the survey, ranging from explicit ones, like the quiz on the basic hypothetical situation at the start of the survey, to implicit ones, such as time spent on each survey question. To encourage attention, I told the respondents about the existence of such attention checks but did not tell them where they were or how to identify them. To encourage greater attention, I told them in the survey's introduction that respondents whose responses are of high quality will be entered in a small ($1) lottery with winning odds of 1 in 100.

are dealt with through robustness checks in Section 6.

I model an observed response for preference parameter x from individual i in wave w as

$$X_{i;w} = \sum_{k} k \cdot \mathbb{1}(T_{k;x} < \hat{x}_{i;w} < T_{k+1;x});$$

where the unobserved latent variable $\hat{x}_{i;w} = x_i + \varepsilon_{i;x;w}$, and $T_{\{k\};x}$ denotes the sequence of known thresholds informed by the elicitation of the parameter. The true parameter value for individual i

data speak as much as possible but also to establish the equivalence between the posterior mode estimates and the maximum likelihood estimates.[26] I run ten Markov chains initialized from random diffuse starting points and collect 15,000 iterations of warmup and 25,000 draws of sample. I report all three Bayesian point estimators—(posterior) mode, mean, and median—and the highest posterior density or mass interval (HPDI or HPMI).

4 Elicitation, Estimation, and Implication

4.1 Existence of Internal Habit Formation

The fundamental characteristic of habit formation is response decrement to repetitive stimulation. In the case of internal habit formation, the higher a person's past consumption (stimulation), the lower her future utility (response). As a measure of the intensity and persistence of past stimulation, habit increases with past consumption. Therefore, internal habit formation is consistent with the utility difference $Q_H \square u.C; H C \square h/ \square u.C; H / < 0$ but not with $Q_H \square 0$, for $\square h > 0$

Universe One in the survey question corresponding to the threshold of ln 2, the module continues with a follow-up question associated with the threshold of ln 7=2. If Universe Two is then chosen, the module ends, and the response implies that the respondent's (with potential response biases and errors[31]) falls between ln

I propose and implement four tests of the two formulations.

Proposition 2. *Additive habit,* $u(C;H) = v(C - \zeta H)$ *with* $\zeta \in R^{C}$, *implies* $\frac{u_{CH}}{u_{HH}} \frac{u_H}{u_C} > 1$ *and* $\frac{u_{CH}}{u_{CC}} \frac{u_C}{u_H} > 1$.

The intuition for this set of tests is that under additive habit, the indifference curves are parallel straight lines so that moving in any direction in the indifference map will not change the slopes of the indifference curves. The two tests are the two bases spanning all such movements: increase H alone and increase C alone (Figure 4a).

Proposition 3. *Multiplicative habit,* $u(C;H) = v(C/H^{\zeta})$ *with* $\zeta \in R^{C}$, *implies* $\frac{H u_H u_{CH}}{u_C u_H - C H u_C u_{HH}} > 1$ *and* $\frac{C u_C u_{CH}}{u_C u_H - C C u_H u_{CC}} > 1$.

In the space of $(\ln C; \ln H)$, the two tests of multiplicative habit have the same intuition as those of additive habit (Figure 4b).

Proposition 5. *Under the second-order approximation,* $\frac{H u_{HH}}{u_H} < \frac{2.\square C2\square/}{\square C\square} \frac{\square C_1=\square C_2\square 1}{.\square C_1=\square C_2/^2 C1} \frac{H}{\square C_2}$ *if the respondent chooses Universe One over Universe Two for a better future experience in a* $\frac{H u_{HH}}{u_H}$ *question.*

The elicitation of $\frac{u_{CH}}{u_{HH}}$ rests on inducing fluctuations in both future and past spending at the same time.[36]

Proposition 6. *Under the third-order approximation,* $\frac{u_{CH}}{u_{HH}} < \square^{.\square C\square/\square C}$

4.4 Existence of External Habit Formation and Composition of Habit

The discussion so far has been holding other people's past spending constant and, therefore, has been abstracting from its potential effect on habit. This section presents evidence on whether and by how much other's past spending affects habit.

The existence of internal habit formation implies $u_H < 0$. It follows that seeing whether external habit formation exists is equivalent to seeing whether others' spending, denoted as C_{others}, affects one's own habit, H. Given the observational equivalence of linear and nonlinear habit evolutions,[39] I model the potential dependence of habit on others' spending as per Grishchenko (2010):

$$\dot{H} = \delta(1 - \omega)(C - \omega C_{others} - H); \tag{1}$$

where the external habit mixture coefficient, ω, governs the contribution of others' spending to the habit. If ω equals 0, others' spending has no effect on the habit and, therefore, external habit formation does not exist. Otherwise, if ω is between 0 and 1, external habit formation exists and the value of ω reflects the importance of external habit formation. To elicit ω, the survey varies both others' and one's own past spending.[40]

Proposition 8. $\omega > \frac{\Delta C}{\Delta C - \Delta C_{others}}$ *if the respondent chooses Universe One over Universe Two for a better future experience in an external habit formation question.*

The 95% HPDI of the estimate of external habit mixture coefficient falls between 0 and 1 (Table 3), consistent with the existence of external habit formation. The point estimate indicates that others' spending contributes to about 18% of one's own habit.

4.5 Relative Welfare Impacts of Habit Formation and Peer Effect

To elicit the relative welfare impacts of habit formation and peer effect, I allow the possibility that other people's spending has a contemporaneous influence—peer effect—on one's own felicity function, $u(C; C_{others}; H)$. Because, to a first-order approximation, $\frac{u_{C_{others}}}{u_H}$ governs the relative welfare impacts of peer effect and habit formation, I elicit this parameter by varying others' spending in both the past and the future.[41]

[39] See Section A of the online Appendix for proof.

[40] The resulting monthly spending graphs are in Figure A.9 of the online Appendix.

[41] See Figure A.10 of the online Appendix for the resulting monthly spending graphs.

Proposition 9. *Under the first-order approximation,* $\frac{u_{C_{others}}}{u_H} < \frac{!}{\square \mathbf{C} \square} \square \frac{\square C_{others}^{U2}}{\square C_{others}^{U1}} \square \square \square$ *if the respondent chooses Universe One over Universe Two for a better future experience in a* $\frac{u_{C_{others}}}{u_H}$ *question.*

The point estimate for $\frac{u_{C_{others}}}{u_H}$ is about 1.03 (Table 3) and not significantly di□erent from 1 at the 95% level, consistent with habit formation and peer e□ect having same-sized welfare impacts.

Two additional implications follow from the significant negative sign of $u_{C_{others}}$ as implied by the estimate and the previously estimated $u_H < 0$

semi-structural simulations based on the previous section's evidence on these two phenomena. In particular, I specify that people are influenced by both internal and external habit formation as well as peer e□ect. Habit evolves according to equation (1) with the habit depreciation rate and the external habit mixture coe□cient calibrated to their estimates, 1.07 and 0.18, respectively. Peer e□ect and external habit formation take e□ect only after others' spending changes become known to the agent, which is assumed to be k

the economy grows so that everyone's consumption permanently increases by a small amount of Δc (Figure 6a). As a result, to a first-order approximation,[47] the residents' happiness as measured by affect goes up by $u_C \Delta c$ at t_0. As time passes, the residents gradually get used to this higher level of self-spending, resulting in a buildup of internal habit that pulls affect down (Figure 6b). At $t_0 + k$, the agent realizes that everyone else also enjoys the same higher level of consumption as she does and feels worse as a result of peer comparison, which further pushes affect down. After that, external habit joins the play and, together with internal habit, erodes the remaining gain of affect until it completely disappears.

Integrating affect discounted by time preference,[48] one gets life satisfaction, the second measure of happiness. From the behavior of affect as analyzed above, it should come as no surprise that life satisfaction first increases, then gradually decreases to its previous steady-state level (Figure 6c). For later reference, this pattern could be labeled as the wear-off effect: over time, habit formation and peer ef

drives the transition effect, leading the agent to a happiness plateau. The instant when such exact cancellation first happens is precisely the moment when the wear-off effect brought by the consumption growth at t_0 is in full swing for the first time.

Because the wear-off effect is proportional to Δc,[51] the transition and plateau effects are also proportional to Δc (Figures 6g and 6h). This could be labeled as the level effect—higher consumption growth leads to higher levels of happiness during both the transition and the plateau phases. The level effect predicts that faster-growing economies tend to enjoy larger increases in happiness. Frijters et al.'s (2004) empirical evidence supports this prediction.

The level effect explains the positive cross-sectional correlation between income and happiness; higher income growth makes people or countries richer and places them on higher happiness curves. Economic fluctuations in reality cause consumption to fluctuate, frequently putting the agent into transition phases. The transition effect, therefore, explains the short-run positive correlation between income and happiness. Note that regardless of income increase or decrease, the transition effect always implies a positive relationship between income and happiness. The plateau effect explains the long-run nil correlation between income and happiness. Even though income frequently fluctuates, it fluctuates around its trend. This trend growth determines the plateaued level of happiness, which governs the long-run trend of happiness. In other words, the long-run trend of the happiness curve flattens even though consumption and income keep growing, hence the nil correlation.

To deepen the intuition, it is helpful to look at an analogy that might be called "running against an escalator." Imagine that you are about to run up a down escalator at a uniform speed of Δc stairs per unit of time. The escalator is initially stationary and, once you step onto it, will gradually accelerate to the speed of $\frac{u_H - u_{C_{others}}}{u_C}\Delta c - \Delta c$ stairs per unit of time. Suppose the escalator is long enough so that it catches up to (the negative of) your speed before you can reach the top. The elevation you reach represents happiness, and the (total) number of stairs you run represents consumption. The escalator symbolizes the joint effect of habit formation and peer effect on happiness.

With this analogy, it is illustrative to propose and resolve another paradox, the escalator paradox, which parallels the Easterlin paradox (Table 5). The escalator (Easterlin) paradox states that running more stairs (increasing income) raises elevation (happiness) in the cross section and short run but not in the long run. Why is this the case? In the long run, the

[51] This is a direct implication of first-order approximations. To the extent that people's marginal utility of consumption is always positive, the analysis still holds: even though the utility difference between the high and low consumption changes will be smaller, the difference remains positive.

escalator (habit formation and peer effect) eventually catches up to your running speed (consumption growth), after which the additional stairs you run (additional consumption you get) do not affect your elevation (happiness). In the short run, you gain elevation (happiness) because your running speed (consumption growth) is faster than that of the escalator (the canceling effect of habit formation and peer effect). In the cross section, people who run faster (people or countries that are richer) are more elevated (happier) because the difference between their running speed (consumption growth) and the speed of the escalator (the canceling effect of habit formation and peer effect) is larger during the transition phase, which accumulates to a higher level of elevation (happiness).

How does the above discussion speak to the questions that motivated the paradox: Does money buy happiness (Easterlin, 1973), and does economic growth improve human lot (Easterlin, 1974)? To phrase the questions in a slightly more accurate way, to the extent that people ultimately only care about happiness and that happiness eventually stops growing with economic growth, should we continue promoting economic growth after happiness plateaus? The answer implied by the explanation is yes. Happiness decreases if the economy grows at slower speeds. In other words, economic growth initially raises happiness and eventually maintains it. If the economy grows slower or even shrinks, the resulting slower consumption growth will cause happiness to drop and to plateau at a level lower than the level at which it would plateau had the economy not slowed down.

6 Robustness

This section discusses the robustness of the estimates that underlie the results to demographics, time horizon, additional attention checks, and response biases and errors of nonzero and wave-varying mean.

6.1 Demographic Effects

The survey collects information on age, gender, household size, and household income of the respondents. Allowing the demographic variables to shift the means of the parameter distributions in the statistical model, I find that the demographics do not affect the estimates (Table 6). In particular, 0 is included in all of the 95% HPDIs of the estimated effects of demographic variables, except those of gender, household size and income on $\frac{\partial u_H}{\partial u_H}$. After

accounting for multiple hypothesis testing, these effects vanish.[52]

This result supports the view that the parameters the survey elicited are deep preference parameters that do not vary with demographic characteristics. Because the ratios of utility derivatives depend on the spending profiles in the survey, it is also reassuring that their estimates do not vary with the demographics of the respondents and, therefore, with their heterogeneous spending profiles in reality, for it implies that the respondents understood the hypothetical situations of the survey and were able to answer the survey questions without letting their own demographic situations confound their responses in the hypothetical situations.

6.2 Finite Horizon

The general model assumes an infinite horizon, as do almost all current habit formation models in the literature. To investigate the effect of this assumption on the results, I rederive all the elicitation propositions of the preference parameters under finite horizons and find that the changes are minimal: no change for the elicitation of some parameters and tiny changes for the rest.[53] As a result, estimation under the finite horizon[54] (column 1 of Table 7) gives essentially identical estimates to the benchmark estimates under the infinite horizon.

6.3 Additional Attention Checks

In fielding the survey, explicit attention checks were used to screen out respondents who did not understand the hypothetical situation or the monthly spending graphs. In getting the sample for the benchmark estimation, the responses of those who sped through the survey, submitted duplicate responses, or were located outside of the United States are also excluded. This section makes use of implicit attention checks to see whether a potential lack of attention biases the estimates. Because they are not perfect proxies for attention, the

Toward the end of the survey, the respondents were quizzed again on the basic hypothetical situation. There are 132 respondents in wave one and 53 in wave two who made at least one mistake in answering the five-question quiz. Deleting their responses from the sample does not significantly change the estimates (column 2 of Table 7).

The survey collected demographic questions in both waves. Within the relatively moderate amount of time that separated the two waves, the demographics should not have changed. In other words, the wave consistency of responses to the demographic questions can serve as an implicit attention check. Applying this check eliminates another 18 respondents from the remaining sample. The estimates are essentially unchanged (column 3 of Table 7).

A third implicit attention check is that people should be indifferent toward the options when there is no difference between them. In the time discount rate question,[55] past spending is the same across the two universes, where the respondents should choose the same past experience. Deleting those who gave different answers shrinks the remaining sample by 97 and 13 responses in waves one and two, respectively. Even though the resulting HPDIs inflate because of the much smaller sample size, the estimates remain very close to the baseline estimates (column 4 of Table 7).

Finally, I use a measure of response consistency across the waves as an attention check. Considering that it involves more speculation, this attention check eliminates only those who gave at least one polar response—any response corresponding to the first (last) bracket of parameter values in wave one and the last (first) in wave two. This check deletes another 34 responses from both waves, resulting in further expansion of the HPDIs, but, again, the estimates are not significantly different (column 5 of Table 7), and therefore the results remain robust.

6.4 Response Bias and Error of Nonzero and Wave-Varying Mean

The statistical model assumes a zero mean for the response bias and error across both waves of the survey. Relaxing this assumption, I arrive at a statistical model with response biases and errors of nonzero means that potentially vary across waves. Without loss of generality,[56]

[55] See Section E of the online Appendix.

[56] Only two means, one for each wave, can be identified. The specification here identifying the average and the difference of the means is equivalent to a specification that specifies the two means using two parameters, one for each mean. If the two means are different, γ should be significantly different from 0.

the joint distribution of parameter α_i for individual i in both waves becomes

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Table 1: Estimates of Habit Parameters in Selected Literature

Study	Internal habit[a]	External habit[a]	!	‘	□[e]	Additive or multiplicative[g]
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Microdata						
Naik and Moore (1996)	Y	*(N)*	(*0*)	0.08	*(Y)*	*(A)*
Dynan (2000)	N	*(N)*	(*0*)	-0.04	(*Y*)	(*A*)
Guariglia and Rossi (2002)	N	*(N)*	(*0*)	-0.27	*(Y)*	*(A)*
Kapteyn and Teppa (2003)	Y	*(N)*	(*0*)	0.78	[f]	*(M)*
Rhee (2004)	Y, N[b]	*(N)*	(*0*)	0.61, 0.62	*(Y)*	*(A)*
Browning and Collado (2007)	Y, N[b]	*(N)*	(*0*)	0.01-0.14	*(Q)*	*(A)*
Alessie and Teppa (2010)	Y	*(N)*	(*0*)	0.21	*(Y)*	*(A)*
Iwamoto (2013)	N	*(N)*	(*0*)	-0.38	*(Y)*	*(A)*
Khanal et al. (2018)	Y	*(N)*	(*0*)	0.55	*(Y)*	*(A)*
Ravina (2019)	Y	N	0.03[c]	0.50	*(Q)*	*(A, M)*
Panel B. Macrodata						
Ferson and Constantinides (1991)	Y	*(N)*	*(0)*	0.64-0.97	*(M, Q, Y)*	*(A)*
Fuhrer (2000)	Y	*(N)*	*(0)*	0.80	99.9%/Q	*(M)*
Stock and Wright (2000)	Y, N[b]	*(N)*	*(0)*	[d]	*(M, Y)*	*(A)*
Smets and Wouters (2003)	*(N)*	Y	*(1)*	0.57	*(Q)*	*(A)*
Lubik and Schorfheide (2004)	Y	*(N)*	*(0)*	0.57	*(Q)*	*(M)*
Christiano et al. (2005)	Y	*(N)*	*(0)*	0.65	*(Q)*	*(A)*
Smets and Wouters (2007)	*(N)*	Y	*(1)*	0.71	*(Q)*	*(A)*
Grishchenko (2010)	Y	N	0.00	0.90[c]	70.7%/Q	*(A)*
Korniotis (2010)	N	Y	0.79[c]	0.33[c]	*(Y)*	*(A)*
Altig et al. (2011)	Y	*(N)*	*(0)*	0.76	*(Q)*	*(A)*

Notes: The studies are selected for representativeness based on citation count, number of habit parameters estimated, and publication year. Each character not in parentheses is a parameter estimate. Characters in parentheses (and italics for further distinction) are assumed parameter values of the studies. Preference parameters in this table are for specializations of the following habit formation model:

$$u(C;H) = \begin{cases} v(C - \text{‘}H) & \text{Additive Habit} \\ v(C/H^{\text{‘}}) & \text{Multiplicative Habit} \end{cases} \quad \text{s.t. } H' = (1-!)H + !C_{others}$$

where C and C_{others} are self and others' consumption, respectively, H is habit, ‘

Table 2: Sample Statistics

	First wave	Second wave	United States
Age, median	38	37	38
Household income, median	$50,001–$60,000	$50,001–$60,000	$57,652
Female percentage	53.2%	48.2%	50.8%
Household size, mean	2.69	2.71	2.63
Time on survey, mean	34'55"	33'36"	
Observations	359	139	

Note: Household income is annual.

Source: For the last column, U.S. Census Bureau—2018 Population Estimates (for age and female percentage), 2017 American Community Survey, and 2017 Puerto Rico Community Survey (for household income and size).

Table 3: Estimates of

Table 4: Effect of Habit Depreciation Speed on Equity Premium

	Postwar	Habit formation				
	(1)	(2)	(3)	(4)	(5)	(6)
Habit depreciation factor	-	0.11	**0.67**	**0.67**	**0.59**	**0.30**
Time discount factor	-	0.89	0.35	**0.89**	0.43	0.71
Expected excess ln return	6.69%	6.71%	43.94%	101.52%	36.58%	16.51%
Std of excess ln return	15.20%	15.64%	31.78%	96.99%	29.33%	22.01%
Sharpe ratio	0.43	0.43	1.38	1.05	1.25	0.75
Mean risk-free rate	0.94%	0.94%	0.94%	-92.19%	0.94%	0.94%

Notes: All annualized values. Columns 2 to 6 are based on Campbell and Cochrane's (1999) framework. Boldface denotes adjustments to the original calibration of Campbell and Cochrane (1999). Column 1 is based on postwar (1947–95) value-weighted New York Stock Exchange stock index returns and 3-month Treasury bill rate; column 2 is based on the original calibration of Campbell and Cochrane (1999) (0.11 is the annual habit depreciation factor implied by Campbell and Cochrane's (1999) calibration of the persistence coe□cient, □, of the surplus consumption ratio); column 3 is based on this paper's estimate of habit depreciation factor; column 4 is based on this paper's estimate of habit depreciation factor and the time discount factor of 0.89; column 5 is based on the lower bound of the 95% HPDI of this paper's estimate of habit depreciation factor; column 6 is based on a habit depreciation factor far smaller than the lower bound of the 99% HPDI of this paper's estimate of it.

Table 5: Twin Paradoxes

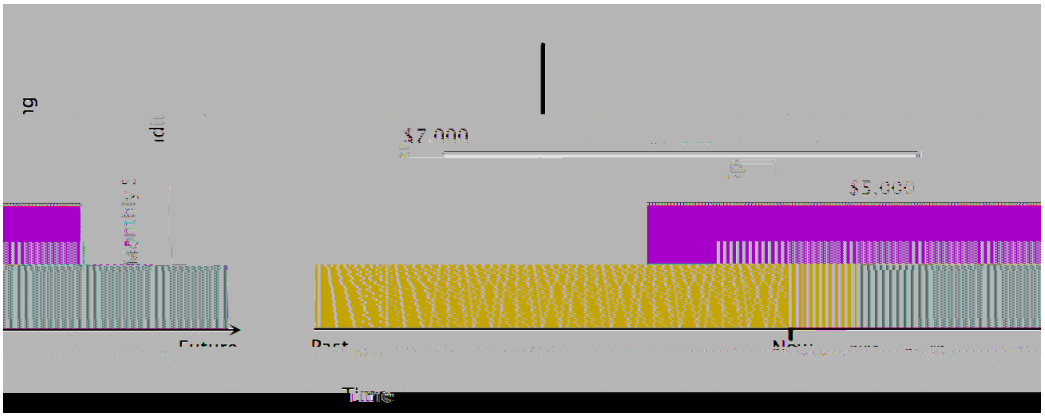
Dimension	Easterlin paradox	Escalator paradox	Explanation
Long run	Why doesn't increasing *income* raise **happiness**?	Why doesn't running more *stairs* raise **elevation**?	Plateau effect
Short run	Why does increasing *income* raise **happiness**?	Why does running more *stairs* raise **elevation**?	Transition effect (+ fluctuation)
Cross section	Why are *richer* people/countries **happier**?	Why are *faster* people **more elevated**?	Level effect

Note: Italics and boldface indicate parallelism of the twin paradoxes.

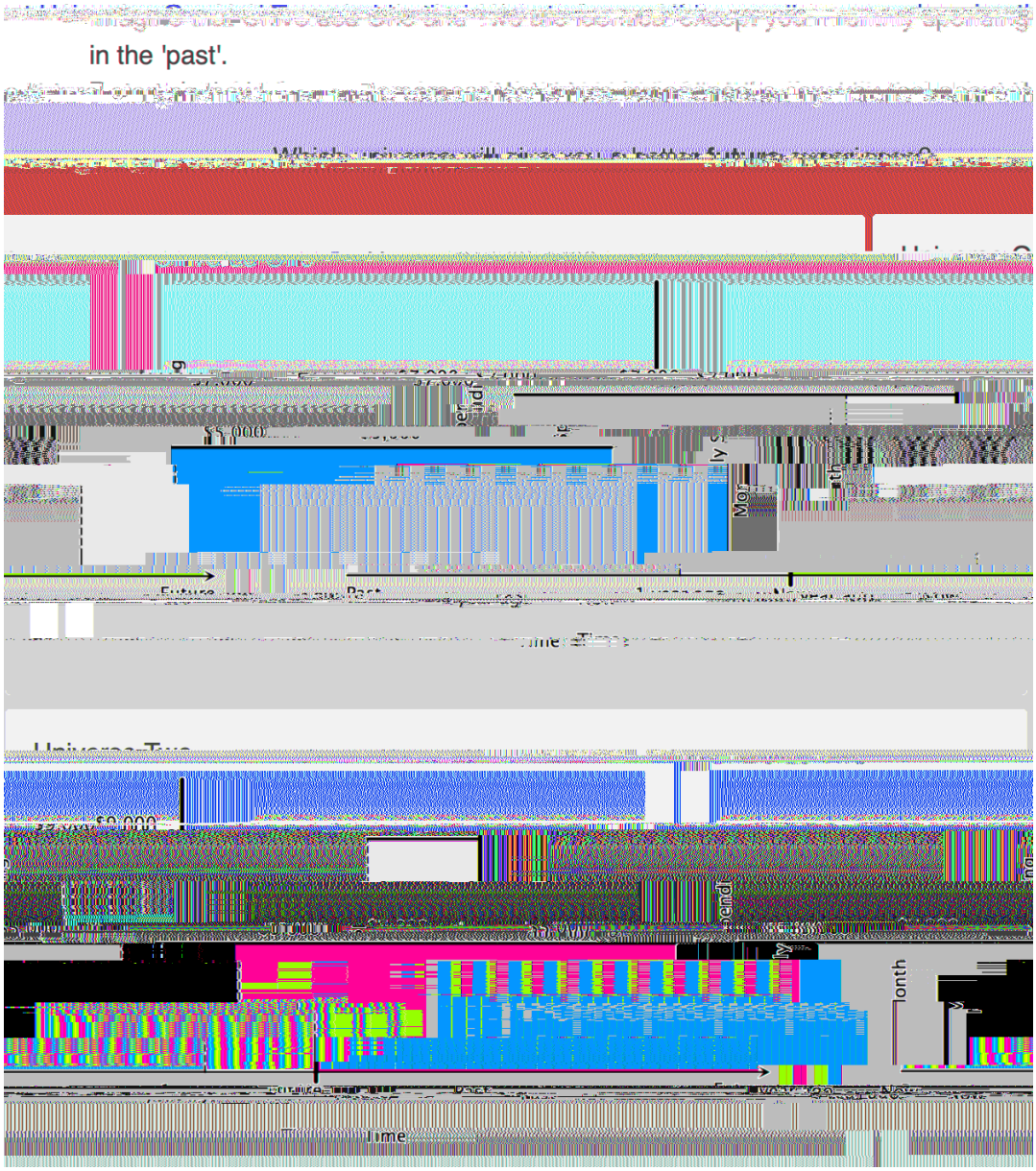
Table 6: Demographic Effects on Parameter Estimates and Flexible Response Biases and Errors

	Demographic E□ects					Response
	Omitted category	Age	Gender	Household size	Household income	bias and error (wave one)
Habit depreciation rate	1.20	0.00	-0.17	0.09	-0.04	-0.02
	[0.75, 1.64]	[-0.02, 0.02]	[-0.58, 0.27]	[-0.06, 0.24]	[-0.09, 0.02]	[-0.24, 0.22]
External habit mixture coe□cient	0.19	0.00	0.03	-0.03	-0.01	-0.03
	[0.02, 0.36]	[-0.00, 0.01]	[-0.15, 0.20]	[-0.09, 0.04]	[-0.04, 0.01]	[-0.12, 0.07]
$\square u_H = u_C$	0.64	0.00	-0.09	0.05	0.02	-0.02
	[0.41, 0.89]	[-0.01, 0.01]	[-0.32, 0.13]	[-0.03, 0.13]	[-0.01, 0.04]	[-0.11, 0.07]
$H u_{HH} = u_H$	6.77	-0.01	1.39	-0.53	0.22	-0.91
	[5.40, 8.27]	[-0.06, 0.05]	[0.17, 1.50]	[-1.00, -0.06]	[0.03, 0.45]	[-3.11, 0.43]
$u_{CH} = u_{HH}$	-0.92	0.00	0.12	0.03	0.03	0.08
	[-1.22, -0.61]	[-0.01, 0.01]	[-0.17, 0.41]	[-0.08, 0.13]	[-0.01, 0.06]	[-0.08, 0.22]
$u_{CC} = u_{HH}$	4.38	0.03	-0.70	-0.36	-0.04	-0.34
	[3.05, 5.69]	[-0.02, 0.09]	[-1.50, 0.50]	[-0.87, 0.08]	[-0.23, 0.13]	[-1.16, 0.33]
$u_{C_{others}} = u_H$	0.71	-0.02	0.12	0.21	0.06	-0.11
	[-0.00, 1.50]	[-0.05, 0.01]	[-0.60, 0.84]	[-0.03, 0.48]	[-0.03, 0.15]	[-0.48, 0.28]

Notes: Posterior mode above 95% HPDI. The omitted category is that of 40-year-old males who live in three-member households with $50,001–$60,000 annual household income.



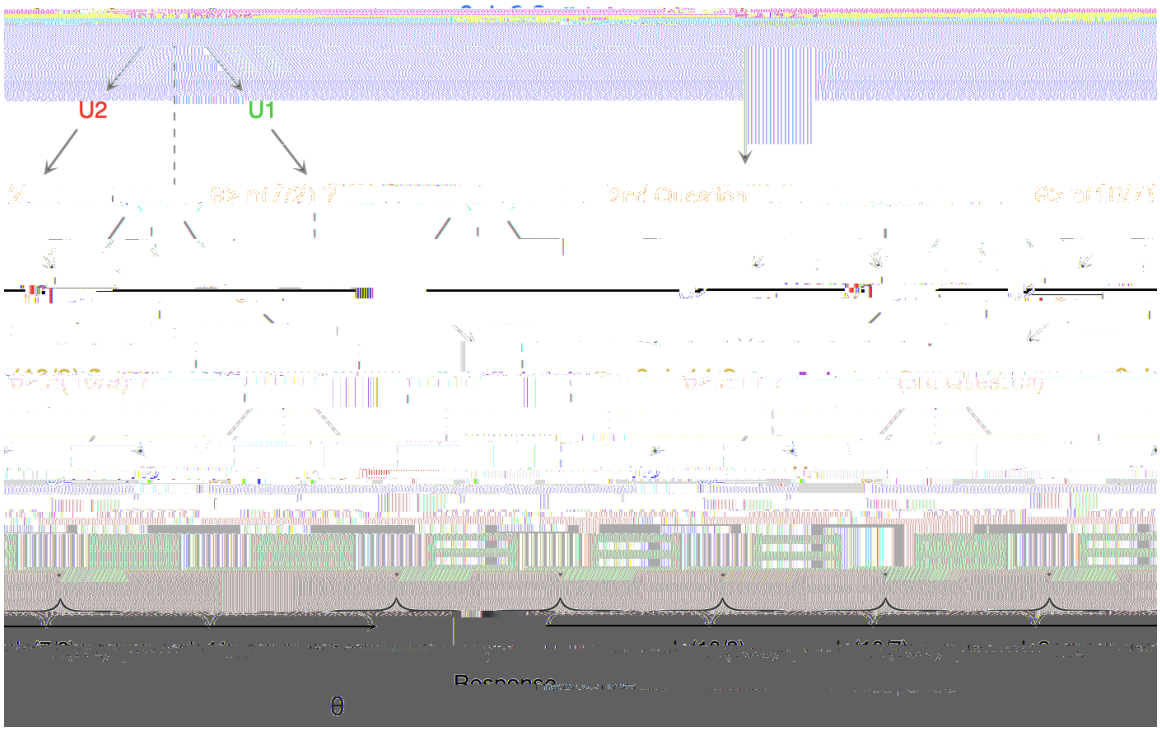
(a) A typical monthly spending graph.



(b) A typical survey question.

Figure 1: A typical monthly spending graph and a typical survey question.

(a) Respondent locations.



(b) Unfolding brackets. U1 and U2 stand for Universe One and Universe Two, respectively.

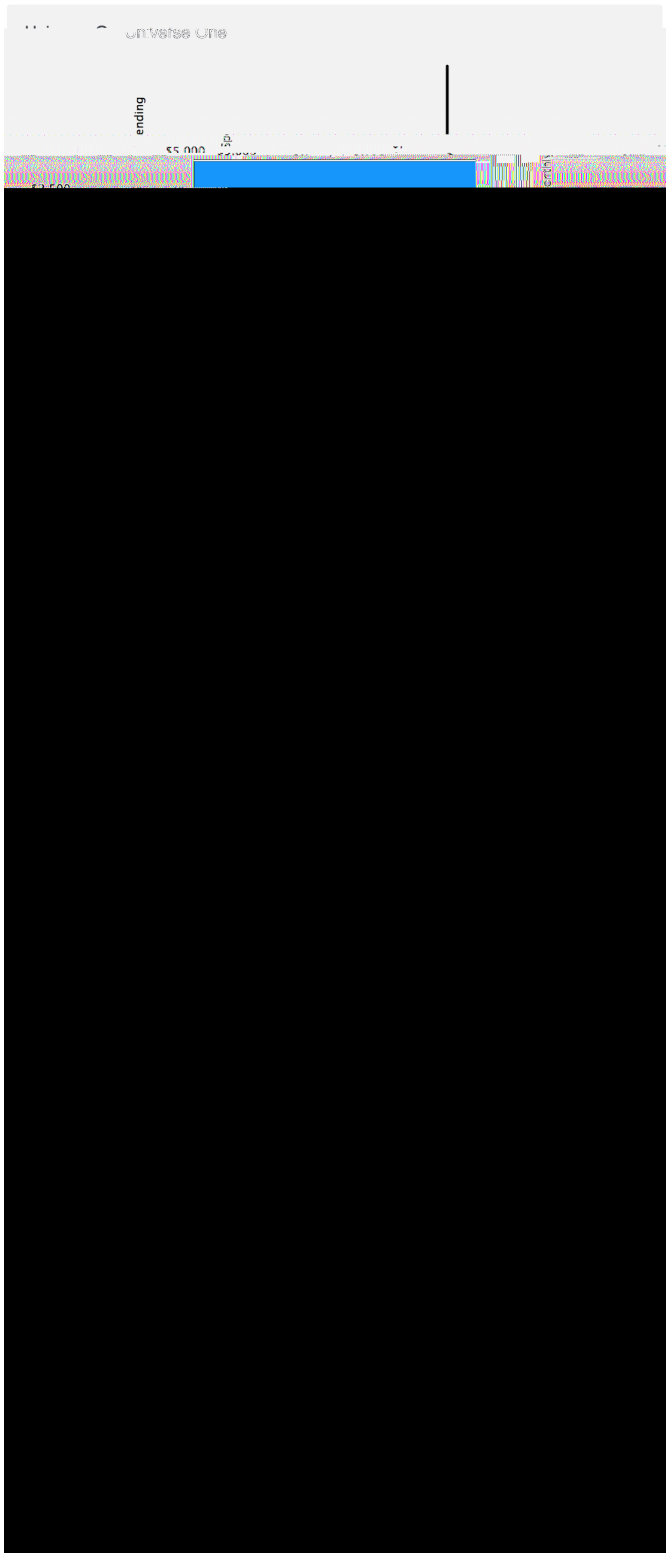
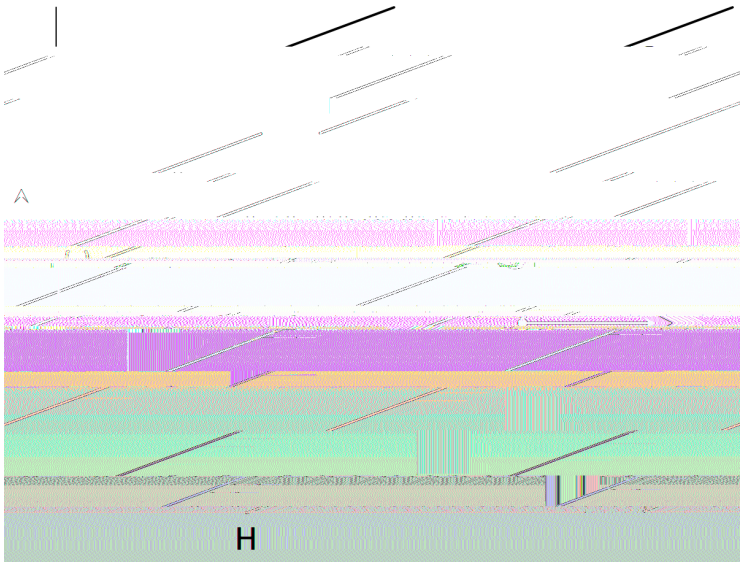
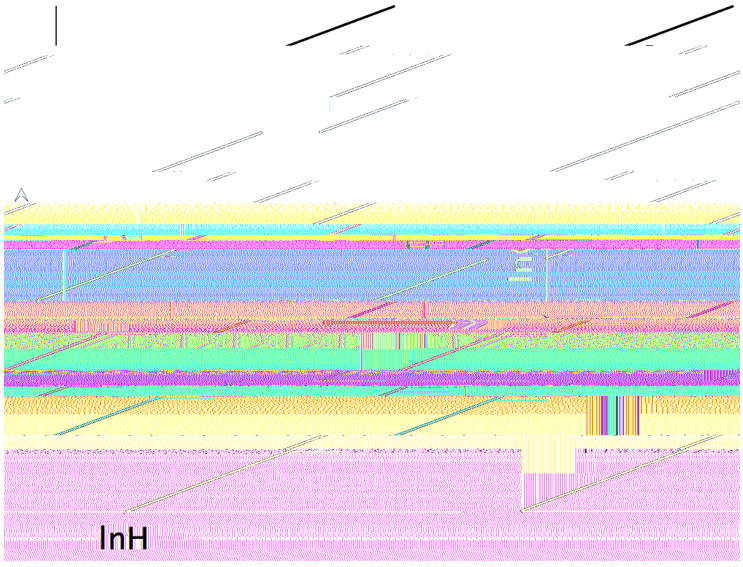


Figure 3: Monthly spending graphs of a survey question for the existence of internal habit formation.

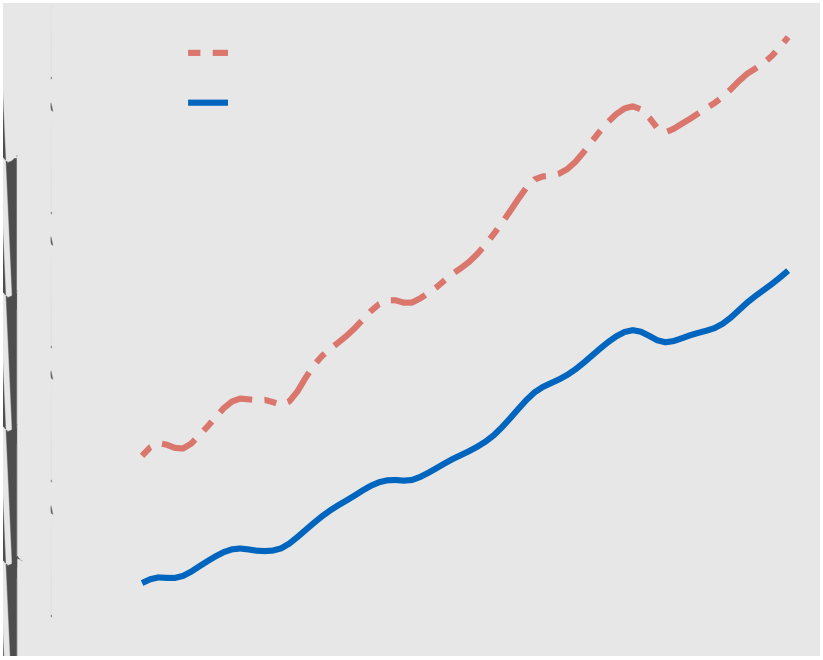


(a) Additive habit



(b) Multiplicative habit (.ln C; ln H / space)

Figure 4: Indi□erence maps for additive and multiplicative habits.



Online Appendix
"Survey Evidence on Habit Formation: Existence, Specification, and Implication"

Because H and H are two measurements of one fundamental—habit, they change at the same time (though in potentially di□erent ways) when habit changes and stop changing when habit stops changing. By Definition 2, their monotonicities are entangled with respect to time.[1]

Proposition 10. *Model L and Model N are observationally equivalent if the monotonicities of* H *and* H *are entangled with respect to time.*

Proof. Suppose that consumption changes at instant 0 and stays at that level afterward: $C_t = C_{t<"} \neq C_{\square"}$ $8\ t \square 0$ and $" > 0$. Without loss of generality, suppose also that habit reaches its new steady state at instant T. Because H and H are entangled monotonically with respect to time, H and H are monotonic from instant 0 to instant T and flat afterward (i.e., remain at constant levels), say at levels $\bar{H}^N$ and $\bar{H}^N$. That is, $H_t = a\,(t|C_0; H_0)$ and $H_t = b\,(t|C_0; H_0)$

at the homogenous steady state of $\bar{C}_i = \bar{H}_i = \bar{\ }\ \forall i$, spending an extra dollar[2] while holding habit constant, brings the same marginal utility to every individual: $u_{i;C}(\bar{C}_i; \bar{H}_i) = u_{j;C}(\bar{C}_j; \bar{H}_j) = \nu\ \forall i; j$.

With the comparability of the individuals' utilities, the representativeness of the representative agent (R) implies that $N u_R$

B.2 Aggregation of Ratios of Utility Derivatives

$$D \left(\frac{u_{i;C\,H}}{u_{i;H\,H}} \right) \left(H\, u_{i;H\,H} \right)$$

and $\theta_R = \frac{1}{N} \sum_i \theta_i$,

$$\omega_R = \frac{1}{N} \sum_i \omega_i .$$

In words, the representative agent's external habit mixture coefficient equals the average of individuals' external habit mixture coefficients.

C Response Distributions

Table A.1 summarizes the distributions of responses to survey questions.

Now,

$$\frac{\sum_{s=0}^{n} .\square e/^{s} .\square f\ /^{n\square s}}{M^{n}} \square \frac{\sum_{s=0}^{nC1} .\square e/^{s} .\square f\ /^{nC1\square s}}{M^{nC1}}$$

$$D \frac{\sum_{s=0}^{n} .\square e/^{s} .\square f\ /^{n\square s}}{M^{n}} \square \sum_{s=0}^{n} .\square e/^{s} .\square f\ /$$

Proof. By $u_H < 0\ 8H$, analyticity of $u\ .C; H$

$\square_{\{k\}}$ achieve this goal.[4]

Suppose, for some $i_k \in I$,

$$\sum_{n=1}^{z-1} e^{-\square n \square t} M \frac{1}{n!} \frac{\partial^n u}{\partial H^n} \left(\sum_{s=0}^{n-1} \binom{n}{s} (-\square e/)^s (-\square f/)^{n-1-s} \right) < 0 \qquad \text{(A.4)}$$

$\forall z \in i_k$.

By inequalities (A.1) and (A.4), Lemmas 1 and 2 can be applied to all $n \in i_k$ in the fashion inequality (A.3) is derived from inequality (A.1), which gives

$$\sum_{n=1}^{i_k-1} e^{-\square n \square t} M \frac{1}{n!} \frac{\partial^n u}{\partial H^n} \left(\sum_{s=0}^{n-1} \binom{n}{s} (-\square e/)^s (-\square f/)^{n-1-s} \right)$$
$$C \frac{\sum_{s=0}^{i_k-2} \binom{i_k-2}{s} (-\square e/)^s (-\square f/)^{i_k-2-s}}{M^{i_k-2}} \sum_{i=i_k}^{\infty} \frac{1}{n!} \frac{\partial^n u}{\partial H^n} \square^n M e^{-\square \square t} \square^n$$

<0:

Now,

$$\left(\sum_{n=1}^{i} e^{-n\pi t}\left(\frac{1}{n!}\frac{\partial^n u}{\partial H^n}\right)\sum_{s=0}^{n-1}\binom{n-1}{s}(e/s)^s (f/s)^{n-1-s}\right)$$

$$D\left(\sum_{n=1}^{i_k-1} e^{-n\pi t}\left(\frac{1}{n!}\frac{\partial^n u}{\partial H^n}\right)\sum_{s}^{n-1}\right)$$

of inequality (A.4) and following the subsequent derivation to inequality (A.6) leads to

$$\sum_{n=1}^{i_j} e^{-n\tau t}\left(\frac{1}{n!}\frac{\partial^n u}{\partial H^n}\right)\sum_{s=0}^{n-1}\binom{n-1}{s}(-e/s)^s(-f/s)^{n-1-s} < 0. \tag{A.7}$$

Because $\partial^n u/\partial H^n < 0 \; \forall n > i_{j \mid j}$,

$$\sum_{n=i_{j \mid j}+1}^{\infty} e^{-n\tau t}\left(\frac{1}{n!}\frac{\partial^n u}{\partial H^n}\right)\sum_{s=0}^{n-1}\binom{n-1}{s}(-e/s)^s(-ef/s)^{n-1-s} < 0. \tag{A.8}$$

Finally,

$$\sum_{n=1}^{\infty} e^{-n\tau t}\left(\frac{1}{n!}\frac{\partial^n u}{\partial H^n}\right)\sum_{s=0}^{n-1}\binom{n-1}{s}(-e$$

$$D\, e^{\square\square.t\square t_0/}\square H\ .t_0/\square H\square C\int_{t_0}^{t} e^{\square\square.t\square s/}\square C\ .s/\square C\square ds$$

$$\square\square$$

$$\tau \quad S$$

$$D\frac{1}{\square}\square u_C B C u_H \frac{\square A C \square B}{\square C \square}$$
$$C \frac{1}{2}\square u_{CC} B^2 C 2u_{CH} \frac{\square AB C \square B^2}{\square C \square} C u_{HH} \frac{\square . \square C \square / A^2 C 2\square\square AB C 2\square^2 B^2}{. \square C \square / . \square C 2\square /}\square\square$$

The second quantity is related to the class of spending paths with

$$\square C .t/ D A \square 1 . \square 1 < t \square 0/ C B \square 1 .0 < t \square 1/ C 0 \square 1 .t \square \square 1 \text{ or } t > 1/ :$$

It follows that, for $t \square 0$,

$$\square H .t/ De^{\square\square 1} \square H . \square 1 / C \int_{\square 1}^{\square 1} e^{\square\square .t \square s/} \square 0 ds C \int_{\square 1}^{0} e^{\square\square .t \square}$$

C $u_H e^{\square}$

$$C\, u_{C\, C_{\text{others}}} BE\; C\, u_{C\, H} B \Big[e^{\square\square t} \;..1 \square\; !\,/\,A\; C\; !\,D/\; C \Big(1 \square e^{\square\square t} \Big) ..1 \square\; !\,/\,B\; C\; !\,E/ \Big]$$

$$C u_{C_{\text{others}}} H\, E \Big[e^{\square\square t} \;..1 \square\; !\,/\,A\; C\; !\,D/\; C \Big(1 \square e^{\square\square t} \Big) ..1 \square\; !\,/\,B\; C\; !\,E/ \Big]\; C \square\square\square \Big\}\; dt:$$

D.3 Proof of Proposition 1

Proof. That □ is habit depreciation rate implies □ 2 R^{C}. Taking M D 5000 gives M □ □$C_{U\,1}$

5000

The inequality, by Lemma 3, implies $\Delta C_{U1}\left(1-e^{-\alpha\rho}\right)-\Delta C_{U2}<0$ or equivalently

$$\rho>-\ln\left(1-\frac{\Delta C_{U1}}{\Delta C_{U2}}\right)\frac{1}{\alpha}.$$

Q:E:D:

It is worth noting that when others' spending does not vary, the elicitation propositions in here and the following, which are based on $\dot{H}=\Phi(C-H)$, give exactly the same thresholds for the preference parameters of interest as under $\dot{H}=\Phi((1-\omega)C+\omega C_{others}-H)$, and therefore lead to precisely the same estimates.

D.4 Proof of Proposition 2

Proof.

$$\frac{u_{CH}}{u_{HH}}\frac{u_H}{u_C}=\rho$$

D.6 Proof of Proposition 4

Proof. A respondent preferring Universe One for a better future experience (U) in a slope of indifference curve question[7] implies

$$
\begin{aligned}
& U(\text{Universe One}) > U(\text{Universe Two}) \\
\Leftrightarrow\ & \left(U(\text{Universe One}) - U(\text{Baseline})\right) > \left(U(\text{Universe Two}) - U(\text{Baseline})\right) \\
\Leftrightarrow\ & \left(\alpha\Delta C_{past} + \beta\Delta C_{future} + \gamma\Delta C_{past}\Delta C_{future}\right) > \left(\alpha\Delta C_{past} + \beta\Delta C_{future} + \gamma\Delta C_{past}\Delta C_{future}\right) \\
\Leftrightarrow\ & \frac{1}{\beta}\left(u_C \Delta C_{future} + u_H \frac{\alpha\Delta C_{past} + \gamma\Delta C_{future}}{\beta + \gamma\Delta C_{past}}\right) \\
& + \frac{1}{2}\left(u_{CC}(\Delta C_{future})^2 + 2u_{CH}\frac{\alpha\Delta C_{past}\Delta C_{future} + \beta(\Delta C_{future})^2}{\beta + \gamma\Delta C_{past}}\right. \\
& \left. + u_{HH}\frac{\beta(\beta + \gamma\Delta C_{past})\Delta C_{past}^2 + 2\alpha\gamma\Delta C_{past}\Delta C_{future} + 2\alpha^2(\Delta C_{future})^2}{(\beta + \gamma\Delta C_{past})(\beta + 2\gamma\Delta C_{past})}\right) \\
\Leftrightarrow\ & \left(\frac{1}{\beta}\left(u_C(\Delta C_{future}) + u_H\frac{\alpha\Delta C_{past} + \beta(\Delta C_{future})}{\beta + \gamma\Delta C_{past}}\right)\right.
\end{aligned}
$$

D.7 Proof of Proposition 5

Proof.

$$
\begin{aligned}
D\frac{1}{2}\frac{1}{\square} \quad & u_C \square C_{future} + u_H \frac{\square\square C_{past} + \square\square C_{future}}{\square + \square} + \frac{1}{2} \quad u_{CC} . \square C_{future} /^2 \\
& + 2u_{CH} \frac{\square\square C_{past} \square C_{future} + \square . \square C_{future} /^2}{\square + \square} \\
& + u_{HH} \frac{\square . \square + \square /^{\square} \square C_{past}^{\square 2} + 2\square\square\square C_{past} \square C_{future} + 2\square^2 . \square C_{future} /^2}{. \square + \square /. \square + 2\square /} \quad !\# \\
& " \\
& + \quad \square u_C \square C_{future} + \square u_H \frac{\square\square C_{past} + \square\square C_{future}}{\square + \square} + \frac{1}{2} \quad u_{CC} . \square C_{future} /^2 \\
& + 2u_{CH} \frac{\square\square C_{past} \square C_{future} + \square . \square C_{future} /^2}{\square + \square} \\
& + u_{HH} \frac{\square . \square + \square /^{\square} \square C_{past}^{\square 2} + 2\square\square\square C_{past} \square C_{future} + 2\square^2 . \square C_{future} /^2}{. \square + \square /. \square + 2\square /} \quad !\# \\
& \square\square \\
& \square \quad u
\end{aligned}
$$

Q:E:D:

D.9 Proof of Proposition 7

Proof. A respondent preferring Universe One for a better future experience (U) in a $\frac{u_{CC}}{u_{HH}}$ question[14] implies

U .Universe One/ □ U .

D.10 Proof of Proposition 8

Proof. Taking M D 5000 gives M □ .1 □ ! / □C □ ! □C

D.11 Proof of Proposition 9

Proof. A respondent preferring Universe One for a better future experience (U) in a $\frac{u_{C_{others}}}{u_H}$ question[18] implies

$$U(\text{Universe One}) \geq U(\text{Universe Two})$$

$$\Leftrightarrow U(\text{Universe One}) - U(\text{Baseline}) \geq U(\text{Universe Two}) - U(\text{Baseline})$$

$$\Leftrightarrow \left(0, 0, 0, C_{others}^{U1}\right) \geq \left(0, 0, 0, C_{others}^{U2}, 0\right)$$

$$\Leftrightarrow \int_0^{\infty} e^{-\rho t}\left[u_{C_{others}}\left(C_{others}^{U1}\right) + u_H\left(1 - e^{-\rho t}\right)\right] dt \geq \int_0^{\infty} e^{-\rho t} u_H\left(e^{-\rho t}\right) dt + C_{others}^{U2}$$

$$\Leftrightarrow \frac{1}{\rho} u_{C_{others}}\left(C_{others}^{U1}\right) \geq C_{others}^{U2}$$

$$D\,[U(\text{Universe One}) - U(\text{Baseline})] - [U(\text{Universe Two}) - U(\text{Baseline})]$$

$$D\,\beta(0, C_{U1}) - e^{\alpha}\,\beta(0, C_{U2})$$

$$D\,C_{U1}\frac{\beta(0, C_{U1})}{C_{U1}} - e^{\alpha}C_{U2}\frac{\beta(0, C_{U2})}{C_{U2}}$$

$$> (C_{U1} - e^{\alpha}C_{U2})\frac{\beta(0, C_{U1})}{C_{U1}}$$

$$> 0;$$

where the first inequality follows from diminishing marginal utility: $\beta(0, C_{U1})$

- 5
- 3
- 1
- No idea

If you rent the durable goods you consume, select any of the following that you own (that is, not rent):

- Residence
- Car
- Furniture
- I do not own any of the above
- No idea

If a respondent makes a mistake in the practice questions, they need to go over the instructions again and redo the practice questions. A maximum of three attempts of the practice questions is allowed.

After the practice questions, the survey continues with instructions on reading the monthly spending graphs:

In this survey, you'll compare your experience in several universes that are identical except that your monthly spending di□ers.

□

The first element of a monthly spending graph is the timeline, with past on the left, now in the middle, future on the right. A thick vertical line representing now separates the past from the future.

[Figure A.2b]

To fix the idea, the 'Past' means as far back in the past as you can remember and the 'Future' as far in the future as you can imagine. If easier, think of the 'Past' as the past 30 years and the 'Future' as the next 30 years.

The second element of a monthly spending graph is the bars above the timeline.

- The height of the bars represents the level of monthly spending (again, not income) in time frames covered by the bars.
- The exact level of monthly spending is labeled on top of the corresponding bar. The words 'per month' are saved for space consideration from now on, but you should always remember that the numbers are per month spending.
- The bars are colored differently to help you distinguish different time frames.

For example, if the following monthly spending graph describes your monthly spending,

[Figure A.2c]

you spent/spend

- $5,500 per month in the 'past' until '1 year ago';
- $7,500 per month from '1 year ago' until 'now' (or in the 'past year');
- $6,500 per month from 'now' to '1 year from now' (or in the 'next year');
- $5,000 per month from '1 year from now' onward.

To highlight the difference of monthly spending, the time frames as in the above example are sometimes collapsed into two or three time frames. For instance, if in Universe One your monthly spending graph is

[Figure A.3a]

while in Universe Two your monthly spending is

[Figure A.3b]

then the difference and the similarity of your monthly spending in the two universes are that

- in Universe Two you spent $1,000 more per month in the ‘past’ than you did in Universe One where you spent $5,000 per month in the ‘past’; and that
-

- Universe One
  [Figure A.2c]
- Universe Two
  [Figure A.3c]

In which universe will you spend more per month from '1 year from now' onward?

- Universe One
  [Figure A.2c]
- Universe Two
  [Figure A.3c]

In the graphs of last question, how much more did you spend in Universe One than in Universe Two from 'as far back in the past as you can remember' until '1 year ago'?

- $0
- $500
- $1,000
- $5,500

A final set of instructions inoculates the respondents against the seeming repetitiveness of follow-up questions and encourages effort with attention checks and a lottery reward. An opportunity to review previous instructions was also presented.

> We designed the survey to learn as much as possible from your answers. To increase the power of the study result, each question is normally followed by additional questions that vary slightly from previous questions. Although the survey may look repetitive, please pay careful attention and answer each question the best you can.
>
> Implicit and explicit attention checks are integrated into this survey. Responses show signs of inattentiveness will be rejected. A small lottery ($1) will be randomly paid as a bonus to workers who show excellence in the responses.

- $\frac{u_{CC}}{u_{HH}}$: [Figure A.8]
- External habit formation and composition of habit: [Figure A.9]
- Relative strength of habit formation and peer effect: [Figure A.10]

F.3 End-of-Survey Quiz on the Basic Hypothetical Situation

At the end of the survey, I check the respondents' understanding of the basic hypothetical situation again using the following questions, which serve as an implicit attention check.

> Under the hypothetical situation of this survey, if you can buy 3 bananas with one dollar in the last year, how many bananas can you buy with one dollar in the next year?
>
> - 5
> - 3
> - 1
> - No idea
>
> Under the hypothetical situation of this survey, select any of the following that you own (that is, not rent):
>
> - Residence
> - Car
> - Furniture
> - I do not own any of the above
> - No idea
>
> Under the hypothetical situation of this survey, do things you want change over time?
>
> - Yes
> - Maybe
> - No

Under the hypothetical situation of this survey, do things not mentioned in the questions change?

- Yes
- Maybe
- No

Under the hypothetical situation of this survey, how much do people not mentioned in questions always spend per month?

- $4,000
- $5,000
- $6,500
- $8,000
- No idea

Table A.1: Response Distributions (Percentage)

Question	Wave	Response					
Panel A. Parameters Identifiable to Scale		U1U1U1	U1U1U2	U1U2	U2U1	U2U2U1	U2U2U2
Habit depreciation rate	1	28	9	17	11	6	28
	2	29	10	14	11	6	30
External habit mixture coe□cient	1	17	5	9	14	9	46
	2	24	5	16	6	4	46
$\square u_H = u_C$	1	33	4	7	7	12	38
	2	32	4	6	2	20	36
$H u_{HH} = u_H$	1	14	5	8	11	3	59
	2	24	2	6	5	1	61
$u_{CH} = u_{HH}$	1	7	4	12	9	28	40
	2	9	3	10	9	34	35
$u_{CC} = u_{HH}$	1	23	30	11	10	5	21
	2	24	19	8	10	9	30
$u_{C_{others}} = u_H$	1	26	18	10	8	3	36
	2	24	19	8	6	3	40
Panel B. Parameter Identifiable to Sign		U1	U2	U3	U4	U5	
Existence of internal habit formation	1	56	4	10	2	29	
	2	60	1	6	1	30	

Notes: UX stands for Universe X. U1U1U2 denotes the response sequence of first choosing U1, then U1 again in the first follow-up question, and finally U2 in the second follow-up question. Similar notations are used to denote other response sequences.

Table A.2: Quantities in Monthly Spending Graphs

	If choosing U2	If choosing U2	Initial	If choosing U1	If choosing U1

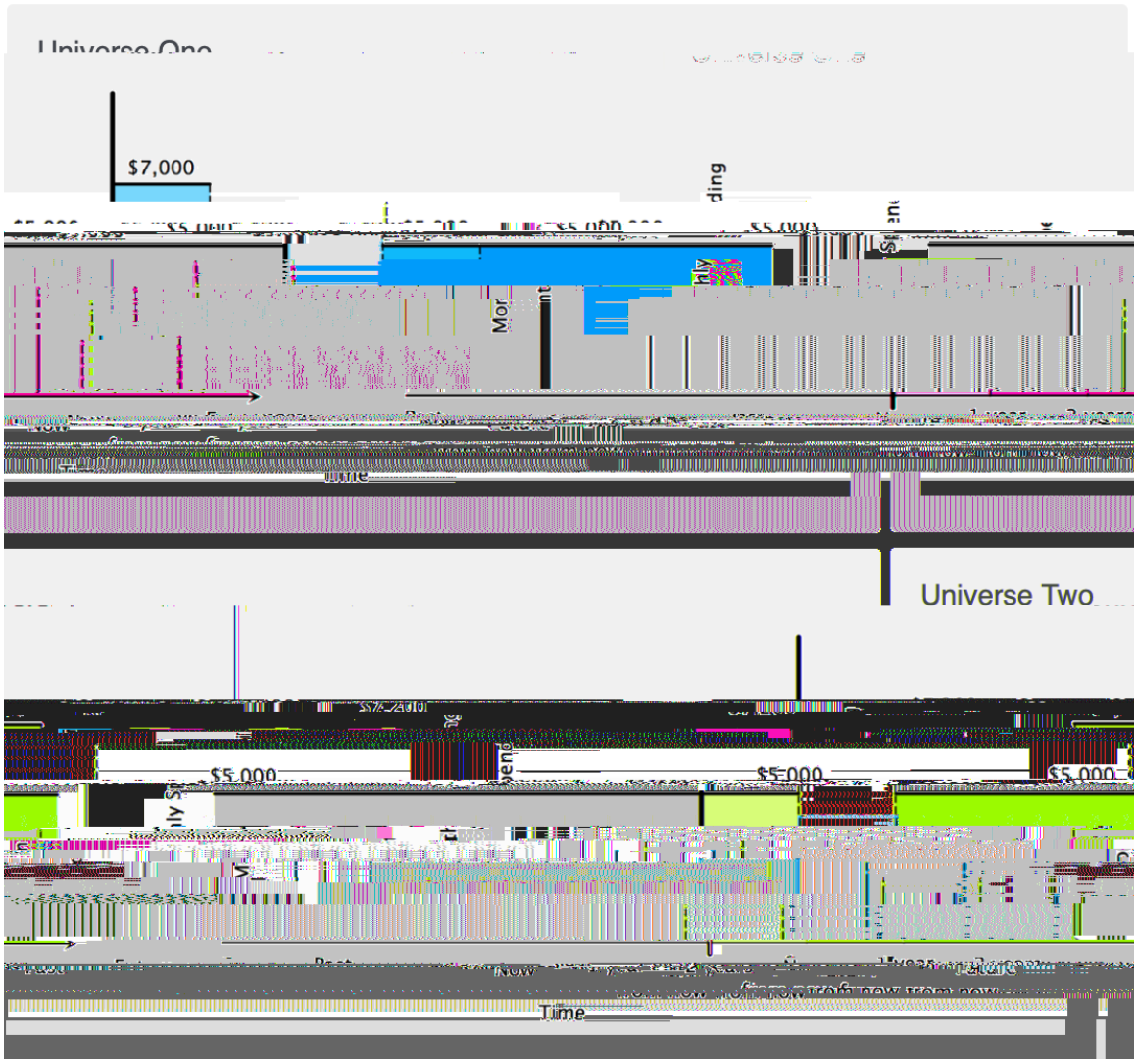
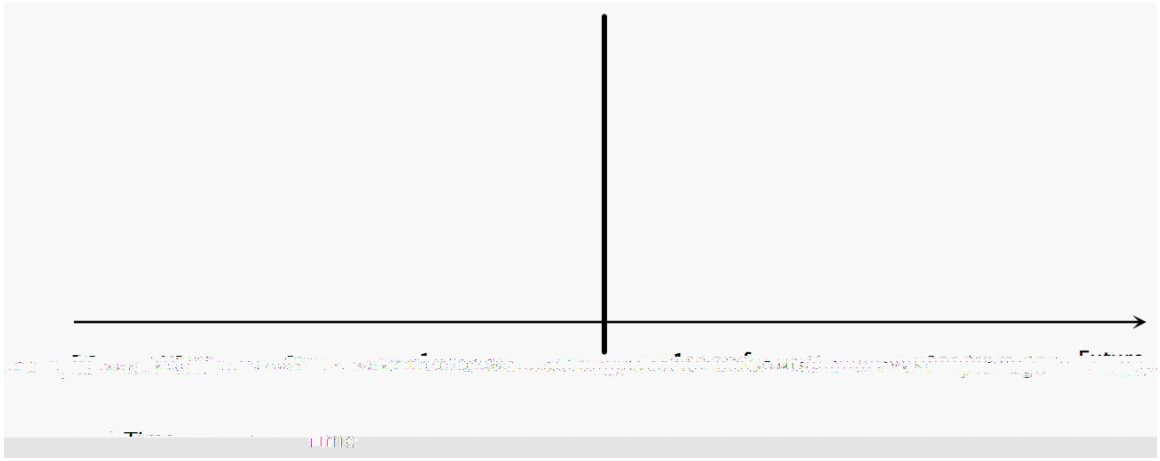
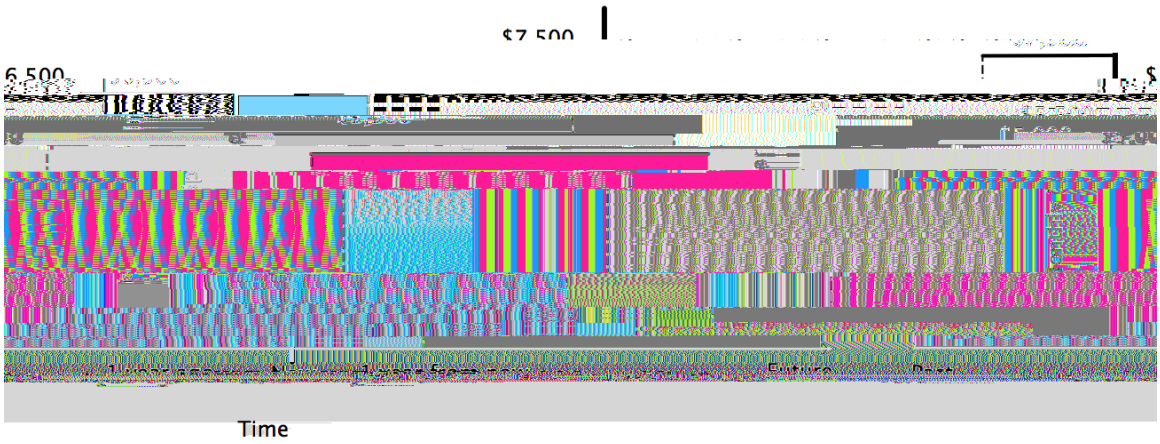


Figure A.1: Monthly spending graphs of a survey question for time discount rate.

(a) More detailed monthly spending graph.

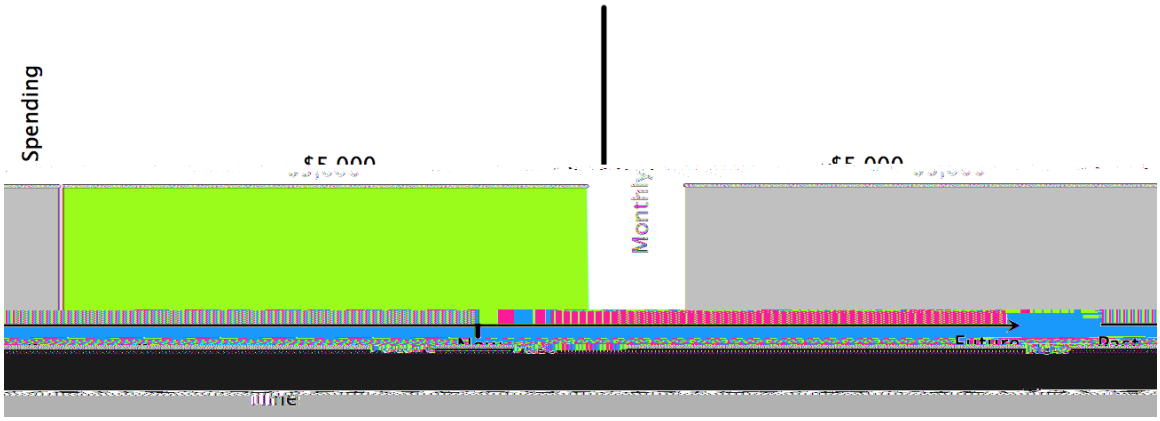


(b) Timeline.

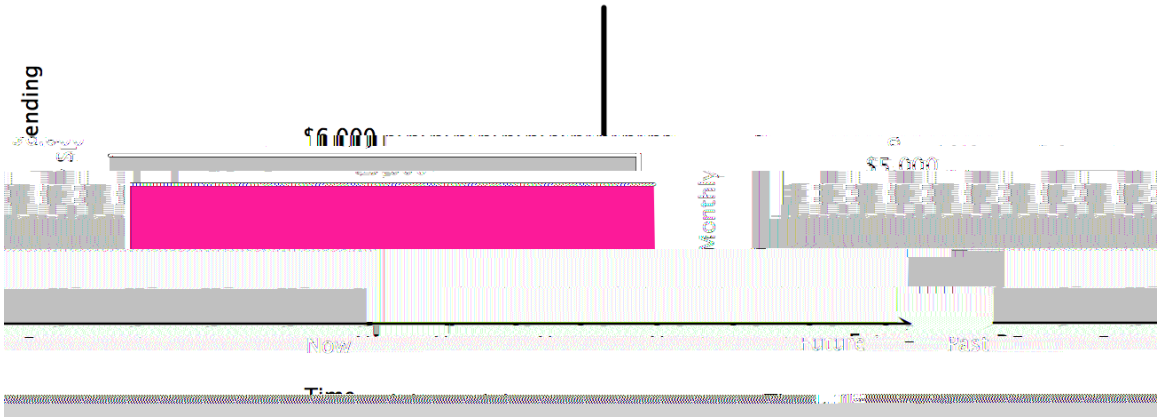


(c)

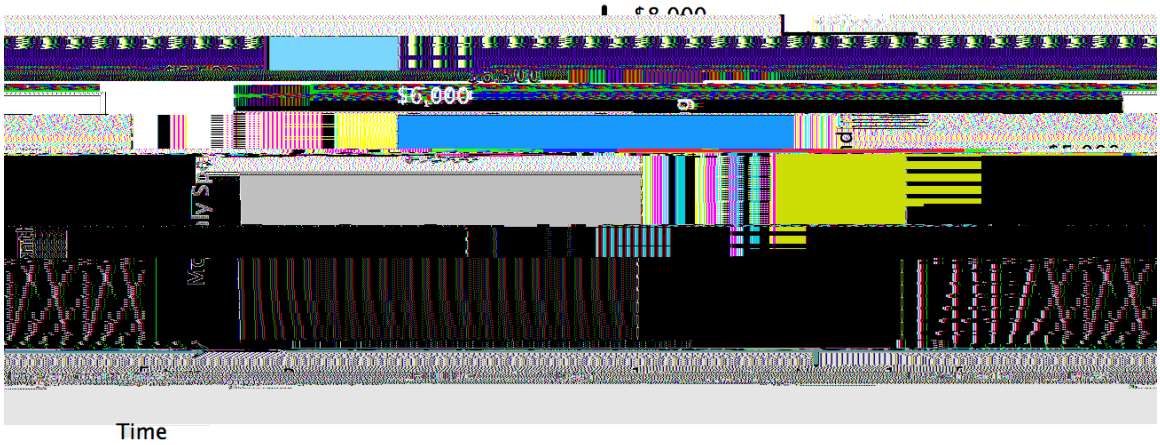
Figure A.2: Instruction—monthly spending graphs and timeline.



(a)



(b)



(c)

Figure A.3: Instruction—monthly spending graphs.

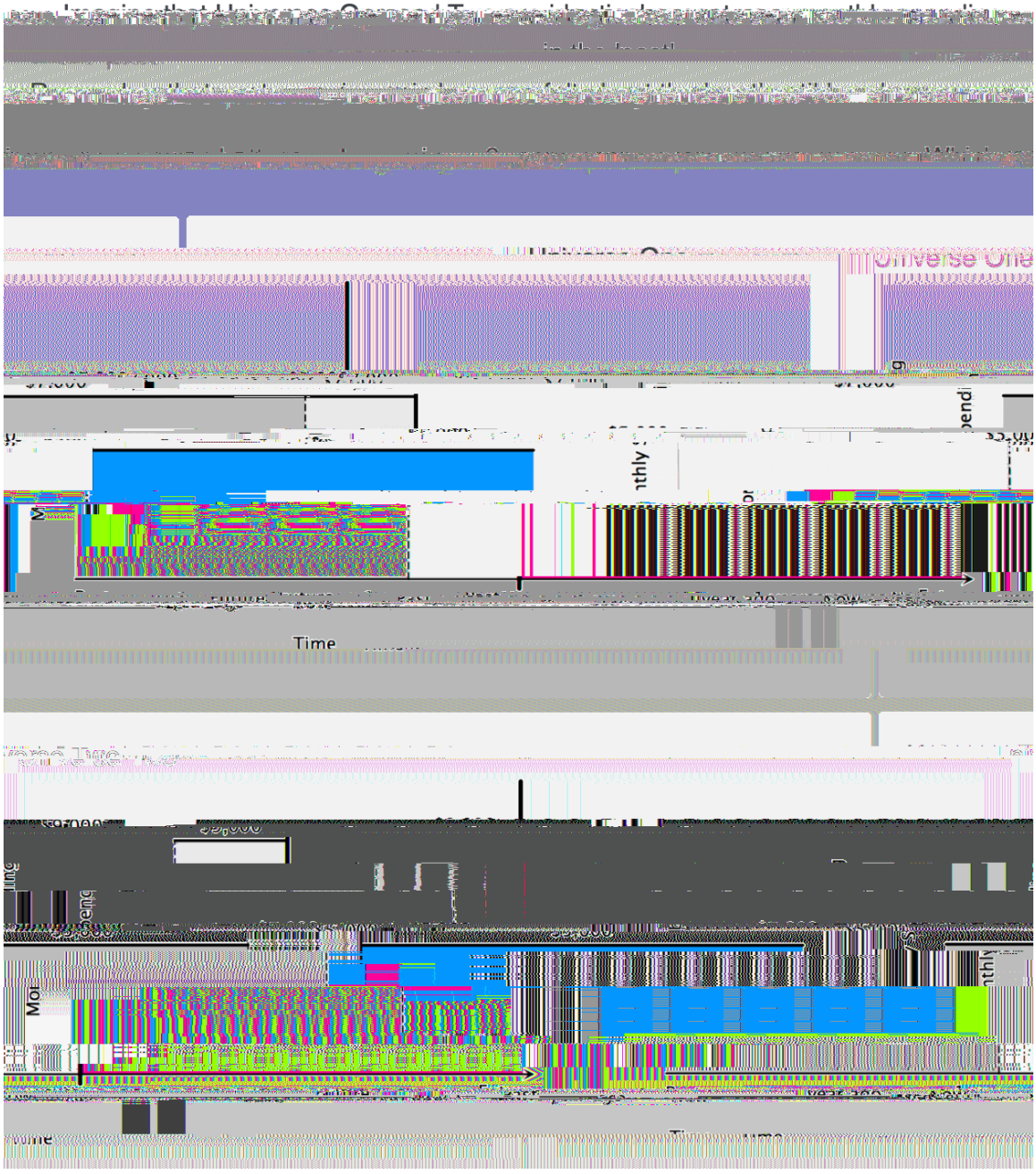


Figure A.4: A typical survey question asking about past experience.

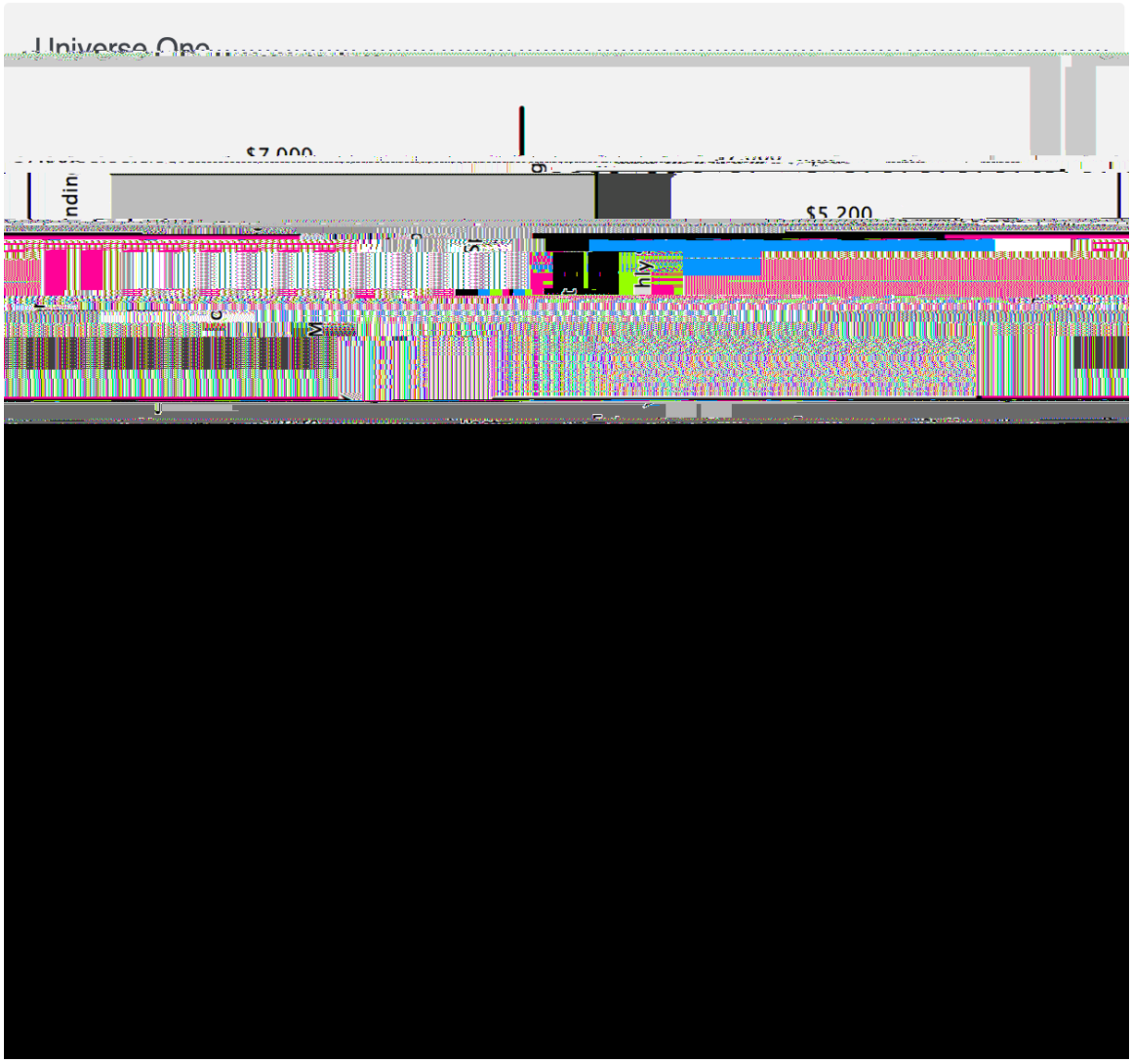


Figure A.5: Monthly spending graphs of a survey question for slope of indi□erence curve.

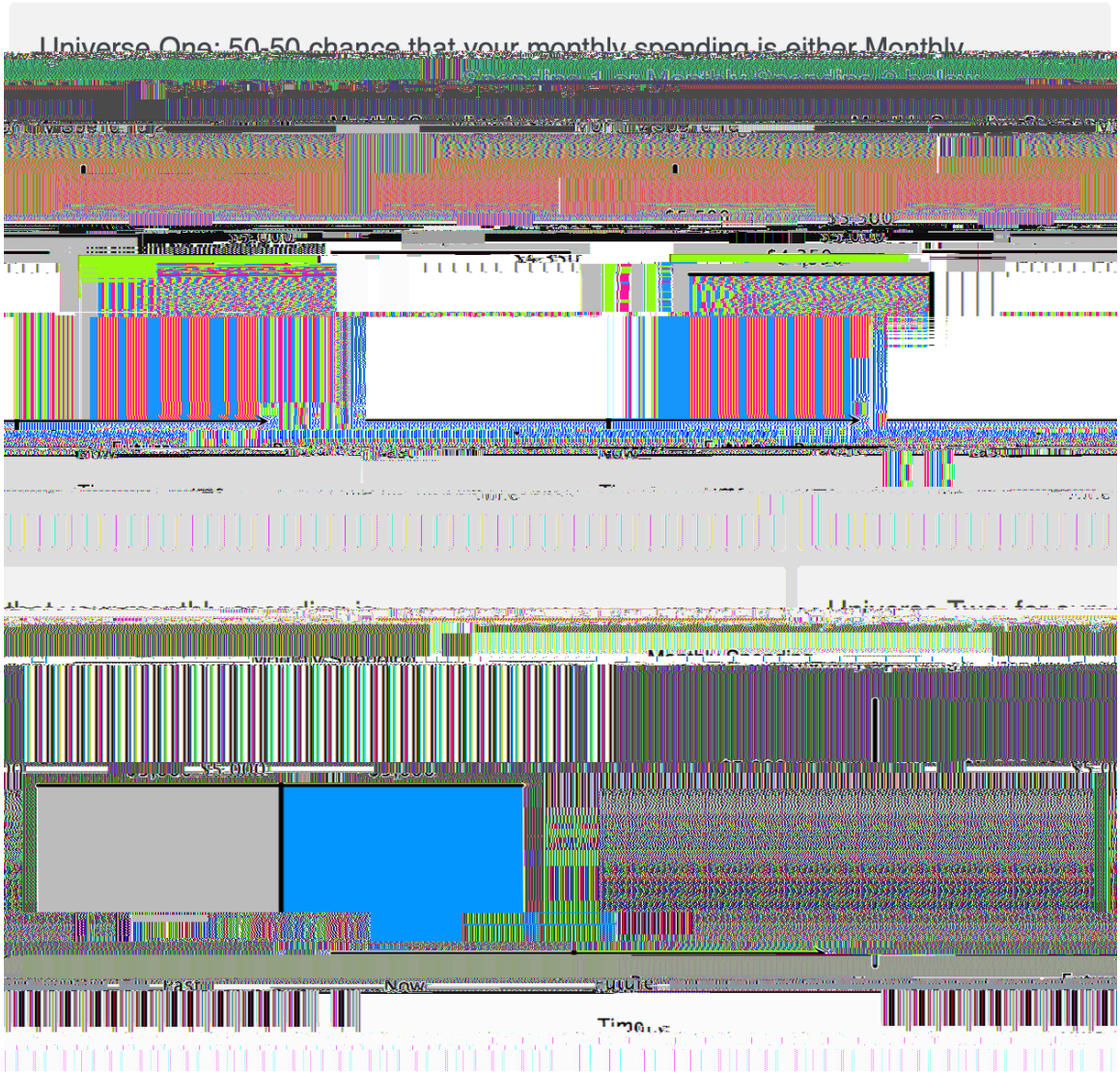


Figure A.6: Monthly spending graphs of a survey question for $^{H\,u_{Hu}}$

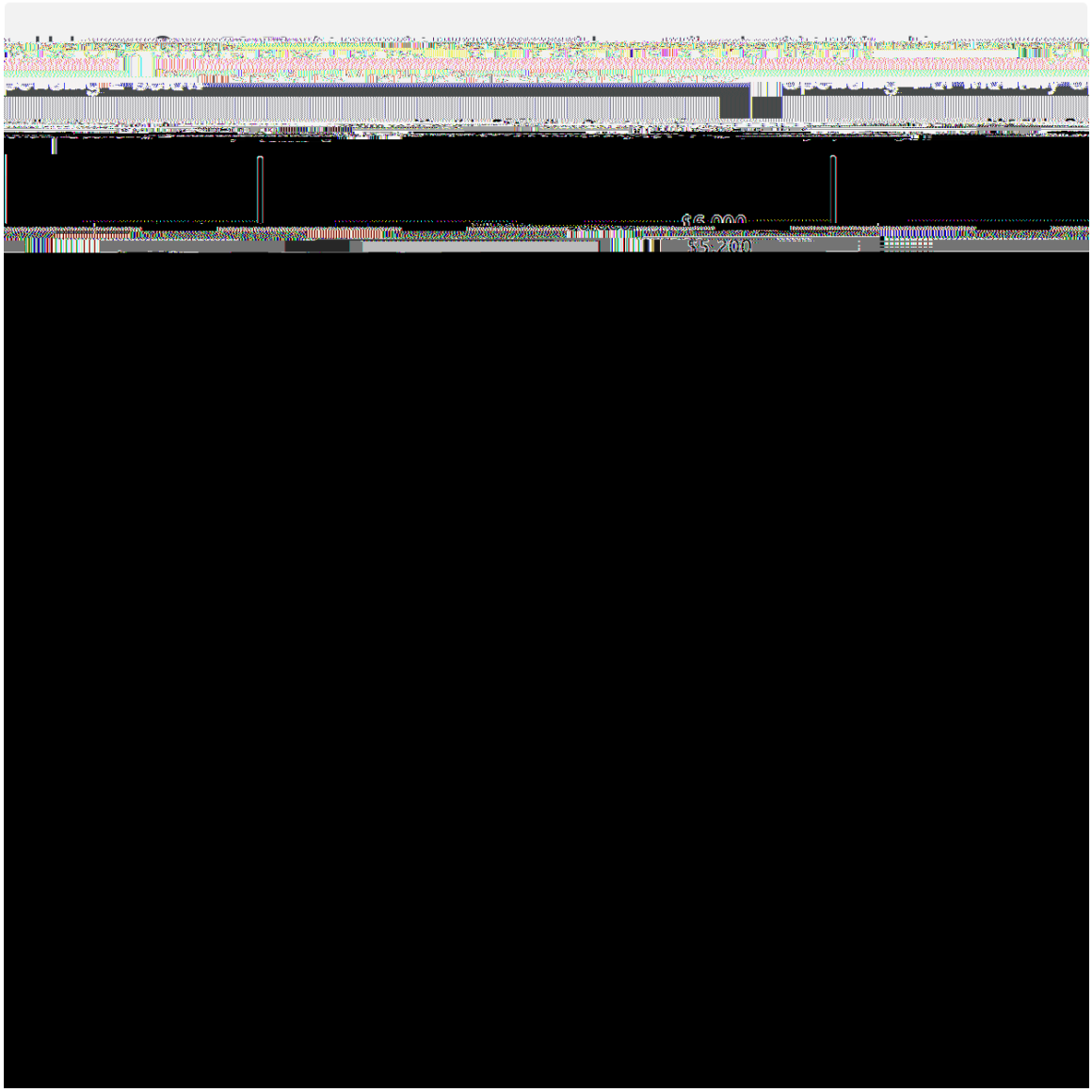


Figure A.7: Monthly spending graphs of a survey question for $\frac{u_{CH}}{u_{HH}}$.

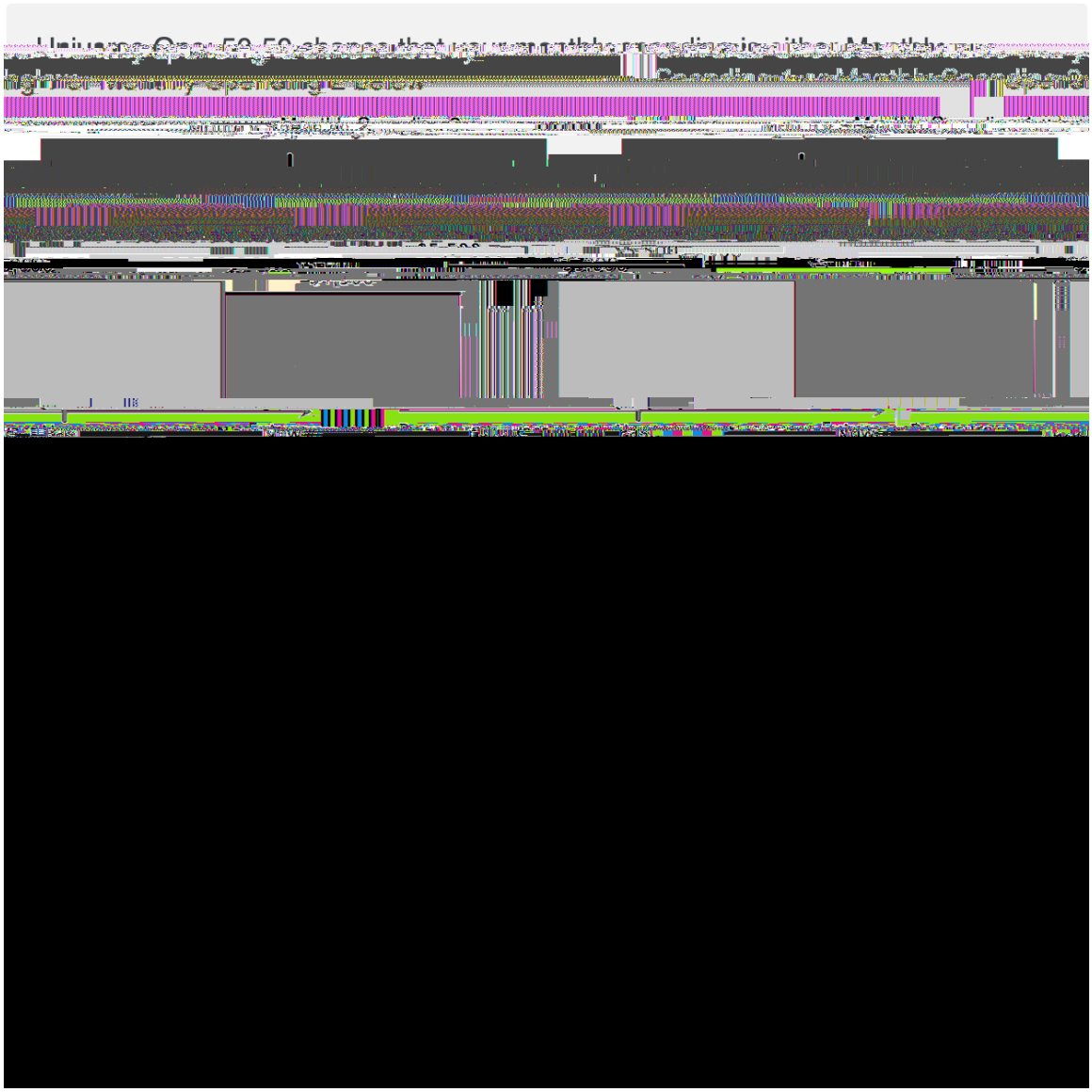
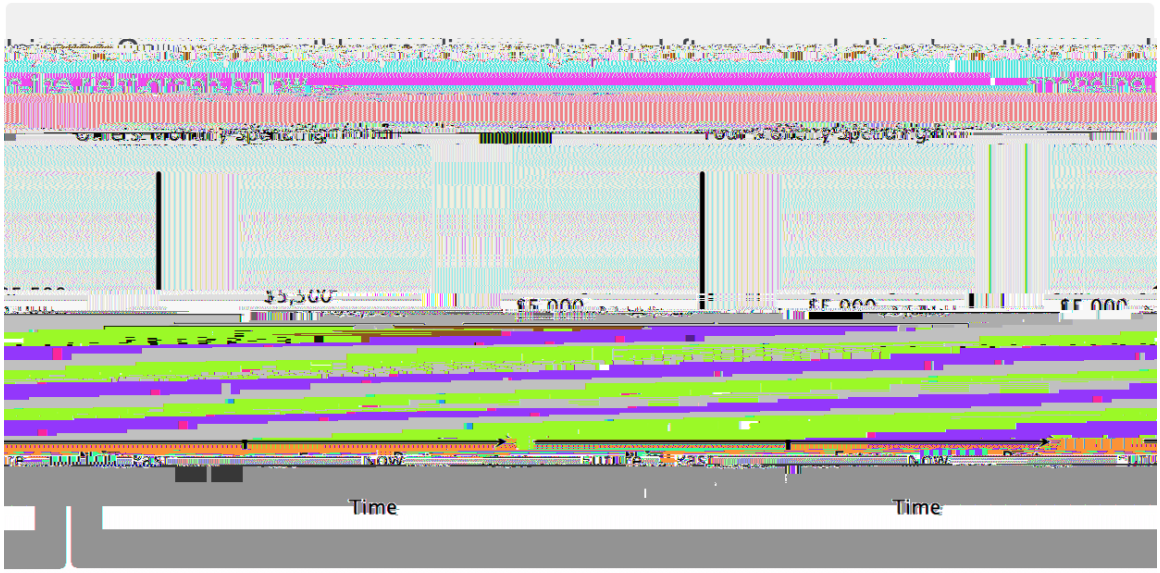


Figure A.8: Monthly spending graphs of a survey question for $\frac{u_{CC}}{u_{HH}}$.


$5,500
$5,000
$5,000
$5,000
Time
Time

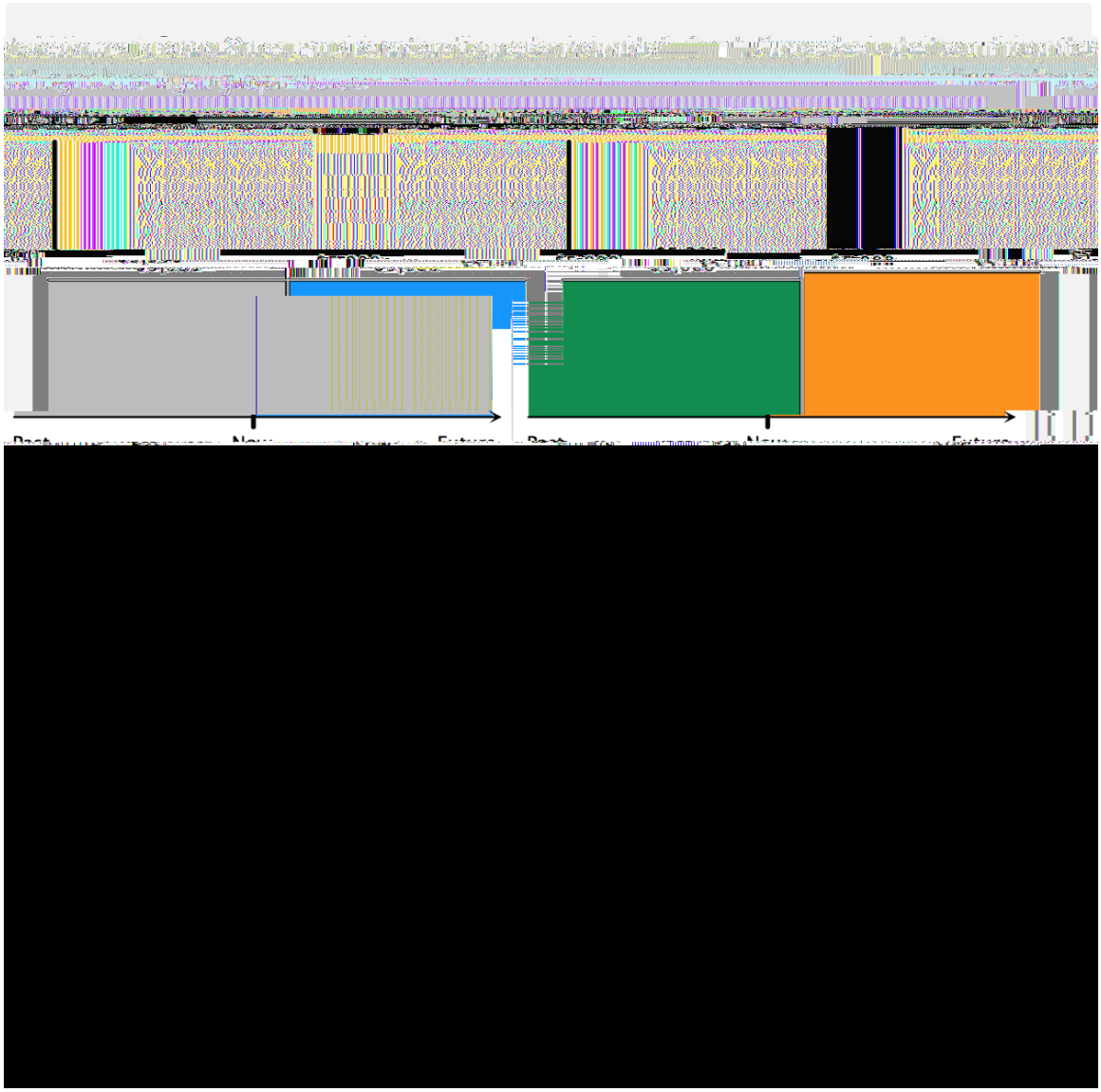


Figure A.10: Monthly spending graphs of a survey question for $\frac{u_{C_{others}}}{u_H}$.