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## The winner's curse under behavioral institutions

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## **The Winner's Curse under Behavioral Institutions**

by

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# The Winner's Curse under Behavioral Institutions

Nadine Chlaß<sup>‡</sup> \*

February 25, 2011

## Abstract

Empirically, social dilemma under information asymmetry are often much less pronounced than theory predicts. Traders experience a winner's curse and maintain efficiency enhancing exchange of commodities when theory predicts none. Especially under competition, cursed parties undergo severe losses and thereby fund social welfare. Hence, if one cures the winner's curse, one often decreases social welfare. Here, I test how market efficiency can be maintained without individual losses. In a competitive common value auction, parties sidestep both market inefficiency and a winner's curse by judging quality-by-price, and setting price-by-quality.

JEL Classification: D61,D82,L13

Key words: imperfect information, common value auction, price-quality relation

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## 1 Introduction

I study two behavioral institutions to cure the so-called winner's curse in a competitive common value auction where the phenomenon tends to be particularly strong (Bazerman and Samuelson 1983), (Giliberto and Varaiya 1989), (Hong and Shum 2002). Thereby, a winner's curse describes how parties disadvantaged by information fail to identify their expected break-even and incur losses. Two prominent potential causes have been put forth. First, it is argued that players somewhat ignore the information hidden in others' actions<sup>1</sup> (Bazerman and Samuelson 1983), (Eyster and Rabin 2005). Second, it is argued that players do not think sufficiently many steps about the other player such as to avoid losses (Crawford and Iriberry 2007).

A number of mechanisms have been tried to cure the winner's curse, such as experience, learning (Grosskopf et al. 2007), or task simplification (Charness and Levin 2009) without definite success. While the curse is clearly undesirable from the individual's point of view, this is not so from a social point of view. The curse typically increases market efficiency, and hence, social welfare under information asymmetry. Rational parties would anticipate a selection effect of low qualities into trade (Akerlof 1970), and would sometimes bid such as to avoid any trade. Hence, there is no surplus, and no social welfare generated<sup>2</sup>. Contrary to rational parties, cursed parties do not account for the selection effect and bid such as to maintain trade. Consequently, market efficiency does not decline, since the cursed party bears the expense to fund social interest. If one cures her curse, one also decreases social welfare.

Here, I study the performance of two behavioral institutions in curing the winner's curse without loss in social welfare: judgment-of-quality-by-price, and setting-price-by-quality<sup>3</sup>. The social dilemma I choose is the acquiring-a-company-game (Bazerman and Samuelson 1983), a bilateral trade situation where the

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<sup>1</sup>A rational player will act such that, given her private information, she does not incur a loss. Hence, from each of her actions, another player can typically infer some bound of the other player's private information.

<sup>2</sup>Since by construction of these common value models, buyers value, say a car, more than sellers do, trade enhances market efficiency since the commodity devolves into those hands which value it most.

<sup>3</sup>This implies that a seller prices a commodity by taking her valuation of that commodity (where she breaks even) and adding either a fixed absolute profit margin, or a profit margin proportional to that value.

acquisition/trade of a target is always efficiency enhancing. Yet, if parties' valuations of the target differs by less than 50%, the selection effect is so strong, that a rational acquirer will not want to trade.

While the decision whether or not to finally agree on an acquisition may be bilateral only, the final pair is likely to result from an interaction of several parties. Typically, an acquirer has identified several acquisition candidates/targets and will also compete against other acquirers for acquiring the most attractive target. I show that, if targets derive their reservation prices from their quality, a price-quality link emerges, and the dilemma under information asymmetry shrinks. It shrinks in direct proportion to an increased number of targets while the degree to which it shrinks, depends on the actual association between target price and target quality. No social dilemma need arise from asymmetric information, and hence, no winner's curse.

Subsequently, I test the multilateral model in an experiment. Therein, targets associate price and quality, and a price-quality link emerges endogenously. It emerges in an environment where targets are given a strong incentive to exploit acquirers who judge quality by price, rather than an incentive to create a price-quality link. The residual experimental winner's curse, and the underlying experimental social dilemma, are small.

My results add to the discussion whether or not the winner's curse may be seen as a pure laboratory phenomenon. It is argued that in the field, certain institutional features which the lab fails to provide, will mitigate the winner's curse (Dyer and Kagel 1996)<sup>4</sup>. Institutional arrangements such as accounting standards, clauses on unfair competition, may in particular cause price-quality links in field. Indeed, there is evidence that companies' market prices relate to quality related variables such as book value and earnings (Collins et al. 1997), firm size, security returns (Barber and Lyon 1997), or R&D activities (Blundell et al. 1999). If acquirers in the field exploit that information, the logic of my model implies there to be no winner's curse which is also claimed by a recent study of take-overs in the field (Boone and Mulherin 2008).

The paper is organized as follows. Section 2 reviews the social dilemma in the

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<sup>4</sup>So far, there is both field evidence against (Boone and Mulherin 2008), and field evidence for winner's curse phenomena (Morck et al. 1990), (Schwert 2000)

bilateral acquiring-a-company game, and introduces a multilateral acquiring-a-company game assuming judgment of quality by price in presence of a price quality link. It also provides some arguments from the literature why these assumptions might hold. Section 3 describes the experiment by which I test my model. Section 4 reviews my results, and section 5 concludes.

## 2 Model

### 2.1 The bilateral acquiring-a-company game

An acquirer  $a$  and a target company  $t$  negotiate target firm ownership. The target firm has quality  $\bar{v}$  which is drawn from a uniform distribution on the interval  $[0,1]$ . A target firm knows her own quality  $\bar{v}$  while an acquirer only knows the overall distribution of target qualities in the market. Acquirer  $a$  moves first and makes an acquisition offer  $p \in [0, 1]$ . Target  $t$  moves second, and decides whether to accept or to reject the offer, i.e.  $\delta_t \in \{0, 1\}$  based on her private information  $\bar{v}$ . If target  $t$  accepts an offer  $p$ , she gets  $p$  and gives up ownership. In this case, the acquirer obtains target ownership and pays offer  $p$ . If a target vetoes an offer, neither party earns anything.

Thereby, parties differ in their valuation of the target. Acquirers value target ownership at the actual target quality  $\bar{v}$ , while targets value ownership only by fraction  $q, q \in [0, 1]$  of this quality. Hence, one has payoffs:  $\Pi_a = (\bar{v} - p) \cdot \delta_t$ , and  $\Pi_t = (p - q \cdot \bar{v}) \cdot \delta_t$ . Thereby,  $q$  interlinks parties' valuation of target ownership and denotes a common-value parameter. Since acquirers value ownership more than targets, acquisitions promote market efficiency/social welfare by devolving ownership to the party who values it most. An acquisition increases market efficiency/social welfare the more, the smaller  $q$ .

If one backwardly inducts, target  $t$  in round two accepts any offer which yields her a nonnegative profit, i.e.  $\delta = 1 \leftrightarrow p \geq q\bar{v}$ . Hence, every acceptance  $\delta_t = 1$  reveals some of a target's private information, i.e.  $p > q\bar{v}$ . In round one, an acquirer rules out dominated strategies by making the minimal offer every target will accept, i.e.  $p = q \cdot v^{max} = q \cdot 1$ . An acquirer's expected payoff conditional on  $p = q$  is:  $E(\Pi_a) = E(v|p \geq qv) - p = E(\frac{p}{2q}) - p^5$ . This expectation is

<sup>5</sup> $E(v|qv \geq p) - p = E(v|v \leq \frac{p}{q}) - p$  and for a uniform distribution  $f(v) = U(0, 1)$ , we have  $E(v|v \leq \frac{p}{q}) = \frac{p}{2q}$ . Hence:  $E(\Pi_a) = (\frac{p}{2q} - p)$

only nonnegative for  $q \leq 1/2$ . For  $q > 1/2$ , an acquirer will offer a price of zero to circumvent losses, and we observe no acquisitions. Hence, in Bayesian Nash equilibrium, we have acceptance thresholds (1) and offers (2):

$$\delta_t^{BNE} = \begin{cases} 1 & : p \geq q \cdot \bar{v} \\ 0 & : \textit{else.} \end{cases} \quad (1) \quad p_a^{BNE} = \begin{cases} q & : q \leq \frac{1}{2} \\ 0 & : \textit{else.} \end{cases} \quad (2)$$

For  $q > 1/2$ , theory predicts a social dilemma since acquisitions which increase market efficiency, do not occur. Experimentally, the dilemma is smaller since often, acquirers experience a winner's curse. If we explicitly allowed for the winner's curse in a so-called  $\chi$  - Cursed equilibrium (Eyster and Rabin 2005), acquirers would offer  $q$  for  $q \leq \frac{1+\chi}{2}$  where  $\chi$  measures an acquirer's degree of cursedness, i.e. the probability which she assigns to the event that a target does *not* condition her acceptance on  $p \geq q\bar{v}$ .

Note that at offer  $q$ , the acquirer can afford even the highest priced target, and that a target has a reservation price at her true break even point, i.e.  $q\bar{v}$ . Hence, if one assumes acquirer  $a$  to judge quality by price<sup>6</sup>, and target  $t$  to set her reservation price by quality, the solution of the game does not change. Similarly, the solution is not affected if, instead of moving sequentially, parties moved simultaneously, and the acquisition was agreed upon whenever the offer exceeded a target's reservation price.

## 2.2 $m$ Naïve Acquirers, $n$ Naïve Targets

Now, assume that there still is only one acquirer  $a$ , but that there are multiple targets, or multiple acquisition candidates,  $t_{j=1, \dots, n(\geq 2)}$ . Each target has quality  $\bar{v}_{t_j}$  which is i.i.d. randomly drawn from a uniform distribution  $U(0,1)$ . Since there are  $n$  targets, qualities follow a multivariate uniform density  $nv_*^{n-1}$  with multivariate uniform cumulative probability density function  $v_*^n$ . Individual payoffs are the same as in 2.1.

Assume that the only acquirer  $a^\zeta$  wants to acquire at most one<sup>7</sup> target, and that in general, she judges quality by price, a characteristic I denote by  $\zeta$ . She

<sup>6</sup>As long as she does not incur losses.

<sup>7</sup>For simplicity, I assume here that the acquirer does not want to acquire more than one firm at once. In practice, the number of acquisitions might be restrained to one at a time by integration costs.

believes that the highest priced target has the highest quality, and wants to acquire the highest priced target she can afford at a given offer  $p_a^\zeta$ . If parallelly,  $n$  targets set reservation prices proportional to their quality, i.e.  $\underline{p}_{t_j}^\xi = \underline{p}_{t_j}^\xi(\bar{v}_{t_j})$ , a price-quality link emerges. I denote this second behavioral rule by  $\xi$ . If the price-quality link is perfect, reservation prices truly reflect targets' break-even points and reservation prices fully reveal quality, i.e.

$$\underline{p}_{t_j}^\xi(\bar{v}_{t_j}) = q\bar{v}_{t_j} \text{ for all } \bar{v}_{t_j} \in [0, 1] \text{ and } j = 1, \dots, n. \quad (3)$$

What are parties' mutual responses constraint to rules  $\xi$  and  $\zeta$ ? In round  $T=2^8$ , targets set reservation prices  $\underline{p}_{t_j}^\xi(\bar{v}_{t_j}) = q\bar{v}_{t_j}$ . In round  $T=1$ , acquirer  $a_i^\zeta$  who judges quality by price, wants to acquire the highest priced target at minimal cost. The minimal offer which even the target with the highest reservation price accepts, is  $q$ . An acquirer's expected payoff from an acquisition conditional on offer  $q$ , writes:

$$\begin{aligned} E(\pi_{a^\zeta} | \underline{p}_{t_j=1, \dots, n}^\xi(v_{t_j=1, \dots, n}) = q\bar{v}_{t_j=1, \dots, n}) &= n \int_0^{p_{a^\zeta}/q} (v_* - p_{a^\zeta}) v_*^{n-1} dv_* \\ &= n \frac{p_{a^\zeta}^{n+1}}{q^n} \left( \frac{1}{(n+1)q} - \frac{1}{n} \right). \end{aligned} \quad (4)$$

Since acquirer  $a^\zeta$  acquires the highest priced target and targets set their reservation prices at  $q\bar{v}_{t_j}$ , acquirer  $a^\zeta$ 's payoff depends now on how the maximal value, i.e.  $\bar{v}^{max}$ , of  $n$  draws from a uniform distribution increases with the number of draws  $n$ . The first factor within the integral is the acquirer's payoff function from the acquisition of the highest priced target, and the second factor is simply the density, or probability mass distributed over the interval of qualities. In particular, acquirer  $a^\zeta$ 's break-even point shifts from  $q = 1/2$  up to  $q = \frac{n}{n+1}$ .

**PROPOSITION 1.** If targets set  $\underline{p}_j^\xi(\bar{v}_{t_j}) = q\bar{v}_{t_j}$  and the only acquirer  $m = 1$  judges quality by price, acquisitions result within range  $q = [0, \frac{n}{n+1}]$  at offer  $p_a^\zeta = q$ . For  $q > \frac{n}{n+1}$ , acquirer  $a^\zeta$  precludes acquisitions by offering  $p_a^\zeta = 0$ .

Hence, an increase in the number of targets  $n$  makes mutually beneficial and efficient acquisitions more likely and certain for  $n \rightarrow \infty$ . Now, let me also

<sup>8</sup>For the sake of a structured presentation, I keep the sequential notion for the solution of the simultaneous game.



allow for multiple acquirers and vary the number of acquirers  $a_{i=1, \dots, m(\geq 2)}^\zeta$  who judge quality by price. Assume that there can be only one final acquisition<sup>9</sup>, the case where, for  $n = 1$ , and/or in absence of a price-quality link, the social dilemma/the winner's curse turns maximal (see appendices 2 and 3).

In  $T=2$ , targets set  $\underline{p}_{t_j}^\xi(\bar{v}_{t_j}) = q\bar{v}_{t_j}$ , and want to be acquired by the acquirer who has stated the highest offer above that reservation price. In  $T=1$ , all  $m$  acquirers compete to acquire the highest priced target  $t_{j^*}$  with  $\underline{p}_{j^*}^\xi = \underline{p}_j^{max}$ . Thereby, offers will increase until all acquirer profits are exhausted. The minimal offer which exceeds even the highest reservation price stated by a target, was  $q^{10}$ . Acquirers break even at  $\frac{n}{n+1}$ . Acquirer competition will now increase price offers up to  $p_{a_i^*}^\zeta = \frac{n}{n+1}$  for  $m \geq 2$ , where all acquirers expect zero payoffs. Altogether, one has responses (5), and (6):

$$\underline{p}_{t_j=1, \dots, n}^\xi = q\bar{v}_{t_j}, \quad (5) \quad p_{a_i=1, \dots, m}^\zeta = \begin{cases} \frac{n}{n+1} : & q \leq \frac{n}{n+1}, m \geq 2, n \geq 2 \\ 0 : & q > \frac{n}{n+1}, m \geq 2, n \geq 2. \end{cases} \quad (6)$$

**PROPOSITION 2.** If  $n$  targets who set  $\underline{p}_{t_j}^\xi(\bar{v}_{t_j}) = q\bar{v}_{t_j}$ , and  $m$  acquirers who judge quality by price compete for an acquisition, price offers increase until

$$p_{a_i}^\zeta = \frac{n}{n+1} \text{ for } i = 1, \dots, m(\geq 2).$$

For the bilateral case we had theory predict a social dilemma (or a winner's curse) for  $q > 1/2$ . If one assumes judgment of quality by price, and setting price-by quality for a number of competing acquirers on the one hand, and for a number of acquisition candidates on the other hand, a social dilemma arises only within  $q \in [\frac{n}{n+1}, 1]$ . Hence, the social dilemma under information asymmetry shrinks in relation to the number of acquisition candidates  $n$ . Thereby, acquirer competition merely increases acquisition offers, while a multiplicity of targets extends the interval for which mutually beneficial acquisitions increase social welfare. Next, I provide some arguments for why and under which conditions, the assumptions which drive this effect, might be realistic.

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<sup>9</sup>This is done for three reasons: with only one acquisition, competition selects the acquirer with the heaviest curse (Bazerman and Samuelson 1983), (Giliberto and Varaiya 1989), (Hong and Shum 2002), and induces the phenomenon to be circumvented by the two behavioral rules. Second, it is the case where targets have the maximal incentive  $\frac{n}{n+1}$  not to establish a price-quality link, if acquirers judge quality by price.

<sup>10</sup>If an acquisition could be achieved at offer  $q$ , an acquirer would earn  $\frac{n}{n+1} - q$ .

### 2.3 Judging quality-by-price, and setting price-by-quality: Theory and Evidence

The literature provides a number of theoretical arguments and empirical findings which support the assumptions of my model that acquirers might judge quality-by-price, and that targets might link their reservation prices to their quality. Some of these apply only in the field, and some also in the laboratory.

*Judgment of quality by price.* A number of studies have found acquirers to judge quality-by-price on field, and on experimental data, such as (Leavitt 1954), (Gabor and Granger 1966), (Rao and Monroe 1989), (Lichtenstein et al. 1993). An early argument points out that such a decision rule could arise from a potentially deceptive belief that price would result from a competitive interplay of rational supply and demand (Scitovszky 1944/45). More applicable to a laboratory setting is the observation that individuals judge quality by price, if price is the only available cue on quality (Tull et al. 1964), (Zeithaml 1988). Intriguingly, (Shiv et al. 2005) find in recent experiments that price exerts a so-called placebo-effect and that judgment of quality by price is partly unconscious. Some studies report that judgment of quality by price is often used for high-priced commodities and reflects a snob effect (Alcaly and Klevorick 1970), (Brucks et al. 2000). Take-overs, one area of application of the acquiring-a-company game are usually prestigious projects, and a snob effect can apply there (Morck et al. 1990), (D'Aveni and Kesner 1993).

*Setting price-by-quality.* In my model, a target has an incentive to deviate from setting  $\underline{p}_{i_j}^{\xi} = q\bar{v}_j$ , since by doing so, she decreases her chances to be acquired. Outside the laboratory, such a rule might be enforced institutionally. Market and takeover prices may institutionally be bound to somewhat reflect quality, for instance by a country's generally accepted accounting principles<sup>11</sup>, or a country's clauses on unfair competition and consumer protection<sup>12</sup>. These

<sup>11</sup>In U.S. GAAP SFAS 141, SFAS 142, FAS 157, any goodwill or difference between a fair market value and a purchase price would underly certain restrictions, i.e. an impairment test, or certain depreciation rules. In particular, US GAAP recently requires intangible assets be evaluated and separated from any goodwill if possible at all. Since a target quality is somewhat traceable for an acquirer, a target in pursuit of an acquisition has less margin to overstate her price.

<sup>12</sup>For Germany, see Gesetz gegen unlauteren Wettbewerb UWG, Bundesgesetzblatt BGBI I 2004, pp. 1414.

would be examples of institutional arrangements (Dyer and Kagel 1996) which enforce  $\xi$  such that given a sufficient number of targets  $n$ , no winner's curse results. Similarly, multiple cues on quality may provide a potential control for the price cue and countervail a target's incentive to misstate her actual reservation price in the field (Wolinsky 1983).

But why should  $\xi$  apply if it is not enforced institutionally? For one, targets might apply a simple pricing rule and state a price which is their own valuation  $q\bar{v}_{t_j}$  plus a profit margin which is proportional to that valuation (20%, for instance). Such a pricing behavior would unintentionally result in a price-quality link. Similarly, targets might hold a preference for honesty (Evans III et al. 2001), (Gneezy 2005), (Charness and Dufwenberg 2006). A target who would accept every offer as long as she does not incur a loss might consider it dishonest to state a reservation price that grossly differs from her actual break even point. These could be reasons for why one might observe a price-quality link in the laboratory. Next, I describe the experimental test of the model derived in sections 2.1 and 2.2.

## 2.4 Experimental Protocol

I conducted a computerized experiment with 256 (138 female and 118 male) undergraduate students at the University of Jena, randomly drawn from various fields of study. Participants were recruited using Orsee (Greiner 2004). The software was developed with the help of z-tree (Fischbacher 2007). At the beginning of each session, participants were randomly seated at visually isolated computer terminals where they received a hardcopy of the German instructions<sup>13</sup>. Subsequently, participants answered a control questionnaire to ensure their understanding. The experiment started after all participants had successfully completed the questionnaire.

I ran eight sessions with 32 participants each. The experiment had a  $2 \times 2 \times 3$  within-subjects-factorial design. I varied the number of acquirers  $m$ , the number of targets  $n$ , and the common value parameter  $q$  as follows:

$$n, m \in \{1, 3\} \quad \text{and} \quad q \in \{.3, .6, .8\}.$$

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<sup>13</sup>See Appendix B for a translation into English.

Each session lasted forty rounds. The competition intensity  $\{n, m\}$  varied such that, for a first cycle of ten rounds, subjects encountered one of two asymmetric markets with either:

- (1) one target  $\{n = 1\}$  and three acquirers  $\{m = 3\}$ , or
- (2) three targets  $\{n = 3\}$  and one acquirer  $\{m = 1\}$ .

In each round, subjects were randomly assigned to one of the four groups in their type of market. For a second cycle of ten rounds, subjects encountered one of the following two symmetric markets with either:

- (3) three targets and three acquirers, i.e.  $\{m = 3 = n\}$ , or
- (4) one acquirer and one target, i.e.  $\{m = 1 = n\}$ .

Then, each subject repeated the first cycle, and afterwards, repeated the second cycle. To check for ordering effects, four out of eight sessions were run in an alternative sequence of cycles.

Within one cycle of ten rounds, the common value parameter  $q$  varied such that  $q$  was set to  $q = 0.3$  for four rounds, then to  $q = 0.6$  for four rounds, and finally, to  $q = 0.8$  for two rounds<sup>14</sup>. Hence, after 10 rounds, a subject had experienced all experimental constellations of the common value parameter  $q \in \{.3, .6, .8\}$ . For the range of qualities  $v$ , I chose an intuitive interval of  $[0,10]$ . Throughout the experiment, it was common knowledge that the acquirer with the highest offer would be selected to acquire the target who had indicated the highest reservation price below that offer. Thereby, I tried to trigger a strong winner's curse on the acquirer side, and gave targets a strategic incentive to overstate  $\underline{p}_{t_j}$  such that any potential price-quality link would be put to a stress test. Let me review the predictions of my model for the experimental constellations above:

**PREDICTION 1.** For  $\{n = 1, m\}$  and  $q \in \{0.6, 0.8\}$ , acquisitions imply a winner's curse. Judging quality by price, and setting price by quality has no effect. The winner's curse will increase if acquirers compete, i.e.  $m = 3$ .

**PREDICTION 2.** For  $\{n = 3, m\}$  and  $q \in \{0.6\}$ , acquisitions imply no

<sup>14</sup>Since for  $q = .8$ , no acquisition is predicted for any  $n, m$  constellation, I wanted to avoid frustrating participants.

winner’s curse if acquirers judge quality by price and sellers set prices by quality.

**PREDICTION 3.** For  $\forall\{n, m\}$  and  $q \in \{0.8\}$ , acquisitions imply a winner’s curse. Increasing the number of targets to  $n = 3$  is insufficient to make acquisitions mutually beneficial, even if quality is judged by price, and prices are set by quality.

A session lasted, on average, 108 minutes (minimum: 90, maximum: 120), and average earnings were €4.50 for acquirers (€19.10 for targets). Minimal payoffs were €-18.50 for acquirers, and €8.50 for targets. Maximal payoffs were €22.70 for acquirers, and €47.50 for targets. At the outset, participants agreed to rules regarding overall losses (see the instructions in Appendix C) and were randomly assigned both roles and cycles.

### 3 Results

#### 3.1 Descriptive Data Analysis

Do parties manage to forego a social dilemma without a winner’s curse for multiple  $n$ ? To see this, table 1 displays parties’ average earnings per round for all experimental parameters  $\{n, m, q\}$ .

	role	$\{n, m\}$	$q = 0.3$	$q = 0.6$	$q = 0.8$
$\bar{\pi}, \sigma^2(\pi)$	$a_{i^*}$	$\{m = 1, n = 1\}$	0.40 (2.85)	-0.64 (2.75)	-1.06 (2.27)
		$\{m = 3, n = 1\}$	-0.01 (2.95)	-1.07 (2.54)	-1.73 (2.33)
		$\{m = 1, n = 3\}$	1.30 (2.47)	-0.29 (2.28)	-1.08 (1.96)
		$\{m = 3, n = 3\}$	0.75 (2.88)	-0.56 (2.31)	-1.19 (2.10)
	$t_{j^*}$	$\{m = 1, n = 1\}$	2.27 (0.85)	1.91 (1.65)	1.59 (1.82)
		$\{m = 3, n = 1\}$	3.27 (0.89)	2.67 (1.53)	2.40 (1.87)
		$\{m = 1, n = 3\}$	1.78 (0.74)	1.58 (1.37)	1.61 (1.57)
		$\{m = 3, n = 3\}$	3.06 (0.86)	2.32 (1.39)	1.98 (1.68)

**Table 1: Average and variance of parties’ earnings for  $\{n, m, q\}$ .**

For all  $q > 0.5$ , acquirers incur losses, i.e., a winner’s curse. A pure increase in acquirer competition, i.e.  $m$ , increases that winner’s curse substantially for all  $\{n, m\}$  constellations (*prediction 1*). However, a pure increase in the number of targets  $n$  within  $n/(n + 1)$ , reduces that winners curse substantially by some 50% (*prediction 2*). Varying  $\{m = 1, n = 1\}$  into  $\{m = 1, n = 3\}$  for  $q = 0.6$

makes losses drop from -0.64 to -0.29. Similarly, if we change a target monopoly  $\{m = 3, n = 1\}$  into  $\{m = 3, n = 3\}$  for  $q = 0.6$ , losses drop from -1.07 to -0.56. At the same time, variance in losses shrinks notably. For  $q = 0.8$  where  $q \not\leq n/(n + 1)$ , a potential price-quality link was predicted to turn ineffective (*prediction 3*). Indeed, an increase in  $n$  for  $q = 0.8$  does not reduce acquirer losses compared to  $\{n = 1, m = 1\}$ . Yet, acquirer losses for  $\{m = 3, n = 1\}$  are much more severe (-1.73) than acquirer losses for  $\{m = 3, n = 3\}$  (-1.19). Hence, an increase in  $n$  for  $q = 0.8$  still seems to take an effect by softening the excess winner's curse from acquirer competition. Target earnings reflect the effect of the price-quality link<sup>15</sup>: A pure increase in targets  $n$  invariably decreases target earnings as long as  $q \not\leq n/(n + 1)$ . However, that price-quality link seems to be imperfect, since acquirers still incur a residual winner's curse.

**RESULT 1.** Acquirer competition triggers a strong winner's curse. If we multiply the number of targets, the curse decreases substantially.

Overall, my model seems to capture the logic behind parties' experimental payoffs. It remains to be seen whether the same holds for parties' decision variables. Figs. 1 and 2 depict densities<sup>16</sup> of acquirer offers and target reservation prices for all  $\{m, n\}$ . I start with acquirers' response to competition and compare offer densities  $\{m = 1, n = 1\}$  and  $\{m = 3, n = 1\}$ , i.e. the thinnest, and the thickest line in Fig. 1. In line with the predictions of the model, offer densities shift rightward (i.e. offers increase), if more acquirers compete. Hence, acquirers make higher offers under acquirer competition and compete against each other for the acquisition of the highest priced target.

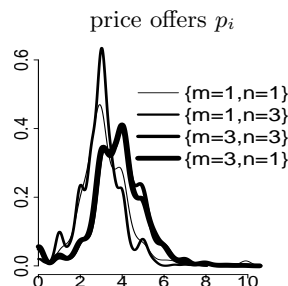


Fig. 1: Offer densities.

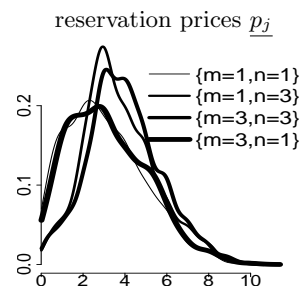


Fig. 2: Reservation price densities.

<sup>15</sup>Since acquirers' and targets' earnings are linked by the common value parameter  $q$ .

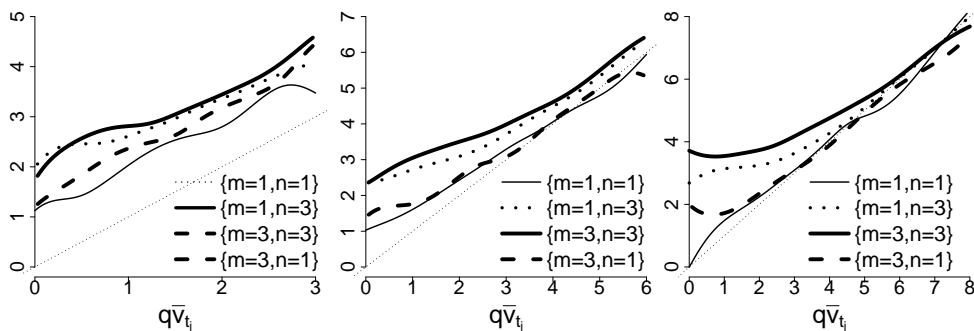
<sup>16</sup>Bandwidth is obtained using Silverman's rule of thumb (Silverman 1986, p.48). Patterns remain invariant under other choices, i.e. via cross validation (Scott and Terrell 1987).

To see whether acquirers' offers react to the number of targets  $n$ , I compare offer densities with the same  $m$ , but different  $n$ . The offer density for  $\{m = 1, n = 1\}$ , i.e. the thinnest line in Fig. 1, peaks earlier, and less pronouncedly than the one for  $\{m = 1, n = 3\}$  which is marked second-thinnest. Hence, offers seem to increase a little in  $n$ , which is a sign for judgment of quality-by-price.

Target reservation prices show very large variance. They might indeed depend upon i.i.d. uniform random draws of the actual target quality  $\bar{v}_{t_j}$  which would reflect a price-quality-link. Multiplying the number of targets  $n$  drives reservation prices upward, i.e. density  $\{m = 1, n = 3\}$  peaks later, and more pronouncedly than the respective density for  $\{m = 1, n = 1\}$ . Moreover, acquirer competition seems to drive reservation prices a little upward since the density for  $\{m = 1, n = 3\}$  peaks slightly earlier than density  $\{m = 3, n = 3\}$ . Such target competition will weaken a potential price-quality link, and may be responsible for the residual winner's curse in table 1.

Figs. 3-5 focus on the essential ingredient of the model, which is the overall strength of the price-quality link. They depict to what extent targets' reservation prices  $\underline{p}_{t_j}$  correlate with targets' actual break-even points  $q\bar{v}_{t_j}$ <sup>17</sup>. For all  $\{n, m, q\}$ , one clearly sees a relationship between  $\underline{p}_{t_j}$  and  $q\bar{v}_{t_j}$ .

**Figs. 3-5: Is there an overall price-quality relationship?**



**Fig. 3:**  $\underline{p}_j(q\bar{v}_{t_j})$ ,  $q=0.3$

**Fig. 4:**  $\underline{p}_j(q\bar{v}_{t_j})$ ,  $q=0.6$ .

**Fig. 5:**  $\underline{p}_j(q\bar{v}_{t_j})$ ,  $q=0.8$ .

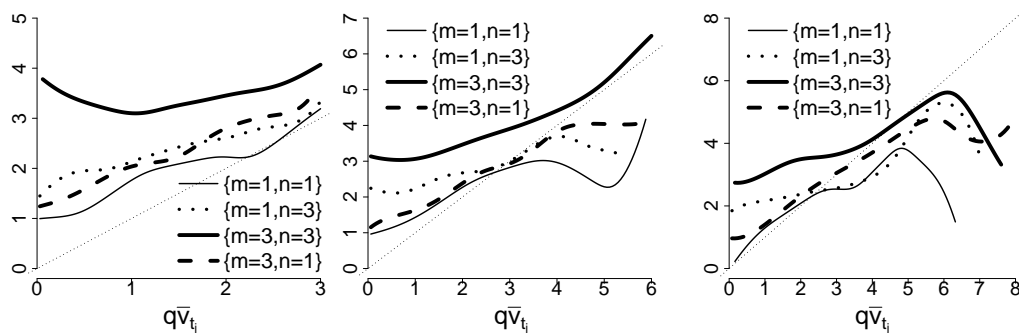
Visually, the assumption given which a multiplicity of targets reduces and the social dilemma, and the winner's curse, holds.

<sup>17</sup>All lines are regression lines estimated by a locally linear kernel regression, a robust local smoothing technique. Characteristics of all lines have been reconfirmed by other, more global regression techniques. Price quality links of mean and median show the same properties.

In particular, a price quality link exists for  $\{\forall m, n = 3\}$ , where targets have a strong incentive to deviate from any price quality relationship since only the highest priced target will qualify for an acquisition. Three aspects of the overall price-quality link stand out: First, with increasing  $q$ , price quality links run closer to the 45° line where one has a perfect price-quality link, i.e.  $p_{t_j} = q\bar{v}_{t_j}$ . Second, an increase in  $q\bar{v}_{t_j}$  by One typically increases  $p_{t_j}$  by less than One. This could result if targets added a fixed amount to  $q\bar{v}_{t_j}$ , or simply reflect that for a higher  $q\bar{v}_{t_j}$ , there is a smaller strategic margin to overstate it. Third, the slopes of the price-quality link vary with  $q$ . For  $q = 0.6$  as compared to  $q = 0.3$ , the price-quality relation for small qualities is a little weaker than for high qualities. For  $q = 0.8$ , the price quality relation for small qualities nearly vanishes when there are several targets, i.e.  $\{m, n \neq 1\}$ .

Are acquirers indeed able to exploit this overall price-quality link such as to circumvent a winner's curse? If so, the price quality link must also exist for the subset of actually acquired targets. In particular, there must not be any selection of targets into acquisitions whose reservation prices are not linked to their break-even. Figures 6-8 depict the price-quality link for the subset of actually acquired targets  $t_{j^*}$  only.

**Figs. 6-8: Is there a price-quality link for acquired targets?**



**Fig. 6:**  $p_{j^*}(q\bar{v}_{t_{j^*}})$ ,  $q=0.3$ .

**Fig. 7:**  $p_{j^*}(q\bar{v}_{t_{j^*}})$ ,  $q=0.6$

**Fig. 8:**  $p_{j^*}(q\bar{v}_{t_{j^*}})$ ,  $q=0.8$ .

The price quality link for the subset of acquired targets matches the overall link in a number of properties. Most importantly, a price-quality link exists also for the set of acquired targets. As before, price-quality links for most  $\{n, m, q\}$  run closer to the 45° line, the higher  $q\bar{v}_{t_{j^*}}$ . Again, the slopes of those price-quality



links are very similar for many  $\{n, m, q\}$ , and typically smaller than One. However, two aspects stand out. First, on markets where acquirers get a larger part of the surplus, i.e.  $q = 0.3$ , targets with  $q\bar{v}_{t_{j^*}}$  in  $[0, 1]$  overstate their break-even more pronouncedly than other targets do. Acquirers select these targets for an acquisition. A positive price-quality link reemerges for  $q\bar{v}_{t_{j^*}} > 1$ . Second, when break evens are very high for  $q \in \{0.6, 0.8\}$ , some lines fall below the 45° degree line. Here, potentially efficiency-loving targets start to set reservation prices below their break even<sup>18</sup>.

### 3.2 Treatment Effects

Here, I quantify to what extent the assumptions and predictions of the model derived in sections 2.1 and 2.2 hold. Throughout, I rely on linear fixed-effects models<sup>19</sup>. Table 2 details my results on acquirers' offers.

<i>variable</i>	<i>coef.</i>	<i>Std. Error</i>	<i>t-Value</i>	<i>p-Value</i>
<i>Intercept</i>	2.97	0.15	19.63	0.00
<i>q08</i>	0.07	0.05	1.33	0.18
<i>nq0306</i>	0.10	0.03	3.05	0.01
<i>nq08</i>	0.15	0.07	2.22	0.03
<i>m</i>	0.68	0.04	18.12	0.00
<i>Period</i>	-0.02	0.00	-14.65	0.00

**Table 2: Acquirer offers,  $R_{adj}^2 = 0.45$ .**

Acquirers who judge quality by price were predicted to increase their offers if  $q = 0.3$  rises to  $q = 0.6$ , but not if it rises to  $q = 0.8$ . Indeed, acquirers increase their offers in *nq0306*, but do not increase their offers in *q08* anymore. Moreover, acquirers who judged quality by price were predicted to increase their offers with the number of sellers  $n$  as long as  $q \in \{0.3, 0.6\}$ . Indeed, offers significantly depend on the respective Dummy *nq0306*. Contrary to the model,

<sup>18</sup>These kinks are not due to kernel boundary bias. Kinks still stand out in the median, and also more global (robust) smoothing techniques, i.e. quantile splines.

<sup>19</sup>All fixed effects models are estimated implementing a dummy on the individual level. Residuals do not correlate with fitted values/regressors. I controlled for these assumption violations to make sure that there is no misspecification of the functional form, or omission of a relevant variable. Throughout, I use heteroscedasticity-robust standard errors.

acquirers seem to increase their offers in  $n$  even for  $q = 0.8$ . The respective Dummy  $nq08$  has an even larger impact than  $nq0306$ , but is only weakly significant. Offers strongly increase in the number of acquirers  $m$  and hence, acquirers seem to strongly compete for the highest priced target. In summary, acquirer offers depend on the essential ingredients of the model, i.e. the number of targets  $n$ , and the number of acquirers  $m$ <sup>20</sup>. Hence, if there was a price quality link,  $n$  would extend the range of  $q$  for which acquisitions are mutually beneficial. However, acquirers seem to rely on  $n$  beyond  $q = 0.6$ . This implies losses, and it also raises the question whether acquirers consciously decide whether or not to rely on a judgment of quality by price.

**RESULT 2.** Acquirers increase their offers in response to target number  $n$ . This is in line with a judgment of quality by price.

The model in section 2.2 predicted mutually beneficial acquisitions beyond  $q = 0.5$  only, if targets linked their reservation prices to their quality. Table 3 details my results on overall targets' reservation prices.

<i>variable</i>	<i>coef.</i>	<i>Std.Error</i>	<i>t-value</i>	<i>p-value</i>
<i>Intercept</i>	3.24	0.27	11.97	0.00
$\bar{q}\bar{v}_{t_j}$	0.68	0.01	79.86	0.00
$n$	0.61	0.05	13.44	0.00
$m$	0.15	0.03	4.56	0.01

**Table 3: Overall targets' reservation prices,  $R_{adj}^2 = 0.63$ .**

Overall targets' reservation prices are strongly linked to targets' break-even point  $\bar{q}\bar{v}_{t_j}$ . While targets also comply somewhat with their incentive to overstate their actual break even in response to  $n$ , the price-quality link is even larger than the corresponding overstatement. Targets seem to expect acquirers to compete, since reservation prices also increase in the number of acquirers  $m$ .

However, it is yet to be seen by how far this price-quality link carries over to the set of acquired targets  $t_{j^*}$ . Since targets respond to  $n$ , it might be that acquirers' judgment of quality by price selects those targets for an acquisition whose prices are *not* linked to their quality. Mutually beneficial acquisitions require yet that a price-quality link also exists on the subset of acquired targets. Table 4 presents the results for this subset only.

<sup>20</sup>The impact of  $n$ , and  $m$  has been verified for a large variety of alternative specifications.

<i>variable</i>	<i>coef.</i>	<i>Std.Error</i>	<i>t-value</i>	<i>p-value</i>
<i>Intercept</i>	2.18	0.44	4.92	0.00
$q\bar{v}_{t_j^*}$	0.50	0.02	25.72	0.00
$n$	0.72	0.06	12.70	0.00
$m$	0.61	0.05	13.07	0.00

**Table 4: Acquired targets' reservation prices,  $R_{adj}^2 = 0.61$ .**

The price-quality link also exists for the set of acquired targets, but it is somewhat weaker than on the set of overall targets. Acquired targets respond more strongly to target competition than overall targets do. They also react more strongly to acquirer competition  $m$  than overall targets do.

**RESULT 3.** There is a link between reservation prices and target qualities in general, and in particular, for the subset of acquired targets.

Altogether, I find empirical support for the essential ingredients of my model. First, acquirers comply with the market mechanism that only the highest offer qualifies for an acquisition. They strongly react to  $m$ . Second, acquirers respond to  $n$ , but do so even when this is not predicted. Third, targets voluntarily establish a price-quality link. Hence, it is not by coincidence that we observe a substantially smaller winner's curse (see section 3.2) as  $n$  increases. Residual losses show that the price quality link is not perfect, that is, reservation prices do not fully reveal quality.

## 4 Conclusion

This paper tests to what extent parties who judge quality by price, and set prices by quality, can forego both a winner's curse, and inefficient market outcomes under information asymmetry. Thereby, the party who has private information would systematically link her actions to her private information, and thereby, reveal that information partly. The degree to which the social dilemma under information asymmetry dissolves, depends on the strength of the link between an individuals' actions and her private information.

The acquiring-a-company game (Bazerman and Samuelson 1983) illustrates

the social dilemma under information asymmetry. Market exchanges are not in an individual's self interest, despite the fact that they would enhance social welfare by improving market efficiency. In particular, rational self interest diverges from social interest (Akerlof 1970), if parties value the object to negotiation similarly. Experimentally, market inefficiency is often less pronounced than theory predicts because one party suffers a winner's curse. Thereby, the informationally disadvantaged party involuntarily funds the socially efficient outcome by an individual loss.

I formulate a multilateral acquiring-a-company game assuming targets who set reservation prices by quality, and acquirers who assume such a price-quality link. If the price-quality link is perfect, the social dilemma fully dissolves if the number of targets is high enough. In an experimental test, I confirm a strong, but imperfect price-quality link, and I find that acquirers increase their offers in competition for the highest priced target. As a consequence, the social dilemma is less pronounced, and acquirer losses shrink by one half as compared to the reference case <sup>21</sup>. Since the price-quality link is imperfect, the number of targets would need to be a little higher than required by my model to fully circumvent a winner's curse. These results are of particular interest given the reported failures to cure the curse by learning, experience (Grosskopf et al. 2007), or task simplification (Charness and Levin 2009).

Judgment of quality by price and a price-quality link can emerge from various sources. Judgment of quality-by-price is an empirical phenomenon when price is the only available cue on quality (Zeithaml 1988). Similarly, judgment of quality-by-price may succeed in the field where a positive price-quality link may be legally enforced, for instance, by laws of consumer protection. Subjects may then carry such decision rules over to the lab (Hoffman et al. 1994), (Hoffman et al. 1996), since judgment of quality-by price is found to be partly unconscious (Shiv et al. 2005). Setting a reservation price which is unrelated to one's quality might be considered to be unethical, or violate a preference for honesty (Gneezy 2005) that may even be revealed in professional/strategic situations

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<sup>21</sup>The bilateral situation under both behavioral institutions coincides with acquiring-a-company (Bazerman and Samuelson 1983) where, if parties differ by less than 50 % in their valuation of the target, a winner's curse (or a market inefficiency) occurs.

(Evans III et al. 2001). I cite evidence from the literature for the existence of those institutions in the field where they may similarly cure the consequences of imperfect information. In particular, we would not always predict a social dilemma under asymmetric information, and consequently, no winner's curse. Hence, the existence of such decision rules may also be a reason why sometimes, a winner's curse is observed in the field (Schwert 2000), (Morck et al. 1990), and sometimes, it is not (Boone and Mulherin 2008).

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## Appendix

### A. Bayesian Nash equilibrium bilateral trade model.

If one backwardly inducts, target  $t$  in round  $T=2$  accepts any offer which yields her a nonnegative profit and hence, we have (7).

$$\delta_t^{BNE} = \begin{cases} 1 & p \geq q \cdot \bar{v} \\ 0 & \text{else.} \end{cases} \quad (7) \quad p_a^{BNE} = \begin{cases} q & q \leq \frac{1}{2} \\ 0 & \text{else.} \end{cases} \quad (8)$$

In  $T=1$ , an acquirer rules out dominated strategies by making the minimal offer every target will accept, i.e.  $p = q \cdot v^{max} = q \cdot 1$ . A buyer's expected payoff conditional on  $p = q$  is:  $E(\Pi_a) = E(v|p \geq qv) - p = E(\frac{p}{2q}) - p^{22}$ . This expectation is only nonnegative for  $q \leq 1/2$ . For  $q > 1/2$ , an acquirer offers zero to circumvent losses, and one observes no acquisitions. Hence, one has (8).

### B: One Naïve Acquirer, $n$ Rational Targets

If an only acquirer  $a^\zeta$  judges quality by price, and multiple acquisition candidates  $t_{j=1, \dots, n(\geq 2)}$  of i.i.d. uniformly distributed qualities  $\bar{v}_j$  do *not* set prices by quality (do not link their reservation prices to their quality), individual payoffs are the same as in 2.1. In  $T=2$ , targets who know that only the highest priced target will be acquired, all state a reservation price equal to the maximal offer an acquirer wants to make. In  $T=1$ , the only acquirer  $a^\zeta$  wants to acquire the highest priced target at minimal cost. The minimal offer even the target with the highest quality  $\bar{v}_{t_j} = v^{max}$  would accept, is  $p_a^\zeta = q$ . Acquirer  $a^\zeta$ 's expected payoff conditional on offer  $p_a^\zeta = q$  writes:

$$\begin{aligned} E(\pi_a^\zeta | v \leq \frac{p_a^\zeta}{q}, n \geq 2) &= \frac{p_a^\zeta}{2q} - p_a^\zeta \left[ 1 - \left( 1 - \frac{p_a^\zeta}{q} \right)^n \right] \\ &= p_a^\zeta \left( \frac{1}{2q} - 1 \right) \left[ 1 - \left( 1 - \frac{p_a^\zeta}{q} \right)^n \right]. \end{aligned} \quad (9)$$

The product is simply acquirer  $a^{\zeta'}$ 's payoff from an acquisition<sup>23</sup> times the likelihood that there by any acquisition at all (the likelihood that offer  $p_a^\zeta$  exceeds

<sup>22</sup> $E(v|qv \geq p) - p = E(v|v \leq \frac{p}{q}) - p$  and for a uniform distribution  $f(v) = U(0, 1)$ , we have  $E(v|v \leq \frac{p}{q}) = \frac{p}{2q}$ . Hence:  $E(\Pi_a) = (\frac{p}{2q} - p)$

<sup>23</sup>The same as in the bilateral model, see App. A p. 21.

at least one target reservation price). Acquirer  $a^{\zeta'}$ 's payoff is nonnegative iff  $q \leq 1/2$  and hence, she offers zero for  $q > 1/2$ . Altogether, we have mutual responses (10), (11).

$$p_{a^{\zeta}}^{BNE} = \begin{cases} q & q \leq \frac{1}{2} \\ 0 & \text{else.} \end{cases} \quad (10) \quad \underline{p}_{t_j} = \begin{cases} q & p \geq q \cdot \bar{v} \\ q\bar{v}_{t_j} & \text{else} \end{cases} \quad (11)$$

Acquirer  $a^{\zeta^*}$  acquires one of the equally priced targets; acquirer  $a^{\zeta^*}$  earns  $v_{t_{j^*}} - p_{a^{\zeta^*}}^{\zeta^*}$ , the acquired target  $t_{j^*}$  earns  $p_{a^{\zeta^*}}^{\zeta^*} - qv_{t_{j^*}}$ , and all other targets  $t_j \neq t_{j^*}$  earn zero.

### C. $m$ Naïve Acquirers, $n$ Rational Targets

If one has several  $a_{i=1, \dots, m(\geq 2)}^{\zeta}$  acquirers who judge quality by price, all  $m$  acquirers will compete against each other to acquire target<sup>24</sup>  $t_{j^*}$  with the highest reservation price.

In  $T=2$ , targets know that only the highest priced target will be acquired. Hence, all targets set their reservation price equal to the very offer which will result from acquirers' competition in  $T=1$ , just as long as that offer allows targets to break even. In  $T=1$ , an only acquirer had expected payoff (9) from an acquisition, and acquisitions were mutually beneficial iff  $q \leq \frac{1}{2}$ . The minimal offer even the highest priced target accepts, is  $q$ . The offer an acquirer can make without incurring a loss, is  $p_{a_i}^{\zeta} = \frac{1}{2}$ <sup>25</sup>. Acquirer competition will now drive up prices within range  $q \leq p_{a_i}^{\zeta} \leq \frac{1}{2}$  up to  $p_{a_i^*}^{\zeta} = \frac{1}{2}$  where all acquirers earn zero. Iff  $q > \frac{1}{2}$  in (3), every acquirer expects a loss from an acquisition. Hence, for  $q > \frac{1}{2}$ , every acquirer precludes an acquisition by offering  $p_{a_i}^{\zeta} = 0$ . Altogether, we have mutual responses:

<sup>24</sup>One could loosen this assumption by allowing for several acquisition pairs. Yet, experimentally, allowing for only one trading pair will induce strong acquirer competition which should bring about a very strong winner's curse (Bazerman and Samuelson 1983), (Giliberto and Varaiya 1989), (Hong and Shum 2002). Since it is the aim of the paper to see whether individuals can sidestep the curse if quality is judged by price and price is set by quality, I allow for only one trading pair.

<sup>25</sup>For  $q = 1/2$ , acquirers break even. Hence, the expected profit from an acquisition would be  $\frac{1}{2} - p_{a_i}^{\zeta}$ .

$$\underline{p}_{t_{j=1,\dots,n}} = \begin{cases} \frac{1}{2} : & q \leq \frac{1}{2} \\ q\bar{v}_{t_j} : & q > \frac{1}{2} \end{cases} \quad (12) \quad p_{a_{i=1,\dots,m}}^\zeta = \begin{cases} \frac{1}{2} : & q \leq \frac{1}{2} \\ 0 : & q > \frac{1}{2} \end{cases} \quad (13)$$

**PROPOSITION A1.** : If  $m$  acquirers who judge quality by price and  $n$  rational targets compete for the only acquisition, price offers increase to  $p_{a_i}^\zeta = \frac{1}{2}$  as long as  $q \leq \frac{1}{2}$ . For  $q > \frac{1}{2}$ , acquirers continue to preclude acquisitions by setting  $p_{a_i}^\zeta = 0$ . In particular, the acquirer with the highest offer  $p_{a_{i^*}}^\zeta \geq p_{a_i}^\zeta$  amongst all acquirers  $i = 1, \dots, m, i \neq i^*$  acquires target  $t_{j^*}$  who, amongst all targets available at  $p_{a_{i^*}}^\zeta$ , has  $\underline{p}_{t_{j^*}} \geq \underline{p}_{t_j}$  for all  $t_{j=1,\dots,n}, j \neq j^*$ .

## B. Instructions<sup>11,12</sup>

### Instructions

Welcome and thank you very much for participating in this experiment. For showing up, you receive €2. Please read the following instructions carefully. Instructions are identical for all participants. Please do not communicate with other participants, and switch off your mobile phones. If you have any questions, raise your hand - we are going to answer them individually at your place.

During the experiment all amounts of money will be indicated in ECU (Experimental Currency Units) where 1 ECU=0.4 €. The sum of your payoffs from all rounds will be disbursed to you in cash at the end of the experiment. Your initial endowment is 4 ECU. Payoffs achieved during the experiment will be added to this amount. Negative payoffs are possible, and an eventually negative overall payoff has to be compensated by working at the institute. The hourly wage in this case is set to 10 €.

<sup>11</sup>Instructions were written in German. The following chapter reproduces a translation into English. Emphases like, e.g., bold font, are taken from the original text.

<sup>12</sup>Notations of variables do not always coincide with the paper - I chose the first letter of the German word (e.g. "offer" is named "g" like 'gebot') to facilitate the experimental task. Especially  $q$ , targets' valuation in the model, is called "a", letter "q" being already used for "quality".

### Information regarding the experiment

The experiment consists of several rounds. Participants take on different roles. Your role is randomly determined at the beginning of the experiment and remains the same throughout all rounds of the experiment. Your role will be communicated at the beginning of the first round. In each round, you are randomly matched to groups of other participants. In each round, participants make decisions. Via their decisions, participants affect their own, and the other participants' payoffs.

On a market, **groups of potential sellers** and **potential buyers** of a commodity meet. Each seller is endowed with a unit of the same commodity, but each unit has a different quality  $q$ . The quality of the commodity is expressed by a number between 0 and 10, randomly drawn at the beginning of each round. Thereby, 0 is the lowest, and 10 is the highest quality. Each quality between 0 and 10 occurs with the same probability. Each potential seller knows the quality of her commodity, while potential buyers do not.

Buyers and sellers value the commodity differently: buyers value the commodity at its actual quality. Each seller values the good only at a fraction of its actual quality, that is,  $a * q$  with  $a < 1$ . This fraction  $a$  is known to both parties. For four successive rounds,  $a$  is fixed at 0.3, followed by four rounds with  $a = 0.6$ , and two rounds with  $a = 0.8$ . (In the beginning of each round the actual value of  $a$  is indicated.) The monetary value of the commodity is thus always higher for buyers than it is for sellers.

A round proceeds as follows:

1. Unaware of the actual quality of the commodity, each **buyer** in a group of buyers indicates an offer  $g$  between 0 and 10.
2. Unaware of buyers' offers, but aware of the actual quality  $q$  of her commodity, each **seller** in a group of sellers chooses a minimum price  $p$ . Starting from this price limit, she is willing to sell her commodity.
3. If at most one offer exceeds one of the minimum prices stated, there is trade. The buyer with the highest offer buys from the seller with the highest minimum price below that offer. Only one unit of the commodity is traded.

Payoffs are as follows:

Buyers and sellers who do not participate in trade receive a payoff of **0 ECU**.

The buyer who participates in trade receives the difference between the actual quality of the acquired commodity and the price paid for its acquisition. She thus receives:  $\mathbf{q} - \mathbf{g}$  in ECU.

The seller who participates in trade receives offer  $g$  and delivers the commodity to the buyer. Her payoff is therefore  $\mathbf{g} - \mathbf{a} * \mathbf{q}$  in ECU.

Group sizes of buyers and sellers vary throughout the experiment. The following situations are possible:

1. Markets with 1 seller and 1 buyer
2. Markets with 3 sellers and 1 buyer
3. Markets with 3 sellers and 3 buyers
4. Markets with 1 seller and 1 buyer

We will inform you at the beginning of each round which situation you are going to encounter.

**Example:** The fraction  $a$  at which sellers evaluate the commodity be 0.3. You encounter a market with two sellers and two buyers. Buyers indicate their offers  $g$ . Unaware of these, sellers determine their individual minimum prices  $p$  as detailed in the following table.

Buyers' bids	Sellers' minimum prices	Quality of goods
B1: $g = 3.0$	S1: $p = 2.5$	S1: $q = 5.0$
B2: $g = 2.8$	S2: $p = 2.0$	S2: $q = 4.2$

Buyer B1 indicates the highest offer with  $g = 3.0$ . The highest minimum price below that offer comes from seller S1 with  $p = 2.5$ . These two participants now exchange seller S1's commodity with quality  $q = 5.0$ . Payoffs are calculated as follows: All those participants not having been involved in trade, that is B2 and S2, receive a payoff of **0 ECU**.

Participants who have traded, that is, S1 and V1, obtain the following: Buyer B1 receives the quality minus her offer,  $q - g = 5 - 3 = 2$  in ECU. Seller S1 gets the offer  $g = 3$ , but delivers the commodity she evaluates at  $a * q = 0.3 * 5 = 1.5$  ECU. Her payoff therefore amounts to:  $g - a * q = 3 - 1.5 = 1.5$  in ECU.

*We ask for your patience until the experiment starts. Please stay calm. If you have any questions, raise your hand. Before the experiment starts, we ask you to answer a number of control questions.*