The merger paradox and why aspiration levels let it fail in the laboratory

Huck, S.; Konrad, K.A.; Müller, W.; Normann, H.T.

Published in:
Economic Journal

Publication date:
2007

The Economic Journal, **117** (*July*), 1073–1095. © The Author(s). Journal compilation © Royal Economic Society 2007. Published by Blackwell Publishing, 9600 Garsington Road, Oxford OX4 2DQ, UK and 350 Main Street, Malden, MA 02148, USA.

THE MERGER PARADOX AND WHY ASPIRATION LEVELS LET IT FAIL IN THE LABORATORY*

Steffen Huck, Kai A. Konrad, Wieland Müller and Hans-Theo Normann

We study the merger paradox, a relative of Harsanyi's bargaining paradox, in an experiment. We examine bilateral mergers in experimental Cournot markets with initially three or four firms. Standard Cournot-Nash equilibrium predicts total outputs well. However, merged firms produce significantly more output than their competitors. As a result, mergers are not unprofitable. By analysing control treatments, we provide an explanation for these results based on the notion of aspiration levels, and show that the same logic also operates when a new firm enters a market. These results have some general consequences for adaptive play in changing environments.

Among all counterintuitive results in game theory, Harsanyi's *bargaining paradox* and its relative, the *merger paradox*, stand out as both, particularly striking and real-world relevant. Cooperation in non-cooperative environments, they say, can be harmful.

Harsanyi (1977, p. 203) considers a situation in which n players bargain about the division of a pie. In sufficiently symmetric environments each player will typically receive a share of $1/n$. Now suppose two players enter into a coalition and act as one united player. Then, so Harsanyi points out, this is equivalent to a symmetric bargaining situation with $n - 1$ players. Hence, while two players receive $2/n$ as long as they act independently, they receive only $1/(n - 1)$ if they act jointly.

A similar logic underpins Salant *et al.*'s (1983) merger paradox. Considering symmetric Cournot markets with homogeneous products and linear demand and cost, they show that bilateral mergers are never profitable as long as there are more than two firms to start with. As in Harsanyi's bargaining paradox, the merged party's profit share falls from $2/n$ to $1/(n - 1)$. In contrast to Harsanyi's case, the 'pie' that is shared among firms is not exogenous. Through the merger, industry concentration increases and so do total industry profits. But the increase is not sufficient to offset the falling profit share. The two firms will find that merger was a bad idea. Essentially, two merging (or perfectly cooperating) firms in a Cournot market have an incentive to reduce their output to internalise the negative externalities they exert on each other. If the other firms were not to react to this output contraction, this cooperation would be profitable. However, in a Cournot market, the firms which are not part of the merger

* We thank Uwe Dulleck, Dan Friedman, Heike Harmgart, Philippe Jehiel, Dorothea Kübler, Jörg Oechssler, Andreas Ortmann, Reinhard Selten, and Georg Weizsäcker for many helpful comments and we are grateful to two anonymous referees and Leonardo Felli who helped to improve this paper further. Thanks are also due to participants of the 2001 ESA meetings in San Antonio and Barcelona and the 2001 SEA meeting in Tampa as well as to seminar participants at Amsterdam (Tinbergen), Bonn, CERGE-EI, Connecticut, Essex, Groningen, Helsinki, Humboldt University, LSE, Magdeburg, Nottingham, NYU, Oxford, Royal Holloway, Rutgers, the Stockholm School of Economics, Tilburg, UCL, and the University of Vienna. The usual caveat applies. Huck acknowledges financial support from the ESRC via ELSE and the Leverhulme Trust. Konrad acknowledges financial support from the German Science Foundation (DFG grant SFB-TR-15). An earlier version of this article circulated under the title 'Mergers and the perception of market power: An experimental study'.

react to this anticipated reduction in output by an increase in their output. This strategic effect harms the merged firms.

In this article, we report results from experiments designed to test the merger paradox. More specifically, we study bilateral mergers in an experimental Cournot market with initially three and four firms, respectively. After the first phase of the experiment, two players consolidate and the second phase of the experiment begins with two firms being merged. The merged firms are jointly owned and profits are to be shared.[1] Implementing the bilateral mergers in markets that have been in existence for a while[2] allows us to observe the same group of subjects before and after the merger. This helps us to investigate whether markets with a merger history perform differently from markets in which a merger has not occurred, even if both have the same number of firms.[3]

Our main result is that, contrary to the prediction for a Cournot oligopoly, post-merger markets are not symmetric. Merged firms behave systematically more competitively than nonmerged firms, i.e., merged firms produce systematically more than predicted, nonmerged firms systematically less. Moreover, nonmerged firms produce quantities that are, on average, best replies to the outputs of the merged firms, whereas the choice of the merged firms is not a best reply. As a consequence, the profits of the merging firms do not decline as drastically as predicted. On the contrary, the merging firms may even experience a transitory increase in profits in the short run and, in larger markets, they are roughly able to maintain their original profits (prior to merger) in the long run. The result is surprising as (pre merger) industry output is well predicted by the Cournot model. As with other studies of Cournot markets,[4] we find some collusion in duopoly markets such that total output is below the Cournot level. With three or four firms, the standard Cournot model predicts actual total output remarkably well. Also, the (post merger) adjustments in quantities players make are clearly anti-competitive and, insofar, in line with the predictions. But, regarding the merger paradox, our results depart distinctly from the predictions of Cournot oligopoly theory.

We present three possible explanations for this result:

(*a*) the mere fact that one firm has resulted from a merger renders the firm 'strong' and the whole market game asymmetric;
(*b*) as the merged firms are jointly owned, fairness considerations shift output (and therefore profits) from unmerged to merged firms;
(*c*) merged firms are committed to maintaining their original profits because of aspiration levels created in the pre merger markets.

[1] This design feature is arguably in line with mergers in the field. Obviously, dividends go to two groups of share holders after the merger.

[2] We depart from the 'cross-sectional' approach where markets with different numbers of competitors are compared in between-subject designs. Such 'pure number effects' have been studied, for example, by Fouraker and Siegel (1963) and, more recently, by Dufwenberg and Gneezy (2000) and Huck, Normann and Oechssler (2004).

[3] Previous experiments with this property include several papers by Davis and his coauthors. Davis and Holt (1994) study posted-offer markets with initially five firms. The merger involves three firms, but market power is held constant by design. Davis and Wilson (2000) also analyse posted-offer markets, but their experiments involve reallocation of plant capacity among firms which may or may not create market power. Davis and Wilson (2005) and Davis (2002) analyse mergers in markets with differentiated products. The experiments are designed to examine the behavioural relevance of the Antitrust Litigation Model.

[4] A survey can be found in Huck, Normann and Oechssler (2004).

To discriminate between these possible explanations, we conduct two further treatments. On the basis of the results, we can rule out explanations (*a*) and (*b*). We then study a third control treatment where, instead of a merger, we have entry of a new firm after a while. The aspiration level hypothesis predicts that incumbents will struggle in order to maintain their pre-entry profits. Remarkably, the hypothesis is confirmed despite the shrinking of industry profits which makes it more difficult to maintain profits than in the merger case where industry profits rise. Thus, we are left with a result that is reminiscent of early work by Cyert and March (1956) who – drawing on Simon's work[5] – argued that firms' behaviour is guided by an 'acceptable-level profit norm' and provided empirical evidence that firms with declining market shares strive harder to increase sales than others.

We discuss the bearings of our findings on the empirical merger literature. We first point out that a structural approach to our data would yield wrong inferences. Assuming equilibrium play one would conclude from our data that the mergers induced cost advantages which they have not. As a consequence of this, a structural approach might also conclude that a merger increased welfare where, in fact, it has not. We also discuss several reduced-form findings as well as results from event studies on merger activity and compare them to our main insights – that, if a merger threatens to turn out unprofitable, the merged firm will resort to more competitive strategies and that, as a consequence, outsiders do not benefit as much from merger activity as predicted by Nash equilibrium.

The remainder of this article is organised as follows. In the next Section we present the predictions of Cournot oligopoly theory and the experimental design. Section 2 contains the data analysis and main results. It also discusses the literature on aspiration levels and implications for mergers. Section 3 concludes.

1. Theory and Experimental Design

In a series of computerised[6] experiments, we studied bilateral mergers in symmetric n-firm Cournot oligopoly markets. For all markets we used the following demand and cost functions. The demand side of the market was modelled with the computer buying all supplied units according to the inverse demand function

$$p = \max\{100 - Q, 0\} \tag{1}$$

with $Q = \sum_{i=1}^{n} q_i$ denoting total quantity, and q_i denoting firm i's quantity. The cost function for each seller was simply

$$C(q_i) = q_i, \tag{2}$$

that is, marginal cost was constant and equal to one.

The individual equilibrium output in the Nash equilibrium is

$$q_i^* = \frac{99}{n+1} \tag{3}$$

and the equilibrium profit is

[5] See, e.g., Simon (1955, 1959).
[6] We used the software toolbox 'Z-Tree', developed by Fischbacher (2007).

$$\pi_i^* = (q_i^*)^2 = 9801/(n+1)^2. \tag{4}$$

In what follows we will refer to these outcomes as the *Cournot predictions.* Alternative benchmark outcomes are the joint profit maximum and the competitive equilibrium. The symmetric collusive output for a firm is $q_i = 99/2n$, and price equals marginal cost if each firm produces $q_i = 99/n$.

Subjects could choose quantities from a finite grid between 0 and 100, with 0.01 as the smallest step. Hence, the action space had a sufficiently fine grid for continuous action spaces to be approximated. Therefore, the above benchmarks are also valid in the experiment.[7]

Subjects had information about demand and cost conditions so they could calculate best replies to the quantities of the other firms. This information was provided verbally (see the Appendix) and in the form of a 'profit calculator'. The profit calculator worked as follows. When fed with data regarding the other firms (total quantities of the other firms), the calculator allowed the consequences of own actions to be tried out. Note that a profit calculator gives qualitatively the same information as a profit table which is often provided in Cournot experiments (Holt, 1985). However, the profit calculator might help to avoid a bias due to the subjects' limited computational capabilities. After each period, subjects were informed about their own quantity and profit and the aggregate quantity their competitors produced.[8]

We studied bilateral mergers in markets with initially four and three firms (treatments '$4 \to 3$' and '$3 \to 2$'). Additionally, we ran a duopoly control treatment ('2const'). The duopoly control treatment consisted of 25 rounds only. In both merger treatments, subjects were informed that the experiment would consist of two phases, each comprising 25 rounds. They were, however, not told what would happen after the end of the first phase. After round 25 they received a new set of instructions informing them that a merger would occur. Table 1 summarises the design of our treatments (the treatments '$4 \to$ 3GO', '$3 + 1$', and '$3 \to 4$' will be introduced below).

The merger was conducted as follows. The firms that merged were chosen randomly. One of the subjects involved in the merger became responsible for making all actual decisions, while the other remained in the lab and was able to send messages to his or her partner.[9] The instructions made it clear that these messages were not binding. We allowed for these messages in order to keep the passive subject somewhat involved in the decision process. Profits were shared equally between the two of them and this was known to all participants.

According to the Cournot predictions, behaviour in each round of all treatments should depend only on the number of firms, i.e., one would expect to observe similar data in, say, the second phase of the treatment '$3 \to 2$' and the duopoly control treat-

[7] The fine grid also has the advantage that multiple Nash equilibria due to the discretisation of the action space (Holt, 1985) can be avoided.

[8] Note that this informational condition was not suitable for identifying individual quantities and profits. Among various different informational conditions, this setup led to outcomes which came closest to the Nash prediction in the four firm oligopolies in Huck *et al.* (1999, 2000).

[9] Subjects could pick one of three possible messages: 'produce more', 'produce less' or 'produce as much as before'. They were allowed to do so every five periods starting at the beginning of the second period after the merger.

Table 1

Treatments

Treatment	subjects	periods	Description
'4→3'	4	2 × 25	2 out of 4 firms merge after 25 periods 2 subjects share profits post merger
'3→2'	3	2 × 25	2 out of 3 firms merge after 25 periods 2 subjects share profits post merger
'2const'	2	25	2-firm control treatment standard Cournot duopoly
'4→3GO'	4	2 × 25	2 out of 4 firms merge after 25 periods 1 subject gets merger profit, 1 leaves the lab
'3+1'	4	25	3 firms, 4 subjects profit of one firm is shared by two subjects
'3→4'	4	2 × 25	a fourth firm enters the market after 25 periods

ment '2const'. Therefore, from (3), the prediction for industry output is $Q(n) = 99n/(n+1)$.

All experiments were conducted at Technical and Humboldt University Berlin. We conducted six markets for each treatment. The six duopolies were run in one session. We had two sessions for each of the treatments '4→3' and '3→2'. Subjects were randomly allocated to computer terminals in the lab so that they could not infer with whom they would interact in a group. 126 subjects participated in this study including the control treatments '4→3GO', '3+ 1', and '3→4'. Subjects were students from various departments, recruited via telephone and e-mail. We varied the exchange rates dependent on the number of firms such that subjects would have made identical earnings at Nash equilibrium play. The average payoff was about euro 20.19 (at the time of the experiment roughly $20). Sessions for treatments '4→3' and '3→2' lasted about 90 minutes, the session for treatment '2const' about 50 minutes including instruction time.

Written instructions (see the Appendix) were distributed in the beginning of each session. After the instructions were read, we explained the different windows of the computer screen. When subjects were familiar with both the rules and the handling of the computer program, we started the first round.

2. Experimental Results

We present our results in several parts. In the first part, we focus exclusively on total output. As we assume constant marginal and average cost, total output perfectly measures the degree of competition and total welfare. In the second part, we analyse firms' quantity setting behaviour , focussing on the importance of merger history. The effects of merger history are quantified with the help of a linear regression. Then we turn to firms' profits thoroughly testing the merger paradox. For this purpose we test whether post-merger profits of merged firms are different from joint pre-merger profits. We also test whether, in line with the theory by Salant *et al.* (1983) non-merged firms gain from the merger. Finally, we discuss the results of three control treatments in order to identify a behavioural explanation for our findings.

2.1. *Total Output*

Table 2 provides information on average total output as observed in the experiment as well as the prediction. We classify the results by the last third before the merger and the first and the last third post merger.[10] Recall that the duopoly market (treatment '2const') serves as a control market that lasted for only 25 rounds. Therefore, only average total quantity in the last third of this market is shown in Table 2. Note that, unless we explicitly state otherwise, for all subsequent statistical tests and for the computation of standard errors, we take one group's average total output as one observation in order to account for possible dependence of observations within one group.

We focus on the behaviour in the last third of the first phase (pre merger) and the first and the last third of the second phase (post merger). This serves two purposes: First, we can analyse experienced, long-run behaviour by comparing the last thirds in which behaviour has settled down. Secondly, by comparing the last third of the first phase and the first third of the second phase, we can analyse the (potentially transient) short-run effects of the changes induced by the merger.

As a first step, we analyse whether markets in the first phase, i.e., before the merger, converge to the Cournot prediction. We answer this question by comparing observed average total output in the last third of the first phase with the predicted numbers. Consider treatment '2const'. Here, predicted industry output is 66.00, whereas we observe on average 60.01 units of output. This implies that our experimental duopoly markets are more collusive than the Cournot prediction.[11] Next, consider the markets with three or four firms prior to merger. Whereas the triopoly pre merger market is slightly less competitive than predicted (72.96 vs. 74.25), we find that the quadropoly pre merger market is slightly more competitive than predicted (81.17 vs. 79.20). Moreover, comparing total outputs in the quadropoly pre merger markets with those in the triopoly markets (81.17 vs. 72.96) and the latter, in turn, with those in the duopolies (72.96 vs. 60.01), we find that 'number effects' are prevalent and statistically significant.[12] We summarise these results as follows

Table 2

Average Industry Quantities

	'4→3'			'3→2'			'2const'
	Pre	Post		Pre	Post		
Phase	last 3rd	first 3rd	last 3rd	last 3rd	first 3rd	last 3rd	last 3rd
Theory	79.20	74.25		74.25	66.00		66.00
Mean	81.17	70.33	75.12	72.96	63.27	67.60	60.01
(std.err.)	(2.59)	(2.03)	(3.09)	(2.10)	(3.80)	(3.01)	(3.08)

[10] We discarded the last round of both phases because we wanted to eliminate end-game effects (which were significant in the duopoly markets). This left us with 24 rounds for each phase which we divided into thirds (1–8, 9–16, 17–24). Comparing the thirds within each treatment it became obvious that behaviour only settled down in the last thirds.

[11] Our finding is consistent with results in Holt (1985) or Huck *et al.* (2001) who report that collusion frequently occurs in repeated Cournot settings with fixed pairs of participants.

[12] Using one-tailed Mann-Whitney U-tests, the p-levels are 0.0125 and 0.008, respectively.

Result 1. *The experimental duopoly markets are more collusive than predicted. Total outputs in the three and four firm pre merger markets are close to the Cournot prediction.*

Now consider the short-run effects induced by the merger. We compare average total quantities in the first third after the merger with those observed in the last third before the merger (treatments '3→2' and '4→3'). Inspecting Table 2, we find that, immediately after the merger, total quantity in both markets drops drastically – from 72.96 to 63.27 in treatment '3→2' and from 81.17 to 70.34 in treatment '4→3'. In both cases, this decline in industry output is statistically significant.[13] Moreover, in both markets, total output drops to a value below the Cournot prediction for the post-merger Nash equilibrium. Therefore, we have

Result 2. *In both markets the short-run effect of merger is more drastic than predicted. Total output drops below the Nash level.*

Given some time for adjustment, subjects' play may differ from that in the first third. Therefore, it seems worth having a look at the long-run effects induced by the merger. Here, we compare average total quantities in the last third post merger with those observed in the last third prior to merger. Inspecting Table 2 again, we see that, during the second phase of the experiment, total quantities rise in both treatments. In fact, in both cases they converge to a value close to the Cournot prediction. In treatment '3→2' average total output converges to 67.70 in the last third of the second phase where the output for the Cournot prediction is 66.00; in treatment '4→3' average total output converges to 75.12 where the Cournot prediction of output is 74.25. Note that average industry output in the last third after the merger is still significantly lower than average industry output in the last third before the merger.[14] Summarising we have

Result 3. *The long-run effects induced by a merger are in line with the prediction as average total quantities decrease from a value around the Nash equilibrium with n firms to a value that is close to the Nash equilibrium with $n - 1$ firms.*

As argued in the introduction, we maintain that a market with a merger history may perform differently from one without a merger. If this is true at the aggregate level, output in post merger markets (last third) should be different from the output in pre merger markets (last third) with the same number of firms. However, the result above already indicates that this does not hold for three firms. Our experimental triopoly markets emerging from a merger do produce on average higher total outputs than triopoly markets without a merger history (75.12 vs. 72.96), but these differences are not significant.[15] With duopoly, we do find a stronger effect. From Table 2, we observe that duopoly markets emerging from a merger are more competitive than the duopoly

[13] At $p = 0.023$ in treatment '3→2' and at $p = 0.014$ in treatment '4→3' (one–tailed Wilcoxon test).
[14] Again, a one-tailed Wilcoxon test, delivers $p = 0.058$ for treatment '3→2' and $p = 0.0865$ for treatment '4→3'.
[15] $p = 0.3745$ (one-tailed Mann-Whitney U test).

markets without a merger history (67.60 vs. 60.01). This difference is significant.[16] We summarise by

RESULT 4. *Duopoly markets emerging from a merger are significantly more competitive than duopoly markets without merger history. This does not hold for triopoly markets.*

The first part of this result indicates that our hypothesis, that history may matter, could indeed be relevant. Therefore, we turn in the next subsection to the analysis of firms' individual behaviour.

2.2 *Individual Outputs*

The central question in this subsection is: does merger history matter at the firm level? Is merger perceived as something that is equivalent to the exit of one firm, or does the fact that one of the remaining firms is generated by the fusion of two firms distinguish this firm from the others? Table 3 shows average individual quantities for the two types of firms. We observe the following facts.

1. In post merger situations, the merged firms choose higher quantities than firms that have not been merged. This result is immediate from Table 3. For both treatments '4→3' and '3→2' we find that this result holds across the entire postmerger phase. In the first third, there are significant differences between merged and non-merged firms. In the last third, however, the gap in average output is slightly smaller than in the first third and is no longer significant in treatment '3→2'. However, differences in treatment '4→3' are still significant.[17]
2. Merged firms also produce higher quantities than firms in markets with no merger history but the same number of competitors. More specifically, we compare the first and the last third of '3→2' post merger with the last third of '2const'. And we compare the first and the last third of '4→3' post merger with the last third '3→2' prior to merger. In all four cases, the merged firm

Table 3
Average Individual Quantities

	'4→3'		(post merger)		'3→2'		(post merger)	
	first 3rd		last 3rd		first 3rd		last 3rd	
Merged	No	Yes	No	Yes	No	Yes	No	Yes
Theory			24.75				33.00	
Mean	20.04	30.25	22.62	29.88	28.25	35.02	31.25	36.35
(std.err.)	(0.89)	(1.71)	(1.96)	(2.59)	(3.00)	(2.16)	(3.04)	(2.30)

[16] At $p = 0.0325$ (one-tailed Mann-Whitney U test).
[17] First third: $p = 0.002$ '4→3' and $p = 0.039$ '3→2'. Last third: $p = 0.039$ '4→ 3' and $p = 0.211$ '3→2'; one-tailed MWU tests.

produces significantly more than a firm in a theoretically equivalent market without merger history.[18]

3. Unmerged firms in (post merger) markets with three firms produce slightly less than firms in three firm markets without a merger history. In the case of two firms, they produce slightly more. However, both observations can be reconciled by considering the behaviour of the respective merged firms. Given the average quantity of a merged firm in the last third of '4→3', the unmerged firms play almost exactly according to the Cournot solution for the resulting residual demand (which predicts 23.04 and compares to 22.62). Similarly, the unmerged firms' best reply in the last third of '3→2' would be 31.33 which compares to an actual average of 31.25.

The last point is worthwhile illustrating. For each treatment let Δ be the difference between the Cournot solution for the residual demand given the merged firm's quantity, $CS(q_{\text{merged}})$, and the actual average of the unmerged firms output, $\overline{q}_{\text{unmerg}}$. That is

$$\Delta = CS(q_{\text{merged}}) - \overline{q}_{\text{unmerg}} = \begin{cases} (99 - q_{\text{merg}})/2 - \overline{q}_{\text{unmerg}} & \text{in '3} \rightarrow \text{2'} \\ (99 - q_{\text{merg}})/3 - \overline{q}_{\text{unmerg}} & \text{in '4} \rightarrow \text{3'}. \end{cases}$$

Figure 1 shows histograms of Δ for the two treatments in the last third after the merger. The histograms reveal that in both treatments about 71% of all observations fall into the interval $[-5, 5]$. This suggests that unmerged firms indeed very often choose actions consistent with the hypothesis that they play Cournot with respect to the residual demand (which amounts in treatment '3→2' simply to playing the best reply against the merged firm).

Our experiments suggest that there is a behavioural asymmetry between firms. The data indicate that merged firms produce more and unmerged firms yield to this more

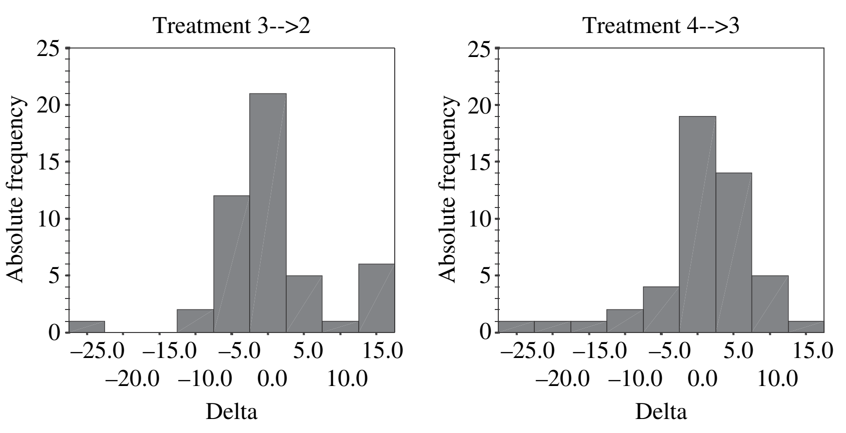

Fig. 1. *Histograms of* Δ *(Last Third Post Merger)*

[18] Treatment '4→3': first third, p = 0.020; last third, p = 0.027. Treatment '3→2': first third, p = 0.055 ; last third, p = 0.0995; one-tailed MWU tests.

competitive behaviour. A consequence of this asymmetry is that markets with a merger history are more concentrated than comparable markets in which a merger has never occurred. This shows nicely in Herfindahl indices. While, in general, the indices are pretty close to the prediction, we find that triopolies that have resulted from a merger are significantly more concentrated than triopolies without that history.[19] The latter average index is 3,450, the former average index is 3,950, which is a significant difference.[20]

We summarise our observations in the following

Result 5. *Merged firms produce more than their Cournot equilibrium share. Unmerged firms choose, on average, Cournot quantities with respect to the residual demand, given the output of merged firms. Accordingly, markets resulting from mergers tend to have greater Herfindahl indices.*

In the next subsection we supplement our analysis of individual differences by a regression that indicates the quantitative effects of merger history.

2.3. *A Panel Model*

In order to assess the explanatory power of merger history we estimate the following panel regression model:

$$q_{it} = \alpha_0 + \alpha_1 TRI + \alpha_2 QUAD + \alpha_3 HIS + \alpha_4 FUS + v_i + \varepsilon_{it}$$

where q_{it} is the individual quantity set by firm i in period t, v_i is the subject-specific random error component and ε_{it} is the overall error component. The explanatory variables included are as follows.

- *TRI* and *QUAD* are dummies for market size. Markets with $n = 2$ firms are the reference group. *TRI*(*opoly*) is the dummy for market size $n = 3$ (i.e., $TRI = 1$ if $n = 3$ and $TRI = 0$ otherwise), and *QUAD*(*ropoly*) is the dummy for $n = 4$ (i.e., $QUAD = 1$ if $n = 4$ and $QUAD = 0$ otherwise).
- *HIS*(*tory*) is a dummy for merger history. That is, $HIS = 0$, if the decision stems from a round in phase 1 of the experiment (where no merger occurred) and $HIS = 1$ if the decision stems from a round in phase 2 of the experiment (where a merger has previously occurred in the market).
- *FUS*(*ion*) is a dummy variable indicating whether or not the quantity is chosen by a firm that emerged from fusion, i.e., we have $FUS = 1$ in the case of a firm that resulted from a merger and $FUS = 0$ otherwise.

If firms followed the Cournot predictions, the parameters α_0, $\alpha_0 + \alpha_1$ and $\alpha_0 + \alpha_2$ would equal the predicted equilibrium quantities chosen in Cournot oligopolies with 2, 3 or 4 firms, respectively, and the coefficients α_3 and α_4 would be equal to zero.

[19] Note, however, that increasing concentration is not necessarily associated with decreasing welfare. If concentration is caused by strategic market power, consumer rents may actually increase. See, for example, Daughety (1990) or Huck, Normann and Oechssler (2004).

[20] One-sided MWU, $p = 0.019$, based on the last thirds of the first phase of treatment '3→2' and the last third of the second phase of treatment '4→3'.

Table 4
Results of the Regressions

GLS random-effects panel regression
$q_{it} = \alpha_0 + \alpha_1 TRI + \alpha_2 QUAD + \alpha_3 HIS + \alpha_4 FUS + v_i + \varepsilon_{it}$

	without history dummies	with history dummies
α_0	32.090***	29.783***
	(40.326)	(25.869)
α_1*(TRI)*	−7.425***	−5.423***
	(−10.877)	(−6.038)
α_2*(QUAD)*	−13.766***	−10.425***
	(−16.013)	(−6.615)
α_3*(HIS)*		−0.511
		(−0.531)
α_4*(FUS)*		6.382***
		(6.834)
R^2	0.167	0.206
Breusch-Pagan test	$\chi^2_{(1)} = 1078.73$	$\chi^2_{(1)} = 741.60$
	$p = 0.0000$	$p = 0.0000$
Hausman test	$\chi^2_{(2)} = 6.35$	$\chi^2_{(3)} = 0.34$
	$p = 0.0418$	$p = 0.9529$

t-values in parentheses. ***indicate significance of the 1%-level

First we estimate the model without the dummy variables capturing market history and firm type. The results are shown in the left column of Table 4.[21] A Hausman (1978) test, however, indicates that this model is misspecified as errors and regressor are correlated. Adding the market- and firm-specific history variables, *HIS* and *FUS*, resolves the problem. The estimation results of the full model are shown in the right column of Table 4.

We make two main observations. First, the Cournot quantity predictions for the numbers α_0, $\alpha_0 + \alpha_1$ and $\alpha_0 + \alpha_2$ are 29.783, 24.36 and 19.358 respectively. Thus, whereas firms produce on average a quantity below the predicted duopoly quantities, in triopoly and quadropoly markets, firms' individual quantities accurately match the equilibrium predictions. Second, while the coefficient α_3 is negative but not significant, the coefficient α_4 is positive and both substantial as well as significant. This confirms that firms that emerged from a merger produce considerably more than others.

2.4. *Profits*

We turn to the question how merger affects the individual firms' profits. First of all, we consider the prediction of Salant *et al.* (1983) that Cournot mergers are not profitable. Table 5 shows the average profits of the two firms involved in the merger for the last third prior to the merger, and for the first and last thirds after the merger. It also shows the expected profits for the Cournot prediction.

In treatment '3→2' the merging firms initially manage to sustain their profits. There is only a tiny difference (1202.6 first third after merger vs. 1214.6 last third before the merger). In later rounds the profit of the merged firms falls to 1112.6. In treatment

[21] Note that according to the Breusch and Pagan (1980) Lagrange multiplier test for random effects, for both GLS estimate the H_0-hypothesis $\mathrm{var}(v_i) = 0$ is rejected, indicating that there are individual effects in the data.

Table 5

Sum of Profits of the Two Firms Involved in the Merger

	'4→3'			'3→2'		
	Pre	Post		Pre	Post	
Phase	last 3rd	first 3rd	last 3rd	last 3rd	first 3rd	last 3rd
Theory	784.1	612.6		1225.1	1089.0	
Mean	773.0	886.1	744.0	1214.6	1202.6	1112.6
(std.err.)	(89.0)	(73.3)	(92.0)	(69.1)	(123.8)	(115.4)

Table 6

Average Profits of the Firms not Involved in the Merger

	'4→3'			'3→2'		
	Pre	Post		Pre	Post	
Phase	last 3rd	first 3rd	last 3rd	last 3rd	first 3rd	last 3rd
Theory	392.0	612.6		612.6	1089.0	
Mean	356.7	549.7	497.3	627.7	942.8	938.5
(std.err.)	(26.8)	(40.4)	(58.6)	(31.8)	(71.2)	(85.5)

'4→3' merging firms initially increase their profits by 14.6% from 773.0 to 886.1. In later periods merged firms see their profits drop back roughly to the original level (744.0 last third after the merger vs. 773.0 last third before the merger). Note also that in treatment '4→3' the merged firms' profits stay far above the predicted equilibrium profits. Formal testing reveals that in contrast to the merger-paradox prediction, for both treatments we cannot reject the hypothesis that pre and post-merger profits (in the last thirds) come from identical distributions.[22] Thus, we find

RESULT 6. *When two firms merge in a market with four or three firms, in the long run, their profits remain unaffected.*

Finally, we turn to the profits of outsiders of the merger. According to the Cournot prediction, they should rise. Table 6 shows the average profits of the outside firms for the same time intervals as above. Here, the qualitative Cournot prediction is fully confirmed, although the two competitors of the merged firm in treatment '4→3' are not able to reach Cournot profits.

RESULT 7. *Average profits of outside firms increase substantially and significantly in both treatments. This is true in the short run as well as in the long run.*[23]

Comparing Tables 5 and 6 we observe that, once the merger has taken place, firms' profits vary substantially even if we focus on the last third where the merged firms earn

[22] Wilcoxon, $p = 0.345$ ('3→2') and $p = 0.917$ ('4→3').
[23] The respective p-values are all below 5% (one-sided Wilcoxon).

considerably less than in the initial adjustment phase. In the duopoly which results from the merger in treatment '3→2', merged firms earn on average 18.5% more than their competitors, in treatment '4→3' this figure becomes even 49.7%. Statistically, only the latter difference is significant ($p = 0.038\%$, one-sided Wilcoxon).

2.5. *Three Control Treatments*

While the results from our main treatments are clear, it is not easy to determine the correct explanation for them. Given the institutional details of our design, we find three plausible explanations for what we observe:

(*a*) the mere fact that one firm has resulted from a merger renders the firm 'strong' and the whole market asymmetric;
(*b*) as the merged firms are jointly owned (and profits are to be shared), fairness considerations may induce subjects to shift output from unmerged to merged firms;
(*c*) merged firms are committed to maintaining their original profits because of aspiration levels created in the pre merger markets.

In order to be able to discriminate between (*a*) on the one hand and (*b*) and (*c*) on the other, we conducted a treatment which we will refer to as '4→3GO'. This treatment is identical to '4→3' with one exception: after the two firms that merge are selected, and after one of the two participants involved is chosen as the manager of the newly merged firm, the second subject does not remain in the laboratory and is sent away. This subject received, in addition to the earnings of the first phase, a flat payment of 5 euro and this was observed by all subjects. The remaining subject received the total profits of the merged firm. Again we conducted six markets.

The hypothesis based on explanation (*a*) is that we should observe the same asymmetry between merged and unmerged firms as in the main treatment. The alternative hypothesis, based on either (*b*) or (*c*), is that the differences between merged and unmerged firms disappear. (*b*) makes this prediction as now all participants earn the same amount in equilibrium, also post merger. And (*c*) makes the same prediction as the sole owner of the newly merged firm now makes higher profits than before, that is, profits above his/her potential aspiration levels. (We will elaborate on the notion of aspiration levels in detail below.)

The results of '4→3GO' are shown in Table 7 (total quantities) and Table 8 (individual quantities). From Table 7, we observe that there are only slight differences with respect to total output in treatments '4→3' and '4→3GO'. For example, whereas total output in the last third before merger is 81.17 in treatment '4→3', it is 80.11 in treatment '4→3GO'. Observed industry outputs in treatment '4→3GO' are slightly lower than in treatment '4→3', but these differences are statistically not significant.[24]

Next, consider (average) individual quantity choices of merged and unmerged firms in post merger situations as shown in Table 8. The result is striking: whereas we find significant and substantial differences in individual output of merged and unmerged firms in treatment '4→3' (see fact 1 in Section 2.2), firms in '4→3GO' are more or less

[24] Pre merger, last third: $p = 0.873$; post merger, first third $p = 0.749$; post merger last third: $p = 0.575$ (two-tailed MWU tests).

Table 7

Additional Treatments: Total Industry Output

Treatment	'4→3'			'4→3GO'		
	Pre	Post		Pre	Post	
Phase	last 3rd	first 3rd	last 3rd	last 3rd	first 3rd	last 3rd
Theory	79.20	74.25		79.20	74.25	
Mean	81.17	70.33	75.12	80.11	69.62	73.50
(std.err.)	(2.59)	(2.03)	(3.09)	(1.86)	(2.25)	(2.12)

Treatment	'3+1'	'3→4'		
	—	Pre	post	
Phase	last 3rd	last 3rd	first 3rd	last 3rd
Theory	74.25	74.25	79.20	
Mean	75.38	79.88	90.23	83.68
(std.err.)	(1.48)	(3.95)	(6.88)	(0.73)

Table 8

Additional Treatments: Average Individual Quantities

Treatment	'4→3'(post merger)				'4→3GO'(post merger)			
	first 3rd		last 3rd		first 3rd		last 3rd	
Merged	No	Yes	No	Yes	No	Yes	No	Yes
Theory	24.75				24.75			
Mean	20.04	30.25	22.62	29.88	22.34	24.94	24.98	23.54
(std.err.)	(0.89)	(1.71)	(1.96)	(2.59)	(1.26)	(1.50)	(0.61)	(1.61)

Treatment	'3+1'		'3→4'(second phase)			
	last 3rd		first 3rd		last 3rd	
Merged	No	Yes	Old	New	Old	New
Theory	24.75		19.80			
Mean	24.20	26.98	24.58	16.50	21.74	18.45
(std.err.)	(0.62)	(1.88)	(1.65)	(2.46)	(1.25)	(3.48)

symmetric after the merger.[25] This clearly rejects explanation (*a*). History alone cannot explain the more competitive behaviour of merged firms in our main treatment.

Thus, we are left with the fairness explanation (*b*) and/or the aspiration-levels explanation (*c*). To discriminate between them, we designed a further treatment which we will call '3+1'. This treatment is identical with the second (post merger) phase of our main treatment '4→3', but there is no first phase. There is neither a merger. Instead, the instructions introduce two firms, one with a sole owner and one with two joint owners. The treatment consisted of 25 periods and, as with all other treatments, we conducted six markets.

[25] Note that, shortly after the merger, average quantities of merged firms are greater than those of others (24.94 vs. 22.34) whereas this is reversed in the last third of the experiment (24.98 vs. 23.54). None of these differences is, however, statistically significant.

In '3+1' explanations (*b*) and (*c*) make opposite predictions. If fairness matters, one would expect asymmetric outcomes as in our main treatment '4→3'. If instead aspiration levels are driving the results of our main treatment, one would expect symmetric Cournot-Nash equilibrium behaviour. With the first phase missing, aspiration levels have not been induced.

The results of treatment '3+1' are also shown in Tables 7 (total quantities) and 8 (individual quantities). We focus exclusively on the last third when behaviour has settled down. Although not decisive for our two explanations, let us start by considering total quantities as shown in Table 7. Total output in the last third of treatment '3+1' is 75.38 and, thus, matches the Cournot prediction as closely as did the last third of the two other treatments.

Next consider (average) individual quantities as shown in Table 8. We observe only a slight difference between the jointly owned firm and the two others. While the former produces on average an output of 26.98, the latter produce on average 24.20, roughly 10% less compared to roughly 25% in the main treatment. Moreover, the difference is not statistically significant. Thus, we can also rule out the fairness explanation (*b*). Indeed, among (*a*), (*b*) and (*c*), only (*c*), aspiration levels, remains as an explanation. Firm owners do not want to see their profits fall. Merger history seems to matter mainly because firms form aspiration levels prior to the merger.

In accordance with the notion of aspiration levels is also an effect we find in the messages that passive players could send to active players in the main treatments. In '4→3', we find that the message 'increase quantity' was only sent if firms experienced decreasing profits in the prior round (which accounts for 80% of all these messages) or constant profits (which accounts for the remaining 20%).[26]

In the two control treatments just described, the aspiration-level hypothesis is tested with regard to mergers. In a third control treatment (which was suggested by a referee), we tested the aspiration-level hypothesis for the case of entry of a new firm. In this control treatment, to which we refer to as '3→4', markets in the first 25 periods consisted of three firms. Then a fourth firm entered the market and again 25 periods were played.[27] If aspiration levels actually drive subjects' behaviour, we would expect that firms already active in the first phase produce more than the entrant after the entry.

[26] Recall that the passive players were allowed to send messages in periods 7, 12, 17, and 22 of the second half. To analyse whether there are any other patterns in the messages we form groups based on the message sent. Then we compare the groups by analysing quantities, profits and changes in both prior to the message. We find that firms in which the passive player sent the 'reduce quantity' message had a significantly higher output than firms where the passive player sent the 'increase' message. This holds for both treatments. (The significance levels are $p = 0.02$ for '3→2' and $p = 0.05$ for '4→3'.) Also, we analyse whether active players followed their partners' recommendations. We find that they do so in 30 of 60 cases. If the message indicates a change, i.e., if it is not 'stay', active players follow it in 21 out of 35 cases.

[27] As in the all other treatments we conducted six markets. The experiments for this third control treatment were conducted in three sessions in each of which we ran two markets. In order to have smooth procedures, we decided to start the sessions with all subjects (including the entrant) already present in the lab. The two subjects who are inactive in the first phase were informed that they would only have to make decisions in a second phase of the experiment. These subjects received no information about the experimental situation in the first phase. We decided to compensate the subjects playing the entrant for the waiting time during the first phase. At the same time we had to make sure not to induce aspiration levels for these subjects. Therefore, at the beginning of the experiment the waiting subjects were informed that at the end of the experiment they would receive a fixed payment for the time they would spend waiting during the first phase. However, at this point no information was given about the exact amount of this payment. (The fixed payment they received for the first phase was euro 7.50.)

The reason is that aspiration levels will make them try to maintain pre-entry profits. The entrant has no aspiration levels and is accordingly willing to accept smaller profits.

Note that there are two important differences between the control treatment '3→4' and our main merger treatments. First, in treatments where two firms merge, post merger industry profits in the Cournot equilibrium increase whereas, in the '3→4' control, post entry industry equilibrium profits decrease. Second, in our main merger treatments, the aspiration level hypothesis says that one firm (the merged firm) will try to maintain its profits at the expense of three firms (the unmerged firms). In '3→4', it is the other way round. Here, the three established firms should try to maintain profits at the expense of the entrant according to the aspiration level hypothesis. Both points suggest that it is much harder for established firms to maintain pre-entry profits in treatment '3→4' after the entry than it is for merged firms to maintain pre-merger profits after the merger.

The results of treatment '3→4' are shown in Tables 7 (total quantities) and 8 (individual quantities). Regarding total quantities (Table 7), we observe in '3→4' that markets with four or three firms are more competitive compared to our main treatment '4→3'. What is important for the aspiration level hypothesis are average individual quantities of entrant and incumbents in the post entry phase of '3→4'. We observe that in the first third of the second phase incumbents produce on average 24.58 units whereas entrants only produce on average 16.50 units. In the last third of the second phase the difference is slightly less pronounced but still substantial: incumbents produce on average 21.74 units whereas entrants produce on average 18.44 units. These differences are significant.[28] These results support our aspiration level hypothesis, despite comparatively adverse circumstances.

3. Empirical Evidence on Aspiration Levels and Mergers

How do our findings fit with the results from the empirical industrial organisation literature? In this Section we review papers that directly suggested aspiration-level theory as an explanation for various phenomena including mergers. We then take a look at the empirical merger literature and check how findings in empirical industrial economics (structural and reduced-form) and in event studies using financial market data square with our results and aspiration level theory.

Aspiration-level theory can be attributed to Simon (1955, 1959). Simon introduced the notion of satisficing as a contender for a new paradigm.[29] One of the building blocks of the new paradigm was that what decision makers find satisfactory is a function of outside comparisons and past experience.[30] Cyert and March (1956) were the first to

[28] First third, second phase: $p = 0.02$; last third, second phase: $p = 0.046$ (one-tailed MWU tests).

[29] Recently, aspiration level theory has experienced a renaissance that seems to be closely related to the rise of evolutionary and learning models. The Journal of Mathematical Psychology, for example, recently published a revised (and English) version of a classical German article by Sauermann and Selten (1962) on 'aspiration adaptation theory' (Selten 1998). Examples of new models include Karandikar *et al.* (1998), Posch (1999), Kim (1999), Börgers and Sarin (2000), Posch *et al.* (1999), and Palomino and Vega-Redondo (1999). Finally, papers studying traditional economic problems with aspiration-level models include Gilboa and Schmeidler (1995, 2001) who analyse how satisficing consumers react to price changes as well as Dixon (2000) and Oechssler (2002) who both study how behavioural rules based on aspiration levels can induce collusion in Cournot games.

[30] For early experimental evidence see, e.g., Simon *et al.* (1954).

apply the notion of satisficing to oligopoly theory and industry field data. They claimed that firms are guided by an 'acceptable-level profit norm' that is determined by experience and comparison and they also provided empirical evidence for this claim. In particular, they found that often firms compete fiercely to increase their sales if they experienced declining profits.[31] Following Cyert and March (1956), several empirical findings confirmed the importance of aspiration-levels. Perhaps the most well-known result that reference levels matter for economic behaviour is by Kahneman and Tversky (1979). They document that risk-taking behaviour crucially depends on the reference levels of participants in experiments. Below the threshold, subjects are risk seeking and above the threshold they are risk averse.[32] There is also some field evidence that aspiration levels affect merger activity. For example, Samila and van Nordenflycht (2003) show that 'troubled' firms are willing to engage in mergers that are more risky. There is also evidence that aspiration levels matter for post-merger performance (Leroy and Ramanantsoa, 1997; Sitkin and Pablo, 2004) with high aspirations being indeed associated with success.[33]

Before turning to the empirical merger literature, we lay out the main implications of the aspiration-based theory for field data. The chief insight from the aspirations approach (which was confirmed in our data) is that, if a merger threatens to turn out unprofitable, then the merged firm will resort to more competitive strategies, for example, it will increase output.[34] Note that this does not imply that unprofitable mergers do not occur. Losses from a merger may simply occur by mistake. But if they occur, merged firms should, according to our theory, struggle in order to recoup at least some of the losses. The second main implication directly follows from the first. If merged firms increase their output, outsiders do not benefit as much as predicted by Nash equilibrium (and again this is what we found in our data). We will discuss further implications of the aspiration-based approach below.

We begin our review of the empirical merger literature with the structural approach to empirical industrial organisation – only to note that this literature cannot be of help for our endeavour. These studies cannot find evidence in favour of aspiration levels because the structural models typically do not allow for such deviations from Nash equilibrium behaviour. In other words, structural empirical modelling typically stipulates that observed outcomes stem from equilibrium play within a given, assumed structure. Our study shows that this might have its own dangers. An econometric analysis of our data that assumes equilibrium play would interpret the observed shift in relative output falsely by merger induced cost advantages and would also come to misleading welfare conclusions. Thus, the assumption of equilibrium

[31] In our experiments, outside comparisons cannot influence behaviour by design but past experience can and, indeed, does.

[32] Along these lines, the strategic management literature has shown that reference levels also matter in the field. Bowman (1980, 1982) and Singh (1986) show that there is a negative relation between firm performance and the variance of firms' returns, suggesting that poorly performing firms are willing to take higher risks, and that this can be attributed to aspiration levels (Bowman, 1982). Mezias *et al.* (2002) demonstrate the role of aspiration levels in a financial services organization. Folta and O'Brien (2003) show that entry depends crucially on aspiration levels and past performance.

[33] Divestitures have been shown to be affected by aspiration levels in a recent study by Shimizu and Hitt (2005).

[34] With price competition in a differentiated good market mergers should cause price increases. By and large this is what is observed in experiments; see e.g. Davis (2002) and Davis and Wilson (2005).

play within a structural model in which aspirations are not accounted for does not only preclude finding anything on aspiration levels but would, in fact, lead to wrong inferences.

Among the set of reduced-form approaches, the most comprehensive recent empirical study is by Gugler *et al.* (2003).[35] They consider a data set of 14,269 acquiring firms and 17,863 acquisitions that took place between 1981 and 1998. They compare actual profits and sales revenues in the five years that follow the acquisition with a reference state (estimates of profits and sales revenue in the counterfactual situation without the merger). Unlike in our experiments, these acquisitions took place voluntarily, and there are many factors that matter but cannot be controlled for, for instance, possible synergies on input or output markets, or changes in the financial structure. Compared with a reference state, for the overall sample, profits go up, not down, whereas sales go down. Horizontal mergers are profitable and significantly more profitable than in the overall sample. Comparing these results with our experimental findings, the profitability effects contradict the predictions of the merger paradox and are more in line with our aspiration-level effects. Of course, the results can also be attributed to other reasons, including efficiency effects. The change of sales revenue is not comparable with the change in output in our framework, as sales is the product of output and price, and the price may have gone up due to increased industry concentration, or down, due to efficiency increases. The comparison shows that it would be useful to study efficiency and market concentration effects of mergers separately; but this typically requires experiments.

Gugler *et al.* (2003) also report a result that they cannot explain well, which, however, can be interpreted as an implication of aspirations. They sort each firm into a 2×2 matrix which is spanned along the dimensions of changes in profits and sales. There are about 15.1% of all merger cases located in the cell ($\Delta\Pi < 0$, $\Delta S > 0$) with lower profits and higher sales compared to what the two unmerged firms presumably would have had. Gugler *et al.* (2003, p. 650) find this outcome 'somewhat puzzling'. One of their explanations is managers' desire for maximising size or growth. However, the performance of these firms is clearly in line with a situation in which the merged firms keep a high output level, or possibly increase their output level, when realising the merger reduces profitability unexpectedly.

There is a large body of empirical literature on mergers using financial-market data. Generally, merger announcements are greeted positively by the stock market, resulting in significantly positive abnormal returns. For a recent study of several hundreds mergers from 1980 to 1997, see, for example, Fee and Thomas (2003). See also the meta-analysis by Bruner (2002) who surveys 130 previous studies on this very question. Of course, positive stock market responses are not evidence against our hypothesis.[36]

[35] Two previous studies consider directly the effects of merger on market shares. Goldberg (1973) considers a sample of 44 firms from an advertising intensive industry that made acquisitions in the 1950s and 1960s and finds no significant effect of merger on market shares. Mueller (1985) finds significant reductions in market shares, particularly for the group of horizontal mergers. Overall, these results are inconclusive, showing that the effects of merger on market shares are not uniform across firms, industries and time.

[36] Increased share prices do not necessarily indicate increased profitability (and therefore they may not contradict the merger paradox) as recently pointed out by Stennek and Fridolfsson (2005).

Such responses simply confirm that, if mergers are endogenous, only those should occur that promise to be profitable.[37]

Andrade *et al.* (2001) also report significant positive abnormal returns on the stock market for the merged firm (acquirer and target combined) when using a three-day window around the merger announcement. Interestingly, when they apply a longer window, beginning several days before the merger announcement and ending at the close of the merger, abnormal returns are still positive but cease to be significant. Our Result 6 is in line with this finding.

Perhaps even more relevant for our purposes is Fee and Thomas' (2003) finding that, contrary to the Nash prediction, the evidence on outsiders' profitability is mixed. For example, if mergers are blocked after having been announced earlier, theory predicts a negative stock market reaction. However, the data do not support this. Similarly, Banerjee and Eckard (1998) find that outsiders do far worse than predicted in the first great merger wave from 1897 to 1903. While this result may be due to cost reductions for the merged firms, aspiration levels in the merged firms in which the cost reductions from the merger are unexpectedly low may also contribute to the finding.

A general implication of our approach is that, anticipating the effects of aspiration levels on both insiders and outsiders, there is scope for more endogenous mergers. In particular we might expect to see merger activity in markets where the merger paradox would suggest that few mergers should go ahead (after all, the merger paradox says that mergers are not profitable and therefore should not occur). Fee and Thomas (2003), for example, report substantial merger activity in a wide range of industries; for similar evidence, see Office of Fair Trading (1999). This suggests that mergers are more ubiquitous than predicted by the merger paradox. Again, other reasons may account for this finding but aspiration levels may be one of them.

Finally, Gallet (2001) finds evidence that the adjustment of prices and output to the new industry equilibrium may take quite some time. He considers the steel industry. In three out of four major mergers, the adjustment to the new industry equilibrium took five years or less. But in one case the adjustment period took up to 15 years. Several explanations for the non-instantaneous adjustment to the new equilibrium market structure are offered, with price stickiness and slack in firms' decision making among them. The aspiration level hypothesis is another alternative that can explain long adjustment processes.

4. Summary

In the experiments reported in this article, we test the merger paradox, a close relative of Harsanyi's bargaining paradox, in a laboratory experiment. We find that if there is some history preceding the merger, the paradox fails. Merged and unmerged firms behave, contrary to what theory predicts, differently from each other. In particular, merged firms behave more competitively than unmerged firms which is tolerated by unmerged firms who simply best respond.

[37] Fee and Thomas (2003) do report some exceptions from the rule and it would be interesting to study whether firm behaviour in these negative cases was subsequently any different from firm behaviour in the common case where the stock market response was positive.

Control treatments show that aspiration levels are likely to drive this result. After having experienced a certain profit stream for a while, merging firms find it hard to accept that their joining forces actually harmed them and they fight back by producing stubbornly more than they should. Their competitors still benefit from the new market constellation. So their aspiration levels are more than met which is probably why they so easily tolerate the competitive behaviour of their merged competitor. In our experimental markets, merged firms are at least able to sustain their pre-merger profits and they sometimes even improve profits in the short run. So, mergers do not lead to the losses the theory predicts. In a third control treatment we show that the same behavioural forces also operate in case of entry of a new firm. In line with the aspiration level hypothesis, incumbents produce consistently higher outputs than entrants.

Our research is consistent with the theoretical merger analysis by Levin (1990). Levin studies a Cournot framework similar to Salant *et al.* (1983) but he allows for a variety of assumptions on post-merger behaviour. In particular, the merged firm may become a Stackelberg leader or a conjectural-variations player whereas unmerged firms are still modelled as adaptive Cournot players. Under this assumption, merging firms maintain or even increase their pre-merger output. Levin (1990) shows that in these cases mergers are profitable, and then they also increase welfare. Our experimental data fully support this approach of modelling merged and unmerged firms in different ways, and our results are consistent with some results predicted.

Our findings should have some relevance in more general classes of games where, after a while, rule changes occur. Agents that are prone to maintaining once established payoff levels, will not easily adjust to new equilibria. Instead, there will be a general tendency to more competitive Stackelberg-like behaviour – in particular if the underlying game is a game with strategic substitutes.

Appendix

Instructions of Treatment '4→3'

Welcome to our experiment!

Please read these instructions carefully! Do not speak to your neighbours and keep quiet during the entire experiment! If you have a question raise your hand! We will come to you.

In this experiment, you will repeatedly make decisions. By doing this you can earn money. How much you earn depends on your decisions and on the decisions of other participants. All participants receive the same instructions.

You will stay anonymous for us and for the other randomly chosen participants you get in touch with during the experiment.

In this experiment, you represent a firm that, like three other firms, produces and sells one and the same product in a market. You will be continually matched with the same other participants. Costs of production are 1 ECU per unit (this holds for all firms). All firms will always have to make one decision, namely, the quantity they wish to produce.

The following important rule holds: the larger total quantity of all firms the smaller the price that will emerge in the market. Moreover, the price will be zero from a certain amount of total output upwards.

Your profit per unit of output will then be the difference between the market price and the unit cost of 1 ECU. Note that you can make a loss, if the market price is below the unit costs. Your profit per round is thus equal to the profit per unit multiplied by the number of units you sell.

In each round the outputs of all four firms will be registered, the corresponding price will be determined and the respective profits will be computed.

From the second period on, in every period you will learn about the total output produced by the other firms and your own profit of the previous period.

Furthermore, you may simulate your decisions in advance. You can do this on the left side of the decision screen. You may simply enter an arbitrary value for your own output and for the total output of the other firms. After pressing the 'compute' button, you will be shown the profit that would result for you in the upper left corner of the screen.

Once you have decided about your quantity, you enter it on the right-hand side of the screen and press the 'OK' button.

In the first phase of the experiment, there are 25 periods. We will tell you about the rules for the second phase after the first phase is over.

Your payment consists of the earnings made in all periods. At the end of the experiment, your earnings will be changed into DM. You will receive 1 DM for every 300 ECU. At the beginning of the experiment, you will receive a initial payment of 500 ECU.

Instructions for the second phase of the experiment.

In the second phase of the experiment, two of the four firms in the market will merge so that there are only three firms left in the market. Which firms merge will not be decided by you but by a random choice of the computer. Before we start the second phase we will let you know whether or not you are participating in the merger.

The second phase of the experiment consists again of 25 periods.

While the two firms which do not participate in the merger continue deciding about their output, only one of the two firms participating the merger will decide about the output of the merged firm. The other firm participating in the merger can only send a message to the firm which decides for the merged firm at the beginning of the second period (and at the beginning of the 7th, 12th, 17th, and 22nd period). More precisely, this firm can recommend producing 'more', 'less' or 'as much as before'. This message will not be sent to the firms not participating in the merger. The decision about which of the two participants decides about output and who may send messages is again determined by a random computer choice. Note that the profits of the merged firms will be split equally. When you participate in a merger, you will get half the profit of the merged firm.

All firms, whether participating in a merger or not, will learn, from the second period on, in every period about the total output produced by the other firms and about the individual output and profit of the previous period.

Again, all participants who have to decide about output may simulate their decisions in advance.

Your payment in the second phase consists of the earnings made in all periods.

University College London
WZB & Free University of Berlin
Tilburg University
Royal Holloway, University of London

Submitted: 2 August 2004
Accepted: 15 February 2006

References

Andrade, G., Mitchell, M. and Stafford, E. (2001). 'New evidence and perspectives on mergers', *Journal of Economic Perspectives*, vol. 15(2) (Spring), pp. 103–20.

Banerjee, A. and Eckard, E.W. (1998). 'Are mega-mergers anticompetitive? Evidence from the first great merger wave', *RAND Journal of Economics*, vol. 29(4) (Winter), pp. 803–27.

Börgers, T. and Sarin, R. (2000). 'Naive reinforcement learning with endogenous aspirations', *International Economic Review*, vol. 41(4) (November), pp. 921–50.

Bowman, E.H. (1980). 'A risk-return paradox for strategic management', *Sloan Management Review*, vol. 21(3) (Spring), pp. 17–31.

Bowman, E.H. (1982). 'Risk seeking by troubled firms', *Sloan Management Review*, vol. 23(4) (Summer), pp. 33–42.

Breusch, T. and Pagan, A. (1980). 'The Lagrange multiplier test and its applications to model specification in econometrics', *Review of Economic Studies*, vol. 47(1) (January), pp. 239–53.

Bruner, R.F. (2002). 'Does M&A pay? A survey of evidence for the decision maker', *Journal of Applied Finance*, vol. 12(1) (Spring/Summer), pp. 48–68.

Cyert, R.M. and March, J.G. (1956). 'Organizational factors in the theory of oligopoly', *Quarterly Journal of Economics*, vol. 70(1) (February), pp. 44–64.

Daughety, A.F. (1990). 'Beneficial concentration', *American Economic Review*, vol. 80(5) (December), pp. 1231–7.

Davis, D.D. (2002). 'Strategic interactions, market information and mergers in differentiated product markets: an experimental investigation', *International Journal of Industrial Organization*, vol. 20(9) (November), pp. 1277–312.

Davis, D.D. and Holt, C.A. (1994). 'Market power and mergers in laboratory markets with posted prices', *RAND Journal of Economics*, vol. 25(3) (Autumn), pp. 467–87.

Davis, D.D. and Wilson, B.J. (2000). 'Firm-specific cost savings and market power', *Economic Theory*, vol. 16(3) (November), pp. 545–65.

Davis, D.D. and Wilson, B.J. (2005). 'Differentiated product competition and the antitrust logit model: an experimental analysis', *Journal of Economic Behavior & Organization*, vol. 57(1) (May), pp. 89–113.

Dixon, H. (2000). 'Keeping up with the Joneses: competition and the evolution of collusion', *Journal of Economic Behavior & Organization*, vol. 43(2) (October), pp. 223–38.

Dufwenberg, M. and Gneezy, U. (2000). 'Price competition and market concentration: an experimental study', *International Journal of Industrial Organization*, vol. 18(1) (January), pp. 7–22.

Fee, C.E. and Thomas, S.E. (2003). 'Sources of gains in horizontal mergers: evidence from customer, supplier, and rival firms', SSRN Working paper, no. 384900.

Fischbacher, U. (2007). 'Z-Tree: Zurich toolbox for readymade economic experiments', *Experimental Economics*, vol. 10, pp. 171–8.

Folta, T.B. and O'Brien, J.P. (2003). 'Entry in the presence of dueling options', *Strategic Management Journal*, vol. 25(2) (February), pp. 121–38.

Fouraker, L. and Siegel, S. (1963). *Bargaining Behavior*, New York: McGraw–Hill.

Gallet, C.A. (2001). 'The gradual response of market power to mergers in the U.S. steel industry', *Review of Industrial Organization*, vol. 18(3) (November), pp. 327–36.

Gilboa, I. and Schmeidler, D. (1995). 'Case-based decision theory', *Quarterly Journal of Economics*, vol. 110(3) (August), pp. 605–40.

Gilboa, I. and Schmeidler, D. (2001). 'Reaction to price changes and aspiration level adjustments', *Review of Economic Design*, vol. 6(2) (September), pp. 215–23.

Goldberg, L.G. (1973). 'The effect of conglomerate mergers on competition', *Journal of Law and Economics*, vol. 16, pp. 137–58.

Gugler, K., Mueller, D.C., Yurtoglu, B.B. and Zulehner, C. (2003). 'The effects of mergers: an international comparison', *International Journal of Industrial Organization*, vol. 21(5) (May), pp. 625–53.

Harsanyi, J. (1977). *Rational Behavior and Bargaining Equilibrium in Games and Social Situations*, Cambridge: Cambridge University Press.

Hausman, J.A. (1978). 'Specification tests in econometrics', *Econometrica*, vol. 46(1) (January), pp. 1251–71.

Holt, C.A. (1985). 'An experimental test of the consistent-conjectures hypothesis', *American Economic Review*, vol. 75(3) (June), pp. 314–25.

Huck, S., Konrad, K.A. and Müller, W. (2004). 'Profitable horizontal mergers without cost advantages: the role of internal organization, information, and market structure', *Economica*, vol. 71(284) (November), pp. 575–87.

Huck, S., Müller, W. and Normann, H.-T. (2001). 'Stackelberg beats Cournot – on collusion and efficiency in experimental markets', ECONOMIC JOURNAL, vol. 111(474) (October), pp. 113–25.

Huck, S., Normann, H.-T. and Oechssler, J. (1999). 'Learning in Cournot oligopoly: an experiment', ECONOMIC JOURNAL, vol. 109(454) (March), pp. 80–95.

Huck, S., Normann, H.-T. and Oechssler, J. (2000). 'Does information about competitors' actions increase or decrease competition in experimental oligopoly markets?', *International Journal of Industrial Organization*, vol. 18(1) (January), pp. 39–58.

Huck, S., Normann, H.-T. and Oechssler, J. (2004). 'Two are few and four are many: number effects in experimental oligopolies', *Journal of Economic Behavior & Organization*, vol. 53(4) (April), pp. 435–46.

Kahneman, D. and Tversky, A. (1979). 'Prospect theory: an analysis of decisions under risk', *Econometrica*, vol. 47(2) (March), pp. 263–92.

Karandikar, R., Mookerherjee, D., Ray, D. and Vega-Redondo, F. (1998). 'Evolving aspirations and cooperation', *Journal of Economic Theory*, vol. 80(2) (June), pp. 292–331.
Kim, Y. (1999). 'Satisficing and optimality in 2 x 2 common interest games', *Economic Theory*, vol. 13(2) (February), pp. 365–75.
Leroy, F. and Ramanantsoa, B. (1997). 'The cognitive and behavioral dimensions of organizational learning in a merger: an empirical study', *Journal of Management Studies*, vol. 34(6) (November), pp. 871–94.
Levin, D. (1990). 'Horizontal mergers: the 50-percent benchmark', *American Economic Review*, vol. 80(5) (December), pp. 1238–45.
Mezias, S.J., Chen, Y.-R. and Murphy, P. (2002). 'Aspiration-level adaptation in an American financial services organization: a field study', *Management Science*, vol. 48(10) (October), pp. 1285–300.
Mueller, D.C. (1985). 'Mergers and market share', *Review of Economics and Statistics*, vol. 67(2) (May), pp. 259–67.
Oechssler, J. (2002). 'Cooperation as a result of learning with aspiration levels', *Journal of Economic Behavior & Organization*, vol. 49(3) (November), pp. 405–9.
Office of Fair Trading (1999). 'Merger appraisal in oligopolistic markets', Research paper 19.
Palomino, F. and Vega-Redondo, F. (1999). 'Convergence of aspirations and (partial) cooperation in the prisoner's dilemma', *International Journal of Game Theory*, vol. 28(4) (November), pp. 465–88.
Posch, M. (1999). 'Win-stay, lose-shift strategies for repeated games: memory length, aspiration levels and noise', *Journal of Theoretical Biology*, vol. 198(2) (May), pp. 183–95.
Posch, M., Pichler, A. and Sigmund, K. (1999). 'The efficiency of adapting aspiration levels', *Proceedings of the Royal Society of London Series B: Biological Sciences*, vol. 266(1427) (July), pp. 1427–35.
Salant, S.W., Switzer, S. and Reynolds, R.J. (1983). 'Losses from horizontal mergers: the effects of an exogenous change in industry structure on Cournot-Nash equilibrium', *Quarterly Journal of Economics*, vol. 98(2) (May), pp. 185–99.
Samila, S. and Nordenflycht, A. van (2003).'Risk taking in hierarchical markets: a theory and test on acquisition behavior', Columbia University, mimeo.
Sauermann, H. and Selten, R. (1962). 'Anspruchsanpassungstheorie der Unternehmung', *Zeitschrift für die gesamte Staatswissenschaft*, vol. 118(4), pp. 577–97.
Selten, R. (1998). 'Aspiration adaptation theory', *Journal of Mathematical Psychology*, vol. 42(2-3) (June), pp. 191–214.
Shimizu, K. and Hitt, M.A. (2005). 'What constraints or facilitates divestitures of formerly acquired firms? The effects of organizational inertia', *Journal of Management*, vol. 31 (February), pp. 50–72.
Simon, H.A. (1955). 'A behavioral model of rational choice', *Quarterly Journal of Economics*, vol. 69(1) (February), pp. 99–118.
Simon, H.A. (1959). 'Theories of decision making in economics and behavioral science', *American Economic Review*, vol. 49(3) (June), pp. 253–83.
Simon, J.R., Shaw, M.E. and Gilchrist, J.C. (1954). 'Some effects of pre-arranged performance scores upon the level of aspiration', *Journal of Experimental Psychology*, vol. 47, pp. 10–12.
Singh, J.V. (1986). 'Performance, slack, and risk taking in organizational decision making', *Academy Management Journal*, vol. 29(3) (September), pp. 562–85.
Sitkin, S.B. and Pablo, L.A. (2003). 'Leadership and the M&A process', Duke University, mimeo.
Stennek, J. and Fridolfsson, S.O. (2005). 'Why mergers reduce profits and raise share prices – a theory of preemptive mergers', *Journal of the European Economic Association*, vol. 3(5) (September), pp. 1083–104.
Vega-Redondo, F. (1997). 'The evolution of Walrasian behavior', *Econometrica*, vol. 65(2) (March), pp. 375–84.