The Impact of Electronic Markets on B2B-Relationships

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Abstract. Although most of the predicted consequences of the internet-revolution in the 90s did not become reality, the internet has lead to sustainable changes in the organization of most industries. In particular, this is true for business-to-business (B2B) relations between firm. An obvious 'proof' for this is the rising number of so-called electronic markets—especially for B2B transactions—since several years. This paper should help to give a better understanding of the organizational impacts of electronic markets in the context of B2B relations. Therefore we use the incomplete contract framework to build a simple model of a repeated game. It will be shown that the existence of an (alternative) electronic market could influence the willingness to cooperate between the up- and the downstream firm in a B2B-relationship. In our special case, the willingness to cooperate by the buyer will decline.

Keywords: Business-to-Business, Electronic Markets, Industry Structure, Repeated Games

JEL classification: L14, L22

...why is there any organization?
Ronald H. Coase, In *The Nature of the Firm* (1937)

1. Introduction

Up to now much has been written about the economic consequences of the internet. Especially the topic of electronic commerce has been extensively analyzed[1]. In contrast to this, little research exists about the long-run impacts of electronic markets on the industry structure. Of course, there are some papers explaining the impact of electronic markets on business-to-customer relationships[2], their properties in general[3] and their property to decrease transaction costs[4]. But on the other hand, up to now only few work has been done in the context

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[1] For an excellent survey hereto see Kauffman and Walden (2001).

[2] See e. g. Bakos (1997).

[3] See Bakos (1991) and Smith et al. (1999).

[4] See Bakos (1998), Brown and Goolsbee (2002) and Brynjolfsson and Smith (2000).

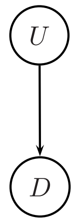

Figure 1. A simple vertical buyer-supplier relation

B2B-relationships. In fact, this is an important gap in recent research, because these relationships are likely to be affected most by the internet. Although their property to decrease transaction costs seems to be quite clear, the fact of decreasing transaction cost by electronic markets is not the only impact of electronic markets on the economics of the firm(s).

The fact that the internet has deep strategic impacts was first realized in the field of business administration[5], while the economic research has ignored this fact for a long time. This work should help to give a better understanding of the strategic effects of electronic markets in the context of B2B-relationships and should also inspire further research in this area.

This paper is organized as follows: first, in section 2.1, we give a short overview about the technological assumptions of our model. Then in section 2.2, we discuss the case of relation-specific investments in an incomplete contract setting. After that, in section 2.3, we analyze the investment decision of one buyer and one supplier in the context of a repeated game. After that, in section 2.4, we extend our model to the case of an existing alternative electronic markets and show the impact of it on the willingness of the buyer to cooperate. Finally, in chapter 3, we summarize our results and discuss some fields of further research.

2. The Model

2.1. Technological Assumptions

Let us first take a look at the case of a simple vertical relationship between a downstream buyer and an upstream supplier, as shown in figure 1. In the following we denote the upstream supplier with U and the downstream buyer with D. We assume that both—the supplier and the buyer—are risk-neutral. Both want to agree on the supply of one

[5] For a critical discussion about the impact of the internet on business administration see Porter (2001).

unit of a non-divisible good. This good has a value to the buyer D of $v \in I\!R^{+}$, whereas $v \in [\underline{v}, \overline{v}]$ with $\underline{v} > 0$, $\overline{v} < \infty$ and $\overline{v} > \underline{v}$. The buyer D has the possibility to increase the value of the good through an investment I^D, i. e. the value of the good after the investment is $v(I^D)$. The production of the good raises production costs of $c \in I\!R^{+}$ on the supplier U, whereas $c \in [\underline{c}, \overline{c}]$ with $\underline{c} > 0$, $\overline{c} < \infty$ and $\overline{c} > \underline{c}$. The supplier has also the possibility to reduce the production costs through an investment I^U, i. e. after the investment his production costs are $c(I^U)$. To focus on the problem of the investment level we suppose that trade is always efficient, i. e. $v(I^D) > c(I^U), \forall\, I^U, I^D$.[6] To simplify the analysis further we suppose that both, I^U and I^D, could only be chosen discrete, this means that $I^U \in \{0,1\}$ and $I^D \in \{0,1\}$. We also suppose that $v(1) > v(0)$ and that $c(0) > c(1)$. Besides that, we assume that the largest possible cost-saving is $1 < \Delta c := c(0) - c(1) < 2$ and that the largest possible increase of value is $1 < \Delta v := v(1) - v(0) < 2$. Additionally we normalize the investment costs for both to 1. Hence, the profit of the supplier is

$$\pi^U = p - c(I^U) - I^U,$$

whereas p denotes the negotiated price between the buyer and the supplier. Therefore the profit of the buyer is

$$\pi^D = v(I^D) - p - I^D.$$

2.2. Relation-Specific Investments

First of all we want to demonstrate the implications of relation-specific investments in our model.[7] Therefore we suppose that it is not possible to write a complete contract, i. e. ex ante it is not possible to write a binding contracts over the level of investment for both, the buyer and the supplier. This could for example be case if both investments, the investment of the supplier I^U and the investment of the buyer I^D, could be observed but not be verified by a third party.[8] Our model induces the following game, as shown in figure 2.

[6] In particular we suppose that $\underline{v} > \overline{c}$.

[7] The following model is an adapted version of the model from Tirole. For further details consult Tirole (1990), pp. 21.

[8] This situation is the same as to say it is prohibitively expensive to specify the level of investment ex ante within a complete contract.

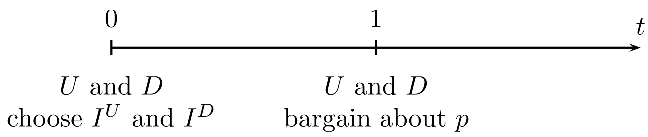

Figure 2. Game structure of the model with relation-specific investments

First in period $t = 0$ both, the buyer and the supplier, have to decide simultaneously about their level of investment. After that, in period $t = 1$, they both bargain about the price of the good p. This induces a two stage sequential game which can be solved via backward induction. Therefore we start our analysis at the last period of the game—in period $t = 1$. For the bargaining process about the price p we assume it leads to the axiomatic Nash bargaining solution[9].

Now, let us start in period $t = 1$. From the assumption of a Nash bargaining solution it follows that trade occurs if,

$$p - c(I^U) = v(I^D) - p.$$

Hence, the equilibrium price is

$$\hat{p} = \frac{v(I^D) + c(I^U)}{2}.$$

Observe that the price $\hat{p}$ increases in I^U as well as in I^D. The price $\hat{p}$ leads to a profit of the supplier of

$$\pi^U = \frac{v(I^D) + c(I^U)}{2} - c(I^U) - I^U,$$

respectively

$$\pi^U = \frac{v(I^D) - c(I^U)}{2} - I^U.$$

To calculate the optimal investment level of the supplier, he solves the optimization problem

$$\max_{I^U \in \{0,1\}} \pi^U = \frac{v(I^D) - c(I^U)}{2} - I^U.$$

[9] See Nash (1950). About their application within economic modelling and for a comparison between the Nash bargaining solution with the strategic bargaining solution of Rubinstein see Binmore et al. (1986). For details about the bargaining solution of Rubinstein see Rubinstein (1982).

This results in an optimal investment level of the supplier of $\hat{I}^U = 0$.[10] Therefore the profit of the buyer is

$$\pi^D = v(I^D) - \frac{v(I^D) + c(I^U)}{2} - I^D,$$

respectively

$$\pi^D = \frac{v(I^D) - c(I^U)}{2} - I^D.$$

For the buyer to find his optimal investment level he solves the optimization problem

$$\max_{I^D \in \{0,1\}} \pi^D = \frac{v(I^D) - c(I^U)}{2} - I^D.$$

This also results in an optimal investment level of $\hat{I}^D = 0$.[11] Hence, in equilibrium neither the buyer nor the supplier will make an investment.

After we have calculated the optimal investment level of the buyer and the supplier, we are now ready to investigate the welfare-optimizing level of investment. This welfare-optimizing level of investment is determinated by the the solution of the optimization problem

$$\max_{I^U, I^D \in \{0,1\}} W = v(I^D) - c(I^U) - I^U - I^D.$$

By solving the above optimization problem the welfare-optimizing level of investment is therefore $\hat{I}^U = 1, \hat{I}^D = 1$.[12] From the result above the following proposition can be stated.

PROPOSITION 1. *Suppose that all assumptions of our model holds: if in a bilateral relationship a buyer and a supplier have to invest in relation-specific assets and the level of investment is not verifiable— i. e. there cannot be written a complete contract that specifies the level of investment ex ante—, then the resulting level of investment will be welfare-inferior.*

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[10] Because we have assumed that the largest possible cost-saving is $\Delta c := c(0) - c(1) < 2$, it results from the fact that $\frac{v(I^D)-c(0)}{2} > \frac{v(I^D)-c(1)}{2} - 1$ that $\pi^U(I^U = 0) > \pi^U(I^U = 1)$.

[11] Because we have assumed that the largest possible value-increase is $\Delta v := v(1) - v(0) < 2$, it results from the fact that $\frac{v(0)-c(I^U)}{2} > \frac{v(1)-c(I^U)}{2} - 1$ that $\pi^D(I^D = 0) > \pi^D(I^D = 1)$.

[12] From the fact that $\Delta v > 1$ and $\Delta c > 1$ it can be concluded that $\Delta v + \Delta c > 2$, which is equivalent to $v(1) - c(1) - 2 > v(0) - c(0)$. Form this it can be finally concluded that $W(I^U = 1, I^D = 1) > W(I^U = 0, I^D = 0)$. It is also easy to show that for all other cases $\hat{I} = (1, 1)$ is the maximum.

Table I. Bi-matrix of the induced game Γ

		I^U: 0	I^U: 1
I^D	0	$\pi^D(0,0)$, $\pi^U(0,0)$	$\pi^D(0,1)$, $\pi^U(1,0)$
	1	$\pi^D(1,0)$, $\pi^U(0,1)$	$\pi^D(1,1)$, $\pi^U(1,1)$

It is easy to perceive that the result is the well-known phenomena of underinvestment in relation-specific assets. This is due to the fact that only half of the value of the investment can privately internalized, because the level of investment cannot be verified and because of the chosen bargaining mechanism. One solution of this problem would e. g. be the integration of the two firms.[13]

2.3. Repeated Interaction

In contrast to section (2.2) we now investigate the case of repeated interaction. Therefore we need a little bit of additional notation. First we define $\pi^i(I^i, I^{-i})$, $i = U, D$ as the profit of player i, if he invests I^i and his opponent $-i$, invests I^{-i}. This leads to the stage game Γ whose bi-matrix is shown in table I. For the payoffs we assume that

$$\pi^i(0,0) > \pi^i(1,0), \quad i = U, D \tag{1}$$

and that

$$\pi^i(0,1) > \pi^i(1,1), \quad i = U, D.$$

From the observation of table I it becomes clear that the game Γ has the structure of the well-known 'prisoner's dilemma'.[14] Therefore it follows that the only unique Nash-equilibrium is that both—neither the supplier U nor the buyer D—invests, i. e. the Nash-equilibrium is $\hat{I} = (\hat{I}^U = 0,\ \hat{I}^D = 0)$. This states the following proposition.

PROPOSITION 2. *If the game Γ is played as an one-shot game, then the only unique* Nash-*equilibrium is that neither the supplier U nor the buyer D invests. Formally, the* Nash-*equilibrium is given by*

$$\hat{I} = (\hat{I}^U = 0, \hat{I}^D = 0).$$

[13] Under specific circumstances an option contract could be another solution of this problem. See Nöldeke and Schmidt (1995) and Maskin and Tirole (1999). Additionally, in some cases the ex ante determination of the renegotiation design could solve this investment problem, too. See Aghion et al. (1994).

[14] For a classical interpretation of the prisoner's dilemma consult Luce and Raiffa (1957), p. 95.

So, is there any possibility to induce cooperate behavior in game Γ? One obvious possibility would be to investigate the repeated play of game Γ. Therefore we need some additional notation. Let us denote the investment decision of player i in period t with I_t^i, the strategy profile of player i and $-i$ (the opponent) in period t with $I_t = (I_t^i, I_t^{-i})$ and the equilibrium strategy profile in period t with $\hat{I}_t = (\hat{I}_t^i, \hat{I}_t^{-i})$. In the following sections we assume that the stage game Γ is static in that sense that the payoffs of the players are constant over time. First we will originate that the game Γ will be repeated finitely, i. e. game Γ will be played in $t = 0, \ldots, T$ with $T < \infty$. If this is the case it can easily be shown by 'backward induction' that even than cooperation in not feasible, i. e. the unique subgame-perfect Nash-equilibrium is that both—neither the buyer nor the supplier—invests in each period. To put formally: $\hat{I}_t = (\hat{I}_t^U = 0, \hat{I}_t^D = 0), \forall t = 0, \ldots, T$.[15] Hence, the following proposition can be concluded.

PROPOSITION 3. *If the game* $\Gamma(T)$ *will be repeated finitely, then the only unique* Nash-*equilibrium is that in each stage* $t = 1, \ldots, T$ *of game* Γ *neither the buyer nor the supplier makes an investment. Formally, the* Nash-*equilibrium is given by*

$$\hat{I}_t = (\hat{I}_t^U = 0, \hat{I}_t^D = 0), \forall t = 1, \ldots, T.$$

In contrast to the last paragraph we now suppose that the game Γ is repeated infinitely with discounting, i. e. $t = 0, \ldots, \infty$.[16] The worst-case utility level of player i is termed as his 'reservation utility' and is defined by

$$\underline{\pi}^i := \min_{I^{-i}} \max_{I^i} \pi^i(I^i, I^{-i}), \quad i = U, D.$$

The utility-level of player i within a stage game could not be lower that his reservation utility.[17] In our specific case the reservation utility of player i is given by

$$\underline{\pi}^i = \pi^i(0, 0), \quad i = U, D.$$

[15] Proof: suppose we are in the last period of the game Γ, i. e. $t = T$. As we have seen in proposition 2 the only unique Nash-equilibrium is that neither the buyer nor the supplier makes an investment. Because both will foresee this result in period $t = T - 1$, both will also not cooperate in $t = T - 1$. And so on. □

[16] Equivalent to that we could imagine that the game is repeated finitely but with a probability of break-off unknown to both of the players. For a brief discussion which model-concept is adequate in which situation see Osborne and Rubinstein (1998), p. 135.

[17] When the stage game is repeated in time, then the average of player i's payoffs could not be lower than his reservation utility.

The most rigid way to motivate a player to make an investment is the so-called 'grim-trigger'-strategy. Within this strategy the reservation utility of the opponent player is used as treat-point, i. e. the player who deviates from the cooperative path will be punished with his reservation utility in all succeeding periods. Hence, the 'grim-trigger'-strategy of player i in period t of our game is formally defined as

$$\text{for } t=0: \qquad I_0^i = 1,$$
$$\text{for } t \geq 1: \qquad I_t^i(h_t) = \begin{cases} 1 & \text{if } h_t = \{(1,1),\ldots,(1,1)\}; \\ 0 & \text{else;} \end{cases} \qquad i = U, D,$$

where h_t denotes the history of the game Γ in period t. To verify under which conditions cooperation is profitable, we have to show at which discount rate the profit of one-sided deviation is smaller than the lasting gain of profit by cooperation. Therefore we define the discount rate for player i[18] $\delta^i \in [0,1]$ as $\delta^i = \frac{1}{1+r^i}$, where $r^i \in I\!R^+$ denotes the interest rate of player i.[19] Additionally we assume that the discount rate is equal for both players $i = U, D$. In the following we use the infinite discounted profits of player i as decision criteria of player i. Hence, the profit of i is defined by

$$\pi^i = \sum_{t=0}^{\infty} (\delta^i)^t \pi^i(I_t) = \frac{1}{1-\delta^i}\pi^i(I_t), \quad i = U, D.$$

To estimate the interval of δ^i within which cooperation is profitable, we have to compare the profit of one-sided deviation with the profit of lasting cooperation. Let us illustrate this point within our game Γ. Does e. g. player $-i$ use the 'grim-trigger'-strategy, then player i will get an one-time profit of $\pi^i(0,1)$ by one-sided deviation in period $t = 0$[20]. Because player $-i$ is using the 'grim-trigger'-strategy, after period $t = 0$ player i will only get a profit of $\pi^i(0,0)$ in all succeeding periods. Therefore it follows that the profit of lasting cooperation must exceed the profit of one-sided deviation for cooperation to be

[18] There is a closely relation between the discount and the interest rate. If the interest rate goes to infinitely $r^i \to \infty$, then all future payoffs become irrelevant, i. e. $\delta^i \to 0$. On the other hand, if the interest rate goes to zero $r^i \to 0$, then the discount rate goes to 1, i. e. $\delta^i \to 1$ and thereby all future payoff will evenly weighted.

[19] In the case of a steady interest rate, which is exactly the case within our model, the discount rate could also be interpreted as $\delta^i = \mathrm{e}^{-\tau r^i}$, where τ denotes the distance between the to periods.

[20] This is also the maximal profit which can be made by one-sided deviation of one player, because future profits are discounted. Because of this, the maximal profit by one-sided deviation can be realized by deviation as soon as possible, respectively in period $t = 0$.

sustainable. Hence, formally cooperation can only be achieved if

$$\pi^i(0,1) + \frac{\delta^i}{1-\delta^i}\pi^i(0,0) \leq \frac{1}{1-\delta^i}\pi^i(1,1), \quad i = U, D,$$

respectively if

$$\pi^i(0,1) - \pi^i(1,1) \leq \frac{\delta^i}{1-\delta^i}\left(\pi^i(1,1) - \pi^i(0,0)\right), \quad i = U, D.$$

From the above follows that δ^i must fulfill the condition

$$\delta^i \geq \frac{\pi^i(0,1) - \pi^i(1,1)}{\pi^i(0,1) - \pi^i(0,0)} := \underline{\delta}^i, \quad i = U, D.$$

Therefore cooperation is feasible for all discount rates $\delta^i \in [\underline{\delta}^i, 1]$, respectively for all interest rates $r^i \in [0, \overline{r}^i]$. This means, that the probability of cooperation is decreasing with the increasing impatience of player i. This is one version of the well-known folk theorem[21], which is stated in the following proposition.

PROPOSITION 4. *In an infinite repeated version of the game* $\Gamma(\infty)$ *both—the supplier and the buyer—make an investment if their discount rate* δ^i *fulfills the condition*

$$\delta^i \geq \frac{\pi^i(0,1) - \pi^i(1,1)}{\pi^i(0,1) - \pi^i(0,0)}, \quad i = U, D.$$

This means, that the discount rate δ *must lie within the interval* $\delta^i \in [\underline{\delta}^i, 1]$ *to make cooperation feasible.*

2.4. Impact of Decreasing Transaction Costs

After we have seen that cooperation can be achieved if both players are patient enough, we now will investigate the impact of decreasing transaction costs on our bilateral relationship. To incorporate this fact in our model we suppose that the buyer refuses to take a relation with the supplier if the supplier does not makes an investment, i. e. if he plays $I^U = 0$. Additionally to that, the buyer has now the possibility to look for an alternative trading partner on an electronic market with $n \in I\!N$ potential partners, respectively potential suppliers. The hierarchical structure of this game is illustrated in figure 3.

[21] For this interpretation of the folk theorem see Friedman (1971). For further interpretations of the folk theorem see e. g. Rubinstein (1979), Fudenberg and Maskin (1986) and Aumann and Shapley (1994).

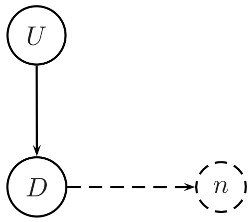

Figure 3. Illustration of a vertical buyer-supplier relation with an alternative electronic market

With the introducing of the new stage our game is now a bit more complex. First in period $t = 0$ both—the buyer and the supplier—decide about the level of investment. If the supplier make an investment, the bargaining process between the buyer and the supplier about the price starts in period $t = 1$. In contrast to that, if the supplier does not make an investment, then the buyer will look for an suitable alternative supplier on the alternative electronic market in period $t = 3$ and the bargaining process will be skipped. The structure of our new game is shown in figure 4.

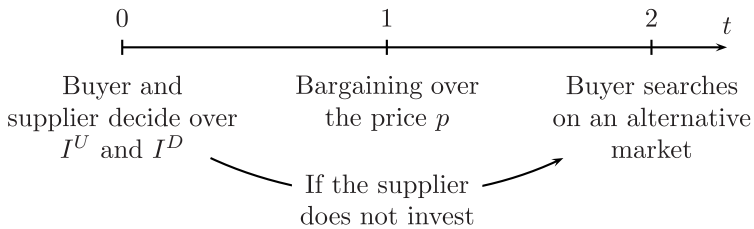

Figure 4. Game structure of the model with an alternative market

To investigate the behavior of the buyer within our model we apply a simple search model[22] in the case that the supplier does not cooperate, i. e. the supplier does not make an investment. We assume that the prices on this market are differentiated and exogenous given, i. e. that this market is not a polypolistic one. Without a loss of generality we want to suppose that the supplier $i, i = 1, \ldots, n$ asks the price $p_i = i$. This means, that supplier 1 asks the price $p_1 = 1$, supplier 2 asks the price $p_2 = 2$, and so forth. This is illustrated in figure 5. In addition to that we assume that the prices will be static over time. The buyer knows the distribution of the prices, but he does not exactly know which supplier asks for which price. This means, that the buyer knows there exists n prices in the order of $p = 1, 2, 3, \ldots, n$, but he does not

[22] For the first work on search theory see Stigler (1951). For more recent work see Rothschild (1974), Weitzmann (1979), Varian (1980) and Stahl (1989). For a good survey see McMillan and Rothschild (1994). The following search model is based on Shy. See Shy (1988), pp. 428.

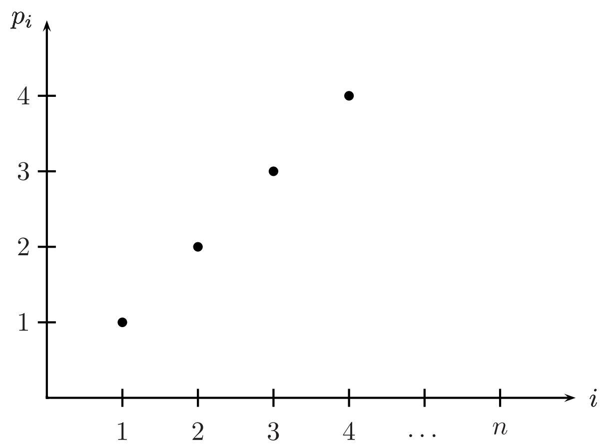

Figure 5. Distribution of the prices

know the exact price which will be asked by a specific supplier. The search induces fixed search costs of $s > 0$ per inquiry, respectively search request, on the buyer. This means, that the buyer has two options after he has received a price offer from one specific supplier: he either can accept the actual price offer at a price of p or he can place another search request at the costs of s. This type of search behavior is known as 'sequential search'. Thereby we suppose that the search costs depend on a technology parameter $\alpha \in \{\underline{\alpha}, \overline{\alpha}\}$, which indicates how well developed the electronic search function on this market is. From this it follows, that the search costs of the buyer per search request are $s(\alpha)$. Additionally we assume that $s'(\alpha) < 0$ and $s''(\alpha) > 0$.[23] We also suppose that the profit of the buyer is in any case bigger than when he initiates bilateral bargaining with the supplier U, i. e. that

$$\pi^D(p(s(\alpha), n)) > \pi^D(0, 0), \quad \forall \alpha \in \{\underline{\alpha}, \overline{\alpha}\}, n$$

and

$$\pi^D(p(s(\alpha), n)) > \pi^D(0, 1), \quad \forall \alpha \in \{\underline{\alpha}, \overline{\alpha}\}, n.$$

Technically spoken, the buyer has to solve a dynamic optimization problem with each search request. If thereby the distribution of the prices on the market is stationary[24], as in our example, then this dynamic optimization problem could be reduced to a simple decision rule.[25]

[23] This means, that the search costs decrease by an increasingly well developed search function, but with a decreasing rate.

[24] This means, that the distribution of the prices does not change in time and the time horizon is finite.

[25] For the proof of this proposition see Lippman and McCall (1976).

Let us assume that the buyer starts a search request at a particular supplier and gets a price offer of p. Additionally let us define $\vartheta(p)$ as the expected price reduction of the buyer, if he starts an additional search request when he has already a price offer p in hand. Because each price is p_i has an equal probability of $g(p_i) = \frac{1}{n}$, $\forall i$, $\vartheta(p)$ is defined by

$$\vartheta(p) := \sum_{i=1}^{p} g(p_i)(p-i) = \sum_{i=1}^{p} \frac{1}{n}(p-i) = \frac{p-1}{n} + \frac{p-2}{n} + \ldots + \frac{1}{n}. \quad (2)$$

In other words: the profit of an additional search request—if the buyer already holds a price offer p in hand—equals whose expected price reduction. This also equals the expected profit of finding a price reduction by one unit of money $\frac{p-1}{n}$ plus the expected profit of finding a price reduction by two units of money $\frac{p-2}{n}$, and so on. To use equation (2) in our model we first need the following lemma.

LEMMA 5. *The sum of J numbers can be calculated by*

$$\sum_{j=1}^{J} j := 1 + 2 + \ldots + J = \frac{J(J+1)}{2}.$$

With the help of lemma 5 we then come to the following lemma.

LEMMA 6. *The function $\vartheta(p)$ which is defined by equation* (2) *and can be written as*

$$\vartheta(p) = \frac{p^2 - p}{2n}.$$

We now take a closer look at the two options of our buyer after he has a price offer p in hand. If he accepts this price offer, then he has to pay price p and the search process is finished. On the other hand, he can continue his search and therefore has to bear the search costs $s(\alpha)$. Formally spoken: the buyer, if he holds already a price offer of p in hand, minimizes

$$\xi(p) = \begin{cases} p, & \text{he buys the good;} \\ s(\alpha) + p - \vartheta(p), & \text{he performs a further search.} \end{cases} \quad (3)$$

Equation (3) shows that a cost-minimizing buyer stops his search, if $p \leq s(\alpha) + p - \vartheta(p)$. On the other hand the buyer will continue to search, if $p > s(\alpha) + p - \vartheta(p)$. From this fact we can state the following proposition.

PROPOSITION 7. *A buyer who holds a price offer p in hand will continue his search, if the expected price reduction of an additional*

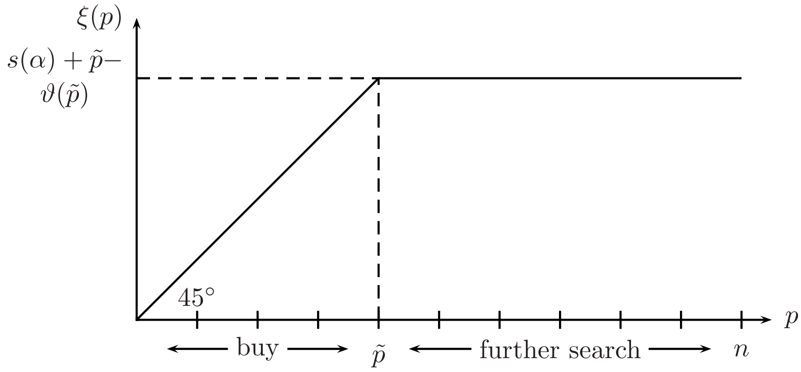

Figure 6. Reservation-price strategy

search exceeds the search costs of an additional search request. Formally this means, that the buyer only continues to search, if the price offer p *he already holds in hand fulfills the condition*

$$\vartheta(p) > s(\alpha).$$

The search strategy described in proposition 7 is known as so-called 'reservation-price strategy', where the reservation-price is definition by the following definition.

DEFINITION 8. A price $\tilde{p}$ is called reservation-price, if he fulfills the condition

$$\vartheta(\tilde{p}) = s(\alpha).$$

Figure 6 illustrates a typical function of a reservation-price strategy of a buyer. In figure 6 the buyer gets a price offer p from a supplier. If $p \leq \tilde{p}$, then then buyer will stop his search and buys the good at once at price p. On the other hand, if the buyer recognizes a price $p > \tilde{p}$, then he starts an additional search request, to accept or reject the following price offer, depending on the fact if $p \leq \tilde{p}$ or $p > \tilde{p}$.

Now let us calculate the reservation-price strategy of the buyer. From definition (8) it is quite clear that the reservation-price is implicit defined by $\xi(\tilde{p}) = s(\alpha)$. Hence, because of lemma 6, the reservation-price can be calculated by solving the equation

$$\begin{aligned} \vartheta(\tilde{p}) = \frac{\tilde{p}^2 - \tilde{p}}{2n} &= s(\alpha) \\ \Leftrightarrow \quad \tilde{p}^2 - \tilde{p} - 2ns(\alpha) &= 0. \end{aligned}$$

From the quadratic equation above results[26] a reservation-price of

$$\tilde{p} = \frac{1 + \sqrt{1 + 8ns(\alpha)}}{2}. \tag{4}$$

A closer look at equation (4) reveals some interesting properties of the reservation-price which are combined in the following proposition.

PROPOSITION 9. *The reservation-price of a buyer $\tilde{p}$ fulfills the following conditions:*

1. *If the search costs come negligibly small, the buyer will continue his search until he will get the lowest price offer. Formally spoken this means if $s(\alpha) \to 0$, $\tilde{p} \to 1$.*
2. *An increase of the search costs results in an increase of the reservation price of the buyer.*
3. *An increase of the number of high-price suppliers, respectively increasing n, leads to an increase of the reservation-price of the buyer.*

Part two of proposition 9 states that if the search costs increase, the buyer is willing to buy at a higher price to avoid these additional search costs. Up to now we have specified if it is possible for the buyer costlessly to return to a previously visited supplier to accept his price offer afterwards.[27] The following proposition explains why we do not have to make an assumption about this fact in our context.

PROPOSITION 10. *Even if it is possible for a buyer in a sequential search costlessly to return to a previously visited supplier from whom he his has already received a price offer p to afterwards accept his offer, he will never do so.*

The above result follows straightforward from the fact that the buyer has already rejected the offer. For the exact proof consult the appendix. Now let us take a closed at the profit of the buyer D. The profit in the case of a reservation-price $\tilde{p}$ on an alternative market is

$$\tilde{\pi}^D(\tilde{p}(s(\alpha), n)) = v(I^D) - \tilde{p}(s(\alpha), n) - I^D. \tag{5}$$

To decide wether the buyer will make an investment or not, he has to solve the optimization problem

$$\max_{I^D \in \{0,1\}} \tilde{\pi}^D(\tilde{p}(s(\alpha), n)) = v(I^D) - \tilde{p}(s(\alpha), n) - I^D.$$

[26] This is the case, because we want to rule out negative prices and because from $n, s > 0$ it follows that $\sqrt{1 + 8ns(\alpha)} > 1$. Hence, only the positive root of the quadratic equation is relevant.

[27] This type of search is commonly known as ‘search with recall’.

Table II. Bi-matrix of the induced game with an alternative market

		I^U: 0	I^U: 1
I^D	0	$\pi^D(0,0)$, $\pi^U(0,0)$	$\pi^D(0,1)$, $\pi^U(1,0)$
	1	$\pi^D(1,0)$, $\pi^U(0,1)$	$\pi^D(1,1)$, $\pi^U(1,1)$

From this it follows that the buyer now invests, respectively he chooses $\hat{I}^D = 1$, because now he is able to acquire the whole marginal profit of his investment privately.[28] Let us now investigate the behavior of the profit of the buyer in dependance on the height of the search costs. Therefore we partially derive the profit of the buyer to α, given by equation (5), so it results

$$\frac{\partial \tilde{\pi}^D(\tilde{p}(s(\alpha), n))}{\partial \alpha} = -\frac{2ns'(\alpha)}{n\sqrt{1+8ns(\alpha)}}. \tag{6}$$

An inspection of equation (6) shows that, according to our assumption (cause $s'(\alpha) < 0$ and $n \in I\!N$), the numerator is smaller than zero and that the denominator, according to $n \in I\!N$ and $s(\alpha) > 0$, is bigger than zero. Therefore it follows that equation (6) increases with increasing α. Hence,

$$\frac{\partial \tilde{\pi}^D(\tilde{p}(s(\alpha), n))}{\partial \alpha} > 0.$$

Because of the modified profit of the buyer $\tilde{\pi}^D$ we now have to look at a slightly different stage game $\tilde{\Gamma}$, which is shown in figure II. In comparison to the stage game Γ without an alternative market in figure I we see, that the prohibitive utility of the buyer D has been increased from $\pi^D(0,0)$ to $\tilde{\pi}^D(0,0)$.[29] The discount rate δ^D which makes cooperation feasible has to fulfill the condition

$$\tilde{\delta}^D \geq \frac{\pi^D(0,1) - \pi^D(1,1)}{\pi^D(0,1) - \tilde{\pi}^D(0,0)} := \underline{\tilde{\delta}}^D. \tag{7}$$

From the assumption in equation (1) it follows that

$$\tilde{\pi}^D(0,0) > \pi^D(0,0).$$

Finally, in connection with equation (7) this means that

$$\underline{\tilde{\delta}}^D > \underline{\delta}^D.$$

[28] This result follows from the assumption that $\Delta v > 1$.
[29] This is true due to equation (1).

Because now the buyer and the supplier have different discount rates, the discount rate which makes cooperation feasible is now determinated by the maximum of the both discount rates, respectively

$$\underline{\tilde{\delta}} := \max\{\underline{\delta}^U, \underline{\tilde{\delta}}^D\} = \underline{\tilde{\delta}}^D.$$

Altogether this means, that the discount rate which makes cooperation feasible is higher in a situation with an existing alternative market than in a situation without one. Or, to put it formally

$$[\underline{\tilde{\delta}}^D, 1] < [\underline{\delta}^i, 1], \quad i = U, D.$$

Recapitulatory this means, that in our model cooperative behavior will become less probable with the existence of an alternative market, which is summarized in the following proposition.

PROPOSITION 11. *In an infinitely repeated version of the game* $\Gamma(\infty)$, *in which one of the players has access to an alternative electronic market, the prohibitive utility of the player who has this access will increase. Therefore the probability of cooperative behavior will decrease.*

3. Discussion

Our analysis shows the impact of relation-specific assets in an incomplete contracts environment on the level of investment. We have seen that the resulting investment level is always welfare-inferior. Additionally, we have seen that even finite repeated interaction does not change this result. In contrast to this, infinite interaction does—but only if both players are sufficiently patient. Finally, we have seen that the existence of an alternative electronic market can have an impact on the willingness to cooperate between firms. Within our setting the willingness to cooperate of the buyer declines.

Our analysis was based on a rather simple model. Nevertheless the model is appropriate for becoming a first intuition about the interfirm organizational consequences of electronic markets. But due to the simplicity of the model, there is much room for extensions. First of all you could think about different distribution of the prices, respectively price dispersion. This would have effects on the reservation-price, and therefore effects on the results. In addition to that you could think about the application of different search strategies. This would also effect the above results. Furthermore, it would be useful to investigate what happens if also the supplier has the possibility to search for an alternative buyer. This would transform the model into a matching model. Also the investigation of the case of different discount rates for the buyer and the supplier—which could be result from different planning horizons—could have impacts on the results.

One assumption of our model was, that the number of firms on the alternative market is exogenously given. But this must not be the case. For instance, you could imagine to build in an endogenously terminated number of firms, which could for instance result from different technology parameters α. In addition to this we have assumed, that the search will strictly result in a higher profit for the searcher. But this must not be the case. This fact could e. g. investigated by an more exactly specification of the value and cost function. Also a more exactly specification of the market with regard to the price-building process and to restricted market access would be meaningful extensions, cause in reality electronic markets are very heterogenous. There could also be won useful insights by including the above model in a much more extensive framework—e. g. for a whole industry with several bilateral trading relations—to determine the dominant coordination structure of his particular industry.

In addition to all the analytical extensions, an empirical validation of the shown results is necessary to verify the shown results. Generally much more research about the welfare impacts of electronic markets is needed.

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Appendix

Proof (of Lemma 5). Let us denote the sum $\sum_{j=1}^{J}$ with ϕ and let us look at the sum

$$\begin{array}{ccccccccccccc} 1 & + & 2 & + & s3 & + & \dots & + & J & + & & \\ J & + & J-1 & + & J-2 & + & \dots & + & 1 & = & 2\phi. \end{array}$$

Because each column adds up to $J+1$ and there exist J columns, it follows that $2\phi = J(J+1)$. Hence, $\phi = \frac{J(J+1)}{2}$. □

Proof (of Lemma 6). By the definition resulting from equation (2) we know that $\vartheta(p) := \frac{1+2+...+(p-1)}{n}$. From this, in conjunction with lemma 5, it follows that $\vartheta(p) = \frac{(p-1)p}{2} = \frac{p^2-p}{2n}$. $\square$

Proof (of Proposition 10). Since the buyer employs a reservation-price strategy, he will always buy if $p \leq \tilde{p}$ and never buy if $p > \tilde{p}$. Hence, if he had not bought at a previously visited supplier—because the supplier asked for a price $p > \tilde{p}$—and we have additionally assumed that the prices of the suppliers are static in time, then the buyer has no incentive to return to the previously visited supplier. $\square$

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