# Essays in Behavioural Economics

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*A thesis submitted for the degree of*
*Doctor of Philosophy*

Trinity 2016

## Abstract

The thesis consists of three stand-alone essays.

Defaults are influential, cheap to change, and therefore of great interest to policymakers. However, it is still unclear what explains their influence. *Optimal Defaults and Uncertainty* presents a model in which uncertainty contributes to default inertia: decision makers may be content to stick with the default and avoid the costs of learning their optimal decision. The socially optimal default policy I find differs significantly from optimal policy in models where procrastination alone drives default inertia. I show that alternative policy measures may be more effective in improving welfare, and so the effectiveness of defaults may be more limited than previous models suggest.

In *Screening Salient Thinkers*, I explore a model of second-degree price discrimination in which consumers with context-dependent preferences choose from a menu of price-quality bundles. Specifically, the range of prices and qualities in the menu determines the weight that consumers give to the two attributes when they evaluate bundles. 'Focusing thinkers' place more weight on the attribute that varies the most within the menu; for 'relative thinkers' the opposite is true. The monopolist exploits both types of bounded rationality. In the focusing case the cost of asymmetric information is directly reduced; with relative thinkers the monopolist can use a 'decoy good' to extract higher revenues from all consumers.

Finally *How Long Is Now?* explores an important degree of freedom in models of present-biased preferences: when does the present end and the future begin? First I present evidence that illustrates how economists have used this degree of freedom to explain behaviour in a variety of different contexts. Second, using a novel, between-subjects experimental design, I test a hypothesis that endogenises the cut-off between the present and the future: the 'as soon as possible' effect. The effect predicts that the soonest option in a menu fixes the present horizon and implies a time-specific form of menu dependence. The experimental data collected does not support the hypothesis and this result appears robust to a number of analytical approaches.

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# Acknowledgements

First and foremost I would like to sincerely thank my supervisors Johannes Abeler and Sujoy Mukerji. Their guidance, support and good humour throughout my DPhil (indeed since they started supervising me during my MPhil) has enabled me to complete this thesis. It has been an absolute pleasure to work with them and I really appreciate all they have done for me.

My interest in behavioural economics started as an undergraduate at LSE: especially attending a public talk by David Laibson and Erik Eyster's inspiring lecture series in EC301. Many Oxford economists have helped me over my DPhil but I must highlight a few individuals: Mark Armstrong's comments at confirmation of status significantly improved my work; Vince Crawford's (along with Sujoy's) MPhil behavioural lectures prepared me to pursue my own research; David Huffman and Collin Raymond were both incredibly generous with their time and insights, and encouraged me in my behavioural pursuits; and Meg Meyer has been very supportive since the MPhil. I also owe a debt of gratitude to Akitaka Matsuo at the Nuffield Centre for Experimental Social Sciences for his help running the experiment in Chapter 4.

Financially, a Economic and Social Research Council studentship provided substantial support; a Department of Economics studentship and graduate teaching assistant award funded the second half of my DPhil; the George Webb Medley fund made a grant towards the experiments in Chapter 4 (many thanks also to Johannes who supplemented this grant with some of his own research budget); and finally I thank St.Anne's College for providing me with grants to attend various conferences.

There is a fantastic, supportive group of DPhil students in the economics department (especially those in the Micro Café collective!). Four individuals in particular have not only been my friends since the MPhil but have also gone above and beyond over recent weeks to help me to complete this thesis: Nick Chesterley, Cornelius Christian, Claudia Herresthal and Fede Torracchi. Away from economics, my time at Oxford has been dominated by O.U.R.F.C. – many thanks to all my friends there for making my time in Oxford so memorable. A particular thank you to my teammate-housemates: Harry Beale, JJ Dargan and Julien Morlet.

Finally my family and my girlfriend are a constant source of support, thank you for everything you continue to do for me, especially to my Mum and Dad (who I owe so much to), my sisters Michelle, Laura and Vicki, my grandmothers Doreen and Marie, and of course to Clare – I could not have done it without you.

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Finally *How Long Is Now?* explores an important degree of freedom in models of present-biased preferences: when does the present end and the future begin? First I present evidence that illustrates how economists have used this degree of freedom to explain behaviour in a variety of different contexts. Second, using a novel, between-subjects experimental design, I test a hypothesis that endogenises the cut-off between the present and the future: the 'as soon as possible' effect. The effect predicts that the soonest option in a menu fixes the present horizon and implies a time-specific form of menu dependence. The experimental data collected does not support the hypothesis and this result appears robust to a number of analytical approaches.

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# 1 Introduction

Behavioural Economics is now an established field of economics that seeks to build upon classical results through the use of better psychological assumptions. The key approach of classical economics has been revealed preference theory – the idea that, after observing an individual's behaviour, it is possible to derive their preferences. Three key assumptions underpin the revealed preference approach: (i) individuals know their current and future preferences, (ii) preferences are stable, and (iii) individuals maximise their preferences (whatever they are). Most behavioural economists relax one of the first two assumptions in their work[1] and the instability of preferences is the common theme running through this thesis.

I consider two scenarios in which preferences may change, the first being choice over time. The particular model of interest here is the model of present-biased preferences or quasi-hyperbolic discounting (Laibson, 1997; O'Donoghue and Rabin, 1999, 2001). In this setting preferences change over time: if my deadline for writing this passage is in two days' time, then today I may decide to write the passage tomorrow; however, when tomorrow comes, if I am present-biased then I may prefer to delay writing again to the final day. This assumption that individuals are biased towards the present at the expense of the future has significantly improved

[1] Relaxing the third assumption, maximisation, is possible but rather more extreme than is typical. Economic theory would be substantially different in the absence of maximisation.

economists' ability to understand choice over time. For example, status quo bias (or default inertia) is a puzzle which classical models struggle to explain – individuals are disproportionately more likely to 'stick' with the default option than 'opt-out' to alternatives. In the case of pension plans this insight has been used to model savings decisions and design optimal default options. Carroll et al. (2009) show that when present bias is the sole cause of default inertia, the welfare maximising default option is frequently to enroll savers into schemes that are undesirable. This policy provides savers with increased incentives to overcome their procrastination and choose their optimal pensions plan.

In Chapter 2, *Optimal Defaults and Uncertainty*, I show that this policy recommendation relies upon the implicit assumption that savers know what their optimal pensions plan is. Instead I make the more realistic assumption that savers face uncertainty over how much to save. The socially optimal default option is now typically the savings plan that is most likely to be desirable for a random saver. This is the case even though the savers in my model have present-biased preferences. Present bias does not only reduce the propensity of savers to opt out of a default; it also reduces the likelihood with which savers choose to learn about their best decision, when learning is immediately costly.

The second scenario is context-dependent or menu-dependent choice. If I choose a banana from a dessert menu consisting of a banana, an apple and a chocolate bar, then I violate axioms of rational choice theory[2] if I would instead choose a chocolate bar when the menu is a banana, a chocolate bar and a sticky toffee pudding. In this example, replacing the apple with the sticky toffee pudding changes an option in the menu which should, assuming rationality, be irrelevant to my preference over bananas and chocolate bars. However, in the first case my choice 'reveals' that I prefer bananas to chocolate bars, and in the second case my choice 'reveals' the opposite. Here preferences are unstable not due to the passage of time, but instead due to the menu or context in which decision-makers act.

[2] In particular the independence of irrelevant alternatives.

Several recent models seek to explain such behaviour; in Chapter 3, *Screening Salient Thinkers*, I apply two of them, ‘focusing’ (Kőszegi and Szeidl, 2013) and ‘relative thinking’ (Bushong et al., 2014), to a model of second degree price discrimination to investigate how these types of context dependence affect optimal menu design and welfare outcomes. The focusing model illustrates that one of the key results of the rational benchmark – that asymmetric information is costly – is not completely robust: a monopolist can get much closer to the first best outcome when consumers are focusing thinkers. When consumers are relative thinkers, a monopolist always employs an expensive ‘decoy’ good which, like the sticky toffee pudding above, alters the decisions that consumers make. In this case, the decoy leads consumers to have a higher willingness to pay for other options on the menu and therefore allows the monopolist to extract higher revenues from the market. In an extension where there are both rational and relative thinkers I show first that rational thinkers find value in products at the lower end of the market, and second that the higher the proportion of rational consumers, the better off the relative thinkers are.

Chapter 4, *How Long Is Now?*, returns to present bias while also incorporating ideas from studies of context-dependent choice, tying together the two types of unstable preferences discussed above. Although present bias has helped economists make significant strides in explaining choice over time, it is not a model without critics or limitations. I outline a degree of freedom in the present bias model which has not received a great deal of attention in the literature – the model does not specify when the present ends and the future begins. Evidence supporting present bias and applications of the model make full use of this flexibility, with the present horizon varying from a matter of seconds (e.g. Solnick et al., 1980) to a year or more (e.g. Angeletos et al., 2001) depending upon what type of behaviour the model is explaining. I design and implement a novel experiment in Chapter 4 which explores one possible hypothesis about the determination of present horizons – the ‘as soon as possible’ or ASAP effect (Glimcher et al., 2007; Kable and Glimcher, 2010). The ASAP effect states that the earliest item on a menu of prize-time outcomes fixes the present horizon; I use this hypothesis to look for a time-specific violation of the independence of irrelevant alternatives axiom. The simple design is, to the best of my knowledge, the first of its kind to examine choice over three time-prize outcomes (rather than the common binary choice). After running the design as an online experiment I find that the results do not support the ASAP hypothesis, therefore leaving the degree of freedom unsolved and a key avenue for future work to investigate.

To conclude, in this thesis I explore behavioural models of unstable preferences. One, present bias, is well established in economics. I challenge the way it has been applied and its implications interpreted in the specific context of pension design in Chapter 2. I then outline a key theoretical issue with the model in Chapter 4, suggesting one possible solution which my experimental data does not support. The second category of context-dependent models[3] is a much more recent modelling approach. I join the first wave of authors applying these models and exploring the consequences of this type of menu-dependent choice. Chapter 3 provides a first application of these models to the scenario of second degree price discrimination, and therefore examines how such models interact with heterogeneity of tastes – another important direction for future research.

[3]Specifically, I categorise Kőszegi and Szeidl (2013) and Bushong et al. (2014) as the 'range-based salience' models.

# 2

# Optimal Defaults and Uncertainty

## Contents



## 2.1 Introduction

In a wide variety of situations individuals tend to stick with the default or status quo decision for large periods of time. This effect is well known in the cases of organ donation registers and pension plan decisions,[1] but has also been found in car purchases, choices of car insurance and signing up to receive email marketing.[2]

[1] See Johnson and Goldstein (2003), and Madrian and Shea (2001) or Chetty et al. (2014) respectively.

[2] Levav et al. (2010), Johnson et al. (1993) and Johnson et al. (2002) respectively.

Defaults are also frequently necessary (in which case there is no opportunity cost to having one) and relatively cheap to change. Thus, many recent papers both from libertarian and asymmetric paternalist perspectives (Thaler and Sunstein, 2003; Camerer et al., 2003) advocate using defaults as a policy intervention to help people make wise decisions. Governments have been especially quick to take this advice on board in recent legislation covering pension schemes due to the combination of the pressures of an aging population, and a long-term shift from *defined benefit* pension schemes to *defined contribution* schemes – placing responsibility for retirement planning onto individuals rather than their employers. For example, in the US, the insights of Thaler and Benartzi (2004) were incorporated into the 2006 Pension Protection Act, while in October 2012 the UK government made automatic enrollment into pension schemes compulsory for employees in the biggest UK businesses, with smaller businesses to be added over the following six years.

In this chapter I ask what default option should policy makers choose in order to maximise welfare. To do this I analyse a model in which a planner sets a default savings rate for a population of present-biased savers. Savers' present bias causes them to overweight the immediate costs of 'opting out' of the default relative to the future benefits foregone from saving at the wrong savings rate.[3] Hence, present bias increases the number of savers who stick with the default, and from a long-run welfare perspective, it implies that too many savers choose to stick with the default. The novelty of my model is to make the additional, realistic assumption that individuals are uncertain about their optimal savings rate (or type) *ex ante*.[4] Initially, they only know the distribution from which their type is drawn, but they can remove this uncertainty by choosing to incur the cost of learning their type (this cost is higher than simply opting out of the default without learning). The main contribution is then to show how the properties of optimal defaults are influenced by the uncertainty that decision makers face. And the key result is that sufficiently

[3] This is a common mechanism utilised in the literature (e.g. Carroll et al., 2009).

[4] Research by Lusardi and Mitchell (2007, 2011) illustrates that financial illiteracy is widespread, with many households lacking knowledge of even basic economic concepts. Furthermore their research illustrates that more financially literate households are more likely to plan for retirement.

high learning costs imply that libertarian paternalist defaults (i.e. choose a default that minimises the number of people who opt out) are optimal. More generally, the results emphasise that it is important to understand the information available to decision makers before deriving optimal policy.

In particular, I model two scenarios with uncertainty. In the first scenario savers act independently. The significance of the results is therefore emphasised by contrasting them with the work of Carroll et al. (2009), whose model is similar to mine but with no uncertainty on the part of savers. Their conclusion is that when present bias is sufficiently severe, the socially optimal default is a savings rate which is a bad choice for the majority of savers. They describe such a default as 'offset' when it is set away from the mean optimal choice.[5] The intuition is that offset defaults increase the costs associated with sticking at the default relative to the cost of opting out. This 'nudges' savers to overcome their procrastination and opt into their individually optimal savings rate. However, I show that uncertainty alters this conclusion. In short, when learning is sufficiently costly, defaults should be used to help decision makers make safe choices rather than forcing them into action. This is because the planner's choice of default cannot compel savers to learn their type, and therefore savers do not necessarily end up at their optimal savings rate if they are nudged into action.

Secondly, I extend this framework to provide decision makers with another channel through which to learn their type – observing their peers through social interaction. This is important to consider simply due to the influence of social interaction, which has been demonstrated in many different scenarios. To name just a few citations, Duflo and Saez (2002, 2003), Hong et al. (2004) and Chetty et al. (2013) all show the importance of social interaction on various financial decisions. Moreover, given my focus on uncertainty, it is perhaps even more crucial to consider social interaction because one might hypothesise that social interaction would reduce decision makers' uncertainty by allowing learning between peers. I

[5] If the optimal default is sufficiently extreme such that all savers wish to opt out immediately then Carroll et al. label this an 'active decision' as it is equivalent to compelling them to make a choice. They describe libertarian paternalist defaults as 'central' defaults.

show that this hypothesis is not necessarily correct since the addition of a simple form of social interaction to the initial framework leads to practically identical results in terms of both saver behaviour and the optimal default that the planner should set. This section complements Carlin et al. (2013) who present a static model assessing defaults when individuals interact socially. The key difference between the models is that their static model is agnostic about how decision making continues into future periods (they model just the initial decision of savers to stick with the default or opt out). In contrast, my model is able to capture default inertia over time which is a key finding of the literature on defaults: defaults are influential not only in the period when initial decisions are made, but often continue to be influential for long stretches of time.[6] I can therefore analyse the effect of defaults and other policies on the speed with which savers learn about their type, and see how this varies as the savers' present bias changes. Furthermore, my analysis predicts clustering in the timing of savers' decisions.

Overall, the analysis suggests that defaults are less effective in increasing welfare than previous papers have argued. Therefore I also explore the use of other policy interventions. Often 'traditional' economic incentives (for example, subsidising the cost of learning) are the best way for a benign planner to increase total welfare or would be an effective means of complementing optimal defaults. Extending the framework to incorporate social interaction also facilitates further policy analysis. For example, I explore the effect of incentivising a subset of savers to invest in learning their type, and confirm Duflo and Saez (2002, 2003)'s empirical result that this can increase welfare. Furthermore, my model also supports the argument in Goda and Manchester (2013) that dividing the population into more homogeneous groups (i.e. setting different pension defaults by age or income etc.) can increase welfare.

The existing literature offers a number of explanations for *why* defaults affect choice but the two most significant welfare analyses of optimal defaults maintain the assumption that decision makers do not face any uncertainty with regards to their

[6] See for example Madrian and Shea (2001) or Beshears et al. (2008).

ideal decision. Therefore, it is the cost of taking a decision rather than the cost of making a decision that drives default inertia in Carroll et al. (2009) and Bernheim et al. (2015). Perhaps the most influential mechanism proposed to explain default inertia is present bias (Carroll et al., 2009; Bernheim et al., 2015). Bernheim et al. question the extent of the result in Carroll et al. (2009), stating that it relies on the assumption that the default-setting principal is unable to reward active decisions and penalise passive decisions. However, both papers emphasise that the optimal policy response is to try to encourage decision makers to opt out of the default and to save at the appropriate savings rate for their type.

Other proposed theories to explain the influence of defaults are that individuals are inattentive (Bernheim et al., 2015; Caplin and Martin, 2012),[7] or that they use the default as an 'anchor' (Bernheim et al., 2015). Finally, a closely related paper to this one is Altmann et al. (2015) who examine the 'endorsement effect' of defaults. They specify a model based upon cheap talk in which decision makers are uncertain about their optimal decision (equivalent to an agent's type in this chapter), before testing their predictions experimentally. In their case, the planner's choice of default conveys information, and so decision makers can learn from the default rather than from their peers. While their theoretical model has a similar flavour to this one, their focus is upon characterising when agents should follow the default, rather than characterising socially optimal defaults – the key prediction confirmed by their experimental evidence is that agents are more likely to stick with the default when the planner's interests are more closely aligned to those of the agents, and when the agents have worse information about what their optimal decision is.

[7] Bernheim et al. (2015) and Caplin and Martin (2012) treat inattention rather differently. In the former paper decision makers know their preferences and the salience of the decision or the attentiveness of the decision maker determines whether or not they opt out of the default to their optimal decision. In the latter paper, however, every decision has an objectively correct answer which decision makers do not know *ex ante*. Their beliefs about how likely it is that the default corresponds to the correct answer determine how much attention is paid to evaluating which answer is the correct one.

## 2.2 A Simple Model

Consider a savings game played by a default-setting planner and a population of agents (or savers). The planner's only involvement is to choose a default savings rate, denoted $x_D$, in period $t = 0$. Her objective in doing so is to maximise the total welfare of the agents. The agents then maximise their utility over their infinite lifetime by their choice of savings rate. For an agent who knows that her optimal savings rate (or type) is $s$, the per-period flow loss of saving at a rate $r$ is given by the quadratic loss function:

$$L(r) = \alpha(r - s)^2$$

where $\alpha > 0$. For consistency with Carroll et al. (2009), the agents are sophisticated, quasi-hyperbolic (or $\beta - \delta$) discounters, and the per-period flow losses from choices in period $t$ are incurred at the start of period $t + 1$.[8]

So far the ingredients of this model closely resemble Carroll et al. (2009). The key differences stem from the information which the principal and agents possess at the start of the game. Rather than assuming that agents know their own type, instead suppose that the agents know only the distribution of types in the population. In particular assume that a given agent knows only that her type, $s$, is an independent draw from the following normal distribution:[9]

$$s \sim N(\tilde{s}, \sigma^2)$$

I also assume that the planner only knows the distribution of types in the population. Given the agents' information set, if they save at the default, $x_D$, then their expected flow loss for a given period is (where $\phi$ is the probability density function of the standard normal distribution):

$$E(L(x_D)) = \alpha \int_{-\infty}^{\infty} \frac{1}{\sigma}\phi\Big(\frac{s - \tilde{s}}{\sigma}\Big)(s - x_D)^2 \mathrm{d}s \ = \alpha(\sigma^2 + (x_D - \tilde{s})^2) \qquad (2.1)$$

[8] This generates the tension between the costs today and the benefits in the future of increasing savings rates.

[9] It is assumed here and in Carroll et al. (2009) that the agents' types do not change over the period modelled and so these models are designed to be medium or short term analyses of savings behaviour.

In each period $t \geq 1$ the agents all face the following decisions. First they choose whether to invest in learning their type (denoted $I$) or not (denoted $N$). The decision to invest removes all uncertainty for the agents, and they move to their optimal savings rate with immediate effect, meaning that they face no future losses from saving at a sub-optimal savings rate. However this comes at a cost $k > 0$, which is incurred in the period $t$ that agents choose to invest; $k$ represents the significant cost to an agent of working out their optimal savings rate. This might involve visiting and paying for advice from a financial advisor; alternately it might entail spending time evaluating how to trade off present and future consumption, researching the expected returns on pensions savings and estimating future earnings individually. In any case, to complete this effectively requires a substantial investment of time and/or money.

If agents decide not to invest in a given period $t$ then they have a further decision to make. They can either stay at their current savings rate at no cost in period $t$ (denote this choice by $S$), or they can change their savings rate (denoted by $C$) at a cost $c$ which is incurred immediately.[10] I assume that $k > c > 0$ so that it is indeed more costly to learn your type (see above) than to simply go through the process of changing your savings rate (e.g. by filling out a form). Furthermore, assume rationality on the part of the agents such that, if they decide to change their savings rate, they choose the rate that minimises their (expected) flow loss. For example, under their initial information set this means that they would choose to save at the rate $\tilde{s}$.

### 2.2.1 Savers' Behaviour

The assumption that agents are sophisticated means that they correctly predict their future behaviour. For example, they cannot plan to put off investment into learning to future periods. They would realise that if they do not want to invest today, then they will also not want to do so tomorrow, as the costs and flow losses do not change. Hence, formally, the equilibrium concept used to describe sophisticated

[10] In Carroll et al. (2009) the opt-out cost $c$ is an independent random draw for each agent in each period. For simplicity I suppose that the opt-out cost is the same in every period here.

behaviour is Markov Perfect Equilibrium (MPE). A Nash equilibrium of a dynamic game is also an MPE if agents condition their strategies only on the state of the world and not on histories of play. Thus, if you face the same choice with the same information in period 5 as you did in period 2 then you should play the same strategy – play is time-invariant. This restriction is intuitively appealing, captures sophistication and is used to allow comparison with the pre-existing literature, which also uses this solution concept.[11]

This refinement is not very restrictive in this game as there are just two states. The first state of the world occurs in period 1 and also in any subsequent period when the agent has not yet invested in learning. There is only one way in which the agent's information set can change – she can learn her type. So the second state of the world occurs in every period $t''$ which follows a period $t'$ in which the agent has learnt her type. In state two, the agent is already saving at her optimal savings rate. Therefore even allowing an agent the option of changing savings rates to a different rate (at cost $c$), no agent would want to do so and hence state two is trivial.

For this reason, the agents' equilibrium behaviour is completely described by what they choose to do in period 1. The agents' payoffs from their various strategies are as follows:

- If the agent chooses $\{I\}$ then her payoff is $-k$.
- If the agent chooses $\{N, S\}$ then her payoff is

$$-\frac{\beta\delta}{1-\delta}\alpha(\sigma^2 + (x_D - \tilde{s})^2) \tag{2.2}$$

- If the agent choose $\{N, C\}$ then her payoff is

$$-\frac{\beta\delta}{1-\delta}\alpha\sigma^2 - c \tag{2.3}$$

Where, following the standard convention, $\beta \in (0, 1]$ measures agents' present bias (with $\beta = 1$ implying no present bias) and $\delta \in (0, 1)$ is the agents' long-term discount factor. Evidently, the planner's default only affects agents' payoffs if they choose

[11] As in Carroll et al. (2009).

strategy $\{N, S\}$ and stick with the default; it has no effect on the payoffs from the other two strategies. Therefore one can divide behaviour into two scenarios: in the first, agents never prefer to invest in learning ($I$), over not investing and opting out of the default to the population mean $\tilde{s}$ ($\{N, C\}$); in the second, the reverse is true.

**Lemma 2.2.1** *The agents prefer the strategy $\{N, C\}$ to $I$ if and only if:*

$$k - c > \frac{\beta\delta}{1-\delta}\alpha\sigma^2 \tag{2.4}$$

This result is attained simply by comparing the payoffs from the strategies. $k - c$ is the cost premium agents incur when investing to learn their true type and the lemma shows that if this premium is sufficiently high then learning does not occur in equilibrium. Furthermore, $\beta\delta\alpha\sigma^2/(1-\delta)$ is the lifetime flow loss incurred by agents who save at the population's expected optimal savings rate $\tilde{s}$. So learning can only occur in equilibrium if the cost premium is smaller than this loss, which represents the best agents can do given their initial information set.

Now consider the first scenario described above when Lemma 2.2.1 holds. The following lemma describes the agents' equilibrium behaviour:

**Lemma 2.2.2** *Assume that:*

$$k - c > \frac{\beta\delta}{1-\delta}\alpha\sigma^2$$

*The agents prefer to opt out of the default (play $\{N, C\}$) if and only if:*

$$x_D \notin \left[\tilde{s} - \sqrt{\frac{(1-\delta)c}{\beta\delta\alpha}}, \tilde{s} + \sqrt{\frac{(1-\delta)c}{\beta\delta\alpha}}\right] \tag{2.5}$$

*Otherwise they prefer to stick with the default (play $\{N, S\}$).*

Simply, if the cost premium of learning is relatively high, agents stick with the default unless the default is set sufficiently far away from $\tilde{s}$. If the default is close enough to $\tilde{s}$ then agents do not find it worthwhile to opt-out of the default.[12]

In the second scenario Lemma 2.2.1 does not hold and so agents prefer $I$ to $\{N, C\}$. Hence agents either learn their type or choose to stay at the default savings

[12]Proofs of Lemma 2.2.2 and other results can be found in Appendix 2.A.

rate forever. Agents' behaviour is determined by the planner's choice of default and is described in the following lemma:

**Lemma 2.2.3** *Assume that:*

$$k - c \leq \frac{\beta\delta}{1-\delta}\alpha\sigma^2 \tag{2.6}$$

*If:*

$$k < \frac{\beta\delta}{1-\delta}\alpha\sigma^2 \tag{2.7}$$

*then agents invest in learning their true type whatever the value of $x_D$. But, if:*

$$k \geq \frac{\beta\delta}{1-\delta}\alpha\sigma^2 \tag{2.8}$$

*then agents invest in learning if and only if $x_D$ is chosen such that:*

$$x_D \notin \left[\tilde{s} - \sqrt{\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2}, \tilde{s} + \sqrt{\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2}\right] \tag{2.9}$$

*For all other choices of $x_D$ agents prefer to stick with the default.*

This implies firstly that when the cost of learning is very small, $k < \beta\delta\alpha\sigma^2/(1-\delta)$, then the agents always choose to learn. But if the cost of learning is somewhat higher, $\beta\delta\alpha\sigma^2/(1-\delta) \leq k < \beta\delta\alpha\sigma^2/(1-\delta) + c$, then the agents only learn if the default is sufficiently far away from their *ex ante* expectation of their optimal savings rate, $\tilde{s}$. A 'nudge' is needed, when $k$ is moderately large, to ensure that agents learn. The size of this nudge is:

$$\Delta = \sqrt{\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2} \tag{2.10}$$

The nudge needs to be larger when agents discount the future more heavily ($\beta$ and $\delta$ become smaller), incur a higher cost to learn ($k$ increases) and face less uncertainty ($\sigma^2$ is smaller).

### 2.2.2 The Planner's Choice and Total Welfare

The planner's objective is to maximise total welfare. As is conventional in the literature with quasi-hyperbolic agents, I assume that the welfare function discounts only by $\delta$ (e.g. welfare is calculated as if agents have no present bias or $\beta = 1$). The main justification of such an approach is that setting $\beta = 1$ to analyse welfare is akin to taking the long term perspective and does not privilege utility in a given period simply because that period happens to be the present.[13]

Start with the high cost premium scenario presented above. If $k-c > \beta\delta\alpha\sigma^2/(1-\delta)$ then the planner has the choice of either setting the default close to $\tilde{s}$, inducing the agents to stick with the default and leading to welfare per agent of:

$$-\frac{\delta}{1-\delta}\alpha(\sigma^2 + (x_D - \tilde{s})^2) \tag{2.11}$$

This is clearly maximised when the planner chooses $x_D = \tilde{s}$. Alternately, the planner can set a default sufficiently far away from $\tilde{s}$ to induce the agents to opt-out of the default leading to welfare per agent of:

$$-\frac{\delta}{1-\delta}\alpha\sigma^2 - c \tag{2.12}$$

**Theorem 2.2.4** *Assume that:*

$$k - c \geq \frac{\beta\delta}{1-\delta}\alpha\sigma^2$$

*The planner's optimal default is* $x_D = \tilde{s}$

The agents never invest in learning in this scenario, due to the size of the learning cost premium. Hence the best the agents can do is to save at their expected optimal savings rate, $\tilde{s}$. Choosing a default not equal to $\tilde{s}$ only decreases welfare, either by inducing the agents to save at a different savings rate or by inducing the agents to opt-out of the default, unnecessarily incurring the opt-out cost $c$.

[13] There are several issues with taking this approach to welfare which are discussed in Bernheim et al. (2015). The main advantage of taking this approach here is that this retains consistency with the approach of Carroll et al. (2009), which clarifies the difference that uncertainty makes to their results.

Importantly, this conclusion does not change as the agents' present bias ($\beta$) worsens; whenever the cost of learning is too high the planner should set a 'central' default. In fact, as present bias worsens ($\beta$ becomes smaller) the result is reinforced since the cost premium $k - c$ becomes relatively larger. Hence the agents have an even stronger preference not to invest in learning their true type. This is an important point of divergence with the results in Carroll et al. (2009), where as present bias worsens the optimal default moves away from a 'central' default towards an 'offset' default or even an active decision.

The planner's optimal course of action is more nuanced in the low cost premium scenario. Now the planner's choice of default affects the agents' choice between investment in learning and continuing to save at the default savings rate. If the agents choose to invest then the average welfare is $-k$, while if they choose to stay at the default then average welfare is $-\delta\alpha(\sigma^2 + (x_D - \tilde{s})^2)/(1-\delta)$. This choice and the agents' behaviour in equilibrium leads to the following result:

**Theorem 2.2.5** *Assume that:*

$$k - c \leq \frac{\beta\delta}{1-\delta}\alpha\sigma^2$$

1. *If:*

$$\frac{\delta}{1-\delta}\alpha\sigma^2 > \frac{\beta\delta}{1-\delta}\alpha\sigma^2 > k \tag{2.13}$$

*then the agents always choose to learn, whatever the planner's choice of $x_D$ and so the planner is indifferent between any choice of $x_D$.*

2. *If:*

$$\frac{\delta}{1-\delta}\alpha\sigma^2 \geq k \geq \frac{\beta\delta}{1-\delta}\alpha\sigma^2 \tag{2.14}$$

*then the planner should choose $x_D$ to induce the agents to learn. Hence $x_D$ should be chosen such that:*

$$x_D \notin \left[\tilde{s} - \sqrt{\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2}, \tilde{s} + \sqrt{\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2}\right]$$

*3. If:*

$$k > \frac{\delta}{1-\delta}\alpha\sigma^2 > \frac{\beta\delta}{1-\delta}\alpha\sigma^2 \tag{2.15}$$

*then the planner should choose $x_D = \tilde{s}$ to induce the agents to stick with the default.*

In this scenario when agents may learn their type, the planner's optimal policy varies as the size of $k$ changes. For very low $k$, the planner's policy is irrelevant; for moderate $k$ an offset default can increase welfare as in Carroll et al. (2009); for high $k$, central defaults are optimal.

The key message to be drawn from this model is that, when agents face uncertainty, offset defaults are only welfare improving if learning costs and opt-out costs are just the right magnitude relative to the agents' present bias. The learning cost premium, $k - c$, must be sufficiently small (or the amount of present bias sufficiently limited) so that it is possible for the planner to induce the agents to invest. But the cost of investment, $k$, must also be both high enough (or present bias severe enough) such that agents do not invest without a nudge from the planner, and small enough such that welfare is optimised when the savers invest. In other words the 'moderate $k$' condition is rather specific.

The two theorems taken together illustrate that offset defaults are only effective when they encourage agents to make the effort to learn their true type, but this can only happen if they prefer learning to saving at $\tilde{s}$ in the first place. Advocates of behavioural policymaking emphasise that interventions are more effective when they make desired behaviour easier;[14] the conclusion here suggests that policy makers may themselves need to take this advice and follow the path of least resistance: when the cost of learning your true type is too costly for agents to ever choose to learn, offset defaults and active decisions can actively reduce welfare. In short, introducing uncertainty removes the monotonicity with which present bias affects the planner's optimal default. It is also important to know how costly it is for savers to determine their optimal decision.

[14]See the joint report from the UK Cabinet Office and Institute of Government (Dolan et al., 2010) and in particular the discussion of policies which help to *enable* decision makers to make choices which further policy objectives.

## 2.3 Social Interaction

I now introduce social interaction. The basic idea is to use free-riding to complement procrastination as a cause of default inertia.[15] This section addresses a theoretical concern that social interaction could reduce uncertainty and therefore diminish the importance of the results of the previous section. In fact, optimal default policy does not change.

Many recent empirical papers illustrate that social interaction can play an important role in shaping decisions. Duflo and Saez (2003) present evidence suggesting that individual savers in a firm run pensions scheme may be influenced by the decisions of their colleagues. Moreover, incentivising a small subset of workers to think about their own type leads both this subset and their colleagues to be much more likely to opt out of the firm's default programme. Hong et al. (2004) and Chetty et al. (2013) do not assess environments with a default-setting planner *per se*, however they illustrate that social interaction is important in two other types of financial decision making – participation in the stock market and labour supply responses to tax policy respectively. In particular, the latter paper studies the response of American taxpayers to the Earned Income Tax Credit (EITC). The results demonstrate that in neighbourhoods which are highly knowledgeable about the EITC, individuals change their wage earnings significantly more in response to a change in EITC eligibility (in order to obtain a larger EITC refund) than individuals in low knowledge areas. The clustering of knowledge in some zipcodes and not in others is consistent with the social interaction model in this chapter if, for example, the less informed zipcodes typically have individuals with higher learning costs than in the more informed zipcodes. In this way, a decision maker's network may influence her propensity to stick with a default decision in a wide array of applications beyond pension savings (which is the initial motivation for the model presented here).

[15]This analysis resonates with the evolutionary model in Conlisk (1980) which illustrated that costly optimisers and imitators could co-exist in equilibrium. While I do not explicitly consider optimisers and imitators here, the equilibrium strategies could imply that some agents learn their type and others imitate them.

Suppose that there are now two agents, labelled $A$ and $B$, whose preferences are identical to the agents in the model above. As above, neither the default-setting planner nor the two agents know their type $s$ at the start of the game. But I assume that at the start of the game both agents know that they share the same type, $s$, which is a random draw from the normal distribution with mean $\tilde{s}$ and variance $\sigma^2$. While it would be more realistic to assume that the agents' types are imperfectly correlated, there are three key reasons for not doing so. First, it significantly increases the tractability of the model.[16] Second, it provides the starkest contrast from the last section, in which there was zero correlation between agents. Third, many of the key results still hold under imperfect correlation – particularly the welfare results and planner's optimal policy – even if the precise strategies of savers would change. I point out exactly which results would be maintained below.

The timing of the game is as follows: in period 0 $s$ is drawn and the planner chooses the default savings rate $x_D$. From period 1 onwards the planner has no influence but the agents interact. In period 1 they first face a choice between investing in learning their type ($I$) and not investing ($N$). As before learning has a cost, $k$, but no further losses accrue to the individual who has invested. The twist with social interaction is that now agents can costlessly copy their peer. Thus, if $A$ learns and $B$ does not then $A$ faces the cost $k$ while $B$ faces 0 cost to save at her optimal savings rate.[17] If neither agent learns then they both face one further decision in that period - whether to stay with the default ($S$) or change to a savings rate of their choice ($C$). $S$ yields the loss $\beta\delta[\alpha(\sigma^2 + (x_D - \tilde{s})^2) + V_D]$ which is the flow loss incurred for saving at $x_D$ plus the expected net present value of playing the game in the next period, $V_D$. Meanwhile $C$ yields the loss $c + \beta\delta[\alpha\sigma^2 + V_{\tilde{s}}]$ which is the immediate cost of opting out of the default, the

[16] Allowing me to solve for simple expressions that completely describe the agents' equilibrium strategies.

[17] Under the assumption of imperfectly correlated types, $B$ would update her belief about her optimal savings rate, given the realisation of $A$'s type, $s'$. $B$ could then either stick with the default, opt-out of the default to her new expected optimal savings rate, or independently pay $k$ to learn her type. Her choice would depend upon the realisation of $s'$ but the key factor is that the lifetime stream of costs from this point is bounded above by $k$.

expected loss from saving at $\tilde{s}$ in the next period plus the expected net present value of playing the game in the next period, $V_{\tilde{s}}$.

Updating the MPE concept from the model without social interaction, the first state of the world occurs in period 1 and also in any subsequent period when both agents are still yet to invest in learning. The second state of the world occurs in every period $t''$ which follows a period $t'$ in which one or both of the agents have invested in learning their type. The state one game is as described above: a simultaneous choice between $I$ and $N$ for the two agents, followed by an individual choice between $S$ and $C$ if they both chose $N$. In state two, as at least one of the agents has played $I$, both will be saving at their optimal savings rate.[18] The agents can change from their optimal savings rate to another savings rate (at a cost $c$) but clearly they would not want to do so. Finally I restrict analysis to symmetric equilibria when there is social interaction. This is appealing since the savers are *ex ante* identical in every way and it is not clear how agents would co-ordinate on one of the possible asymmetric equilibria.[19]

The results of the previous section effectively carry over to this one without major modifications. The only change is in the savers' play: in situations where before the savers would prefer to immediately invest in learning, now they mix between investing and not investing because they have the opportunity to free ride off their peer.

### 2.3.1 Savers' Behaviour

It cannot be the case that both agents invest – if your peer invests then it is always preferable not to do so but to free ride off the investment of your peer.[20] Therefore

[18]In the imperfect correlation case the agent that did not learn her type initially may not be at her optimal savings rate (if it was preferable, for example, to stick with the default). However, she would have no incentive to choose a different savings rate in state 2. This is due to the choice outlined in footnote 17 above: whatever decision she makes in that choice remains optimal in future periods.

[19]In section 2.4 I examine the effects of subsidising learning costs for one of the two agents. In that case it becomes more reasonable for the agents to co-ordinate on the lower cost asymmetric equilibrium and I analyse that possibility.

[20]This is also true in the imperfect correlation case. As footnote 17 outlines, the payoff is this case is bounded below by $-k$.

there are two different types of equilibria: one in which $A$ and $B$ mix between investing and not investing, and one in which they never learn their type.

If the agents play a mixed strategy equilibrium then their payoff in expectation must be $-k$, due to the fact that they are mixing between investing and not investing, and investing always leads to a payoff of $-k$. If instead they never invest in learning their type then their expected payoff is either $-\beta\delta\alpha(\sigma^2 + (x_D - \tilde{s})^2)/(1-\delta)$ if they choose $S$ or $-\beta\delta\alpha(\sigma^2)/(1-\delta) - c$ if they choose $C$. The latter does not depend upon the planner's choice of $x_D$ and so a result identical to Lemma 2.2.1 identifies parameter values for which a mixed strategy equilibrium is impossible:

**Lemma 2.3.1** *If:*

$$k - c > \frac{\beta\delta}{1-\delta}\alpha\sigma^2$$

*then the agents never discover their true type in equilibrium.*

As in the model without social interaction, when the learning cost premium is too high (and hence agents never play a mixed strategy), the agents' decision over whether to stay at the default or to opt out depends upon the planner's choice of default. Lemma 2.2.2 still holds in exactly the same way with the agents preferring to immediately opt out of the default if and only if:

$$x_D \notin \left[\tilde{s} - \sqrt{\frac{(1-\delta)c}{\beta\delta\alpha}}, \tilde{s} + \sqrt{\frac{(1-\delta)c}{\beta\delta\alpha}}\right]$$

Otherwise they stick with the default forever.

When investing in learning is less costly, Lemma 2.2.3 changes in the following way:

**Lemma 2.3.2** *Assume that:*

$$k - c \leq \frac{\beta\delta}{1-\delta}\alpha\sigma^2$$

*If:*

$$k < \frac{\beta\delta}{1-\delta}\alpha\sigma^2$$

*then, for all values of $x_D$, the agents mix between investing and not investing in the first period But, if:*

$$k \geq \frac{\beta\delta}{1-\delta}\alpha\sigma^2$$

*then agents mix in the first period if and only if $x_D$ is chosen such that:*

$$x_D \notin \left[\tilde{s} - \sqrt{\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2}, \tilde{s} + \sqrt{\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2}\right]$$

*For all other choices of $x_D$ agents prefer to stick with the default in the first period (and for every subsequent period).*

Note that neither Lemma 2.3.1 nor Lemma 2.3.2 depends upon the assumption of perfect correlation between the two agents' optimal savings rate. This is because the results are simply derived by comparing the cost of learning, and the stream of costs from saving at the default or at $\tilde{s}$ forever. These costs are not affected by the correlation between the agents' saving rates. Hence the 'free-riding' style of social interaction modelled here (I have less incentive to learn my type if I can copy my colleague when she learns) modifies the 'all invest' equilibria from section 2.2 so that they are now mixed strategy equilibria, but does not affect the conditions determining whether there is some learning or no learning in equilibrium.

Lemma 2.3.2 outlines when mixed strategies are played in the first period of the game; I now turn to the details of these mixed strategy equilibria, and these results do rely upon the perfect correlation assumption. There are a number of different ways in which the mixed strategy equilibria could play out. This is due to the fact that, following an initial period in which both agents mix but neither actually invests in learning their type, the agents have a choice between staying with the default and opting out. Given the restriction to MPE, in the former case (staying with the default) it must be optimal for the agents to continue to play the same mixed strategy in every period until one of them invests. However in the latter case (opting out) the agents' strategies do change in period 2. Either they continue to play a mixed strategy but the probability of investing changes (decreasing) or they stay at the default in every subsequent period and never invest in learning their type. What action the agents choose to take depends upon the size of the opt out cost $c$ and the distance the default is from $\tilde{s}$. Readers who are solely interested in the planner's optimal default policy can move ahead to section 3.2, as the details of these equilibria outlined below do not have a bearing on the planner's decision.

Before the results, note two definitions. Let:

$$\begin{aligned} p^* =& \frac{\delta[(2-\beta)k + \beta\alpha(\sigma^2 + (x_D - \tilde{s})^2)]}{2\delta(1-\beta)k} \\ &- \frac{\sqrt{\delta(\delta\beta^2(\alpha(\sigma^2 + (x_D - \tilde{s})^2) + k)^2 + 4(1-\beta)k^2)}}{2\delta(1-\beta)k} \end{aligned} \tag{2.16}$$

$$\tilde{p} = \frac{\delta[(2-\beta)k + \beta\alpha\sigma^2] - \sqrt{\delta(\delta\beta^2(\alpha\sigma^2 + k)^2 + 4(1-\beta)k^2)}}{2\delta(1-\beta)k} \tag{2.17}$$

Note that $\tilde{p}$ is simply equal to $p^*$ when $x_D = \tilde{s}$. Then:

**Proposition 2.3.3** *Assume that:*

$$k < \frac{\beta\delta}{1-\delta}\alpha\sigma^2$$

*If* $2c > \beta\delta\alpha(x_D - \tilde{s})^2$ *then the agents invest with probability* $p^*$ *and do not invest with probability* $(1 - p^*)$*, and choose to stay with the default in any period in which neither agent learns their true type.*

*However, if* $2c \leq \beta\delta\alpha(x_D - \tilde{s})^2$ *then in the first period agents invest with probability* $f$ *and do not invest with probability* $1 - f$*, where* $f$ *satisfies:*

$$f = \frac{\tilde{p}k + (1-\tilde{p})c}{k} \tag{2.18}$$

*If neither agent invests in the first period then the agents opt out of the default to save at* $\tilde{s}$ *in the first period. Then in subsequent periods the agents invest with probability* $\tilde{p}$ *and do not invest with probability* $\tilde{p}$ *until at least one of them has invested.*

When opt out costs are high relative to the losses from saving at the default, the agents play the same mixed strategy until at least one of them invests in learning. The planner's choice of default influences both $p^*$, or the speed with which individuals invest in learning, and also whether or not the opt out costs are relatively high. But, when opt out costs are relatively low then the agents may find it beneficial to opt out of the default should neither of them invest in the first period. However they continue to mix between investing and not investing until at least one of them has learnt their type. The probability $f$ is greater than or equal to $\tilde{p}$ so the agents place more weight on investing in the first period than subsequent periods when opt out costs are relatively low.

**Proposition 2.3.4** *Assume that:*

$$\frac{\beta\delta}{1-\delta}\alpha\sigma^2 \leq k < \frac{\beta\delta}{1-\delta}\alpha\sigma^2 + c$$

*and:*

$$x_D \notin \left[\tilde{s} - \sqrt{\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2}, \tilde{s} + \sqrt{\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2}\right]$$

*so that the agents mix in the first period. Let:*

$$\begin{aligned} c^* = & \sqrt{\delta\left[\delta\beta^2(\alpha(\sigma^2 + (x_D - \tilde{s})^2) + k)^2 + 4(1-\beta)k^2\right]} + \beta\delta(k + \alpha(x_D - \tilde{s})^2) \\ & - \frac{\beta\delta(1+\delta)}{(1-\delta)}\alpha\sigma^2 \end{aligned} \tag{2.19}$$

*If $2c \leq c^*$, then in the first period agents invest with probability $g$ and do not invest with probability $1-g$, where $g$ satisfies:*

$$g = \frac{\beta\delta\alpha\sigma^2 - (1-\delta)(k-c)}{\beta\delta\alpha\sigma^2} \tag{2.20}$$

*If at least one of the agents invests in the first period then they both save at their optimal savings rate. However, if both fail to invest then they opt out of the default in the first period and save at $\tilde{s}$ in every subsequent period, never learning their type.*

*In contrast if $2c > c^*$ the agents invest with probability $p^*$ and do not invest with probability $1-p^*$ in every period until at least one of them has learnt their type.*

Again, if neither saver invests in a given period they only opt out of the default to save at $\tilde{s}$ if opt out costs are sufficiently small. The difference in this case is that, given that $k > \beta\delta\alpha\sigma^2/(1-\delta)$, once the savers have opted out then it is optimal for them to continue to save at $\tilde{s}$ and not mix between investing and not investing.

### 2.3.2 The Planner's Choice and Total Welfare

The planner's optimal default policy does not change after introducing social interaction. This is because the mixed strategy equilibria, in the model with social interaction, occur for the same parameter values and lead to the same expected loss per agent, as the equilibrium in which all agents invest in the model without social interaction.

Hence Theorem 2.2.4 remains exactly the same in the model with social interaction – when investing is too costly the planner should help the agents who stick with the default by setting $x_D = \tilde{s}$. The intuition remains the same: there is no possibility that the agents invest in learning and therefore no benefit to encouraging the agents into action.

The intuition of Theorem 2.2.5 also remains the same although now an offset default induces a mixed strategy equilibrium rather than leading all the agents to invest immediately, and so it requires a slight rewording:

**Theorem 2.3.5** *Assume that:*

$$k - c \leq \frac{\beta\delta}{1-\delta}\alpha\sigma^2$$

1. *If:*

$$\frac{\delta}{1-\delta}\alpha\sigma^2 > \frac{\beta\delta}{1-\delta}\alpha\sigma^2 > k$$

*then the agents always choose to mix between investing and not investing, whatever the planner's choice of $x_D$ and so the planner is indifferent between any choice of $x_D$.*

2. *If:*

$$\frac{\delta}{1-\delta}\alpha\sigma^2 \geq k \geq \frac{\beta\delta}{1-\delta}\alpha\sigma^2$$

*then the planner should choose $x_D$ to induce the agents to mix. Hence $x_D$ should be chosen such that:*

$$x_D \notin \left[\tilde{s} - \sqrt{\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2}, \tilde{s} + \sqrt{\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2}\right]$$

3. *If:*

$$k > \frac{\delta}{1-\delta}\alpha\sigma^2 > \frac{\beta\delta}{1-\delta}\alpha\sigma^2$$

*then the planner should choose* $x_D = \tilde{s}$ *to induce the agents to stick with the default.*

Importantly, these optimal policy results do not change as the correlation between the agents changes: if an agent can observe her peer's optimal savings rate, $s'$, and her payoff after seeing $s'$ is higher than $-k$, then there is a free-riding incentive which leads to mixed strategy MPE rather than equilibria in which all the agents invest. While the exact mixed strategy played differs, the parameter values determining whether agents play the mixed strategy MPE or stick with the default, and the resultant welfare outcomes do not depend on the correlation between the agents. Hence optimal default policy also does not depend on the degree of correlation.

## 2.4 Further Policy Implications – Beyond Defaults

The analysis thus far illustrates that the planner's ability to improve welfare solely through the use of the default savings rate $x_D$ is somewhat limited in both of the scenarios presented. But there are other ways in which the planner could affect welfare. In this section I assess the implications of the planner intervening to vary $\sigma^2$ and $k$. Changing $\sigma^2$ alters the uncertainty facing both the agents and the planner. One may also think of reducing $\sigma^2$ as dividing a large group of agents into smaller, more homogeneous groups. Adjusting $k$ corresponds to reducing the price of financial advice, incentivising employees to invest into learning their type or educating agents so that they can work out their optimal savings rate themselves at a lower cost.

### 2.4.1 Tailored Defaults – Varying $\sigma^2$

Reducing $\sigma^2$ in our model can be interpreted as identifying outliers and removing some of them from the particular default programme (perhaps into another one). Such a policy can have two effects on welfare. First, it can affect which equilibrium is played. Sufficiently large reductions in $\sigma^2$ can shift the savers from an equilibrium in which they invest (or mix between investing and not) into an equilibrium in which they stick with the default or immediately opt out to their expected optimal savings rate (if the default is not set optimally). This increases welfare so long as the cost of reducing $\sigma^2$ is not too high. Secondly, reducing $\sigma^2$ increases welfare in all equilibria where the savers do not invest, because their payoffs are dependent upon $\sigma^2$ in these equilibria.

This supports the conclusions of Goda and Manchester (2013) who illustrate that dividing up the population into categories (such that the distribution of agents' types is more homogeneous within the category than in the whole population) and then setting defaults for each category can improve welfare. This can be achieved by making defaults dependent on employees' characteristics, such as age. However, it does provide the caveat that when starting with a very heterogeneous population (such high $\sigma^2$ that the savers are playing the mixed strategy MPE if there is social interaction, or all investing otherwise) that the reduction in $\sigma^2$ required may be very high in order to increase welfare. If this large reduction is very costly then it may not be as beneficial as other policy measures (such as decreasing $k$).

It is important to note that the model assumes that $\sigma^2$ is the same for all parties, and so a different framework is required to analyse changes in information that affect some savers more than others and/or more than the planner. I leave the issue of differing amounts of information to papers such as Altmann et al. (2015).

A potential unintended consequence of policies such as reducing $\sigma^2$ is outlined by Caplin and Martin (2012). They raise the following issue with libertarian paternalism: if decision makers frequently find that the default option is a good decision, then they may become 'too' trusting of defaults. Passively accepting defaults in the future may then decrease welfare if they stick with defaults which they should opt out of. Benevolent social planners do not choose all defaults and even in this model, a saver whose optimal savings rate is actually very far away from $\tilde{s}$ incurs a large stream of costs by sticking with the optimal default. This long-term cost is not a feature of the model here but should be taken into consideration when evaluating this sort of intervention.

### 2.4.2 Incentivising Employees – Varying $k$

In contrast to changing $\sigma^2$, incentivising agents by reducing $k$ potentially offers a means to increase welfare without leading them to passively accept the default.

There are two ways a planner may want to vary $k$: she could reduce $k$ for all agents simultaneously (either by subsidising financial advice to all savers or incentivising all savers in the same way) or she could just reduce $k$ for a subset of the population (perhaps by targeting incentives to opt out of the default to this particular subset). The latter corresponds to the empirical study conducted by Duflo and Saez (2003), which indicated that incentivising a subset of decision makers could, via a multiplier effect, help a much larger number change their retirement savings behaviour. The analysis below provides a possible theoretical explanation for their results:

**Incentives for Everyone:** If the agents play the mixed strategy or 'all invest' equilibria absent incentives, then their average welfare ($-k$) is automatically improved by reducing $k$. Thus, in such situations, reducing $k$ is clearly desirable if the cost of the incentives to the planner is smaller than the improvement in welfare. If the agents are impatient however, and so play an equilibrium in which there is no investment in learning, then reducing $k$ only improves welfare if the reduction is sufficiently large to push the agents into the mixed strategy (or 'all invest') equilibrium.

**Incentives for the Few:** Suppose that agent $A$ is incentivised by the planner. If she plays $L$ then her payoff is: $-(k - \epsilon)$, where $0 < \epsilon < k$. Agent $B$ in contrast receives no incentive: her cost of learning is still $k$. The size of $\epsilon$ is chosen by the planner before $A$ and $B$ interact, and the welfare cost to the planner of the incentive $\epsilon$ is described by the function $g(\epsilon)$, where the function $g$ is such that: $g(0) = 0$ and $g'(.) > 0$.

Introducing $\epsilon > 0$ clearly alters the existing forms of equilibria but the most interesting scenario to consider is the potential for the incentive to allow co-ordination on an asymmetric equilibrium in which $A$ invests in learning her type and $B$ does not.[21] The following propositions summarise when each equilibrium is played.

[21] It is worth noting that the other asymmetric strategy profile ($B$ invests at cost $k$ but $A$ does

**Proposition 2.4.1** *Assume $\epsilon \in (0, k)$, then: The agents do not invest in learning but opt out of the default immediately and save at $\tilde{s}$ forever if the following two conditions hold:*

1.
$$\epsilon < k - \frac{\beta\delta}{1-\delta}\alpha\sigma^2 - c \tag{2.21}$$

2.
$$x_D \notin \left[\tilde{s} - \sqrt{\frac{(1-\delta)c}{\beta\delta\alpha}}, \tilde{s} + \sqrt{\frac{(1-\delta)c}{\beta\delta\alpha}}\right]$$

**Proposition 2.4.2** *Assume $\epsilon > 0$, then: The agents do not invest in learning but save at the default rate forever if the following conditions hold:*

1.
$$\epsilon < k - \frac{\beta\delta}{(1-\delta)}\alpha\sigma^2 \tag{2.22}$$

*and*

$$x_D \in \left[\tilde{s} - \sqrt{\frac{(1-\delta)(k-\epsilon)}{\beta\delta\alpha} - \sigma^2}, \tilde{s} + \sqrt{\frac{(1-\delta)(k-\epsilon)}{\beta\delta\alpha} - \sigma^2}\right] \tag{2.23}$$

2.
$$x_D \in \left[\tilde{s} - \sqrt{\frac{(1-\delta)c}{\beta\delta\alpha}}, \tilde{s} + \sqrt{\frac{(1-\delta)c}{\beta\delta\alpha}}\right]$$

**Proposition 2.4.3** *Assume $\epsilon > 0$, then: The agents could play a mixed strategy MPE if the following conditions hold:*

1.
$$k - c \leq \frac{\beta\delta}{(1-\delta)}\alpha\sigma^2$$

2. *Either:*
$$\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2 < 0$$

*or else:*
$$x_D \notin \left[\tilde{s} - \sqrt{\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2}, \tilde{s} + \sqrt{\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2}\right]$$

not) is also an equilibrium of the game whenever the mixed strategy profile is an equilibrium. I did not consider asymmetric equilibria before due to the co-ordination problem facing the savers; for the same reason I ignore the latter asymmetric equilibrium here as it would be perverse to expect $B$ to invest and $A$ not to when only $A$ receives the incentive to do so.

**Proposition 2.4.4** *Assume $\epsilon > 0$, then: The agents could play an asymmetric equilibrium in which $A$ invests and $B$ does not if the following conditions hold:*

1.
$$k - c - \frac{\beta\delta}{(1-\delta)}\alpha\sigma^2 \leq \epsilon \tag{2.24}$$

2. *Either*
$$\frac{(1-\delta)(k-\epsilon)}{\beta\delta\alpha} - \sigma^2 < 0 \tag{2.25}$$

*or else:*
$$x_D \notin \left[\tilde{s} - \sqrt{\frac{(1-\delta)(k-\epsilon)}{\beta\delta\alpha} - \sigma^2}, \tilde{s} + \sqrt{\frac{(1-\delta)(k-\epsilon)}{\beta\delta\alpha} - \sigma^2}\right] \tag{2.26}$$

In summary, the 'no investment' MPE become less likely; the condition for when the mixed strategy MPE is an equilibrium does not change, but the equilibrium strategies used in it do change (namely agent $A$ is more likely to learn); and a new asymmetric equilibrium emerges. Whenever the 'no investment' strategy profile would have been but is no longer an MPE, the asymmetric equilibrium could be played instead. Moreover, the asymmetric strategy profile can also be played in equilibrium whenever the mixed strategy profile could be an equilibrium.

The key question now is what is the welfare outcome from each of the equilibria? In the mixed strategy MPE, the aggregate welfare loss is $-(k-\epsilon) + (-k) - g(\epsilon) = \epsilon - 2k - g(\epsilon)$. This is clearly an improvement on not incentivising agent $A$ if and only if $\epsilon - g(\epsilon) \geq 0$, i.e. if it costs less to incentivise the agent than the effectual incentive provided. In the 'no investment' MPE, nothing changes after the introduction of $\epsilon$ so long as the magnitude of the incentive is not so large as to push the savers into a different equilibrium. Therefore the introduction of incentives in this case is not welfare improving (under the assumption that the incentive does not change which equilibrium is played).

If the asymmetric equilibrium is played, then the welfare loss is $-(k-\epsilon) - g(\epsilon) = \epsilon - k - g(\epsilon)$.[22] This welfare dominates moving to the mixed strategy equilibrium

[22] If the savers were risk averse they would both prefer the asymmetric MPE to the mixed strategy MPE. The former provides agent $A$ with a sure payoff of $-(k-\epsilon)$ and agent $B$ with a sure payoff of $0 \geq -k$, whereas the latter yields $A$ an expected payoff of $-(k-\epsilon)$ and $B$ an expected payoff of $-k$.

with $\epsilon > 0$, when both equilibria are possible, since $0 \leq k$. Does this asymmetric equilibrium improve on the mixed strategy equilibrium without incentives? It does so if $\epsilon - k - g(\epsilon) \geq -2k$ or $k \geq g(\epsilon) - \epsilon$. If $g(\epsilon) - \epsilon \geq 0$ then this condition simply states that a welfare improvement requires that the difference between the planner's cost of providing the incentive and the size of the incentive to $A$, be less than the *ex ante* cost of investment. If $g(\epsilon) - \epsilon \leq 0$, then of course this is a strict welfare improvement.

However, there are also some scenarios in which introducing the incentive $\epsilon$ means that the asymmetric equilibrium replaces a 'no investment' MPE. Can the incentive cause a welfare improvement in these situations? Compare the welfare from the 'no investment' MPE when the planner acts optimally and sets $x_D = \tilde{s}$, $-2\beta\delta\alpha\sigma^2/(1-\delta)$, and that from the asymmetric equilibrium, $\epsilon - k - g(\epsilon)$. I derive necessary and sufficient conditions under which the latter is preferred to the former. From Lemma 2.3.1 $k - c \geq (\beta\delta\alpha\sigma^2)/(1-\delta)$ outlines the parameter values for which there is no investment in equilibrium (absent incentives). And from Proposition 2.4.4, $k - c - (\beta\delta\alpha\sigma^2)/(1-\delta) \leq \epsilon$ illustrates how large $\epsilon$ needs to be to shift the savers into the asymmetric equilibrium.

Using these two equations leads to the following two propositions:

**Proposition 2.4.5** *Assume that introducing the incentive $\epsilon$ shifts the agents from the 'no investment' MPE to the asymmetric equilibrium. A necessary condition for this to lead to a welfare improvement is:*

$$g(\epsilon) - \epsilon \leq \frac{\beta\delta}{1-\delta}\alpha\sigma^2 - c \tag{2.27}$$

**Proposition 2.4.6** *Assume that introducing the incentive $\epsilon$ shifts the agents from the 'no investment' MPE to the asymmetric equilibrium. A sufficient condition for this to lead to a welfare improvement is:*

$$g(\epsilon) \leq \frac{\beta\delta}{1-\delta}\alpha\sigma^2 - c \tag{2.28}$$

These propositions relate the cost of incentives to the expected cost to a saver who opts out of the default and saves at $\tilde{s}$ forever. As long as the cost to the planner of introducing the incentive is low enough relative to an agent's expected costs from saving at $\tilde{s}$, then the incentive leads to a welfare improvement.

In essence, incentivising a single agent can be beneficial to welfare, as long as the cost of doing so is relatively small. The evidence of Duflo and Saez (2003) implies that these requirements would be met in many pensions schemes. They find that incentives totalling only $\$12,000$ (which was used to encourage college employees to attend a benefits information fair) led to an estimated increase in retirement savings of $\$175,000$ per year. In environments where uncertainty is a factor, therefore, such targeted incentives may prove to be as important a tool as defaults are in helping individuals make good decisions.

## 2.5 Concluding Remarks

When individuals make decisions under uncertainty there are limits to what a benign default-setting planner can achieve through her choice of default alone. The results of Carroll et al. (2009) indicated that an 'offset' default or 'active decision' would often be optimal if default inertia was caused by present bias alone. The analysis here only supports that view in very specific scenarios. Once agents face uncertainty concerning their optimal decision a libertarian paternalist 'central' default is frequently an optimal choice of default, unless learning costs are sufficiently small.

Despite the somewhat disappointing scope of defaults to increase welfare in the model presented here, there are alternative policy instruments a benign planner can use. Measures such as dividing the population up into groups with different defaults or incentivising investment in learning can be effective. If social interaction is important then incentivising a subset of the population can be particularly effective, and the model provides a theoretical underpinning for the empirical results seen in Duflo and Saez (2003).

On a broader note, my results make two key points. First, they add weight to the view that optimal default policy is dependent upon the mechanism causing default inertia. Therefore it is important to carefully consider all the factors that are important in decision making. Secondly, my results illustrate the importance of understanding how behavioural biases interact with other elements of a model. Here, if agents procrastinate about opting out of a decision they may also procrastinate learning about their optimal decision. While the implications for behaviour remain the same – there is still default inertia – optimal policy changes significantly.

# Appendix

## 2.A Proofs

**Proof of Lemma 2.2.2** $\{N, C\}$ is preferred to $\{N, S\}$ whenever:

$$-\frac{\beta\delta}{1-\delta}\alpha\sigma^2 - c > -\frac{\beta\delta}{1-\delta}\alpha(\sigma^2 + (x_D - \tilde{s})^2) \tag{2.29}$$

$$\Rightarrow (x_D - \tilde{s})^2 > \frac{(1-\delta)c}{\beta\delta\alpha} \tag{2.30}$$

$$\Rightarrow x_D \notin \left[\tilde{s} - \sqrt{\frac{(1-\delta)c}{\beta\delta\alpha}}, \tilde{s} + \sqrt{\frac{(1-\delta)c}{\beta\delta\alpha}}\right] \tag{2.31}$$

∎

**Proof of Lemma 2.2.3** If:

$$k < \frac{\beta\delta}{1-\delta}\alpha\sigma^2 \tag{2.32}$$

then it must be the case that:

$$k < \frac{\beta\delta}{1-\delta}\alpha(\sigma^2 + (x_D - \tilde{s})^2) \tag{2.33}$$

or the cost from investing is less than the cost of $\{N, S\}$ for any choice of $x_D$. Hence investing is preferred whatever the choice of $x_D$ in this case. If instead:

$$k \geq \frac{\beta\delta}{1-\delta}\alpha\sigma^2 \tag{2.34}$$

then only certain choices of $x_D$ imply that:

$$k < \frac{\beta\delta}{1-\delta}\alpha(\sigma^2 + (x_D - \tilde{s})^2) \tag{2.35}$$

The expression is equivalent to:

$$\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2 < (x_D - \tilde{s})^2 \tag{2.36}$$

$$\Leftrightarrow x_D \notin \left[\tilde{s} - \sqrt{\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2}, \tilde{s} + \sqrt{\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2}\right] \tag{2.37}$$

∎

**Proof of Theorem 2.2.4** Given that:

$$k - c \geq \frac{\beta\delta}{1-\delta}\alpha\sigma^2 \tag{2.38}$$

the planner knows that if:

$$x_D \in \left[\tilde{s} - \sqrt{\frac{(1-\delta)c}{\beta\delta\alpha}}, \tilde{s} + \sqrt{\frac{(1-\delta)c}{\beta\delta\alpha}}\right] \tag{2.39}$$

then the savers save at $x_D$ forever, and welfare per saver is equal to:

$$-\frac{\delta}{1-\delta}\alpha(\sigma^2 + (x_D - \tilde{s})^2) \tag{2.40}$$

In contrast if:

$$x_D \notin \left[\tilde{s} - \sqrt{\frac{(1-\delta)c}{\beta\delta\alpha}}, \tilde{s} + \sqrt{\frac{(1-\delta)c}{\beta\delta\alpha}}\right]$$

then the savers immediately opt out of the default, and welfare per saver is equal to:

$$-\frac{\delta}{1-\delta}\alpha\sigma^2 - c \tag{2.41}$$

Setting the default at $x_D = \tilde{s}$ does not only lead to savers staying at the default forever but it also maximises welfare per saver in this scenario (easily checked by consulting equation 2.40). Finally it is always preferable to the other equilibrium because:

$$-\frac{\delta}{1-\delta}\alpha\sigma^2 > -\frac{\delta}{1-\delta}\alpha\sigma^2 - c \tag{2.42}$$

∎

**Proof of Theorem 2.2.5** Assume that:

$$k - c < \frac{\beta\delta}{1-\delta}\alpha\sigma^2$$

1. If:

$$\frac{\delta}{1-\delta}\alpha\sigma^2 > \frac{\beta\delta}{1-\delta}\alpha\sigma^2 > k \tag{2.43}$$

   then the savers always choose to learn, regardless of the planner's choice of $x_D$ (Lemma 2.2.3). Thus the planner is indifferent between any choice of $x_D$.

2. If:

$$\frac{\delta}{1-\delta}\alpha\sigma^2 \geq k \geq \frac{\beta\delta}{1-\delta}\alpha\sigma^2 \tag{2.44}$$

then the planner prefers the savers to invest rather than to save at the default, because:

$$-k \geq -\frac{\delta}{1-\delta}\alpha(\sigma^2 + (x_D - \tilde{s})^2) \tag{2.45}$$

Hence, the planner should choose $x_D$ to induce the savers to learn. Lemma 2.2.3 implies that $x_D$ should be chosen such that:

$$x_D \notin \left[\tilde{s} - \sqrt{\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2}, \tilde{s} + \sqrt{\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2}\right]$$

3. If:

$$k > \frac{\delta}{1-\delta}\alpha\sigma^2 > \frac{\beta\delta}{1-\delta}\alpha\sigma^2 \tag{2.46}$$

then welfare is maximised if the savers stick with a default set at $\tilde{s}$, since

$$-\frac{\delta}{1-\delta}\alpha\sigma^2 > -k \tag{2.47}$$

Hence the planner should choose $x_D = \tilde{s}$.

**Proof of Lemma 2.3.2** The proof is identical to the proof of Lemma 2.2.3. This is because the mixed strategy MPE is played exactly when the invest equilibrium is played in the model without social interaction, since the payoffs and deviation payoffs in the two models are identical – in the mixed strategy equilibrium, the savers are mixing between investing, which has a certain payoff of $-k$, and not investing, where the payoff is dependent upon the mixed strategy of the other player. The mixed strategy is only played when the payoffs from the two strategies are equal and thus the savers' expected payoff must be $-k$.

**Proof of Proposition 2.3.3** Since:

$$k < \frac{\beta\delta}{1-\delta}\alpha\sigma^2$$

the savers always prefer mixing to staying with the default or saving at $\tilde{s}$ forever, whatever the value of $x_D$. If in period 1 of a mixed strategy equilibrium neither saver invests would they prefer to stay with the default or opt out to save at $\tilde{s}$?

Consider first the strategy profile in which savers play invest with probability $p$ and not invest with probability $(1-p)$, and in which they stay at the default if neither saver invests in a given period. $p$ satisfies:

$$k = p(0) + (1-p)\beta\delta[\alpha(\sigma^2 + (x_D - \tilde{s})^2) + V_D] \tag{2.48}$$

The cost of investing is equal in expectation to the cost of not investing. Furthermore, $V_D$, which is the expected cost from playing the game again in the next period satisfies:

$$V_D = pk + (1-p)\left[p(0) + (1-p)\delta[\alpha(\sigma^2 + (x_D - \tilde{s})^2) + V_D]\right] \tag{2.49}$$

With probability $p$ the saver herself invests, incurring cost $k$, but with probability $(1-p)$ the saver does not invest. The future costs in the equation above are not discounted by $\beta$ because $V_D$ itself is already discounted by $\beta$ in equation 2.48.

Rearrange equation 2.48 to see that:

$$\frac{k}{\beta} = (1-p)\delta[\alpha(\sigma^2 + (x_D - \tilde{s})^2) + V_D] \tag{2.50}$$

Then substitute this into equation 2.49 to see that:

$$V_D = pk + (1-p)\left[\frac{k}{\beta}\right] \tag{2.51}$$

Using this expression for $V_D$ in equation 2.48 leads to a quadratic function in $p$:

$$k = (1-p)\beta\delta\left[\alpha(\sigma^2 + (x_D - \tilde{s})^2) + (1-p)\frac{k}{\beta} + pk\right] \tag{2.52}$$

$$\Rightarrow 0 = \beta\delta[\alpha(\sigma^2 + (x + D - \tilde{s})^2)] - (1-\delta)k + p[\delta k(\beta - 2) - \beta\delta[\alpha(\sigma^2 + (x_D - \tilde{s})^2)]] + p^2\delta k(1-\beta)$$

Using the quadratic formula, the two values of $p$ satisfying the equation are:

$$p = \frac{\delta[(2-\beta)k + \beta\alpha(\sigma^2 + (x_D - \tilde{s})^2)] \pm \sqrt{\delta(\delta\beta^2(\alpha(\sigma^2 + (x_D - \tilde{s})^2) + k)^2 + 4(1-\beta)k^2)}}{2\delta(1-\beta)k}$$

Simple algebraic manipulation illustrates that the positive root is always greater than 1 (and so cannot be the solution), while the negative root is always less than 1. It turns out that the negative root is positive as long as one of the necessary conditions for a mixed strategy MPE is satisfied. Hence the negative root is indeed the probability with which savers invest in the mixed strategy MPE. This is evident from manipulation of the condition needed for the negative root to be greater than 0:

$$2\delta k + \beta\delta(\alpha(\sigma^2 + (x_D - \tilde{s})^2) - k) - \sqrt{\delta(\delta\beta^2(\alpha(\sigma^2 + (x_D - \tilde{s})^2) + k)^2 + 4(1-\beta)k^2)} > 0$$

$$\Rightarrow [2\delta k + \beta\delta(\alpha(\sigma^2 + (x_D - \tilde{s})^2) - k)]^2 > \beta^2\delta^2(\alpha(\sigma^2 + (x_D - \tilde{s})^2) + k)^2 + 4\delta(1-\beta)k^2$$

$$\Rightarrow 4\delta^2 k^2 + 4\beta\delta^2 k(\alpha(\sigma^2 + (x_D - \tilde{s})^2) - k) + \beta^2\delta^2(\alpha(\sigma^2 + (x_D - \tilde{s})^2) - k)^2 > \beta^2\delta^2(\alpha(\sigma^2 + (x_D - \tilde{s})^2) + k)^2 + 4\delta(1-\beta)k^2$$

$$\Rightarrow k^2(4\delta^2 - 4\beta\delta^2 - 4\delta + 4\delta\beta) > k\alpha(\sigma^2 + (x_D - \tilde{s})^2)(4\beta^2\delta^2 - 4\beta\delta^2)$$

$$\Rightarrow \alpha(\sigma^2 + (x_D - \tilde{s})^2)\delta^2\beta(1-\beta) > k\delta(1-\delta)(1-\beta)$$

$$\Rightarrow \frac{\beta\delta}{1-\delta}\alpha(\sigma^2 + (x_D - \tilde{s})^2) > k$$

The last expression is exactly the condition required for the savers to prefer the mixed strategy MPE to saving at the default savings rate forever. Therefore in the mixed strategy MPE where the savers do not opt out of the default, they invest with probability:

$$p^* = \frac{\delta[(2-\beta)k + \beta\alpha(\sigma^2 + (x_D - \tilde{s})^2)] - \sqrt{\delta(\delta\beta^2(\alpha(\sigma^2 + (x_D - \tilde{s})^2) + k)^2 + 4(1-\beta)k^2)}}{2\delta(1-\beta)k} \tag{2.53}$$

Now suppose that the initial default $x_D$ was set at $\tilde{s}$. In this case the optimal probability of playing invest would be $p^*$ evaluated at $x_D = \tilde{s}$ or $\tilde{p}$ as defined in the main text:

$$\tilde{p} = \frac{\delta[(2-\beta)k + \beta\alpha\sigma^2] - \sqrt{\delta(\delta\beta^2(\alpha\sigma^2 + k)^2 + 4(1-\beta)k^2)}}{2\delta(1-\beta)k} \tag{2.54}$$

That is, $\tilde{p}$ satisfies:

$$k = (1-\tilde{p})\beta\delta(\alpha\sigma^2 + V_{\tilde{S}}) \tag{2.55}$$

where $V_{\tilde{S}}$ is the cost of playing the game again in the next period if the default $x_D = \tilde{s}$.

Now, at the end of the first period, if neither saver has invested, then the cost from staying at the default and mixing again in the next period is:

$$\beta\delta[\alpha(\sigma^2 + (x_D - \tilde{s})^2) + V_D] \tag{2.56}$$

If, however, the savers decide to opt out of the default and mix in the next period, then the cost they suffer is:

$$c + \beta\delta[\alpha\sigma^2 + V_{\tilde{S}}] \tag{2.57}$$

where:

$$V_{\tilde{S}} = \tilde{p}k + (1-\tilde{p})\left[\frac{k}{\beta}\right] \tag{2.58}$$

Hence to ascertain whether or not the savers prefer to opt out or not it is necessary to compare cost 2.56 with cost 2.57. In particular, staying with the default is preferred if and only if:

$$c + \beta\delta[\alpha\sigma^2 + V_{\tilde{S}}] \geq \beta\delta[\alpha(\sigma^2 + (x_D - \tilde{s})^2) + V_D] \tag{2.59}$$

Substituting in equations 2.51 (with $p = p^*$) and 2.58 and rearranging yields:

$$\frac{c}{\beta\delta} - \alpha(x_D - \tilde{s})^2 \geq (\tilde{p} - p^*)k\left(\frac{1-\beta}{\beta}\right) \tag{2.60}$$

Substituting in for $\tilde{p}$ and $p^*$ and multiplying both sides by $2\beta\delta$ yields:

$$2c - \beta\delta\alpha(x_D - \tilde{s})^2 \geq$$

$$\sqrt{\delta(\delta\beta^2(\alpha(\sigma^2 + (x_D - \tilde{s})^2) + k)^2 + 4(1-\beta)k^2)} - \sqrt{\delta(\delta\beta^2(\alpha\sigma^2 + k)^2 + 4(1-\beta)k^2)}$$

The right hand side is greater than 0, thus a necessary condition that staying with the default is preferred is that $2c - \beta\delta\alpha(x_D - \tilde{s})^2 \geq 0$. This is also a sufficient condition, which can be shown by rearranging terms:

$$2c - \beta\delta\alpha(x_D - \tilde{s})^2 + \sqrt{\delta(\delta\beta^2(\alpha\sigma^2 + k)^2 + 4(1-\beta)k^2)} \geq \sqrt{\delta(\delta\beta^2(\alpha(\sigma^2 + (x_D - \tilde{s})^2) + k)^2 + 4(1-\beta)k^2)} \tag{2.61}$$

Let $A = 2c - \beta\delta\alpha(x_D - \tilde{s})^2$, $D = \sqrt{\delta(\delta\beta^2(\alpha\sigma^2 + k)^2 + 4(1-\beta)k^2)}$, and also $B = \sqrt{\delta(\delta\beta^2(\alpha(\sigma^2 + (x_D - \tilde{s})^2) + k)^2 + 4(1-\beta)k^2)}$, then squaring both sides yields $A^2 + 2AD + D^2 \geq B^2$. $A^2 - B^2$ is positive since:

$$A^2 - B^2 = \beta^2\delta^2\alpha^2(\sigma^2 + (x_D - \tilde{s})^2)^2 + 2\beta^2\delta^2\alpha\sigma^2 k + 2\beta^2\delta^2\alpha(x_D - \tilde{s})^2 k \tag{2.62}$$

Hence as long as $A \geq 0$, then $(A^2 - B^2) + 2AD + D^2 \geq 0$ and so $2c - \beta\delta\alpha(x_D - \tilde{s})^2 \geq 0$ is also a sufficient condition for staying with the default to be preferred.

Finally, if it is the case that $2c - \beta\delta\alpha(x_D - \tilde{s})^2 < 0$ and so the savers opt out at the end of a first period in which neither invests, then the mixed strategy played in the first period must be different to that played in subsequent periods. Use $f$ to denote the probability of investing in the first period and it satisfies:

$$k = f(0) + (1-f)(c + \beta\delta[\alpha\sigma^2 + V_{\tilde{S}}]) \tag{2.63}$$

Hence:

$$f = \frac{c + \beta\delta[\alpha\sigma^2 + V_{\tilde{S}}] - k}{c + \beta\delta[\alpha\sigma^2 + V_{\tilde{S}}]} \tag{2.64}$$

Using equation 2.55 it is clear that:

$$f = \frac{\left(\frac{\tilde{p}}{1-\tilde{p}}\right)k + c}{\frac{k}{1-\tilde{p}}} = \frac{\tilde{p}k + (1-\tilde{p})c}{k} > \tilde{p} \geq 0 \tag{2.65}$$

Also, $f < 1$ because $c < k$. ∎

**Proof of Proposition 2.3.4** Given that:

$$\frac{\beta\delta}{1-\delta}\alpha\sigma^2 \leq k < \frac{\beta\delta}{1-\delta}\alpha\sigma^2 + c$$

and:

$$x_D \notin \left[\tilde{s} - \sqrt{\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2}, \tilde{s} + \sqrt{\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2}\right]$$

savers must mix in the first period. However, if they opt out, and so are saving at $\tilde{s}$, then they would rather stick with the savings rate $\tilde{s}$ forever, with an overall payoff of $-\beta\delta\alpha\sigma^2/(1-\delta)$, than mix again, which would yield a payoff of $-k$.

So, in a mixed strategy equilibrium, if neither saver invests in period 1 they could either stick with the default and mix again in the next period, or they could opt out of the default and save at $\tilde{s}$ forever. The analysis of the first case follows the exact same steps as in the proof of Proposition 2.3.3 in the case where savers stick with the default there: savers play invest with probability $p^*$ and do not invest with probability $1-p^*$.

If the savers planned to opt out of the default in a period in which neither invested, then the savers' mixed strategy (denoted by $g$ the probability of playing invest) satisfies:

$$k = g(0) + (1-g)\left[\frac{\beta\delta}{1-\delta}\alpha\sigma^2 + c\right] \tag{2.66}$$

Rearrange this expression to see that:

$$g = \frac{\beta\delta\alpha\sigma^2 - (1-\delta)(k-c)}{\beta\delta\alpha\sigma^2}$$

By inspection $g$ is less than 1. The fact that $k < [\beta\delta\alpha\sigma^2/(1-\delta)] + c$ guarantees that $g > 0$.

It now remains to work out which of the strategies above the savers prefer. At the end of period 1 if neither saver has invested, they prefer opting out and saving at $\tilde{s}$ forever over sticking with the default and mixing again if and only if:

$$-\beta\delta[\alpha(\sigma^2 + (x_D - \tilde{s})^2) + V_D] > -\frac{\beta\delta}{1-\delta}\alpha\sigma^2 - c \tag{2.67}$$

where equation 2.16 is used again to produce:

$$V_D = p^*k + (1-p^*)\left[\frac{k}{\beta}\right] \tag{2.68}$$

Rearranging implies:

$$c > \beta\delta\alpha(x_D - \tilde{s})^2 - \frac{\beta\delta^2}{1-\delta}\alpha\sigma^2 + \delta k - p^*\delta(1-\beta)k \tag{2.69}$$

Substituting in for $p^*$ and multiplying by 2 leads to the condition $2c > c^*$, where:

$$\begin{aligned} c^* =& \sqrt{\delta \left[\delta\beta^2(\alpha(\sigma^2 + (x_D - \tilde{s})^2) + k)^2 + 4(1-\beta)k^2\right]} \\ &+ \beta\delta(k + \alpha(x_D - \tilde{s})^2) - \frac{\beta\delta(1+\delta)}{(1-\delta)}\alpha\sigma^2 \end{aligned} \tag{2.70}$$

Thus, if $2c > c^*$ the savers invest with probability $p^*$ and do not invest with probability $1 - p^*$ in every period until at least one of the savers has learnt their type. But, if $2c \leq c^*$, then in the first period savers invest with probability $g$ and do not invest with probability $1 - g$. If at least one of the savers invests in the first period then they both save at their optimal savings rate. However, if both fail to invest then they opt out of the default in the first period and save at $\tilde{s}$ in every subsequent period, never learning their type.

Finally $c^* > 0$ can be shown by exploiting the fact that:

$$(x_D - \tilde{s})^2 > \frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2$$

This implies that:

$$c^* > \sqrt{\delta \left[\delta\beta^2 \left(\frac{(1-\delta)k}{\beta\delta} + k\right)^2 + 4(1-\beta)k^2\right]} + (1-\delta+\beta\delta)k - \beta\delta\alpha\sigma^2 - \frac{\beta\delta(1+\delta)}{1-\delta}\alpha\sigma^2$$

$$\Rightarrow c^* > \sqrt{k^2(\delta(1-\beta)+1)^2} + (1-\delta(1-\beta))k - \frac{2\beta\delta}{1-\delta}\alpha\sigma^2$$

$$\Rightarrow c^* > 2k - \frac{2\beta\delta}{1-\delta}\alpha\sigma^2 > 0 \tag{2.71}$$

Where the final inequality follows from the assumption in this scenario that:

$$k - \frac{\beta\delta}{1-\delta}\alpha\sigma^2 > 0$$

**Proof of Theorem 2.3.5** The proof here follows exactly the same steps as for Theorem 2.2.5. The only difference being that where, in the model without social interaction assessed for Theorem 2.2.5, agents invested in learning, now the agents mix between investing and not investing. ∎

**Proof of Proposition 2.4.1** The first condition means both savers prefer to opt out of the default immediately rather than learn because::

$$\epsilon < k - \frac{\beta\delta}{1-\delta}\alpha\sigma^2 - c \Leftrightarrow -k < -(k-\epsilon) < -\frac{\beta\delta}{1-\delta}\alpha\sigma^2 - c \tag{2.72}$$

The second condition:

$$x_D \notin \left[\tilde{s} - \sqrt{\frac{(1-\delta)c}{\beta\delta\alpha}}, \tilde{s} + \sqrt{\frac{(1-\delta)c}{\beta\delta\alpha}}\right]$$

guarantees that the savers prefer opting out of the default and saving at $\tilde{s}$ forever over staying with the default forever, because the condition implies that:

$$-\frac{\beta\delta}{1-\delta}\alpha(\sigma^2 + (x_D - \tilde{s})^2) < -\frac{\beta\delta}{1-\delta}\alpha\sigma^2 - c$$

Hence $\{N, C\}$ is the savers' optimal strategy.

**Proof of Proposition 2.4.2** The first conditions:

$$\epsilon < k - \frac{\beta\delta}{(1-\delta)}\alpha\sigma^2 \tag{2.73}$$

and

$$x_D \in \left[\tilde{s} - \sqrt{\frac{(1-\delta)(k-\epsilon)}{\beta\delta\alpha} - \sigma^2}, \tilde{s} + \sqrt{\frac{(1-\delta)(k-\epsilon)}{\beta\delta\alpha} - \sigma^2}\right] \tag{2.74}$$

guarantee that the savers both prefer sticking with the default over investing since:

$$-k < -(k-\epsilon) < -\frac{\beta\delta}{1-\delta}\alpha(\sigma^2 + (x_D - \tilde{s})^2) \tag{2.75}$$

The second condition:

$$x_D \in \left[\tilde{s} - \sqrt{\frac{(1-\delta)c}{\beta\delta\alpha}}, \tilde{s} + \sqrt{\frac{(1-\delta)c}{\beta\delta\alpha}}\right]$$

guarantees that both savers prefer sticking with the default over opting out immediately. Hence $\{N, S\}$ is the savers' optimal strategy.

**Proof of Proposition 2.4.3** The first condition:

$$k - c \leq \frac{\beta\delta}{(1-\delta)}\alpha\sigma^2$$

ensures that both savers prefer mixing to opting out of the default immediately, as even Agent B (with no extra incentive) prefers learning to playing $\{N, C\}$. The second condition, that either:

$$\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2 < 0$$

or else:

$$x_D \notin \left[\tilde{s} - \sqrt{\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2}, \tilde{s} + \sqrt{\frac{(1-\delta)k}{\beta\delta\alpha} - \sigma^2}\right]$$

ensures both savers prefer mixing to sticking with the default forever because they guarantee this to be true for Agent B. Hence if the two conditions hold it is an equilibrium for both savers to mix in the first period. ∎

**Proof of Proposition 2.4.4** The first condition:

$$k - c - \frac{\beta\delta}{(1-\delta)}\alpha\sigma^2 \leq \epsilon \tag{2.76}$$

guarantees that agent $A$ prefers investing to opting out of the default and saving at $\tilde{s}$ because it implies that:

$$-\frac{\beta\delta}{(1-\delta)}\alpha\sigma^2 - c \leq -(k - \epsilon) \tag{2.77}$$

The second condition, that either:

$$\frac{(1-\delta)(k-\epsilon)}{\beta\delta\alpha} - \sigma^2 < 0$$

or else:

$$x_D \notin \left[\tilde{s} - \sqrt{\frac{(1-\delta)(k-\epsilon)}{\beta\delta\alpha} - \sigma^2}, \tilde{s} + \sqrt{\frac{(1-\delta)(k-\epsilon)}{\beta\delta\alpha} - \sigma^2}\right]$$

ensures that agent $A$ prefers investing to sticking with the default savings rate forever since it means that:

$$-\frac{\beta\delta}{(1-\delta)}\alpha(\sigma^2 + (x_D - \tilde{s})^2) \leq -(k - \epsilon)$$

Finally, agent $B$ prefers not investing to investing given agent $A$'s strategy because $0 > -k$.

Hence, it is an equilibrium for $A$ to invest and $B$ not to invest when these conditions hold. ∎

**Proof of Proposition 2.4.5** The asymmetric equilibrium is a welfare improvement on the mixed strategy MPE (with the default set at $x_D = \tilde{s}$) when:

$$-2\frac{\beta\delta}{1-\delta}\alpha\sigma^2 \leq \epsilon - k - g(\epsilon) \tag{2.78}$$

Rearranging yields:

$$g(\epsilon) - \epsilon \leq -k + 2\frac{\beta\delta}{1-\delta}\alpha\sigma^2 \tag{2.79}$$

From equation 2.4 it is the case that:

$$k - c \geq \frac{\beta\delta}{1-\delta}\alpha\sigma^2$$

Hence for equation 2.79 to hold it is necessary that:

$$g(\epsilon) - \epsilon \leq \frac{\beta\delta}{1-\delta}\alpha\sigma^2 - c \tag{2.80}$$

∎

**Proof of Proposition 2.4.6** As in the proof above, equation 2.79 needs to hold for the asymmetric MPE to improve upon the mixed strategy MPE. Equation 2.24 states that:

$$k - c - \frac{\beta\delta}{1-\delta}\alpha\sigma^2 \leq \epsilon$$

Therefore, using equation 2.24, the left hand side of equation 2.79, $g(\epsilon) - \epsilon$, satisfies:

$$g(\epsilon) - \epsilon \leq g(\epsilon) - k + c + \frac{\beta\delta}{1-\delta}\alpha\sigma^2 \tag{2.81}$$

If the right hand side of 2.81 is less than or equal to the right hand side of 2.79 this determines a sufficient condition for a welfare improvement:

$$g(\epsilon) - k + c + \frac{\beta\delta}{1-\delta}\alpha\sigma^2 \leq -k + 2\frac{\beta\delta}{1-\delta}\alpha\sigma^2 \tag{2.82}$$

Rearranging yields:

$$g(\epsilon) \leq \frac{\beta\delta}{1-\delta}\alpha\sigma^2 - c \tag{2.83}$$

∎

# 3

# Screening Salient Thinkers

## Contents

## 3.1 Introduction

Standard models of consumer choice assume that preferences are fixed. However, it is well known in the psychology literature that humans often make relative judgments and choices are affected by context (Volkmann, 1951; Parducci, 1965, 1974). For example, £50 may seem a reasonable amount to spend on a bottle of wine when an alternative costs £100, but £50 may be deemed too much for the very same bottle if it is the most expensive on the wine list. Similarly, Americans who evaluate the difference between living in California and in the Midwest are too likely to judge that Californians have a higher quality of life, because they focus upon the biggest difference between the two regions (the weather), giving too little weight to other factors which are similar between the two regions (Schkade and Kahneman, 1998).[1] In this chapter I examine the optimal menus that a monopolist should use when facing a market of decision makers whose context-dependent preferences would lead them to exhibit the types of behaviour described above. The benchmark case from classical economics is the simple Mussa and Rosen (1978) model of second degree price discrimination in which consumers either have a low or high valuation for a monopolist's product. I consider the 'range-based salience' models (see below) of context dependence within this framework and seek to answer several key questions. First, how do the benchmark results change when consumers have this form of context-dependent preferences? In other words, how robust are the classical results to the relaxation of the stable preference assumption and what are the effects on welfare. Secondly, what are the practical implications for firms' pricing strategies when consumers have these preferences – what type of menus do we expect to

[1] There are numerous examples of context effects in choice, including the similarity effect Tversky (1972), the asymmetric dominance or attraction effect (Huber et al., 1982) and the compromise effect (Simonson, 1989). These and other context effects have been found and modelled in a wide variety of applications including consumer choice (Kamenica, 2008; McFadden, 1999; Simonson and Tversky, 1992), political economy (Callander and Wilson, 2008; Herne, 1997; Pan et al., 1995), labour economics (Highhouse, 1996; Kahneman et al., 2006) and financial decision making (Benartzi and Thaler, 2002).

observe or should firms be using? Thirdly, how do context-dependent preferences interact with heterogeneous tastes to determine market equilibria?

Models of context-dependent choice typically assume that consumers choose between objects made up of multiple attributes. While there is an experienced utility function that describes underlying preferences, context-dependent consumers make choices on the basis of a (potentially distorted) decision utility function.[2] Crucially, the weight given to each of the attributes in the decision utility function is determined by the consideration set – the different objects available for consumers to pick from or which are relevants points of comparison. How consideration sets are determined is an open question in the literature, but following the current convention I typically assume that considerations sets are simply the menu of options which are available to consumers.

'Range-based salience' is simply one category of context-dependence. Keeping with the common usage of the word, something is *salient* if it stands out in comparison to its neighbours. In these models, different attributes are more or less salient depending upon the items in the menu. The more salient an attribute is, the more influence it has in consumers' decisions.[3] For example, consider two job applicants $A$ and $B$, where $A$ has more years of experience but $B$ has a better education record. If the applicants are $A$, $B$ and $C$ and from this 'menu' of applicants experience is the most salient attribute, then it is more likely that $A$ is preferred to $B$. In contrast, if $D$ applied in place of $C$ and now education is more salient, then it is more likely that $B$ is preferred to $A$.

The key question is how is salience determined? In the range-based models, the range or variance of each attribute within the menu determines saliency. Back to the example, suppose that the employer cares about the total number of years of both experience and education (this is translated into utilities below in the formal model). The range for experience is determined by subtracting the number of years experience

[2]The idea of a gap between experienced and decision utility dates back at least to Bentham (1789). In recent years there has been a revival of interest in the topic, much of which is due to the work of Daniel Kahneman and co-authors. For example, see Kahneman et al. (1997) or Dolan and Kahneman (2008).

[3]Or, the more weight it has in the consumer's decision utility function.

of the least experienced applicant, away from the number of years experience of the most experienced applicant. Having determined the range for each attribute, there are two tractable models within this class of preferences which make different assumptions over exactly how the range determines salience. 'Focusing' (Kőszegi and Szeidl, 2013) assumes that the bigger the range, the more salient an attribute is. Intuitively this captures a type of mental shortcut – evaluating different options is difficult, but the problem can be simplified by focusing upon those attributes that vary the most within the menu. Focusing captures the California/Midwest example above. The second model is called 'relative thinking' (Bushong et al., 2014) and actually assumes the opposite – attributes with smaller ranges are more salient. The interpretation now is that a given number seems bigger when it is compared to a small number: if $A$ has been working for five more years than $B$ and the range from most to least experienced applicant is five years, then this seems to be a significant advantage for $A$. In contrast, if the range in experience is twenty years, then five years more experience seems less important. Relative thinking can explain the wine list example above.

The Mussa and Rosen (1978) model provides a well-known benchmark in which to examine the implications of range-based salience. The familiar result of the benchmark is that asymmetric information (consumers know their preferences but the monopolist does not) is costly to the monopolist who cannot achieve the first best outcome. Instead the monopolist sells a menu of price-quality bundles which separates high and low value consumers, and high types receive an information rent in equilibrium. Examining context-dependent preferences in this framework is important because the rational model already raises interesting policy and welfare issues in a situation where the monopolist separates consumers with a menu[4] and so it is useful to see how robust conclusions are to making psychologically more realistic assumptions about preferences. Moreover, context-dependent choice adds an additional element to the monopolist's choice of menu: the design of the bundle for the high types may influence the willingness of low types to pay for their

[4]Given that the first best outcome does not arise in equilibrium, should policy makers regulate markets? If so, how should they do this?

bundle. If consumers are subject to these sorts of effects, then firms must take them into account in order to maximise profits. Finally, the model provides a simple means of capturing consumers' heterogeneous tastes, facilitating the study of how heterogeneity interacts with context dependence.

In general the monopolist can exploit both forms of context-dependent choice to increase her profits. When consumers are focusing thinkers and focusing is sufficiently severe, then the costs of asymmetric information are significantly, though not completely, reduced: the firm earns profits in equilibrium which are vanishingly close to the first best level from high types whilst also serving low types. Clearly these results stand in stark contrast to the rational benchmark in which a monopolist must give high types an information rent in order to serve both high and low types at the same time. The mechanism driving these results is that in order to separate focusing consumers, the monopolist's menu typically leads consumers with different valuations to focus more upon different attributes. High types find quality more salient than price, while the low types always focus more upon price – i.e. the menu exaggerates the underlying heterogeneity of consumers. This implies that incentive compatibility constraints do not bind when focusing is pronounced enough.

Turning to welfare, the overall effect on social efficiency is ambiguous relative to the rational benchmark. The key force improving social efficiency is that it is always optimal for the firm to serve all consumers in the market, when consumers are focusing thinkers. However, there are also sometimes distortionary effects on the precise quality produced which can reduce efficiency. The parameter values describing the market of consumers determine which force is dominant. Moreover, in all cases where low types consume a strictly positive quality good, they actually end up with strictly positive experienced utility – a 'focusing rent' – in equilibrium. This result, combined with the differing focus of consumers in equilibrium, implies that high types' experienced utility can actually be lower than the experienced utility of the low types.

When consumers are relative thinkers, asymmetric information is costly. However, the firm always uses a 'decoy' good which allows it to extract more surplus from relative thinkers than is possible from rational consumers. Decoy goods are items on the menu which are designed not to be consumed, but solely to influence consumers's perceptions of the alternatives – in particular to make these alternatives appear more desirable and therefore to increase consumers' willingness to pay. The presence of decoy goods leads to a fall in consumer welfare, but there is a highly counter-intuitive result that social efficiency can nevertheless increase. It would be natural to assume that a decoy good reduces social efficiency and indeed this is the case if information is symmetric or in the asymmetric information case when it is optimal for the firm to only serve high types. However, social efficiency can increase in a market with asymmetric information when all types of consumers purchase one of the firm's products. This result holds only when relative thinking is mild (i.e. the deviation from rationality is not too large). Crucially this result illustrates the importance of allowing for heterogeneity when studying the effects of behavioural biases on markets.

Low types have strictly negative experienced utility – they incur a 'relative thinking penalty' – whenever they consume a good with strictly positive quality in equilibrium. Nevertheless, for a large subset of the parameter space, high types have even lower experienced utility than low types. Hence for both models of range-based salience the information rent of high types (in experienced utility terms) can be reduced significantly, if not disappear.

The monopolist, given the choice, prefers to face a market of relative thinkers. In such a case it is always possible for her to use decoy goods to substantially increase her profits. This leads to a 'paradox of choice'[5] – the monopolist's profits weakly increase as she can increase the number of goods she markets, while consumers are worse off.

Finally, given that the monopolist can significantly increase her profits from relative thinkers by using decoy goods, I consider whether the presence of rational thinkers in the market can mitigate the loss of consumer welfare caused by decoy goods – and conclude that they can, so long as they are sufficient in number.

In the rest of the paper I immediately place the paper in the relevant literature; section 3.2 explores in more detail the evidence for and approach to modelling

[5]See Iyengar and Lepper (2000) or Schwartz (2004) for examples of studies where there is 'choice overload'.

range-based salience; section 3.3 briefly reviews the benchmark Mussa and Rosen (1978) model; sections 3.4 and 3.5 analyse the model with focusing and relative thinking in turn; section 3.6 considers an economy in which the monopolist faces a combination of relative and rational thinkers, before section 3.7 concludes.

### 3.1.1 Related literature

This paper is part of a growing literature which considers how profit-maximising firms should act when faced with consumers who exhibit some behavioural bias.[6] The most closely related papers are those by Dahremöller and Fels (2015), Bordalo et al. (2013a) and Ok et al. (2011). The first presents a model of a monopolist who faces a market of consumers with limited attention, whose behaviour is closely linked to Kőszegi and Szeidl (2013).[7] They focus only upon the case when consumers' preferences are homogeneous and their key finding is that *bait* or decoy goods are used to increase firm profits from the *primary* good that consumers buy.[8]

Meanwhile, Bordalo et al. (2013a) analyse a duopoly who face consumers whose salience-weighted preferences are taken from their own Bordalo et al. (2013b) model. Consumers again are homogeneous in their model and they find that the cost of producing quality determines whether markets have "commoditized" price salient equilibria or "decommoditized" quality salient equilibria. In contrast, the simple form of heterogeneity modelled in this paper allows me to show that a monopolist's optimal menu may lead different groups of consumers to focus on different attributes (see section 3.4).

Ok et al. (2011) also consider a behavioural bias within the Mussa and Rosen (1978) framework, but they assume that consumers have reference-dependent preferences à la Ok et al. (2015) (rather than based upon salience). Similarly

[6]There are several general overviews of this field, often described as behavioural or boundedly rational industrial organisation. For example, see Ellison (2006) or Spiegler (2011).

[7]The Kőszegi and Szeidl (2013) model has also been applied to study bargaining and incomplete contracts (Canidio and Karle, 2014) and poverty traps (Canidio, 2015).

[8]This result depends upon there being at least 3 attributes which describe a good. The implications of their result for this paper are outlined in Lemma 3.4.2.

to this paper, they find that the monopolist can partially overcome incentive compatibility constraints (under certain parametric restrictions) to increase profits.

The ideas in this paper also relate to research by Eliaz and Spiegler (2011a,b). Eliaz and Spiegler (2011a) consider the possibility that agents consider only a subset of the goods that are available to purchase. They find that a firm's profit is non-monotonic in the irrationality of consumers. In the model here, firm profits can be non-monotonic for focusing thinkers, but not for relative thinkers.

Meanwhile, Eliaz and Spiegler (2011b) examine 'attention-grabbing' goods which attract the attention of consumers to one firm's menu over a competitor.[9] This is somewhat similar to the idea of decoy goods employed in this paper, but rather than being used to make one firm's menu appear more attractive than another firms, here the decoy good affects decision makers' perception of other goods on the same menu.

Finally, section 3.6 considers a mixture of rational and relative thinkers. In the nomenclature of Armstrong (2015) I find that there exists a *search externality* for the relative thinkers but no *ripoff externality* for the rational thinkers: if there is a high enough proportion of rational thinkers in the market then this leads the monopolist to separate the two types of consumers and therefore this increases relative thinkers' welfare over the case where rational thinkers are not served. However in every possible equilibrium, rational thinkers are left with zero utility so there is no ripoff externality. See Armstrong (2015) for a discussion of (behavioural) IO models with and without these two types of externality.

## 3.2 The Idea of 'Range-Based' Salience

Salience is the state or quality of an object which makes it stand out relative to its neighbours. Consider a decision maker who chooses a multi-attribute good from a consideration set. The extent to which a given attribute varies within the consideration set determines the saliency of that attribute. The saliency of an

[9] Their model is one of a two stage choice process. First consumers choose which menu to choose from – i.e. which firm to patronise – and then which option to choose from that menu.

attribute then affects how much weight you give to that attribute in evaluating objects in the set.

Suppose that there are $N$ goods in the consideration set, $C$, and that every good in the consideration set has $K$ attributes. Denote the utility that attribute $k$ from good $i$ gives the decision maker by $u_{ik}$. Both Kőszegi and Szeidl (2013) and Bushong et al. (2014) assume that utility over attributes is separable, and so the experienced utility that the decision maker receives if she chooses good $i$ is given by:

$$U^E(i) = \sum_{k=1}^{K} u_{ik} \tag{3.1}$$

However, the saliency of different attributes in the consideration set distorts the decision utility function that the decision maker maximises when making her choice. Therefore the salience-weighted decision utility function is:

$$U^S(i;C) = \sum_{k=1}^{K} g(u_{ik}, C)u_{ik} \tag{3.2}$$

Define $\Delta_k(C) = \max_{i\in C} u_{ik} - \min_{j\in C} u_{jk}$. That is, $\Delta_k(C)$ is the range in utility from attribute $k$ over all of the goods in the consideration set.[10] Both papers assume that the $g$ function takes the following form:

$$g(u_{ik}, C) = g(\Delta_k(C)) \tag{3.3}$$

The difference between Kőszegi and Szeidl (2013) and Bushong et al. (2014) comes in the assumptions they make about the properties of the $g$ function. Both assume that $g(x) \geq 0$ for all $x \geq 0$ but they differ in their assumption about $g'(x)$:

**Assumption** In Kőszegi and Szeidl's model of 'focusing thinkers', $g(\Delta)$ is assumed to be strictly increasing in $\Delta$.

Thus focusing thinkers place more weight on attributes whose utility varies more widely in the consideration set. Assuming that the utility function in equation 3.1 is

[10] This is an important assumption – if salience was determined by the value of the attribute itself, e.g. £1.50 rather than the disutility of paying £1.50 minus the disutility of paying nothing, then all agents would perceive the saliency of different attributes in the same way.

our welfare criterion,[11] there are two key results generated by Kőszegi and Szeidl's assumption on focusing thinkers. First, focusing thinkers exhibit a *bias towards concentration.* They often focus on a small number of large advantages a good has which can lead them to overlook a large number of small disadvantages. Secondly, focusing thinkers always make unbiased decisions when they are faced with a *balanced choice.* A decision between two options is a balanced choice when the number of attributes in which the first option is superior is equal to the number of attributes in which the second option is superior.

One of the best examples of focusing illusion is given by Schkade and Kahneman (1998). In a comparison between living in the Midwest and Southern California, students in both regions incorrectly predicted Californians to have higher life satisfaction than those that live in the Midwest. In fact, happiness was essentially equal across the two groups. The authors' explanation was that subjects disproportionately focused upon the biggest difference between the two regions, the climate, and gave less attention to other, more important factors that vary less between the two regions. This finding has also been documented in other scenarios, including students' evaluations of their halls of residence, shoppers being more responsive to changes in prices than to increased nutritional information about foodstuffs and job applicants focusing too much on salary when choosing between different positions.[12] Work on salience and taxation has also produced evidence which supports focusing.[13]

In contrast:

**Assumption** In Bushong et al.'s model of 'relative thinkers', $g(\Delta)$ is assumed to be strictly decreasing in $\Delta$. Additionally, they assume that $g(\Delta)\Delta$ is strictly increasing in $\Delta$.

[11] Following both Kőszegi and Szeidl (2013) and Bushong et al. (2014).

[12] See Dunn et al. (2003), Abaluck (2011) and Kahneman et al. (2006) respectively.

[13] Chetty et al. (2009) find that shoppers are more responsive to a change in excise tax (included in an outlet's posted price) than to changes in sales tax (added at the till). The posted price is larger than any additional sales tax and therefore the more salient dimension seems to be the one that varies more. However, Abeler and Jäger (2015) present mixed evidence: subjects in an already complex tax environment made smaller adjustments to additional tax changes than subjects initially facing a simple environment. Yet they were unable to reject the hypothesis that subjects responded in the same way to large and small changes to the tax code.

Hence relative thinkers are more sensitive to a difference of 5 utils when it occurs for an attribute which varies by only 10 utils in the consideration set than when it occurs for an attribute which varies by 100 utils in the consideration set. In short, it captures the idea that a fixed difference appears smaller when one compares it to a large range than to a small range. The second part of the definition importantly guarantees that respect is paid to *absolute* differences in utility.[14]

A great example of relative thinking comes from an examination of housing demand (Simonsohn and Loewenstein, 2006). New residents in a given city exhibited markedly different behaviour dependent upon whether they arrived from more or less expensive cities. Assume that the attributes of housing are quality and rent, and a consumer's consideration set includes her previous contract. If she moves to 'Newtown' from a more expensive city, then differences in price between residences in Newtown seem relatively smaller than they would do if she was moving from a cheaper city. Thus, relative thinking is consistent with field evidence documenting that migrants arriving from cities with a low cost of living tend to spend less on rent than those arriving from more expensive cities.[15]

In addition, relative thinking is also consistent with much of the experimental evidence on the asymmetric dominance or attraction effect[16] and several examples from the literature on contingent valuation. Baron (1997) finds that if subjects are told that $t$ people will die from a disease, but an intervention can save $x$ of those individuals, they report a higher willingness to contribute towards the intervention as $t$ decreases. Similarly, Frederick and Fischhoff (1998, page 116) write: "we predict that the value of cleaning up ten miles of a polluted river would be higher

[14]To use an example directly from Bushong et al. (2014), suppose a decision maker has the following consideration set: {(1 apple, 0 oranges), (0 apples, 1 orange)} and that the decision maker receives more utility from an apple then she does from an orange. The assumption that $g(\Delta)\Delta$ is increasing in $\Delta$ is necessary to prevent the model predicting that a relative thinker chooses the orange over the apple.

[15]Simonsohn and Loewenstein explore and rule out alternative explanations such as the wealth of migrants driving this effect.

[16]The model yields the basic effect, first noted in Huber et al. (1982), whilst also making predictions consistent with more nuanced results, such as sensitivity to 'relatively inferior' as well as dominated options (Huber and Puto, 1983).

in a study where respondents valued one mile and ten miles of cleanup than in a study where they valued ten miles and 100 miles."

Therefore there is evidence consistent with both models – despite the fact that they make opposing assumptions about how the saliency of attributes is determined. Most examples supporting focusing seem to occur in environments in which the objects of choice have many (more than 3) attributes, whereas examples that support relative thinking tend to be for a small number of attributes. Bushong et al. (2014) take up this point and suggest that there may be a broader underlying decision making heuristic underpinning this sort of behaviour: first, decision makers decide which attributes they should consider – attributes that vary the most attract the most focus. Secondly, relative thinking is used with these relevant attributes to determine which objects are chosen. Focusing would thus be more important in more complex environments, relative thinking in simpler environments.

Models which are especially related to Kőszegi and Szeidl (2013) and Bushong et al. (2014) include Bordalo et al. (2013b, 2012)[17] and Cunningham (2012),[18] while there are a large number of recent papers all in the same spirit, capturing the general idea that individuals focus on and incorporate some aspects of the environment much more than others when making decisions.[19]

## 3.3 The Case of Rational Consumers

I now turn to the rational benchmark model into which I introduce range-based salience. There is a risk neutral monopolist whose profit from producing a good

[17]Bordalo et al.'s basic formulation in terms of equations 3.1 and 3.2 is the same as the range-based models described above. The key thing that they do differently is to focus on deviation from the average rather than the range as the statistic which determines the $g$ weight for each attribute $k$. They also have a rank-based notion of salience weights, rather than using the continuous $g$ function employed in the range-based models.

[18]Cunningham presents a similar model but incorporates the idea of history or previously observed options into his model of context dependence. In particular he assesses a scenario in which a decision maker is less sensitive to changes in a given attribute after she has observed larger absolute values in that attribute in the past.

[19]For example, see Gabaix (2014), Mullainathan (2002), Schwartzstein (2014) and Woodford (2012).

of quality level $q \geq 0$ and selling it at price $p$ is (under the assumption of quadratic costs):

$$\pi(p, q) = p - \frac{q^2}{2} \tag{3.4}$$

The monopolist faces a market of two types of consumers, who have utility functions:

$$\theta_i q - p \text{ where } i \in H, L \text{ and } \theta_H = \theta > \theta_L = 1 \tag{3.5}$$

High types (denoted by $H$) have a higher marginal utility from quality, $\theta$, than low types, whose marginal utility is normalised to 1. The proportion of high types is $\lambda \in (0, 1)$.

In the symmetric information case, the monopolist can distinguish between the consumers and offers each type a different bundle. The monopolist simply maximises profit subject to the constraint that both types have non-negative utility from buying their good. It is straightforward to see that the optimal price-quality bundles are:

$$\text{For the high types: } q_H = \theta,\ p_H = \theta^2 \tag{3.6}$$

$$\text{And for the low types: } q_L = 1,\ p_H = 1 \tag{3.7}$$

The optimal price-quality bundles are efficient and ensure that the monopolist extracts all of the surplus – consumers are left with 0 utility, while the monopolist's profit is:

$$\frac{\lambda\theta^2}{2} + \frac{1-\lambda}{2} \tag{3.8}$$

Finding the optimal second degree price discrimination programme in such a situation is a well studied problem,[20] and it is always optimal for the monopolist to separate high and low type consumers – the values of $\lambda$ and $\theta$ merely determine whether low types consume a good with strictly positive quality or zero quality. The monopolist's equilibrium menu maximises her expected profit subject to individual

[20] While the classic reference is Mussa and Rosen (1978), there are many textbook treatments, such as Salanié (1997).

rationality and incentive compatibility constraints for both types of consumer. These constraints are:

$$q_{LR} - p_{LR} \geq 0 \; (IR_L) \tag{3.9}$$

$$q_{LR} - p_{LR} \geq q_{HR} - p_{HR} \; (IC_L) \tag{3.10}$$

$$\theta q_{HR} - p_{HR} \geq 0 \; (IR_H) \tag{3.11}$$

$$\theta q_{HR} - p_{HR} \geq \theta q_{LR} - p_{LR} \; (IC_H) \tag{3.12}$$

As is normal, at the optimum the low type's individual rationality constraint and the high type's incentive compatibility constraint bind. Under asymmetric information the high types may want to buy the low type bundle, but the converse is not true. Therefore, high types receive an information rent while low types are restricted to 0 utility.

There is also the famous 'no distortion at the top' result and so the quality of the high type good is always efficient (equal to the quality produced in the symmetric information case). When $1 \geq \lambda\theta$ (using '$iR$' to denote the equilibrium level for type $i$ in this rational benchmark) the optimal menu consists of bundles with quality:

$$q_{HR} = \theta \text{ and } q_{LR} = \frac{1 - \lambda\theta}{(1 - \lambda)} \tag{3.13}$$

And these goods are sold at the prices:

$$p_{HR} = \frac{\theta(\theta - 1) + 1 - \lambda\theta}{(1 - \lambda)} \text{ and } p_{LR} = \frac{1 - \lambda\theta}{(1 - \lambda)} \tag{3.14}$$

Meanwhile when $1 < \lambda\theta$ the optimal menu sets $q_{HR} = \theta$, $p_{HR} = \theta^2$ and $q_{LR} = p_{LR} = 0$.

When $1 \geq \lambda\theta$, the monopolist's profit is:

$$\frac{1}{(1 - \lambda)} \left( \frac{1}{2} - \lambda\theta + \frac{\lambda\theta^2}{2} \right) \tag{3.15}$$

And when $1 < \lambda\theta$, the monopolist's profit is:

$$\frac{\lambda\theta^2}{2} \tag{3.16}$$

Therefore asymmetric information is always costly to the monopolist in this rational benchmark model – the monopolist either foregoes profit by ensuring that high types do not wish to purchase the low type bundle (information rent), or by solely serving the high types and not serving the low types.

## 3.4 Focusing Thinkers

*Focusing thinkers* focus more on attributes which vary more in the consideration set. Consider a menu of price-quality bundles: $\{(p_H, q_H), (p_L, q_L), (0, 0)\}$, where $q_H \geq q_L \geq 0$ and $p_H \geq p_L \geq 0$. The consumers' underlying *experienced utility* is identical to a rational consumer's utility function and is therefore given by:

$$U_i(p, q) = \theta_i q - p \text{ for } i \in \{L, H\} \tag{3.17}$$

Focusing changes consumers' *decision utility* functions. Each good has two attributes, the utility from quality $q$ and the disutility from paying price $p$. The range in disutility of prices is therefore given by $p_H - 0 = p_H$ for high and low type consumers, while the range in the utility of quality is given by $\theta q_H - 0 = \theta q_H$ for high types and simply $q_H$ for low types. I use a step function (with $0 < \delta \leq 1$) to capture the focusing thinkers' salience weights. Therefore, a high type consumer's decision utility from a bundle $(p, q)$ is:

$$U_H(p, q) = \begin{cases} \theta q - \delta p, & \text{if } \theta q_H > p_H \\ \theta q - p, & \text{if } \theta q_H = p_H \\ \delta \theta q - p, & \text{if } \theta q_H < p_H \end{cases} \tag{3.18}$$

Similarly for the low type consumers, decision utility for a bundle $(p, q)$ is:

$$U_L(p, q) = \begin{cases} q - \delta p, & \text{if } q_H > p_H \\ q - p, & \text{if } q_H = p_H \\ \delta q - p, & \text{if } q_H < p_H \end{cases} \tag{3.19}$$

These utility functions capture the idea that consumers focus more on attributes that vary more widely in a consideration set. The step function is a special case of Kőszegi and Szeidl (2013) which makes for a tractable model and leads to analytic solutions for the monopolist's optimal menu.

### 3.4.1 Symmetric Information

What is the monopolist's profit maximising choice of bundle in the symmetric information case? In answering this question an issue emerges with salient thinkers which is not present with rational agents – namely, which items are in a consumer's consideration set?

Suppose first that consumers only consider items which they are able to buy. For example, this means that a low type consumer does not consider a good which the monopolist only sells to high types.[21] Moreover, a consumer does not consider any good listed on the menu which is not actually available to purchase. An example where this would be reasonable is in transport – if a commuter needs to arrive at a train station by 8.30am then the price of trains arriving later arguably should not be relevant. In this case, the following results hold:

**Lemma 3.4.1** *In the symmetric information case facing focusing thinkers who only consider items available to buy, the monopolist sells goods with quality and price given by:*

$$q_i^* = \theta_i,\ p_i^* = \theta_i^2$$

*where $\theta_i = 1$ for low types and $\theta > 1$ for high types.*

Intuitively,[22] in a menu of two goods (in this case, the good $q_i^*, p_i^*$ and the null good $0, 0$) a focusing thinker makes a balanced choice which is therefore rational. Hence the monopolist knows that she can sell a good if and only if $\theta_i q \geq p$ and so the problem is identical to facing rational thinkers.

In the case where goods have a single quality attribute (which I maintain throughout this paper) there is no incentive for the monopolists to market any additional goods, including decoys. This is a result pointed out in Dahremöller and Fels (2015):

[21] This is equivalent to supposing there is only one type of consumer in the population.
[22] Proofs not in the main body of text are contained in Appendices 3.A and 3.B.

**Lemma 3.4.2** *In the symmetric information case facing focusing thinkers who only consider items available to buy, the monopolist has no incentive to add a decoy good to the menu.*

Decoy goods are useful to the monopolist if they meet two criteria. First, they need to increase the range of quality, so that quality is more salient than price. This leads consumers to spend more on other items. Second they cannot be desirable themselves – a good is no longer a decoy if consumers purchase it. However, no good satisfies both criteria in this setting. Without decoys, the monopolist already needs to ensure that $\theta_i q \geq p$ in order to sell $(p, q)$. If the monopolist introduces a decoy whose quality utility strictly surpasses its price disutility, consumers then purchase this decoy good instead of $(p, q)$. Having a lower price to quality ratio, this would reduce profits. On the other hand, if the decoy makes price more salient, then the monopolist has to decrease the price $p$ of the primary good in order to continue to sell it. This again reduces the profits made by the monopolist. Therefore there is no benefit to decoy goods with focusing thinkers in this setting, under the assumption that consumers only consider goods that are available to them. Consequently the analysis is essentially identical to the rational consumer case.

However, if consumers include in their consideration set goods which are unavailable to purchase,[23] there is clearly a different optimal menu. In the symmetric information case this means that the monopolist can advertise a decoy good with a high quality to price ratio. Despite the fact that this decoy good is unavailable to consumers, it is nevertheless in the consumers' consideration sets, increasing their focus on quality relative to price. The following lemma holds:

**Lemma 3.4.3** *In the symmetric information case facing focusing thinkers who consider all items a monopolist advertises, the monopolist sells a bundle which satisfies:*

$$q_i^* = \frac{\theta_i}{\delta},\ p_i^* = \frac{\theta_i^2}{\delta^2}$$

[23] An assumption maintained by Cunningham (2012) for example, who supposes that decision makers take into account options that were available to them in previous choices.

*where $\theta_i = 1$ for low types and $\theta > 1$ for high types.*

*The monopolist also advertises a decoy good, $q_d^*, p_d^*$, which satisfies:*

$$\min_i \theta_i q_d^* > p_d^*$$

It is vital that the consumer is not permitted by the monopolist to consume $q_d^*, p_d^*$, since consumers would prefer this to $q_i^*, p_i^*$. Under these conditions, the optimal decoy is the most expensive and highest quality item on the menu.[24]

### 3.4.2 Asymmetric Information

Now consider the case in which the monopolist cannot distinguish between different types of consumer – all she knows is that a proportion $\lambda \in (0, 1)$ of consumers are high types (with $\theta_H = \theta > 1$) and the remainder of consumers are low types (with $\theta_L = 1$). Throughout this section I assume that every item in the monopolist's menu is available to purchase and in the consumers' consideration set. Hence the relevant symmetric information first best is given by Lemma 3.4.1. This assumption meant that decoy goods were always ineffective in the symmetric information case. Under asymmetric information, the assumption continues to limit the effectiveness of decoys when consumers are focusing thinkers. However, as will be seen below, there is a subset of cases in which the monopolist's optimal menu contains a decoy.

Solving immediately for the monopolist's unrestricted optimal menu, would add a layer of complexity that reduces the clarity of the results. Therefore, to help present the intuition as clearly as possible, I initially find the optimal menu assuming that decoy goods are not allowed, before relaxing that assumption later. Doing this divides $\delta - \theta$ space into four distinct regions, in each of which the monopolist chooses a different menu of products. These four regions help to convey

[24] Thus focusing may offer a partial explanation of why high-end products are often marketed to low-income consumers – even if consumers cannot afford these products, if they are present in a consumer's consideration set then they may make quality more salient to the consumer. Vikander (2011) provides several examples of such advertising (such as Audi advertising a very expensive sports car during Super Bowl XLII) but outlines a social status signalling model which could explain such advertising.

how focusing affects the monopolist's optimal menu. First, the following three equations demarcate the parameter space. Let:

$$\theta^{Black} = \frac{\delta(1+\delta-\lambda+\delta\lambda)+\delta\sqrt{(1-\delta)(1-\lambda)(1-\lambda+\delta(3+\lambda))}}{2} \tag{3.20}$$

$$\theta^{Blue} = \frac{\delta^2(1+\lambda)+\delta^2\sqrt{(1-\lambda)(4\delta-3-\lambda)}}{2(1-\delta+\delta\lambda)} \tag{3.21}$$

$$\theta^{Red} = \frac{\delta^2}{1-\delta} \tag{3.22}$$

There is also one critical value of $\lambda$:

$$\lambda^* = \frac{-B+\sqrt{B^2-4AC}}{2A} \tag{3.23}$$

where:

$$A = \theta^2(\theta-\delta)^2,\ B = \delta(2(1-\delta)\theta^3 - (2+\delta-2\delta^2)\theta^2 + 2\delta\theta - \delta^3)$$

and

$$C = -(1-\delta^2)(1-\delta)^2\theta^2$$

Figures 1, 2 and 3 below illustrate the four regions of $\delta - \theta$ space for different values of $\lambda$. In each region the optimal menu is different. The figures demonstrate that changes to $\lambda$ make some small changes to the values of $\theta$ and $\delta$ which are included in each region, but qualitatively there is no significant effect.

Whenever the monopolist separates the two types of consumer, the menu satisfies $\theta q_H > p_H > q_H$: in other words the high types focus on quality and the low types focus on price. This fact drives all of the changes to the monopolist's optimal menu which are caused by focusing. The focusing causes two key effects. First it leads to an exaggeration of the difference between the two types: the high types' decision utility function leads them to have a higher willingness to pay than their experienced utility implies; conversely, the low types have a lower willingness to pay. This helps to loosen the high type's incentive compatibility constraint. Secondly the focusing now ensures that the low types receive strictly positive experienced utility

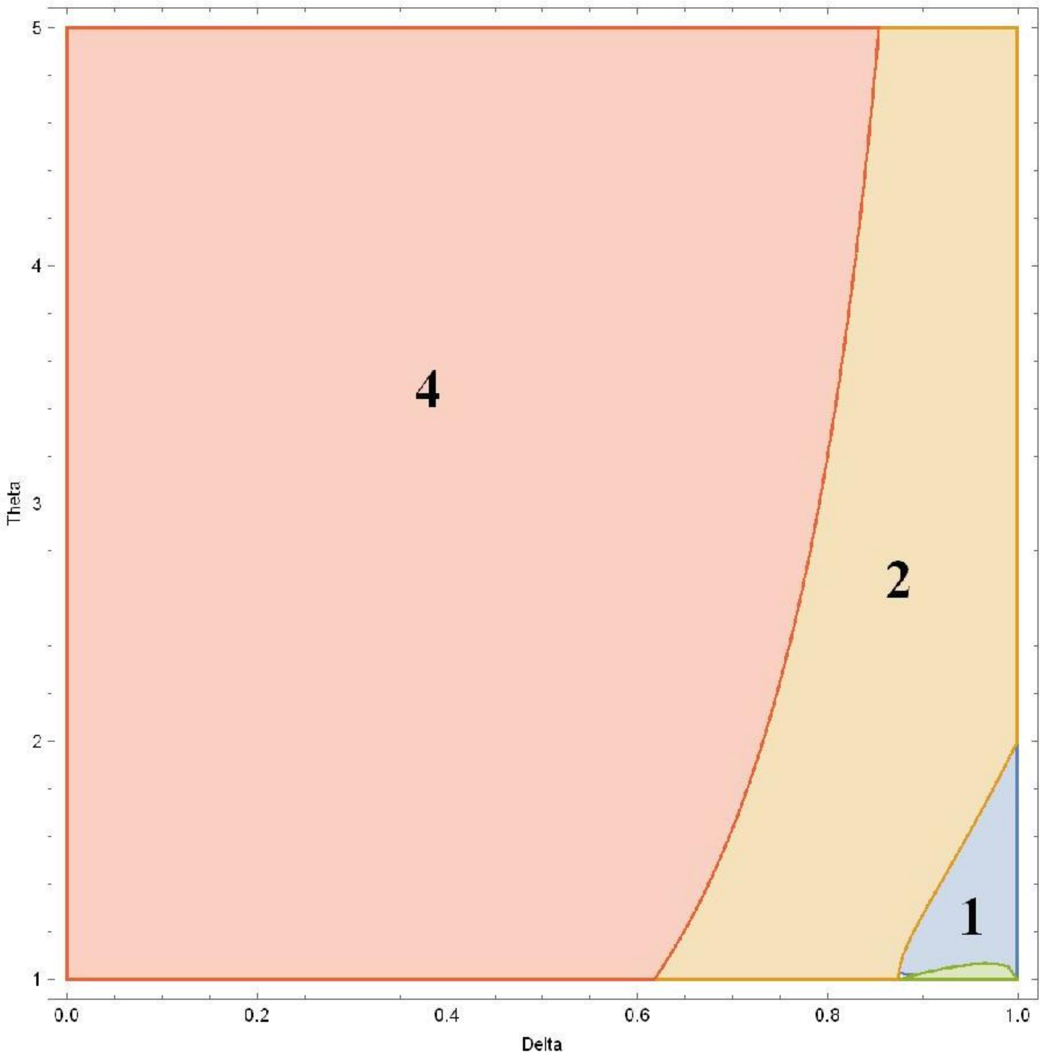


**Figure 3.1:** Focusing Equilibrium Regions: $\lambda = \frac{1}{2}$

whenever they consume a product with strictly positive quality.[25] This reduces the profit the monopolist earns from the low types and can make it harder to separate the two types, since the low types receive a better deal than in the benchmark model. The relative strength of these two effects varies in the four regions of $\delta - \theta$ space, leading to the differences in the optimal menus between the regions.

The following four propositions describe the monopolist's menu in each of the four regions. The first two describe regions 1 (blue area) and 2 (yellow area) which include the case where $\delta = 1$. As one would expect, in both cases the optimal menu tends towards the optimal menu in the benchmark model as $\delta$ tends towards 1. In

[25] I label this a 'focusing rent' in Proposition 3.4.9 below.

region 1 the menu is an exact equilibrium but in region 2 I find an approximate equilibrium due to the consumers' discontinuous salience weighting functions:

**Proposition 3.4.4** *Assume that the monopolist does not use decoy goods. The monopolist is in region 1 when* $\delta \geq \frac{3}{4}$ *and:*

$$\theta^{Black} < \theta < \theta^{Blue} \tag{3.24}$$

$IC_H$ *and* $IR_L$ *bind and the monopolist sells products with quality:*

$$q_H = \frac{\theta}{\delta} \text{ and } q_L = \frac{\delta^2 - \lambda\theta}{(1-\lambda)\delta} \tag{3.25}$$

*and respective prices:*

$$p_H = \frac{\theta^2 - \delta^2(1+\lambda)\theta + \delta^4}{\delta^2(1-\lambda)} \text{ and } p_L = \frac{\delta^2 - \lambda\theta}{(1-\lambda)} \tag{3.26}$$

This part of the menu is just like the benchmark menu when $1 \geq \lambda\theta$ but distorted to reflect the fact that consumers are focusing thinkers with $\delta \leq 1$. The low types' focus on price and the subsequently higher experienced utility they receive is the dominant effect here. It explains why quality increases in the high type bundle but decreases in the low type bundle, relative to the benchmark optimum. The $IC_H$ constraint is now more demanding and high type decision utility needs to increase in order for high types to prefer their bundle over the low type bundle.

**Proposition 3.4.5** *Assume that the monopolist does not use decoy goods. The monopolist is in region 2 when* $\delta \geq \frac{3}{4}$ *and:*

$$\theta^{Blue} < \theta < \theta^{Red} \tag{3.27}$$

*or when* $\delta < \frac{3}{4}$ *and* $\theta < \theta^{Red}$*, then if* $\lambda > \lambda^*$*, then* $IC_H$*,* $IR_L$ *and* $IR_H$ *bind and the monopolist sells products with quality:*

$$q_H = \frac{\theta(\theta-\delta^2)(\lambda(\theta-\delta^2) + \delta(1-\delta)(1-\lambda))}{\lambda(\theta-\delta^2)^2 + (1-\delta)^2(1-\lambda)\theta^2} \tag{3.28}$$

$$q_L = \frac{\theta^2(1-\delta)\left(\lambda(\theta-\delta^2) + \delta(1-\delta)(1-\lambda)\right)}{\lambda(\theta-\delta^2)^2 + (1-\delta)^2(1-\lambda)\theta^2} \tag{3.29}$$

*and respective prices:*

$$p_H = \theta q_H - \xi \text{ and } p_L = \frac{\delta(1-\delta)\theta^2\left(\lambda(\theta-\delta^2)+\delta(1-\delta)(1-\lambda)\right)}{\lambda(\theta-\delta^2)^2+(1-\delta)^2(1-\lambda)\theta^2} \tag{3.30}$$

*where $\xi > 0$ when $\delta < 1$ (and $\xi = 0$ for $\delta = 1$). But if $\lambda < \lambda^*$ then the monopolist pools the two types of consumer, setting $q_H = q_L = 1$ and $p_H = p_L = 1$.*

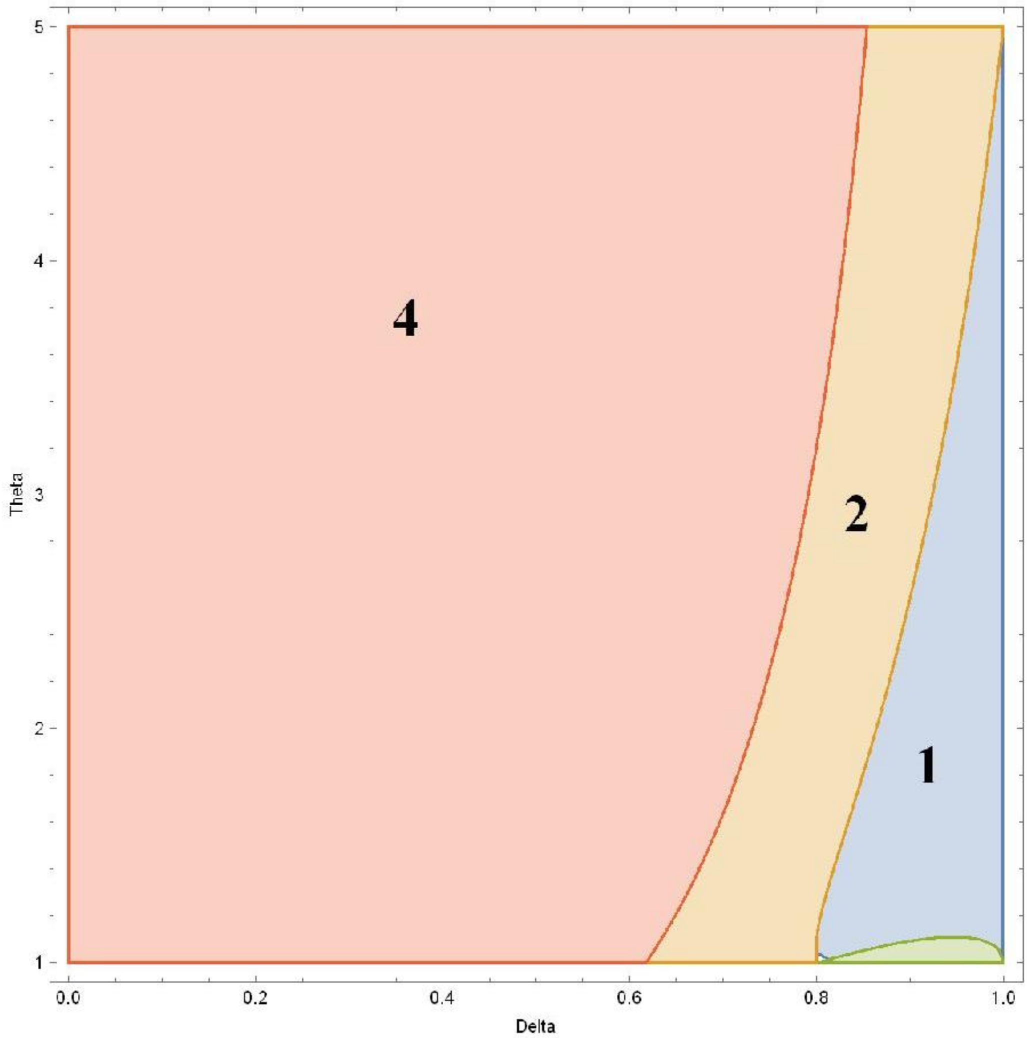


**Figure 3.2:** Focusing Equilibrium Regions: $\lambda = \frac{1}{5}$

As long as the proportion of high types is sufficiently large, then the menu in region 2 is just like the benchmark menu when $1 < \lambda\theta$ in the benchmark model, but distorted when $\delta < 1$. Of particular interest is the fact that in region 2 low types consume a good with strictly positive quality whenever $\delta < 1$.[26] When $\delta < 1$ the monopolist is better off leaving $\xi > 0$ surplus with the high types and this allows the monopolist to additionally serve the low types. The monopolist is able and is willing to do this is that because the focusing effect which exaggerates the difference between the two types of consumer dominates in this region (assuming that $\lambda > \lambda^*$). Essentially the monopolist is willing to sacrifice a second-order decrease in profits on the high types (by setting $p_H = \theta q_H - \xi$) for a first-order increase in profits from serving the low types.

While in region 1 the optimal menu is a Nash equilibrium, in region 2 the menu yields an approximate or $\epsilon$-equilibrium when $\delta < 1$. In region 2 (and 4, as will be seen below) the $\epsilon$-equilibrium implies that the monopolist is satisficing:[27] in particular, for a fixed $\epsilon$ she sets $p_H = q_H - \xi$, where $\epsilon \geq \xi > 0$. For any given choice of $\xi$ the monopolist could increase profits by reducing the difference between $p_H$ and $q_H$ to $\xi/2$. The important insight, however, is that there always exists some value of $\epsilon$ such that the monopolist prefers the menu described in the propositions, over a menu in which $p_H = q_H$ (equivalently $\epsilon = 0$). This is due to the structure of the consumers' decision utility functions: at $\epsilon = 0$ the high type consumers' focus would change so that they give equal weight to quality and price. If this happens then the $IC_H$ constraint would be violated and high type consumers would shift towards buying the low type bundle. I explore both the benefits and disadvantages of examining approximate equilibria, and also alternative approaches to solving the model in Appendix 3.C – this approach appears to be the best compromise between tractability and reducing the number of ancillary assumptions required to generate a result.

While regions 1 and 2 have direct analogues in the rational benchmark model, regions 3 (green area) and 4 (red area) are qualitatively different.

[26] Recall that in the benchmark equivalent of region 2, low types are not served in equilibrium and the monopolist extracts all of the surplus from high types.

[27] Therefore, this means that the monopolist is modelled as being close to but less than fully rational.

**Proposition 3.4.6** *Assume that the monopolist does not use decoy goods. The monopolist is in region 3 when:*

$$\theta < \theta^{Black} \tag{3.31}$$

*then it is optimal for the monopolist to pool the two types of consumers, setting* $q_H = q_L = 1$ *and* $p_H = p_L = 1$

Why does the monopolist pool consumers in region 3? Similarly to region 1 above, low types' focus on price is the dominant effect of focusing in region 3. However, given that $\theta$ and $\delta$ are relatively so small in region 3 this effect becomes so powerful that focusing actually makes it more difficult for the monopolist to separate the two types of consumer. In region 1, $\theta$ was large enough that the monopolist could increase the high type quality in response to this; in region 3 because the two types of consumer are so close to begin with ($\theta$ is so close to 1) it no longer pays to separate the consumers and the monopolist maximises profit by pooling the consumers. This is noteworthy given that the monopolist never pools in the benchmark model.

**Proposition 3.4.7** *Assume that the monopolist does not use decoy goods. The monopolist is in region 4 when:*

$$\theta^{Red} < \theta \tag{3.32}$$

*If it is also true that:*

$$\theta > \sqrt{\frac{1-(1-\lambda)\delta^2}{\lambda}} \tag{3.33}$$

*then* $IR_H$ *and* $IR_L$ *bind and the monopolist sells products with quality:*

$$q_H = \theta \text{ and } q_L = \delta \tag{3.34}$$

*These good are priced respectively at:*

$$p_H = \theta^2 - \epsilon \text{ and } p_L = \delta^2 \tag{3.35}$$

*where* $\epsilon > 0$. *However if:*

$$\theta^{Red} < \theta < \sqrt{\frac{1-(1-\lambda)\delta^2}{\lambda}} \tag{3.36}$$

*then the monopolist pools the two types of consumer, setting* $q_H = q_L = 1$ *and* $p_H = p_L = 1$.

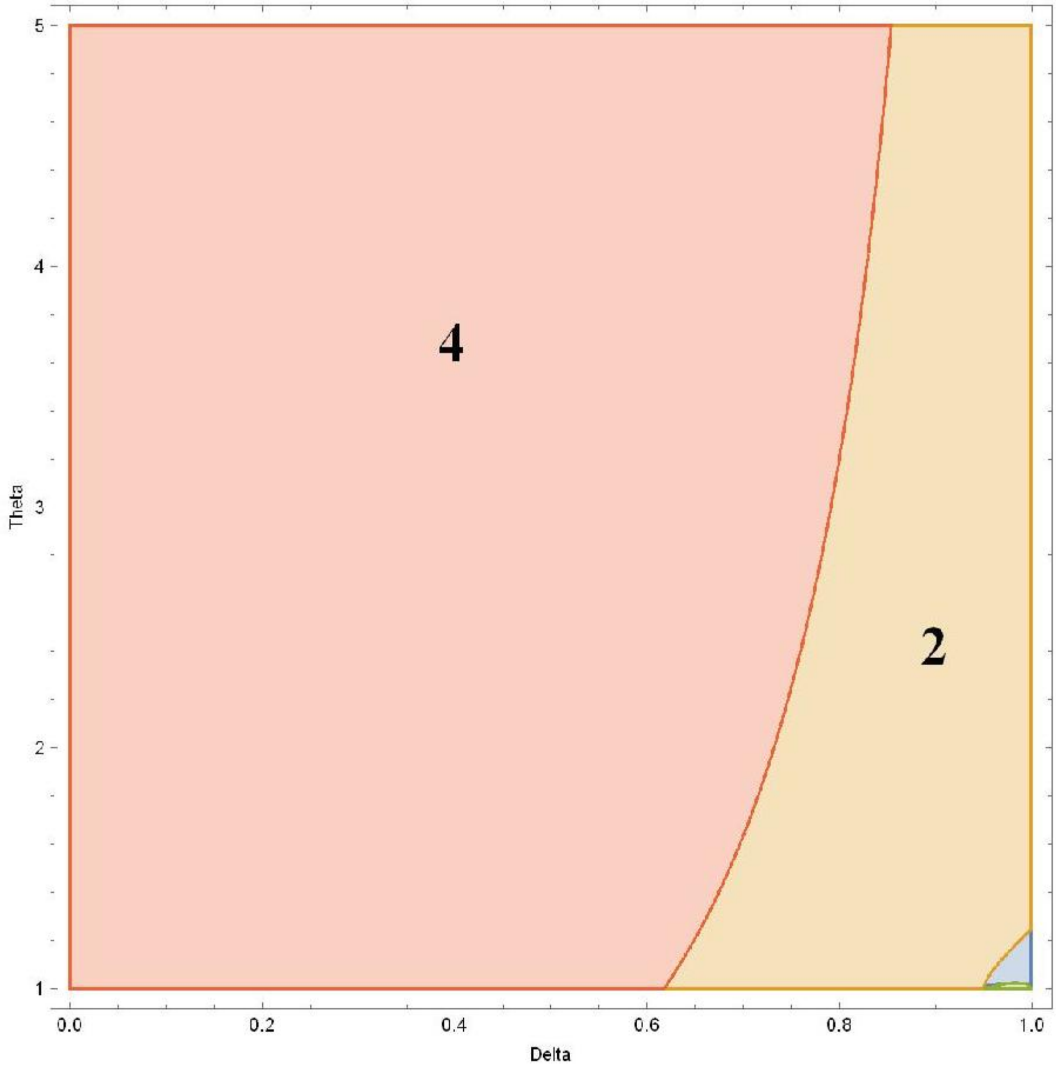


**Figure 3.3:** Focusing Equilibrium Regions: $\lambda = \frac{4}{5}$

Region 4 is the subset of $\delta - \theta$ space in which the advantages of focusing are maximised for the monopolist: the fact that focusing generates a wider gap between high and low types' valuation of quality is completely dominant. For these values of $\theta$ and $\delta$, the firm can serve both types whilst selling (essentially) the first best bundle to high types. Hence in region 4, asymmetric information is no longer as costly to the firm – the $IC_H$ constraint no longer binds. However, the other focusing effect still plays a role, preventing the monopolist from completely eliminating the costs of asymmetric information in this region. Given the low types' focus on price, the monopolist is unable to extract the first-best level of surplus from low types here.[28] Nevertheless, for every $\delta \in (0,1)$, it is optimal for the low types to consume a good with strictly positive quality, whereas for high enough values of $\theta$ (or equivalently $\lambda$) in the benchmark model, the monopolist would choose only to serve the high types. Finally, for low enough $\theta$, the monopolist actually prefers to pool consumers here despite the large profits she can extract from high types (this is for the same reason that pooling is optimal in region 3).

The driver of these changes to the equilibrium menu as $\delta$ decreases from 1 has been the difference in focus of the two types of consumer. Why is this the optimal response of the monopolist to focusing? If $p$ and $q$ are the price and quality of the highest price-quality bundle then there are five possible types of menu:

(i) $p > \theta q (> q)$

(ii) $p = \theta q (> q)$

(iii) $\theta q > p > q$

(iv) $\theta q > p = q$

(v) $(\theta q >) q > p$

As shown in the proof of Propositions 3.4.4-3.4.7, in the absence of decoy goods, conditions (i) and (v) are not optimal– in the first case no one would buy the most expensive bundle;[29] the second case would never be optimal as the firm would always drive the quality of other bundles up to equal $q$ (but if the firm is going to pool then the most profitable menu satisfies condition (iv), rather than condition (v)).

This leaves us with (ii), (iii) and (iv). As alluded to above, the best the monopolist can do under (iv) is to pool the two types and so all menus which serve both types of consumer with different bundles satisfies either (ii) or (iii).

[28] Lemma 3.4.1 illustrates that the first best menu implies that high types would buy a good with quality equal to $\theta$ and price equal to $\theta^2$, while low types would buy a good with quality and price equal to 1. While the high type bundle is essentially the same, the low type bundle generates $\delta^2$ of the profit from low types that the monopolist would receive under the symmetric information first best.

[29] Which would only serve to reduce consumers' willingness to pay for cheaper bundles (by making them focus on prices rather than quality).

Under condition (ii)[30] salience only affects the decision utility of the low type consumers; furthermore it implies that high type consumers receive no information rent (in decision utility) and so the best that the monopolist can do with such a menu is to serve just the high type consumers. Therefore only menus that satisfy condition (iii) allow the monopolist to serve both types of consumer with different bundles of strictly positive quality. Consider the $IR$ and $IC$ constraints for the two types under a (iii) type menu:

$$\delta q_L - p_L \geq 0 \ (IR_L) \tag{3.37}$$

$$\delta q_L - p_L \geq \delta q_H - p_H \ (IC_L) \tag{3.38}$$

$$\theta q_H - p_H \geq 0 \ (IR_H) \tag{3.39}$$

$$\theta q_H - \delta p_H \geq \theta q_L - \delta p_L \ (IC_H) \tag{3.40}$$

The fact that salience alters $IR_L$, $IC_L$ and $IC_H$ in (iii) type menus gives the firm a wider range of possibilities for $\delta < 1$ than for $\delta = 1$. The explanation for why region 4, in which $IC_H$ is slack, is possible for small enough $\delta$ can be seen directly from these constraints. Suppose that $IR_L$ and $IR_H$[31] bind and then consider $IC_H$. This yields:

$$\theta q_H(1-\delta) \geq q_L \left(\theta - \delta^2\right) \tag{3.41}$$

When $\delta = 1$ this can never be true with $q_H \geq q_L > 0$, since the right hand side would be strictly positive and the left hand side would be equal to 0. However as $\delta$ decreases, this inequality can clearly be satisfied for strictly positive $q_H$ and $q_L$. This underpins the existence of region 4 (and also why it is possible for $q_L > 0$ in region 2 when $\delta < 1$). The monopolist is able to extract the first best from high type consumers whilst continuing to serve low types; the cost of doing this is that the saliency of the menu reduces low types' willingness to pay for quality.

[30] Specifically, because $p = \theta q$.

[31] Note that $IR_H$ is $\theta q_H - p_H \geq 0$ and not $\theta q_H - \delta p_H \geq 0$ in order to respect the balanced choice property of Kőszegi and Szeidl (2013).

### 3.4.3 Asymmetric Information – Unrestricted Menus

Allowing decoy goods does not add as many options to the monopolist as one may have expected *ex ante*. (iv) and (v) type menus are not optimal because the decoy good would then be too attractive an option for consumers. It is not profitable to sell goods that would be preferred to such a decoy. Meanwhile the (iii) menu recovers the same menu as in the no decoy case – which is intuitive since the salience weights from the menu are the same in both cases. However (i) and (ii) are sometimes optimal despite leading high types to focus more or equally upon price, thus reducing their willingness to pay for quality. Therefore using decoy goods only makes minor changes to the monopolist's optimal menu but the partition of $\delta - \theta$ space remains the same. There are two new menus which are sometimes optimal:

(I) In this menu, with a decoy good chosen such that $p_d > \theta q_d$ (and $p_d > p_H$ and $q_d > q_H$) the monopolist sells goods with qualities:

$$q_H^* = \delta\theta \text{ and } q_L^* = \frac{\delta(1-\lambda\theta)}{(1-\lambda)} \tag{3.42}$$

and respective prices:

$$p_H^* = \frac{\delta^2(\theta^2 - (1+\lambda)\theta + 1)}{(1-\lambda)} \text{ and } p_L^* = \frac{\delta^2(1-\lambda\theta)}{(1-\lambda)} \tag{3.43}$$

(II) In this menu, with a decoy good chosen such that $p_d = \theta q_d$ (and $p_d > p_H$ and $q_d > q_H$) the monopolist sells goods with qualities:

$$q_H^* = \theta \text{ and } q_L^* = \frac{\delta - \lambda\theta}{(1-\lambda)} \tag{3.44}$$

and respective prices:

$$p_H^* = \frac{\theta^2 - \delta(1+\lambda)\theta + \delta^2)}{(1-\lambda)} \text{ and } p_L^* = \frac{\delta(\delta-\lambda\theta)}{(1-\lambda)} \tag{3.45}$$

Labelling these menus (I) and (II) I now outline the monopolist's optimal behaviour, allowing for the use of decoy goods:

**Theorem 3.4.8** *The monopolist's optimal menu follows the menus outlined in Propositions 3.4.4-3.4.7, with the following exceptions:*

- *In region 2, if:*

$$\tilde{\lambda} = \frac{(1-\delta)^2(1-\delta^2)}{(1-\delta)^2 - 2\delta^3(1-\delta) + \delta^4} \geq \lambda \tag{3.46}$$

*then the monopolist uses the menu outlined in Proposition 3.4.5. However if* $\lambda > \tilde{\lambda}$ *then the monopolist may prefer to use menu (I) or (II).*

- *In region 3, if:*

$$\delta + \sqrt{\left(\frac{1-\lambda}{\lambda}\right)(1-\delta^2)} < \theta < \theta^{Black} \tag{3.47}$$

*then it is optimal for the monopolist to use menu (II). Otherwise, it is optimal for the monopolist to pool the two types of consumers, as in Proposition 3.4.6.*

- *In region 4, if it is also true that:*

$$\theta > \sqrt{\frac{1-(1-\lambda)\delta^2}{\lambda}} \tag{3.48}$$

*it is optimal for the monopolist to use the menu outlined in Proposition 3.4.7. However if:*

$$\theta^{Red} < \theta < \sqrt{\frac{1-(1-\lambda)\delta^2}{\lambda}} \tag{3.49}$$

*then the monopolist uses menu (II) whenever* $\delta^2 > \lambda$ *and:*

$$\sqrt{\frac{1-(1-\lambda)\delta^2}{\lambda}} > \theta > \delta + \sqrt{\left(\frac{1-\lambda}{\lambda}\right)(1-\delta^2)} \tag{3.50}$$

*and she pools the two types as she does in Proposition 3.4.7 whenever* $\delta^2 \leq \lambda$*, or if* $\delta^2 > \lambda$ *and:*

$$\delta + \sqrt{\left(\frac{1-\lambda}{\lambda}\right)(1-\delta^2)} > \theta > \theta^{Red} \tag{3.51}$$

In regions 3 and 4 the new menu (II) can raise the monopolist's profits when she would otherwise pool the two types of consumers. However, in general, decoy goods can only raise profits by a limited extent. In region 1 (where the monopolist never pools) the best that the monopolist can do with a decoy good is exactly the same as the best she can do without a decoy good. This is due to the same logic that gave us lemma 3.4.2 – the difficulty in using decoy goods with focusing thinkers (when there is only one quality and one price attribute) is that a decoy good that raises consumers' willingness to pay must itself be desirable. Therefore the monopolist has to raise the quality/price ratios of the goods they want to sell to ensure that consumers do not prefer to buy the decoy instead. As the next section shows, there are no such problems with relative thinkers.

### 3.4.4 Welfare

Following Kőszegi and Szeidl (2013) I evaluate consumers' welfare using their underlying experienced utility rather than their salience-weighted decision utility. First consider the low type consumers.

**Proposition 3.4.9** *In equilibrium, whenever the monopolist separates the two types of consumer, low types have strictly positive experienced utility, receiving a 'focusing rent' when $\delta < 1$, so long as the quality of their bundle is strictly positive.*

**Proof** In any equilibrium separating menu the top of the range bundle satisfies $p > q$, and thus low type consumers focus more on prices than on quality. Hence, even though $IR_L$ binds in equilibrium, $IR_L$ is a condition on decision utility and therefore:

$$\delta q_L = p_L \Rightarrow q_L - p_L = (1 - \delta)\, q_L \geq 0 \tag{3.52}$$

Where the final inequality is low type consumers' experienced utility and is strict for $\delta < 1$. ∎

Hence, low type consumers prefer that all consumers in the market were focusing thinkers with $\delta < 1$ rather than rational thinkers. They cannot be any worse off if the monopolist pools the consumers, but if the monopolist separates the two types of consumer they are strictly better off, given that, as Theorem 3.4.8 indicates, whenever there is a separating menu with $\delta \in (0, 1)$, low types consume a good with strictly positive quality.

Turning now to the high types, the most striking result is that their welfare can be lower than low types.

**Proposition 3.4.10** *When the monopolist separates the types in region 4 and when she separates the types without using a decoy good in region 2, the high types' experienced utility is less than that for the low types.*

**Proof** In both cases high types consume a good $q_H, p_H$ such that $p_H = \theta q_H - \epsilon$ for some $\epsilon > 0$, which the monopolist sets as close to zero as possible. Meanwhile the low types receive a strictly positive focusing rent, when $\delta \in (0,1)$, since $q_L > 0$.
$\blacksquare$

Clearly, high type consumers are worse off in region 4 then they would be in the rational benchmark, whenever $1 \geq \lambda\theta$. In that case, with $\delta = 1$, they would instead be receiving a positive information rent. When $1 < \lambda\theta$ the high types are no worse off, given that if $\delta = 1$ they alone would be served in equilibrium and therefore restricted to zero utility. So whenever $\delta$ is sufficiently small, the high type information rent in *experienced* utility essentially disappears as a result of the salient thinking of consumers.

Next, consider the monopolist. The key result is that a decrease in $\delta$ is not always desirable from the point of view of the firm.[32]

**Proposition 3.4.11** *In region 1, the firm is worse off relative to the case with rational thinkers if* $\delta > \sqrt{\lambda\theta^2}$ *but is better off if* $\sqrt{\lambda\theta^2} \geq \delta > \sqrt{\lambda\theta}$*.*

Thus if $\sqrt{\lambda\theta^2} \geq 1$, then the firm is always better off in region 1 if the consumers are focusing thinkers. However, if $1 > \sqrt{\lambda\theta^2}$, the firm's profit in region 1 is non-monotonic in $\delta$.

Finally, consider social efficiency and focus upon regions 1 and 4. Throughout the paper when I discuss social efficiency I assume for simplicity that experienced utility provides a unit comparable (across types of consumer), cardinal measure of utility:

**Proposition 3.4.12** *In region 1 social efficiency is always lower for* $\delta < 1$ *than* $\delta = 1$*.*

[32] Indeed, it is clear in region 4 that profits from the optimal separating menu are *increasing* in $\delta$ (since the profit from low types is $(1-\lambda)\delta^2/2$).

**Proposition 3.4.13** *In region 4 social efficiency is higher when the monopolist separates the consumers with $q_H = \theta$ and $q_L = \delta$, than the* ceteris paribus *menu at $\delta = 1$ if and only if:*

$$\theta \geq \frac{1 - \delta + \delta\lambda}{\lambda}$$

These results indicate that the effect on social welfare relative to the rational case is ambiguous. Small deviations from rationality are always worse than the rational benchmark in region 1, but, in contrast, large deviations from rationality tend to increase social welfare. As a final point the effect on social welfare is clearly non-monotonic: welfare has increased once we get into region 4; but once in region 4 social welfare is at its highest when $\delta$ is as high as possible.

### 3.4.5 Stochastic Offers

Before moving on to relative thinking, an aspect of focusing that readers may be interested in, is the possibility that the monopolist could increase profits by making a stochastic offer.[33] I examine this possibility in Appendix 3.D. To summarise, the answer depends upon how stochastic outcomes are evaluated. If the state-by-state approach of Bordalo et al. (2012) is used then the monopolist is able to increase profits by randomising quality; however if the expected utility approach suggested in Kőszegi and Szeidl (2013) is used then the monopolist is no better off making stochastic offers.

## 3.5 Relative Thinkers

*Relative thinkers* focus more on attributes which vary less in the consideration set. Consider again a menu of price-quality bundles: $\{(p_H, q_H), (p_L, q_L), (0, 0)\}$, where $q_H \geq q_L \geq 0$ and $p_H \geq p_L \geq 0$. The consumers' underlying experienced utility is again identical to the rational consumer's utility function and therefore is still the utility function given in equation 3.17.

[33]I thank Mark Armstrong for making this suggestion.

The decision utility function for relative thinkers weights the utility function in the opposite way to focusing. Therefore, a high type consumer's decision utility from a bundle $(p, q)$ is:

$$U_H(p,q) = \begin{cases} \theta q - \delta p, & \text{if } \theta q_H < p_H \\ \theta q - p, & \text{if } \theta q_H = p_H \\ \delta\theta q - p, & \text{if } \theta q_H > p_H \end{cases} \tag{3.53}$$

Similarly for the low type consumers, decision utility for a bundle $(p, q)$ is:

$$U_L(p,q) = \begin{cases} q - \delta p, & \text{if } q_H < p_H \\ q - p, & \text{if } q_H = p_H \\ \delta q - p, & \text{if } q_H > p_H \end{cases} \tag{3.54}$$

Once again the use of the step function is a tractable, special case of the more general model outlined by Bushong et al. (2014). There is one important additional point to emphasise in our application of the utility function above in order to adhere to the assumptions of Bushong et al.. When agents consider the bundle in the choice set which simultaneously has the highest price and highest quality – in this case $(p_H, q_H)$ – it must be the case that they only ever prefer it to the null good when $\theta_i q_H \geq p_H$. This assumption prevents a situation in which an agent is indifferent between a bundle $(p_1, q_1)$ and the null good, but then there exists some $x > 0$ such that the same agent would strictly prefer to buy a bundle $(p_1 + x, q_1)$ over the null good.[34]

### 3.5.1 Symmetric Information

When consumers are relative thinkers, decoy goods are always effective tools for the firm to increase their profits. The monopolist's optimal menu contains a decoy good which is a high price, high quality bundle $(p_d, q_d)$ and primary goods, which are bundles $(p_i, q_i)$.

[34] This also reflects respect for absolute differences in utility as mentioned in section 3.2.

**Proposition 3.5.1** *In the symmetric information case facing relative thinkers, the primary bundles have quality and price given by:*

$$q_i = \frac{\theta_i}{\delta}, \text{ and } p_i = \frac{\theta_i^2}{\delta^2} \tag{3.55}$$

*and the decoy good satisfies:*

$$p_d > \max_i p_i, \; q_d > \max_i q_i, \text{ and } p_d > \frac{\max_i \theta_i q_d}{\delta} \tag{3.56}$$

Essentially, the monopolist is always able to use an expensive decoy good which makes the other items on the menu appear more reasonably priced. The monopolist then chooses a price-quality bundle to maximise profits in the usual way, given that the decoy increases consumers' willingness to pay. Such a decoy can always be constructed and the benefit of doing so is considerable if $\delta$ is small, since the profit with decoy goods is $1/\delta^2$ times larger than the profit the monopolist achieves without decoy goods.

Unlike in the focusing thinker case there is no distinction to be made over which items are in a consumer's consideration set because consumers always prefer consuming the null good to consuming the decoy good. Therefore the monopolist can extract a higher willingness to pay from consumers regardless of whether or not consumers consider goods which are not available to them.

### 3.5.2 Asymmetric Information

Now suppose that the monopolist cannot distinguish between different types of consumer and that a proportion $\lambda \in (0,1)$ of consumers are high types (with $\theta_i = 1$) while the remainder of consumers are low types with ($\theta_i = \theta > 1$). The following theorem describes the monopolist's optimal menu:

**Theorem 3.5.2** *1. If $1 \geq \lambda\theta$ then the optimal menu contains bundles with qualities:*

$$\hat{q}_d, \, \hat{q}_H = \frac{\theta}{\delta} \text{ and } \hat{q}_L = \frac{(1-\lambda\theta)}{\delta(1-\lambda)} \tag{3.57}$$

*And these goods are sold at the prices:*

$$\hat{p}_d,\, \hat{p}_H = \frac{(\theta(\theta-1)+1-\lambda\theta)}{\delta^2(1-\lambda)} \text{ and } \hat{p}_L = \frac{(1-\lambda\theta)}{\delta^2(1-\lambda)} \tag{3.58}$$

*The decoy good satisfies* $\hat{q}_d \geq \hat{q}_H$ *and*

$$\hat{p}_d > \max\left[\theta\hat{q}_d, \frac{\theta(\hat{q}_d - \hat{q}_L)}{\delta} + \frac{\hat{q}_L}{\delta}\right] \tag{3.59}$$

2. *If* $1 < \lambda\theta$ *then the optimal menu contains bundles with qualities:*

$$\hat{q}_d,\, \hat{q}_H = \frac{\theta}{\delta} \text{ and } \hat{q}_L = 0 \tag{3.60}$$

*and prices:*

$$\hat{p}_d,\, \hat{p}_H = \frac{\theta^2}{\delta^2} \text{ and } \hat{p}_L = 0 \tag{3.61}$$

*Where the decoy good satisfies:*

$$\hat{p}_d > \hat{p}_H,\, \hat{q}_d > \hat{q}_H, \text{ and } \hat{p}_d > \frac{\theta\hat{q}_d}{\delta} \tag{3.62}$$

This menu is simply an adjusted version of the optimal rational benchmark menu. There are just two changes: first, $q_H$ and $q_L$ are multiplied by $1/\delta$ with their corresponding prices multiplied by $1/\delta^2$, and second, there is the addition of a decoy good to the menu. In exactly the same way as in the symmetric information case, the expensive decoy changes the perception of both types of consumers, making the other bundles appear more reasonably priced. This allows the monopolist to make higher profits than in the rational benchmark.

Because the decoy good increases the willingness to pay of both types of consumer, the optimal menu satisfies the same qualitative properties as in the benchmark case. The high type incentive compatibility constraint binds in equilibrium, because the high types prefer the first best, low type bundle to the first best, high type bundle. Hence asymmetric information is still costly to the firm since the profits in the symmetric information case exceed profits in the asymmetric information case. However the relative thinking of consumers allows the monopolist to considerably increase profits relative to the benchmark model. This is entirely due to the use of the decoy good.

### 3.5.3 Welfare

**Proposition 3.5.3** *In equilibrium, low type consumers have strictly negative experienced utility – they incur a 'relative thinking penalty' – when they consume a good with strictly positive quality.*

**Proof** In equilibrium $\hat{p}_d > \hat{q}_d$ and $IR_L$ binds. Therefore:

$$\hat{q}_L = \delta\hat{p}_L \Rightarrow \hat{q}_L - \hat{p}_L = \hat{q}_L\left(1 - \frac{1}{\delta}\right) \leq 0 \tag{3.63}$$

Where the inequality illustrates that low type consumers' experienced utility is negative, and it is strict when $\delta < 1$. ∎

**Proposition 3.5.4** *For any fixed $\theta$, high type relative thinkers are always worse off in equilibrium than high type rational thinkers are in the rational benchmark case.*

Hence both types of consumer are worse off as relative thinkers than they would be in the rational benchmark model. Relative thinking, and the use of a decoy good transfers surplus from consumers to the monopolist. In this sense there is a paradox of choice. When consumers are relative thinkers, the monopolist adds a decoy good to her menu; but the extra choice does not increase utility, instead it guarantees weakly lower experienced utility for both high types and low types, despite the fact that $IC_H$ binds.

A surprising implication of the model with relative thinkers is that high types often have lower experienced utility than low types in equilibrium:

**Proposition 3.5.5** *Comparing the experienced utility of high and low type consumers:*

1. *If $1 < \lambda\theta$ then high types are always worse off than low types.*

2. *If $1 \geq \lambda\theta$ and either $\delta < \frac{1}{2}$ or $\lambda > \frac{2\delta-1}{\delta}$ then high types are worse off than low types.*

3. *If* $1 \geq \lambda\theta$ *and both* $\delta \geq \frac{1}{2}$ *and* $\lambda \leq \frac{2\delta-1}{\delta}$*, then whenever:*

$$\theta > \frac{\delta}{1-\delta+\delta\lambda}$$

*high types are worse off than low types.*

An alternative way of looking at this proposition is to say that high types only have higher experienced utility than low types when $\delta \geq \frac{1}{2}$, $\lambda \leq \frac{2\delta-1}{\delta}$, and:

$$1 < \theta \leq \frac{\delta}{1-\delta+\delta\lambda} \tag{3.64}$$

Hence, even though the equilibrium with relative thinkers appears to correspond closely to the rational benchmark case, the use of a decoy good and the difference between decision and experienced utility can cause high types to have worse experienced utility outcomes than low types. And this can be true even when $1 \geq \lambda\theta$ in which case the monopolist is serving both types of consumer and $IC_H$ binds. The gap between decision and experienced utility is therefore enabling the monopolist to appropriate a larger profit by reducing the experienced utility of consumers as, in equilibrium, at least one type of consumer has negative experienced utility.

Finally, turning to social efficiency, the following results hold:

**Proposition 3.5.6** *If* $1 < \lambda\theta$*, then social efficiency is everywhere increasing in* $\delta$*.*

This proposition simply states that whenever the monopolist optimally only serves high types, social efficiency is lower the more pronounced relative thinking is. This is a straightforward corollary of the fact that $\hat{q}_H = \theta/\delta$ is further away from its optimal level, $\theta$, the further $\delta$ is from 1.

This simple intuition does not carry over completely to the situation where the monopolist serves all types of consumers:

**Proposition 3.5.7** *If* $1 \geq \lambda\theta$*, then social efficiency is non-monotonic in* $\delta$*. In particular, there exists a* $D \in (0,1)$ *such that social efficiency is higher for* $\delta \in [D,1)$ *than at* $\delta = 1$*.*

At $\delta = 1$, $\hat{q}_L$ is below its socially optimal level while $\hat{q}_H$ is socially optimal – the famous no distortion at the top result in the rational benchmark. As $\delta$ decreases away from 1, the quality of both goods increases. Before $\hat{q}_L$ reaches its optimal level, a decrease in $\delta$ has two opposing effects on social efficiency – a positive effect reflecting the fact that $\hat{q}_L$ moves closer to its optimal level, 1, and a negative effect reflecting the movement of $\hat{q}_H$ away from $\theta$. It turns out that for $\delta$ close enough to 1, the positive effect always outweighs the negative effect and so social efficiency increases overall. Eventually, however, a point is reached where the $\hat{q}_L$ is above 1 and continues to increase as $\delta$ decreases. Therefore, for $\delta$ any smaller than this level, social efficiency would only decrease if the consumers were more strongly affected by relative thinking.[35]

This illustrates two key points. First, that it is possible for social efficiency to increase even though firms are using menus (here with decoy goods) clearly intended to exploit the salient thinking of consumers. Secondly, it neatly underlines the importance in general of analysing the interaction between behavioural biases and heterogeneous preferences. Social efficiency can never be higher for salient thinkers than rational consumers in this model if there is only one type of consumer: in fact, in the symmetric information case for relative thinkers, social efficiency is strictly increasing in $\delta$.

## 3.6 Screening Rational and Relative Thinkers

The above analysis illustrates that in the case of relative thinkers a well-chosen decoy good helps the monopolist to extract a much larger surplus from consumers. Is it possible that the presence of rational thinkers could protect relative thinkers? On the other side of the coin, does the presence of salient thinkers reduce the welfare of rational consumers in a market?

[35] The results here assume that utility is cardinal and unit comparable across consumers of different type. This implies that the measure of social welfare is weighted towards high type consumers who value quality more strongly. Instead it is possible to transform utility values so that consumers are not weighted by the intensity of their preference for quality. Doing this would strengthen the result, in the sense that a wider range of values of $\delta$ would lead to social efficiency higher than in the rational benchmark model.

Suppose now that all consumers share the same quality price tradeoff in experienced utility, and so a bundle $(p, q)$ yields utility $q - p$.[36] Now suppose that a proportion $(1 - \mu) \in (0, 1)$ of consumers are rational and so choose bundles based upon this experienced utility function, while the other $\mu$ of consumers are relative thinkers maximising a decision utility function as outlined in equation 3.54 above.

Using $d$ as the subscript for the decoy good, $r$ as the subscript for the rational thinker (and their good) and $s$ as the subscript for the relative ($s$ for salient) thinker (and their good), the following theorem describes the monopolist's optimal menu in this model:

**Theorem 3.6.1** *If $\delta \geq \mu$, then the monopolist's optimal menu of price-quality bundles have qualities:*

$$q_d^*,\, q_s^* = \frac{1}{\delta},\; q_r^* = \frac{(\delta - \mu)}{\delta(1-\mu)} \tag{3.65}$$

*and prices:*

$$p_d^*,\, p_s^* = \frac{(\delta(\delta - \mu) + (1-\delta))}{\delta^2(1-\mu)},\; p_r^* = \frac{(\delta - \mu)}{\delta(1-\mu)} \tag{3.66}$$

*where the decoy good $q_d^*$, $p_d^*$ satisfies $p_d^* > q_d^* \geq q_s^*$ and:*

$$p_d^* \geq p_s^* + \frac{(q_d^* - q_s^*)}{\delta} \tag{3.67}$$

*But if $\delta < \mu$ then the monopolist's optimal menu of price-quality bundles have qualities:*

$$q_d^*,\, q_s^* = \frac{1}{\delta},\; \textit{and } q_r^* = 0 \tag{3.68}$$

*and prices:*

$$p_d^*,\, p_s^* = \frac{1}{\delta^2},\; p_r^* = 0 \tag{3.69}$$

*where the decoy good $q_d^*$, $p_d^*$ satisfies:*

$$p_d^* > p_s^*,\; q_d^* > q_s^*,\; \textit{and } p_d^* > \frac{q_d^*}{\delta} \tag{3.70}$$

[36] I set $\theta_i = 1$ in this section of the model given that $\theta_i$ would play no qualitative role in the analysis here.

The story to this equilibrium is straightforward and intuitive. In all cases, the monopolist uses a high price, high quality market leading bundle in order to increase the willingness of relative thinkers to pay for quality. This causes their decision utility function to diverge from those of the rational thinkers – the smaller is $\delta$, the bigger the difference that emerges between the two types of consumer in equilibrium. The problem becomes essentially the same as the benchmark case of screening rational thinkers with different types in Section 3.3 – the relative thinkers play the role of high value types and the monopolist always separates the two types of consumers.

When $\delta < \mu$ the decoy good creates a large difference between rational and relative thinkers, and the proportion of relative thinkers is quite large. Hence the monopolist only serves the relative thinkers. The potential increase in profits from serving the rational thinkers is outweighed by the reduction in profits the monopolist would be forced to absorb on the relative thinkers. They would have to be compensated with an information rent (in decision utility) so that they prefer their bundle to the rational thinker bundle. An alternative interpretation is that rational consumers realise that no product on the monopolist's optimal menu yields positive experienced utility and so do not buy from the monopolist. But this is optimal for the monopolist given the small proportion of rational thinkers in the market.

When $\delta \geq \mu$, the extent to which the decoy good generates a difference between rational and relative thinkers is relatively more modest. The monopolist still separates the two types of consumer but serves both types. The relative thinkers perceive that a middle of the range bundle has the most attractive quality to price ratio of all the options on the menu, because the high price of the market leader leads them to underweight the disutility of price. However, rational thinkers can clearly see that neither the market leading bundle nor the middle of the range bundle would yield positive experienced utility. They find the lowest quality option on the menu in some sense to be a bargain, although in the model here the assumption of profit maximisation means that this bundle restricts them to zero utility.

*Ex ante*, one may have thought that a monopolist could screen the two types at no cost, by using a well-chosen decoy good to exploit the relative thinkers but which has no effect on the rational types. This is not the case for the same reason that high types obtain an information rent in the rational benchmark model of Section 3.3. The relative thinkers would be better off by pretending to be rational types and consuming the rational type bundle. Therefore the relative thinkers' incentive compatibililty constraint is binding in equilibrium.[37]

This seems to capture the type of behaviour consumers often exhibit when they face a drinks menu, perhaps a wine list at a restaurant. The social norm, when faced with restaurant wine lists for non-connoisseurs, is to pick the second cheapest bottle. This norm can inspire a number of different rationales (in particular that there is an aversion to looking 'cheap', both to staff and fellow diners) but the norm is definitely consistent with a belief that the premium paid for the second cheapest bottle compared to the cheapest one is worth it for the perceived increase in quality. Perhaps this belief and the norm itself would be less prevalent if wine lists more frequently featured 2 bottles rather than $N > 2$, of which higher quality bottles are often very expensive.[38] If consumers are, to some extent, relative thinkers then it does seem reasonable to argue that the number of very expensive options on the menu may be designed to lead consumers to spend more than they otherwise would (in a context without the more expensive options). Clearly, the optimal choice of wine is partially determined by a consumer's type[39] but perhaps rational consumers pick the cheapest bottle on the list (or at least the cheapest of the options which are suitable, given their taste for quality).

A final point to note is that the monopolist's profits behave monotonically with respect to $\delta$ and $\mu$:

**Proposition 3.6.2** *The monopolist's profit is decreasing in $\delta$ and increasing in $\mu$.*

[37] Relative thinking distorts preferences but consumers are not oblivious to other items on the menu.

[38] Recall that in models of range-based salience, if goods have only two attributes – here they are quality and price – then at least 3 goods are needed in order for decision utility to diverge from experienced utility.

[39] Do they have a high or low value for good quality wine?

As one would expect the monopolist generates higher profits as consumers become 'less rational' whether this is because the relative thinkers are affected to a larger extent by salience or because they make up a larger proportion of the consumers.

### 3.6.1 Welfare

#### Rational Thinkers

Rational thinkers are restricted to zero utility in every equilibrium, but they receive an inefficient level of quality in the case where the monopolist only serves relative thinkers $(0 < 1)$ and in the case where the monopolist separates relative and rational thinkers:

$$\frac{(\delta - \mu)}{\delta(1-\mu)} < 1 \tag{3.71}$$

Hence, in both cases, rational thinkers receive an inefficiently low quality when in a market with relative thinkers.[40]

#### Relative Thinkers

When $\delta < \mu$, the relative thinkers' experienced utility is:

$$\frac{1}{\delta} - \frac{1}{\delta^2} = -\frac{(1-\delta)}{\delta^2} \tag{3.72}$$

But when $\delta \geq \mu$ their experienced utility is instead:

$$\frac{1}{\delta} - \frac{(\delta(\delta-\mu) + (1-\delta))}{\delta^2(1-\mu)} = -\frac{(1-\delta)^2}{\delta^2(1-\mu)} \tag{3.73}$$

Comparing these expressions yields:

**Proposition 3.6.3** $\forall \delta \in (0,1)$, *relative thinkers are better off when* $\delta \geq \mu$.

Thus, the presence of more rational consumers does raise the experienced utility of relative thinkers and reducing $\mu$ has two beneficial effects on total consumer welfare – firstly, if $\mu$ decreases from above $\delta$ to below $\delta$ then the monopolist optimally serves both rational and relative thinkers which helps to protect relative

[40] Unless $\delta = 1$ or $\mu = 0$, either of which would equate to an absence of relative thinkers in the market.

thinkers. Secondly, further decreases to $\mu$ continue to increase the relative thinkers' experienced utility in equilibrium. Moreover, while the rational thinkers' experienced utility always equals 0, decreasing $\mu$ ensures that the quality they consume is closer to the efficient quality, 1.

Finally consider social efficiency:

**Proposition 3.6.4** *Social efficiency is monotonically increasing in $\delta$.*

**Proof** For the rational thinkers, quality is fixed at 0 when $\delta < \mu$. For $\delta \geq \mu$, the rational good quality is:

$$q_r^* = \frac{(\delta - \mu)}{\delta(1-\mu)} < 1 \text{ with } \frac{\partial q_r^*}{\partial \delta} = \frac{\mu}{\delta^2(1-\mu)} > 0$$

Hence the rational good quality is always weakly increasing from 0 to 1 as $\delta$ increases.

For the relative thinkers, quality is given by $q_s^* = 1/\delta$ which clearly tends to infinity as $\delta$ tends to 0 and is everywhere decreasing in $\delta$.

Therefore, the lower is $\delta$, the further away are $q_r^*$ and $q_s^*$ from the efficient quality 1. ■

This result underlines the fact that the social efficiency result from section 3.5 relies upon heterogeneity of underlying tastes, not heterogeneity of context dependence.

### A Utilitarian Optimum

Finally, a social planner maximising some sum of the consumers' experienced utilities and the firm's profits would clearly wish to pool rational and relative thinkers, since their experienced utility functions are identical. This outcome, however, does not occur in equilibrium with $\delta < 1$ and $\mu > 0$, unless a policy maker restricts the number of goods the monopolist is allowed to list on her menu.

A socially optimal rule of thumb in this model is to restrict a monopolist who lists $n$ non-null goods on her menu in the unrestricted equilibrium, to only being allowed to list $n-1$ goods on her menu instead. When $\delta < \mu$ this means that the monopolist goes from listing 2 goods to listing 1, and since decoys are now impossible to use she optimally pools the two types of consumer. When $\delta \geq \mu$, restricting the monopolist to 2 goods implies that she faces the choice between pooling the consumers or separating the consumers, serving only the relative thinkers while using a decoy good. However, for these parameter values, pooling gives the larger profit of $\frac{1}{2}$ rather than $\frac{\mu}{2\delta}$.

## 3.7 Conclusion

In this chapter I have shown how a monopolist exploits the range-based salience of consumers to extract more surplus from them. When consumers are relative thinkers the equilibrium outcomes resemble the classic rational model, with the exception that a decoy good helps the monopolist to make higher profits. In contrast, when consumers are focusing thinkers there is little benefit to employing a decoy good. In fact when focusing is sufficiently pronounced, it widens the gap between consumers even without a decoy good, allowing the monopolist both to sell the first best bundle to high types and to serve low types – directly reducing the costs of asymmetric information.

Salience also changes the typical welfare conclusions drawn from such a model. Low types' welfare improves when consumers are focusing thinkers, but falls when consumers are relative thinkers. Strikingly, while high types are always weakly better off than low types in the rational benchmark, their welfare can be lower than low types' welfare in both the relative thinking and focusing thinking models. Finally, social efficiency need not be smaller in these markets when consumers exhibit range-based salience, even though the monopolist exploits these preferences to increase her profits. The social efficiency results are crucially intertwined with heterogeneity of consumers' tastes. For example, relative thinking always reduces social welfare when there is one type of consumer; welfare can rise when there are two types.

The permutations of range-based salience discussed in this chapter assume that consumers are either focusing thinkers, relative thinkers or rational thinkers. Furthermore, the analysis here and in other papers assume that consumers act in a particular way across all situations they might encounter. The very fact that there is evidence consistent with both focusing and relative thinking implies that such a fixed assumption represents a significant abstraction from reality; it also offers the tantalising prospect that the way firms market their good may be able to encourage one form of thinking over another. The results in this paper suggest that a monopolist would prefer consumers to be relative thinkers when a good has unidimensional quality and price attributes. This may provide the beginnings of a story for why retailers use the marketing techniques they do, for example the prevalence of "50% off/50% free" stickers on reduced items. However, more research is required on our understanding of salience and context-dependent decision making to satisfactorily achieve this. A particularly important direction for future research is to understand how different forms of context-dependent decision making are linked to each other, when different models are more plausible descriptions of behaviour and how interaction with firms and other institutions might influence the form of context-dependence exhibited by consumers.

# Appendix

## 3.A Short Proofs

**Proof of Lemma 3.4.1** A focusing thinker prefers a bundle $(p, q)$ to the null good whenever $\theta_i q \geq p$. But this is the same constraint the monopolist faces with rational consumers and hence the profit maximising bundle is the same. ∎

**Proof of Lemma 3.4.2** Suppose that a monopolist offers the following menu, $M = \{(p_d, q_d), (p, q), (0, 0)\}$ in which $(p_d, q_d)$ is a decoy good. If the decoy good does not alter the relative ranges of $p$ or $\theta_i q$ then either it has no effect on the consumer – who consumes $(p, q)$ – or it leads the consumer to buy the new decoy good. But if the latter is true then the decoy good is more attractive than the primary bundle $(p, q)$. So if the primary bundle was set optimally, adding this type of decoy good reduces profits.

There are three possibilities if the decoy good changes the menu's range of $p$ and/or $\theta_i q$. First, the decoy good could make $\max_{p \in M}[p] > \max_{q \in M}[\theta_i q]$. This cannot be preferred to having no decoy good, since making the consumer focus on price means that any good that is sold must satisfy $\delta \theta_i q \geq p$. Hence the firm receives less revenue per unit of quality then they would without using a decoy good, reducing profits. Secondly, the decoy good could make $\max_{p \in M}[p] < \max_{q \in M}[\theta_i q]$. If this is the case the consumer either buys the decoy good, which must have $\theta_i q_d > p_d$ or they buy the other bundle which would imply that $\theta_i q > p$. To see this, note that to consume $(p, q)$ implies that:

$$\theta_i q - \delta p \geq \theta_i q_d - \delta p_d \Rightarrow \theta_i q > \theta_i q_d - \delta(p_d - p) \tag{3.74}$$

Suppose that $p \geq \theta_i q$. Combining the two conditions produces a contradiction. Consider the implied necessary condition:

$$p > \theta_i q_d - \delta(p_d - p) \Leftrightarrow \delta(p_d - p) > \theta_i q_d - p \tag{3.75}$$

The decoy ensures that $\max_{q \in M}[\theta_i q] = \theta_i q_d > \max_{p \in M}[p]$ and so the right hand side is greater than $(p_d - p)$, let alone $\delta(p_d - p)$. Thus we have our contradiction.

Finally the decoy good could make $\max_{p \in M}[p] = \max_{q \in M}[\theta_i q]$ but then we are back to the standard condition needed for the consumer to purchase a bundle – one of the bundles needs to satisfy $\theta_i q \geq p$ – and therefore the firm is no better off. ∎

**Proof of Lemma 3.4.3** Advertising a decoy good with $\min_i \theta_i q_d^* > p_d^*$ ensures that each type of consumer focuses more upon quality than price. Given that there are no incentive compatibility constraints, the monopolist therefore maximises profit from each type of consumer subject to the constraint:

$$\theta_i q_i - \delta p_i \geq 0 \tag{3.76}$$

The conclusion in the lemma follows directly. ∎

**Proof of Proposition 3.4.11** The profit in region 1 is bigger for $\delta < 1$ compared to $\delta = 1$ whenever:

$$\frac{1}{(1-\lambda)}\left(\frac{\delta^2}{2} - \lambda\theta + \frac{\lambda\theta^2}{2\delta^2}\right) \geq \frac{1}{(1-\lambda)}\left(\frac{1}{2} - \lambda\theta + \frac{\lambda\theta^2}{2}\right) \tag{3.77}$$

$$\therefore \frac{\lambda\theta^2}{2\delta^2}\left(1-\delta^2\right) \geq \frac{1-\delta^2}{2} \Leftrightarrow \lambda\theta^2 \geq \delta^2 \tag{3.78}$$

Hence the monopolist makes higher profits from focusing thinkers than rational thinkers in this equilibrium when $\delta \leq \sqrt{\lambda}\theta$, but conversely when $\delta > \sqrt{\lambda}\theta$ the firm makes higher profits from rational consumers. ∎

**Proof of Proposition 3.4.12** By incorporating consumers' experienced utility with the monopolist's costs of producing quality, social welfare is given by:

$$\lambda\left(\theta q_H - \frac{q_H^2}{2}\right) + (1-\lambda)\left(q_L - \frac{q_L^2}{2}\right)$$

This is clearly maximised at $q_H = \theta$ and $q_L = 1$ so the welfare loss from bundles with $\hat{q}_H$ and $\hat{q}_L$ is:

$$-\frac{\lambda\theta}{2}(\theta - \hat{q}_H)^2 - \frac{(1-\lambda)}{2}(1 - \hat{q}_L)^2$$

So at $\delta = 1$, given that $1 \geq \lambda\theta$, $\hat{q}_H = \theta$ and $\hat{q}_L = \frac{1-\lambda\theta}{1-\lambda}$, so the welfare loss in the rational case is:

$$-\frac{\lambda^2(\theta-1)^2}{2(1-\lambda)}$$

But when $\delta < 1$, $\hat{q}_H = \frac{\theta}{\delta}$ and $\hat{q}_L = \frac{\delta^2 - \lambda\theta}{\delta(1-\lambda)}$. $\hat{q}_H$ is now greater than $\theta$ and $\hat{q}_L$ is smaller (and therefore further away from 1) than when $\delta = 1$. Therefore the welfare loss is greater when $\delta < 1$. ∎

**Proof of Proposition 3.4.13** If $\lambda\theta > 1$ then when $\delta = 1$ the monopolist would set $q_H = \theta$ and $q_L = 0$; the region 4 separating menu is socially more efficient because $q_H$ is optimal and $q_L = \delta > 0$ is closer to the efficient level of 1.

When $\lambda\theta \leq 1$ in the rational benchmark, $q_H = \theta$ and $q_L = \frac{1-\lambda\theta}{1-\lambda}$. The region 4 menu is more efficient whenever its low type quality is closer to 1 than the low type quality in the rational benchmark menu. This is equivalent to:

$$\delta > \frac{1-\lambda\theta}{1-\lambda} \Leftrightarrow \theta \geq \frac{1-\delta+\delta\lambda}{\lambda} \tag{3.79}$$

Note that if $\lambda\theta > 1$ then the inequality in 3.79 must hold. ∎

**Proof of Proposition 3.5.1** Consider a decoy good with $p_d > \max_i \theta_i q_d$ and which has both a higher price and quality than the primary goods ($p_d > \max_i p_i$ and $q_d > \max_i q_i$), i.e. the decoy is non-dominated. Consumers prefer the null good to the decoy good, but its presence leads relative thinkers to place more weight on quality than price in their decision utility function. Hence consumers are willing to buy bundle $(p_i, q_i)$ if it satisfies $\theta_i q_i - \delta p_i \geq 0$. Profit maximisation over this participation constraint yields the optimal bundles in the proposition. Note that this increases profits relative to not using a decoy good since the monopolist can now extract a higher price per unit of quality (without a decoy good the participation constraint would instead be $\theta_i q_i - p_i \geq 0$).

Finally I check that consumers prefer the primary good to the decoy good, ruling out cycles in preferences. The condition which needs to be satisfied is:

$$\theta_i q_i - \delta p_i \geq \theta_i q_d - \delta p_d \Leftrightarrow p_d \geq \frac{\theta_i q_d}{\delta} \tag{3.80}$$

If this is true for the largest value of $\theta_i$, it is true for all $\theta_i$. ∎

**Proof of Theorem 3.5.2** A decoy with $p_d > \theta q_d$ maximises the willingness to pay of all consumers as it leads both types of consumer to place more decision weight on quality than on price. Therefore, for any optimal choice of $q_L$ and $q_H$ under another regime, the monopolist would maximise her revenue by adding a decoy good to the menu. Finally, using a decoy is the only way to lead both types to place more decision weight on quality than price – no consumer would buy the decoy as it does not satisfy the $IR_H$ condition since it is not preferred to the null good. So without a decoy the most expensive good would have to satisfy $\theta q_H \geq p_H$ and so at least one type of consumer must have a lower willingness to pay for quality.

The monopolist's optimal menu maximises the firm's expected profits subject to the $IR_L$, $IC_L$, $IR_H$ and $IC_H$ constraints. As in the standard case, $IR_L$ and $IC_H$ are the active constraints and the optimal qualities and prices are exactly as in the benchmark if the disutility of spending $p$ is $\delta p$ for both high and low types (rather than simply being $p$ as normal).

Finally both types must prefer their good to the decoy good to rule out preference cycles. When $1 < \lambda\theta$ this simply means that:

$$\theta \hat{q}_H - \delta \hat{p}_H = 0 \geq \theta \hat{q}_d - \delta \hat{p}_d \Leftrightarrow \hat{p}_d \geq \frac{\theta \hat{q}_d}{\delta} \tag{3.81}$$

And when $1 \geq \lambda\theta$ this implies, for the high types:

$$\theta \hat{q}_H - \delta \hat{p}_H = \theta \hat{q}_L - \delta \hat{p}_L = \hat{q}_L(\theta - 1) \geq \theta \hat{q}_d - \delta \hat{p}_d \tag{3.82}$$

$$\Leftrightarrow \hat{p}_d \geq \frac{\theta(\hat{q}_d - \hat{q}_L)}{\delta} + \frac{\hat{q}_L}{\delta} \tag{3.83}$$

While for the low types:

$$\hat{q}_L - \delta \hat{p}_L = 0 \geq \hat{q}_d - \delta \hat{p}_d \Leftrightarrow \hat{p}_d \geq \frac{\hat{q}_d}{\delta} \tag{3.84}$$

This second condition is always less restrictive than the first, since $\hat{q}_d > \hat{q}_L$ and $\theta > 1$ ∎

**Proof of Proposition 3.5.4** High type welfare is given by:

$$\frac{\theta^2}{\delta} - \frac{(\theta(\theta-1)+1-\lambda\theta)}{\delta^2(1-\lambda)} = \frac{\theta^2(-1+\delta(1-\lambda))+(1+\lambda)\theta-1}{\delta^2(1-\lambda)} \tag{3.85}$$

So welfare is lower for $\delta < 1$ than for $\delta = 1$ whenever:

$$\frac{\theta^2(-1+\delta(1-\lambda))+(1+\lambda)\theta-1}{\delta^2(1-\lambda)} < \frac{\theta^2(-\lambda)+(1+\lambda)\theta-1}{(1-\lambda)} \tag{3.86}$$

$$\therefore 0 < \theta^2(1+\delta\lambda) - (1+\lambda)(1+\delta)\theta + (1+\delta) \tag{3.87}$$

The determinant of this polynomial is:

$$(1+\delta)(\lambda^2(1+\delta)+2(1-\delta)\lambda-(3-\delta)) \tag{3.88}$$

The critical values of $\lambda$ at which the determinant is equal to 0 are:

$$\frac{-3+\delta}{1+\delta} \text{ and } 1 \tag{3.89}$$

Since $\lambda \in (0,1)$, it is always between these critical values and thus the determinant is always negative. Therefore the original inequality is satisfied for all $\theta$. ∎

**Proof of Proposition 3.5.5** Part 1 of the proposition is clear from inspection of $\hat{q}_H$ and $\hat{p}_H$, meaning therefore that high types' experienced utility is negative and noting that since $\hat{q}_L$ and $\hat{p}_L$ are both equal to 0, low types have 0 experienced utility. Parts 2 and 3 establish values of $\theta$ and $\delta$ satisfying the following inequality (comparing high type and low type experienced utility for $1 \geq \lambda\theta$):

$$\frac{\theta^2(-1+\delta(1-\lambda))+(1+\lambda)\theta-1}{\delta^2(1-\lambda)} \geq \frac{-(1-\delta)(1-\lambda\theta)}{\delta^2(1-\lambda)} \tag{3.90}$$

This is equivalent to:

$$0 \geq \theta^2(1-\delta+\delta\lambda) - \theta(1+\delta\lambda) + \delta \tag{3.91}$$

The critical values of $\theta$ between which the inequality holds are:

$$1 \text{ and } \frac{\delta}{1-\delta+\delta\lambda}$$

The second critical value is only larger than 1 when we have:

$$\delta > \frac{1}{2} \text{ and } \lambda < \frac{2\delta - 1}{\delta}$$

Hence whenever these conditions are not met, it must be the case that high types are worse off than low types (part 2). However, when these conditions are met, then high types are worse off than low types (part 3) only if we also have:

$$\theta > \frac{\delta}{1 - \delta + \delta\lambda}$$

$\blacksquare$

**Proof of Proposition 3.5.6** In equilibrium when $1 < \lambda\theta$, high types consume a good with quality $\hat{q}_H = \theta/\delta$ and low types do not purchase any good. Since the efficient qualities are respectively $\theta$ and 1, for $\delta \in [0, 1]$ an increase in $\delta$ moves $\hat{q}_H$ closer to its efficient level, while the low type quality does not change. Therefore social efficiency is increasing in $\delta$. $\blacksquare$

**Proof of Proposition 3.5.7** When $1 \geq \lambda\theta$ the equilibrium qualities are $\hat{q}_H = \theta/\delta$ and $\hat{q}_L = (1 - \lambda\theta)/(\delta(1 - \lambda))$. Let $q_L^* = (1 - \lambda\theta)/(1 - \lambda)$, so that $\hat{q}_L = q_L^*/\delta$. The welfare loss, relative to the symmetric information first best is:

$$L = \frac{\lambda\theta^3}{2}\left(\frac{1-\delta}{\delta}\right)^2 + \frac{1-\lambda}{2}\left(1 - \frac{q_L^*}{\delta}\right)^2$$

Welfare is higher than in the benchmark case when $\delta$ satisfies:

$$\frac{\lambda\theta^3}{2}\left(\frac{1-\delta}{\delta}\right)^2 + \frac{1-\lambda}{2}\left(1 - \frac{q_L^*}{\delta}\right)^2 \leq \frac{1-\lambda}{2}(1 - q_L^*)^2$$

$$\Leftrightarrow \frac{\lambda\theta^3}{2}\left(\frac{1-\delta}{\delta}\right)^2 \leq \frac{1-\lambda}{2}\left(2q_L^*\left(\frac{1-\delta}{\delta}\right) - q_L^{*2}\left(\frac{1-\delta^2}{\delta^2}\right)\right)$$

$$\Leftrightarrow \lambda\theta^3 + (1-\lambda)q_L^{*2} \leq \delta\left(2(1-\lambda)q_L^* + \lambda\theta^3 - (1-\lambda)q_L^{*2}\right)$$

$$\Leftrightarrow \delta \geq \frac{\lambda\theta^3 + (1-\lambda)q_L^{*2}}{\lambda\theta^3 + (1-\lambda)q_L(2 - q_L^*)} = D$$

The numerator and denominator of $D$ are both positive, since $q_L^* \in [0, 1)$, and so $D > 0$. $q_L^* < 1$ is also sufficient for $D < 1$. Finally, substituting for $q_L^*$:

$$D = \frac{\lambda(1-\lambda)\theta^3 + (1-\lambda\theta)^2}{\lambda(1-\lambda)\theta^3 + (1-\lambda\theta)(1-\lambda+\lambda(\theta-1))}$$

$\blacksquare$

**Sketch proof of Theorem 3.6.1** The proof of this theorem follows the rational benchmark case, except the decoy good means that the relative thinkers are essentially the 'high types' while the rational thinkers are the 'low types'. $IR_L$ and $IC_H$ are active while a decoy good makes the consumers place more weight on quality than on price. Therefore, the firm maximises the following expression for profits with respect to $p_s$, $q_s$, $p_r$ and $q_r$:

$$\mu\left(p_s - \frac{q_s^2}{2}\right) + (1-\mu)\left(p_r - \frac{q_r^2}{2}\right) + \gamma_0(q_r - p_r) + \gamma_1(q_s - \delta p_s - q_r + \delta p_r) \quad (3.92)$$

First order conditions provide the two optimal menus, depending upon whether $\delta \geq \mu$ or not.

Meanwhile decoy goods simply need to satisfy $p_d > q_d$ (which ensures that rational thinkers do not buy the decoy and that relative thinkers' decision utility is distorted in the optimal way) and:

$$q_s - \delta p_s \geq q_d - \delta p_d \quad (3.93)$$

which ensures that relative thinkers prefer their bundle to the decoy good (and therefore there are no cycles in preferences). ∎

**Proof of Proposition 3.6.2** In the $\delta \geq \mu$ case the monopolist's profits are equal to:

$$\tilde{\pi} = \frac{\frac{1}{2} - \frac{\mu}{\delta} + \frac{\mu}{2\delta^2}}{1-\mu} \quad (3.94)$$

$$\frac{\partial \tilde{\pi}}{\partial \delta} = -\frac{\mu}{1-\mu}\left(\frac{1-\delta}{\delta^3}\right) < 0 \quad (3.95)$$

$$\frac{\partial \tilde{\pi}}{\partial \mu} = \frac{1}{(1-\mu)^2}\left(\frac{(1-\delta)^2}{2\delta^2}\right) > 0 \quad (3.96)$$

Finally, when $\delta < \mu$ the monopolist's profits are:

$$\frac{\mu}{2\delta^2} \quad (3.97)$$

which is clearly also increasing in $\mu$ and decreasing in $\delta$. ∎

**Proof of Proposition 3.6.3** Fix $\delta$. Relative thinkers have higher experienced utility when both relative thinkers and rational thinkers are served by the monopolist ($\delta \geq \mu$) whenever:

$$-\left(\frac{(1-\delta)^2}{\delta^2(1-\mu)}\right) \geq -\left(\frac{(1-\delta)}{\delta^2}\right) \Leftrightarrow 1 \geq \frac{1-\delta}{1-\mu} \tag{3.98}$$

It is clear that this requires $\delta \geq \mu$. ∎

# 3.B Long Proofs (Propositions 3.4.4-3.4.7 & Theorem 3.4.8)

**Proof of Propositions 3.4.4-3.4.7** If the monopolist does not use a decoy good then she has five possible types of menu:

(i) $p_H > \theta q_H (> q_H)$

(ii) $p_H = \theta q_H (> q_H)$

(iii) $\theta q_H > p_H > q_H$

(iv) $\theta q_H > p_H = q_H$

(v) $(\theta q_H >) q_H > p_H$

First rule out options (i) and (v). Under (i) the $(p_H, q_H)$ good is not consumed. But if the monopolist only sells one good then there are strictly better menus to do so – this menu reduces the willingness of consumers to pay for the other good by making them focus on price over quality.

In (v), $\theta q_H > p_H$ means that $IR_H$ is satisfied, and moreover $IC_L$ (not $IR_L$) is active for low types, since $q_H - \delta p_H > 0$. $IC_L$ binding implies:

$$p_L = p_H - \frac{(q_H - q_L)}{\delta} \tag{3.99}$$

and taking into account the salience constraint $q_H > p_H$ we have $p_H = q_H - \epsilon$ for some $\epsilon > 0$. Now evaluate $IC_H$ and note that for $IC_H$ to hold requires $q_H \geq q_L$:

$$\theta q_H - \delta(q_H - \epsilon) \geq \theta q_L - \delta\left(q_H - \epsilon - \frac{(q_H - q_L)}{\delta}\right) \tag{3.100}$$

Rearrange to yield:

$$q_H(\theta - 1) \geq q_L(\theta - 1) \Leftrightarrow q_H \geq q_L \tag{3.101}$$

Now, if $q_H = q_L$ then the monopolist pools the two types of consumers. Optimally the firm should set $q = p$, as in scenario (iv), to maximise revenue when pooling the consumers.[41] And indeed, assessing the monopolist's maximisation programme without constraining $q_H$ and $q_L$ implies that the monopolist would choose $q_H < q_L$ – hence it is optimal here to pool the two types of consumers:

$$\max_{q_H, q_L} \lambda \left( q_H - \epsilon - \frac{q_H^2}{2} \right) + (1 - \lambda) \left( q_H - \epsilon - \frac{(q_H - q_L)}{\delta} - \frac{q_L^2}{2} \right) \tag{3.102}$$

Taking first order conditions:

$$q_L^* = \frac{1}{\delta} \text{ and } q_H^* = \frac{(\delta - (1 - \lambda))}{\delta\lambda} \tag{3.103}$$

But $q_L^* > q_H^*$ since:

$$\frac{\delta - (1 - \lambda)}{\lambda} < 1 \Leftrightarrow 1 - \delta > 0 \tag{3.104}$$

If the monopolist chooses a menu satisfying (ii), $p_H = \theta q_H (> q_H)$, she only serves high types, and this is implied from the constraints alone. $IR_H$ binds, $IC_H$ implies $0 \geq \theta q_L - p_L$, $IR_L$ implies $\delta q_L - p_L \geq 0$ and $IC_L$ always holds when $IR_L$ does since $\delta q_L - p_L \geq \delta q_H - p_H = -(\theta - \delta) q_H$. Hence the low type bundle has to satisfy $p_L \geq q_L \geq \frac{1}{\delta} p_L$ which is only possible for $q_L = p_L = 0$. Thus if the monopolist chooses a (ii) menu she would set $q_H = p_H = 1$.

If the monopolist chooses a menu satisfying (iv), $\theta q_H > p_H = q_H$, she prefers to pool the two types of consumers and this again can be noted from the constraints alone. The salience constraints give us $p_H = q_H$. Meanwhile, since $p_H = q_H$, $IR_L$ and $IC_L$ are the same inequality: $q_L - p_L \geq 0$. And thus, maximising revenue implies that $p_L = q_L$. Consequently, the monopolist sets $q_L = q_H = q = 1$ and $p_H = p_L = p = 1$.

Type (iii) menus are the only type of menu without decoy goods which both are possibly optimal for the monopolist and allow her to serve high and low types a different, strictly positive bundle. Under the constraints $\theta q_H > p_H > q_H$, $IR_H$

[41] The salience constraint in case $(v)$ explains why the price is $\epsilon$ units lower than in scenario (iv).

is satisfied, $IC_H$ is $\theta q_H - \delta p_H \geq \theta q_L - \delta p_L$, $IR_L$ is $\delta q_L - p_L \geq 0$ and $IC_L$ is $\delta q_L - p_L \geq \delta q_H - p_H$. Since $p_H > q_H$ it is clear that $IR_L$, not $IC_L$, is active and binds since the monopolist wishes to maximise revenue, and increasing $p_L$ slackens $IC_H$. Hence the following Lagrangian is used to solve the constrained maximisation problem for type (iii) menus:

$$\max_{p_H, q_H, q_L} \quad \lambda \left( p_H - \frac{q_H^2}{2} \right) + (1 - \lambda) \left( \delta q_L - \frac{q_L^2}{2} \right) + \mu_1 \left( \theta q_H - \delta p_H - q_L \left( \theta - \delta^2 \right) \right) + \mu_2 (\theta q_H - p_H) + \mu_3 (p_H - q_H)$$

First order conditions are, with respect to $p_H$, $q_H$ and $q_L$ respectively:

$$\lambda - \delta \mu_1 - \mu_2 + \mu_3 = 0 \tag{3.105}$$

$$-\lambda q_H + \theta \mu_1 + \theta \mu_2 - \mu_3 = 0 \tag{3.106}$$

$$(1 - \lambda)(\delta - q_L) - \left( \theta - \delta^2 \right) \mu_1 = 0 \tag{3.107}$$

There are two important points to this optimisation – the constraints $\theta q_H > p_H$ and $p_H > q_H$ are strict and so cannot bind. If the maximisation problem implies that an optimal choice would be, for example, $\theta q_H = p_H$ then instead I set $\theta q_H = p_H + \epsilon$ for some $\epsilon > 0$. Furthermore I can rule out the possibility of the first order condition with respect to $q_L$ being less than 0. If the monopolist chose not to serve the low types then she would set $\theta q_H = p_H$ not $\theta q_H > p_H$.

The first order conditions lead to the four regions of $\delta - \theta$ space:

1. Firstly, consider $\mu_1 > 0$, $\mu_2 = \mu_3 = 0$ – $IC_H$ binds and the salience constraints do not bind. Denote this region 1. This corresponds to the rational benchmark case in which $IR_L$ and $IC_H$ bind.

   In this region we have:

$$\mu_1^* = \frac{\lambda}{\delta}, \; q_H^* = \frac{\theta}{\delta}, \; q_L^* = \frac{\delta^2 - \lambda \theta}{\delta(1 - \lambda)}$$

$$p_H^* = \frac{\theta^2 - \delta^2(1+\lambda)\theta + \delta^4}{\delta^2(1-\lambda)},\ p_L^* = \frac{\delta^2 - \lambda\theta}{(1-\lambda)}$$

The boundaries of this region are determined by checking $\theta q_H > p_H$ and $p_H > q_H$. The first is equivalent to:

$$0 > (1 - \delta + \delta\lambda)\theta^2 - \delta^2(1+\lambda)\theta + \delta^4 \tag{3.108}$$

The roots of this quadratic are:

$$\frac{\delta^2(1+\lambda) \pm \delta^2\sqrt{(1-\lambda)(4\delta - 3 - \lambda)}}{2(1-\delta+\delta\lambda)}$$

so for the inequality to be satisfied, it is necessary that $\delta \geq \frac{3}{4}$ (in which case the determinant of the quadratic is positive) and moreover it is also necessary that:

$$\theta < \theta^{Blue} = \frac{\delta^2(1+\lambda) + \delta^2\sqrt{(1-\lambda)(4\delta - 3 - \lambda)}}{2(1-\delta+\delta\lambda)} \tag{3.109}$$

since the negative root is less than 1. The second boundary is:

$$\theta^2 - \delta((1-\lambda) + \delta(1+\lambda))\theta + \delta^4 > 0 \tag{3.110}$$

The roots of this quadratic are:

$$\frac{\delta(1 + \delta - \lambda + \delta\lambda) \pm \delta\sqrt{(1-\delta)(1-\lambda)(1-\lambda+\delta(3+\lambda))}}{2}$$

and so:

$$\theta > \theta^{Black} = \frac{\delta(1 + \delta - \lambda + \delta\lambda) + \delta\sqrt{(1-\delta)(1-\lambda)(1-\lambda+\delta(3+\lambda))}}{2} \tag{3.111}$$

since the negative root is less than 1. The profit in this region is:

$$\frac{\lambda\theta^2}{2\delta^2} + \frac{(\delta^2 - \lambda\theta)^2}{2\delta^2(1-\lambda)} \tag{3.112}$$

which is greater than the maximal profits the monopolist could make from pooling or just serving the high types.

2. Secondly, consider $\mu_1 > 0$, $\mu_2 > 0$ and $\mu_3 = 0$ – $IC_H$ binds, it is additionally optimal to set $p_H$ as close to $\theta q_H$ as possible. Denote this region 2 . This corresponds to the rational benchmark case in which only high types are served at $\delta = 1$, however, with $\delta < 1$, it is optimal for the low type bundle to be strictly positive too.

   In this region:

$$\mu_1^* = \frac{(1-\lambda)(\delta - q_L^*)}{\theta - \delta^2},\ \mu_2^* = \frac{\lambda(\theta-\delta^2) - \delta(1-\lambda)(\delta - q_L^*)}{\theta - \delta^2}$$
$$q_H^* = \frac{\theta\left(\lambda(\theta-\delta^2)^2 + \delta(1-\delta)(1-\lambda)(\theta-\delta^2)\right)}{\lambda(\theta-\delta^2)^2 + \theta^2(1-\delta)^2(1-\lambda)}$$
$$q_L^* = \frac{\theta^2(1-\delta)(\lambda(\theta-\delta^2) + \delta(1-\delta)(1-\lambda))}{\lambda(\theta-\delta^2)^2 + \theta^2(1-\delta)^2(1-\lambda)}$$
$$p_H^* = \theta q_H^* - \epsilon,\ p_L^* = \frac{\delta\theta^2(1-\delta)(\lambda(\theta-\delta^2) + \delta(1-\delta)(1-\lambda))}{\lambda(\theta-\delta^2)^2 + \theta^2(1-\delta)^2(1-\lambda)}$$

   For some $\epsilon > 0$. The boundaries of this region are determined by checking $\delta - q_L^* > 0$ and $\lambda(\theta - \delta^2) - \delta(1-\lambda)(\delta - q_L^*) > 0$. The first is equivalent to:

$$0 > (1-\delta)\theta^2 - \delta\theta + \delta^3 \tag{3.113}$$

   The roots of this quadratic are $\delta$ and $\frac{\delta^2}{1-\delta}$. Since $\delta < 1$ this means that the inequality is satisfied whenever:

$$\theta < \frac{\delta^2}{1-\delta} = \theta^{Red} \tag{3.114}$$

   The second:

$$(1-\delta+\delta\lambda)\theta^2 - \delta^2(1+\lambda)\theta + \delta^4 > 0 \tag{3.115}$$

   This boundary is shared with region 1 so the inequality is satisfied whenever $\delta < \frac{3}{4}$ (in which case the determinant of the quadratic is negative) or, if $\delta \geq \frac{3}{4}$, whenever:

$$\theta > \theta^{Blue} = \frac{\delta^2(1+\lambda) + \delta^2\sqrt{(1-\lambda)(4\delta - 3 - \lambda)}}{2(1-\delta+\delta\lambda)} \tag{3.116}$$

   The profit in this region is:

$$\frac{\theta^2(\lambda(\theta-\delta^2) + (1-\lambda)\delta(1-\delta))^2}{2(\lambda(\theta-\delta^2)^2 + (1-\delta)^2(1-\lambda)\theta^2)} - \lambda\epsilon \tag{3.117}$$

which is greater than the maximal profits the monopolist could make just serving the high types, since saying that this expression (with $\epsilon = 0$) is greater than $\frac{\lambda\theta^2}{2}$ is equivalent to:

$$\lambda(\delta(\theta^2 - \delta^2) - (\theta - \delta)^2) > -\delta^2(1 - \delta) \tag{3.118}$$

And $\delta(\theta^2 - \delta^2) - (\theta - \delta)^2 > 0$ is equivalent to:

$$\frac{\delta(1 + \delta)}{1 - \delta} > \theta \tag{3.119}$$

But in this region it is already the case that $\theta < \delta^2/(1-\delta)$ and so this equation is always satisfied.

However pooling can sometimes dominate the menu derived from the first order conditions. In particular the condition that the profit is greater than the pooling profit $\frac{1}{2}$ is equivalent to saying that the following quadratic in $\lambda$ has to be positive:

$$\lambda^2\theta^2(\theta - \delta)^2 + \lambda\delta(\theta^3(2 - 2\delta) + \theta^2(-2 - \delta + 2\delta^2) + 2\delta\theta - \delta^3) - (1 - \delta^2)(1 - \delta)^2\theta^2 \tag{3.120}$$

It turns out that the negative root is less than 0 and the positive root is less than 1, so the quadratic is positive and the separating menu is preferred (not preferred) to pooling whenever $\lambda$ is greater (less) than the positive root.

3. Thirdly, consider $\mu_1 > 0$, $\mu_2 = 0$ and $\mu_3 > 0$ – $IC_H$ binds, it is additionally optimal to set $p_H$ as close to $q_H$ as possible. Denote this region 3. In this region:

$$\mu_1^* = \frac{\lambda}{\delta} + \frac{\mu_3^*}{\delta},\ \mu_3^* = \frac{\lambda(\delta q_H^* - \theta)}{\theta - \delta}$$

$$q_H^* = \frac{(\theta - \delta^2)(\delta(\theta - \delta) + (1 - \delta)\lambda\theta)}{\lambda(\theta - \delta^2)^2 + (1 - \lambda)(\theta - \delta)^2}$$

$$q_L^* = \frac{(\theta - \delta)(\delta(\theta - \delta) + (1 - \delta)\lambda\theta)}{\lambda(\theta - \delta^2)^2 + (1 - \lambda)(\theta - \delta)^2}$$

$$p_H^* = q_H^* + \gamma,\ p_L^* = \frac{\delta(\theta - \delta)(\delta(\theta - \delta) + (1 - \delta)\lambda\theta)}{\lambda(\theta - \delta^2)^2 + (1 - \lambda)(\theta - \delta)^2}$$

For some $\gamma > 0$. The boundaries of this region are determined by checking that $\delta q_H^* > \theta$, which is equivalent to:

$$0 > \theta^2 - \delta((1-\lambda) + \delta(1+\lambda))\theta + \delta^4 \tag{3.121}$$

This boundary is shared with region 1 and hence:

$$\theta < \theta^{Black} = \frac{\delta(1+\delta-\lambda+\delta\lambda) + \delta\sqrt{(1-\delta)(1-\lambda)(1-\lambda+\delta(3+\lambda))}}{2} \tag{3.122}$$

The profit under this menu is approximately equal to:

$$\frac{1}{2}\left(\frac{(\delta(\theta-\delta)+(1-\delta)\lambda\theta)^2}{\lambda(\theta-\delta^2)^2+(1-\lambda)(\theta-\delta)^2}\right)$$

It turns out that this is less than the profit from the best pooling menu, $\frac{1}{2}$, which can be shown in the following steps:

$$1 > \frac{(\delta(\theta-\delta)+(1-\delta)\lambda\theta)^2}{\lambda(\theta-\delta^2)^2+(1-\lambda)(\theta-\delta)^2} \tag{3.123}$$

$$\Leftrightarrow 0 > (1-\delta)\theta^2\lambda^2 + \delta(2\theta^2 - 2(1+\delta)\theta + \delta(1+\delta))\lambda - (1+\delta)(\theta-\delta)^2 \tag{3.124}$$

At $\lambda = 1$, the right hand side of the equation above is 0. And at $\lambda = 0$, the right hand side of the equation above is $-(1+\delta)(\theta-\delta)^2 < 0$. Hence, given the convexity of the quadratic in $\lambda$, it must be the case that for all $\lambda \in [0,1]$ the optimal pooling menu is preferred to the menu derived from the first order conditions of the Lagrangian.

In this region pooling is also preferred to just serving high types. The condition for preferring pooling to serving just high types is simply $\lambda < \frac{1}{\theta^2}$ and we can rewrite the boundary condition in terms of $\lambda$ to give us:

$$\lambda < \frac{-\theta^2 + \delta(1+\delta)\theta - \delta^4}{\delta(1-\delta)\theta} \tag{3.125}$$

We show that:

$$\frac{1}{\theta^2} > \frac{-\theta^2 + \delta(1+\delta)\theta - \delta^4}{\delta(1-\delta)\theta} \tag{3.126}$$

$$\Leftrightarrow 0 > -\theta^3 + \delta(1+\delta)\theta^2 - \delta^4\theta - \delta(1-\delta) \tag{3.127}$$

Taking the derivative of this cubic and solving for its roots, the cubic is increasing between:

$$\frac{\delta(1+\delta)}{3} - \frac{\delta\sqrt{1+2\delta-2\delta^2}}{3} \text{ and } \frac{\delta(1+\delta)}{3} + \frac{\delta\sqrt{1+2\delta-2\delta^2}}{3} \tag{3.128}$$

The positive root is less than 1 (as the inequality is equivalent to $6(1-\delta) + 3(1-\delta^2)^2 > 0$). Hence for all $\theta > 1$ the cubic must be decreasing. Finally evaluating the cubic at $\theta = 1$, note that it is equal to $-(1-\delta^2)^2 < 0$. Hence for all $\theta$ the monopolist prefers the optimal pooling menu in region 3.

4. Finally, consider $\mu_1 = 0$, $\mu_2 > 0$ and $\mu_3 = 0$ – $IC_H$ is slack, the monopolist sets $p_H$ as close to $q_H$ as possible. Denote this region 4. In this region we have:

$$\mu_2^* = \lambda,\ q_H^* = \theta,\ q_L^* = \delta$$

$$p_H^* = \theta^2 - \epsilon,\ p_L^* = \delta^2$$

For some $\epsilon > 0$. The boundaries of this region are determined by checking that $IC_H$ is satisfied, which is equivalent to:

$$(1-\delta)\theta^2 - \delta\theta + \delta^3 \geq 0 \tag{3.129}$$

As in region 2, which shares this boundary with region 4, the critical value of $\theta$ is $\theta^{Red}$ and region 4 is the subset of $\theta$ and $\delta$ that satisfies:

$$\theta \geq \frac{\delta^2}{1-\delta} = \theta^{Red} \tag{3.130}$$

The profit under this menu is equal to:

$$\frac{\lambda\theta^2}{2} - \lambda\epsilon + \frac{(1-\lambda)\delta^2}{2}$$

This is clearly always better than just serving the high types since $\epsilon$ can be small enough such that:

$$\epsilon < \frac{(1-\lambda)\delta^2}{2\lambda} \tag{3.131}$$

But there are low values of $\theta$ such that pooling is preferred. In particular the following condition must hold to prefer the separating menu over the pooling menu:

$$\theta > \sqrt{\frac{1-(1-\lambda)\delta^2}{\lambda}} \tag{3.132}$$

$\blacksquare$

**Proof of Theorem 3.4.8** As in the proof of Propositions 3.4.4-3.4.7, there are five types of menu (now with a decoy good) that must be considered. The decoy good $(p_d, q_d)$ either satisfies $q_d > p_d$, $q_d = p_d$, $\theta q_d > p_d > q_d$, $\theta q_d = p_d$ or $p_d > \theta q_d$. The first two of these cases are not optimal. This is because the decoy good is so attractive to consumers that the monopolist would have to sell other goods from the same menu very cheaply in order that consumers prefer them to the decoy. In fact both possibilities are dominated by a straightforward pooling menu.

Consider $q_d > p_d$. For the high types to choose a good $q_H, p_H$ it must be the case that:

$$\theta q_H - \delta p_H \geq 0,\ \theta q_H - \delta p_H \geq \theta q_L - \delta p_L \text{ and } \theta q_H - \delta p_H \geq \theta q_d - \delta p_d > 0 \tag{3.133}$$

Since $q_d - \delta p_d > 0$ by assumption, the first of these constraints always holds if the third one does. Similarly for low types to choose a good $q_L, p_L$ it must be the case that:

$$q_L - \delta p_L \geq 0,\ q_L - \delta p_L \geq q_H - \delta p_H \text{ and } q_L - \delta p_L \geq q_d - \delta p_d > 0 \tag{3.134}$$

Since $q_d - \delta p_d > 0$, by the same logic I also ignore the first of these constraints.

Now it cannot be the case that both $\theta q_H - \delta p_H \geq \theta q_L - \delta p_L$ and $q_L - \delta p_L \geq q_H - \delta p_H$ bind unless the two bundles are the same. But, from the symmetric information analysis, if the monopolist pools the two types then adding a decoy good can only decrease her profits, so I ignore this case. Therefore there are three combinations of the constraints to consider.

If $\theta q_H - \delta p_H \geq \theta q_L - \delta p_L$ and $q_L - \delta p_L \geq q_d - \delta p_d$ bind then both:

$$\theta q_H - \delta p_H = \theta q_L - \delta p_L > \theta q_d - \delta p_d \tag{3.135}$$

and:

$$q_L - \delta p_L = q_d - \delta p_d \Rightarrow q_L = q_d - \delta(p_d - p_L) \tag{3.136}$$

must hold. But, because $\theta > 1$, these cannot both hold unless $p_d \leq p_L$, which is a contradiction.

Alternately, if $\theta q_H - \delta p_H \geq \theta q_d - \delta p_d$ and $q_L - \delta p_L \geq q_d - \delta p_d$ bind then:

$$q_L - \delta p_L = q_d - \delta p_d > q_H - \delta p_H = q_H + \theta(q_d - q_H) - \delta p_d \tag{3.137}$$

must hold. But, because $\theta > 1$, this cannot hold unless $q_d \leq q_H$, which is a contradiction.

Finally, if $\theta q_H - \delta p_H \geq \theta q_d - \delta p_d$ and $q_L - \delta p_L \geq q_H - \delta p_H$ bind then it is possible for the monopolist to separate the two types of consumer. Consider the maximisation problem:

$$\max_{q_d, p_d, q_H, q_L} \lambda \left( \frac{\theta(q_H - q_d)}{\delta} + p_d - \frac{q_H^2}{2} \right) + (1-\lambda) \left( \frac{(\theta - 1)q_H + q_L}{\delta} - \frac{\theta q_d}{\delta} + p_d - \frac{q_L^2}{2} \right) \tag{3.138}$$

Clearly this implies that the monopolist would want to decrease $q_d$ as far as possible which would be to $q_H + \epsilon$ for $\epsilon > 0$, and increase $p_d$ as far as possible which would be to $q_d - \gamma = q_H + \epsilon - \gamma$ for $\gamma > 0$. To simplify suppose that $\gamma = \epsilon$, so $p_d = q_H$. Meanwhile, the first order conditions imply that $q_L^* = 1/\delta$ and:

$$q_H^* = \frac{\theta - (1-\lambda)}{\delta \lambda} \tag{3.139}$$

But under this optimal menu the monopolist's profits are lower than the profits that could be achieved from pooling the two types of consumer:

$$\frac{-\theta^2 + 2\delta\theta + (1-\lambda)(1-2\delta)}{2\delta^2 \lambda} < \frac{1}{2} \tag{3.140}$$

$$\Leftrightarrow 0 < \theta^2 - 2\delta\theta + \delta^2\lambda - (1-\lambda)(1-2\delta) \tag{3.141}$$

The positive root of the polynomial above is $\delta + (1-\delta)\sqrt{1-\lambda} < 1$ and so for all $\theta > 1$ the inequality above is true. Therefore the monopolist does not use a menu with $q_d > p_d$.

Now consider $q_d = p_d$. The relevant constraints for $H$ types are $\theta q_H - \delta p_H \geq \theta q_L - \delta p_L$ and $\theta q_H - \delta p_H \geq \theta q_d - \delta p_d > 0$. And for $L$ types the relevant constraints are $q_L - p_L \geq 0$ and $q_L - p_L \geq q_H - p_H$.[42]

It cannot be the case that $\theta q_H - \delta p_H = \theta q_L - \delta p_L$ and $q_L - p_L = 0$ because it is not possible to also have $\theta q_H - \delta p_H = \theta q_L - \delta p_L = (\theta-\delta)p_L > \theta q_d - \delta p_d = (\theta - \delta)p_d$, which cannot hold since $p_d > p_L$.

It also cannot be the case that $\theta q_H - \delta p_H = \theta q_d - \delta p_d$ and $q_L - p_L = 0$ because $q_L - p_L > q_H - p_H$ requires $p_H > q_H$ but using $\theta q_H - \delta p_H = \theta q_d - \delta p_d$ this is equivalent to:

$$\frac{\theta(q_H - q_d)}{\delta} + p_d > q_H \Leftrightarrow (\theta - \delta)q_H > (\theta-\delta)q_d \tag{3.142}$$

and it must be the case that $q_d > q_H$.

This leaves the case where $q_L - p_L = q_H - p_H$ and $\theta q_H - \delta p_H = \theta q_d - \delta p_d$. Consider the maximisation problem:

$$\max_{p_d, q_H, q_L} \lambda\left(\frac{\theta q_H}{\delta} - \frac{(\theta-\delta)p_d}{\delta} - \frac{q_H^2}{2}\right) + (1-\lambda)\left(q_L + \frac{(\theta-\delta)q_H}{\delta} - \frac{(\theta-\delta)p_d}{\delta} - \frac{q_L^2}{2}\right) \tag{3.143}$$

Clearly, the monopolist wishes to decrease $p_d$ as far as possible, which is to make it approximately equal to $p_H$. But therefore:

$$p_d = \frac{\theta q_H}{\delta} - \frac{(\theta-\delta)p_d}{\delta} \Rightarrow p_d = q_H \tag{3.144}$$

and hence:

$$p_H = \frac{\theta q_H}{\delta} - \frac{(\theta-\delta)q_H}{\delta} = q_H \tag{3.145}$$

$$p_L = q_L + \frac{(\theta-\delta)q_H}{\delta} - \frac{(\theta-\delta)q_H}{\delta} = q_L \tag{3.146}$$

[42]Since $q_d - \theta p_L = 0$ the incentive constraint to make the $L$ types prefer their own good to the decoy good is equivalent to $IR_L$.

Therefore the monopolist's revenues relative to the qualities $q_H$ and $q_L$ are no better than if she used a pooling menu. Hence such a menu is dominated by pooling the two types.

Now consider the third case: $\theta q_d > p_d > q_d$. Any menu satisfying this condition cannot improve upon menus with decoy goods satisfying $\theta q_H > p_H > q_H$.

The relevant constraints for $H$ types are $\theta q_H - \delta p_H \geq \theta q_L - \delta p_L$ and $\theta q_H - \delta p_H \geq \theta q_d - \delta p_d > 0$. And for $L$ types the relevant constraints are $\delta q_L - p_L \geq 0$ and $\delta q_L - p_L \geq \delta q_H - p_H$.[43]

Consider the case in which $\theta q_H - \delta p_H = \theta q_d - \delta p_d$ and $\delta q_L - p_L = \delta q_H - p_H$. In this case, for the low type's individual rationality constraint to hold would imply both:

$$\delta q_L \geq p_L \text{ and } \delta q_H \geq p_H \tag{3.147}$$

But clearly this means that revenues must be lower than they could be even in a pooling menu and therefore this type of menu cannot be optimal.

An alternative is $\delta q_L - p_L = 0$ and $\theta q_H - \delta p_H = \theta q_d - \delta p_d$. In this case the maximisation problem would be:

$$\max_{p_d, q_d, q_H, q_L} \lambda \left( \frac{\theta q_H}{\delta} + p_d - \frac{\theta q_d}{\delta} - \frac{q_H^2}{2} \right) + (1-\lambda) \left( \delta q_L - \frac{q_L^2}{2} \right) + \mu_0 (q_d - q_H) + \mu_1 (\theta q_d - p_d) \tag{3.148}$$

Solving this problem implies that $q_H = \theta$, $p_H = \theta^2$, and $q_L = \delta$, $p_L = \delta^2$ – the menu from region 4 in Proposition 3.4.7. Moreover, checking the incentive compatibility constraint for high types[44] yields the same region of $\delta - \theta$ space for this menu. Unfortunately, the optimisation problem also indicates that the monopolist would want to set $q_d$ as low as possible and $p_d$ as high as possible. This means that $q_d = q_H + \epsilon$ and $p_d = \theta q_d - \gamma$ and at least one of $\epsilon$ and $\gamma$ is greater than 0. Unfortunately, high types would prefer to consume such a decoy good over $q_H, p_H$. Therefore in region 4 a menu with a decoy good satisfying $\theta q_d > p_d > q_d$ cannot do any better than the region 4 menu in the no decoy case.

[43] Since $\delta q_d - p_d < 0$ the incentive constraint to make the $L$ types prefer their own good to the decoy good is always satisfied if $IR_L$ is.

[44] $\theta q_H - \delta p_H > \theta q_L - \delta p_L$.

The final possible set of binding constraints is: $\delta q_L - p_L = 0$ and $\theta q_H - \delta p_H = \theta q_L - \delta p_L$. This leads to the optimal menu for region 1 in the no decoy case. However it is necessary to check that there exists a decoy good satisfying $\theta q_d > p_d > q_d$, $q_d > q_H$, $p_d > p_H$ and $\theta q_H - \delta p_H \geq \theta q_d - \delta p_d$. The latter constraint yields:

$$\frac{-\lambda\theta^2 + \delta^2(1+\lambda)\theta - \delta^4}{\delta(1-\lambda)} > \theta q_d - \delta p_d > (1-\delta)p_d \tag{3.149}$$

where the final inequality follows from $\theta q_d > p_d$. Therefore there is an upper bound on $p_d$ which must be larger than $p_H$ or:

$$\frac{-\lambda\theta^2 + \delta^2(1+\lambda)\theta - \delta^4}{\delta(1-\lambda)(1-\delta)} > p_d > p_H = \frac{\theta(\theta-\delta^2) + \delta^4 - \delta^2\lambda\theta}{\delta^2(1-\lambda)} \tag{3.150}$$

Hence it is necessary that:

$$0 > \theta^2(1-\delta(1-\lambda)) - \delta^2(1+\lambda)\theta + \delta^4 \tag{3.151}$$

or that $\theta < \theta^{Blue}$. Finally consider that we can find an appropriate value for $q_d$ if $p_d > p_H > q_d > q_H$. It is therefore necessary that $p_H > q_H$ or:

$$\frac{\theta}{\delta^2} - \frac{(\theta-\delta^2)(\delta^2-\lambda\theta)}{\delta^2\theta(1-\lambda)} > \frac{1}{\delta} \tag{3.152}$$

But this is equivalent to:

$$\theta^2 - \delta\theta(1-\lambda+\delta(1+\lambda)) + \delta^4 > 0 \tag{3.153}$$

and so $\theta > \theta^{Black}$ is also a necessary condition. Therefore in region 1 the monopolist can achieve identical profits with and without a decoy good.

Finally consider optimal menus when the decoy good satisfies $p_d > \theta q_d$ (I) or $\theta q_d = p_d$ (II). When are these menus preferred to the optimal menus utilised in the no decoy case?

If $p_d > \theta q_d$ then the relevant constraints for $H$s are $\delta\theta q_H - p_H \geq 0$ and $\delta\theta q_H - p_H \geq \delta\theta q_L - p_L$; and for $L$s are $\delta q_L - p_L \geq 0$ and $\delta q_L - p_L \geq \delta q_H - p_H$. Hence, from the similarity to the rational case, an optimal menu satisfying these constraints sets $\delta q_L - p_L = 0$ and $\delta\theta q_H - p_H = \delta\theta q_L - p_L$.

Thus the optimal menu satisfies:

$$q_H^* = \delta\theta \text{ and } q_L^* = \frac{\delta(1-\lambda\theta)}{(1-\lambda)} \tag{3.154}$$

and:

$$p_H^* = \frac{\delta^2(\theta^2-(1+\lambda)\theta+1)}{(1-\lambda)} \text{ and } p_L^* = \frac{\delta^2(1-\lambda\theta)}{(1-\lambda)} \tag{3.155}$$

while any decoy good satisfying $p_d > \theta q_d$, $q_d > q_H^*$ and $p_d > p_H^*$ allows this menu to be implemented,[45] as long as $1-\lambda\theta \geq 0$.

The profit from this menu is equal to:

$$\pi_I = \frac{\delta^2}{(1-\lambda)}\left(\frac{1}{2} - \lambda\theta + \frac{\lambda\theta^2}{2}\right) \tag{3.156}$$

If $p_d = \theta q_d$ then the relevant constraints for $H$s are $\theta q_H - p_H \geq 0$ and $\theta q_H - p_H \geq \theta q_L - p_L$; and for $L$s are $\delta q_L - p_L \geq 0$ and $\delta q_L - p_L \geq \delta q_H - p_H$. Hence, from the similarity to the rational case, an optimal menu satisfying these constraints sets $\delta q_L - p_L = 0$ and $\theta q_H - p_H = \theta q_L - p_L$. The optimal menu therefore satisfies:

$$q_H^* = \theta \text{ and } q_L^* = \frac{\delta-\lambda\theta}{(1-\lambda)} \tag{3.157}$$

and:

$$p_H^* = \frac{\theta^2-\delta(1+\lambda)\theta+\delta^2}{(1-\lambda)} \text{ and } p_L^* = \frac{\delta(\delta-\lambda\theta)}{(1-\lambda)} \tag{3.158}$$

while any decoy good satisfying $p_d = \theta q_d$, $q_d > q_H^*$ and $p_d > p_H^*$ allows this menu to be implemented,[46] as long as $\delta - \lambda\theta \geq 0$.

The profit from this menu is equal to:

$$\pi_{II} = \frac{1}{(1-\lambda)}\left(\frac{\delta^2}{2} - \delta\lambda\theta + \frac{\lambda\theta^2}{2}\right) \tag{3.159}$$

Finally it remains to compare these profits to the amounts the monopolist could make without using a decoy good. The first thing to establish is that (II) is preferred to (I) whenever (II) is possible. $\pi_{II} > \pi_I$ is equivalent to:

$$\theta > \frac{2\delta}{1+\delta} \tag{3.160}$$

[45] Since $\delta\theta q_d - p_d < 0$ and $\delta q_d - p_d < 0$, consumers never want to consume the decoy good.

[46] Since $\theta q_d - p_d = 0$ and $\delta q_d - p_d < 0$ consumers never want to consume the decoy good.

Given that $\delta < 1$, this is true $\forall \theta > 1$.

Next, $\forall \theta < \theta^{Blue}$ it must be the case that (II) can be implemented since $\delta/\theta > \theta^{Blue}$. Hence in regions 1 and 3 the monopolist never uses menu (I). Menu (II) is sometimes preferred to pooling in region 3:

$$\pi_{II} = \frac{1}{(1-\lambda)}\left(\frac{\delta^2}{2} - \delta\lambda\theta + \frac{\lambda\theta^2}{2}\right) > \frac{1}{2} \Leftrightarrow \lambda\theta^2 - 2\delta\lambda\theta + \delta^2 - (1-\lambda) > 0 \quad (3.161)$$

For this to be true requires:

$$\theta > \delta + \sqrt{\left(\frac{1-\lambda}{\lambda}\right)(1-\delta^2)} \quad (3.162)$$

Now consider region 1. The profit that can be achieved without a decoy in region 1 always exceeds $\pi_{II}$.

$$\frac{1}{\delta^2(1-\lambda)}\left(\frac{\delta^4}{2} - \delta^2\lambda\theta + \frac{\lambda\theta^2}{2}\right) > \frac{1}{(1-\lambda)}\left(\frac{\delta^2}{2} - \delta\lambda\theta + \frac{\lambda\theta^2}{2}\right) \quad (3.163)$$

$$\theta^2 > \frac{2\delta^2}{1+\delta} \quad (3.164)$$

By inspection, since $\delta < 1$, the above inequality is true $\forall \theta > 1$ and therefore menu (II) (and by extension (I)) is never used in region 1.

Now consider region 4. The no decoy region 4 menu is preferred to (II) when:

$$\frac{\lambda\theta^2}{2} + \frac{(1-\lambda)\delta^2}{2} > \frac{1}{(1-\lambda)\theta^2}\left(\frac{\delta^2}{2} - \delta\lambda\theta + \frac{\lambda}{2}\right) \quad (3.165)$$

$$\Leftrightarrow \lambda^2\theta^2 - 2\delta\lambda\theta + \delta^2(1-(1-\lambda)^2) > 0 \Leftrightarrow \theta > \frac{2\delta - \delta\lambda}{\lambda} \quad (3.166)$$

However, $\delta/\lambda > \theta$ is necessary in order to be able to use menu (II) and:

$$\frac{\delta}{\lambda} < \frac{2\delta - \delta\lambda}{\lambda} \because \lambda < 1 \quad (3.167)$$

Therefore when menu (II) is possible in 4 it is not used. A similar argument rules out menu (I). If (I) was preferred then:

$$\frac{\lambda\theta}{2} + \frac{(1-\lambda)\delta^2}{2} > \frac{\delta^2}{(1-\lambda)}\left(\frac{1}{2} - \lambda\theta + \frac{\lambda\theta^2}{2}\right) \quad (3.168)$$

$$\Leftrightarrow \lambda(\delta^2 - (1-\lambda))\theta^2 - 2\delta^2\lambda\theta + \delta^2(1-(1-\lambda)^2) > 0 \quad (3.169)$$

If $(\delta^2 - (1-\lambda)) > 0$ then the roots of the polynomial are:

$$\frac{\delta^2 \pm \delta\sqrt{(1-\lambda)(1-\lambda+1-\delta^2)}}{\delta^2 - (1-\lambda)} \tag{3.170}$$

The negative root is less than 1 and so $\theta$ must be larger than the positive root. However this cannot hold simultaneously with $1 > \lambda\theta$ since:

$$\frac{1}{\lambda} < \frac{\delta^2 + \delta\sqrt{(1-\lambda)(1-\lambda+1-\delta^2)}}{\delta^2 - (1-\lambda)} \tag{3.171}$$

$$\because -(1-\lambda)(1-\delta^2) < \delta\lambda\sqrt{(1-\lambda)(1-\lambda+1-\delta^2)} \tag{3.172}$$

Similarly if $(\delta^2 - (1-\lambda)) < 0$ then it must be the case that:

$$0 > \lambda((1-\lambda) - \delta^2)\theta^2 + 2\delta^2\lambda\theta - \delta^2(1-(1-\lambda)^2) \tag{3.173}$$

or $\theta$ between the roots:

$$\frac{-\delta^2 \pm \delta\sqrt{(1-\lambda)(1-\lambda+1-\delta^2)}}{(1-\lambda) - \delta^2} \tag{3.174}$$

However the negative root is clearly less than 0, while the positive root is less than 1 when $(\delta^2 - (1-\lambda)) < 0$ and hence $\theta$ is never small enought to prefer (I) here.

Finally we could have $\delta^2 = 1 - \lambda$. But in this case we would need:

$$0 > 2\delta^2(1-\delta^2)\theta - \delta^2(1-\delta^4) \Leftrightarrow \frac{1+\delta^2}{2} > \theta \tag{3.175}$$

and since $\delta < 1$ the final inequality is never true. Thus menus (I) and (II) are never used in region 4 when the monopolist prefers to separate the two types. However the monopolist also sometimes pools the two types in region 4 (when not using a decoy), whenever:

$$\theta^{Red} < \theta < \sqrt{\frac{1-(1-\lambda)\delta^2}{\lambda}} \tag{3.176}$$

We know from earlier in this proof that menu (II) is preferred to a pooling menu when:

$$\theta > \delta + \sqrt{\left(\frac{1-\lambda}{\lambda}\right)(1-\delta^2)} \tag{3.177}$$

and therefore combining these two conditions gives us the subset of region 4 in which the monopolist uses menu (II). Is menu (II) possible here: i.e. is $\delta > \lambda\theta$? This is equivalent to:

$$\frac{\delta}{\lambda} > \delta + \sqrt{\left(\frac{1-\lambda}{\lambda}\right)(1-\delta^2)} \Leftrightarrow \delta^2 > \lambda \tag{3.178}$$

which is true. Finally menu (I) is not used since:

$$\pi_I > \frac{1}{2} \Leftrightarrow \delta^2\lambda\theta^2 - 2\delta^2\lambda\theta + \delta^2 - (1-\lambda) > 0 \tag{3.179}$$

and hence for the monopolist to prefer menu (I) over pooling the two types requires:

$$\theta > 1 + \sqrt{\left(\frac{1-\lambda}{\lambda}\right)\left(\frac{1-\delta^2}{\delta^2}\right)} \tag{3.180}$$

But this value is always too large for the monopolist to want to use menu (I):

$$\sqrt{\frac{1-(1-\lambda)\delta^2}{\lambda}} < 1 + \sqrt{\left(\frac{1-\lambda}{\lambda}\right)\left(\frac{1-\delta^2}{\delta^2}\right)} \tag{3.181}$$

which is equivalent to:

$$-\frac{(1-\delta^2)^2(1-\lambda)}{\delta^2\lambda} < 2\sqrt{\left(\frac{1-\lambda}{\lambda}\right)\left(\frac{1-\delta^2}{\delta^2}\right)} \tag{3.182}$$

Hence the monopolist never uses menu (I) in region 4.

Finally consider region 2. The monopolist does not use menu (I) or (II) in region 2 if:

$$\delta + \sqrt{\left(\frac{1-\lambda}{\lambda}\right)(1-\delta^2)} > \frac{\delta^2}{1-\delta} = \theta^{Red} \tag{3.183}$$

as this condition guarantees that menu (II) (and by extension menu (I)) would not be as profitable as the pooling menu in region 2. This condition can be rewritten as:

$$\lambda < \tilde{\lambda} = \frac{(1-\delta)^2(1-\delta^2)}{(1-\delta)^2 - 2\delta^3(1-\delta) + \delta^4} \tag{3.184}$$

∎

# 3.C Continuous Salience Functions and Concavity

In section 3.4 I find approximate equilibria in regions of the parameter space where the discontinuous salience weighting function implies that no exact equilibrium exists. There are two possible ways to look for exact equilibria. First one can use continuous weighting functions, however this leads to its own issues – below I provide a simple theorem that indicates how doing this invalidates the use of normal, simple calculus methods for solving the model. The second is to assume that price and quality are discrete rather than continuous variables.[47] Then if the model tells us, for example, that the monopolist should set $p_H < p^*$, there is a unique price which is optimal for the monopolist to choose.

## 3.C.1 A Theorem on Continuous Focusing

If utility over attributes is linear, then the decision utility function of a Kőszegi and Szeidl (2013) agent is not globally concave and therefore the solution to the Lagrangian method is not necessarily the optimal menu.

**Theorem 3.C.1** *Consider a decision utility function $\tilde{U}(q,p) = g(q)q - g(p)p$ where $\forall x \geq 0$ we have $g(x) \geq 0$ and $g'(x) > 0$. This decision utility function is not globally concave.*

**Proof** Consider the scenario in which $(p,q)$ has the highest price and quality in the consideration set, and the null good is also a member. If price disutility and quality utility is linear then $\tilde{U}(q,p) = g(q)q - g(p)p$. Since $q \geq 0$ we have:

$$\tilde{U}_q = g(q) + g'(q)q > 0 \tag{3.185}$$

and:

$$\tilde{U}_{qq} = 2g'(q) + g''(q)q \tag{3.186}$$

For $\tilde{U}_{qq} \leq 0$, we need:

$$g''(q)q \leq -2g'(q) \tag{3.187}$$

[47] Of course, this is an old idea in economics. See for example Gomory and Baumol (1960).

Integrating both sides, the left hand side by parts, between $q = 0$ and $q = X > 0$ implies that:

$$Xg'(X) - g(X) \leq -2g(X) \Leftrightarrow Xg'(X) \leq -g(X) \tag{3.188}$$

But this is a contradiction since the left hand side is positive and the right hand side is negative. ∎

### 3.C.2 Pricing on the Grid

Consider the following example: Suppose that the quality and price of bundles must be chosen from a set $P$, where $P$ is a discrete set. Consecutive elements of $P$ are a distance $d$ apart – i.e. $P = \{0, d, 2d, 3d, \dots\}$. Suppose that $\delta$, $\delta^2$, $\theta$ and $\theta^2$ are all members of $P$. Consider region 4 of $\delta - \theta$ space. We know from the analysis above that the monopolist finds it optimal to use a menu that approximately extracts the first best from high types if $d$ is sufficiently small. What is the precise menu that the monopolist chooses?

Since $\delta$ and $\delta^2$ are in $P$, $q_L^* = \delta$, and $p_L^* = \delta^2$. The high type individual rationality constraint now changes; because $q_H, p_H \in P$ the constraint is equivalent to $\theta q_H - d \geq p_H$. Maximising $\theta q_H - d - \frac{q_H^2}{2}$ yields $q_H^* = \theta$ and $p_H^* = \theta^2 - d$.

This new menu changes the boundary of region 4, which is now the area which satisfies $\theta^2(1-\delta) - \delta\theta + \delta^3 + \delta d \geq 0$ – i.e. for every $\delta$, a slightly larger range of $\theta$ is in region 4. Furthermore the profit in the region is changed to:

$$\frac{\lambda\theta^2}{2} + \frac{(1-\lambda)\delta^2}{2} - \lambda d$$

It is now somewhat more likely that the monopolist prefers to pool the consumers, earning $\frac{1}{2}$, rather than use the separating menu. It is also now possible that the monopolist may prefer to exclusively serve the high types, earning $\frac{\lambda\theta^2}{2}$ if $d$ is large enough. In particular if:

$$d > \frac{(1-\lambda)\delta^2}{2\lambda}$$

The example illustrates that there are some changes to the model's implications when under discrete pricing. But these changes are likely to be small: if $d = £0.01$

or \$0.01 then for most goods $d$ is a small fraction of the price consumers pay. Under the assumption that $\lambda = 1/2$, for instance, the monopolist would only serve high types exclusively in region 4 when $\delta < \sqrt{1/50} \approx 0.14$. This seems like an implausibly extreme degree of focusing, and so the qualitative lessons from the model with fully continuous attributes carry over.

The example above is very simple, due to the assumption that the qualities and prices from the optimal continuous menu were themselves members of $P$, but integer programming can be used to pin down the monopolist's optimal menu without assuming that $\delta$, $\delta^2$, $\theta$ and $\theta^2$ are all members of $P$. Consider a sequence of grids $P_z$, such that for each $P_z$ the distance between consecutive elements is given by $d_z$. Let $d_0 = 1$. For every $z$, where $z$ is a member of the set of integers $\{1, 2, 3, \ldots\}$, define $d_z = d_{z-1} * \frac{1}{z}$. Therefore the sequence of $d_z$s is:

$$1, \frac{1}{2}, \frac{1}{6}, \frac{1}{24}, \ldots$$

This implies that if $x \in P_z$ then we also have $x \in P_{z+1}$. With such a grid, if our optimal values for $q_i$ and $p_i$ are rational numbers then there exists $z^*$ such that $\forall z \geq z^*$ it must be the case that $q_i$ and $p_i$ are elements of $P_z$.

In general the prices and qualities on the optimal menu are not rational numbers (given that $\delta$ and $\theta$ are real numbers). However, given the relationship between the real and rational numbers as $i$ becomes large (the grid becomes more granular) there exists an element of $P_i$ arbitrarily close to any real number, and, in particular, to the monopolist's optimal prices and qualities. Therefore, this argument sketches out that as the grid $P_i$ becomes arbitrarily fine, an exact equilibrium exists on the grid which is arbitrarily close to the approximate equilibria found in the main text.

## 3.D Stochastic Offers and Focusing Thinkers

Returning briefly to the case of symmetric information, consider the scenario in which the monopolist fixes a price $p$ but the quality of product consumed is random. It is high quality, $\bar{q}$, with some probability $r$ and low quality, $\underline{q}$, with probability

$1-r$. Is the monopolist able to earn higher profits by making such a stochastic offer? The answer depends upon how focusing thinkers evaluate stochastic outcomes.

Following the approach in Bordalo et al. (2012)[48] the answer is yes. In this approach the attributes that consumers consider are the overall payoffs in each state. So the stochastic offer yields $\theta_i\bar{q}-p$ in the 'good' state and $\theta_i\underline{q}-p$ in the 'bad' state, while declining the offer yields 0 in both states. Accordingly, if $|\theta_i\bar{q}-p|>|\theta_i\underline{q}-p|$ then the good state is be more salient to the consumer and vice versa.

If the good state is more salient then the consumer accepts the stochastic offer whenever:

$$r(\theta_i\bar{q}-p)+\delta(1-r)(\theta_i\underline{q}-p)\geq 0 \tag{3.189}$$

Hence the monopolist's maximisation problem is:

$$\max_{r,\bar{q},\underline{q}} E\pi=\frac{r\theta_i\bar{q}+\delta(1-r)\theta_i\underline{q}}{\delta+r(1-\delta)}-r\frac{\bar{q}^2}{2}-(1-r)\frac{\underline{q}^2}{2} \tag{3.190}$$

The optimal menu is:

$$r^*=\frac{\delta}{1+\delta},\ \bar{q}^*=\frac{\theta_i(1+\delta)}{2\delta},\ \underline{q}^*=\frac{\theta_i(1+\delta)}{2},\ p^*=\frac{(1+\delta)^2\theta_i^2}{4\delta}-\epsilon$$

for some $\epsilon>0$, where $\epsilon$ ensures that the good state is indeed more salient than the bad state (at $\epsilon=0$ the states would be equally salient). The profit from this menu can indeed be greater than the first best with non-stochastic offers:

$$\frac{\theta_i^2}{2}\left(\frac{(1+\delta)^2}{4\delta}\right)-\epsilon>\frac{\theta_i^2}{2}\Leftrightarrow\frac{\theta_i^2(1-\delta)^2}{8\delta}>\epsilon \tag{3.191}$$

There is an alternative approach one could take to modelling risky choice as proposed by Kőszegi and Szeidl (2013) – assume that the attributes of a stochastic offer are the expected quality utility $(r\theta_i\bar{q}+(1-r)\theta_i\underline{q})$ and the expected price utility $(p)$ of the offer. If focusing thinkers view the stochastic offer in this way, then the monopolist would not be able to do any better than in the non-stochastic case. Optimal $\bar{q}$ and $\underline{q}$ would in fact both equal $\theta_i$.

[48] A paper that specifically deals with the evaluation of risky choices – for example, a leading example in their paper uses their theory of salience to provide an interpretation of choices consistent with the Allais paradox.

To see this, consider that the consumer accepts the offer if:

$$r\theta_i\bar{q} + (1-r)\theta_i\underline{q} \geq p \tag{3.192}$$

Hence the monopolist's maximisation problem is:

$$\max_{r,\bar{q},\underline{q}} E\pi = r\theta_i\bar{q} + (1-r)\theta_i\underline{q} - r\frac{\bar{q}^2}{2} - (1-r)\frac{\underline{q}^2}{2} \tag{3.193}$$

Formally there are two optimal menus, but in practice they amount to the same outcome. The first is:

$$r^* \in [0,1],\ \bar{q}^* = \underline{q}^* = \theta_i,\ p^* = \theta_i^2$$

The second[49] has $r^* = 1$, $\bar{q}^* = \theta_i$ and $\underline{q}^* = 0$. In either case the consumer faces a bundle of certain quality and there is no advantage to the stochastic offer.

Kőszegi and Szeidl briefly discuss whether state by state payoffs or expected utilities are the "right" attributes to use. They conclude that in situations such as that outlined above, where the "state-space representation of uncertainty is explicit," (pg.87, Kőszegi and Szeidl, 2013) the state by state approach of Bordalo et al. (2012) is probably the natural modelling approach to take. They make the point that there are many types of decisions involving uncertainty but without a clear-cut (or easily comprehendable) state space, such as whether or not to smoke, and suggest that in these cases it may be more natural to use expected utilities.

The field is therefore in need of a model which endogenises these considerations and removes the degree of freedom that has been illustrated in the short stochastic example given here. In much the same way as Kőszegi and Rabin (2006) were able to remove a key degree of freedom from models of reference dependence (how is the reference point determined), for a general model of salient decision making to be truly convincing and widely applicable, it needs to endogenise both the attributes consumers care about when making a decision, and also the contents of a consumer's consideration set. If the attributes are not pinned down endogenously then, as

[49]Assuming that $\bar{q} \geq \underline{q}$. If this assumption is not made then there is a third solution, which is just the mirror image of the second solution (i.e. $r^* = 0$, $\underline{q}^* = \theta_i$ etc.).

demonstrated above, it is possible that the same model of decision-making predicts different behaviour solely due to the choice of attributes made by the modeller.

*When you say it's gonna happen "now"*

*Well, when exactly do you mean?*

*See I've already waited too long*

*And all my hope is gone*

— The Smiths, *"How Soon Is Now?"*

# 4

# How Long Is Now? A test of the 'as soon as possible' effect

## Contents

## 4.1 Introduction

Present-biased preferences (Laibson, 1997; O'Donoghue and Rabin, 1999, 2001) represent a significant improvement upon the classical exponential discounting utility (EDU) model of choice over time (Samuelson, 1937). The model is a true success story of modern behavioural economics providing a framework which can explain evidence from a variety of contexts which the EDU model cannot, in a manner which is both tractable and and also captures key intuitions which ring true with daily life, such as the propensity to procrastinate. There are two key degrees of freedom in the model. One, which has been discussed at length in the literature is whether to model present-biased agents as naïve, sophisticated or partially naïve.[1] The second, equally important but less considered degree of freedom is the length of the present. Time horizon effects are demonstrably important: the present horizon varies in order for quasi-hyperbolic discounting to explain behaviour in a number of different contexts. For example, a period is a day long in DellaVigna and Malmendier (2006)'s study of gym use, while a period lasts a month in Gruber and Kőszegi (2004)'s study of the effect of cigarette taxes. Both papers illustrate that their applications of present bias fit the data better than the classic EDU model, but, if one swapped the period length around between the two studies, the improvement in fit over EDU would be dramatically reduced. This is an important issue which needs to be solved, the question is how?

There are essentially two options. The most radical would be to replace the theory of present bias with a new model (or models) of intertemporal choice. The challenge of this approach is to find theories which do not only explain a number of stylised

[1] Indeed, Acland and Levy (2015) is a recent example of an experiment designed (in part) to measure the extent of naïvete in their sample of gym users.

facts,[2] but which are also tractable and portable – one of the biggest advantages of quasi-hyperbolic discounting is the ease with which it can be applied to so many different scenarios. The alternative is to find a way to endogenise the length of the present and therefore save present bias as the leading theory of intertemporal choice.

This chapter presents results from an experiment designed to explore one possible way of endogenising the length of the present. The 'as soon as possible' or ASAP hypothesis (Glimcher et al., 2007; Kable and Glimcher, 2010) is an intuitive approach to determining the present horizon. Given a menu of options which occur at different points in time, the ASAP hypothesis supposes that the option which is realised soonest fixes the present – all later options are perceived to be in the future. As well as being a simple way of determining the present horizon, there is the added advantage that the ASAP hypothesis is able to explain the variation in present horizon in many of the existing applications of present bias, where period length is often determined on an *ad hoc* basis by the structure of the available data.

I explore the ASAP effect through an experimental design which is both novel to the field of intertemporal choice and ASAP studies more specifically. While many recent intertemporal choice experiments have implemented Convex Time Budget designs (e.g. Andreoni and Sprenger, 2012), the canonical experiment is a multiple price list in which subjects face a sequence of binary choices between a smaller, sooner (SS) option and a larger, later (LL) option. The between-subjects design presented here, draws upon studies of menu-dependence (Huber et al., 1982; Simonson, 1989) and considers menus with three prize, time options. The third option, denoted $a$, is added to standard SS and LL options. The intention is that $a$ is so unattractive that it is never chosen, but is still attractive enough to influence the perception of the length of a period. Subjects facing treatment questions are given a menu in which $a$ is realised prior to the SS option, while for those in the control group $a$ is realised after the LL option. The ASAP effect predicts that the proportion

[2] A number of such models exist: for example, even the economist who spearheaded the modern adoption of quasi-hyperbolic discounting, David Laibson, has co-authored a paper on the heuristic 'ITCH' model (Ericson et al., 2015), which appears to explain experimental evidence on intertemporal, monetary choices better than any discounting model.

choosing the LL option should be higher in the treatment group. Finally, the design provides a straightforward suggestion for a novel policy instrument – a menu with an unattractive early option may help individuals to choose more patiently.

The experimental data collected does not support the ASAP effect. Five parameterisations of the design were carried out for incentivised monetary stakes on the online platform Amazon Mechanical Turk[3] – for only one of the five parameterisations is there a positive and significant treatment effect, in the other four cases and in aggregate, subjects in the treatment group actually appear to make slightly less patient choices (although statistically, this effect is not significant).

Therefore the problem of varying time horizons still stands. The ASAP effect does not appear to work and so after explaining the concept, method and results of the experiment conducted, I discuss the implications of the results for future research on time preference.

## 4.2 The Degree of Freedom

### 4.2.1 Varying Time Horizons

The economics profession has been very liberal in its interpretation of the present. Quasi-hyperbolic preferences are widely applied and the length of the present or a period within a model varies significantly between papers.

#### How long is now assumed to be?

Typically, little discussion is given over to the length of the present horizon in applications of quasi-hyperbolic discounting. Instead units of time are chosen if they seem reasonable, convenient (given the available data) or in keeping with previous studies. Table 4.1 outlines a number of the more prominent applications, illustrating the variety of present horizons used in the literature.

In many of these studies the authors do not really have a choice over which present horizon to use. In Shui and Ausubel (2005)'s study of data from a large-scale field experiment on credit card usage, their dataset provides a detailed account of

[3]Often abbreviated as 'mTurk', `www.mturk.com`.

**Table 4.1:** Field Applications of Quasi-Hyperbolic Discounting with Different Present Horizons

| Study | Present Horizon | Context |
|---|---|---|
| DellaVigna and Malmendier (2006) | A day | Gym usage and membership decisions. |
| Shapiro (2005) | A day | Food stamp nutrition cycle. |
| Tarozzi and Mahajan (2011) | 2-3 days* | Insecticide treated net purchases. |
| Paserman (2008) | A week | Job search. |
| Acland and Levy (2015) | A week | Habit formation in gym usage. |
| Gruber and Kőszegi (2004) | A month | Tax incidence in the case of cigarette excise taxes. |
| Carroll et al. (2009) | A month | Pension (401k) savings decisions. |
| Shui and Ausubel (2005) | A month | Credit card usage. |
| Angeletos et al. (2001) | A year | Macro consumption model. |
| Laibson et al. (2007) | A year | Lifecycle consumption choices. |
| Fang and Silverman (2009) | A year | Welfare program participation. |
| Fang and Wang (2015) | Two years | Mammography decisions. |

*In Tarozzi and Mahajan (2011) households have 2-3 days to make a decision on whether to purchase insecticide treated nets from the experimenters.

monthly usage of their credit card – weekly or daily information does not exist in this dataset. Similarly, Fang and Wang (2015) follow biannual surveys of women's mammography decisions. However, this is not true for all of the studies: for instance the surveys in Fang and Silverman (2009) include weekly employment data and monthly welfare data, yet they aggregate this data into yearly variables which describe individual's labour market decisions.

The way that the horizon varies between study often makes sense intuitively. For example, Paserman (2008)'s week horizon makes sense in a job search model, when many governments (e.g. the UK) require weekly or perhaps fortnightly meetings to provide proof of job applications or to plan job search. Similarly it is intuitive that a model of credit cards sets the time horizon as a month (Shui and Ausubel, 2005), when practically all card payments are automatically made on a monthly basis.[4]

Whether the time horizon is convenient or intuitive for any paper considered alone, quasi-hyperbolic discounting does not provide a coherent story without an understanding of why different horizons are necessary to explain different sets of stylised facts. For instance take two studies from opposite ends of the horizon scale. In DellaVigna and Malmendier (2006)'s story of gym usage and membership, the costs of going to the gym are incurred on the day you go, but the benefits (such as improved health and fitness) are realised on subsequent days. If gym users are present-biased and naïve then, at the start of a month, many will overestimate how often they will go to the gym that month. This is because, from that first day's perspective, all the costs of working out at future visits are incurred in the future. If they are (at least partially) naïve, then they will fail to foresee that these future costs will become more significant when the day comes to actually attend the gym. This provides an explanation for why people may buy expensive monthly memberships, even though, fixing their limited usage, they would spend less money if they paid a daily per-visit fee instead. This story simply would not work if the present horizon was a year long: all the costs of working out in a given month

[4]Nevertheless, other decisions which feed in to the data analysed in these papers may occur over different horizons: e.g. do I complete this job application today or tomorrow? Do I buy this good or service now/over the next thirty minutes or later?

would now be in the present. Hence it would not be possible for a naïf to think about their predicted monthly usage and expect to work out on lots of occasions this month if they would not also be willing to go today.[5]

A similar argument implies that using horizons that are too short also reduces the model's capacity to explain data. If the present horizon was a day in Laibson et al. (2007) then they would struggle to explain their annual consumption data. A present horizon of a day, when data is annual, is very close to simply assuming an EDU model over that data (since a day is a very small proportion of a year). However, Laibson et al. (2007) and the other studies in Table 4.1 show that quasi-hyperbolic discounting explains the data significantly better than EDU models.[6]

**How long is now in experimental data?**

Variation in present horizons also exists in the traditional laboratory evidence which supports present bias; and, in general, experimental horizons are significantly shorter. Table 4.2 lists a number of supportive studies.

The main distinction to make amongst experimental studies is between studies with and without a 'front-end delay'. One of the possible confounds in intertemporal choice experiments is whether subjects make decisions based (in part) upon the perceived reliability of payment (Thaler, 1981). Payments or outcomes that happen immediately (or at the end of an experimental session) are in some sense certain,

[5]As an aside, if one could induce individuals to make gym use decisions using a year long horizon, it is highly likely that they would attend the gym more frequently. This is because some (or a higher proportion) of the benefits of gym use would now be realised within the present horizon, and so would be valued more by decision makers.

[6]It seems implausible that all consumption decisions are made on a yearly basis – e.g. this certainly seems unlikely for groceries – but because the data is structured this way, economists have few options in how to treat the data. However there has been no analysis (to the best of my knowledge) examining how consumption decisions over small horizons feed into aggregate consumption decisions. If economists wish to use an annual quasi-hyperbolic discounting model then they should justify why, if earnings are paid monthly and consumption decisions are made weekly, the resulting annual data would resemble consumption decisions as if they were made annually under the quasi-hyperbolic model. And if this justification cannot be made, perhaps it would instead be possible to deduce from annual data what the best estimate is of the horizon over which consumption decisions are made.

**Table 4.2:** Different Present Horizons in Experimental Studies Consistent with Present Bias

| Study | Present Horizon* | Comment |
|---|---|---|
| *Immediate outcome is immediate* | | |
| Solnick et al. (1980) | 0–150 seconds | Termination of white noise during a task. |
| McClure et al. (2007) | 0–5 minutes | Juice consumption. |
| Brown et al. (2009) | 0–10 minutes | Soda consumption. |
| Read and Van Leeuwen (1998) | 0–1 week | Snack choices. |
| Balakrishnan et al. (2016) | 0–2 weeks | Money payments via M-Pesa in Kenya. |
| *Unclear front end delays* | | |
| Tanaka et al. (2010) | $\hat{0}$–1 day | Money rewards in Vietnam. |
| Badger et al. (2007) | $\hat{0}$–5 days | Buprenorphine doses for recovering heroin addicts. |
| Read et al. (1999) | $\hat{0}$–2 days | Movie rental. |
| Benhabib et al. (2010) | $\hat{0}$–3 days | Cheques ($\hat{0}$ = time to cash a cheque). |
| Augenblick et al. (2015) | $\hat{0}$–1 week | Real effort task. |
| Kuhn et al. (2014) | $\hat{0}$–5 weeks | CTB study with money wired to bank accounts. (Evidence for present bias "small but significant".) |
| Carvalho et al. (2016) | $\hat{5}$–35 days | Real effort task. (Earliest task to be completed within 5 days; evidence "*consistent* with present bias.") |
| *Deliberate front end delays* | | |
| Meier and Sprenger (2015) | $x$–1 month + $x$ (Where $x$ = time to post a letter) | Money payments. |
| Giné et al. (2012) | 1–30 days | Cash payments in Malawi. (Weak evidence for present-bias as main determinant of choice.) |

*Implicit present horizons based on author calculations.

whereas future payments are not. Experiments with immediate payments that suggest the presence of present bias may instead capture a preference for certainty.[7]

One approach to solving this certainty confound is to use a front end delay. This means that the 'immediate' options in intertemporal choice questions are realised with a small delay and not immediately after they are chosen. For example, in Read et al. (1999) subjects chose what type of movie they wanted to rent to watch at home either on the same evening as they made their choice, or on subsequent evenings. While it is not completely clear how long the delay was between making the decision and watching the video, there is a delay (after choices were made, subjects had to go to the video rental store to collect the movie and then go home to watch it). Similarly, in Meier and Sprenger (2015) all payments were made by money order sent by mail to subjects' home addresses. Therefore immediate payments were received at least a day after choices were made, and this was a deliberate effort by the experimenters to equalise transaction costs across payments on different dates.

The existence of studies consistent with present bias both with and without a front-end delay ensures that no single present horizon can simultaneously explain all of the studies in Table 4.2. Some of the experiments without front-end delay require extremely short present horizons – for example, shorter than 2 minutes 30 seconds in Solnick et al. (1980) and less than 5 and 10 minutes respectively for McClure et al. (2007) and Brown et al. (2009).[8] Front-end delays are often longer than 10 minutes, whether this is due to a deliberate postage delay (Meier and Sprenger, 2015), or due to collecting a lot of data and making payments at the end of a session (as in Tanaka et al., 2010, whose experimental sessions lasted 4 hours)

### 4.2.2 The ASAP Effect: A Possible Solution

The first paper to consider the ASAP effect in the economics literature was Glimcher et al. (2007). Their concise paper makes two key contributions. First they dispute

[7]Indeed there are models that derive present bias as a consequence of non-expected utility – see e.g. Halevy (2008).

[8]Solnick et al. (1980) examines how individuals would prefer to avoid distracting white noise while they were trying to complete a task, while McClure et al. (2007) and Brown et al. (2009) study drinking decisions made by thirsty subjects.

neuroeconomic evidence from McClure et al. (2004), who argue that there is evidence for two separate systems operating inside the brain during intertemporal decision making. When choices include immediate rewards, this engaged parts of the limbic system; delays (whether large or small) activated areas of the lateral prefrontal cortex and posterior parietal cortex. McClure et al. find that these activations are correlated with the decisions that subjects made, therefore taking this as evidence for a distinction between patient and impatient areas of the brain. However Glimcher et al. point out a key problem with this argument:

> "We note, however, that an area where activity was linearly correlated with a hyperbolic-like discounted utility function of any kind (which necessarily favors immediate over delayed gains) would also show this property. The critical test of the multiple-selves model at a neural level, which these authors did not perform, would be to show that the area in question discounted faster than behavioral measurements of the subjects' indifference curves or, at least, that different brain areas discounted at different rates. We show that this is not the case." (Glimcher et al., 2007, p.143)

Such a result questions the common dual-self motivation (internal conflict between an inpatient and a patient 'self') behind quasi-hyperbolic discounting models and so led the authors to run an additional experiment leading to their second contribution. In their first experiment, subjects face a sequence of SS/LL choices which all involve an SS option of $20 immediately. The delay of the LL options varies from 6 hours to 6 months. An indifference curve was estimated for each subject and was found to be hyperbolic.

The follow-up experiment recruited a new subject pool and asked them both questions resembling those from the first experiment (immediate-option set) and a set of questions in which all options were shifted 60 days into the future (delayed-option set). The immediate-option questions yielded hyperbolic indifference curves that were statistically indistinguishable from those found in the first experiment. However, the surprising, and fundamentally new, result was that for each subject the indifference curves from the delayed-option set were statistically indistinguishable from those found in the immediate-option set (if 60 days was taken off each outcome). This finding is the ASAP effect, which Kable and Glimcher (2010) expand upon.

The attraction of considering the ASAP effect is that it provides an intuitive explanation for why time horizons of different lengths would occur in different circumstances. If individuals consider a gym visit as a possible daily occurrence (typically gym users either go on a given day or they do not; it's very rare for people to visit two or more times a day), then a day is the correct time horizon to use to explain gym usage data. If credit card bills arrive monthly and therefore individuals make decisions about paying off credit card debt on that basis, then a month is the appropriate horizon. Finally, from the lab, if the earliest that annoying static noise can be removed is in a matter of seconds, then the time horizon should be measured in seconds. Importantly, therefore, the same individual can have different time horizons in different contexts, and quasi-hyperbolic discounting (plus the ASAP effect) would then truly be able to claim to be a general model of time preference which explains decision making even when time horizons vary.

## 4.3 Experimental Design

Figure 4.1 encapsulates the key to the between-subjects experiment in a single diagram. A control group face a menu consisting of outcomes $B$, $C$ and $a$. In the experiment analysed here these outcomes are dated monetary payments \$$B$ at time $t$, \$$C$ at time $s$ and \$$a$ at time $r'$ (but in principle, these outcomes do not need to be monetary). The relative size of the circles associated with each outcome depicts how desirable they are – i.e. how much money is associated with each outcome. So $B$ is the SS outcome, $C$ is the LL outcome and $a$ is not only less desirable but also comes later in the control group– therefore it should be irrelevant to a subject's choice and, if they have monotonic preferences, never chosen. In contrast, in the menu that treatment group subjects face, the outcome $a$ is brought forward before the SS outcome, at time $r$. Now, assuming that $a$ is sufficiently small such that subjects do not prefer $a$ to the SS or LL outcomes, but it is also sufficiently salient such that the ASAP effect comes into play, then the prediction is that more subjects choose the LL outcome in the treatment group than in the control group. Why? Because the treatment group subjects should perceive that the present ends at time $r$, meaning that both the SS and LL outcomes occur 'in the future'. (For further explanation, see section 4.4 below.)

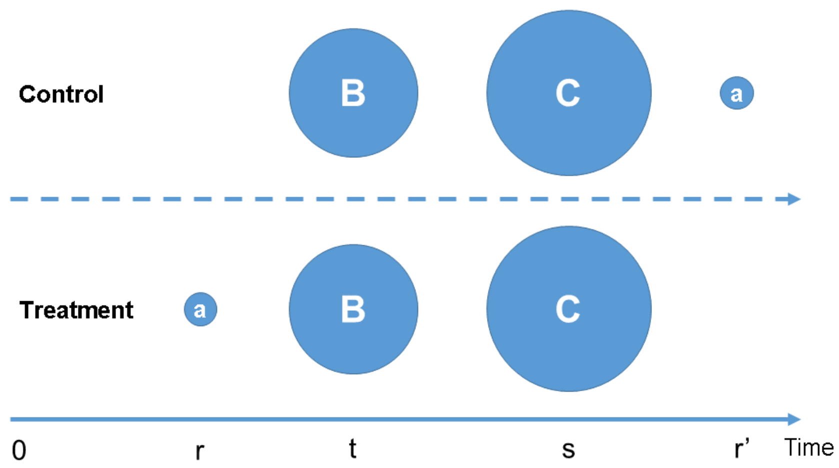


**Figure 4.1:** Abstract Experimental Design

Hence, the design tests the ASAP effect very simply: I evaluate the ASAP hypothesis by comparing the proportions of subjects choosing $B$ and $C$ in the control group with the equivalent proportions in the treatment group.

The decision to test the hypothesis with a between-subjects design and not a within-subjects design is an important one. While within-subject designs are now the most common approach in the time preference literature,[9] the results of this design are focused upon answers to a single question for each subject. Why? There are three key reasons. First, the results of this approach are straightforward and easy to interpret, while the design also captures an angle through which policy makers or contract designers may wish to harness the ASAP effect. Secondly, implementing this idea in a within-subjects design requires answers to a number of

[9]The recent literature also emphasises the importance of eliciting estimates of utility curvature in conjunction with estimates of discounting behaviour, a point made forcefully in Andersen et al. (2008).

secondary questions: for example, does your present horizon carry over from one question to the next?[10] The point of this experiment is simply to establish whether or not different menus affect intertemporal choice, in a manner consistent with the ASAP effect. The between-subjects, single question design is the cleanest way to achieve this. Thirdly, within-subject designs are precisely what is required to estimate deep-seated preference parameters. However, they seem unnecessary and even inappropriate to explore whether preferences are more flexible than typical discounting models would suppose. Thus this experiment follows the pioneering papers of the literature on menu-dependent choice (Huber et al., 1982; Simonson, 1989) which used between-subjects designs.

### 4.3.1 Practicalities

The experiment was run in three waves with online workers on mTurk.[11] The waves occurred between the 8th and the 14th February 2016 (surveys 1-3), between the 14th and 15th March 2016 (survey 4) and between the 22nd and 26th March 2016 (survey 5). In each wave workers were randomly assigned to treatment and control groups (and within the first wave, to surveys) before answering a number of questions. These include the incentivised $aBC/BCa$ question, eleven subsequent unincentivised questions in which the size of $a$ was varied, demographic questions on age, household income and gender, and finally, for the final wave/survey only, a question asking subjects to explain the thought process behind their decision on the incentivised question.

In order to standardise the design, the relative timings of each outcome were fixed across surveys: the SS outcome was $\$B$ received after four units of time; the LL outcome was $\$C$ after six units of time; in the treatment group $\$a$ was available after one unit of time, while in the control group it was available after seven units

[10] In the context of menu-dependent choice more generally, such questions are taken up by Cunningham (2012).

[11] For a brief discussion of mTurk and previous economics studies conducted on the website, see Appendix 4.A.

of time. In the experiment I used days and weeks as the units of time.[12] The key differences between the surveys carried out are described in table 4.3. The hypothetical questions for each subject are the same as the incentivised question they answered with the exception that the size of $a$ was varied.[13]

**Table 4.3:** Experimental Design Features

| | Incentivised Question | | Hypothetical variation of $a$ | | |
|---|---|---|---|---|---|
| Survey | $\$a, \$B, \$C$ | Unit | Treatment | Control | Explain? |
| 1 | $\$2, \$9, \$10$ | Days | $\$0.50 - \$6$ | $\$1 - \$21$ | No |
| 2 | $\$4, \$16, \$20$ | Weeks | $\$1 - \$21$ | $\$3 - \$23$ | No |
| 3 | $\$4, \$9, \$10$ | Days | $\$0.50 - \$6$ | $\$1 - \$21$ | No |
| 4 | $\$2, \$16, \$19$ | Weeks | $\$1 - \$21$ | $\$3 - \$23$ | No |
| 5 | $\$4, \$16, \$19$ | Weeks | $\$1 - \$21$ | $\$3 - \$23$ | Yes |

One of the key challenges in choosing parameters for the experiments was to set the appropriate value for $a$ relative to $B$ and $C$. Too small and it could be ignored (or not be a salient option), thereby minimising the difference between control and treatment groups. However, setting $a$ too large presents the converse possibility: subjects could frequently pick $a$ over $B$ and $C$, obscuring the effect of $a$ on a subject's ranking of $B$ and $C$. This explains the eleven hypothetical questions in which the size of $a$ was varied[14] – the choices from the first wave of surveys helped to inform the choice of $a$ in subsequent surveys.[15]

## 4.4 Theory

As a benchmark consider a basic discounting model of intertemporal choice. Suppose that receiving $\$w$ yields utility $u(w)$ in the period in which the money is received. The discount factor applied to payments made in period $l$ is $d(l)$. A decision

[12]It may have been nice to also look at months but bonus payments in mTurk have to be made within 40 days of the HIT closing and so it would not have been feasible to explore the $aBC/BCa$ design over months on the mTurk platform.

[13]See Appendix 4.C for an example of the interface presented to subjects online.

[14]Learning by doing was also useful with respect to $B$ and $C$ choices: in the final two surveys, the control group's choices were much closer to a $50 : 50$ split between the $B$ and $C$ options, whereas in the first wave of surveys, a fairly large majority chose $C$.

[15]I retained the hypothetical questions in the later surveys for consistency with the earlier surveys and also because the hypothetical choice data provided additional data that was useful for carrying out robustness checks of the results.

maker prefers \$$B$ at time $t$ over \$$C$ at time $s$ in both the control and treatment groups whenever:

$$d(t)u(B) \geq d(s)u(C) \Leftrightarrow \frac{u(B)}{u(C)} = \Gamma \geq \frac{d(s)}{d(t)} \tag{4.1}$$

Where $\Gamma \in (0,1)$ so long as $u$ is strictly increasing in wealth and $u(w) > 0$ for every $w > 0$. Decision makers pick $B$ if they are sufficiently impatient. In the case of the EDU model this becomes:

$$\Gamma \geq \delta^{s-t} \tag{4.2}$$

Where $\delta \in (0,1)$ is the exponential discount factor over one unit of time. If the decision maker has present-biased preferences then it is slightly more complicated. Define $\bar{l}$ as the present horizon. The discounting function $d$ takes on the following form:

$$d(l) = \begin{cases} 1 & \text{if } l \leq \bar{l} \\ \beta\delta^{l-\bar{l}} & \text{if } l > \bar{l} \end{cases} \tag{4.3}$$

Where $\beta \in (0,1)$ is the degree of present bias. Hence, if $\bar{l} < t$, the condition is exactly the same as in equation 4.2 above, while if $t \leq \bar{l} < s$, then:

$$\Gamma \geq \beta\delta^{s-\bar{l}} \tag{4.4}$$

Finally, if $t \leq \bar{l}$ then the right hand side of the inequality is equal to 1 and the decision maker never prefers $B$ – in this case both options are in the present and so the decision maker simply chooses the largest reward, $C$.

The key point is that whether decision makers are in the control group or in the treatment group, this has no influence on the conditions above. Therefore, even if values of $\delta$, $\beta$ and $\Gamma$ vary from person to person, the randomisation process should ensure that the distribution of these parameters is roughly the same in control and treatment groups (if the sample of subjects is large enough).

Denote the proportion of subjects choosing $a$, $B$ and $C$ as $a_i$, $B_i$ and $C_i$ respectively, where $i = c$ for the control group and $i = t$ for the treatment group. Assume that no subject chooses the option $a$, then the prediction for behaviour is as follows:

**Null Hypothesis – typical discounting, $H_0$:** Varying the timing of $a$ has no effect on the proportion of subjects choosing $B$ and $C$. i.e. $B_c = B_t$ and $C_c = C_t$.

Evaluating the effects of the ASAP effect on the present horizon, leads to the alternative hypothesis. Discount factors are still given by equation 4.3, but now the present horizon $\bar{l}$ is equal to $r < t$ for treatment group subjects, and equal to $t$ for control group subjects. Subjects in the control group therefore pick $B$ when $\Gamma \geq \beta\delta^{s-t}$ (substituting $t$ for $\bar{l}$ in equation 4.4), whereas for the treatment group the respective condition is $\Gamma \geq \delta^{s-t}$.

For fixed $\Gamma$ and $\delta$, because $\beta \leq 1$, every subject is more likely to choose $B$ facing the control group menu rather than the treatment group menu. Therefore, again assuming that no one picks $a$, the prediction under the ASAP effect is as follows:

**Alternative Hypothesis – ASAP effect, $H_1$:** In the treatment group, relatively more subjects choose $C$. i.e. $B_c > B_t$ and $C_c < C_t$.

### 4.4.1 How sizeable an effect does the benchmark model predict?

Given that the rewards are relatively small, assume that the utility function $u(w)$ is linear over experimental rewards. Under this assumption the benchmark model predicts rather a large treatment effect. Take survey 2 to begin and let $\delta_w$ be the weekly discount factor. In the treatment group, subjects choose \$16 in four weeks whenever:

$$\frac{4}{5} \geq \delta_w^2 \Leftrightarrow \delta_w \leq \frac{2\sqrt{5}}{5} \approx 0.89 \tag{4.5}$$

This clearly implies that only individuals who discount the future very quickly would choose the $B$ option.[16] In contrast, for the control group the following condition holds:

$$\frac{4}{5} \geq \beta\delta_w^2 \Leftrightarrow \frac{2\sqrt{5}}{5\sqrt{\beta}} \geq \delta \tag{4.6}$$

[16] The weekly discount factor is equivalent to an annual discount factor (not rate!) of approximately 0.003. Note that under the survey 4 or 5 parameterisations, where $C$ pays out \$19, the implied cut-off is $\delta_w \approx 0.92$, which still implies an absurdly low (although relatively larger) annual discount factor of about 0.011.

If $\beta < 0.8$,[17] then this implies that subjects in the control group would choose the $B$ option, whatever their $\delta$. So, depending upon a subject's value of $\beta$, in theory the treatment should have a significant effect on choice.

In the days surveys, the treatment effect should be even more pronounced. Let $\delta_d$ be the daily discount factor. In the treatment group $B$ is preferred to $C$ when:

$$\frac{9}{10} \geq \delta_d^2 \Leftrightarrow \delta_d \leq \frac{3\sqrt{10}}{10} \approx 0.95 \Rightarrow \delta_w \leq \delta^* \approx 0.69 \tag{4.7}$$

Comparing the cutoff weekly discount factor between the days and weeks questions shows that subjects would have to be even more impatient to choose $B$ over $C$ in the treatment group of surveys 1 or 3.[18] Considering the control group:

$$\frac{9}{10} \geq \beta\delta_d^2 \Leftrightarrow \delta_d \leq \frac{3\sqrt{10}}{10\sqrt{\beta}} \tag{4.8}$$

It turns out that this condition is satisfied for all $\delta \leq 1$ whenever $\beta < 0.9$, which is less restrictive than the respective condition from the weeks survey of $\beta < 0.8$. Hence, whether the unit of time is a day or a week, the benchmark model predicts that the design should provide convincing evidence for the ASAP effect, if utility is linear.

### 4.4.2 What if Subjects Choose $a$?

If subjects choose $a$ in the treatment group, does this imply anything about their preferences over $B$ and $C$? Continuing with the model of the ASAP effect outlined above, first consider survey 2. Picking $a$ means that they prefer $a$ to $B$:

$$4 \geq \beta\delta_w^4 16 \Leftrightarrow \frac{1}{4\beta} \geq \delta_w^4 \Leftrightarrow \delta_w \leq \frac{\sqrt{2}}{2\sqrt[4]{\beta}} \tag{4.9}$$

And also $a$ to $C$:

$$4 \geq \beta\delta_w^6 20 \Leftrightarrow \frac{1}{5\beta} \geq \delta_w^6 \Leftrightarrow \delta_w \leq \frac{1}{\sqrt[6]{5\beta}} \tag{4.10}$$

[17] Not an unreasonable value given that many studies suggest $\beta$ to be close to 0.7, for example Brown et al. (2009) estimate a value of $\beta$ somewhere between 0.6 and 0.7. That said, even amongst studies that do support present bias, estimates for $\beta$ do vary: Augenblick et al. (2015) estimate $\beta = 0.888$ from their effort tasks, while McClure et al. (2007) estimate that $\beta = 0.52$.

[18] This is borne out in the data – more individuals choose $C$ in the days surveys than in the weeks surveys.

The first condition is more restrictive than the second for most values of $\beta$. To be precise:

$$\frac{\sqrt{2}}{2\sqrt[4]{\beta}} \leq \frac{1}{\sqrt[6]{5\beta}} \Leftrightarrow \beta \geq \frac{25}{64} \approx 0.39 \tag{4.11}$$

If this is true, a choice of $a$ implies a preference for $B$ over $C$ in this menu since (using the condition from equation 4.5):

$$\frac{\sqrt{2}}{2\sqrt[4]{\beta}} < \frac{2\sqrt{5}}{5} \Leftrightarrow \frac{5^{\frac{1}{2}}}{2^{\frac{3}{2}}} < \beta^{\frac{1}{4}} \Leftrightarrow \beta > \frac{25}{64} \approx 0.39 \tag{4.12}$$

The simple ASAP model therefore implies that a choice of $a$ from a treatment group menu indicates that the subject also prefers $B$ to $C$ as long as $\beta > 0.39$ (which seems reasonable given typical estimates for $\beta$ in the literature).

A similar exercise can be undertaken for the days designs. For $\$a = \$4$ (survey 3) the equivalent condition for a choice of $a$ to indicate preference for $B$ over $C$ is that $\beta > \frac{400}{729} \approx 0.55$ – again a very reasonable cutoff for $\beta$ but perhaps slightly less so than 0.39 above.[19]

Hence these benchmark calculations suggest that it is reasonable to infer that a choice of $a$ in the treatment group is akin to revealing a preference for $B$ over $C$.

### 4.4.3 Other Menu Effects

The experimental design is constructed so that other known effects in the menu dependence literature cannot easily explain evidence that supports the alternative hypothesis. Supposing only that preferences are monotonic (subjects prefer more money sooner), any evidence in support of the ASAP effect directly contradicts the compromise effect (Simonson, 1989). If subjects exhibit the compromise effect then the modal choice should be the $B$ option in the treatment group, since the options $a, B, C$ are increasing in size of payment and delay. There is no possible compromise effect in the control group because the $a$ reward is both the smallest prize and occurs last. Hence, if the ASAP effect is not important but the compromise effect is, then the expected results would be the opposite of $H_1$.

[19] In the days survey with $\$a = \$2$ the condition is instead $\beta > \frac{200}{729} \approx 0.27$ – I am not aware of any study that estimates $\beta$ to be this small.

Another concern is the asymmetric dominance or attraction effect (Huber et al., 1982). Both control and treatment groups face a menu with three options. The control group menus could have had two options – within the ASAP hypothesis this would not change the predictions made about choice. However, it would instead leave open the possibility that any difference in choice between the treatment and control groups could be explained by the way in which subjects approach menus of different size, rather than due to an ASAP effect. There are two possibilities for when to position $a$ in the control group – either between $B$ and $C$, or after $B$ and $C$. The design implements the latter option because the former would create a menu typical in studies of the asymmetric dominance effect: if the reward $B$ paid out before $a$ which paid out before $C$, then $B$ would strictly dominate $a$ (earlier and a larger reward), while $C$ would not dominate $a$ (whilst it is a larger reward it pays out later). In such menus, subjects are more likely to choose the $B$ option than the $C$ option. Because this effect would generate results consistent with the ASAP effect (and so could not be distinguished from it), the control group faced $BCa$ menus (rather than $BaC$ menus).

The last of the key context effects is the similarity effect (Tversky, 1972). Imagine asking one sample of individuals to choose one of two options, call them $X$ and $Y$, and comparing the choices that sample makes against a second sample who face the same menu with an additional third option, $Z$. Suppose that the decision makers perceive $Z$ as similar to but not dominated by $Y$, but also that $Z$ is not similar to $X$: the similarity effect predicts that individuals perceive $Z$ and $Y$ as one sub-group of the second menu. Hence the proportion choosing $X$ would be roughly the same in both the first and second sample, but the proportion choosing $Y$ would be approximately twice as big from the $XY$ menu than from the $XYZ$ menu. If the $B$ and $C$ options in this chapter's design are not perceived by subjects as similar, then the similarity effect should not influence the results here – in the control group $a$ is dominated, while in the treatment group the timing of $a$ is significantly sooner than the timing of $B$. However, if $B$ and $C$ are perceived to be similar, then the similarity effect predicts that the ratio of $B$ to $C$ choices remains roughly the same for the control and treatment group, but in the treatment group the option $a$ is chosen by a number of subjects.[20]

A final note for this section is that while the design fixes the size of the reward in dollars, \$$a$, of the irrelevant prize in both menus, some economists might argue that the design should fix the overall utility value of the irrelevant prize.[21] This would mean that while the treatment group faces the menu $aBC$, the appropriate comparison for a control group would be a menu $BCd$ where, *ex ante*, a decision maker is indifferent between \$$a$ at time $r$ and \$$d$ at time $r'$. This could be an interesting design to consider but raises a number of complications because it eschews the typical approach of studies concerning menu dependence, which separate utility into different attributes. Suppose that the experiment first elicited the value $d$ for each subject then used that value for those subjects assigned to the control condition. There are two immediate issues:

1. There is the danger that the control group would no longer be a true control. Because subjects first face the choice between options at time $r$ and time $r'$ ,the ASAP effect predicts that their present horizon is of size $r$ for that question. If there is any carryover to the next ($BCa$) question, then the present horizon would not be $t$ as intended.

2. Patient and impatient subjects could face qualitatively different menus in the control group. A patient subject is likely to have $\$d < \$B$. In contrast, more impatient subjects may have $\$B < \$d < \$C$, in which case the asymmetric dominance effect would predict more choices of $C$.[22] The more impatient subjects are exactly the subjects that one would expect to pick $B$ and so this could make it more difficult to interpret the results

To avoid these issues I focus on the prize and time attributes separately in this design, and fix the amount \$$a$ rather than attempt to fix the utility value of $a$.

[20] There is some evidence consistent with the similarity effect as outlined – see especially survey 5.

[21] I thank Alexis Grigorieff for suggesting this point.

[22] $C$ dominates $d$ since it is a larger reward and is paid sooner, while $B$ does not dominate $d$, being a smaller amount paid sooner.

# 4.5 Results

## 4.5.1 Main Findings

Tables 4.4 and 4.5 summarise the key results of the study. In these tables data from every incentivised choice is aggregated. Overall, the data shows, if anything, evidence against the ASAP effect. Statistically the treatment effect is not distinguishable from 0, but point estimates imply that on aggregate treated subjects are less likely to choose $C$ than control subjects. There is also little overall evidence of menu dependence in this data set.[23]

**Table 4.4:** Treatment Effect

| **I) Whole Sample** | | | | | |
|---|---|---|---|---|---|
| | early a | B | C | late a | Total |
| Treatment Group? | % | % | % | % | No. |
| No | 0.0 | 38.6 | 61.1 | 0.3 | 350 |
| Yes | 7.1 | 34.4 | 58.5 | 0.0 | 352 |
| Total | 3.6 | 36.5 | 59.8 | 0.1 | 702 |
| **II) Days Sample** | | | | | |
| | early a | B | C | late a | Total |
| Treatment Group? | % | % | % | % | No. |
| No | 0.0 | 21.6 | 77.5 | 1.0 | 102 |
| Yes | 2.8 | 22.4 | 74.8 | 0.0 | 107 |
| Total | 1.4 | 22.0 | 76.1 | 0.5 | 209 |
| **III) Weeks Sample** | | | | | |
| | early a | B | C | late a | Total |
| Treatment Group? | % | % | % | % | No. |
| No | 0.0 | 45.6 | 54.4 | 0 0 | 248 |
| Yes | 9.0 | 39.6 | 51.4 | 0 0 | 245 |
| Total | 4.5 | 42.6 | 52.9 | 0 0 | 493 |

Table 4.4 illustrates the raw data for the overall sample and for the weeks surveys and days surveys separately. The pattern is largely similar for weeks and days, although there are two clear differences. First, a larger proportion of subjects choose the $C$ option in the days sample; second, many more subjects choose $a$ in the treatment group within the weeks sample (the number choosing $B$ decreases, in

[23] To the extent that there is a difference between the treatment and control groups, the data from the whole sample (and the days subset) suggests a weak similarity effect, if the $B$ and $C$ options are deemed similar to each other.

contrast to the days sample where it increases slightly).[24] For the respective raw data from each survey see Appendix 4.B – four out of five surveys follow this same pattern of evidence which does not support the ASAP effect, although survey 2 appears to be strongly in support of the effect, taken on its own.

The variable described in Table 4.4 is defined as the 'Choice' variable – with values 1, 2, 3 or 4 corresponding to $a$ in the treatment group, $B$, $C$ and $a$ in the control group respectively. In order to obtain a surer sense of the significance and size of the treatment effect, controlling for demographic data, I define a binary variable, 'Chose $C$', which is based on Choice. Chose $C$ takes the value 1 if subjects chose $C$ and the value 0 otherwise. As discussed in section 4.4 above, I define the variable this way because it is reasonable to argue that someone choosing the $a$ option would also choose $B$ over $C$. An alternate way of viewing this would be from a policy intervention perspective – if a policymaker wished to use this design to increase the number of individuals choosing $C$ over $B$, any choices of $a$ would not count as a success.

Chose $C$ is regressed on a dummy treatment variable plus controls in a number of specifications, typically using the probit model.[25] The explanatory variables[26] used are:

- The treatment dummy (1 for treatment, 0 for control).
- A household income group variable which has 11 categories coded 1-11. These range from "less than $\$10,000$" to "$\$70,000 - \$79,999$" in $\$10,000$ increments before the last three categories: "$\$80,000 - \$99,999$', "$\$100,000 - \$150,000$" and "more than $\$150,000$".
- An age variable, which works out their age in years based on a reported year of birth.

[24]This second effect is largely driven by a single survey, survey 5 – see Table 4.12.

[25]Table 4.5 is replicated for the logit and linear probability models, and also with an ordered probit using the Choice (rather than Chose $C$) variable in Appendix 4.B. As can be seen the models all report broadly similar results, although the ordered probit model suggests that the treatment leads to significantly more *impatient* choices – however this is slightly unfair because the 'early $a$' option is not available in the control group menu.

[26]Table 4.11 is a table of summary statistics for these variables and can be found in Appendix 4.B.

**Table 4.5:** Probit Estimates for Chose $C$

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| Treatment | -0.0678 | -0.0772 | -0.0725 | -0.0866 | -0.0622 | -0.0829 | -0.0756 | -0.0944 | -0.0887 |
| | (0.0957) | (0.0966) | (0.0986) | (0.190) | (0.193) | (0.205) | (0.113) | (0.114) | (0.116) |
| Income Group | | 0.0126 | 0.00682 | | -0.00617 | -0.0244 | | 0.0195 | 0.0168 |
| | | (0.0170) | (0.0173) | | (0.0353) | (0.0374) | | (0.0198) | (0.0201) |
| Age | | 0.000983 | 0.00186 | | 0.00755 | 0.0156 | | 0.000160 | 0.000463 |
| | | (0.00435) | (0.00446) | | (0.00937) | (0.0105) | | (0.00505) | (0.00512) |
| Female | | -0.324*** | -0.313** | | -0.414* | -0.338 | | -0.257* | -0.256* |
| | | (0.0978) | (0.0998) | | (0.195) | (0.208) | | (0.116) | (0.117) |
| Latitude | | | 0.0101 | | | 0.0186 | | | 0.00474 |
| | | | (0.00787) | | | (0.0185) | | | (0.00894) |
| Longitude | | | 0.00240 | | | 0.00222 | | | 0.00263 |
| | | | (0.00185) | | | (0.00367) | | | (0.00220) |
| Constant | 0.283*** | 0.355 | 0.183 | 0.754*** | 0.714 | 0.0524 | 0.111 | 0.147 | 0.196 |
| | (0.0680) | (0.197) | (0.363) | (0.138) | (0.387) | (0.868) | (0.0798) | (0.236) | (0.409) |
| Observations | 702 | 700 | 676 | 209 | 209 | 195 | 493 | 491 | 481 |
| Pseudo $R^2$ | 0.001 | 0.013 | 0.015 | 0.001 | 0.023 | 0.031 | 0.001 | 0.009 | 0.011 |

Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The dependent variable Chose $C$ takes the value 1 if a subject chose $C$ in the incentivised decision, 0 otherwise.

Columns 1-3 are probit estimates for the whole sample. 4-6 are estimates for the days sample and 7-9 for the weeks sample respectively.

- A female dummy (1 for female, 0 for male). Two subjects reported that their gender was neither male nor female – their data is excluded from regressions involving the female dummy.

- Latitude and longitude co-ordinates. (These are missing for just under 4% of the sample.)

Table 4.5 displays 9 different probit specifications. Models 1-3 are for the full data set, 4-6 for the days sample and 7-9 for the weeks sample. In each case the table provides a simple constant and treatment only specification, a treatment and controls specification, and a treatment and controls (including geographic co-ordinates) specification. The results are very consistent across specifications and samples: the treatment effect is small and negative, never significant; income group and age have very small effects on the model's ability to predict the data (as do latitude and longitude co-ordinates); but being female does seem to have a large and significant effect on behaviour – in this sample women make less patient choices. It is instructive to compare the size of the female coefficient with the treatment coefficient: the standard errors for both variables are very similar, but the effect of being female is significantly larger than the treatment effect.

A final note in this section would be that econometrically one can be confident, given the standard error, that the coefficient on the treatment dummy in model 1 of Table 4.5 is no larger than $-0.0678 + 0.0957 = 0.0279$. With the model's constant of 0.283, this means that the largest proportion of treatment group subjects choosing $C$ that could be expected is 62.2% – this would be a positive treatment effect of only 1.1%, which would not be economically significant.

### 4.5.2 Power calculation

What is the minimum detectable effect size in this experiment given the sample sizes and proportions of the control group choosing $C$? For what follows I use a simple likelihood ratio test for detecting whether there is a difference between two independent samples.

Taking the dataset as a whole, with a control group of 350 subjects, 61.1% of whom choose $C$, and a treatment group of 352 subjects, assume that the significance level required is 5%, and the power of the test is 80%. The experiment detects the effect size as significant if the proportion choosing $C$ in the treatment group surpasses 70.01%.

Similarly, for just the weeks sample, noting that now there are 248 control group subjects, 54.4% of whom chose $C$, and 245 treatment group subjects, the experiment detects the effect size as significant so long as more than 65.36% of the treatment group pick $C$.

Therefore, the experiment finds that the treatment effect is significant if the it increases the proportion choosing $C$ by more than about 10%. This is not unreasonable, given that in survey 2 there is a $16 - 17\%$ increase in the proportion choosing $C$.

### 4.5.3 Robustness

#### Treatment Interactions

Consider treatment interaction effects – do they provide any support for the ASAP effect? In this section I analyse whether the treatment effect is stronger for subjects of different characteristics. I pick three demographic characteristics that are associated with more impatient behaviour: gender (as seen above, in the data women are more likely to pick earlier options), age and income level. For age and income I define two new dummy variables (young and low income) which are equal to 1 when subjects are in the bottom half of the age or income distribution. These dummies (along with the female dummy) are used to create interaction variables which are examined in Table 4.6. In this section I use the linear probability (OLS) model due to the well-known fact (Ai and Norton, 2003; Greene, 2010) that when estimating non-linear models (e.g. probit models) with interaction terms, the estimated partial effect of the interaction term does not generally represent the true interaction effect in the model.

Overall there is little evidence to suggest that the interaction variables help to explain the data. There is a hint that the ASAP effect could lead the youngest

**Table 4.6:** Linear Probability Model Estimates for Chose $C$: Treatment Interaction Terms

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| Treatment | -0.0262 | 0.0115 | -0.0777 | -0.0730 | -0.0835 | -0.0286 | -0.0470 |
| | (0.0370) | (0.0459) | (0.0533) | (0.0472) | (0.0549) | (0.0455) | (0.0543) |
| Treated and Female | | -0.0741 | 0.0945 | | | | |
| | | (0.0523) | (0.0737) | | | | |
| Female | | | -0.169** | | | | |
| | | | (0.0523) | | | | |
| Treated and Youngest | | | | 0.0840 | 0.104 | | |
| | | | | (0.0526) | (0.0744) | | |
| Youngest | | | | | -0.0198 | | |
| | | | | | (0.0525) | | |
| Treated and Low Income | | | | | | 0.00471 | 0.0376 |
| | | | | | | (0.0524) | (0.0744) |
| Low Income | | | | | | | -0.0329 |
| | | | | | | | (0.0529) |
| Constant | 0.611*** | 0.612*** | 0.701*** | 0.611*** | 0.622*** | 0.611*** | 0.630*** |
| | (0.0262) | (0.0263) | (0.0380) | (0.0262) | (0.0383) | (0.0263) | (0.0396) |
| Observations | 702 | 700 | 700 | 702 | 702 | 702 | 702 |
| $R^2$ | 0.001 | 0.004 | 0.018 | 0.004 | 0.005 | 0.001 | 0.001 |

Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

OLS estimates for the whole sample. Columns 2-3, 4-5 and 6-7 for gender, age and income respectively.

subjects to make more patient choices but the overall effect (when the treatment dummy is also taken into account) is very small. It is clear, in the case of female subjects, that the fact that female subjects make less patient choices than male subjects is much more important than the effect of the interaction variable – e.g. see the sign difference on the female interaction dummy between specifications 2 and 3 in Table 4.6. Splitting the sample into weeks and days leads to broadly similar conclusions (see Table 4.16 and Table 4.17 in Appendix 4.B).

**Consistency**

One concern about conducting experiments on mTurk is that because subjects are completing the survey online with no supervision, experimenters do not know the conditions under which the survey is completed. A subject could face multiple distractions or, even worse, pick answers at random.[27] One way to assess this issue is to try to ascertain how carefully subjects responded. To do this I define a concept of consistency based upon subjects' answers to the incentivised and hypothetical $aBC/BCa$ questions in the survey. Subjects are defined as inconsistent if their choices exhibit at least one of the following patterns:

1. They pick both the $B$ and the $C$ option at least once (for different values of $a$).

2. For the treatment group as $a$ increases they do not (weakly) bring consumption forward. For example, they are allowed to pick one of $B$ or $C$ for small values of $a$, and at some large enough level $a$ switch to choosing $a$, but they are never allowed to switch in the opposite direction. And for the control group there is the converse condition: as $a$ increases subjects are only allowed to switch from $B/C$ to $a$.

3. They choose a dominated option or don't choose a dominant option (where dominance is defined by monotonicity). In practice this means that whenever

[27]That said workers have an incentive not to do this, since their reputations suffer if they do not complete HITs accurately.

$\$a < \$B$, control group subjects should not pick $a$, and treatment group subjects must pick, for example, \$21 this week over \$16 in four weeks and \$20 in six weeks.

Subjects who meet at least one of these criteria are inconsistent; subjects which do not meet any of these criteria are deemed consistent (and there exists monotonic preference orderings which rationalise their choices).

Just under 85% of subjects meet this consistency criterion, which is a promising statistic suggesting that the large majority of participants took the surveys seriously (recall that some of the questions are hypothetical and the subjects knew this, so had little incentive to maintain a consistent choice pattern over these questions). If noise from the inconsistent subjects was obscuring the ASAP effect, then analysis of the consistent subjects would show more support for the ASAP effect – in fact Table 4.7 shows the opposite pattern. Consistent subjects are more patient on average than subjects are overall, and the treatment group actually exhibit approximately a 6% swing in the opposite direction to the ASAP effect.[28] Comparing Table 4.8 with Table 4.5 confirms a larger effect in the consistent subjects sample, but illustrates that the size of the treatment effect is not quite significant.

**Table 4.7:** Treatment Effects for Consistent and Inconsistent Subjects

| **Consistent Subjects** | | | | | |
|---|---|---|---|---|---|
| Treatment Group? | early a % | B % | C % | late a % | Total No. |
| No | 0.0 | 33.7 | 66.3 | 0 | 288 |
| Yes | 5.2 | 35.1 | 59.7 | 0 | 308 |
| Total | 2.7 | 34.4 | 62.9 | 0 | 596 |
| **Inconsistent Subjects** | | | | | |
| Treatment Group? | early a % | B % | C % | late a % | Total No. |
| No | 0.0 | 61.3 | 37.1 | 1.6 | 62 |
| Yes | 20.5 | 29.6 | 50.0 | 0.0 | 44 |
| Total | 8.5 | 48.1 | 42.5 | 0.9 | 106 |

It is also worth briefly discussing the inconsistent subjects: the proportion of inconsistent subjects choosing $C$ increases from 37.1% in the control group to 50%

[28] Recall it was about a 3% swing in this direction in the overall sample.

**Table 4.8:** Probit Estimates for Chose $C$: Consistent and Inconsistent Subjects

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Treatment | -0.175 | -0.166 | -0.157 | 0.329 | 0.271 | 0.190 |
| | (0.105) | (0.106) | (0.108) | (0.249) | (0.261) | (0.271) |
| Income Group | | 0.00949 | 0.00406 | | 0.00577 | 0.0126 |
| | | (0.0184) | (0.0188) | | (0.0496) | (0.0523) |
| Age | | 0.00634 | 0.00775 | | -0.0308* | -0.0321** |
| | | (0.00484) | (0.00500) | | (0.0121) | (0.0122) |
| Female | | -0.333** | -0.328** | | -0.167 | -0.192 |
| | | (0.108) | (0.110) | | (0.259) | (0.268) |
| Latitude | | | 0.0129 | | | -0.0207 |
| | | | (0.00832) | | | (0.0291) |
| Longitude | | | 0.00203 | | | 0.00890 |
| | | | (0.00191) | | | (0.00883) |
| Constant | 0.421*** | 0.309 | -0.0198 | -0.329* | 0.861 | 2.515 |
| | (0.0763) | (0.218) | (0.385) | (0.162) | (0.522) | (1.517) |
| Observations | 596 | 594 | 573 | 106 | 106 | 103 |
| Pseudo $R^2$ | 0.004 | 0.017 | 0.020 | 0.012 | 0.067 | 0.081 |

Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Columns 1-3 are estimates for the consistent subset; 4-6 for the inconsistent subset.

in the treatment group. This is a sizeable swing in line with the ASAP effect[29] but there are a number of key caveats to make here: first, 62 control subjects are inconsistent compared to only 44 treatment subjects. This muddies the waters as to whether it is possible to distinguish a treatment effect for this subsample. Secondly, while there is an impressive increase in the numbers choosing $C$ there is perhaps an even more noticeable change in treated subjects choosing $a$: 5.2% of consistent subjects choose $a$ but a staggering 20.5% of inconsistent subjects do so. Even if the ASAP effect 'works' for inconsistent subjects, it would be hard to recommend the design here as a policy intervention if it also leads a significant number of subjects to choose the $a$ option over $B$.

#### Excluding simple decision makers

A final approach to dividing the sample would be to consider the possibility of heterogeneous types of decision maker. For example Brocas et al. (2015) divide their sample by the models which best describe each subject's choices. For example, one cluster may discount exponentially, another group present-biased, a third future-biased etc. The data here does not allow for that specific type of group analysis but one distinction which can usefully be made is to separate out individuals for whom the timing of payment never seems to matter. In particular there is a subset of the sample that chooses the option with the highest monetary value in every decision (incentivised and hypothetical). I describe the members of this subset as 'simple decision makers', because a simple rule (such as "pick the option which pays the most, ignore the timing") is sufficient to perfectly match their choice data.[30] The remainder of the sample are denoted 'complex decision makers' – in at least one question they actively choose a smaller but sooner reward and therefore must trade off time against money.

[29] Although columns 4 – 6 in Table 4.8 show that it is not a statistically significant one and that the size of the effect reduces as the model includes a larger number of controls.

[30] It is unclear exactly what motivates these individuals. Possible explanations include (but are not limited to) a) that they do not discount the future or are simply very patient, b) the size of the payment is the only attribute in these menus which is salient to them, and c) that they just adopt some heuristic which involves picking the highest number when they are faced with a sequence of decisions.

**Table 4.9:** Probit Estimates for Chose $C$: Complex Decision Makers

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| Treatment | 0.378** | 0.362** | 0.364** | -0.0632 | -0.152 | -0.211 | 0.00518 | -0.0625 | -0.0901 |
| | (0.129) | (0.131) | (0.133) | (0.227) | (0.234) | (0.238) | (0.231) | (0.237) | (0.240) |
| Income Group | | 0.00764 | 0.00169 | | 0.0206 | 0.0449 | | 0.0357 | 0.0581 |
| | | (0.0226) | (0.0231) | | (0.0366) | (0.0389) | | (0.0398) | (0.0420) |
| Age | | -0.00544 | -0.00564 | | -0.00245 | -0.00118 | | 0.00786 | 0.00910 |
| | | (0.00594) | (0.00610) | | (0.00992) | (0.0101) | | (0.00960) | (0.00982) |
| Female | | -0.131 | -0.132 | | -0.470* | -0.451 | | -0.358 | -0.269 |
| | | (0.130) | (0.132) | | (0.232) | (0.235) | | (0.238) | (0.245) |
| Latitude | | | 0.00101 | | | -0.0345 | | | -0.0233 |
| | | | (0.00980) | | | (0.0201) | | | (0.0176) |
| Longitude | | | 0.000430 | | | 0.00495 | | | 0.00655 |
| | | | (0.00262) | | | (0.00454) | | | (0.00506) |
| Constant | -0.653*** | -0.414 | -0.370 | -0.414* | -0.151 | 1.401 | -0.649*** | -0.937* | 0.287 |
| | (0.100) | (0.262) | (0.470) | (0.173) | (0.460) | (0.909) | (0.172) | (0.476) | (0.804) |
| Observations | 423 | 422 | 406 | 135 | 134 | 134 | 139 | 138 | 138 |
| Pseudo $R^2$ | 0.016 | 0.020 | 0.020 | 0.000 | 0.030 | 0.061 | 0.000 | 0.022 | 0.051 |

Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The sample for columns 1-3 is determined by the choice data criterion – these subjects are taken from the whole dataset.

Subjects' explanations (all survey 5) fix the samples for columns 4-9. 4-6 and 7-9 are automatic and manual criteria respectively.

Under the ASAP effect, decision makers do trade off time against money, so is there support for the ASAP hypothesis when ignoring the choices of simple decision makers? As columns 1-3 of Table 4.9 illustrate, the treatment effect is both in line with the ASAP effect and significant at the 1% level for complex decision makers when the criterion for dividing the sample between simple and complex is based upon subjects' individual choice data as described above. Panel I of Table 4.10 confirms that there is an impressive increase in the proportion choosing $C$ of 13.5% between the control group and the treatment group. However, Table 4.10 also makes clear that complex decision makers tend disproportionately to come from the treatment group and therefore it is once again difficult to know how to interpret this treatment effect.

**Table 4.10:** Treatment Effect for Complex Decision Makers

| **I) Choice Criterion** | | | | | |
|---|---|---|---|---|---|
| | early a | B | C | late a | Total |
| Treatment Group? | % | % | % | % | No. |
| No | 0.0 | 73.8 | 25.7 | 0.6 | 183 |
| Yes | 10.4 | 50.4 | 39.2 | 0.0 | 240 |
| Total | 5.9 | 60.5 | 33.3 | 0.2 | 423 |
| **II) Explanation: Automatic Criterion** | | | | | |
| | early a | B | C | late a | Total |
| Treatment Group? | % | % | % | % | No. |
| No | 0.0 | 66.1 | 33.9 | 0.0 | 56 |
| Yes | 20.3 | 48.1 | 31.7 | 0.0 | 79 |
| Total | 11.9 | 55.6 | 32.6 | 0.5 | 135 |
| **III) Explanation: Manual Criterion** | | | | | |
| | early a | B | C | late a | Total |
| Treatment Group? | % | % | % | % | No. |
| No | 0.0 | 74.2 | 25.8 | 0 0 | 62 |
| Yes | 20.8 | 53.3 | 26.0 | 0 0 | 77 |
| Total | 11.5 | 62.6 | 25.9 | 0 0 | 139 |

The other columns of Table 4.9 and panels of Table 4.10 explore this further by using different criteria for dividing the sample into simple and complex decision makers. Subjects in survey 5 wrote a brief sentence or two to describe how they came to their decisions – the text data is used to construct two new criteria for dividing simple from complex decision makers. The first criterion (columns 4-6 of of Table 4.9 and panel II of Table 4.10) is automatic – decision makers are simple if their explanation contains at least one of the following words: "biggest, largest, most, highest". The second criterion (columns 7-9 of of Table 4.9 and panel III of Table 4.10) is manual – decision makers are simple if I inferred from reading their explanation that their choices did not take timing into account.[31]

Unfortunately, all the criteria suffer from the same problem that more subjects in the control group seem to be simple decision makers: the automatic criterion is actually, proportionally, even more slanted towards control subjects than treatment subjects; the manual criterion in comparison does improve somewhat upon the simple criterion.

Importantly, the significant and positive treatment effect seen using the choice criterion is not present when the explanation criteria are used instead. Therefore while the choice criterion suggests that the ASAP effect may be important if targeted at the appropriate population, the effect is not robust to other criteria[32] attempting to capture the same type of decision-making behaviour. Hence, especially in light of all the other evidence presented above, it is hard to argue with any confidence that the ASAP effect is a significant factor in decision making – at least in the monetary outcome context examined here.

**An aside on the control group**

The analysis on consistency and maximisers illustrates that subjects in the control group were both more likely to be inconsistent and more likely to be maximisers than their treated peers. This hints at two possibilities: first, control menus might have been confusing to subjects; second, control menus may have provided more meaningful opportunities to make trade-offs. Either possibility could explain both a decrease in consistency, and an increased tendency to use simple heuristics

[31] A full list of subjects' explanations is given in Appendix 4.D, divided into the simple and complex groups.

[32] It is unfortunate that the explanation question was only asked in the final survey when it seems to be such an outlier in terms of behaviour – while the proportions choosing $a$ in the treatment group varied only between 2% and 4.4% in surveys $1-4$, it was a much larger 16.2% in survey 5 (see Table 4.12 in the appendix). This reduces the extent to which results can really be compared across the different criteria.

such as 'pick the largest amount' in order to make decisions. This may sound contradictory – if subjects follow a simple heuristic then they should not also be inconsistent – but it could reflect heterogeneity within the pool of subjects. Some adapt to more complexity by using heuristics, while those who do not are instead more likely to appear inconsistent.

Either way, it is worth noting that the vast majority of the data used to decide whether or not subjects were consistent and/or maximisers came after the initial incentivised question. Therefore, whatever can be found by digging into sub-samples of the data, it should not be forgotten that the raw data provides very weak evidence for the ASAP effect – if the effect is important, it was certainly outweighed by other determinants of choice in this dataset.

## 4.6 Discussion

Having identified that economists use a range of present horizons to explain behaviour, I then explored an intuitive approach to closing this degree of freedom, by implementing a simple experimental design. Despite running the design on a relatively large sample, the data offers essentially no support to the ASAP hypothesis.

How else can economists determine time horizons? Below I explore three possible approaches: simple hypotheses similar to the ASAP effect; formal approaches to endogenising the present horizon; and models which would throw out either present bias or, more radically, discounting to create new intertemporal choice frameworks. I outline the related literature in each case before offering some concluding remarks.

### 4.6.1 Alternative Intuitive Determinants of Present Horizon

The *ad hoc* way in which present bias has been applied (and largely, successfully) suggests that there could still be an intuitive criterion which would provide a simple explanation for time horizon effects and allow economists to continue to use quasi hyperbolic discounting essentially as they currently do. One possibility is that the ASAP effect could successfully endogenise the present horizon, but that the context in which the experiment was carried out was not the right one to see this, or that there is more nuance to the hypothesis which the experiment did not capture.

Augenblick et al. (2015) records the results of an influential recent experiment which demonstrates very little present bias in decisions over monetary outcomes; in contrast subjects exhibit a much larger degree of time inconsistency in choices over real effort tasks.[33] On a related note, a potential reason why present bias is more often found in real rather than monetary choices could be that in studies of real outcomes, typically only one question is asked and the choice is realised for sure. In contrast, most monetary experiments involve a number of questions and one question is picked at random to be realised. There are theoretical frameworks that can explain this pattern – for instance construal level theory (Trope and Liberman, 2003, 2010) argues that time, uncertainty, social and geographical distance are all connected in 'psychological distance'. Decreasing the chance of a choice being realised would therefore be akin to delaying both SS and LL options. Hence, while I used monetary payments online (in order to cheaply secure a large sample, helping to improve the experiment's power) and realised the choice of one in ten participants (so that the size of the prize amounts was significant, particularly over a delay of weeks), it is possible that an equivalent real effort experiment could find evidence that would support the ASAP effect.

Alternately, it is clearly possible that the ASAP effect could be *too* simple an idea and a more nuanced criterion is necessary. For example, the relative timing of the three options presented in this experiment does not vary (always 1, 4, 7 for treatment subjects and 4, 7, 8 for the control group), but it is an important feature of other models (Ericson et al., 2015; Rubinstein, 2003; Scholten and Read, 2010) and indeed is the crucial component of the paper by Ok and Masatlioglu (2007) which provides a framework to consider a number of intertemporal choice models. While the ASAP hypothesis is intuitive, taken at face value it has clear limitations: if offered a choice between an outcome $X$ in one year and an outcome $Y$ in one

[33]This evidence reinforces the arbitrage arguments of Cubitt and Read (2007) that experimental monetary choices should reveal borrowing and lending opportunities, not intertemporal choice attitudes.

year and a month, is it reasonable to suppose that decision makers consider that the first option occurs in the present? Perhaps not, but it would surely be more reasonable if the second option was instead an outcome $Z$ in ten years. Hence present horizon might be influenced by the relative timing of options on the menu and not solely the timing of the first option.

Finally it may be the case that menu dependence is not an effective means of affecting a subject's present horizon. For example, temporal frames may change more between questions rather than within questions.[34] This means that once you think about one decision, for which you have a particular present horizon, this horizon would carry over to the next choice. In principle, existing data from multiple price list experiments could explore this hypothesis, although a specifically designed experiment may be helpful to clarify whether an effect exists or not. For instance, it might be difficult to look for such effects within existing experiments with a large number of questions, say 20 or more, where the order of all questions is randomised. To give the effect the best chance of being exhibited, an ideal test would explore 'deliberate' shifts of horizon, for example giving subjects a sequence, $\hat{s}$, of questions where the SS and LL options' delay is fairly constant, before facing a second sequence $\tilde{s}$ in which the delay of SS and LL options is different to those in $\hat{s}$. This could quite easily be designed as a 2x2 experiment in which $\hat{s}$ and $\tilde{s}$ have two different pools of questions.

### 4.6.2 Theories of Endogenous Time Horizon

Studies of endogenous time preference largely build upon the paper by Becker and Mulligan (1997), which considers a model in which agents can invest in visualising the future, influencing their (exponential) discount factor. Two recent papers consider endogenous present-biased preferences: while Chesterley (2015) models an agent whose degree of present bias (but not their present horizon) is endogenous to their consumption choices, Laajaj (2015) actively endogenises the present horizon.

[34] Cunningham (2012) studies this sort of effect in the context of general multi-attribute choice.

In Laajaj (2015)'s model a series of naïve 'outer selves' maximise a stream of current and anticipated utility for a given time horizon. This time horizon is chosen by a rational 'inner self' given the anticipated choices of the 'outer selves'. The basic intuition of the model's equilibrium is that if an agent anticipates poor future prospects then the inner self optimally shortens the time horizon to reduce anticipatory disutility. The paper also analyses an agro-input subsidy experiment carried out in Mozambique and the results there generally seem to support the model's hypothesis. A key issue which would prevent the model from immediately closing the degree of freedom raised in this paper is that it is not clear how the theory would yield different time horizons for different decisions. Clearly, using the model to determine a single present horizon and then applying this to different contexts would not suffice; following Banerjee and Mullainathan (2010), situations could be divided into tempting and non-tempting goods which would have different horizons. This would nevertheless seem to leave something missing: suppose that the juice in McClure et al. (2007)'s study was tempting to the thirsty subjects and also that cigarettes are tempting to smokers: the experiment requires a present horizon measured in minutes to explain the data, while Gruber and Kőszegi (2004) uses a horizon of a month to fit their data on cigarette consumption. So dividing goods into tempting and non-tempting categories seems too blunt an instrument.

There are other models which endogenise present bias itself but very few (to my knowledge) have much to say on how the length of the present is determined. Dual-self models (Thaler and Shefrin, 1981; Fudenberg and Levine, 2006) can generate patterns of behaviour consistent with present bias but the question of how long the present lasts is replaced by the question of how long does a doing self 'exist'? The studies by Halevy (2008) and Saito (2011) illustrate that present bias can be a consequence of assuming that the present is certain and the future uncertain, as long as decision makers violate expected-utility theory in the manner outlined by Allais (1953) and Kahneman and Tversky (1979). This again would push the explanation of horizon effects back to a different question – at what delay does an outcome become uncertain and how/why does this vary between contexts? Finally

Galperti and Strulovici (2015) opens an interesting new angle on our understanding of present bias by illustrating that 'direct pure altruism' always leads to present bias, but period length is again fixed and their model would be incapable of dealing with different horizons for different contexts.

Therefore at this point, with the exception of Laajaj (2015), models which endogenise present bias have not directly addressed varying time horizons. Meanwhile practically all the models mentioned in this section focus on overall consumption streams and therefore are not designed to explore differences in time preference across different situations.

### 4.6.3 Different Models of Intertemporal Choice

While quasi-hyperbolic discounting models are now seemingly ubiquitous, it took a long time for the model to be used by a broad range of economists,[35] and there is a long history of opposition to present bias, subsequent to its widespread adoption. An example of opposition which was concurrent with the propagation of present bias in the mid-1990s comes from Mulligan (1996) who illustrated that a 'money-pump' could ruin an agent with hyperbolic preferences. More recent criticisms focus on behaviour that present bias cannot explain and/or analyse different psychological processes underpinning intertemporal choice.

There is mounting evidence that disputes that present bias accurately explains choice over monetary outcomes. Andreoni and Sprenger (2012) introduce the Convex Time Budget approach to measuring intertemporal choice. Several recent studies that use this approach[36] confirm their observation that the evidence for subjects being present-biased over monetary outcomes is weak at best.[37][38] This result is in

[35] Early proponents of the model include Strotz (1955-56), Phelps and Pollak (1968) and Ainslie (1991), but it was the advent of modern behavioural economics, and especially the works of Laibson and O'Donoghue and Rabin that spread present-biased preferences throughout the profession.

[36] And others that do not, but which take care to measure or avoid potential confounds such as background consumption or subjects not believing that all payments are equally likely.

[37] See studies such as Augenblick et al. (2015), Andersen et al. (2014), Brocas et al. (2015), Carvalho et al. (2016) and Giné et al. (2012).

[38] Echenique et al. (2015) use a non-parametric revealed-preference test to reassess the data reported from the CTB studies in Andreoni and Sprenger (2012) and Carvalho et al. (2016). They find that the number of agents who can be rationalised by the EDU model is rather small, while almost all (all in the case of Andreoni and Sprenger, 2012, 's data) subjects whose choices can be

line with the argument made by Cubitt and Read (2007): given that present bias is a theory about consumption, experiments over monetary outcomes only reveal intertemporal preferences if subjects face external constraints. Despite the growing number of studies which confirm the Andreoni and Sprenger (2012) finding, there is also recent evidence that when the early option of receiving some money 'now' is truly immediate (e.g. transferred to a mobile phone spending account as subjects leave the end of a laboratory experiment) then subjects do exhibit some present bias (Balakrishnan et al., 2016). However, in real effort and consumption tasks, present bias appears to be much stronger (Augenblick et al., 2015).

Other challenging pieces of evidence for the present bias story include Dohmen et al. (2012), who find that the type of design used in experiments affects subjects' discounting pattern; Eil (2012), who finds that asking subjects for the delay that makes them indifferent between a smaller and a larger payment[39] leads to 'hypobolic' rather than hyperbolic discounting; and Halevy (2015), who by separately identifying time consistent, stationary and time invariant choices, finds evidence that contradicts the hypothesis that present bias is the main cause of time inconsistency.

The main alternatives proposed in the literature to address this dissenting evidence are models which focus on background consumption and constraints, heuristic or perceptional models, and fixed cost theories. Epper et al. (2015) presents a model that rationalises anomalies in intertemporal choice within a standard model of behaviour with credit constraints. Anomalies result from positive rational (and in an extension, boundedly rational or overly optimistic) expectations about future income. Quasi-hyperbolic behaviour is therefore derived from the interplay between liquidity constraints and income expectations and is not a deep-seated preference. The idea that anomalies in intertemporal choice are driven by beliefs and constraints is plausible and the model certainly seems well suited to consumption and income problems but it may be a harder story to sell in different

rationalised by the quasi-hyperbolic discounting model can also be rationalised by the EDU model. Finally, only about a half of subjects can be rationalised by a time-separable utility model.

[39]Instead of the canonical question: how big would one of those payment have to be to make you indifferent.

contexts: do we avoid going to the gym today because we believe we will go in the future,[40] or because we would prefer to relax now?

Heuristic inspired models are currently very much in vogue. Two papers stand out: Ericson et al. (2015) and Read et al. (2013).[41] Both show that their simple heuristic models are better than typical discounting models at predicting choice from canonical binary intertemporal choice experiments. They outline attribute-based theories of choice rather than alternative-based theories[42] and share a number of attributes. Read et al. (2013)'s model focuses slightly more on framing, and explains choice by a weighted sum of the DRIFT variables: D stands for the absolute difference between the SS and LL prize amounts, R for the relative difference between them, I for the experimental interest rate, F captures the extent to which the question presents the choice as an opportunity to invest (finance) rather than consume, and T stands for the time to wait until the LL option is realised. Roughly, if the appropriately weighted sum of the DRIF variables exceeds the T variable then the model predicts that subjects choose the LL option. In a very similar way, Ericson et al. (2015)'s intertemporal choice heuristics model (ITCH) uses the absolute and relative difference between both the prize and time values of the SS and LL options. The weighted sum of these four attributes is used with a logistic distribution to determine the probability with which a subject picks the LL option.

The fact that these attribute-based models are better at fitting experimental data is actually an old result, as for example, Rubinstein (2003) illustrates that his similarity model not only explains experimental data which had been presented in support of hyperbolic discounting, but is also able to explain data from experiments he himself ran which contradict hyperbolic discounting. The issue is that while

[40]Such naïvete learning issues – the idea that it seems unlikely that individuals will repeatedly fail to learn from their experience that naïve beliefs are incorrect – are oft-articulated, for example as early as Strotz (1955-56). However, Ali (2011) illustrated that rational learning need not lead to full sophistication.

[41]They are also notable for their authors. David Laibson, whose work was instrumental in the spread of present-biased preferences is a co-author on Ericson et al. (2015), while Shane Frederick, a co-author of the famous survey of time preference (Frederick et al., 2002), and Daniel Read, notable in particular for his work on subadditivity (Read, 2001) co-author Read et al. (2013) with Marc Scholten.

[42]All standard discounting models are alternative-based.

the heuristic models have been very effective in explaining SS/LL question data, where the attributes of different options are crystal clear, there is not necessarily an obvious answer to the question: what are the attributes that individuals consider in more complex problems, such as how to smooth consumption over time, or whether to buy a gym membership.

If such issues are to be solved then it is possible that the nascent literature on salience in decision-making (Bordalo et al., 2012, 2013b; Kőszegi and Szeidl, 2013; Bushong et al., 2014) could help to bridge the gap that heuristic models face between experimental data and dynamic problems. For example, one can think of the Kőszegi and Szeidl (2013) model when outcomes have two dimensions as a continuous closure of the Rubinstein (1988, 2003) framework, in the sense that it is straightforward to show that for any Rubinstein heuristic there is a corresponding Kőszegi and Szeidl model and vice versa. Kőszegi and Szeidl (2013) consider intertemporal problems by assuming that attributes coincide with utility in each period. Using this framing, they find a number of interesting results over consumption streams, but find that their model cannot replicate experimental anomalies normally attributed to hyperbolic discounting. However, given the link with the Rubinstein similarity model, this result is clearly dependent upon framing. Framing SS/LL choices in terms of prize and delay would recover such results, and therefore a falsifiable theory of framing to accompany salience models would be an interesting avenue for future research.[43]

Finally, some authors argue that present bias could be modelled by a fixed cost rather than with quasi-hyperbolic discounting models (which imply a variable cost structure). Benhabib et al. (2010) undertake a neat econometric exercise which illustrates that their experimental data support a fixed cost model over quasi-hyperbolic discounting, and outline several results which such a model could explain – like the magnitude effect. Recently Haushofer (2014) has presented a model motivating a fixed cost as 'the cost of keeping track' of future, fleshing out the

[43] Appendix 3.D provides an explicit example of how decision makers can make different choices from the same menu when the attributes used to describe options in the menu are changed. This occurs despite using the same model of context-dependent choice in both cases.

theory suggested by Benhabib et al. to illustrate further results such as differences in decisions about gains and losses. However the fixed cost model does not solve the degree of freedom raised here because, like in quasi-hyperbolic discounting models, there is a division between the present ($t = 0$) and the future ($t > 0$) in which fixed costs are incurred. These models do not discuss how different contexts might change the present horizon; but differences in salience or frequency of reminders across different contexts could endogenise the delay at which fixed costs are incurred.[44]

### 4.6.4 Concluding Remarks

There are two key factors that underpin the elegance and utility of discounting models. First they capture the intuition that generally people are impatient for good outcomes to happen soon and like to put off horrible outcomes.[45] Secondly, by assigning a weight to utility at any given point in time they are able to deal tractably with both of the key intertemporal choice scenarios economists consider: the static problem of which time, prize option to pick from a menu of options, and the dynamic problem of how to make choices when an individual is able to update their decisions over time.

To simplify somewhat, the issue that discounting models face is how to update the model to add further nuance to that initial intuition that the sooner an outcome is the more important it is. Meanwhile the challenge facing completely different frameworks is how to create models which are both tractable and portable. Heuristic-based intuition explains binary choice data extremely well, but how can economists use these models to analyse not only choice over menus of three or more options but also decisions about streams of outcomes?

The results here rule out one simple, intuitive approach to adjusting present horizons in quasi-hyperbolic discounting models; future research must continue both

[44]Perhaps gym users that live close to their gym are less likely to violate plans of attendence and are more likely to pick optimal contracts?

[45]It is, of course, easy to think of scenarios which would suggest the opposite, such as workers preferring rising income sequences (Loewenstein and Sicherman, 1991) or individuals reporting that they would pay more to avoid a (non-lethal but painful) electric shock in ten years than they would if it was due to occur in 24 hours, due to anticipatory utility (Loewenstein, 1987).

to refine the application of present bias and to explore alternative approaches that do not rely on discounting, in order to improve our understanding and modelling of intertemporal choice.

# Appendix

## 4.A A Note on the Platform: Amazon Mechanical Turk (mTurk)

mTurk is an online labour market in which 'requesters' post human intelligence tasks (or HITs),[46] which 'workers' can choose to accept. Payment is conditional upon successful completion of HITs (as specified by the requester) and there are reputational incentives on both sides.[47]

A growing number of papers in economics use mTurk to conduct experiments. For example, evidence from mTurk is used to support the salience theory of risky choice in Bordalo et al. (2012), provide puzzling evidence on penalty labour contracts in de Quidt (2014) and replicate a number of classic experimental results in Horton et al. (2011).

A thorough discussion of pros and cons of using such online labour markets can be found in Horton et al. (2011), but some key advantages are that the platform generates large samples quickly and relatively cheaply. My surveys were short[48] and so a sample of over 700 subjects quickly signed up for a participation fee of $0.20 and the 1 in 10 chance of earning a substantial (relative to the duration of the survey) bonus payment.[49] It is also easier to collect subjects from across the population and not just from the student population – the mainstay of laboratory experiments.[50]

[46]These could be transcribing recordings, categorising images, filling out surveys etc.

[47]E.g. a consistent record of good work earns workers a 'master' qualification – requesters can utilise this as a criterion for selection of workers in more important/higher paid HITs.

[48]Amongst all subjects who finished the survey (702) the average duration to complete it was 3 minutes 50 seconds. Excluding the 3 subjects who took longer than 30 minutes to finish the survey the average comes down to 2 minutes 55 seconds.

[49]The size of the participation fee was fixed following discussion with the Centre for Experimental Social Sciences (CESS) who administered the online experiment for me, to check that the incentives provided fitted in with their typical payment policy for HITs.

[50]For example the mean age of respondents amongst those who completed one of my surveys was about 37. About 50% of the sample was over 34 and the oldest subject was born in 1945.

A concern that often arises in discussion of online experiments is the possibility that subjects are inattentive, answering at random or not concentrating upon the task at hand. It is difficult to completely eliminate that possibility but there are a number of steps that can be taken to attempt to control for this. See, for example, the robustness checks carried out in this thesis.

## 4.B Other Results

This section collects other results and tables. These include summary statistics for variables used in the regressions (Table 4.11), raw data for each survey (Table 4.12), different regression models for comparison to the probit model used in the main text (Tables 4.13, 4.14 and 4.15) and an assessment of treatment interaction effects on the days and weeks samples (Tables 4.16 and 4.17).

**Table 4.11:** Summary Statistics

| Variable | Obs. | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| Treatment | 702 | 0.501 | 0.500 | 0 | 1 |
| Income Group | 702 | 5.61 | 2.85 | 1 | 11 |
| Age | 702 | 36.7 | 11.3 | 19 | 71 |
| Female | 702 | 0.527 | 0.505 | 0 | 2 |
| Latitude | 678 | 37.5 | 6.36 | -27.6 | 53.0 |
| Longitude | 678 | -87.1 | 27.5 | -124 | 137 |

Summary statistics for all subjects who completed the survey.
All non-integers are given to three significant figures.

**Table 4.12:** Treatment Effect by Survey

| | | | | | |
|---|---|---|---|---|---|
| **Survey 1) Days** − $a = \$2, B = \$9, C = \$10$ | | | | | |
| | early a | B | C | late a | Total |
| Treatment Group? | % | % | % | % | No. |
| No | 0.0 | 18.5 | 79.6 | 1.9 | 54 |
| Yes | 2.0 | 21.6 | 76.5 | 0.0 | 51 |
| Total | 1.0 | 20.0 | 78.1 | 1.0 | 105 |
| **Survey 2) Weeks** − $a = \$4, B = \$16, C = \$20$ | | | | | |
| | early a | B | C | late a | Total |
| Treatment Group? | % | % | % | % | No. |
| No | 0.0 | 40.4 | 59.6 | 0.0 | 47 |
| Yes | 4.4 | 19.6 | 76.1 | 0.0 | 46 |
| Total | 2.2 | 30.1 | 67.7 | 0.0 | 93 |
| **Survey 3) Days** − $a = \$4, B = \$9, C = \$10$ | | | | | |
| | early a | B | C | late a | Total |
| Treatment Group? | % | % | % | % | No. |
| No | 0.0 | 25.0 | 75.0 | 0 0 | 48 |
| Yes | 3.6 | 23.2 | 73.2 | 0 0 | 56 |
| Total | 1.9 | 24.0 | 74.0 | 0 0 | 104 |
| **Survey 4) Weeks** − $a = \$2, B = \$16, C = \$19$ | | | | | |
| | early a | B | C | late a | Total |
| Treatment Group? | % | % | % | % | No. |
| No | 0.0 | 45.0 | 55.0 | 0.0 | 100 |
| Yes | 4.0 | 47.0 | 49.0 | 0.0 | 100 |
| Total | 2.0 | 46.0 | 52.0 | 0.0 | 200 |
| **Survey 5) Weeks** − $a = \$4, B = \$16, C = \$19$ | | | | | |
| | early a | B | C | late a | Total |
| Treatment Group? | % | % | % | % | No. |
| No | 0.0 | 48.5 | 51.5 | 0 0 | 101 |
| Yes | 16.2 | 41.4 | 42.4 | 0 0 | 99 |
| Total | 8.0 | 45.0 | 47.0 | 0 0 | 200 |

**Table 4.13:** Logit Estimates for Chose $C$

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| Treatment | -0.109 | -0.122 | -0.115 | -0.148 | -0.0955 | -0.137 | -0.121 | -0.151 | -0.141 |
| | (0.154) | (0.156) | (0.159) | (0.325) | (0.330) | (0.354) | (0.181) | (0.183) | (0.186) |
| Income Group | | 0.0204 | 0.0106 | | -0.0105 | -0.0420 | | 0.0312 | 0.0267 |
| | | (0.0274) | (0.0280) | | (0.0593) | (0.0637) | | (0.0318) | (0.0323) |
| Age | | 0.00150 | 0.00299 | | 0.0133 | 0.0290 | | 0.000233 | 0.000685 |
| | | (0.00700) | (0.00720) | | (0.0164) | (0.0191) | | (0.00807) | (0.00818) |
| Female | | -0.521*** | -0.505** | | -0.711* | -0.610 | | -0.411* | -0.409* |
| | | (0.158) | (0.162) | | (0.336) | (0.363) | | (0.186) | (0.188) |
| Latitude | | | 0.0164 | | | 0.0333 | | | 0.00764 |
| | | | (0.0127) | | | (0.0311) | | | (0.0144) |
| Longitude | | | 0.00399 | | | 0.00443 | | | 0.00431 |
| | | | (0.00309) | | | (0.00629) | | | (0.00366) |
| Constant | 0.453*** | 0.572 | 0.301 | 1.234*** | 1.154 | -0.0129 | 0.178 | 0.235 | 0.324 |
| | (0.110) | (0.318) | (0.590) | (0.237) | (0.669) | (1.440) | (0.128) | (0.377) | (0.663) |
| Observations | 702 | 700 | 676 | 209 | 209 | 195 | 493 | 491 | 481 |
| Pseudo $R^2$ | 0.001 | 0.013 | 0.015 | 0.001 | 0.023 | 0.032 | 0.001 | 0.009 | 0.011 |

Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Columns 1-3 are logit estimates for the whole sample. 4-6 are estimates for the days sample and 7-9 for the weeks sample respectively.

**Table 4.14:** Linear Probability Model Estimates for Chose *C*

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| Treatment | -0.0262 | -0.0289 | -0.0270 | -0.0268 | -0.0172 | -0.0235 | -0.0301 | -0.0371 | -0.0347 |
| | (0.0370) | (0.0370) | (0.0376) | (0.0593) | (0.0592) | (0.0598) | (0.0450) | (0.0452) | (0.0458) |
| Income Group | | 0.00481 | 0.00252 | | -0.00180 | -0.00706 | | 0.00767 | 0.00658 |
| | | (0.00650) | (0.00662) | | (0.0108) | (0.0110) | | (0.00784) | (0.00797) |
| Age | | 0.000353 | 0.000706 | | 0.00224 | 0.00446 | | 0.0000555 | 0.000166 |
| | | (0.00166) | (0.00170) | | (0.00279) | (0.00291) | | (0.00199) | (0.00202) |
| Female | | -0.124*** | -0.120** | | -0.128* | -0.103 | | -0.101* | -0.101* |
| | | (0.0373) | (0.0380) | | (0.0600) | (0.0611) | | (0.0458) | (0.0464) |
| Latitude | | | 0.00390 | | | 0.00576 | | | 0.00190 |
| | | | (0.00301) | | | (0.00532) | | | (0.00355) |
| Longitude | | | 0.000914 | | | 0.000713 | | | 0.00103 |
| | | | (0.000697) | | | (0.00106) | | | (0.000867) |
| Constant | 0.611*** | 0.638*** | 0.570*** | 0.775*** | 0.759*** | 0.561* | 0.544*** | 0.558*** | 0.576*** |
| | (0.0262) | (0.0753) | (0.139) | (0.0424) | (0.118) | (0.252) | (0.0317) | (0.0931) | (0.162) |
| Observations | 702 | 700 | 676 | 209 | 209 | 195 | 493 | 491 | 481 |
| $R^2$ | 0.001 | 0.017 | 0.019 | 0.001 | 0.025 | 0.033 | 0.001 | 0.013 | 0.015 |

Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Columns 1-3 are OLS estimates for the whole sample. 4-6 are estimates for the days sample and 7-9 for the weeks sample respectively.

**Table 4.15:** Ordered Probit Estimates for Choice

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| Treatment | -0.214* | -0.225* | -0.218* | -0.211 | -0.193 | -0.218 | -0.240* | -0.257* | -0.252* |
| | (0.0914) | (0.0921) | (0.0940) | (0.184) | (0.185) | (0.197) | (0.107) | (0.108) | (0.110) |
| Income Group | | 0.00846 | 0.00459 | | -0.0112 | -0.0279 | | 0.0157 | 0.0149 |
| | | (0.0161) | (0.0164) | | (0.0336) | (0.0357) | | (0.0187) | (0.0190) |
| Age | | 0.0000493 | 0.000689 | | 0.00236 | 0.00901 | | 0.000551 | 0.000828 |
| | | (0.00411) | (0.00422) | | (0.00878) | (0.00970) | | (0.00476) | (0.00483) |
| Female | | -0.265** | -0.257** | | -0.291 | -0.192 | | -0.223* | -0.231* |
| | | (0.0930) | (0.0949) | | (0.186) | (0.198) | | (0.110) | (0.111) |
| Geographic Controls | No | No | Yes | No | No | Yes | No | No | Yes |
| Cut 1 | -1.928*** | -2.036*** | -1.928*** | -2.313*** | -2.445*** | -1.827* | -1.838*** | -1.868*** | -1.990*** |
| | (0.105) | (0.205) | (0.352) | (0.254) | (0.429) | (0.865) | (0.119) | (0.240) | (0.397) |
| Cut 2 | -0.359*** | -0.458* | -0.331 | -0.835*** | -0.949* | -0.253 | -0.191* | -0.214 | -0.319 |
| | (0.0663) | (0.187) | (0.342) | (0.137) | (0.369) | (0.831) | (0.0773) | (0.223) | (0.385) |
| Cut 3 | 2.896*** | 2.813*** | 2.943*** | 2.504*** | 2.406*** | 3.172*** | | | |
| | (0.312) | (0.351) | (0.456) | (0.355) | (0.479) | (0.907) | | | |
| Observations | 702 | 700 | 676 | 209 | 209 | 195 | 493 | 491 | 481 |
| Pseudo $R^2$ | 0.005 | 0.012 | 0.014 | 0.005 | 0.016 | 0.023 | 0.006 | 0.012 | 0.013 |

Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The dependent variable Choice takes the value 1 if a subject chose early $a$, 2 if a subject chose $B$, 3 if a subject chose $C$ and 4 if a subject chose late $a$.

Columns 1-3 are ordered probit estimates for the whole sample. 4-6 are estimates for the days sample and 7-9 for the weeks sample respectively.

**Table 4.16:** Linear Probability Model Estimates for Chose $C$: Treatment Interaction Terms in the Days Sample

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| Treatment | -0.0268 | 0.0179 | -0.0524 | -0.0571 | -0.0652 | -0.108 | -0.114 |
| | (0.0593) | (0.0725) | (0.0809) | (0.0762) | (0.0897) | (0.0730) | (0.0895) |
| Treated and Female | | -0.0887 | 0.0743 | | | | |
| | | (0.0828) | (0.118) | | | | |
| Female | | | -0.163 | | | | |
| | | | (0.0851) | | | | |
| Treated and Youngest | | | | 0.0531 | 0.0679 | | |
| | | | | (0.0838) | (0.120) | | |
| Youngest | | | | | -0.0148 | | |
| | | | | | (0.0856) | | |
| Treated and Low Income | | | | | | 0.155 | 0.165 |
| | | | | | | (0.0824) | (0.119) |
| Low Income | | | | | | | -0.01000 |
| | | | | | | | (0.0862) |
| Constant | 0.775*** | 0.775*** | 0.845*** | 0.775*** | 0.783*** | 0.775*** | 0.780*** |
| | (0.0424) | (0.0424) | (0.0559) | (0.0425) | (0.0634) | (0.0422) | (0.0667) |
| Observations | 209 | 209 | 209 | 209 | 209 | 209 | 209 |
| $R^2$ | 0.001 | 0.007 | 0.024 | 0.003 | 0.003 | 0.018 | 0.018 |

Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

OLS estimates for the days sample. Columns 2-3, 4-5 and 6-7 for gender, age and income respectively.

**Table 4.17:** Linear Probability Model Estimates for Chose $C$: Treatment Interaction Terms in the Weeks Sample

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| Treatment | -0.0301 | 0.00229 | -0.0756 | -0.0807 | -0.0957 | 0.00403 | -0.0268 |
| | (0.0450) | (0.0561) | (0.0668) | (0.0572) | (0.0662) | (0.0550) | (0.0650) |
| Treated and Female | | -0.0626 | 0.0743 | | | | |
| | | (0.0639) | (0.0904) | | | | |
| Female | | | -0.137* | | | | |
| | | | (0.0641) | | | | |
| Treated and Youngest | | | | 0.0919 | 0.120 | | |
| | | | | (0.0641) | (0.0903) | | |
| Youngest | | | | | -0.0286 | | |
| | | | | | (0.0635) | | |
| Treated and Low Income | | | | | | -0.0690 | -0.0123 |
| | | | | | | (0.0639) | (0.0902) |
| Low Income | | | | | | | -0.0567 |
| | | | | | | | (0.0637) |
| Constant | 0.544*** | 0.545*** | 0.623*** | 0.544*** | 0.559*** | 0.544*** | 0.575*** |
| | (0.0317) | (0.0319) | (0.0484) | (0.0317) | (0.0460) | (0.0317) | (0.0470) |
| Observations | 493 | 491 | 491 | 493 | 493 | 493 | 493 |
| $R^2$ | 0.001 | 0.003 | 0.012 | 0.005 | 0.005 | 0.003 | 0.005 |

Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

OLS estimates for the weeks sample. Columns 2-3, 4-5 and 6-7 for gender, age and income respectively.

# 4.C Figures – Experimental Interface and Maps of Subject Location

*The first group of images show the experimental interface that subjects saw on Qualtrics if they accessed the survey using a computer (there was also the possibility of completing the survey on their mobile phone and the mobile interface was very similar). These images are for a treatment group subject in survey 5 who is not chosen for bonus payments. N.b. Recall that survey 5 is the only survey which asked subjects to explain the choice they made (screen 7).*

*The second set of figures plot the latitude and longitude co-ordinates estimated by Qualtrics (the platform for the survey) to correspond with the location of each subject. I provide a world map, and then a closer view for North America, where most subjects were based. The figures were created using the software on* `www.gpsvisualiser.com` *which utilises the Google Maps platform.*

**Figure 4.2:** mTurk Advert

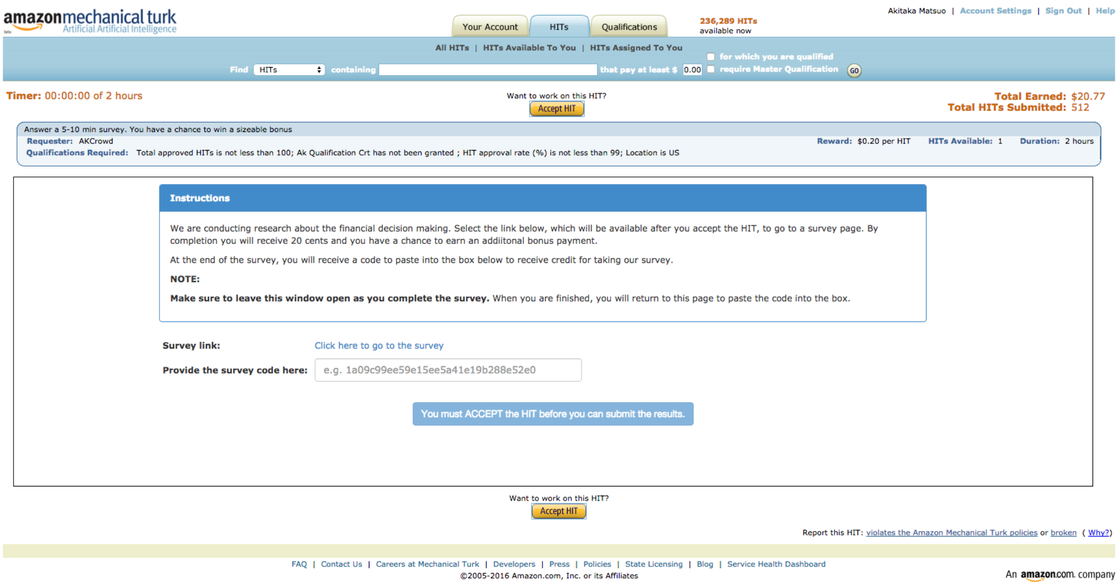

**Figure 4.3:** Survey Screen 1

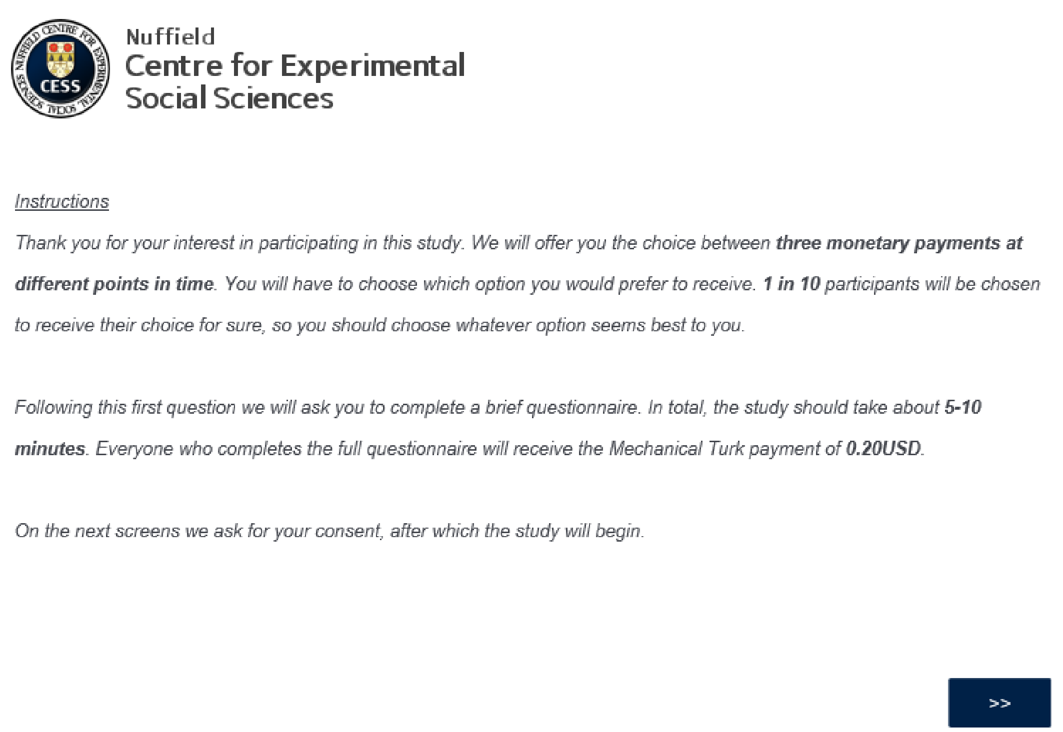

**Figure 4.4:** Survey Screen 2

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Social Sciences

*General Information*

*This questionnaire is being used for a PhD project. The principal researcher is James Wisson, a student attached to the Economics department at the University of Oxford. This project is being completed under the supervision of Dr.Johannes Abeler. This project has been reviewed by, and received ethics clearance through the University of Oxford Central University Research Ethics Committee.*

*Your answers will be kept* ***confidential*** *and your worker ID number will only be used for the purposes of payment – all worker ID data will be deleted as soon as payments have been made. Answer data will be stored in a password-protected file and may be used in academic publications.*

*Please note that your participation is* ***voluntary****. You may withdraw at any point during the questionnaire for any reason, before submitting your answers. However, we can only reimburse participants who complete the full survey.*

>>

**Figure 4.5:** Survey Screen 3

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Social Sciences

*<u>What if there is a problem?</u>*

*If you have a concern about any aspect of this project, please speak to the researcher (james.wisson@economics.ox.ac.uk) or their supervisor (johannes.abeler@economics.ox.ac.uk), who will do their best to answer your query. The researcher should acknowledge your concern within 10 working days and give you an indication of how they intend to deal with it. If you remain unhappy or wish to make a formal complaint, please contact the chair of the Research Ethics Committee at the University of Oxford (Chair, Social Sciences & Humanities Inter-Divisional Research Ethics Committee; Email: ethics@socsci.ox.ac.uk; Address: Research Services, University of Oxford, Wellington Square, Oxford OX1 2JD). The chair will seek to resolve the matter in a reasonably expeditious manner.*

*Please note that you may only participate in this survey if you are 18 years of age.*

- ○ I certify that I am over 18 years of age.

*If you agree to participate and have read the terms above, please check the relevant box below to get started.*

- ○ Yes, I agree to take part
- ○ No, I do not wish to take part

>>

**Figure 4.6:** Survey Screen 4

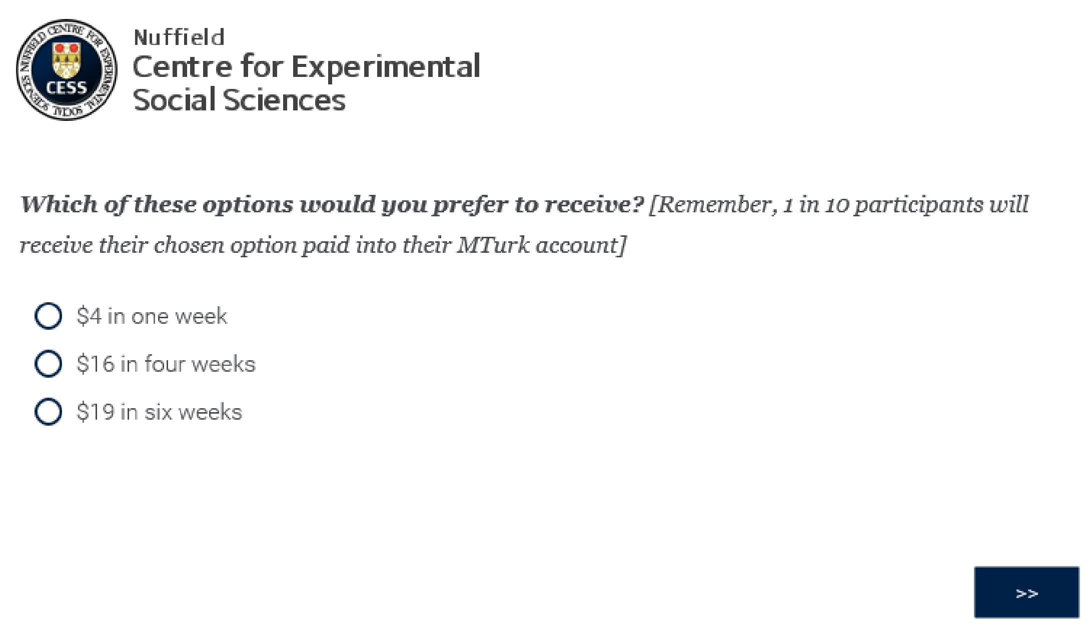



**Figure 4.7:** Survey Screen 5

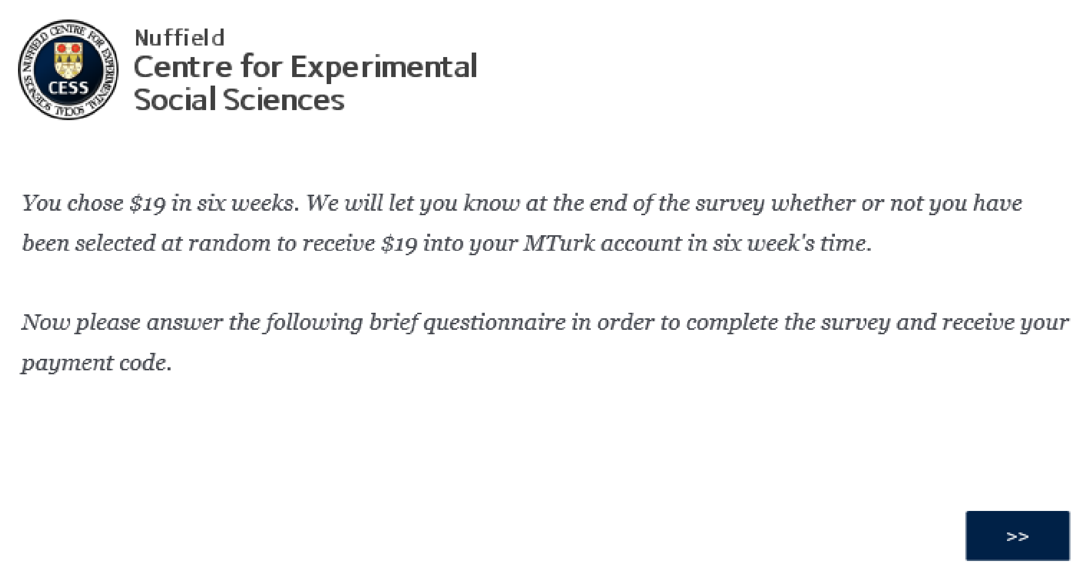
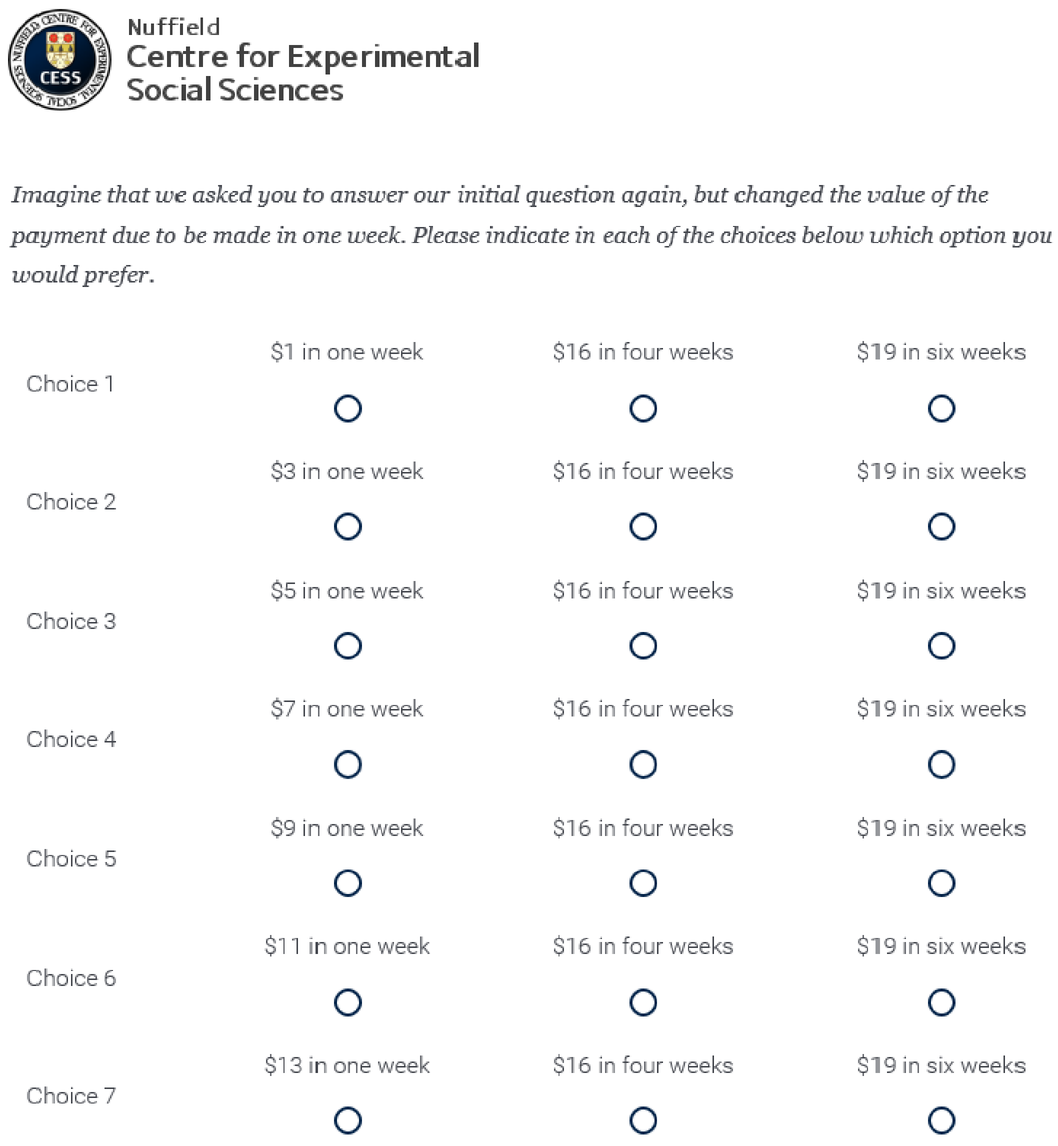


**Figure 4.8:** Survey Screen 6a



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*Imagine that we asked you to answer our initial question again, but changed the value of the payment due to be made in one week. Please indicate in each of the choices below which option you would prefer.*

| | | | |
|---|---|---|---|
| Choice 1 | $1 in one week | $16 in four weeks | $19 in six weeks |
| Choice 2 | $3 in one week | $16 in four weeks | $19 in six weeks |
| Choice 3 | $5 in one week | $16 in four weeks | $19 in six weeks |
| Choice 4 | $7 in one week | $16 in four weeks | $19 in six weeks |
| Choice 5 | $9 in one week | $16 in four weeks | $19 in six weeks |
| Choice 6 | $11 in one week | $16 in four weeks | $19 in six weeks |
| Choice 7 | $13 in one week | $16 in four weeks | $19 in six weeks |

**Figure 4.9:** Survey Screen 6b

| | | | |
|---|---|---|---|
| Choice 8 | $15 in one week ○ | $16 in four weeks ○ | $19 in six weeks ○ |
| Choice 9 | $17 in one week ○ | $16 in four weeks ○ | $19 in six weeks ○ |
| Choice 10 | $19 in one week ○ | $16 in four weeks ○ | $19 in six weeks ○ |
| Choice 11 | $21 in one week ○ | $16 in four weeks ○ | $19 in six weeks ○ |

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**Figure 4.10:** Survey Screen 7

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*Please would you write a sentence or two to explain how you made your initial choice:*

*(To remind you, your options were $4 in one week, $16 in four weeks or $19 in six weeks.)*

>>

**Figure 4.11:** Survey Screen 8

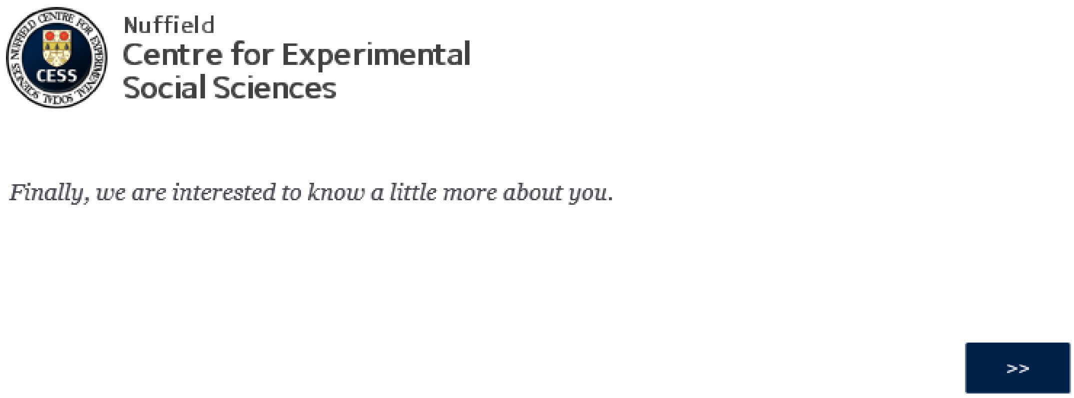


**Figure 4.12:** Survey Screen 9a

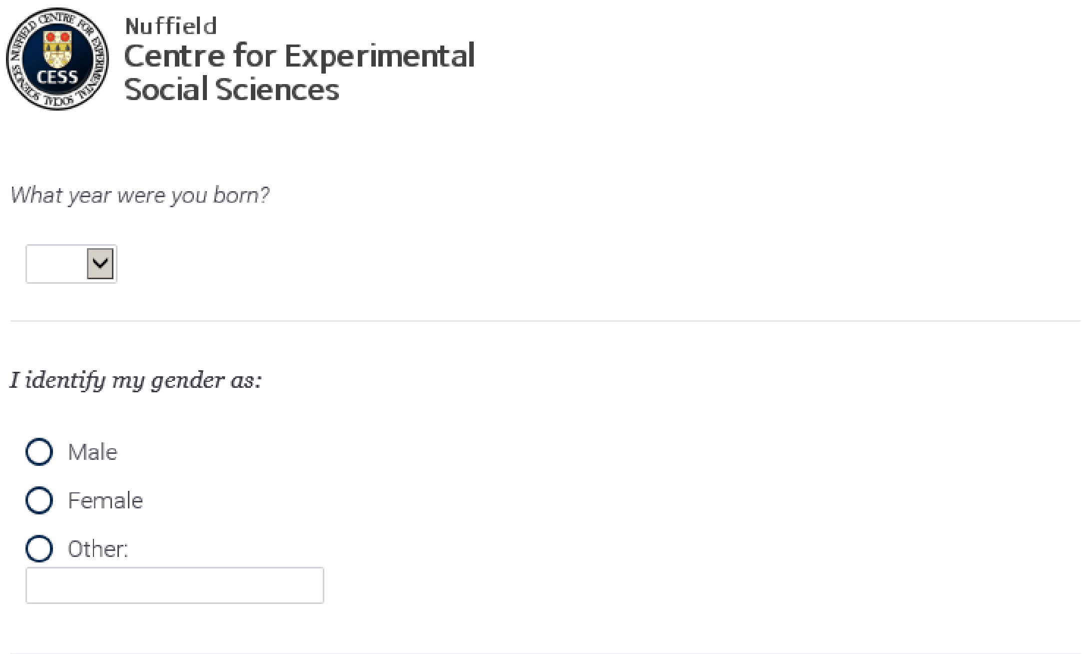

**Figure 4.13:** Survey Screen 9b

*Thinking back over the last year, what was your family's annual income?*

- Less than $10,000
- • $10,000 - $19,999
- • $20,000 - $29,999
- • $30,000 - $39,999
- • $40,000 - $49,999
- • $50,000 - $59,999
- • $60,000 - $69,999
- • $70,000 - $79,999
- • $80,000 - $99,999
- • $100,000 - $150,000
- • More than $150,000

>>

**Figure 4.14:** Survey Screen 10

Nuffield
Centre for Experimental
Social Sciences

Feedback: Unfortunately you were not chosen to receive your choice from the first question.
However, thank you for participating.
Your validation code is:
3043603
To receive payment for participating, click "Accept HIT" in the Mechanical Turk window, enter this validation code, then click "Submit".

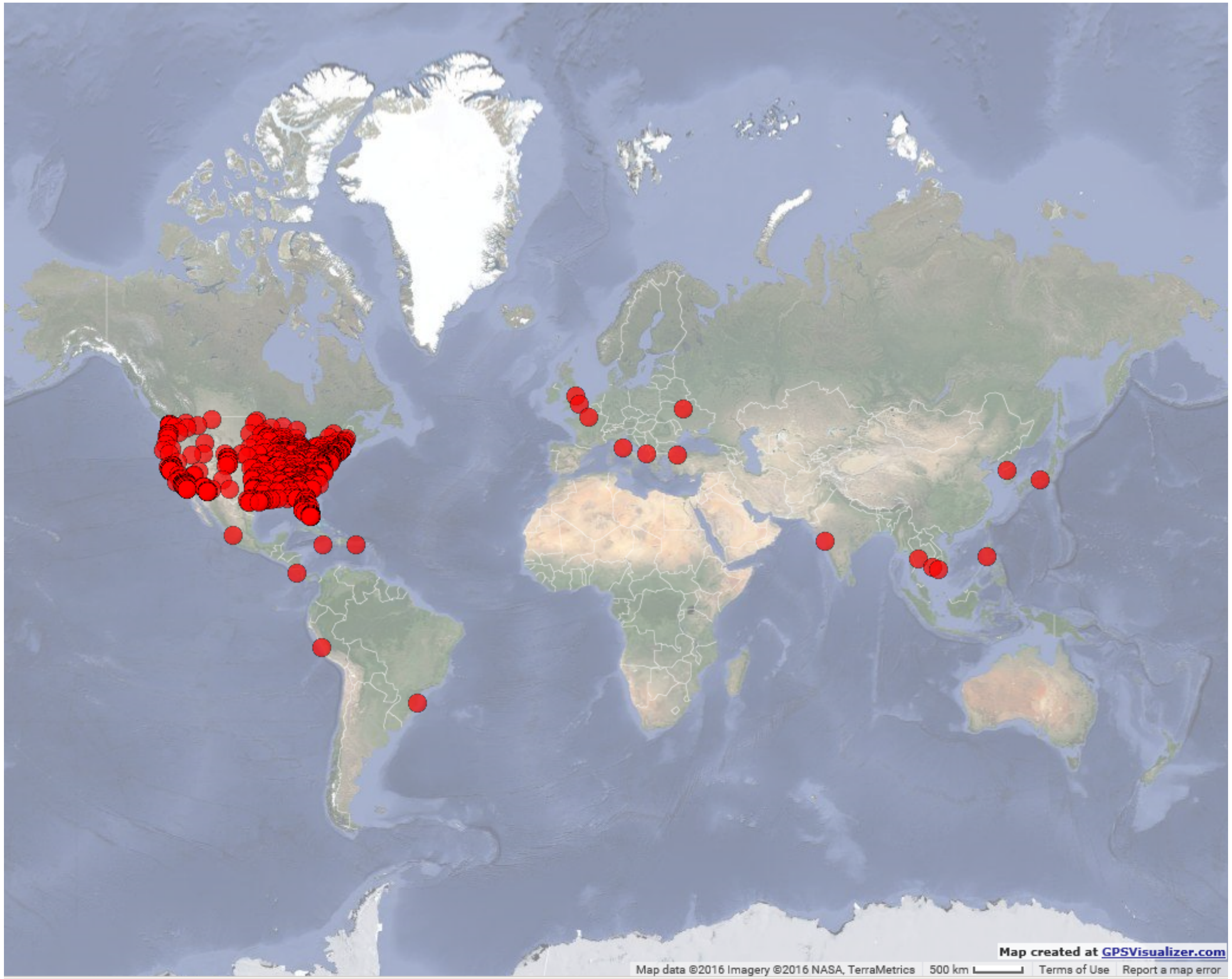


**Figure 4.15:** Subject Locations: World Map

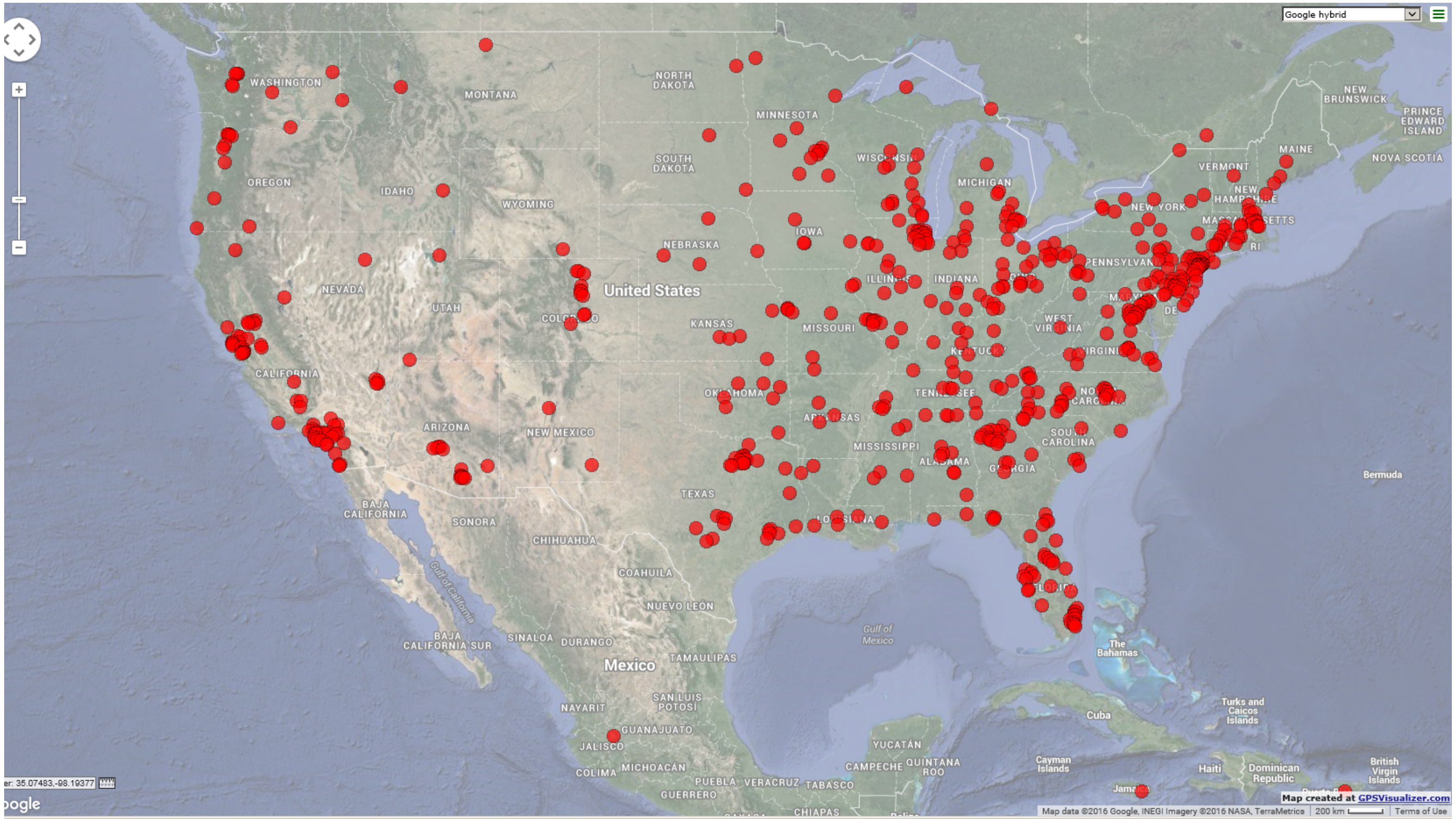


**Figure 4.16:** Subject Locations: North America

# 4.D Subjects' Explanations of their Decision Making

*Each new paragraph is the response given from a different subject to the question: "Please would you write a sentence or two to explain how you made your initial choice."*

## 4.D.1 Simple decision makers – based upon manual categorisation of subjects' explanations

It was the most amount of money I could receive. I didn't care how many weeks it would take.

I made my initial choice by the highest payment.

I meant to click $19 in six weeks as my initial choice. Unfortunately, my hand slipped and I clicked 16 instead without realizing it until I clicked next. I would prefer the maximum payment. The waiting time to receive the payment does not matter to me.

I went for the highest paying amount even though it was the longest period

I decided to go with the most amount of money possible because every dollar counts.

I made the choice for $19 in six weeks because I am no rush to cash out my earnings from Mturk. Sometimes being patient pays.

I just went for the most money

None of it's really my money until I get it, so i might as well hold out another week for three bucks.

I accidentally chose $16 in 4 weeks instead of $19 in six weeks. I'd rather take the largest sum as I am not currently in dire need of money. I have savings to live off of.

I wanted the maximum amount of money, and I don't mind waiting a long time to receive it.

I can wait for the highest payment. This is extra money, so why not wait?

I would like to get the most money, and I don't mind waiting longer for it.

I chose the option offering the most amount of money

I'm the turtle in the race, the ultimate goal is what I'm after no matter how long I have to wait, if I get more for waiting, I'll gladly do it.

I chose the highest amount of money offered - the amount of time it would take to get it was irrelevant to me.

I wanted the highest payoff, I don't mind the wait.

I don't nee money right away so I just chose the highest value.

I would choose the one that gives the most money because time isn't as important for me right now.

i wanted the highest payout possible - time was not important

THIS WAS BONUS MONEY ANYWAY SO WHY NOT WAIT FOR THE MOST PROFITABLE.

Since it is isn't a significant amount of money and would be supplementary income, I would always choose the highest amount of money since I do not care how long I have to wait for compensation.

I want the most money, I don't care how long it takes. I am wiling to wait because a few weeks is not that long

I want the most money, I don't care how long it takes to wait

I've got a one in ten chance, so I might as well go for the most amount, because the odds are not in my favor.

I made my initial choice by taking the largest amount. I was thinking I have a 1 and 10 chance, let's swing for the fences.

i chose the most money, the time was short no matter what so, i can wait

I wanted to maximize the amount of money I could receive.

I don't need the money so I chose the highest of the three amounts and the wait period was not extremely different so it did not matter how long the period of time.

Always go for the most money. Time will pass in any case.

that last question made no sense. YOU SAID imagine the payment would be made tomorrow. So why did the choices say in 6 weeks, or 4 weeks? Not sure what you were even asking in the last question, so I picked the largest amount since you said the payment would be made tomorrow.

I chose $19 in six weeks because it is the highest amount. I'm in need of money, but the payment date isn't as important in my situation.

I really wasn't concentrating too much on the time factor, but rather I looked to maximize the payment received.

I would like to receive the highest amount possible, regardless of when it is paid.

I wanted the most money, so I chose the option with the most money regardless of time.

I chose the option with the most money. I have to wait at least one month to get any money. I will have forgotten about it by then, so I may as well wait the additional weeks, to get the higher payout.

I wanted to get the largest amount possible and since the sum wasn't that high I could live without it for a few weeks.

I chose the largest sum of money that I could receive even if it meant waiting for a longer period of time. I am not in a hurry to get it.

I have no immediate need for the money, so I would prefer to maximize the amount awarded to me even if I have to wait longer. Therefore, I chose the maximum amount of money available to me, namely $19. By the way, I'd never choose the last option: why wait the maximum time for the minimum amount of money?

I went with the amount that would give me the most in the end.

I made my choice because I do not need immediate funds. I work on Mturk for spare cash for investing. I would rather have the larger payout in a few weeks.

Well I figured waiting the six weeks for the highest payment made the most sense, because it is a bonus so I can be patient. Also, it would be like a little surprise when the day comes I can be like, "Oh yeah I forgot about the extra payment, yay." It will most likely make that future day a good day.

I figure, there is equal chance of each, so I should just go for the highest amount. It's a bonus anyway, so I can wait for it.

The maximum reward was $19, and it didn't seem like a big deal to wait a few weeks for the biggest bonus.

I would rather wait and receive the most amount of money.

It might be a longer waiting period but it is the most beneficial choice.

I am patient and would wait for larger payoff.

more money

After about a week I would forgot I even had a bonus and it would come as a surprise. Given that, I would rather have a surprise $19 than a surprise $16.

I went with the option that would give me the most money in the end

I would rather maximize my earnings as much as I can. I don't really mind waiting 6 weeks to be paid.

I chose $19 in six weeks because I wanted the highest reward amount. Time of delivery does not matter to me.

I wanted the most amount of money and six weeks is not that long to wait.

I'm doing this survey to help fund a vacation planned for June. Since interest rates are low right now and I won't need the money for well more than six weeks, it makes no sense to take less money to get it sooner.

I'd take the higher payment. The time isnt a big deal

I wanted to win the most amount of money that I could and I am willing to wait a few weeks in order to do that.

I would be totally willing to wait. Six weeks isnt that long. I don't NEED the money right now so why not wait, costing me NOTHING and get more money?? it doesn't make sense unless you need the money urgently right now and even then. Who needs four bucks that bad?

More money is better. In six weeks I will really appreciate $19.

I would rather have more money.

I would want the higher amount no matter how long I would have to wait.

I picked the biggest bonus even though I would have to wait longer. I am not desperate for the cash immediately.

I chose the maximum amount that was given as an option. I figured it would be a nice surprise to see that money in six weeks.

### 4.D.2 Complex decision makers – based upon manual categorisation of subjects' explanations

The $16 in four weeks had the fastest return of money and the second highest payment.

I'm not hurting for $19. I can wait the six weeks it might take to get it. I'd rather have a bigger amount and have to wait a bit longer, than having a smaller amount and getting it right away.

It's the fast time to be paid, and it's a reasonable amount of money. The extra money for the longer waits weren't enough money to make a difference.

I would pick the one that sounded most believable. I would like 16 dollars in for weeks but I don't believe that it will be given. I believe 4 dollars in seven weeks is more believable so I choose 4 dollars in seven weeks.

I would like the option where the bonus comes the quickest. Because for me I would rather have the money come faster than have to wait a lot longer for more.

I would rather have more money in a shorter period of time than waiting.

I thought $16 in four weeks was a reasonable option. You can't be too choosy when something is free.

I chose $16 in four weeks because i don't feel two extra weeks waiting time is worth $3.

I definitely would not want the $4 as it is less money. The $16 is not far enough from $19 to make it worth me waiting an additional 2 weeks.

It just seemed like the best money to time ratio.

I didnt see $ 19 as being that much more to justify waiting an additional two weeks. Selecting $4 in an even longer period of time made no sense as it is less money.

I wouldn't want to wait two more weeks for another 3 dollars. And the 7 week option is horrible.

I would be willing to wait 2 more weeks for more money.

16 dollars in four weeks would be worth waiting. 4 more dollars for 2 extra weeks could be worth it but I have little patience.

Wait for four weeks to get $16 is more appealing than the other two options as $4 in seven weeks is less and extra 2 weeks for $3 is waste.

The higher payout made it worth waiting the extra weeks for the payment, where as the money between 4 and 6 weeks was not that significant, and I would rather received the amount paid at a quicker date.

Seven weeks for $4.00 was obviously not a good choice. I chose $16.00 in four weeks because $3.00 for two additional weeks didn't seem like enough, and also, I could really use a little money in four weeks time.

I felt I could have the patience for four weeks to receive $16.00. I thought the extra two week waiting time wasn't work the extra $3.00. I didn't understand the $4.00 in seven week option though. That was throwing me for a loop.

It's not a lot of time to wait for the $19 (six weeks vs four or seven).

Six weeks seemed like too long to wait for an amount that was just a little more than $16, which seemed like a decent amount. Certainly better than $4 for a longer time.

I remained consistent $16 within 4 weeks, I felt $19 (+3) was not worth the wait and the seven week amounts with the exception of 2 were never worth an even longer wait.

I think waiting an extra 2 weeks for $3 or $12 less in 3 more weeks isn't worth it.

The $16 option equalled the most money per week.

I'd rather have the money as soon as possible if there is only a few dollars difference.

Patience is always best and a dollar saved is a dollar earned. I would love 19 dollars honestly. Whether I had to wait 6 weeks. It isn't that long.

$3 less to receive 2 weeks early is very appealing. It isn't much of a loss, and is 4x better than what's offered for waiting the longest.

This amount of money is not significant enough that I would badly need it immediately or soon. To me it makes sense to wait out the maximum amount of time offered to me, in order to maximize my earnings potential.

So I wanted the highest pay possible. However, the difference between the 2 highest was $3. Was waiting two more weeks worth $3? I sided with no. I would rather have the $16 in a shorter amount of time.

I made my choice because four weeks is a shorter time to wait.

I ignored the last option as obviously the worst, then considered whether I would want to wait two weeks for an extra $3, and decided that I would not, so I chose $16 in four weeks.

The $4 choice is worthless. If I'm going to wait 4 weeks for $16, I might as well stick it out for a couple more weeks and get a few bucks more. So $19 in six weeks. I would rather wait a little longer to get a little more money. Every dollar adds up and I could always use extra. I dont mind waiting for extra money to fall in my hands.

The $16 is given in a shorter time and we need that money now.

Four weeks is the smallest amount of time to wait. Also, $16 sounds like a very reasonable and fair payment.

I'm willing to wait for a bigger payout. Immediate gratification is not as important to me.

I chose the largest amount. I can wait for the longer time period.

I chose $16 in four weeks because timing is also of value to me just as money is.

I'd like to receive the $16 in four weeks because I wouldn't want to wait two more weeks for $3 extra. $4 in seven weeks seems a long wait for such a small sum. seemed most amount for shortest time frame

I would like to receive the maximum amount of money. The time factor is somewhat secondary, at least in the choices given in this exercise. The $16 in four weeks option is tempting but the extra three weeks to receive and additional won out, in that receiving the most amount of money is my preference as long as the time window is not that onerous.

I choose the highest amount available. Waiting a few weeks more for a larger payment is worth it. Waiting longer for less money doesn't make sense.

My choice was based on maximum payout in a week.

I did the math in my head and figured that $16 in four weeks would provide the most optimal pay per week.

Waiting 7 weeks for $4 is just ridiculous, if it was a sure thing I suppose I would accept it but if I had any other (better options) no way at all. $19 for 6 weeks is a lot more attractive and the highest paying, however it's only $3 more for 2 weeks time, those $3 while welcome can be made fairly quick and I would just rather receive $16 (which is 4 times $4) as fast as possible.

$4 in seven weeks seems like a long wait, for so little and $19 isn't much more than $16, so four weeks seems like a faster and sizable return

i chose $19 in 6 weeks.it was the largest payment available and by choosing it over $16 in 4 weeks, i receive 20

I selected short time

I would prefer to get the money sooner, but also a greater amount in relation to time. It is not worth waiting an additional 2 weeks for only $3 extra.

I'm a fastidious saver and every single dollar counts. I don't mind waiting a few weeks for a few extra dollars.

I chose the option with the most payout. I don't mind waiting longer for a higher amount.

$16 in four weeks sounded like the best option to me. 7 weeks for less money didn't make sense and I didn't think $3 was worth waiting 2 weeks for.

I chose to stay with the $16 in 4 weeks option. The difference in the money to wait he extra 3 weeks was not worth it to change my opinion

I viewed the amount received as a basis for my decision. I could wait four weeks and receive $16, but I have no problem waiting an additional two weeks to receive a little bit extra; waiting longer for less ($4) was not even a considerable option for me.

Four weeks is shorter than six and/or seven weeks.

It's $4 per week versus $4 in seven weeks

I think that $16 is still a high amount for waiting a fair amount of time. I would not want to receive only $4, and waiting an additional 2 weeks for just $3 more.

I made the choice of $16 in four weeks because that is the most per week of all of the options. $19 in 6 weeks is $3.16/week, and $16 in four weeks is $4/week.

would rather just get $16 in four weeks since the amounts for the rest of the weeks are not that much more,so chose $16 in four weeks for all.

$16 in four weeks is the most amount in the shortest time

I would rather get 16 dollars in a month. waiting two more weeks for an extra 3 dollars is not that much money so choose the $16 in four weeks. No one would want to wait 7 weeks for less money.

I made the choice $19 in six weeks because I don't mind waiting longer for some extra money.

My Initial choice was 16 in 4 weeks because it was the most available in the shortest time

I can wait to be paid a little more, the fact that it's all small amounts of money, makes it easy to wait.

I am patient enough to wait the three additional weeks for the $12 additional dollars. a $3 increase for 2 additional weeks is not worth it.

Waiting three more weeks for four times the payout seemed like the benefit of the increase was greater than the detriment of waiting. Waiting two more weeks for only three extra dollars was not a proper payoff.

Basically, I went for the highest payoff regardless of the time frame. The $4 payment I'd get more quickly isn't enough to really change my life, so I'm not missing much by waiting for the bigger amount.

$19 is the largest amount. The downside is it will take longer to get it. I saw this as an investment and chose the highest return. Ultimately it is wiser to take the larger amount of guaranteed money than it is to take a lower amount just because you will get it sooner. The exception would be if you could put the money to work for you on the amounts you would receive earlier so that it gets you more money ultimately than you would have gotten if you waited. I.E.: Could I take the $16 in four weeks then invest it into something that would make me more than $3 in two weeks time. If I did then ultimately I would see a higher return in six weeks than the $19 in six weeks option. In this case the potential investment return on $16 in three weeks time is too minimal without ineffective time cost utilization (I spend more time on the investment than is worth the amount I'd get back from it, my time could be better spent on another endeavor). In this situation, my reasoning with logic leads me to the conclusion that $19 in six weeks is the best investment.

I can wait six weeks for the largest amount. There isn't any advantage for me to receive a smaller amount sooner.

$19 in six weeks equal less than $4 per week. $16 in four weeks is equal to the first choice of $4 in one week, but I could use the money sooner rather than later. I need to purchase brake pads from Amazon ASAP and need my mturk balance to increase as quickly as possible.

First of all I analyzed the average payout per week. The $4 and $16 option offer the same average payout, so the $19 over six weeks is off the table. I chose the $4 option with the hope to maximize my chance to receive the bonus payout. I'm assuming the lower payout is more likely to be paid.

I picked $16 because if I delayed gratification I could quadruple my money. I didn't particularly need the money right away either. the $3 difference for the additional 2 weeks was only $1.50 extra per week.

I made my choice by choosing to be lazy and not wait six weeks for anything, and seeking the patience of about a month to consciously remember and be interested at the given price point. Until the choices changed where I would receive more money in a shorter time span, laziness and net worth increased.

The main motivation for me was the overall value of the money, regardless of the time. However, the $15 in one week and above was pretty desirable since it would be paid at one time.

I made the choice of $16 in four weeks because that would make it $4 a week for 4 weeks so it makes sense to me to choose that one

I did not select $19 in 6 weeks because I did not see the point in waiting 2 extra weeks for only 4 more dollars. $4 isn't a lot of money. Neither is $16, but I could at least spend $16 on something.

I would rather have instant gratification.

Sixteen dollars is sizeably more than $4, so it is worth the wait. It is not, however, worth waiting three more weeks just to gain an additional $3.

Six weeks is not long to wait. I don't mind waiting that period of time for a nice payment.

I'm willing to wait a make a few extra dollars.

I went with the highest amount possible until I felt the other price would work for me. Mainly gut instinct.

4 weeks is long enough to wait and for $3 more, I do not want to wait another 2 weeks- but I would rather wait a month and get $16 rather than get just $4 in 1 week.

4 dollars is easy to make on Mturk. 16 dollars in addition to what I make regularly would be good (about half as much as I make a day), and 19 dollars was just too long to wait for not enough of an increase. Though of course, any bonus is a good bonus!

I felt it would be worth to be patient and hold out for the higher monetary payout. The scenario is comparable to watching a stock account, savings account, mutual fund, etc, grow interest over time. Sometimes it pays to leave the money alone and wait for the value to increase.

A random payment of $16 that I will get in 4 weeks time is a good choice. I decided based on the first amount being too little, and the last amount having too little of a monetary increase for the amount of time increased.

I thought $4 in a week was substantial, but the other two choices didn't seem worth the wait.

It sounds silly but I would rather have the $4. 4 weeks seems like a long time to wait for 16. I felt that the 4 was large enough to accept. If it was 3 or less then I would have waited for the 16.

$19 in six weeks is usually very good return instead of selecting $4 in one week or $16 in four weeks.

I like free money and I am able to hold back until I can get more. I wouldn't wait around longer for just a few dollars though.

I my choice was made according to how quickly I would receive payment.

Once it got to 13 dollars in one week as opposed to what I normally would choose. It seemed a deal to take a three dollar cu to get it three weeks sooner. After that it was only logical to choose the one week option.

4 in one week was not a lot.16 in four weeks is worth waiting for. 3 more dollars two weeks later is not worth it

in 4 wks i can get 4x the money and that's worth the wait. the incremental $3 for two extra weeks isn't worth it

I made the initial choice in that $19 is a lot more than $4 in one week, and I figure if I've already waited four weeks for $16, I may as well wait another two weeks to get $19 instead of 16.

I would rather have the money now than to wait four weeks.

I would rather wait a little bit of time and receive the higher compensation amount. Also, waiting several more weeks makes the compensation amount be almost 5xs getting it at the earliest time, so it's worth the wait to me.

First I chose $16 in 4 weeks, then moved onto 1 week when the payment value went to $11 or over. I did not mind forfeiting $5 to have the money 3 weeks sooner. well, $4 is pretty low and i still need to wait a week. $19 is nice but 6 weeks is too long. $16 is earning $4 for every week I wait.

It just seemed to be a reasonable choice.

I would have to wait four times as long to receive the 16 dollars, so I opted to wait 1/4 of the time for 1/4 of the money.

$16 seemed equivalent to $4 in one week, except it was more money for doing nothing. $19 is not a significant increase for such a longer amount of time.

Take the largest amount first, until the first option acceded the the third in the shortest time interval.

The net present value on the future payment was just too enticing, I'd much rather have the extra $15 for waiting five weeks.

$4 doesn't mean that much to me and I don't need it this week. On mTurk I'm trying to save up for a camera in about a month so $16 in four weeks works perfectly because that's when I need the money.

I believe that good things happen when you wait. I am a very patient man and instead of getting instant gratification (1 week) I chose the long term goal.

4 dollars in a week seems fair. the rest seems to long to wait for

I thought I could wait four weeks for the amount as it was high and did not want to wait longer than that.

six weeks isn't that long and I went with the biggest payoff vs time

I felt like $4 was too little, and I'm a little more patient than that. $16 in 4 weeks sounds okay to me. Since it seems like I was getting $4 a week, $19 in 6 weeks seemed stingy, so I didn't really want to wait around the extra 2 weeks for it.

It seems pointless to wait as I might not have as much need in the future

I tend to think long term, and 16 dollar in four week is a way better deal than just getting 4 dollar in just one week. 6 weeks is too long for me to wait for 19 dollars

I'd always prefer to have more money even if it means I have to wait a bit, so it's not too hard to choose between $4 and $16/$19. The decision that's slightly more difficult is picking between $16/$19, since it's only a $3 difference, but if I'm already waiting 4 weeks to get $16, another 2 weeks to get $19 instead doesn't seem too bad.

$16 is much greater than $4, thus worth the wait. however $19 is only slightly more than $16, yet with a 50

I decided I could wait several weeks to receive the higher amount of money. However, when it got to the point where I would receive a pretty good amount on the first week and close to the same weeks later, I decided to receive the money sooner than later. The higher the amount given on the first week and the closer the amount was to what is offered if I waited a few weeks, was when I decided to take the money on the first week.

I would rather have less sooner. Who knows where I'll be in 4 or 6 weeks but odds are I'll be here next week.

To make 4 times as much in 4 times as long seems fair and like the best profit margin. I can handle the wait.

I chose this option because I don't mind waiting a longer period of time for this payout.

I would want more than $4 so I picked $16 since it was only four weeks away. I would not want to wait the additional two weeks to receive an extra $3.

$16 is quite a bit more than $4, and I can wait 4 weeks for it. But $19 is only a bit more than $16, and I have bills to pay in 4 weeks.

Four times the money is worth waiting 4 times as long.

I think 4 in one week is much more likely to happen and it's about the same pay as the others regarding payment

I have chosen the biggest payout in four weeks.

I chose the one that would allow me to get money the soonest

Because I am a little short on cash and would like to receive the money ASAP.

It was the perfect balance between the amount of money, and the time that would have to be spent waiting for it. It was a reasonable amount of money and would be available relatively soon.

I haven't put $19 into my budget as a gain, so it really doesn't matter when I get the money. It's still extra money, and there's no priority on it.

$16 dollars in 4 weeks is equal to $4 in one week. Looking at the long term amount, and knowing that the mturk policy is 30 days for payment, natural response is to stay in the time frame and make the most money.

I would much rather receive $19.00 in 6 weeks than $4.00 in a week simply because it is $15.00 more. What I earn from doing MTurk surveys is really money I use to put towards vacations, savings, etc. So waiting an extra 5 weeks to increase my overall bonus by 415.00 is fine by me!

I went with what felt like "more" to me. Whether it be now or having to wait, at what point did it feel like more money to me. That's what I chose. the amount of money vs the time is how i came to my choice

I would much rather have $19 in six weeks and wait on it rather than having less quicker.

I just went with what I figured I had the best shot with as I just don't see anyone giving too much for free on these Amazon HIT's.

There is not much of a difference between $16 and $19 but there is one between $4 and $16. I would rather have more money sooner than wait two extra weeks

I believe this was worded wrong, it stated that the amount would be changed to one day where as this is time and not amount. That being said I opted for the most I could collect in the least amount of time.

Because 4 dollars hardly buys a latte these days, so that choice is definitely not worth it. Also, if I am going to wait a month for $16, I might as well wait two more weeks for the $19.

I chose 16 in four weeks because that's way better than 4 in a week and I didn't want to wait an additional two weeks for just three more dollars

I'd rather receive about the same amount of money in one week rather than waiting for four.

$4 in one week is too long to wait for such a small amount. $19 seems like too little to wait for six weeks, as well, so I went with the middle of the road, because I wanted more than $4.

I don't have much cash right now but $4 wouldn't be of much help for the couple of days until I get paid.

I figured that by waiting six weeks, I can nearly increase my bonus by five times.

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