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Output Commitment through Product Bundling: Experimental Evidence*

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ABSTRACT: We analyze the impact of product bundling in experimental markets. A firm has monopoly power in one market but faces competition by a second firm in another market. We compare treatments where the monopolist can bundle its two products to treatments where it cannot, and we contrast simultaneous and sequential order of moves. Our data indicate support for the theory of product bundling, even though substantial payoff differences between players exist. With bundling and simultaneous moves, the monopolist offers the predicted number of units. When the monopolist is the Stackelberg leader, the predicted equilibrium is better attained with bundling although in theory bundling should not make a difference here. In sum: bundling works as a commitment device that enables the transfer of market power from one market to another.

KEYWORDS: Cournot; commitment; experiments; product bundling; Stackelberg

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1. INTRODUCTION

One of the key results in experimental economics is that subjects dislike payoff asymmetries. This has been observed, for example, in ultimatum games (Güth *et al*., 1982), dictator games (Forsythe *et al*., 1994), trust games (Berg *et al*., 1995) and gift-exchange games (Fehr *et al*., 1993). In these experiments, a considerable share of participants sacrifices money in order to obtain more equitable outcomes. A growing literature explains this by allowing for other-regarding motives in players' utility functions (e.g., Fehr and Schmidt, 1999, Bolton and Ockenfels, 2000).

In the field of Industrial Organization (IO), asymmetric outcomes are ubiquitous and therefore, more often than not, experimental support for these theories is weak. In theory, structural differences, including cost and capacity asymmetries, and a sequential order of moves (Stackelberg leadership and other forms of strategic commitments) yield asymmetric equilibria where one player earns considerably more than others. Experimental data typically refute these theoretical predictions. In experiments with Cournot competition and asymmetric costs, Mason *et al*. (1992) observe industry output averaging above the Nash equilibrium prediction and that high-cost firms produce more than predicted. Keser (1993) observes payoff differences that are smaller than predicted in a Cournot duopoly with cost differences and demand inertia. Stackelberg followers produce more than what theory predicts, presumably to discipline leader's behaviour (Huck *et al*., 2001, 2002). In a Bertrand-Edgeworth setting with asymmetric capacities, Fonseca and Normann (2008) find that median prices and price distributions are pretty much alike among the different firm types, in violation of the mixed strategy Nash equilibrium which entails considerable pay-off differences. And for a duopoly game with endogenous quality choices, Henze and Schuett (2011) find that products tend to be of equal quality, while theory unambiguously predicts maximal differentiation whereby the high quality supplier earns significantly more than the supplier of the low quality product.

While at odds with standard IO theory, the experimental results are often well explained by models of other-regarding preferences. The behavior of Stackelberg followers for example can be rationalised when players have Fehr and Schmidt (1999) preferences (see the theory papers by Santos-Pinto, 2008, and Lau and Leung, 2010), or when they are considered to act reciprocally (Cox *et al*., 2007). And inequality aversion can explain why players often achieve equal profits in asymmetric Cournot oligopoly (Iris and Santos-Pinto, 2010).

In this paper, we examine asymmetric outcomes in duopoly experiments that involve product bundling. In the literature, product bundling is typically analyzed for an asymmetric industry: a firm with monopoly power in one market faces competition by a second firm in another market. Offering its two products as a bundle allows the multiproduct firm to leverage its monopoly power to the market where it faces a rival. Its market share in the duopolistic market will increase, possibly at the expense of losing some customers in the monopoly market, even if demand is independent across the two markets (Martin, 1999; Nalebuff, 2004). That is, bundling allows the multiproduct firm to credibly commit to a larger output on the duopoly market. As such, a bundling strategy mainly reduces the profits of the second firm or deters entry altogether. Given subjects' alleged aversion to asymmetric payoffs, equilibrium predictions for product bundling are not likely to be observed in lab experiments.

Van Damme *et al*. (2009, p. 107) review the experimental literature on abusive practices in general and conclude that "little experimental work has been done in this area". Indeed, our paper is part of the small but increasing experimental literature on abusive market practices. Pioneering on abuses of dominant positions is Isaac and Smith's (1985) experimental work on predatory pricing (see also Goeree *et al*., 2004). Recent work in this area includes experimental analyses of vertical foreclosure (Martin *et al*., 2001), exclusive dealing (Landeo and Spier, 2009, Boone *et al*., 2009, Smith, 2011), and price discrimination (Normann *et al*., 2007). The only existing experimental paper on bundling we are aware of is by Caliskan *et al.* (2007). Their focus is, however, how a fringe competitor in the monopoly market affects welfare. In a posted-offer-market setting, they find that the fringe seller increases the consumer surplus while decreasing the seller surplus, and that the fringe seller does not affect the consumer surplus extracted from the bundle despite a decrease in the bundle transaction price.

The basis of our experiments is a quantity-setting framework where one firm is an uncontested monopolist in one market and a duopolist in a second, unrelated market. In the bundling treatments, the multiproduct firm bundles its products for the two markets. We compare the results from this treatment to a baseline treatment without the bundling opportunity. Thus our first treatment variable is "bundling" vs. "no bundling".

The second treatment variable is the sequence of moves: simultaneous vs. sequential. We introduce this second treatment variable in order to examine explicitly the commitment value of product bundling (as highlighted by Whinston, 1990, Choi, 1998, and Nalebuff, 2004). With simultaneous-move Cournot competition, the bundling firm trades off reduced sales in its monopoly market to increased output in the duopoly market. The bundling strategy works as a commitment to sell more in the competitive segment. But of course, *ex post*, the monopolist would want to deviate from this outcome and would want to best respond against the second firm. In the Stackelberg setting, when both markets have an identical demand and cost structure, bundling *does not* require additional commitments as the monopolist is a first mover anyhow. That is, bundling does not affect optimal quantities in theory. This feature allows us to test if bundling gives the Stackelberg leader additional (and unpredicted) commitment power because, as it is known from previous experiments, absent bundling, Stackelberg leaders find it difficult to gain from their first-mover advantage (Huck *et al*., 2001, 2002, Fonseca *et al*., 2004, Müller, 2006).

Our results support the theory of product bundling to a large extent, which is remarkable in light of the received experimental literature yielding little support for asymmetric outcomes. First, in the Cournot setting without bundling, firms play roughly symmetric Cournot-Nash outputs in the duopoly market, even though the multiproduct firm has substantial additional earnings in its monopoly market. These payoff differences have little impact, however, on the outcomes in the duopoly market. Second, when the multiproduct firm bundles its products with simultaneous moves, it offers the number of bundles predicted by theory. The single product competitor produces more than predicted, but substantial payoff differences remain. In fact, bundling increases the difference in payoffs. Third, when the multiproduct firm is the Stackelberg leader but cannot bundle, the previously observed non-equilibrium behaviour of the followers maintains: Stackelberg followers substantially produce more than predicted, effectively reducing the Stackelberg leader's first-mover advantage. Fourth, the predicted asymmetric equilibrium in the sequential-move case of Stackelberg with product bundling is closely attained in the lab. We observe very large payoffs asymmetries, which are larger than under Stackelberg competition absent bundling. In sum, we find that bundling successfully works as a commitment device, which is robust with respect to the order of moves (simultaneous or sequential). It is thus a means of transferring market power from one market to another, which suggest that bundling is a practice of (abuse of) dominance.

Our results raise two questions pertinent to behavioral economics and the debate about payoff inequality aversion. First, why do our no-bundling treatments confirm previous duopoly experiments even though in previous studies the extra monopoly payoff does not exist and the payoff inequality is much smaller?[1] In Section 5, we argue that this is actually consistent with models of inequality aversion (Bolton and Ockenfels, 2000; Fehr and Schmidt's, 1999). The reason is that the multiproduct firm's profits in the monopoly market does not affect the marginal costs and benefits of 'punishment' (that is, producing more than the standard best reply) by the single-product firm in the duopoly market. Second, why are the results in the Stackelberg bundling treatment better in line with the prediction than the no-bundling treatment, even though it yields greater payoff inequalities? The answer lies in the possibility to commit to an output level through product bundling. A non-bundling monopolist can give in to "punishing" behavior of the smaller firm by producing less. But a bundling monopolist loses additional payoff from such concessions and is thus less likely to reduce output. This is anticipated by the small firms who punish less. Intentions therefore seem to matter: because the bundling firm is merely maximizing the monopoly profit in its home market, the intentions of this kind of behaviour may not be seen as hostile towards the duopolist. Indeed, a non-bundling Stackelberg leader can freely earn monopoly rents in its home market and is not "forced" to produce the Stackelberg leader quantity on the duopoly market.

The remainder of the paper is organized as follows. In Section 2 we derive several theoretical predictions, followed by an outline of the experimental design and procedure in Section 3. The experimental results are in Section 4. In Section 5 we briefly discuss our results and Section 6 concludes.

2. MODEL AND PREDICTIONS

The Cournot model underlying our experiments has two firms, 1 and 2, and two markets, D and M, where 'D' and 'M' stand for 'duopoly' and 'monopoly' respectively. We assume that in both markets inverse demand is linear, such that $p^D = d^D - q_1^D - q_2^D$ and $p^M = d^M - q_1^M - q_2^M$, and identical across markets: $d^D = d^M = d$. Both firms produce at constant marginal cost of c.

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[1] Despite the myriads of economics experiments exploring issues of fairness and inequality, we have not been able to find an experiment that tackles the issue of a fixed additional payoff for one player. Hennig-Schmidt *et al.* (2008) investigate ultimatum games with various *outside* options for proposers and responders. These outside options are only relevant when responders reject. Out setting would be comparable to an ultimatum game where the proposer earns an additional amount of money regardless of the responders' actions.

In market D, firm 1 and firm 2 are Cournot duopoly competitors. In market M, firm 1 is a monopolist; hence $q_2^M = 0$. Firm 1 will sometimes be referred to as the monopolist or the multi-product firm whereas firm 2 will occasionally also be labeled the duopolist.

Cournot - no bundling

Suppose first that there is no bundling, that is, output decisions in markets D and M are independent. In this case, we obtain the following profit function for firm 1

(1) $$\pi_1 = (d - q_1^D - q_2^D - c)q_1^D + (d - q_1^M - c)q_1^M,$$

while firm 2's profit function is

(2) $$\pi_2 = (d - q_1^D - q_2^D - c)q_2^D.$$

For market D, the unique Cournot Nash equilibrium is

(3) $$q_1^D = q_2^D = (d - c)/3,$$

and equilibrium profits are $\pi_1^D = \pi_2^D = (d-c)^2/9$. The monopoly solution for market M is

(4) $$q_1^M = (d - c)/2,$$

and the monopoly profit is $\pi_1^M = (d-c)^2/4$.

Cournot - bundling

Now consider the bundling case. Bundling implies that firm 1 can credibly commit to produce its output for both markets in a fixed proportion. Without loss of generality we assume that this ratio is one to one (see also Martin, 1999): for each unit of q_1^D, one unit of q_1^M will be produced such that we can simply state $q_1^D = q_1^M = q_1$. Accordingly, in the bundling case, firm 1's profit function is

(5) $$\pi_1 = (d - q_1 - c)q_1 + (d - q_1 - q_2^D - c)q_1,$$

while firm 2's profits equal

(6) $$\pi_2 = (d - q_1 - q_2^D - c)q_2^D.$$

The best-reply functions then follow: $q_1(q_2^D) = (d - q_2^D / 2 - c) / 2$ and $q_2^D(q_1) = (d - q_1 - c) / 2$. Nash equilibrium outputs (bundles) are

(7) $$q_1 = 3(d-c)/7,\ q_2^D = 2(d-c)/7,$$

and Nash profits are $\pi_1 = 18(d-c)^2 / 49$ and $\pi_1 = 4(d-c)^2 / 49$.

Firm 1's equilibrium output of $q_1 = 3(d-c)/7$ satisfies $(d-c)/3 < q_1 < (d-c)/2$. That is, the optimal output with bundling is larger than the Cournot duopoly solution but smaller than the monopoly output. For firm 2, we get $q_2^D = 2(d-c)/7 < (d-c)/3$. Hence, bundling increases firm 1's profits while it reduces the profits of firm 2.

Stackelberg – no bundling

If firm 1 cannot bundle but is the first mover in market D, we obtain the Stackelberg duopoly solution. Profit functions are as in the Cournot case but firm 1 has a first-mover advantage such that equilibrium outputs become

(8) $$q_1^D = (d-c)/2,\ q_2^D = (d-c)/4.$$

Profits are $\pi_1^D = (d-c)^2 / 8$ and $\pi_2^D = (d-c)^2 / 16$. The monopoly solution for market M is as above in the Cournot case with $q_1^M = (d-c)/2$ and $\pi_1^M = (d-c)^2 / 4$.

Stackelberg – bundling

Suppose firm 1 can bundle its two products and that it is the first mover in market D. It is straightforward to see that we then obtain the same equilibrium as in the Stackelberg case absent bundling. Indeed, without bundling a Stackelberg leader in market D produces the same output as the monopolist in market M, given identical demand and cost structures across markets.

Hence, with our design we can explore specifically the commitment value of product bundling, both in case of simultaneous moves (where product bundling should affect quantity choices) and in the case where moves are sequential (where product bundling should not affect quantity choices).

3. EXPERIMENTAL DESIGN AND PROCEDURES

We developed a two-by-two treatment design. The two treatment variables are bundling / no bundling, and Cournot / Stackelberg. Table 1 summarizes the treatment design and treatment labels.

Table 1: Treatments and treatment labels

	No Bundling	Bundling
Cournot	NOBUNDCOUR	BUNDCOUR
Stackelberg	NOBUNDSTACK	BUNDSTACK

We implemented the above model by giving subjects a payoff table, which was derived from the model using parameter values d = 54 and c = 6. Subjects had to choose integer quantities between 9 and 27.[2] In each session, half the subjects played the role of the firm 1, the other half played the role of firm 2. These roles remained fixed for the entire course of the experiment. The experimental markets were repeated over 15 periods, and subjects knew the number of periods from the instructions (see the Appendix, Section A). In each period, subjects were randomly matched ("strangers" design).

In the instructions, subjects were told that they would act as a firm which, together with another firm serves a market, and that one firm gained some additional business in a second market. In all treatments, subjects received feedback about what happened in their market at the end of each round. The computer screen displayed the output decision of both duopolists in market D and also firm 1's output in market M. Feedback on profits was given about firm i's own payoff. The information feedback after each period, the instructions (which were also read aloud) and the payoff table, ensured common knowledge of the rules of the game. After having read the instructions, participants could privately ask questions. Before the start of the experiment subjects were asked to answer several control questions.

[2]The payoff table gives all necessary details of the model while avoiding formulae, parameters and technical terms. In the experiment, we rescaled the strategy space such that subjects had to choose a number between 1 and 19. As subjects are unfamiliar with the model, the labels of the actions are meaningless to them. Further, as is well known (Holt, 1985), payoff tables with integer choices sometimes have not unique best replies. Whenever necessary, we manipulated the payoff table in minor details such that all best replies are unique.

The experiments were computerized (Fischbacher, 1999) and conducted at CenterLab of Tilburg University. For each treatment, 32 subjects participated in total. Subjects were randomly matched within groups of eight participants but subjects were not informed about this. Hence, we have four independent observations for each treatment. Sessions usually had 16 participants but in two cases we had to reduce the session size to eight because insufficiently many subjects showed up. Participants were students from various departments, many from fields other than economics or business administration. The monetary payment was computed by using an exchange rate of 500 “points” for one Euro and adding a flat payment of 5 Euros.[3] Subjects’ average earnings were 25.27 Euros including the flat payment. Sessions lasted between 60 and 75 minutes.

4. EXPERIMENTAL RESULTS

Table 2 reports the average quantities in the four treatments. The three average quantities are firm 1’s (the monopolist’s) output in market D (q_1^D), firm 2’s output in market D (q_2^D), and firm 1’s output in market M (q_1^M, which is equal to q_1^D in the bundling treatments). The table also reports the predictions and the 95% confidence intervals. The asterisks next to the inequality signs indicate whether the differences observed are significant according to an exact non-parametric ranksum tests (Wilcoxon, Mann-Whitney).[4]

We start the discussion with the no bundling treatments. First, in the Cournot markets without bundling, the average quantities are pretty much the predicted values, as has been observed earlier (Holt 1985; Huck *et al*., 2001). Here, both firms produce only slightly more than the predicted number of units, but there are no economically or statistically meaningful differences between firms and the predictions are contained in the 95% confidence interval. Also, in the monopoly market, the multiproduct firm produces about the monopoly output. Effectively, our data confirm the theoretical predictions and previous experimental results.

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[3] This payment was made since subjects could have made losses in the experiment.

[4] Section B of the Appendix lists all per-period quantities for each individual matching group

Table 2: Average quantities

	market D, firm 1 q_1^D			market D, firm 2 q_2^D			market M, firm 1 q_1^M		
	NB		B	NB		B	NB		B
	16.00		*20.00*	*16.00*		*14.00*	*24.00*		*20.00*
Cournot	16.32	$<^{**}$	19.42	16.76	$>^{*}$	15.42	24.41	$>^{**}$	19.42
	[14.13, 18.51]		[18.25, 20.59]	[15.84, 17.68]		[13.88, 16.96]	[23.35, 25.47]		[18.25, 20.59]
	$\wedge^{**}$		$\wedge^{**}$	$\vee^{**}$		$\vee^{*}$	$\vee$		$\wedge^{**}$
Stackelberg	*24.00*		*24.00*	*12.00*		*12.00*	*24.00*		*24.00*
	19.00	$<^{**}$	22.08	15.58	$>^{*}$	13.59	23.92	$>^{**}$	22.08
	[17.83, 20.17]		[21.39, 22.76]	[14.30, 16.85]		[14.27, 16.55]	[23.44, 24.40]		[21.39, 22.76]

Notes: NB = No bundling, B = Bundling. Predictions are in italics, 95% confidence intervals (based on simple linear regressions that are clustered at the group level) are in square brackets. Significance levels of inequality comparisons are calculated with Wilcoxon rank-sum tests, conservatively counting each matching group as one independent observation; ***, ** and * indicate statistical significance at the 1%, 5% and 10% level respectively.

Second, in the NoBundStack treatment, the theory fails. This finding has been documented earlier (Huck *et al*. 2001, 2002). In the duopoly market, the Stackelberg followers produce more than predicted, the Stackelberg leaders produce less. The results are very similar to Huck *et al*. (2001), a finding we come back to in Section 5. The two papers use linear demand and cost for their payoffs tables but have different demand and cost values. Hence, we compare the results by taking the ratio of observed output levels and predictions. In Huck *et al*. (2001), Stackelberg followers produce 100% × 8.32/6.00 = 139% of the predicted output level and Stackelberg leaders produce 100% × 10.19/12.00 = 85% of the prediction. For our data, these figures read 100% × 15.58/12 = 130% and 100% × 19.00/24.00 = 79%, respectively. While both Stackelberg leaders and followers produce relatively less in our data, it is probably fair to say that these ratios are of a similar magnitude. At the same time, firm 1 produces roughly the monopoly output in market M.

While the Cournot and Stackelberg no-bundling results confirm previous experiments, this confirmation is, at least at first sight, surprising. Recall that in our experiments the multiproduct firms earn extra monopoly profit in market M, causing rather large payoff differences. Given that subjects dislike payoff asymmetries, a-priori it is not clear whether our data would confirm the single-market settings as analyzed in Huck *et al.* (2001). We will also get back to this point in Section 5.

Result 1. *In the no bundling treatments, the data confirm the predictions in the Cournot markets, and reject the predictions in the Stackelberg markets. Both findings confirm previous experimental results despite the fact that the payoff inequality is substantially higher in our design due to the addition of the monopoly market.*

We now turn to the bundling treatments. In the Cournot sessions, firm 1 produces slightly less than the predicted 20 units, but the prediction is well within the 95% confidence interval around the average output (19.42). Firm 2 produces 15.42, more than the Cournot-Nash equilibrium quantity of 14 but this value is inside the 95% confidence interval. By and large, and despite a substantial payoff difference, the asymmetric equilibrium in market D prevails.

In BUNDSTACK, the output levels are much closer to the prediction than in the Stackelberg treatment without bundling. Stackelberg leaders now produce only two output units less than predicted (92% of the predicted output), as compared to the five units under production absent bundling. Stackelberg followers produce roughly 1.6 units more than predicted (113% of the prediction), as opposed to 3.6 units more than predicted (130% of the equilibrium value) without bundling. Overall, with sequential moves, product bundling brings average outputs much closer to the theoretical prediction.

Result 2. *In the bundling treatments, the data confirm the predictions reasonably well in the Cournot treatment, although firm 2 produces more than predicted. In the Stackelberg treatment with bundling, the deviation from the theoretical benchmark is much smaller than in the no bundling treatment.*

Next, we turn to the comparison of the bundling and no bundling data: what is the effect of product bundling? It turns out that bundling has a similar effect in the Cournot and the Stackelberg treatments: the multi-product firm significantly increases its output in the duopolistic market at the expense of losing some customers in the market where it holds a monopoly, and the single-product firm adapts to this increased output by significantly reducing its supply. That is, through product bundling an asymmetric outcome emerges. Although this finding is in line with theory, it is in sharp contrast to the many experimental studies that fail to find support for asymmetric equilibria in the lab, in particular the Stackelberg equilibrium.

Result 3. *The effect of product bundling is similar in the Cournot and Stackelberg treatments: the multi-product firm supplies more to the duopolistic market and less to the market where it holds a monopoly; the single-product firm produces less.*

Finally, Figure 1 suggests that there are no time trends in our data. Indeed, even if we ignore the possible dependence between observations within sessions and treat each decision as an independent observation, we do not observe a single significant correlation.[5,6]

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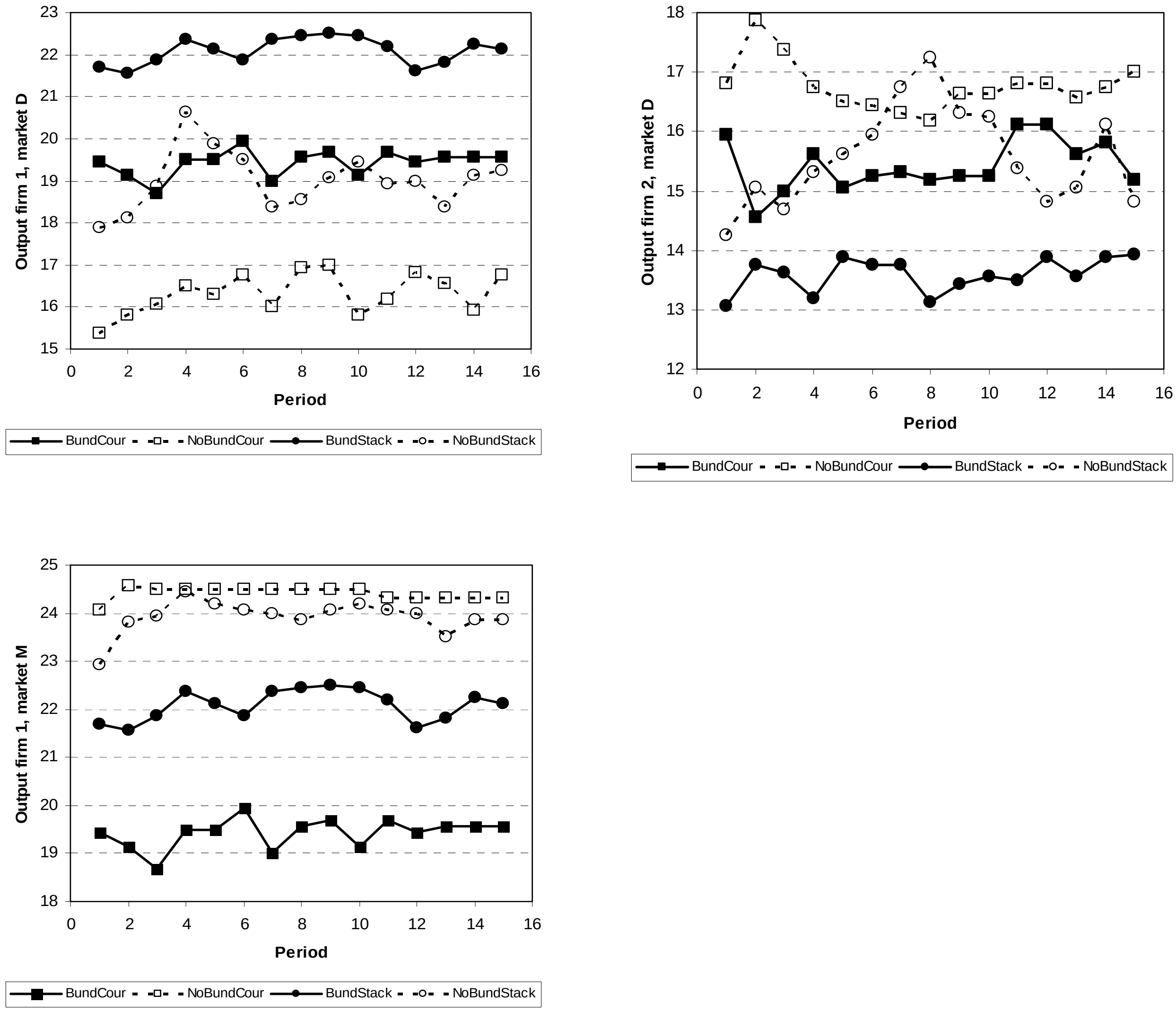
[5] Spearman's rho is always smaller than 0.1 and not significant for all treatments and all three output decisions.

[6] An interesting evolution over time can be observed for firm 2 in NoBundStack. One interpretation is that subjects initialy punish the Stackelberg leaders strategically despite the random matching scheme, but then give up on doing so over the second half of the experiment.

Figure 1: Average quantities over time



5. DISCUSSION

The previous section shows that our results are roughly consistent with the theory in three of the four treatments and it fails in one case (NOBUNDSTACK). This raises two questions. First, why do our no-bundling results confirm previous duopoly experiments even though the extra monopoly payoff does not exist and the payoff inequality is much smaller in the previous studies? Second, why are the results in the bundling treatments better in line with the prediction than in the no-bundling case even though this implies even greater payoff inequalities?[7] Putting this more generally, why does inequality aversion have – apparently – no bite in the bundling treatments, even though it is considered the prime explanation for the Stackelberg data in Huck *et al.* (2001) and similar experiments?[8]

Consider question one. In models of inequality aversion (Bolton and Ockenfels, 2000; Fehr and Schmidt, 1999), the additional profit of the multiproduct firm reduces players' utilities compared to standard duopolies. However, the *marginal* change in utility from the duopolist producing more than predicted is the same in both the regular duopolies and our multiproduct setup. The reason is that the output chosen in the duopoly market does not affect the payoff difference in the monopoly market. The amount produced by firm 2 in NOBUNDSTACK compared to the prediction is, therefore, very similar to the figures observed in the Stackelberg duopolies of Huck *et al.* (2001), as noted above. This behavior is consistent with Fehr and Schmidt (1999) because the utility-maximizing output choice (balancing the marginal cost of producing more than the standard best reply and the marginal gain of reducing the payoff inequality) is the same in both cases. A similar argument explains why our multiproduct firms in NOBUNDSTACK produce similar amounts as in the standard Stackelberg duopolies in Huck *et al*. (2001).

Second, why are the results in the Stackelberg bundling treatment better in line with the prediction than in the no-bundling case, despite greater payoff inequalities? In BUNDSTACK, there is now a link between the two markets because product bundling makes π_1^M a function of q_1^D as well. In particular, it is more costly for firm 1 to reduce its output: any reduction in output on market D causes losses in the monopoly market. Not surprisingly, we observe that in market D firm 1 produces significantly more (22.08) with bundling than without (19.00). This behavior is consistent with inequality aversion because it reflects the cost of reducing the inequality on the

[7] Let us make precise the statement that the multi-product firm earns more than the single-product firm. In NOBUNDCOUR, the multi-product firm is predicted to earn 576 in the monopoly market, and both firms should earn 256 in the duopoly market; thus, the multi-product firm is predicted to earn 3.3 times more than the duopolist. In both Stackelberg treatments, the leader (follower) is predicted to earn 288 (144) in the duopoly market plus 576 for the multi-product firm; hence, the multi-product firm is predicted to earn 6 times as much. The observed average profit ratio (multi-product firm profit over single-product firm profits) ranges from 3.3 (NOBUNDCOUR) to 5.1 (BUNDSTACK). These payoff differences are substantial indeed.

[8] We focus here on the Stackelberg treatments as both Cournot treatments are consistent with what theory predicts.

part of the multiproduct firm. More intriguing is the finding that firm 2's behavior also changes. What we observe in BUNDSTACK is that, even though the multiproduct firm produces more than in NOBUNDSTACK, firm 2 reduces it punishment behavior (that is, it reduces the amount of *excess* output it produces on top of its best reply). In fact, the standard best reply to the Stackelberg leaders' average output (12.96) is not too distant from the actual average output of 13.59. Moreover, in BUNDSTACK firm 2 plays more often the standard best reply (222 of 480 cases, or 46.25%) than In NOBUNDSTACK (32.29%).[9]

Table 3: Estimates of the actual response of the Stackelberg followers

	$q_2^D = \beta_0 + \beta_1 q_1^D$	
	NOBUNDSTACK	BUNDSTACK
β_0	20.58***	27.15***
	(4.86)	(6.79)
β_1	-0.26	-0.62**
	(0.26)	(0.31)

Notes: ***, ** and * denotes statistical significance at the 1%, 5% and 10% level respectively. The regressions include period and matching group dummies, for both intercept and slope parameters. These estimates are restricted to sum up to 0 in order to obtain the 'true' averages for β_0 and β_1 (Suits, 1984).

The conjecture that firm 2's behavior changes if firm 1 bundles can also be illustrated when we consider the entire best reply function rather than merely the treatments' average outputs and best reply frequencies. Previous Stackelberg experiments found that the Stackelberg followers produce more than predicted, essentially leading to a non-negatively sloped reaction curve (Huck *et al*. 2001, 2002). Table 3 contains the estimates of followers' actual response function in our data. Recall that the standard best response function is given by $q_2^D(q_1^D) = 24 - 0.5q_1^D$. The estimated response function in treatment NOBUNDSTACK is much flatter than predicted. It appears that followers in this treatment employ a reward-and-punishment scheme as the response function is below (above) the standard best response

[9]At first sight, another explanation could be that our experiments remove the possibility of an equal split. As has been observed (Andreoni and Bernheim, 2009; Güth *et al*., 2001), this causes behavior to be more in line with what theory predicts. However, due to the additional monopoly market an equal split is not possible in *both* our bundling and no-bundling treatments..

function for low (high) leader quantities. On the other hand, in BUNDSTACK, the reaction curve is significantly negatively sloped with a magnitude consistent with the prediction of minus 0.5.

These findings suggest that the monopolists' *intentions* matter (see Cox *et al*., 2007). Indeed, a non-bundling Stackelberg leader can freely earn monopoly rents in its home market and is not "forced" to produce the Stackelberg leader quantity on the duopoly market. Stackelberg leaders that bundle, however, create additional commitment power as it is more costly for them to give concessions in market D through output reductions. Put differently, Stackelberg-leader kind of behavior with bundling is not interpreted as hostile towards the duopolist. As a result, if the Stackelberg leader supplies a bundle, observed play is much closer to the Stackelberg equilibrium.

6. CONCLUSION

Product bundling is a strategy that allows dominant firms to leverage market power from one market to another market. Even though demand is independent across markets, the monopolist can credibly increase its market share in the duopolistic market at the expense of losing some customers in the monopolistic market (Martin, 1999, Nalebuff, 2004).

Our experimental treatments allow us to compare markets where the monopolist can bundle its two products to treatments where it cannot. As large payoff asymmetries result, bundling theory seems an unlikely candidate to survive an experimental test. Indeed, the single-product firms produce more than predicted in all treatments. However, these deviations are often not significant and, overall, we find a surprising high degree of support for the theory of product bundling.

The degree of conformity with theory is particularly noticeable for one of the sequential-move treatments we conduct. While standard Stackelberg duopoly theory by and large fails in the lab (Huck *et al*., 2001), the treatment with bundling leads to average outputs that are significantly closer to the prediction, even though in theory bundling should not make a difference here. Indeed, without bundling followers employ a reward-and-punishment scheme; with bundling followers' reaction functions are significantly negatively sloped. We argue that this is because the followers perceive the intentions of a bundling monopolists as less hostile; they understand that any output reduction of the Stackelberg leader would come at a larger costs.

A novel finding in the experimental literature is that our treatments without bundling basically replicate previous Cournot and Stackelberg duopoly experiments—even though in our design one firm earns additional (and substantial) monopoly payoffs. While at first sight this may seem to contradict models of inequality aversion, we argue that this finding is actually in line with models of inequality aversion. We were surprised to fail to find an experiment exploring the effect that a fixed additional payoff for one player has on inequality-driven behavior. Our current work in progress further investigates this issue in an ultimatum game where the proposer earns an additional amount of money regardless of the responders' actions.

REFERENCES

Berg, J., Dickhaut, J., and McCabe, K. (1995), "Trust, reciprocity, and social history", *Games and Economic Behavior* 10: 122 – 142.

Bolton, G. E. and Ockenfels, A. (2000), "A theory of equity, reciprocity, and competition", *American Economic Review* 90: 166 – 193.

Boone, J., Müller, W., and Suetens, S. (2009), "Naked exclusion: towards a behavioral approach to exclusive dealing", CentER Discussion Paper No. 2009 – 30.

Caliskan , A., Porter, D., Rassenti, S., Smith, V.L., and Wilson, B. (2007), "Exclusionary Bundling and the Effects of a Competitive Fringe", *Journal of Institutional and Theoretical Economics* 163: 109–132.

Cox.J., D. Friedman and S. Gjerstad (2007),"A tractable model of reciprocity and fairness", *Games and Economic Behavior* 59: 17–45.

Damme, E. van, Larouche, P. and Müller, W. (2009), "Abuse of a dominant position: cases and experiments", in Hinloopen, J. and Normann, H.-T. (eds.), *Experiments and competition policy*, Cambridge: Cambridge University Press, 107 – 160.

Fehr, E., Kirchsteiger, G. and Riedl, A. (1993), "Does fairness prevent market clearing? An experimental investigation", *Quarterly Journal of Economics* 108: 437 – 460.

Fehr, E. and Schmidt, K. (1999), "A theory of fairness, competition, and cooperation", *Quarterly Journal of Economics* 114: 817 – 868.

Fonseca, M. A., Huck, S. and Normann, H.-T. (2005), "Playing Cournot although they shouldn't: endogenous timing in experimental duopolies with asymmetric costs", *Economic Theory* 25: 669 – 677.

Fonseca, M. A. and Normann, H.-T. (2008), "Mergers, capacity consolidations and collusion: experimental evidence, *Economic Journal* 118: 387 – 400.

Forsythe, R., Horowitz, J. L., Savin, N. E. and Sefton, M. (1994), "Fairness in simple bargaining experiments", *Games and Economic Behavior* 6: 347 – 369.

Goeree, J. K. and Gomez, R. and C. Holt (2004), Predatory Pricing: Rare Like a Unicorn?, in press in C. Plott and V. L. Smith (eds.), *Handbook of Experimental Economic Results*, New York: Elsevier Press, 178 – 184.

Güth, W., Schmittberger, R. and Schwarze, B. (1982), "An experimental analysis of ultimatum bargaining", *Journal of Economic Behavior and Organization* 3: 367 – 388.

Hennig-Schmidt, H., Li Z.-Y., and Yang C.(2008), "Why people reject advantageous offers - Non-monotonic strategies in ultimatum bargaining", *Journal of Economic Behavior and Organization* 65: 373–384.

Henze, B. and Schuett, F. (2011), "Transparency in markets for experience goods: experimental evidence", presented at the annual M-BEES conference, June 2011, Maastricht.

Holt, C.A. (1985), "An Experimental Test of the Consistent-Conjectures Hypothesis," *American Economic Review* 75, 314-325.

Huck, S., Müller, W. and Normann, H.-T. (2001), "Stackelberg beats Cournot: on collusion and efficiency in experimental markets", *Economic Journal* 111: 749 – 765.

Huck, S., Müller, W. and Normann, H.-T., (2002), "To Commit or not to Commit: Endogenous Timing in Experimental Duopoly", *Games and Economic Behavior* 38: 240 – 264.

Isaac, M. R. and V. L. Smith (1985), "In Search of Predatory Pricing", *Journal of Political Economy* 93: 320-345.

Keser, C. (1993), "Some results of experimental duopoly markets with demand inertia", *Journal of Industrial Economics* 41: 133 – 151.

Lau, S.-H. P. and Leung, F., (2010), "Estimating a parsimonious model of inequality aversion in Stackelberg duopoly experiments", *Oxford Bulletin of Economics and Statistics* 72: 669–686.

Landeo, C.M., Spier, K.E. (2009), "Naked Exclusion: An Experimental Study of Contracts with Externalities", *American Economic Review* 99: 1850– 1877.

Martin, S., 1999, "Strategic and welfare implications of bundling", *Economics Letters* 62: 371 – 376.

Martin, S., Normann, H.T. and Snyder C. (2001) "Vertical Foreclosure in Experimental Markets", *RAND Journal of Economics* 32: 466 – 496.

Mason, C.F., Phillips, O.R. and Nowell, C. (1992), "Duopoly behavior in asymmetric markets: an experimental investigation", *The Review of Economics and Statistics* 74: 662– 670.

Müller. W. (2006), "Allowing for two production periods in the Cournot duopoly: Experimental evidence", *Journal of Economic Behavior and Organization* 60: 100 – 111.

Nalebuff, B. (2004), "Bundling as an entry barrier", *Quarterly Journal of Economics* 119: 159 – 187.

Normann, H.T., Ruffle, B. and Snyder, C. (2007), "Do Buyer-Size Discounts Depend on the Curvature of the Surplus Function? Experimental Tests of Bargaining Models", *RAND Journal of Economics*, 38: 747 – 767.

Santos-Pinto, L. (2008), "Making sense of the experimental evidence on endogenous timing in duopoly markets", *Journal of Economic Behaviour and Organization* 68: 657 – 666.

Santos-Pinto, L. and Iris, D. (2010), "Experimental Cournot oligopoly and inequity aversion", available at: http://www.hec.unil.ch/lspinto/Papers%20&%20CV/ineaveoligop-competition26may2010.pdf

Smith, A.M. (2011), "An experimental study of exclusive contracts", *International Journal of Industrial Organization* 29: 4 – 13.

Suits, D. B. (1984), "Dummy variables: mechanics vs. interpretation", *The Review of Economics and Statistics*, 66: 177 – 180.

Appendix A: Instructions

Cournot - bundling

Welcome!

This is an experiment on market decision-making. Take the time to read carefully the instructions. A good understanding of the instructions and well thought out decisions during the experiment can earn you a considerable amount of money. All earnings from the experiment will be paid to you in cash at the end of the experiment.

Your role and task in the experiment

In this experiment, you just like everybody else in the room will represent a firm. There are two types of firms, firm A and firm B. The computer randomly assigns half of the participants the role of firm A and the other half the role of firm B. Your role as firm A or firm B will remain fixed throughout the experiment, and you will learn whether you are firm A or firm B before we begin the experiment.

The experiment takes place over 15 rounds. In each round, one firm A and one firm B will meet in a market for a fictitious commodity, called Market 1. Firm A operates also in Market 2 but firm B does not.

The computer will randomly match two firms (one firm A, one firm B) for Market 1 in every round from a group of eight subjects. The matching is completely random, meaning that there is no relation between the participant you have been matched with last round (or any other previous round) and the participant to whom you will be assigned this round.

In every period, firm A and firm B have to choose a quantity. This quantity can be any whole number between 1 and 19. Firm B's choice applies to Market 1. Firm A's quantity choice is relevant both in Market 1 as well as in Market 2. That is, firm A has only one quantity choice so that the quantity in Market 1 will be the same as the one in Market 2.

Profit calculation

In the table we distributed, you can see how the profits for both firms are determined. Generally, the column on the left ("Market 2") indicates the profit of firm A on Market 2 and the big payoff table ("Market 1") indicates the profits for firm A and firm B in Market 1.

Market 1

In the payoff table for Market 1, the head of each row represents an A-firm's quantity and the head of the column represents the quantity of the other firm (the B-firm). For each quantity combination (that is, for each of the firm A choices in the rows and the firm B choices in the columns), there is one relevant cell in the payoff table. In these cells, the lower left entry is firm A's profit and the upper right profit is firm B's profit in Market 1.

Market 2

As mentioned, firm A also operates in Market 2. Firm A's profit in Market 2 is contained in the second column of your table, the one with the title "Market 2". The profit firm A earns in Market 2 is in addition to the profit it earns in Market 1.

At the end of each period, Firm A will be informed about the quantity choice of Firm B and Firm B will be informed about the quantity choice of Firm A, and the computer also calculates your profits.

Each period

In each of the 15 rounds, you and the other participant with whom you are randomly matched have to decide simultaneously about your quantities. That is, you have to pick your quantity without knowing what the other participants will choose.

At the end of each period, you will be informed about the quantity the other participant chose, and the computer also calculates your profits.

Payments

The profits in the table are denoted in a fictitious unit of money which we call Florin. For each 500 Florin, you (like all other participants) will be paid € 1 in cash at the end.

In the beginning of the experiment, we will pay you and the other participants 2500 Florin as an initial capital to start with (these are the € 5 show-up fee you were promised). Also these 2500 Florins will be paid in cash to you at the end.

Questions?

If you have a question, please indicate that by raising your hand, and we will answer immediately and privately.

Stackelberg - bundling

Each period

In each of the 15 rounds, you and the other participant with whom you are randomly matched have to decide about your quantities. Firm A will decide about its quantity first. The computer will then inform Firm B about Firm A's choice in Market 1 and Market 2, and then Firm B has to pick the quantity, knowing Firm A's choice. (Firm B will not be informed about Firm A's choice in Market 2.)

APPENDIX B: DATA

Table B1: q_1^D

	BundCour				NoBundCour			
matching group period	1	2	3	4	1	2	3	4
1	20.25	21.50	17.00	19.00	17.00	13.75	16.75	14.00
2	20.25	20.50	18.00	17.75	17.00	16.00	16.50	13.75
3	19.75	19.50	17.75	17.75	16.25	18.00	16.00	14.00
4	20.25	20.00	18.00	19.75	17.00	16.75	19.50	12.75
5	20.25	20.00	17.75	20.00	16.25	17.50	17.75	13.75
6	21.00	20.00	18.25	20.50	17.75	17.25	18.50	13.50
7	19.75	19.75	18.00	18.50	15.00	17.00	17.75	14.25
8	20.25	19.50	19.25	19.25	16.75	17.75	18.50	14.75
9	20.25	19.50	19.25	19.75	17.75	16.75	18.50	15.00
10	19.00	20.00	18.75	18.75	16.75	15.50	16.50	14.50
11	20.25	19.50	19.25	19.75	17.50	16.00	16.50	14.75
12	20.25	19.25	19.25	19.00	17.25	16.75	18.50	14.75
13	20.25	19.75	19.25	19.00	17.75	15.75	18.25	14.50
14	20.25	19.75	19.25	19.00	17.00	15.75	15.75	15.25
15	20.25	19.75	19.25	19.00	16.75	15.75	18.25	16.25
	BundStack				NoBundStack			
matching group period	1	2	3	4	1	2	3	4
1	20.75	23.50	22.25	20.25	14.75	19.25	21.75	15.75
2	20.50	22.75	21.75	21.25	17.50	19.25	19.50	16.25
3	22.75	21.50	22.25	21.00	19.25	17.75	19.50	19.00
4	22.25	23.00	22.50	21.75	21.50	18.75	20.25	22.00
5	22.25	22.75	20.25	23.25	19.25	18.00	21.00	21.25
6	21.50	22.50	21.50	22.00	18.50	19.25	20.25	20.00
7	21.00	24.00	22.50	22.00	16.75	19.00	19.50	18.25
8	23.25	22.75	22.25	21.50	17.00	18.50	19.50	19.25
9	23.00	23.00	21.75	22.25	17.75	19.25	20.25	19.00
10	23.00	22.00	22.75	22.00	17.00	20.00	19.50	21.25
11	22.75	22.50	22.00	21.50	17.75	21.25	17.00	19.75
12	22.25	22.00	21.25	21.00	17.75	19.75	19.50	19.00
13	22.25	22.50	20.75	21.75	16.75	17.50	19.50	19.75
14	22.50	22.50	21.75	22.25	17.75	20.25	19.50	19.00
15	22.50	22.50	22.25	21.25	19.50	20.25	17.00	20.25

Table B2: q_1^M

	BundCour				NoBundCour			
matching group period	1	2	3	4	1	2	3	4
1	16.00	17.25	15.50	15.00	17.00	17.25	15.75	17.25
2	14.50	15.25	15.50	13.00	19.00	16.50	16.75	19.25
3	14.25	17.25	16.00	12.50	17.50	17.00	18.00	17.00
4	16.25	15.50	15.75	15.00	18.75	15.75	14.50	18.00
5	16.75	14.75	15.50	13.25	17.25	16.25	16.25	16.25
6	16.50	15.25	15.50	13.75	16.00	16.25	15.75	17.75
7	16.25	15.25	15.50	14.25	15.75	16.25	16.00	17.25
8	15.75	14.75	15.50	14.75	15.50	16.50	15.25	17.50
9	16.75	16.00	15.25	13.00	16.25	16.25	16.50	17.50
10	16.25	15.75	15.50	13.50	16.00	16.50	16.75	17.25
11	17.75	15.75	16.25	14.75	17.50	16.50	16.50	16.75
12	18.00	16.00	16.25	14.25	17.25	16.50	16.25	17.25
13	16.25	15.25	15.50	15.50	17.50	15.50	15.75	17.50
14	18.25	15.25	15.50	14.25	17.75	16.00	16.00	17.25
15	16.00	14.25	16.25	14.25	17.50	15.75	17.50	17.25
	BundStack				NoBundStack			
matching group period	1	2	3	4	1	2	3	4
1	13.50	11.50	12.00	15.25	15.25	12.75	14.50	14.50
2	14.00	12.50	15.00	13.50	16.50	12.25	14.75	16.75
3	12.75	13.25	16.25	12.25	14.50	14.25	14.25	15.75
4	13.00	12.50	14.75	12.50	13.75	16.00	14.75	16.75
5	13.00	15.25	15.50	11.75	19.00	14.25	16.00	13.25
6	13.25	12.75	16.75	12.25	18.00	14.75	17.75	13.25
7	13.50	12.00	14.00	15.50	15.25	17.25	18.50	16.00
8	12.50	12.50	15.25	12.25	18.00	14.50	18.50	18.00
9	12.50	12.75	16.25	12.25	15.25	14.00	17.75	18.25
10	12.50	13.00	16.25	12.50	18.00	14.00	17.25	15.75
11	12.75	13.00	16.00	12.25	15.50	13.50	18.50	14.00
12	12.75	13.50	16.50	12.75	14.75	14.75	14.25	15.50
13	12.75	13.25	15.50	12.75	13.75	15.75	16.50	14.25
14	12.75	13.25	17.25	12.25	17.75	14.50	16.50	15.75
15	12.75	13.25	16.75	13.00	14.75	13.75	13.25	17.50

Table B3: q_2^D

	BundCour				NoBundCour			
matching group period	1	2	3	4	1	2	3	4
1	20.25	21.50	17.00	19.00	24.00	26.00	25.25	21.00
2	20.25	20.50	18.00	17.75	24.00	25.75	24.25	24.25
3	19.75	19.50	17.75	17.75	24.00	25.50	24.50	24.00
4	20.25	20.00	18.00	19.75	24.00	25.50	24.50	24.00
5	20.25	20.00	17.75	20.00	24.00	25.50	24.50	24.00
6	21.00	20.00	18.25	20.50	24.00	25.50	24.50	24.00
7	19.75	19.75	18.00	18.50	24.00	25.50	24.50	24.00
8	20.25	19.50	19.25	19.25	24.00	25.50	24.50	24.00
9	20.25	19.50	19.25	19.75	24.00	25.50	24.50	24.00
10	19.00	20.00	18.75	18.75	24.00	25.50	24.50	24.00
11	20.25	19.50	19.25	19.75	24.00	24.75	24.50	24.00
12	20.25	19.25	19.25	19.00	24.00	24.75	24.50	24.00
13	20.25	19.75	19.25	19.00	24.00	24.75	24.50	24.00
14	20.25	19.75	19.25	19.00	24.00	24.75	24.50	24.00
15	20.25	19.75	19.25	19.00	24.00	24.75	24.50	24.00
	BundStack				NoBundStack			
matching group period	1	2	3	4	1	2	3	4
1	20.75	23.50	22.25	20.25	22.75	21.75	22.25	25.00
2	20.50	22.75	21.75	21.25	24.00	22.75	23.75	24.75
3	22.75	21.50	22.25	21.00	24.00	24.00	24.00	23.75
4	22.25	23.00	22.50	21.75	24.00	24.25	24.00	25.50
5	22.25	22.75	20.25	23.25	24.00	24.75	24.00	24.00
6	21.50	22.50	21.50	22.00	24.00	23.50	24.00	24.75
7	21.00	24.00	22.50	22.00	24.00	24.25	24.00	23.75
8	23.25	22.75	22.25	21.50	24.00	24.25	24.00	23.25
9	23.00	23.00	21.75	22.25	24.00	24.00	24.00	24.25
10	23.00	22.00	22.75	22.00	24.00	24.00	24.00	24.75
11	22.75	22.50	22.00	21.50	24.00	23.50	24.00	24.75
12	22.25	22.00	21.25	21.00	24.00	22.75	24.00	25.25
13	22.25	22.50	20.75	21.75	24.00	22.50	24.00	23.50
14	22.50	22.50	21.75	22.25	24.00	24.00	24.00	23.50
15	22.50	22.50	22.25	21.25	24.00	23.50	24.00	24.00