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Visceral Emotions, Within-Community Communication, and (Ill-Judged) Endorsement of Financial Propositions*

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Abstract

The 2007-08 financial crisis exposed poignant examples of ill-judged risk accretion in *both tails* of the Lorenz curve: concentrations of inappropriate mortgages within low-income neighborhoods, and concentrations of Bernard Madoff's victims within wealthy, predominantly Jewish country-club communities. These examples share three key elements. First, individual behavioral decision makers take decisions privately but contribute to the build-up of risk within the community. Second, sales agents employ psychological persuasion techniques (bypassing logical processes), and trigger visceral emotions (overriding rational deliberation). Third, community membership immerses individuals within information flows that trigger invidious visceral emotions, and leads to biased inferences due to *sample-size illusion* and *persuasion bias*. We develop a closed-form model based on Signal-Detection Theory (SDT) that incorporates all three above-mentioned elements: it is behavioral in employing a Prospect Theory (PT) objective function; peripheral-route persuasion and visceral emotions are incorporated through their impacts on discriminability d'; and sample-size illusion and persuasion bias are incorporated through their effects on the score θ. This PT-SDT model predicts that visceral-emotion-charged *hot states* can short-circuit the capacity to practice *caveat emptor*, carrying implications for regulation and for our understanding of US household-borrowing growth 2001–2006.

Keywords: within-community risk accretion; signal detection theory; prospect theory; psychology of deception; peripheral-route persuasion; visceral emotions; persuasion bias; mortgage mis-selling; predatory lending; Madoff ponzi scheme; caveat emptor; accredited investor status

JEL classification: G11, D81

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Distiniguishing the borrowing constraints theory from the behavioral biases view remains one of the biggest challenges in the study of household spending behavior.

Mian and Sufi, 2014

1 Introduction

When accretions of financial risk implode with devastating economic effect, culpable causation is often traced to one or more traits prevalent within economically consequential subsets of the population: e.g. inability to distinguish signal from noise, time-inconsistent intertemporal (myopic) preferences, predominance of intuitive (system I) decision making over rational deliberation (system II), or even moral turpitude. And for accretions of financial risk forming asset-price bubbles, a long tradition of economic analysis holds that animal spirits are ultimately responsible (Keynes, 1936; Akerlof and Shiller, 2009).

Yet the latest empirical work rejects price-bubble-mediated animal spirits as an explanation of US households' aggressive ramp-up of borrowing between 2001 and 2006. Borrowing increased rapidly both in cities without geographical restrictions to new housing supply – which therefore did not experience a property-price bubble – as well as in cities with geographical restrictions on new housing supply – which did experience a property-price bubble. Animal spirits operating via property-price feedback loops clearly cannot be responsible for increased borrowing in cities that did not experience a property-price bubble. Yet in both types of cities, borrowing increases were largest within low-income, low-credit-score zipcodes. The two remaining potential explanations are (i) borrowing constraints and (ii) myopia e.g. hyperbolic intertemporal preferences. However, the borrowing-constraints explanation does not withstand scrutiny in the face of the magnitude of US households' new borrowing.[1] Without additional differentiating structure, myopia (hyperbolic discounting) stands as a generic construct which alone does not yield predictions that are observationally distinguishable from those implied by borrowing constraints (Mian and Sufi, 2011, 2014). Neither does it explain the great differentials in the quantity of borrowing and the quality of borrowing[2] between different communities.

[1] $7 trillion between 2000 and 2007. "We already know that the new borrowers during the credit boom of the 2000s had declining incomes, and we've seen no evidence of improving incomes. If a household borrows aggressively today and never sees an increase in income in the future, it is hard to explain their behavior with the borrowing constraints story." (Mian and Sufi, 2014, p. 92.)

[2] i.e. 'bad borrowing', in the sense of fundamentally inappropriate mortgage types and contractual terms

The 2007–08 financial crisis also revealed stark between-community differentials in financial ill judgment at the opposite end of the socio-economic spectrum. The victims of Bernie Madoff's ponzi scheme cascaded along kinship and close friendship-trust lines within communities defined by the intersection of cultural affinity, geographical location, socioeconomic status, and formal membership. Wealthy Jewish communities centered on exclusive Long Island country clubs or synagogues such as the 5$^{\text{th}}$ Avenue synagogue in New York – and similar closed-membership communities within the coastal corridor, from the Pine Brook Country Club in Weston MA, near Boston, down to the Palm Beach Country Club in Florida – these are the communities that bore a disproportionate concentration of Bernard L. Madoff Investment Securities LLC's victims. (Arvedlund, 2009; Kirtzman, 2009; Owens and Shores, 2010.)

We develop a closed-form model of decision making that applies equally to the rash of ill-judged mortgage contracts among inhabitants of low-income communities as well as to the rash of ill-judged investment decisions among members of specific wealthy communities. These examples from opposite ends of the wealth distribution share three key elements.

First, membership in a social community inherently involves on-going face-to-face communication with other community members, whereby individuals become apprised of their fellow community members' major financial events: noteworthy financial and real investments, noteworthy major purchases, as well as indications – by direct revelation or by hearsay – of the associated financing. The interpretation and processing of this information is subject to *persuasion bias*, i.e. the failure to adjust properly for information repetitions (DeMarzo, Vayanos and Zwiebel, 2003). It is also subject to *sample-size illusion*, i.e. the failure to adjust for effective sample size, which will be lower than the nominal sample size when community members' financial decisions are correlated. Of course, within-community communication also supplies the informational conditions for invidious comparisons, which in turn trigger envy, conformist and competitive social pressures to keep up with the Joneses, and anxiety over missing a closing window of opportunity and being left behind.

Second, individual community members' decision making is most aptly characterized as behavioral. The above-mentioned sample-size illusion and persuasion bias constitute deviations from Bayes-rational information processing. Anchoring on initial purchase price (respectively investment principal) and resistance to realizing paper losses – as are prevalent among homeowners and wealth managers' clients – require a reference-dependent model featuring loss aversion such

as Prospect Theory (PT). And intertemporal consistency of rational (exponential) discounting is violated by the myopic, *ill-judged* nature of the financial decisions.

Third, visceral-factor triggers are present both in the community's communication flows as well as in the sales techniques of mortgage brokers (respectively sales agents). In general, visceral factors include negative emotions, drive states and feeling states. With slight abuse of psychological terminology, we will henceforth refer to the subset that is of direct relevance to financial decisions – i.e. fear, anxiety, envy, and greed – as 'visceral emotions'. Visceral factors induce a direct hedonic impact as well as alter the relative desirability of different hedonic cues/attributes. They also induce a narrowing and restriction of attention to a specific hedonic cue/attribute and its availability in the present, i.e. under the action of visceral factors, a decision maker's evaluation horizon collapses to the present. At sufficiently high levels of intensity, visceral factors can override or short-circuit rational deliberation entirely. Mortgage- and investment-product sales techniques exploit and expand upon the visceral emotions already triggered by within-community communication. Furthermore, psychological sales techniques complement the manipulation of visceral emotions (which suppress rational deliberation) with peripheral-route persuasion (which bypasses logical reasoning processes) and almost invariably introduce a requirement for immediate action (which heightens anxiety and precludes cooling off for rational contemplation). (Loewenstein, 1996, 2000.)

Although descriptive validity calls for incorporation of visceral emotions into modeling, this departure from normative assumptions is also motivated by theoretical and empirical testing considerations. The difficulty of distinguishing the effects of borrowing constraints from those of behavioral biases in household spending behavior remains one of the most important issues and biggest challenges in the literature (Mian and Sufi, 2011, 2014). The simplest and most straightforward formulation of myopia, or its implementation as hyperbolic discounting, lacks sufficient structure to be crisply distinguished from borrowing constraints. Such differentiating structure may be found, however, by moving away from a black-box formulation toward a behaviorally and psychologically informed formulation of myopia. Inside the black box, "disjunctions between perceived self-interest and behavior result from the action of *visceral factors*" (Loewenstein, 1996). Visceral factors are arguably *central* to a refined, structurally articulated notion of myopic behavior.

George Loewenstein's work is seminal in identifying the critical role that visceral factors play

in intertemporal choice and in causing "people who otherwise display 'normal' decision-making behavior to behave in ways that give the appearance of extreme discounting of the future" (2000, p. 430). In other words, visceral factors lead to myopic behavior, e.g. hyperbolic discounting. "In fact many, if not most, self-control problems involve visceral factors, and likewise, almost all visceral factors are associated with self-control problems" (Loewenstein, 2000, p. 430). Visceral factors also play a key role in the psychology of persuasion and deception (Langenderfer and Shimp, 2001; Cialdini, 2007). Manipulation of visceral factors is a core skill in professional sales roles, and no less so in ethically ambiguous sales roles (Easley, 1994). Sales professionals combine such manipulation of visceral factors with peripheral-route persuasion that may employ appeals to authority, scarcity, similarity and identification, reciprocation, consistency following commitment, and social proof (Petty and Cacioppo, 1986; Cialdini, 2007).

The modeling challenge is not simply to acknowledge behavioral departures from normative benchmarks, but to trade a modicum of parsimony for more-than-offsetting improvement in descriptive accuracy while retaining tractability in a closed-form model. To this end, we develop a model based on Signal-Detection Theory (SDT) that incorporates all three above-mentioned elements. We 'behavioralize' SDT by substituting a specific variant of Prospect Theory (PT) for the classical SDT objective function of expected misclassification cost. We incorporate the effects of visceral emotions and peripheral-route persuasion by allowing them to affect the PT-SDT model's discriminability parameter. Finally, we incorporate sample-size illusion (failure to adjust for effective sample size) and persuasion bias (failure to adjust for message repetitions).

The SDT framework is well suited to this application. First, it is not 'hard coded' with any particular family of objective function, and therefore permits the above-described 'behavioralization' with PT. Second, it formalizes and displays the information-processing component of decision making, whereas it remains embedded within the conditional probability calculations associated with the workhorse decision-theoretic frameworks of Expected Utility (EU) and Subjective Expected Utility (SEU). The quality of the decision-maker's information processing determines the locus of best attainable true-positive and false-positive likelihood combinations, called a Receiver Operating Characteristics (ROC) curve. Third, it reveals that the location of the optimal cutoff threshold is not a purely statistical and non-economic matter. Instead, the *decision maker's* prior beliefs and (mis-)classification cost matrix affect the location of the optimal cutoff threshold. Comparative static analysis, as implemented in the sequel, consists of

examining the impact of a change in a variable of interest upon the location of the optimal cutoff threshold, i.e. either more conservative (decreased true-positive and false-positive likelihood) or more permissive/liberal (increased true-positive and false-positive likelihoods).

Loewenstein's (1996, 2000) seminal work includes formal modeling apparatus that we nevertheless do not employ here. This is because our emphasis is slightly different: choice under risk and uncertainty rather than choice under certainty; information processing rather than full information. The implementation developed here rests especially upon the 'narrowing of attention' effects of visceral factors, and it complements the work of Loewenstein (1996, 2000) in modeling the impact of visceral factors through their disruptive effect on the logical reasoning required for information processing.

2 Peer effects literature

The community social-network effects modeled in this paper build upon recent work that documents peer effects – on car purchases, debt, stock market participation, and retirement saving – with the aid of novel, high-quality datasets, and carefully implemented econometrics.

Using Dutch Postcode Lottery[3] data, Kuhn et al. (2011) find that winning households increase their car and other durable expenditures moderately. However, the effects on winning households' immediate neighbors are even larger: increasing the probability that neighbors will buy a car in the next half year by nearly 7%, and reducing the average age of their principal cars by 7%. Grinblatt et al. (2008) also study car purchases, using high-quality, daily data with comprehensive coverage of Finland's two most-populated provinces, containing precise geographic location, car puchase information (including make and model), as well as a large number of control variables. Their econometric methodology concentrates on estimating the marginal effect on a household of the car purchases of its ten nearest neighbors, using more distant neighbors as an instrument for omitted control variables. They find that purchases by a household's nearest neighbors in the recent past (last 10 days) increase the household's propensity to purchase a car. This effect is stronger in rural areas and within the lowest income decile. The authors interpret the short-lived nature of the effect as strongly suggesting that it cannot be caused by an emotion such as envy, because "[e]nvy is a more persistent emotion" (Grinblatt et al.,

[3]A weekly lottery in which a prize is allocated to a randomly chosen participating postcode. The participation rate is high, exceeding one quarter of the Dutch population.

2008, p. 750). Although visceral emotions may not dissipate below moderate levels of intensity over relatively short horizons, high-intensity visceral emotions indeed do dissipate over relatively short horizons – and it is high-intensity visceral emotions that interfere with reasoned judgement (see Section 3.5). The authors' finding that the effect is stronger in rural areas and within the bottom income decile are also reflected in the sequel.

Georgarakos et al. (2014) study household debt and the likelihood of financial distress using the Dutch National Bank Household Survey (DNBHS) 2001–08. This dataset includes responses to an extensive questionnaire on income, real and financial wealth, as well as questions focussing on collateralized and uncollateralized loans separately. Furthermore, the DNBHS asks respondents to report "a number of characteristics about those with whom they 'associate frequently, such as friends, neighbors, acquaintances, or maybe people at work,'" as well as their perception of the average annual total net household income among the people in their social circle (Georgarakos et al., 2014, p. 1408). With these data, Georgarakos et al. (2014) find that higher perceived average income in a household's social circle is associated with a higher tendency for the household to have outstanding and sizeable loans. A €1,000 increase in social peers' average monthly household income raises the unconditional likelihood of collateralized loans by 10% and uncollateralized loans by 7%. This effect is significant specifically among those who perceive members of their social circle to have a higher incomes than their own.

A number of empirical studies have investigated the effects of neighbors, social interaction, and sociability on stock market participation. Here we mention just two. Using US Health and Retirement Study[4] data, Hong et al. (2004) contrast the stock-market participation of non-social investors with that of social investors. The latter class of 'social' investors face lower fixed costs to investing in the stock market when the stock-market participation rate is higher among their peers. This comes about through word-of-mouth learning on the one hand, and through a separate component of utility that a social investor obtains from social interaction with peers on investment topics – e.g. conversations about the market's ups and downs, the performance of his investments and of others' investments, and of the various products, firms, and advisors operating in this space. Hong et al.'s (2004) 'sociable'-household indicator classes a household as being sociable if its members either (i) know their neighbors or (ii) attend church. Despite the coarseness of this indicator, Hong et al. (2004) find that social investors are 4% more likely

[4]which is administered by the University of Michigan's Institute for Social Research and is available at `http://www.umich.edu/~hrswww/`

than non-social investors to participate in the stock market, controlling for wealth, race, education and risk tolerance. The effect of sociability on stock market participation is twice as large among white, educated households with above-average wealth. Using instrumental-variables techniques applied to a 10-year panel data set drawn from the US Internal Revenue Service's annual cross-sectional samples of tax returns, Brown et al. (2008) empirically demonstrate that an individual's stock-market participation is *causally* related to to average stock-market participation in her community. Furthermore, this community-ownership effect is stronger in more 'sociable' communities, where sociability is proxied by whether households are likely to be asked for advice by neighbors. This directly demonstrates that within-community communication is causally connected to stock market participation decisions – one of the numerous financial participation decisions faced by households.

Finally, Duflo and Saez (2002) investigate university employees' decisions to enrol in Tax Deferred Accounts (TDAs) and find that peer effects are a statistically significant extra-economic influence on individual financial decision making. Using data from a large university, the authors find that individual employees' decisions to enrol in a TDA, and the choice of vendor once enrolled, are affected by the choices of their department colleagues. And after appropriately instrumenting average department participation, average participation within departmental gender, service, status, and age sub-groupings has a strong effect on both participation and vendor choice.

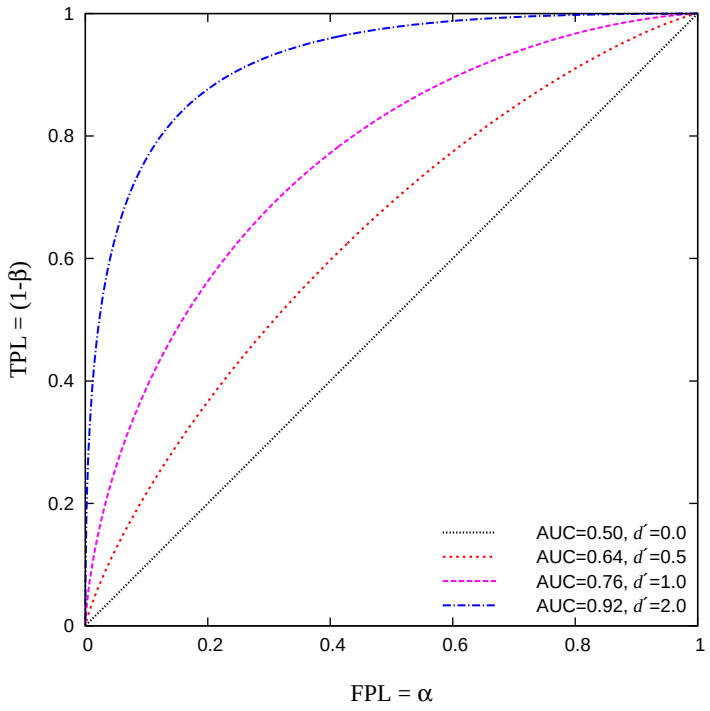
Overall, the empirical case for within-community word-of-mouth peer effects is well established. These effects are revisited again in Section 3.4, where they are incorporated into the SDT-based modeling framework.

3 The model

3.1 SDT preliminaries

We seek, for a specific decision maker, an optimal classifier for whether a financial contract is inappropriate (I) or appropriate ($\neg I$). The decision maker assimilates information from available sources, and this information is summarized in a score variable value $\theta \in \Theta = [\underline{\theta}, \overline{\theta}] \subset \mathbb{R}$. SDT determines the optimal cutoff threshold θ^*, which partitions observed score values θ into the acceptance region ($\underline{\theta} < \theta \leq \theta^*$) where the null hypothesis of the contract being appropriate $H_0 : \neg I$ is retained, and the rejection region ($\theta^* < \theta \leq \overline{\theta}$) where the null hypothesis is rejected in favor of

Figure 1: Binormal ROC curves generated from unit-variance sampling distributions.



the alternative hypothesis $H_1 : I$ under which the financial contract is classed as 'inappropriate' for the decision maker. The procedure of generating a score value θ from given available information represents the decision maker's information processing. The effectiveness of the decision maker's information processing may be characterized with the sampling distributions of the score variable under the null $f(\theta|\neg I)$ and alternative $f(\theta|I)$ hypotheses. Uninformative scoring procedures yield sampling distributions that coincide everywhere $f(\theta|\neg I) = f(\theta|I) \;\forall\, \theta \in \Theta$, and the associated classifiers do no better than chance in distinguishing $\neg I$ from I. Score sampling distributions that are stochastically ordered as $F(\theta|\neg I) \leq F(\theta|I) \;\forall\, \theta \in \Theta$ where $\exists\, \theta \in \Theta : F(\theta|\neg I) < F(\theta|I)$ yield classifiers that *can* do better than chance. For fixed sampling distributions, every threshold value θ' defines a four-way combination of True-Negative Likelihood ($\text{TNL}_{\theta'} = 1 - \alpha_{\theta'}$), False-Positive Likelihood ($\text{FPL}_{\theta'} = \alpha_{\theta'}$), False-Negative Likelihood ($\text{FNL}_{\theta'} = \beta_{\theta'}$), and True-Positive Likelihood ($\text{TPL}_{\theta'} = 1 - \beta_{\theta'}$), where $\alpha_{\theta'}$ and $\beta_{\theta'}$ denote the conventional type-I and type-II error likelihoods under the cutoff threshold θ'.

With the sampling distributions held fixed, the ROC curve is the plot of all ($\text{FPL}_{\theta'}$, $\text{TPL}_{\theta'}$)= ($\alpha_{\theta'}$, 1–$\beta_{\theta'}$) combinations in the unit square as the cutoff threshold θ' is varied throughout its support $\{(P(\theta > \theta'|\neg I), P(\theta > \theta'|I)) : \theta' \in \Theta\}$. Figure 1 illustrates various ROC curves generated

from Gaussian score-variable sampling distributions. Henceforth we assume, for derivational convenience, that the score variable's sampling distribution is Gaussian and shares common variance σ^2 under both the null hypothesis (appropriate financial contract) $\theta \sim \mathcal{N}(\mu_{\neg I}, \sigma^2)$ and the alternative hypothesis (inappropriate financial contract) $\theta \sim \mathcal{N}(\mu_I, \sigma^2)$, where $\mu_I > \mu_{\neg I}$ for strictly effective information processing. With these well-behaved sampling distributions, the ROC curve can be expressed as the mapping $G : [0,1] \to [0,1]$ where $\text{TPL} = G(\text{FPL})$. Furthermore, the Area Under the Curve $\text{AUC} = \int_0^1 G(\text{FPL})\, d\,\text{FPL} = \int_\Theta G(\text{FPL}_{\theta'})\, d\,\theta'$ can be expressed as a function of the *discriminability index*, d', defined as

$$d' = \frac{\mu_I - \mu_{\neg I}}{\sigma} \quad , \tag{3.1}$$

which is the standardized distance between the two sampling distributions' means. Letting $\Phi(\cdot)$ denote the standard Gaussian CDF,

$$\text{AUC} = \Phi\left(\frac{\mu_I - \mu_{\neg I}}{\sqrt{\sigma_I^2 + \sigma_{\neg I}^2}}\right) \quad , \tag{3.2}$$

which, under the simplification $\sigma_I = \sigma_{\neg I} = 1$, reduces to

$$\text{AUC} = \Phi\left(\frac{d'}{\sqrt{2}}\right) \quad . \tag{3.3}$$

The greater the discriminability index – i.e. the greater the separation between the sampling distributions – the closer the AUG to 1. As $d' \to 0$, $\text{AUC} \to \frac{1}{2}$. We restrict attention to the $d' \geq 0$, $\text{AUC} \geq \frac{1}{2}$ range.

3.2 Classical SDT

Classical SDT determines optimal cutoff threshold θ^* by minimizing expected (mis-)classification cost $E(C) = C_0 + C_{\text{TP}}P(\text{TP}) + C_{\text{FN}}P(\text{FN}) + C_{\text{TN}}P(\text{TN}) + C_{\text{FP}}P(\text{FP})$ subject to the ROC constraint on achievable ($\text{FPL}_{\theta'}$, $\text{TPL}_{\theta'}$) combinations.[5]

$$\theta^* \;=\; \arg\min_{\theta'} \; E(C) \qquad \text{s.t.} \qquad \text{TPL} = G(\text{FPL}) \tag{3.4}$$

[5]For general references on SDT, see Green and Swets (1966), Egan (1975), and Macmillan and Creelman (1991); for applications to insurance fraud detection, credit scoring and relationship lending, see Viaene et al. (2002), Stein (2005), Blöchlinger and Leippold (2006), and Kaivanto (2006).

The optimal cutoff threshold θ^* identifies the point on the ROC curve (FPL_{θ^*}, TPL_{θ^*}) where the slope of the ROC curve equals the slope of the iso-$E(C)$ contour:

$$\left(\frac{\text{dTPL}}{\text{dFPL}}\right)_{\bar{C}^*} = \frac{P(\neg I)}{P(I)}\left[\frac{C_{\text{FP}} - C_{\text{TN}}}{C_{\text{FN}} - C_{\text{TP}}}\right] \quad . \tag{3.5}$$

The first term on the right-hand side is the prior odds of the contract being appropriate, while the second, square bracketed term is the ratio of incremental cost of misclassifying an appropriate contract to the incremental cost of misclassifying an inappropriate contract. So the slope of the iso-expected-cost contour (a straight line) is the ratio of expected opportunity cost of misclassifying an appropriate contract ($\neg I$) to the expected opportunity cost of misclassifying an inappropriate contract (I).

Increases in (3.5) entail a point of tangency with the ROC curve that is closer to the south-west corner, with smaller FPL and TPL, higher θ^*, and thus a more conservative classifier.

In the binormal sampling distributions with $\sigma_I = \sigma_{\neg I} = 1$ case, the slope of the ROC curve is

$$\frac{\text{dTPL}}{\text{dFPL}} \;=\; \exp\left\{\left(\frac{\theta' - \mu_{\neg I}}{\sigma} - \frac{d'}{2}\right) d'\right\} \quad . \tag{3.6}$$

Setting $\mu_{\neg I} = 0$ without loss of generality, we may equate (3.6) with (3.5) and solve for the optimal cutoff threshold as

$$\theta^*_{\bar{C}^*} \;=\; \frac{1}{\mu_I}\left(\ln(C_{\text{FP}} - C_{\text{TN}}) - \ln(C_{\text{FN}} - C_{\text{TP}}) + \ln(1-p) - \ln p + \frac{\mu_I^2}{2}\right) \quad . \tag{3.7}$$

3.3 PT-CPT

3.3.1 PT preliminaries

SDT may be 'behavioralized' by substituting PT for the objective function in the constrained optimization problem (3.4). To facilitate this, three elements require specification: the structure of misclassification costs, the probability weighting function, and the PT preference function.

PT is a sign- and rank-dependent theory. Application of PT to the set of (mis-)classification costs entails rank ordering these costs. Fortunately, there is a natural ordering of these costs within each state separately, that is, under $\neg I$, $C_{\text{FP}} > C_{\text{TN}}$, while under I, $C_{\text{FN}} > C_{\text{TP}}$. The cost of correctly classifying an appropriate financial contract as 'appropriate' forms the natural reference point, i.e. $C_{\text{TN}} = 0$. 'Better safe than sorry' is reflected in $C_{\text{FN}} > C_{\text{FP}}$. Establishing

the directionality of the final inequality $C_{\text{TP}} > C_{\text{FP}}$ is requires careful examination. To falsely abandon an appropriate contract is to err on the side of caution; the cost of erring on the side of caution, C_{FP}, is clearly greater than zero. However, the cost of such false alarms are not as great as the cost of dealing with motivated mis-selling, C_{TP}. Thus the sequel is developed with reference to the following ranking of (mis-)classification costs:

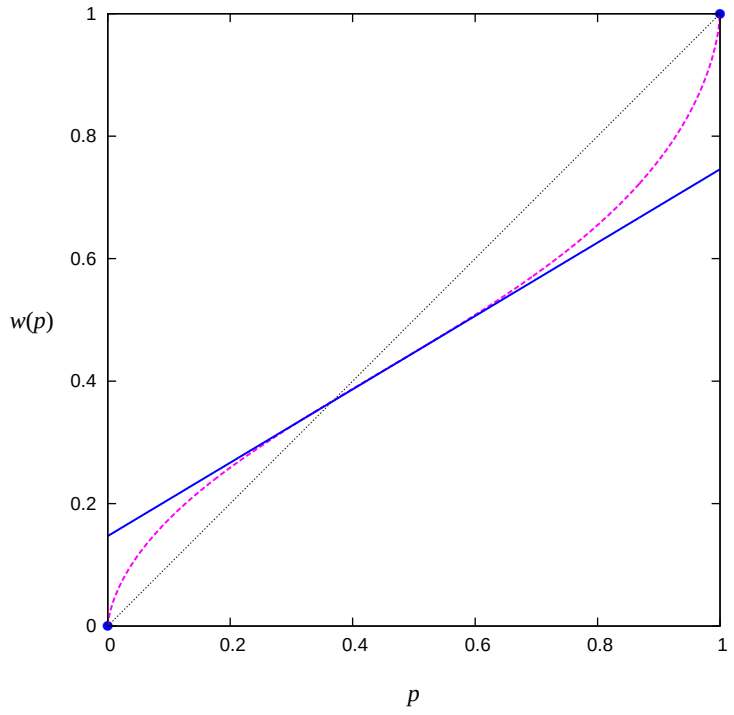
$$C_{\text{FN}} > C_{\text{TP}} > C_{\text{FP}} > C_{\text{TN}} = 0 \ . \tag{3.8}$$

One- and two-parameter probability weighting functions (Tversky and Kahneman, 1992; Prelec, 1998), which are popular in econometric studies of experimental data, prove intractable in the present PT-SDT setting, where uniqueness of the cutoff threshold is necessary. Peter Wakker commends *neo-additive* probability weighting functions as being "among the most promising candidates regarding the optimal trade-off of parsimony and fit" (2010, pp. 209–210). The neo-additive family of probability weighting functions – presented in (3.9) and illustrated with the blue solid line in Figure 2 – displays *overweighting* of small probabilities, *underweighting* of large probabilities, the *possibility effect* in the neighborhood of $p = 0$, and the *certainty effect* in the neighborhood of $p = 1$.

$$w(p) = \begin{cases} 0 & \text{for } p = 0 \\ \mathsf{a}\,p + \mathsf{b} & \text{for } 0 < p < 1 \\ 1 & \text{for } p = 1 \end{cases} \qquad 0 \leq \mathsf{b} < 1, \ \ 0 < \mathsf{a} \leq 1 - \mathsf{b} \tag{3.9}$$

The possibility effect and the certainty effect may be formalized straightforwardly following Fox et al. (1996). Let a 'weighting function' be a mapping $W : \Omega \to [0, 1]$ that is normalized $W(\emptyset) = 0$, $W(\Omega) = 1$ and monotonic in set inclusion $W(A) \geq W(B)$ when $A \supset B$ $(A, B \in \Omega)$. This is thus a non-additive probability measure, or a *capacity*. W possesses lower subadditivity, capturing the possibility effect, if $W(A) \geq W(A \cup B) - W(B)$ where $A \cap B = \emptyset$ and $W(A \cup B)$ is bounded away from one. In other words, the impact of event A is greater when it is added to the null event (the left-had side of the inequality) than when it is added to a non-null event B. In turn W also possesses upper subadditivity, capturing the certainty effect, if $W(S) - W(S - A) \geq W(A \cup B) - W(B)$. Thus, the neo-additive probability weighting function (3.9) displays both of these characteristics.

Figure 2: Neo-additive probability weighting function (solid, blue); Tversky and Kahneman (1992) probability weighting function (dashed, magenta).



Moreover, in a growing number of theoretical and empirical applications, the neo-additive probability weighting function is gaining acceptance (Bell, 1985; Cohen, 1992; Abdellaoui, 2000; Abdellaoui et al., 2005; Viscusi and Evans, 2006; Abdellaoui et al., 2010; Viscusi and Evans, 2006; Chateauneuf et al., 2007).

In order to keep notation simple, we specialize the presentation of the PT preference function to the four cost outcomes in (3.8). Reintroducing the sign into the (mis-)classification costs $x_{-3} = -C_{\text{FN}}$, $x_{-2} = -C_{\text{TP}}$, $x_{-1} = -C_{\text{FP}}$, $x_0 = -C_{\text{TN}} = 0$, $x_{-3} < x_{-2} < x_{-1} < x_0 = 0$, we may write the costs as the (negative) payoff vector as $\boldsymbol{x} = (x_{-3}, x_{-2}, x_{-1}, x_0)$ which is associated with the probability vector $\boldsymbol{p} = (p_{-3}, p_{-2}, p_{-1}, p_0)$. Given that all the payouts are in the loss domain, the PT preference function becomes

$$\begin{aligned} V^-(\boldsymbol{x}, \boldsymbol{p}) = \; & w^-(p_{-3})v^-(x_{-3}) \\ & + [w^-(p_{-2} + p_{-3}) - w^-(p_{-3}))]v^-(x_{-2}) \\ & + [w^-(p_{-1} + p_{-2} + p_{-3}) - w^-(p_{-2} + p_{-3})]v^-(x_{-1}) \\ & + [1 - w^-(p_{-1} + p_{-2} + p_{-3})]v^-(x_0) \end{aligned} \tag{3.10}$$

where we employ the Tversky and Kahneman (1992) power function over losses

$$v^{-}(x) = -\lambda(-x)^{\phi^{-}} \quad \text{for} \quad x \leq 0 \ , \tag{3.11}$$

with the power parameter $\phi^{-} = 0.88$ and the loss aversion parameter $\lambda = 2.25$.

3.3.2 PT-SDT optimal cutoff threshold

Recalling that the prior probability of the financial contract being inappropriate is $p = P(I)$ and that it is appropriate with the complementary probability, and furthermore that FNL $= \beta$ and FPL $= \alpha$, the PT preference function over the (mis-)classification costs becomes

$$\begin{aligned} V^{-}(C) \ = \ & - \ w^{-}(p\beta)\lambda[v^{-}(C_{\text{FN}}) - v^{-}(C_{\text{TP}})] \ - \ w^{-}(p)\lambda[v^{-}(C_{\text{TP}}) - v^{-}(C_{\text{FP}})] \\ & - w^{-}(p + (1-p)\alpha)\lambda[v^{-}(C_{\text{FP}}) - v^{-}(C_{\text{TN}})] \ - \ w^{-}(1)\lambda v^{-}(C_{\text{TN}}) \ . \end{aligned} \tag{3.12}$$

Substituting the neo-additive probability weighting function (3.9) into (3.12), we may solve for the slope of the iso-$V^{-}(C)$ contours, which yields

$$\left(\frac{\text{dTPL}}{\text{dFPL}}\right)_{V^{-}(C)^{*}} = \left(\frac{1-p}{p}\right)\left[\frac{(C_{\text{FP}})^{\phi^{-}} - (C_{\text{TN}})^{\phi^{-}}}{(C_{\text{FN}})^{\phi^{-}} - (C_{\text{TP}})^{\phi^{-}}}\right] \ . \tag{3.13}$$

Due to the linearity of the neo-additive probability weighting function used here, the PT-SDT iso-$V^{-}(C)$ contours possess the required linearity to yield unique optimal cutoff thresholds. Note that the loss aversion parameter λ cancels out, and consequently has no effect on the location of the optimal cutoff threshold. The PT-SDT iso-$V^{-}(C)$ contour slope expression (3.13) differs from the classical SDT iso-$E(C)$ contour slope expression (3.5) only insofar as the square-bracketed term in (3.13) raises each of the (mis-)classification cost terms to the power of ϕ^{-}. Since $0 < \phi^{-} < 1$,

$$\left(\frac{\text{dTPL}}{\text{dFPL}}\right)_{V^{-}(C)^{*}} > \left(\frac{\text{dTPL}}{\text{dFPL}}\right)_{\bar{C}^{*}} \tag{3.14}$$

and for identical ROC curves, the behavioral decision maker is more *conservative* in employing a larger cutoff threshold $\theta^{*}_{V^{-}(C)^{*}} > \theta^{*}_{\bar{C}^{*}}$. This means that behavioral PT-SDT decision makers are more likely to accept inappropriate contracts than classical risk-neutral SDT decision makers.

The expression for the slope of the binormal ROC curve (3.6) may be equated with slope of

the iso-$V^{-}(C)$ contours contours (3.13) to yield the optimal behavioral cutoff threshold

$$\theta^*_{V^{-}(C)^*} = \frac{1}{\mu_I}\left(\ln\left((C_{\text{FP}})^{\phi^-} - (C_{\text{TN}})^{\phi^-}\right) - \ln\left((C_{\text{FN}})^{\phi^-} - (C_{\text{TP}})^{\phi^-}\right) + \ln(1-p) - \ln p + \frac{\mu_I^2}{2}\right) \quad . \tag{3.15}$$

The TPL and FPL associated with both (3.15) and (3.7) may be obtained by substituting $\theta^*_{V^{-}(C)^*}$ or respectively $\theta^*_{\bar{C}^*}$ into

$$\text{TPL}_{\theta'} = (1 - \beta_{\theta'}) = \Phi\left(\frac{\mu_I - \theta'}{\sigma_I}\right) \tag{3.16}$$

$$\text{FPL}_{\theta'} = \alpha_{\theta'} \qquad = \Phi\left(\frac{\mu_{\neg I} - \theta'}{\sigma_{\neg I}}\right) \quad . \tag{3.17}$$

3.4 Within-community communication

3.4.1 Background

In *Irrational Exuberance*, Robert Shiller argues that word-of-mouth communications are "an essential part of the propagation of speculative bubbles" (2000, p. 162). He also draws on research into the socially directed nature of attention – and by implication – inattention as well.

> We pay attention to many of the same things that others around us are paying attention to. This social basis for attention... ...creates a view of the world and an information set that are common to the community. Such a view and information set allow the community to act well in concert. At the same time, the social component of attention does not work perfectly, and it may cause errors to be made in common by the entire group because the common focus of attention pushes aside attention to details that individuals might otherwise notice. (Shiller, 2000, pp. 164–165)

The present focus on within-community communication is instrumental to formalizing specific aspects of Shiller's propositions concerning the social component of attention anomalies (Shiller, 1999, 2000). It also limits this paper's scope to modeling attentional shifts that occur within the community, rather than those occurring more widely across the economy. As will be seen in the sequel, within-community communication is also instrumental to formalizing the endogenous triggering of visceral emotions (Section 3.5).

In a Federal Reserve Bank of San Francisco working paper, Carolina Reid finds that local social networks define and constrain the types of information available to households and thereby

exert great influence on the types of mortgage products and specific contractual terms that become common within the community (Reid, 2010). Her analysis, which builds on Mark Granovetter's work on the social embeddedness of economic activity (Granovetter, 2005), is supported by both quantitative data as well as by qualitative analysis of 100 in-depth interviews of residents in the communities of Oakland and Stockton CA, where inappropriate mortgage contracts and ensuing payment delinquencies and foreclosures were concentrated (see Figure 3).

Figure 3: Distribution of seriously delinquent mortgages in Oakland and Stockton CA (Reid, 2010).

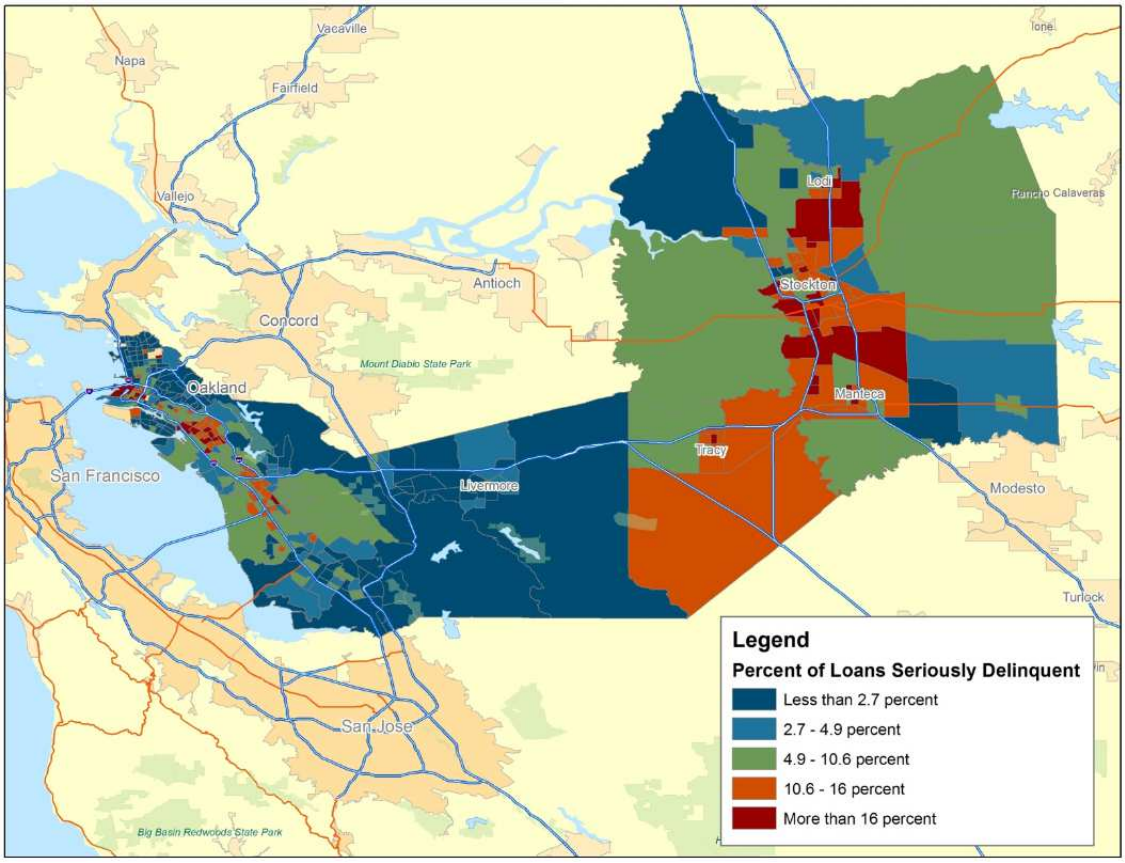
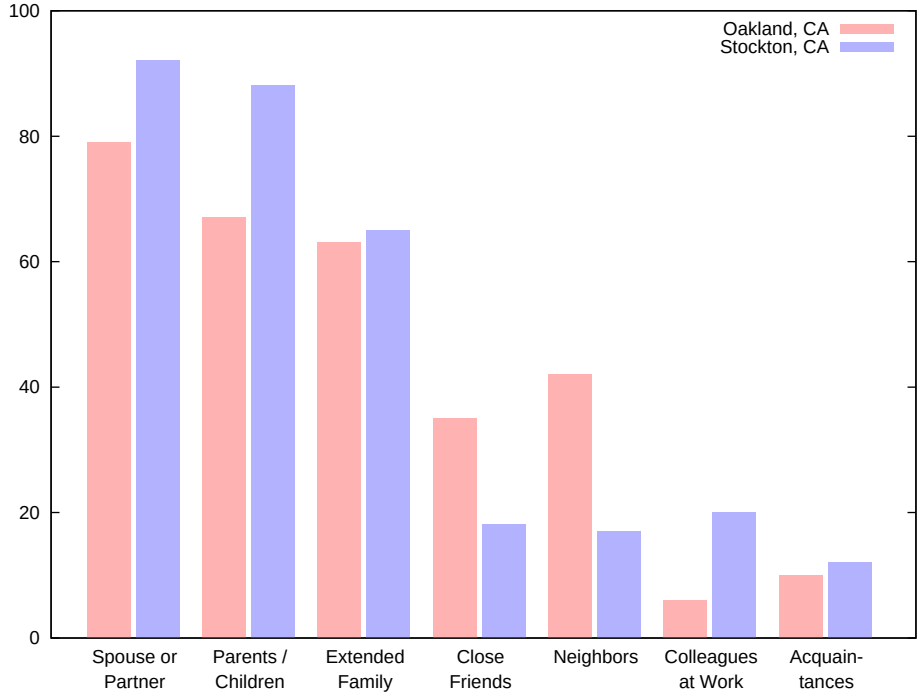


Figure 4 presents a breakdown of responses to Reid's question, 'Who did you talk to for advice about obtaining a mortgage?' Family members dominate, followed by close friends and neighbors. But with regard to specific contractual terms, "Almost nobody said that they discussed specific mortgage terms with anyone other than those who were going to be co-signers on the documents or responsible for part of the mortgage payments. Even so, many respondents acknowledged that they didn't get very useful advice from their family" (Reid, 2010, p. 9).

Figure 4: Sources of information about the mortgage process (Reid, 2010).



3.4.2 Community as a social network

A financial decision maker situated within a community obtains information via her communicational network links with other members of the community. Setting social conformity pressures aside for the time being, the network structure of communication and the resulting information flows are the basis for the decision maker's score value θ. Let the community consist of a set of individuals $\mathcal{N} = \{n_1, n_2, ..., n_N\}$ with cardinality $|\mathcal{N}| = N$. The network structure of within-community communication may be represented as the undirected graph $(\mathcal{N}, \mathcal{E})$ where $\mathcal{E}$ is a set of pairs called edges $(n_i, n_j) \in \mathcal{E}$; $i, j \in (1, 2, ..., N)$, $i \neq j$.

Consistent with experience in sub-prime mortgage sales in low-income communities, where mortgage brokers were members of the community both by neighborhood and ethnic affiliation, and consistent with the experience of Bernard Madoff's sales agents recruiting victims in synagogues and country clubs, there is a salesman n_s of financial products, who is a member of the community $\exists\, s \in \{1, 2, ..., N\} : n_s \in \mathcal{N}$ and who is part of the network structure of within-community communication $\exists\, (n_s, n_j) : (n_s, n_j) \in \mathcal{E};\ s, j \in (1, 2, ..., N),\ s \neq j$. The academic literature on the diffusion of products and innovations has found that a salesman's community-membership credentials – e.g. homophily with clients, extent of contact with clients, empathy

with clients, credibility with clients – are positively associated with sales success (Rogers, 1995). Hence it is not mere coincidence that Madoff's sales agents and private-label-securitization mortgage brokers were fully-fledged members of the communities that they canvassed for customers.

To abstract from network structure issues for present purposes, let us assume that the graph is complete, and that there are currently $B_t = |\mathcal{B}_t|$, $\mathcal{B}_t \subset \mathcal{N}$, other community members who have bought the financial product. An arbitrary community member $n_k \in \mathcal{N}$, $k \neq s$, $n_k \notin \mathcal{B}_t$, receives information – pre-crash – from B_t buyers, from ν_t people who received a pitch from the salesman ($B_t \leq \nu_t$), from the salesman n_s concerning the financial product, as well as indirect repetitions.

3.4.3 Effect via prior

The ratio $\wp_{\nu t} = \dfrac{B_t}{\nu_t}$ captures n_k's prior probability that the financial product is appropriate ($\neg I$). n_k's prior odds, as appear in the slope of the iso-$V^-(C)$ contours expression (3.13), are therefore

$$\frac{P(\neg I)}{P(I)} \;=\; \frac{B_t}{\nu_t - B_t} \quad . \tag{3.18}$$

Note that $\nu_t - B_t$ in the denominator is the number of individuals who rejected the salesman's pitch, i.e. those who were offered the financial product but refused to buy it.

This $\nu_t - B_t$ term is small both within Madoff's victim communities as well as within the low-income communities targeted by mortgage brokers working for private-label-securitization pipelines. Evidence that $\nu_t - B_t$ was considerably smaller than it objectively could have been in low-income communities may be seen in the proportion of mistaken sub-prime borrowers, i.e. borrowers with a prime credit score who nevertheless received a subprime mortgage. For instance Reid and Laderman (2011) show that the percentage of African Americans borrowing via an independent mortgage company (Jan 2004 – Dec 2006) with a prime credit score (FICO score > 640) but nevertheless receiving a subprime loan was 11.5% in California, 13% in Ohio and 13% in Pennsylvania. Thus the denominator term $\nu_t - B_t$ is smaller than it could be if those African Americans who should have rejected subprime loans would have actually done so. Although a small number of community members remained outside Madoff's investment vehicle by choice, they were numerically overwhelmed by those vying for the opportunity to be included among Madoff's clients. Madoff managed his client list to enhance and maintain the perception of exclusivity, such that investing with Madoff was seen as a status symbol above and beyond

its promised monetary return (Kirtzman, 2009).

Without invoking behavioral effects at all, the fact that an individual community member n_k may form her prior odds by learning what other community members before her have done exerts a large influence on the location of the optimal cutoff threshold θ_k^*. A small number of rejected offers $\nu_t - B_t$ entails large prior odds (3.18), which increases the slope of the iso-$E(C)$ contours (3.5) (or equally the iso-$V^-(C)$ contours (3.13) in the behavioral case), reducing the magnitude of $(1-\beta_k^*, \alpha_k^*)$ and thereby increasing θ_k^*. In the extreme, the prior odds (3.18) may dominate within (3.13), leading to the boundary solution $(1-\beta_k^*, \alpha_k^*) = (0,0)$ where $\theta_k^* \to \infty$, i.e. an infinitely conservative classifier that always retains the null hypothesis $H_0 : \neg I$.

3.4.4 Effect via scoring

Sample-size illusion Messages flowing within the community network are correlated a priori. Generic reasons include homophily[6] and propinquity.[7] Recent evidence shows that social influences are so pervasive, even in experimental settings, so as to undermine the 'wisdom of the crowd' effect (Lorenz et al., 2011). And because of the network structure's assortativity (greater within-community connectivity than with extra-community networks) most of the information available with which to illuminate a current decision has already been recycled many times and is likely to have influenced the existing set of $\mathcal{B}_t$ community members already – hence learning $\mathcal{B}_t$ does not add much independent information above what is already in circulation. Robert Shiller's more recent work emphasizes these 'echo chamber' effects (Akerlof and Shiller, 2009).

The arbitrary individual n_k's score is thus a function of the community network structure $(\mathcal{N}, \mathcal{E})$, the proportion of buyers among those approached by the salesman $\wp_{\nu t} = \frac{B_t}{\nu_t}$, the variance of the proportion $\wp_{\nu t}$ without adjusting the sample size ν_t to account for correlation among the B_t buyers ($s^2_{\wp_{\nu t}}$), and the proportion $\wp_{Nt} = \frac{B_t}{N}$ of B_t buyers among the N nodes comprising the community

$$\theta_k = \Gamma((\mathcal{N}, \mathcal{E}), \wp_{\nu t}, s^2_{\wp_{\nu t}}, \wp_{Nt}, s^2_{\wp_{Nt}}, ...) \ . \tag{3.19}$$

Early in the diffusion process, when $\frac{B_t}{N}$ is small, the proportion $\wp_{\nu t}$ is informative from n_k's standpoint. Formulae for computing *effective sample size* are well known.[8] However the variance

[6] Informally, 'Birds of a feather flock together.'

[7] Informally, 'Birds who just happen to be near to each other grow similar feathers.'

[8] The effective sample size is the number of observations obtained by simple random sampling that has the same sampling error as the (correlated) sample in question. $N_{\text{eff}} = \frac{N}{s^2/s^2_{srs}}$, where, for *simple random sampling*

of $\wp_{\nu t}$ will be under-estimated to the extent that n_k fails to recognize that the effective sample size $\nu_e < \nu$ which accounts for the within-community correlation requires attaching a larger variance to the proportion $\wp_{\nu_e t}$, that is $s^2_{\wp_{\nu_e t}} > s^2_{\wp_{\nu t}}$. We refer to this specific variant of over-inference from small samples as sample-size illusion. Hence, the behavioral influence of a larger $\wp_{\nu t}$ upon θ_k will be greater than justified by the statistically correct variance, $s^2_{\wp_{\nu_e t}}$,

$$\Gamma(..., \wp_{\nu t}, s^2_{\wp_{\nu_e t}}, ...) \; > \; \Gamma(..., \wp_{\nu t}, s^2_{\wp_{\nu t}}, ...) \;\; , \tag{3.20}$$

meaning that θ_k will be biased *downward*, over-emphasizing the information content of observing a large $\wp_{\nu t}$. Later in the diffusion process $\wp_{Nt} = \frac{B_t}{N}$ becomes larger, and correspondingly the behavioral decision maker who does not explicitly account for the within-community correlation has a down-ward biased score

$$\Gamma(..., \wp_{Nt}, s^2_{\wp_{N_e t}}, ...) \; > \; \Gamma(..., \wp_{Nt}, s^2_{\wp_{Nt}}, ...) \;\; . \tag{3.21}$$

Here the assumption that the social network is complete – i.e. that all nodes within $\mathcal{N}$ are connected – means that each n_k's immediate social network is precisely the whole community. In the absence of this assumption, (3.19) could be modified by e.g. weighting each buyer by her social distance from n_k. Although network topology can have a great influence on the flow of information, we defer investigation of the effects of network topology to future work. We therefore proceed with (3.19) under the simplifying assumption that the network is complete. Notice that other behavioral effects, such as the 'rule of three' or 'ratio bias', can in principle also be incorporated into and studied within the context of the scoring function $\Gamma(\cdot)$. We leave these elaborations for future investigations.

Persuasion bias Psychological evidence suggests that mere repetition of a message increases listeners' belief in the validity of the message's content. Several pathways have been identified: via increased familiarity, via increased salience, and via increased availability in memory. (Fiske and Taylor, 1984; Hawkins and Hoch, 1992; Nisbett and Ross, 1980; Tversky and Kahneman, 1973; Zallner, 1992.)

$s^2_{srs} = p(1-p)/N$, it follows from $\frac{s^2}{s^2_{srs}} > 1$ when the prerequisites for simple random sampling are not met that $N_{\text{eff}} < N$.

DeMarzo, Vayanos and Zwiebel (2003) study behavior within communication networks, and discover a phenomenon they call *persuasion bias*: "the failure to adjust properly for information repetitions... ...can be viewed as a simple, boundedly rational heuristic for dealing with a very complicated [if not intractable] inference problem" (DeMarzo, Vayanos and Zwiebel, 2003, pp. 910–911). Therefore it is not only the number of pre-crisis 'happy customers' B, but the number of times the decision maker n_k receives a message about one of these B showcase examples, that feeds into the score θ_k, which is biased downward by failure to adjust for repeated messages. To incorporate network messaging activity, we augment the specification of network edges with a time period and a record of the time stamps during which the edge is active within the monitoring period. The set of all edge activations is specified as $\mathcal{E}_{(t_0,T)}$, where t_0 is the time at which monitoring is commenced and T is the time at which monitoring is stopped (T may be the current time, t). Then the elements of this set are specified as triples $(n_i, n_j, \tau) \in \mathcal{E}_{(t_0,t)}, \tau \in (t_0, t), i, j \in (1, 2, ..., N), i \neq j$, where τ is the timestamp $\tau \in (t_0, t)$ at which edge (n_i, n_j) is activated. The scoring function of n_k may therefore be re-written in the following form

$$\theta_k = \Gamma((\mathcal{N}, \mathcal{E}_{(t_0,t)}), \wp_{\nu t}, s^2_{\wp_{\nu t}}, \wp_{Nt}, s^2_{\wp_{Nt}}, ...) \ . \tag{3.22}$$

Consistent with persuasion bias, the number of messages reaching n_k inclusive of repetitions $|(\cdot, n_k, \cdot) \cap \mathcal{E}_{(t_0,t)}|$ enter the scoring function (3.22) without adjustment. Let $m_k \in \mathbb{N}_0$ be the number of $\mathcal{B}_t$-themed edge activations (messages) sent to n_k within the time interval (t_0, t), that is $m_k = |(\cdot, n_k, \cdot) \cap \mathcal{E}_{(t_0,t)}|$. Thus the effect of persuasion bias on n_k's score may be formalized as

$$\frac{\partial \theta_k}{\partial m_k} \ < \ 0 \ . \tag{3.23}$$

Using a scoring function of the form (3.22), the decision maker is ceteris paribus less likely to generate a score exceeding the threshold θ^* and thus is less likely to reject the offered financial contract as being inappropriate.

3.5 Visceral emotions

Immediate emotions – as opposed to anticipated emotions – have only very recently begun to be studied and incorporated into mainstream economics and finance research.[9] Given the dominant

[9] Jeremy Bentham's (1789) original conception of utility as the net sum of positive over negative emotions was not incorporated into the neoclassical formalization of microecomic theory.

role of rationality in the theory that defines these areas, emotions are typically grouped with factors that may induce departures from rational and efficient outcomes. It is worth noting however, that emotions have emerged as adaptive (fitness-maximizing) responses to the environment in which human evolution has taken place. In such a broader view, emotions are a "biologically vital source of information processing," which "although *not* perfect cognitive systems," they nevertheless embody "appraisal systems that are pervasive to all levels of the brain to facilitate function, adaptation, and survival" (Schulkin et al., 2003, p. 15).[10] This perspective is currently not prevalent within economics and finance research, although in 1988 the path-breaking Cornell economist Robert Frank made a case for the instrumental value of emotions as commitment devices in strategic situations (Frank, 1988).[11] Ten years later, Jon Elster observed that the domain of 'economics and psychology' still contained virtually no references to the emotions (Elster, 1998).

At moderate intensity levels, visceral emotions function in their evolutionarily adaptive modes serving in a range of important interrupting, prioritizing and energizing functions that regulate and direct behavior. At higher intensity levels however, visceral emotions lead to suboptimal if not dysfunctional behavior – and may do so without conscious cognitive mediation. What this means is that when a decision maker's attention across the goods-and-services space collapses down upon a single financial contract to the exclusion of all possible alternatives, this is not the result of a conscious information selection-and-processing procedure. Instead, it is the direct result of the visceral emotion.

Conditions for triggering visceral emotions arise naturally in within-community communication. Learning which neighbors have just purchased a house, or have just undertaken big-ticket purchases or major home improvement naturally prompts invidious comparisons and the question, 'Could we do the same?' Urban rumours – 'stories' in the terminology of Akerlof and Shiller (2009) – tell of the capital gains made by buyers, or of units being 'snapped up' in new developments. Envy – and perhaps greed – are triggered, even if they are not easily observable. And then it becomes apparent that those purchases and life-style-changing contracts were possible because of very specific circumstances: the presence of a fellow community member who

[10] "Many demonstrations of emotional influences on perception *can* be attributed to effects on attentional allocation. ...Also consistent with the notion that emotional stimuli grab attentional resources that support perceptual awareness, the presence of emotional stimuli can actually impair perception of neighboring information... ." (Most, 2009, p. 392.)

[11] Hirshleifer (1987) follows similar lines.

can arrange access, but that this access is not generally available, and the window for gaining access may be closing soon. This configuration in turn triggers anxiety about the prospect of losing the opportunity to improve the household's quality of life, and of being left behind those local-community comparators who did make the leap.

Madoff and his sales agents made a point of not accepting every potential investor expressing interest – at least not at first. He would say the fund is closed and not accepting new investors, only to subsequently make a dramatic exception and to break his own rules as a favor to that individual. Investing with Bernie Madoff became a status symbol and a sought-after social prize (Arvedlund, 2009, p. 223; Kirtzman, 2009, p. 4; Frankel, 2012, p. 19; Lewis, 2012, p. 297). This put Madoff and his sales agents in a strong position when the offer of participation was eventually extended, and the fear of being expelled from among the 'select few' proved to be a strong disciplining device against investor-victims discussing Madoff's investment strategy or other particulars with others (Frankel, 2012, p. 18). In Madoff's own words to a potential investor, "If you invest with me, you must never tell anyone that you're invested with me. It's no one's business what goes on here" (Arvedlund, 2001).

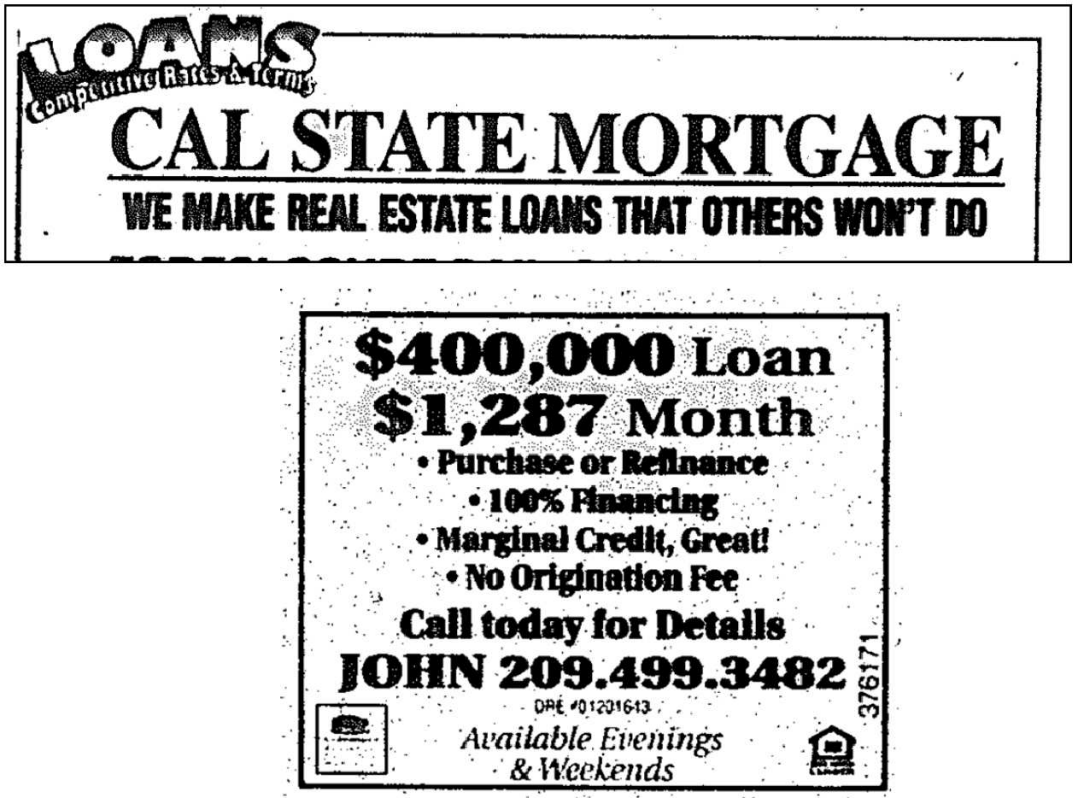
The skilled salesman (mortgage broker, sales agent) enters at this point, and in turn contrives the conditions for triggering further visceral emotions. Some of the 'levers' of peripheral-route persuasion are already in place. The mortgage broker (equally, sales agent) is a community member by neighborhood affiliation and by cultural/ethnic affiliation – thought to be 'one of us' by his clients – hence activating the 'similarity and identification' lever of peripheral-route persuasion.[12] Social proof (pre-crash) is directly available among the B existing customers already present in the community. Reciprocation is present in the implicit trade between broker/agent and customer: the broker will act on behalf of the customer, smoothing out any problems of access, in return for an arrangement fee. And finally, the urgency to act quickly ensures that the client will have to commit – one way or the other – while still in a viscerally 'hot' state. (Petty and Cacioppo, 1986; Cialdini, 2007; Langenderfer and Shimp, 2001; Easley, 1994.)

3.5.1 Severe disruption

The narrowing of attention and short-circuiting of conscious reasoning as a result of high-intensity visceral emotion is naturally interpreted as the interruption of information assimilation

[12]Hence the importance of explicitly defining the salesman as a member of the community network $n_s \in \mathcal{N}$.

Figure 5: Mortgage brokers' adverts from the Oakland Record and the Stockton Record (Reid, 2010).



and processing. The discriminability parameter d', being a measure of the effectiveness of information processing via the relationship $\text{AUC} = \Phi\left(\frac{d'}{\sqrt{2}}\right)$, is compromised under the effect of high-intensity visceral emotion. The extent to which d' is compromised depends on the severity of disruption to information assimilation and processing. In the case of Bernard Madoff's ponzi scheme, there was very little information to be processed in the first place, as potential new investors were kept in the dark as to how Madoff used investor funds (for ex post obvious reasons). In the case of the low-income, marginal credit-score borrowers interviewed by Reid (2010), very few even read the disclosure and mortgage documents before signing. The following quotation is representative:

> *I didn't read them carefully. I just pretended to look over them and then asked for the pen.*
> Interviewer: *Why didn't you feel like you need to read the documents?*
> *They were going to give me the keys. I wasn't going to raise any kind of concern at that point.* (Reid, 2010, p. 14)

Mortgage banker Steve Sanders echoes these private observations on a wider scale:

> *After witnessing literally thousands of signings, I will tell you that most people are so*

focused on getting into their new home that they have no idea what it was they just signed. (Statman, 2009, p. 22)

In the absence of search and information acquisition to inform a scoring procedure, the discriminability parameter collapses to zero ($d' \to 0$) and the Area Under the Curve collapses to one-half (AUC $\to \frac{1}{2}$). For all objective functions – classical and behavioral – characterized by contours having slope greater than unity $\left(\frac{\text{dTPL}}{\text{dFPL}}\right) > 1$, there is no interior point of tangency between a contour and the ROC curve. Instead, the objective-function-maximizing, ROC-constraint-satisfying contour is the one that intersects precisely with the origin of the ROC space. In this boundary solution, the optimal cutoff threshold is infinite $\theta^* = \infty$, yielding maximally conservative classifications: there is not even an ϵ-chance that the nature of the contractual terms will lead the decision maker to reject the contract as inappropriate.

3.5.2 Intermediate disruption

Whereas severe disruption is both striking and well documented among marginal credit-score borrowers (Reid 2010; Statman 2009) and Madoff victims (Arvedlund 2009; Kirtzman 2009), the possibility of less-than comprehensively compromized information assimilation and processing has received less attention. We develop the modeling apparatus to capture intermediate levels of disruption, which in the limit converges to the severe disruption case.

Community member n_k's discriminability parameter $d'_{kt} \in \mathbb{R}_+$ is a function of her information-processing capital $K_{kt} \in \mathbb{R}_+$, representing knowledge and experience, and her effort $e_{kt} \in \mathbb{R}_+$. This function $d : \mathbb{R}_+ \times \mathbb{R}_+ \to \mathbb{R}_+$ is assumed to be continuous and twice differentiable in each of its arguments, with the usual partial-derivative restrictions characteristic of production functions.

$$d'_{kt} \;=\; d(K_{kt}, e_{kt}) \;, \qquad \frac{\partial d}{\partial K}, \frac{\partial d}{\partial e} \geq 0 \;, \qquad \frac{\partial^2 d}{\partial K^2}, \frac{\partial^2 d}{\partial e^2} \leq 0 \;\; . \tag{3.24}$$

In the absence of visceral factors, the level of effort exerted reflects n_k's perception of her opportunity costs and the trade-offs she perceives between this use of effort and all other possible applications of her effort.[13] Call this level of effort e^0_{kt}.

Under the influence of visceral factors, n_k shifts from 'cold state' decision making to 'hot state' decision making. The terms 'cold' and 'hot' are labels attached to relative degrees of

[13]Different approaches to fully endogenizing e^0_{kt} are possible, ranging from the household production model (Becker, 1965) to satisficing (Simon, 1955; Radner, 1975). However, as our primary interest here is to capture the marginal effects of visceral factors, we leave full endogenization of e^0_{kt} to future work.

intensity. We denote the intensity of the effect of visceral factors with the variable $\psi_{kt} \in \mathbb{R}_+$. This intensity affects the effort expended via the differentiable function $e : \mathbb{R}_+ \to \mathbb{R}_+$, which has the following notation and properties.

$$e_{kt} = e(\psi_{kt}) \tag{3.25}$$

$$e(0) = e^0_{kt} \ , \qquad e(\psi_{kt}) = 0 \ \ \forall \, \psi'_k \ \leq \ \psi_{kt} \ , \qquad \frac{\mathrm{d}e}{\mathrm{d}\psi} \leq 0 \ \ \forall \, \psi \in (0, \psi'_k) \tag{3.26}$$

Effort is unaffected in the absence of visceral factors $e(0) = e^0_{kt}$. At an individual-specific threshold $\psi'_k \in \mathbb{R}_{++}$, information acquisition and processing effort ceases entirely, leading to the severe disruption case of Section 3.5.1. In-between, effort decreases monotonically.

Finally, the intensity of the viscerally charged hot state ψ_{kt} is a function of *passively* and *actively* triggered visceral factors. Although empirically one expects there to be triggered visceral-factor intensity differences between different message forms and types, here this heterogeneity is suppressed: intensity will be formulated as a function of the unweighted sum of the visceral-factor triggers.[14] However, the distinction between actively and passively triggered visceral factors is maintained, and this allows a clear representation of the structural features that cause a salesman who is a full-fledged member of the community to be, ceteris paribus, more effective than an outsider salesman.

A subset of $\mathcal{B}_t$-themed messages sent by $n_i \in \mathcal{N}$ $(i \neq k, s)$ to n_k trigger visceral factors passively, in the sense that these messages are not constructed intentionally by the senders to trigger visceral factors. Abstracting from interpersonal heterogeneity, denote the finite set of visceral-factor triggers as $\mathcal{Z}$ and its cardinality as $|\mathcal{Z}| = Z$. Let the message-specific indicator vector $\boldsymbol{z}' = (z_1, z_2, ..., z_Z)$ contains a 0 for each visceral-factor trigger absent and a 1 for each visceral-factor present in the message. Then the vector product $\boldsymbol{z}'\mathbf{1}$ is the number of different visceral factors triggered by the message. We augment the previously developed concept of an edge activation (i.e. directed message from n_i to n_j at time τ) written as $(n_i, n_j, \tau) \in \mathcal{E}_{t_0,t}$, $\tau \leq t$, $i \neq j$, to incorporate visceral-trigger-content coding as follows.

$$(n_i, n_j, \tau, \boldsymbol{z}) \in \mathcal{E}^{\boldsymbol{z}}_{(t_0,t)} \qquad \tau \leq t, i \neq j \ \ . \tag{3.27}$$

[14] It is straightforward, if notationally more complicated, to introduce differential weighting of visceral-factor triggers. Here we do not undertake this extension because it does not add substantively to the primary question under investigation.

Denoting the Z-vector of zeros, corresponding to a message with no visceral triggers at all, as z^0, then the subset of passive visceral-factor trigger messages up to time t is

$$\mathcal{E}^{\boldsymbol{z}\mathrm{p}}_{(t_0,t)} = \mathcal{E}^{\boldsymbol{z}}_{(t_0,t)} \setminus \{(n_s, n_k, \cdot, \cdot) \cup (\cdot, \cdot, \cdot, z^0)\} \ . \tag{3.28}$$

Here the superscript 'p' indicates that this is the set of *passive* visceral-factor trigger messages. Notice that (3.28) only excludes the salesman n_s's direct communication with n_k. All of the salesman's communication with the rest of the community network remains. Since positive messaging by the salesman boosts the positive messaging undertaken in turn by the receivers, passive positive messaging is boosted relative to the counterfactual case of the salesman being an outsider. This is the first pathway by which the salesman's community membership confers a ceteris paribus advantage over outsider status. Bringing the above elements together, the total number of passive visceral-factor triggers up to time t may be written as

$$m^{\boldsymbol{z}\mathrm{p}}_{kt} = \sum_{q \in \mathcal{E}^{\boldsymbol{z}\mathrm{p}}_{(t_0,t)}} \boldsymbol{z}'_q \mathbf{1} \ . \tag{3.29}$$

Similarly to the above development of passive visceral-factor triggers, a subset of $\mathcal{B}_t$-themed messages sent by n_s to n_k trigger visceral factors actively, in the sense that these messages are intentionally constructed by the salesman to trigger visceral factors. The subset of active visceral-factor trigger messages up to time t is

$$\mathcal{E}^{\boldsymbol{z}\mathrm{a}}_{(t_0,t)} = \{\mathcal{E}^{\boldsymbol{z}}_{(t_0,t)} \cap (n_s, n_k, \cdot, \cdot)\} \setminus (\cdot, \cdot, \cdot, z^0) \ . \tag{3.30}$$

The salesman deploys human capital $K_{st} \in \mathbb{R}_+$ and effort $e_{st} \in \mathbb{R}_+$ in tailoring the number, timing and content of his messages in order to increase the intensity of the visceral factors triggered. Thus the salesman will optimize effort e^*_{st} and message content $\boldsymbol{z}^*_q$ to maximize after-tax income conditional upon his contractual mix of salary, fee and commission income. We denote by $m^{\mathrm{a}} : \mathbb{R}_+ \times \mathbb{R}_+ \to \mathbb{R}_+$ the function, twice differentiable in its real-valued variables, that transforms the raw active visceral-factor trigger count $\sum_{q \in \mathcal{E}^{\boldsymbol{z}\mathrm{a}}_{(t_0,t)}} \boldsymbol{z}^{*\prime}_q \mathbf{1} \in \mathbb{N}_0$ into the passive-equivalent metric in a way that reflects the intensity-enhancing effect of the salesman's

application of human capital K_{st} and effort e^*_{st}.

$$m^{\boldsymbol{z}\mathrm{a}}_{kt} = m^{\mathrm{a}}\Big(K_{st}, e^*_{st}\Big) \cdot \sum_{q \in \mathcal{E}^{\boldsymbol{z}\mathrm{a}}_{(t_0,t)}} \boldsymbol{z}^{*\prime}_q \mathbf{1} \ . \tag{3.31}$$

The function m^{a} has all of the usual properties of a production function in its real-valued factors $\frac{\partial m^{\mathrm{a}}}{\partial K}, \frac{\partial m^{\mathrm{a}}}{\partial e} \geq 0$, $\frac{\partial^2 m^{\mathrm{a}}}{\partial K^2}, \frac{\partial^2 m^{\mathrm{a}}}{\partial e^2} \leq 0$, and $m^{\mathrm{a}}(\cdot, 0) = 1$ meaning that in the absence of salesman effort active message triggers are equally effective as passive message triggers. Now the total index of visceral-factor triggers $m^{\boldsymbol{z}}_{kt} \in \mathbb{R}_+$ up to time t is simply the sum of the passive and active components

$$m^{\boldsymbol{z}}_{kt} = m^{\boldsymbol{z}\mathrm{p}}_{kt} + m^{\boldsymbol{z}\mathrm{a}}_{kt} \ , \tag{3.32}$$

which allows the intensity of the effect of visceral factors $\psi : \mathbb{R}_+ \to \mathbb{R}_+$ to be written in the simple form

$$\psi_{kt} = \psi(m^{\boldsymbol{z}}_{kt}) \ , \qquad \frac{\mathrm{d}\psi}{\mathrm{d}m^{\boldsymbol{z}}_{kt}} \geq 0, \ \frac{\mathrm{d}^2\psi}{\mathrm{d}{m^{\boldsymbol{z}}_{kt}}^2} \leq 0 \ . \tag{3.33}$$

Note that due to m^{a} in (3.31),

$$\frac{\triangle \psi_{kt}}{\triangle \sum_{q \in \mathcal{E}^{\boldsymbol{z}\mathrm{a}}_{(t_0,t)}} \boldsymbol{z}^{\prime}_q \mathbf{1}} \ > \ \frac{\triangle \psi_{kt}}{\triangle \sum_{q \in \mathcal{E}^{\boldsymbol{z}\mathrm{p}}_{(t_0,t)}} \boldsymbol{z}^{\prime}_q \mathbf{1}} \ , \tag{3.34}$$

which is the second pathway by which the salesman's community membership confers a ceteris paribus advantage over outsider status.

Substituting (3.33) into (3.25), which in turn may be substituted into (3.24), yields

$$d^{\prime}_{kt} \ = \ d(K_{kt}, e(\psi(m^{\boldsymbol{z}}_{kt}))) \ . \tag{3.35}$$

Within the interior $\forall\, \psi_{kt} \in (0, \psi^{\prime}_k)$ discriminability is non-increasing with

(a) the intensity of visceral factors $\frac{\partial d}{\partial \psi} \leq 0$;

(b) the index of visceral-factor triggers $\frac{\partial d}{\partial m^{\boldsymbol{z}}_{kt}} \leq 0$;

(c) salesman effort $\frac{\partial d}{\partial e_{st}} \leq 0$; and

(d) salesman human capital $\frac{\partial d}{\partial K_{st}} \leq 0$.

Whereas severe disruption of information acquisition and processing results in systematic

non-rejection of the offered financial contract, intermediate disruption amplifies the impact of factors that increase the slope of the objective function's contours in ROC space. Decreases in d'_{kt} diminish the AUC and the curvature of the ROC curve. Consequently for any given increase in the slope of the objective function's contours, the associated change in the optimal false positive likelihood $\triangle \alpha^*$, and thus the change in the optimal cutoff threshold $\triangle \theta^*$, will be greater under the smaller, partially compromised d'_{kt}, relative to the uncompromised reference point. This follows directly from the sign of the cross-partial derivative of the optimal cutoff threshold expressions (3.7) and (3.15). For present purposes, let x denote the slope of the objective function's (linear) contours, and note that $\mu_I = d'$ when $\mu_{\neg I} = 0$ and $\sigma = 1$. Under both classical SDT and PT-SDT,

$$\frac{\partial^2 \theta^*}{\partial x \partial d'} = \frac{-1}{(d')^2 x} < 0 \ , \tag{3.36}$$

from which it follows that decreases in d' serve to increase the magnitude of the right-ward shift of the optimal operating point θ^* in response to any given increase in the slope of the objective function's contours.

What factors increase the slope of the objective function's contours? First, PT-SDT behavioral decision makers have steeper objective-function contours than classical risk-neutral SDT decision makers (3.14). Second, decision makers with larger prior odds $\frac{B_t}{\nu_t - B_t}$ have steeper objective-function contours (see Section 3.4.3). Within a connected, actively communicating community, n_k learns B_t and $\nu_t - B_t$ without separate expenditure of effort. Crucially, if the salesman is himself a member of the community, he has sufficiently detailed information on his potential clients so as to avoid making pitches that have a low likelihood of being accepted. This may be contrasted with the outsider salesman who will have less information at his disposal to avoid such low-success-probability pitches. Hence the community-member salesman has a smaller $\nu_t - B_t$ and a consequently larger $\frac{B_t}{\nu_t - B_t}$ than the outsider salesman.[15] In summary, intermediate disruption of discriminability by visceral factors amplifies the conservative shift associated with (i) PT-SDT behavioral decision makers, and (ii) community embeddedness of the salesman n_s.

[15] This is the third pathway by which the salesman's community membership confers a ceteris paribus advantage over outsider status.

4 Discussion

4.1 Borrowing constraints vs. myopia

The wider significance of the present model includes implications for distinguishing between the borrowing constraints and behavioral biases accounts of US household-borrowing growth 2001–2006. We have shown that visceral emotions, within-community communication, and PT-SDT decision making prove sufficient to generate ill-judged risk accretion via borrowing growth. Here we follow Shiller (2000) in emphasizing word-of-mouth communication, but investigate its effects without invoking the existence of a price-bubble. Hence the present model is not inconsistent with the growth of mortgage credit in supply-unconstrained cities, which averted price-bubble dynamics (see Figure 6). Actions undertaken under the influence of visceral emotions may play out in the volume domain, not only the price domain. Insofar as visceral emotions fall under the rubric of animal spirits,[16] the present results suggest a tempering of Mian and Sufi's (2014) rejection of animal spirits as a driver of household-borrowing growth.

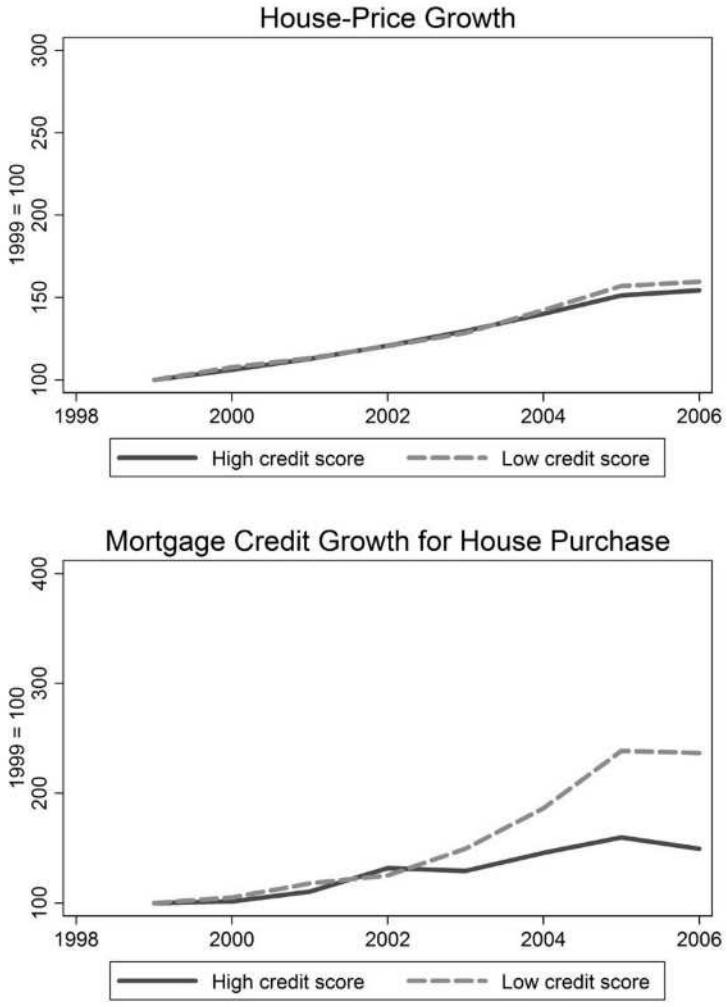
Whereas some elements of the present model are state-independent traits (PT risk preferences, persuasion bias, sample-size illusion), others are external state variables ($B_t,\ \nu_t$), while some are internal state variables ($m^{\tilde{\boldsymbol{z}}}_{kt},\ \psi_{kt},\ d'_{kt}$). It is these internal state variables – which are linked to network structure, within-community messaging activity, salesman insider status, and intensity of visceral factors – that differentiate the present model from fixed-trait myopia.

Thus we may identify three candidate explanations for US household borrowing growth 2001–2006: (i) borrowing constraints combined with a failure of rational expectations,[17] (ii) fixed-trait behavioral biases, in particular myopia formulated as hyperbolic discounting, and (iii) internal state variables that come under the influence of within-community communication and visceral factors. The first two explanations are indeed difficult to distinguish with observational data. However, these explanations shed little light on why borrowing growth was concentrated within low-income, low-credit-score neighborhoods. The last explanation – as developed in this paper – incorporates variables with which to reflect differences between neighborhood communities, which in turn impact upon prospective borrowers' internal state variables. In this sense we argue that the crucial question is not solely the fact of borrowing growth, but also differences in its magnitude across communities (see Figure 6).

[16] "individual feelings, impressions and passions" (Akerlof and Shiller, 2009, p. 1)

[17] i.e. either a systematic mistaken belief that earnings will subsequently materialize to cover loan principal plus interest, or that real-estate prices will continue to grow indefinitely

Figure 6: Debt and house prices in supply-unconstrained cities (Mian and Sufi, 2014, Fig. 6.2).



4.2 Regulation

4.2.1 Cooling-off periods

A key stipulation of the EU Mortgage Credit Directive 2014/17/EU, to be implemented in Member States' national laws by March 2016, is the introduction of a 'reflection period' of at least seven days, either before the conclusion of the mortgage credit agreement, or as a period after the conclusion of the mortgage credit agreement during which the consumer may exercise the right of withdrawal. Individual Member States will be able to stipulate a minimum reflection period, not exceeding ten days, during which consumers will not be permitted to accept the mortgage lender's offer.

For many types of goods – experience goods in particular – the consumer learns a great deal

about the product during the initial weeks of ownership. For such goods, the first 7 to 14 days of ownership coincide with rapid accumulation of information about the product. Thus empowered by experience with the product, the consumer is better placed to exercise informed judgment than at the time of original purchase. For such products, there are good a priori reasons to expect a cooling-off period between 7 and 14 days to be sufficient from the consumer's standpoint.

The effectiveness of cooling-off periods for mortgage contracts depend partly on whether they take place before or after contract acceptance, and what learning takes place during the cooling-off period. Before contract acceptance, home buyers are fixated on concluding the purchase, and consequently avoid taking actions that may jeopardize achieving that objective. As we documented in Section 3.5.1, this can include explicit avoidance of reading and probing the often complex and lengthy mortgage contract itself. Furthermore, the mortgage approval process includes features – including a credit-rating penalty for multiple credit searches – that act as an explicit disincentive to seeking multiple mortgage quotations in parallel. So if the period of reflection is stipulated to take place before contract acceptance, it is not clear what would motivate or incentivize the purchaser to undertake search and information acquisition that would broaden her narrow focus on completing the purchase.

At the time of writing, it is still an open question whether a post-contract-acceptance period of reflection is compatible with e.g. English contract law. But setting aside contractual feasibility, there is a fundamental difference between mortgage contracts and most other goods. Having exchanged contracts and received door keys, the purchaser begins the process of moving and settling into the house. During this period, the mortgagee learns about the *house* through direct experience – not about the *mortgage contract* or whether there are more suitable contracts available in the market. Although the purpose of the cooling-off period is to allow a mortgagee to withdraw from an inappropriate, ill-judged mortgage, all of the mortgagee's learning during the post-contract-acceptance period concerns the property, not the contract or possible superior alternatives. During any reasonable post-contract-acceptance cooling-off period, the mortgagee will not have occasion to make even the first repayment instalment, or to experience the impact of changes in interest rates or real-estate prices. Hence there are ex ante grounds for expecting that a post-contract-acceptance period of reflection would not function as presumably intended, to allow the final decision to take place in an informed, viscerally uncharged state of mind. Indeed it is arguable that it may instead give rise to mortgagees withdrawing – perhaps even

with a view to renegotiating the original agreed sale price – as a result of discoveries concerning the condition of the property. As a means of mitigating the effects of asymmetric information between seller and buyer, a post-contract-acceptance period of reflection may have some merit. However, this would be an unintended consequence of the EU Directive.

For a cooling-off period to function in isolation, the present model suggests that it is necessary both for the attention-narrowing effect of a viscerally charged hot state to subside *and* for the mortgagee to acquire information about the mortgage contract, its long-term consequences, and how it compares to other mortgage contracts on the market. Field-experiment evidence suggests however, that both aspects are addressed if the borrower is exogenously endowed with relevant information.[18] The EU Mortgage Credit Directive's package of measures includes stipulations to harmonize pre-contract information provision across Member States with the European Standardized Information Sheet (ESIS). In the UK this will supersede the current Key Facts Illustration (KFI) form. Despite the attempt to introduce a 'risks-and-warnings' section into the ESIS, it is absent from the final version ultimately approved by the European Parliament. Although this appears to be a missed opportunity to press home the consequences of interest rate risk and of real estate price risk, the effectiveness of a risks-and-warnings section would ultimately depend on the rigor and degree of personalization of its preparation. Nevertheless it is undeniable that ESIS information serves well as a starting point for 'cold' contemplation. Whether mortgagees choose to inform their cooling-off-period final decision with ESIS remains an empirical question for the future.

Default effects – one of the principal 'nudge' instruments in choice architecture (Johnson et al., 2012) – appear to have been overlooked in the discussion surrounding cooling-off periods. Once a house buyer has secured a particular mortgage contract, several inter-related and mutually reinforcing effects raise the threshold to subsequently abandoning this mortgage contract: the endowment effect (Kahneman and Tversky, 2000), the asymmetry between errors of omission and errors of commission (Gilovich et al., 1995), and the status quo effect (Samuelson and Zeckhauser, 1988). From a purely conceptual standpoint therefore, in order for a cooling-off period to be effective, not only (i) must high-intensity visceral emotion subside, but also (ii) the mortgagee must obtain or receive new information about the mortgage contract, its suitability, or available substitutes, and (iii) the motivation to withdraw from the contract must overcome

[18] In the related context of payday borrowing, Bertrand and Morse (2011) show that "information that makes people think less narrowly (over time) about finance costs results in less borrowing."

the endowment effect, the aversion to errors of commission, and the status quo effect. To the author's best knowledge, these cooling-off period considerations regarding mortgages have not yet been been subjected to empirical investigation – e.g. by way of field experiments – and therefore remain as open policy-relevant research questions.

4.2.2 Suitability and exceptions

Suitability rules formalize the obligations and responsibilities owed by sellers of financial contracts and securities to their customers, in particular with regard to the customer-specific appropriateness of the recommended products. Whereas suitability rules "reflect the general duty to act fairly, honestly and professionally and in accordance with the best interests of the client," this nevertheless stops short of formal fiduciary duty (IOSCO, 2012). Suitability rules fall on a spectrum ranging from the no-paternalism extreme of *caveat emptor* to the full-paternalism extreme where sellers are obligated to recommend only financial products that are appropriate in light of information on customers' needs and financial situations, where it is the seller's duty to solicit and verify this information. Suitability rules in the limited-paternalism middle ground obligate the seller to recommend only financial products that are appropriate in light of information *voluntarily disclosed* by customers. (Shefrin and Statman, 1993)

United States In the US, some of the earliest evidence of a transition to more paternalistic forms of regulation may be found in the Securities Act of 1933, which requires a company offering or selling its securities to register the securities with the Securities Exchange Commission (SEC). Rule 501(a) of Regulation D under this act stipulates that 'Accredited Investors' are exempt from the above-mentioned registration requirement. This rule includes two categories of natural persons classed as Accredited Investors:

1. those with individual net worth, or joint net worth with the persons spouse, that exceeds $1 million at the time of the purchase, excluding the value of the primary residence of such person;

2. those with income exceeding $200,000 in each of the two most recent years or joint income with a spouse exceeding $300,000 for those years and a reasonable expectation of the same income level in the current year.

In a later release, the SEC explains the Accredited Investor exemption as being intended to "eliminat[e] the need for subjective judgments by the issuer about... ...suitability."[19] A recent Government Accounting Office (GAO) report elaborates further that the intended purpose is to "protect investors by allowing only those who can withstand financial losses [to gain] access to unregistered securities offerings" (GAO, 2013, p. 2). Thus, the Accredited Investor exemption currently gives no explicit, direct weight to financial sophistication or to the ability to regulate visceral emotions. In the wake of the Madoff Ponzi scheme – many victims of which satisfy the Accredited Investor criteria – calls to abolish the Accredited Investor exemption have increased in number and intensity (e.g. Shadab, 2008; Smith, 2010; Shane, 2011). Meeting the Accredited Investor wealth and income thresholds does not in itself offer assurance of financial knowledge and acuity, or of emotion-regulation ability to maintain cold reasoning in the presence of visceral-emotion triggers. Under the Dodd-Frank Wall Street Reform and Consumer Protection Act (2010), the SEC is raising the standard for Broker-Dealers from Suitability to Fiduciary Duty, and is reviewing the the extent to which Accredited Investor wealth and income criteria need to be (a) raised and (b) supplemented with other criteria. Other legislative initiatives have focussed on extending suitability rules to mortgage brokers, "so that lenders could be sued for providing unsuitable mortgages for borrowing homeowners" (Statman, 2009, p. 26).

In the US, the concept of 'abusive' or 'predatory' lending draws legal underpinnings from several federal acts and rules, including: (i) the Consumer Credit Protection Act of 1968, incorporating the Truth in Lending ACT (TILA); (ii) the Home Ownership and Equity Protection Act (HOEPA) of 1994, which amends TILA; (iii) the Real Estate Settlement Procedures Act (RESPA) of 2011; and (iv) the Consumer Financial Protection Bureau's (CFPB's) HOEPA Rule of 2013, which amends TILA's Regulation Z to implement Dodd-Frank's changes to TILA. The FDIC and related agencies[20] characterize predatory lending as involving one or more of "(1) Making unaffordable loans based on the assets of the borrower rather than on the borrower's ability to repay an obligation; (2) Inducing a borrower to refinance a loan repeatedly in order to charge high points and fees each time the loan is refinanced ("loan flipping"); or (3) Engaging in fraud or deception to conceal the true nature of the loan obligation, or ancillary products, from an unsuspecting or unsophisticated borrower" (FDIC, 2001). Implicit in these characterizations is the intent to monetize the client relationship without regard to what is suitable and

[19]SEC Release No. 33-6339 [46 FR 41791] (August 7, 1981), location 41793

[20]Office of the Comptroller of the Currency, the Board of Governors of the Federal Reserve System, and the Office of Thrift Supervision

appropriate for the client.

A direct assessment of the degree of paternalism involved in these rules would examine whether it is the client or the salesman who is responsible for revealing/eliciting the information needed to gauge product suitability. The above-quoted FDIC characterizations of predatory lending adduce other considerations beyond whether suitability information is revealed by the client or elicited by the seller. The latter two characterizations involve the intent, and its successful actualization, to extract detrimentally more revenue from a client than is possible while adhering to suitability as the ethical touch-stone for client interaction. In this sense the hurdle for demonstrating predatory lending is higher than for demonstrating a violation of the full-paternalism variant of suitability.

United Kingdom Under the EU Alternative Investment Fund Managers' Directive (AIFMD) and the Markets in Financial Instruments Directive (MiFID),[21] the UK approach as formalized in the Financial Conduct Authority's (FCA's) Code of Business Sourcebook (COBS)[22] is more differentiated than that of the US. It places restrictions on communication with and promotion of specific classes of products to particular categories of investors. Suitability of the client to the product must either be known in advance or be assessed as such before undertaking communication or promotion.

Communication and promotion to eligible counterparties (firms, organisations; COBS 3.6), elective eligible counterparties, per se professional clients (firms, organisations; COBS 3.5), and elective professional clients,[23] is not restricted. However among retail investors, defined as clients who are neither professional clients nor eligible counterparties, there is a real possibility

[21] Section 2, Article 19, paragraph 4 requires that, "When providing investment advice or portfolio management the investment firm shall obtain the necessary information regarding the client's or potential client's knowledge and experience in the investment field relevant to the specific type of product or service, his financial situation and his investment objectives so as to enable the firm to recommend to the client or potential client the investment services and financial instruments that are *suitable* for him" (MiFID 2004/39/EC). (Emphasis added.) Thus, the MiFID's wording is at the full-paternalism extreme of the spectrum of suitability rules.

[22] `http://fshandbook.info/FS/html/FCA/COBS`

[23] The client complies with (1) and (3), and where the client is a third-country business, (2) as well:
(1) the firm undertakes a 'qualitative test' of the client's expertise, experience and knowledge to obtain reasonable assurance that the client is capable of making his own investment decisions and understanding the risks involved in regard to the nature of the transactions/services envisaged;
(2) a 'quantitative test', where applicable, consisting of at least two of the following: (i) Has carried out transactions of significant size (at least €1,000) on securities markets at an average frequency of, at least, ten per quarter for the last four quarters, (ii) Has a security portfolio, consisting of cash deposits and financial instruments, in excess of €0.5 million, (iii) Works – or has worked for at least one year – in the financial sector in a professional position which requires knowledge of securities investment;
(3) formal written request to be treated as a professional client, followed by a clear written warning (by the firm) of the protections and investor-compensation rights forgone by doing so, and written acknowledgement and acceptance of the consequences of losing such protections (by the client).

of unsuitability. Retail investors are further subdivided into the mutually exclusive categories of (i) sophisticated investors (certified or self-certified) with extensive investment experience and knowledge of complex instruments (COBS[24] 4.12.7/8.), (ii) certified high net worth individuals (COBS 4.12.6),[25] and (iii) ordinary retail investors. As acknowledged in IOSCO (2012), ordinary retail investors "face difficulty understanding the terms and features of complex financial products [and hence] are at particular risk in relation to inappropriate promotion of non-mainstream pooled investments" (FCA, 2013, p. 5). Accordingly, the FCA's COBS places restrictions on the promotion of Non-Mainstream Pooled Investments (NMPIs) – a category that includes Unregulated Collective Investment Schemes (UCIS), certain Special-Purpose Vehicles (SPVs), Qualified Investor Schemes (QIS), and Traded Life Policy Investments (TLPIs) – to ordinary retail investors. (Self-)certified sophisticated investors – "who are better able to understand and evaluate the risks and potential rewards of unusual, complex and/or illiquid investments such as NMPIs" – are exempt from this communication and promotion restriction (FCA, 2013, p. 5). Similarly, certified high net worth individuals – who can in principle withstand a large nominal loss without becoming destitute in an absolute sense – are also exempt from this communication and promotion ban.

These European approach is therefore finer-grained than the US approach. Exemption from paternalistic retail-investor protection is granted not only to wealthy retail investors, but also to sophisticated investors with knowledge, experience and understanding commensurate with the NMPI product under consideration.

Furthermore, the European full-paternalism form of suitability is also present in several other parts of the UK FCA's rules: COBS 4.2 states that communications and financial promotions must be "fair, clear and not misleading"; COBS 9 pertains to suitability, including basic advice;[26] and COBS 10 pertains to appropriateness for non-advised services.

In the UK, the FCA employs these rules to prevent – and if necessary, redress – 'mis-selling', which is taken to occur when (a.i) a client is given unsuitable advice, or (a.ii) the risks are not

[24]Communicating with clients, including financial promotions `http://fshandbook.info/FS/html/FCA/COBS/4`

[25]Those with either an annual income in excess of £100,000 or investable assets in excess of £250,000.

[26]COBS 9.2.1 R on assessing suitability states:
(1) A firm must take reasonable steps to ensure that a personal recommendation, or a decision to trade, is suitable for its client.
(2) When making the personal recommendation or managing his investments, the firm must obtain the necessary information regarding the client's:
(a) knowledge and experience in the investment field relevant to the specific type of designated investment or service; (b) financial situation; and (c) investment objectives;
so as to enable the firm to make the recommendation, or take the decision, which is suitable for him.

adequately explained, or (a.iii) the client is not is not given the information she needs, and (b) the client ends up with an unsuitable product. Indeed instances of mis-selling have been found and (with great public outcy) addressed in a variety of financial product markets, including Payment Protection Insurance (PPI), pension plans, pension annuities, Interest Rate Swap Agreements (IRSAs), and home repair insurance. The mis-selling of mortgages has not become a comparable publicly recognized issue. And from the beginning of 2015, the statute of limitations precludes the raising of new mortgage mis-selling cases from house purchases concluded in 2008 or earlier.

Congruities and distinctions The above summaries suggest that UK regulation tracks the contours of the full-paternalism variant of suitability more closely than US regulation.

The exception, provided in UK regulation to (self-)certified sophisticated investors from the prohibition of receiving NMPI-product promotions, expands UK investors' access to NMPIs without weakening suitability protection. The exception offered to high-net-worth individuals is common to both UK and US regulation. But once an investor satisfies the criteria of this layer of protection, she must practice *caveat emptor*. Yet the emotion regulation required to do so in the presence of visceral-emotion triggers is not addressed by the exception criteria. Indeed it is not clear that workable, socially and legally acceptable exception criteria could be drafted to incorporate such a stoicism requirement.

For financial products that are classed neither as Alternative Investment Funds nor as NMPIs, UK regulation incorporates a two-part prohibition against mis-selling. The first part requires that advice and information is neither unsuitable nor insufficient, and the second part requires that the product is not unsuitable. An FCA finding of mis-selling requires both parts to be violated. Hence the criteria for mis-selling implement full-paternalism suitability. It would be a distortion of legal competence (to enter into a contract) if responsibility were not to remain with a client who purchases an unsuitable product despite being given suitable and sufficient information and advice. For mis-selling, UK suitability regulation could be no tighter, short of abrogating citizens' legal capacity to contract. US laws in turn give legal expression to the concept of predatory lending, which must be established via the courts by individuals, or by groups of individuals as class action suits, for claims of damages. This is potentially a longer-duration process than the process for mis-selling redress in the UK with active FCA (i.e. regulator) involvement.

Ultimately, within a market economy where the freedom to contract is a right enjoyed by

legally competent individuals, there are limits to the protection that suitability regulation can offer against the over-riding of judgement by visceral emotion. Cooling-off periods complement suitability regulation insofar as they weaken the final influence of visceral emotion where suitability regulations cannot do so. Hence the importance of ensuring that the implementation of cooling-off periods is effective (see Section 4.2.1).

5 Conclusion

The present behavioral model presents an alternative to existing constructs deployed to explain the magnitude of sub-prime borrowing in the run-up to the financial crisis of 2007-08. Whereas Mian and Sufi (2014) appear to be claiming that animal spirits are empirically rejected, in fact it would be more correct to say that 'exclusively price-bubble-mediated' forms of animal spirits are empirically rejected. In cities without geographical constraints to new housing supply, it is true that behavioral and social processes did not result in a real-estate price bubble. Instead, the behavioral and social processes translated into additional purchases and additional borrowing that played out in the volume domain, rather than in the price domain.

In one sense the present model is the result obtained from attempting to reconstitute, from empirically and theoretically plausible lower-level elements, aspects of both animal spirits and generic myopia. The present model contains a specific theoretical structure with which to explain myopic behavior. Rather than positing that households have hyperbolic intertemporal preferences as a *trait*, valid across all contexts – as empirical applications implicitly assume when fitting (quasi-)hyperbolic discount functions – the present model shows that myopic financial decisions result from the confluence of situational, decision-maker-specific *state* variables. The present model predicts that decisions will be made in a non-myopic manner whenever the decision maker is not in a visceral-emotion-charged hot state.

In countries without strong consumer protection laws, the determination of wether a mortgage contract is appropriate ($\neg I$) or inappropriate (I) to the borrower's circumstances is crucial – and necessary in order to practice *caveat emptor*. The present model identifies classes of circumstances under which consumers' ability to practice *caveat emptor* is likely to be compromised. However, even European-style 'cooling-off periods' may not be effective if the borrower does not learn – during the cooling off period – anything new about the details and future implications of the mortgage contract. If the borrower does not study the details of the contract

and think through its implications before signing, it is even less likely that the borrower will do so in the midst of packing, transporting, unpacking, setting up and settling into a new home. Rather than place reliance entirely on cooling-off periods, legal prohibition of 'mis-selling' and legal obligations on lenders to undertake steps to enhance borrowers' informational readiness for distinguishing between appropriate and inappropriate mortgage contracts – such as those recently introduced in the UK – appear warranted.

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APPENDICES

A Derivation with neo-additive probability weighting function

Substitute the neo-additive probability weighting function $w(p)$ from (3.9) into equation (3.12)

$$\begin{aligned} V^-(C) \;=\; & -\;[\mathsf{a}p\beta+\mathsf{b}]\lambda[v^-(C_{\mathrm{FN}})-v^-(C_{\mathrm{TP}})] \\ & -\;[\mathsf{a}p+\mathsf{b}]\lambda[v^-(C_{\mathrm{TP}})-v^-(C_{\mathrm{FP}})] \\ & -\;[\mathsf{a}(p+(1-p)\alpha)+\mathsf{b}]\lambda[v^-(C_{\mathrm{FP}})-v^-(C_{\mathrm{TN}})] \\ & -\;\lambda v^-(C_{\mathrm{TN}})\;\;. \end{aligned} \tag{A.1}$$

The total differential of this expression, set to zero:

$$\mathsf{a}p\lambda[v^-(C_{\mathrm{FN}})-v^-(C_{\mathrm{TP}})]\mathrm{dTPL}-\mathsf{a}(1-p)\lambda[v^-(C_{\mathrm{FP}})-v^-(C_{\mathrm{TN}})]\mathrm{dFPL}=0 \tag{A.2}$$

from which λ and a cancel out, giving the slope of the iso-$V^-_{\text{n-a}}(C)$ contours as

$$\frac{\mathrm{dTPL}}{\mathrm{dFPL}}=\left[\frac{v^-(C_{\mathrm{FP}})-v^-(C_{\mathrm{TN}})}{v^-(C_{\mathrm{FN}})-v^-(C_{\mathrm{TP}})}\right]\cdot\left(\frac{1-p}{p}\right) \tag{A.3}$$

consistent with (3.13).