Measuring the impact of emotions on decision-making in electronic markets: A physio-economic approach

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1. Introduction

Recent research in the field of behavioral economics provides strong evidence for the intuition that human decision-making is not merely a single, indivisible maximization of utility, but rather a complex and dynamic process comprising both rational and emotional components (e.g. Camerer et al. 2005; Bechara and Damasio 2005). In particular, when decision-making includes strategic interaction with, or even just the mere presence of, other human agents, the role of emotions becomes even more dominant (cf. Bault et al. 2008). Therefore, especially bidding decisions in auctions and negotiations can involve a high degree of emotionality; for instance, one phenomenon often linked to a high degree of emotionality is auction fever (cf. Ku et al. 2005).

Smith and Dickhaut (2005) show that not only exogenously induced emotional states, but also the design of electronic markets itself has an influence on market participants' emotional processing. In order to analyze the interdependencies of single market design facets, market participants' emotional processing and their decision-making behavior, we propose a complementary approach to traditional behavioral laboratory and field experiment methodologies: *Physio-Economics*. The methodology of physio-economics allows for objectively assessing market participants' physiological arousal in laboratory as well as in field experiments. We claim that a deeper understanding of how single facets of market design affect market participants' emotional processing is essential for successful market engineering.

2. Physio-Economics

Physio-economics is an extension of the methodology of experimental economics; it enhances existing methods by applying psychophysiological methodologies. In particular, physiological parameters, e.g. heart rate and skin conductance, are measured as proxies for participants' physiological arousal. Being an economic discipline, physio-economics complies with the paradigms of experimental economics, e.g. non-deception and performance-based payment of participants. The focus is to gain a deeper understanding of emotional processes in order to enrich economic models of decision-making.

Physiological parameters, as skin conductance or heart rate, are either under control of the sympathetic, the parasympathetic, or both branches of the autonomic nervous system, and therefore usually cannot be influenced by free will (cf. Cacioppo et al. 2007). Experimental studies more related to the field of psycho-physiology have shown that these physiological parameters can be linked to economic decision-making and that physiological arousal can even be a reliable predictor for decision-making behavior (Bault et al. 2008; Ben-Shakhar et al. 2007).

By analyzing physiological parameters, it is possible to assess the degree of arousal as well as the valence associated with a single stimulus, e.g. market events such as being outbidden, winning or losing an auction. In contrast to the mere use of questionnaires and interviews, which often have to deal with the problem of subjectivity and social-desirability bias, the analysis of physiological parameters offers the intriguing opportunity to examine objective parameters that show a strong correlation to emotional processes of human agents. Further, as the measurement overhead is comparatively low in contrast to neuro-economics, physio-economics allows for larger sample sizes and even experiments in the field, as e.g. on trading floors.

3. A Framework for Auction Experiments

For the analysis of how single market design facets affect market participants' physiological arousal in ascending auctions, we introduce an experimental framework. Consider an ascending auction with *n* bidders in which a single commodity is sold. The auction is divided into a sequence of stages as depicted in Figure 1. In each stage the auctioneer raises the price by the fixed increment δ and each bidder has to decide whether she *accepts* the current standing price or *not*. At the end of each stage, the information sets of the bidders are updated. By dividing the auction into a sequence of stages, it is possible to identify stimuli relevant for changes in the observed physiological parameters. Without the predefined stages, bids could be submitted in very short intervals, cutting out the possibility to distinguish the physiological response to individual market events. Moreover, bidders only have to click once per stage, which clearly reduces the possibility of measurement artifacts caused by keyboard inputs and body movements.

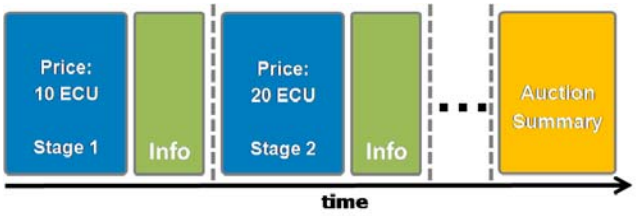

Figure 1: Stages of the experimental framework

The framework allows for a wide range of variations and, therefore, for the analysis of single market design facets. For instance, variation of decision time τ and information set can be used in order to investigate bidders' *competitive arousal* (cf. Ku et al. 2005) induced by the auction design, as a short decision time can result in the experience of time pressure and a larger information set in a higher degree of rivalry. Charging a bidding fee β for staying in the auction triggers another elicitor of auction fever, referred to as *escalation of commitment*, as the degree of commitment associated with each decision is amplified by sunk costs. The *pseudo-endowment* and *source-dependence effect* (Ehrhart et al. 2008) can be analyzed by varying the high-bidder rule, the number of rounds, and the increment δ.

4. Pilot Study

In a pilot study, we analyze the impact of bidding fees on bidders' physiological arousal and bidding behavior. In each stage, one of the bidders accepting the current standing price is randomly chosen as high bidder and charged a bidding fee β - bidders may reenter the auction at any stage. The auction ends when none of the bidders accepts the current standing price, with the high bidder of the previous stage being the winner of the auction. The bidding fee β is either set to 0, 2, or 5 tokens, denoted as the *no*, *low*, and *high* fee treatment, respectively. The number of bidders *n* in a single auction is set to 4 (48 subjects in 12 sessions altogether), the decision time τ is set to 5 seconds, the fixed increment δ is 10 tokens, and the value of the commodity being sold is identical to all bidders and randomly drawn after the auction has ended from the uniform distribution U[170;270]. This is common knowledge to all bidders.

Treatment	Final Price	Seller Revenue	SCR
No Fees	228 (σ = 6.80)	228	0.0712
Low Fees	170 (σ = 79.18)	204	0.1037
High Fees	122 (σ = 87.20)	183	0.1169

Table 1: Final prices, seller revenues, and amplitudes of skin conductance responses

In Table 1, the average final prices, seller revenues, and skin conductance responses (SCR) are listed for the different degrees of bidding fees. Amplitudes of SCRs are recorded and analyzed in response to updates of participants' information sets at the end of each stage. Intuitively, average final prices decline from the no fee to the high fee treatment (Jonckheere-Terpstra-Test, p-value < .0001). Including the charged bidding fees in seller revenue, which is realistic as this particular auction mechanism is usually employed by auction retail sites, reveals that the difference between treatments is rather moderate though. The large price variance σ in the low and high fee treatment indicates an increasing escalation of commitment, as auctions in those treatments either yield very high or very low prices. Therefore, as the theory of escalation situations predicts, bidders either seem to stick to their previous course of action by prolonging the auction or drop out early in the auction. The normalized amplitudes of skin conductance responses (SCR) reveal an increased degree of emotional response to market events in the low and high fee treatment (Jonckheere-

Terpstra-Test, p-value < .0001). Therefore, bidders experience a higher degree of bidders' arousal when bidding fees are charged, which might be associated with an increased escalation of commitment in these auctions. As emotions are frequently regarded as a quality characteristic of electronic markets (Herschlag and Zwick 2000), the higher degree of physiological arousal and price variance can be a significant advantage in platform competition. As a matter of fact, auction retail sites such as *swoopo.com* or *tencents.de* apply this particular auction mechanism and often advertise their low prices and the thrill bidders experience on their platforms.

5. Conclusions & Future Research

Physio-economics turns out to be a promising methodology for analyzing market participants' emotional processing and therefore a complementary approach to traditional techniques for the design of (electronic) markets and market engineering in general. The results of our pilot study, as well as related work in the field of psychophysiology, further emphasize the future potential of physio-economics. The introduced framework allows for analyzing a wide range of single market design facets, which will ultimately contribute to more sophisticated economic models of market decision-making. Further, while research in experimental economics traditionally intends to perform experiments in a neutral environment, future research in the field of physio-economics can also investigate the interrelation of market design, decision-making behavior, and *induced* emotional states such as stress, anger, or joy, as these induced emotions might have different impact on decision-making behavior in alternating economic institutions.

Beyond the scope of laboratory experiments, physio-economics offers the intriguing opportunity of assessing market participants' emotional processing in real life environments, e.g. trading floors, and even provide the decision-maker with instantaneous biofeedback. In particular, we are researching and developing intelligent decision-support agents for professional traders at the Dutch flower auction market *FloraHolland* in the Netherlands (Kambil and van Heck 1998). These agents rapidly process and aggregate information from a wide area of resources, including news and market data. Enriching this information with physiological data gathered from wireless sensor technology (Gharbi et al. 2008) is both a challenging and promising approach to support economic decision making, as emotions presumably play an important role in this highly complex and dynamic environment, and even to elicit human preferences in a non-intrusive way and incorporating them in a decision model of an intelligent software agent.

6. References

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