Bundling: Examinations of Experimental Data

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To my Mother and the Memory of my Father

To the Memory of Dr. Altamiro Machado

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Abstract

In addition to being a price discrimination tool under monopoly and oligopoly environments, bundling has recently been regarded (especially in information goods industries) as an effective and profitable entry deterrence strategy against a potential one-product competitor.

This study undertakes an experimental analysis to examine the effectiveness of the two-good bundling strategy. Using Nalebuff (1999)'s basic model for theoretical foundation, a set of three treatments are investigated. 'Independent pricing', 'pure bundling', and 'independent pricing or pure bundling' model both three-stage (the first two) and four-stage, two-person non-cooperative games where subjects face potential entry situations according to different entry costs – 'high' and 'low'. These are perfect information games and thus entry costs and payoffs are common knowledge. The equilibria for both 'independent pricing' and 'pure bundling' games entail the incumbent player selecting a price to: (1) deter entry in both 'independent pricing' and 'pure bundling' with 'high' entry costs, and also in the 'pure bundling' with 'low' entry costs sessions; (2) accommodate entry in the 'independent pricing' with 'low' entry costs session. As for both 'independent pricing or pure bundling' with 'high' and 'low' entry costs sessions, the equilibria entail the incumbent player choosing to bundle and selecting a price to deter entry.

While many subjects played according the theoretical predictions, others never succeeded in doing so. Especially in both 'pure bundling' treatment and 'independent pricing or pure bundling' with 'low' entry costs session, a significant proportion of

subjects playing the one-product competitor role entered when entry yielded negative payoffs. Past play and different experimental conditions seem to have influenced subjects' (either playing the incumbent or the one-product competitor role) tendencies to engage in the theoretically predicted equilibria.

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Chapter 1: Pricing Information Goods

According to Shapiro and Varian's (1999) work, computer and communications infrastructure or data networks (e.g., the Internet) might make it possible for today's entrepreneurs dealing in *information goods* to build new monopolies (e.g., Microsoft) since they can take advantage of unprecedented economies of scale.

An *information good* is "something that can be digitized or encoded as a stream of bits" (Shapiro and Varian 1999), e.g., software applications, databases, books, photographs, video clips, movies, music, stock quotes, news stories, and research reports (Bakos and Brynjolfsson 2000). Theoretically, markets for information goods tend to be more monopolistically competitive[1] or "dominant firm-like" than perfectly competitive because of their specific production cost structure, which involves high fixed costs and extremely low marginal costs (i.e., *reproduction* costs for information goods can be quite cheap or even zero). Hence, if information goods were priced at their marginal cost and sold in perfectly competitive markets producers would probably not recover their high fixed costs (Varian 1995, Varian 1996).

[1] Monopolistic competition features markets with few producers of differentiated goods, some of which being close substitutes (e.g., software industry, automobile industry) (Varian 1995).

For instance, expensive research and development efforts are needed to produce the first version of a software application, with most of these costs being sunk and not recoverable. But, additional copies of that application can be made for just a few cents, meaning that information goods have low marginal and variable costs of production.

Large scale of operation also characterizes the making of information goods when their reproduction is not constrained by capacity. Therefore, the higher the production levels of information goods the lower the average cost of production (Varian 1995, Shapiro and Varian 1999).

Network externalities[2] are another characteristic of some information goods (e.g., software applications) and those usually lead to demand-side economies of scale, which favors large producers (Bakos and Brynjolfsson 2000). The literature suggests that Microsoft, for example, took advantage of network externalities exploiting consumers' desires for standard products, such as Microsoft Office. And once Microsoft Office was in place, switching costs of coordination and retraining were too expensive for consumers and firms to replace it with something new (Shapiro and Varian 1999).

Still most information goods producers struggle with a variety of pricing strategies, especially because consumers' willingness-to-pay is heterogeneous and should be taken into account by those strategies. Non-linear pricing schemes and bundling are some of the pricing strategies often adopted by information goods producers since, usually, their application is profitable and helps reduce heterogeneity in consumers' valuations (e.g., the dispersion of valuations over bundles is less than over individual goods).

[2] A good is characterized by network externalities if its value for each consumer depends on how many other consumers are using the good (i.e., "the good becomes more valuable to consume as its market share increases" (Shapiro and Varian 1999, Bakos and Brynjolfsson 2000).

Reduced dispersion in consumers' willingness-to-pay makes it easier for sellers to extract a larger fraction of surplus from all consumers.

1.1 Non-Linear Pricing

Every profit-maximizing producer of information goods would like to be able to charge its product according to each consumer's willingness-to-pay (i.e., first-degree price discrimination). However, consumer's willingness-to-pay is unknown to producers and also hard to determine, and preventing 'high willingness-to-pay' consumers from buying cheaper products that are intended for those with 'low willingness-to-pay' is also complicated. Hence, pure first-degree price discrimination may not be a feasible pricing strategy.

In order to make 'high willingness-to-pay' consumers pay more, producers are willing to differentiate their products by adjusting an information good's characteristics, e.g., timeliness and/or quality (this is essentially second-degree price discrimination). Therefore, producers might offer both high and low quality information goods. The latter is, generally, a degraded version of the high quality product which has some of its features disabled or tasks delayed in order to prevent 'high willingness-to-pay' consumers from buying the low quality version. By adopting these strategies, profit-maximizing producers can get revenues not only from high but also from low-demand sectors of the market.

Also, based on some consumers' characteristics usually associated with their willingness-to-pay, producers might group consumers and practice price discrimination (i.e., third-degree price discrimination) based on, e.g., consumer type (e.g., business, educational, and/or member of a particular group) (Varian 1995, Shapiro and Varian 1999).

1.2 Bundling

Bundling implies selling two or more products (i.e., information goods) in a package that is priced at a fixed amount. Since the marginal cost of *reproducing* information goods has been considerably reduced by computer and communications infrastructure, bundling has been regarded as a powerful and attractive pricing strategy permitting producers to extract more revenue from consumers based on differences in consumers' valuations over bundles of those goods.

The significantly low marginal cost (i.e., almost equal to zero) of each information good that is included in a bundle makes bundling an attractive strategy. However, for higher marginal costs some consumers might be buying the bundle valuing one its components at below production cost, which creates an inefficiency that can make bundling less attractive. In this case, unbundled sales seem to be a better strategy (Chen 1997, MacKie-Mason et al. 1999, Bakos and Brynjolfsson 1999, Shapiro and Varian 1999).

Microsoft has been quite successful selling packages of software applications (e.g., Microsoft Office[3], Microsoft Windows 98 and Explorer). Most consumers prefer buying Microsoft's Office software package (containing a word processor –Word, a spreadsheet –Excel, a presentation tool –PowerPoint, a database –Access and an email tool) to searching and assembling several independent software applications (sometimes of higher quality) to execute the same tasks. For instance, Corel's Word Perfect, IBM's Lotus 123, and Qualcomm's Eudora, bought separately, should be good substitutes for Microsoft's Word, Excel, and email tool, respectively.

Elsevier Science agreed to a pricing field trial – PEAK, involving different bundling schemes and pricing structures, to sell its academic publications on the Internet. Two of the experiment's first concerns were to compare the sales profitability of and the demand for electronic journals[4] (or "traditional subscription"), independent articles, and user-defined bundles of articles (or "generalized subscription", under which users could choose the articles they wanted to include in the bundle, post publication). With the price per article in a per-article purchase being higher than the same price in a "generalized subscription", which in turn was also higher than the one in a "traditional subscription", PEAK experiment revealed that the "generalized subscription" was quite successful[5]

[3] Besides exploiting network externalities, the package succeeded for several other reasons. First, links can be created and material can be transferred between applications with a certain degree of confidence. Second, the package requires less disk space (because applications share common libraries) and works more effectively than if the same set of applications is acquired separately (especially if different versions of each application are sold and installed separately). Third, the package's price is cheaper than the sum of its component prices (Nalebuff 1999, Shapiro and Varian 1999).

[4] An electronic journal is viewed as a bundle of different articles about a particular area of research (MacKie-Mason et al. 1999, Shapiro and Varian 1999, Nalebuff 1999, Bakos and Brynjolfsson 2000).

[5] With the "generalized subscription" people had easier and faster access to a wider collection of articles than they previously had from printed subscriptions (MacKie-Mason et al. 1999).

among users and also profitable for Elsevier Science. Nowadays, special prices are being charged for bundles of subscriptions of related academic journals (Varian 1995, MacKie-Mason et al. 1999, Shapiro and Varian 1999, Nalebuff 1999, Bakos and Brynjolfsson 2000).

Dun & Bradstreet sells data packages to manufacturers that contain detailed information about consumer purchases of branded products from different geographic areas.

A common feature to the above-mentioned examples of Microsoft, Elsevier Science and Dun & Bradstreet is that the price of bundles is lower than the sum of the included component prices. Therefore, bundling two-goods that separately would sell for \$*x* each, e.g., is a way of selling the higher valued good for its stand-alone price (i.e., \$*x*) to a consumer that would only be willing to give an additional smaller amount (lower than \$*x*, also called the incremental price or value) to buy the other good (Shapiro and Varian 1999).

Chapter 2: Reasons to Bundle Information Goods

Authors like Nalebuff (1999), Shapiro and Varian (1999), and Bakos and Brynjolfsson (1999, 2000) argue that monopolists and incumbent oligopolies might take advantage of bundling for several reasons. First, bundling is capable of reducing dispersion in consumers' willingness-to-pay, enabling sellers to possibly extract a significantly increased surplus from all consumers compared to the surplus extracted from selling the same information goods separately. Bundling may permit the firm to increase sales, economic efficiency, and sellers' profits per good. Consumers' valuations for bundles are less dispersed than for individual information goods when such valuations across bundled components are negatively correlated (i.e., when "consumers with high willingness-to-pay for one component tend to have low willingness-to-pay for another component"). However, and as long as consumer valuations are not perfectly correlated, bundling will also tend to reduce dispersion in consumers' willingness-to-pay when such valuations are independent or positively correlated (McAfee et al 1989, Nalebuff 1999, Shapiro and Varian 1999). Bakos and Brynjolfsson (1999, 2000) showed that, as long as resale is not permitted or profitable among consumers, the higher the number of components included in the bundle the higher the multiproduct monopolist's profit per good, the lower the deadweight loss and the lower the consumers' surplus per good. This proposition still holds whether:

(i) Information goods are complements or substitutes.

(ii) Information goods have diminishing or increasing returns to scale.

However, that proposition does not hold for rival bundles that include only two goods each.

Bakos and Brynjolfsson (1999, 2000) also suggested that bundling should be combined with third-degree price discrimination in order to make consumer valuations be independent and identically distributed conditional on, e.g., consumer type (i.e., consumers' market should be segmented and prices charged according to consumer type). Therefore, bundling might be able to create new opportunities for price discrimination under monopoly environments, even achieve perfect price discrimination with bundles containing an infinite number of goods.

Second, while the traditional economic explanation for bundling suggests that it can be an effective price discrimination tool if used by monopolists, Nalebuff (1999) shows that it still is effective under oligopoly environments when a two-product incumbent faces a one-product competitor. By bundling both products, the two-product incumbent will be able to get higher profits selling the bundle than selling both goods separately even though it might have only monopoly power on one good. This means that bundling strategy mitigates the impact of competition faced by the incumbent firm in oligopoly environments (Nalebuff 1999, Bakos and Brynjolfsson 2000). Third, bundling can be an effective entry-deterrent strategy (Nalebuff 1999, Bakos and Brynjolfsson 2000). Bakos and Brynjolfsson (2000) showed that incumbent producers aggregating a large number of information goods in a bundle and selling it for a fixed fee (e.g., America Online, Dow

Jones, Consumer Reports, and Association for Computing Machinery (ACM)), might discourage or foreclose potential one-product competitors' entry. In their setting, pairs of non-perfect substitute information goods (e.g., A_1 and B_1, A_2 and B_2, …, A_n and B_n) produced by different firms (e.g., A and B providing unrelated goods A_1, A_2, …, A_n and B_1, B_2, …, B_n, respectively) compete for consumers' attention, with each good in the pair having independent linear demand (i.e., consumer valuations are independent and uniformly distributed in [0, 1]). Under these circumstances, bundling all products (say, e.g., firm A selling a bundle containing A_1, A_2, …, A_n) is a dominant strategy for the multi-product producer (i.e., "a good facing competition is more profitable as part of a bundle") because, by doing so, bundler's profits will be higher than if it sells all its goods separately. One-product producers competing against such a bundler will be forced to charge a lower price for each substitute product, make lower revenues, and be limited to a lower market share than if they were competing against a firm that did not bundle at all.

By choosing a price that maximizes its profits, an incumbent bundler is also selecting a better way to maintain its market share, making entry quite unattractive for one-product producers that want to compete with one of the bundled products and multi-product producers selling competing goods separately. The result holds even if potential entrants have lower production costs and/or higher quality products than the incumbent bundler since entrants will only sell their products (for their incremental values) to those consumers regarding them as superior, while the incumbent will sell its bundle to all the remaining consumers (Nalebuff 1999, Bakos and Brynjolfsson 2000).

Still, entering the incumbent bundler's market can be profitable if the potential entrant is able to offer a rival bundle, or if one-product potential entrants are able to enter the market simultaneously with an implicit bundle (e.g., coordinating their entry and pricing, or through merger). If consumer valuations for the information goods included in each bundle are not correlated, every time a bundle that competes with the incumbent's is offered most consumers will be willing to buy either seller's bundle because they are equally likely to find their preferred information goods in either bundle. In this case, fixed costs will no longer be an entry barrier for one-product producers entering the market simultaneously as a bundle, and consumers will be better off since their welfare increases by having two rival bundles being offered in the market (Bakos and Brynjolfsson 2000).

Under oligopoly environments, a two-product incumbent possessing market power in both products and bundling them together would make it harder for one-product rivals (producing a substitute for one of the incumbent's products) to enter the market, and would keep the incumbent from lowering the price in each of its products. Therefore, by choosing to bundle its products the two-product incumbent will be able to, e.g., significantly lower the potential one-product entrant's profits. However, it would be possible for an entrant offering a rival bundle to compete with a two-product incumbent bundler (Nalebuff 1999).

The bundling entry-deterrent effect against a possible one-product competitor has not been mentioned often in the literature because researchers (mainly the Chicago School) were skeptical about the possibility of extending the firm's monopoly power from one product to another through bundling. However, Whinston (1990) showed that it is possible for a monopolist in one good facing non-perfect competition on another to take advantage of bundling them together. Therefore, it seems that the Chicago School's criticism only applies to monopoly power being leveraged from one product's market to another if the latter is perfectly competitive (Nalebuff 1999).

Fourth, bundling might facilitate predation. Adding a new information good (e.g., a substitute to the one-product incumbent good) to an existing bundle of unrelated goods might help its bundler to enter this new information good's market, capture most of the one-product incumbent's market share and even force it to exit. Entering under these circumstances can be profitable (even if it would not be with a stand-alone good) because "there is a range of fixed costs for which entry is profitable if and only if the entrant sells a bundle" (Bakos and Brynjolfsson 2000). According to Bakos and Brynjolfsson (2000), selling a new good as part of an already existing bundle makes it credible for the entrant to charge a sufficiently low price in order to keep its high market share, and even earn more profits than it would by selling the same good separately.

Fifth, bundling might promote cost savings in production and transaction costs. For instance, in the software market it is cheaper for a producer to include several applications in one CD disc and sell the package than to sell them separately, while possibly being a producer's strategy to create real convenience for consumers. Finally, mixed bundling[6] (of two or more information goods) usually dominates pure bundling[7] with the latter dominating over unbundled sales in terms of profitability (McAfee et al. 1989, Chen 1997, Bakos and Brynjolfsson 1999, Nalebuff 1999, Bakos and Brynjolfsson

[6] Mixed bundling refers to a multiproduct producer offering the bundle containing all goods currently being produced and a set of bundles containing only part of those goods (Adams and Yellen 1976, McAfee et al. 1989, Nalebuff 1999, Shapiro and Varian 1999, Bakos and Brynjolfsson 1999, Bakos and Brynjolfsson 2000).

[7] Pure bundling is a special case of mixed bundling which refers to a multiproduct producer offering just the bundle containing all goods currently being produced (Adams and Yellen 1976, McAfee et al. 1989, Nalebuff 1999, Shapiro and Varian 1999, Bakos and Brynjolfsson 1999, Bakos and Brynjolfsson 2000).

2000).

Chapter 3: This Study

The study will focus on bundling (a strategy of packaging, pricing, and selling information goods) as a more profitable strategy than selling the same goods separately and as an effective entry-deterrence mechanism, under monopoly and/or oligopoly environments.

Despite the many attractions of bundling as a pricing strategy for selling information goods, the entry-deterrent effect only recently captured the attention of researchers (e.g., Nalebuff (1999), and Bakos and Brynjolfsson (2000)). At least two models have been built – one by Bakos and Brynjolfsson (2000) and another by Nalebuff (1999), to explain the role of bundling in deterring entry.

Assuming that consumer valuations were independent and uniformly distributed over [0, 1], Bakos and Brynjolfsson (2000) solved for equilibrium quantities, prices and revenues under alternative parameter settings (see Table 1, page 76, in their paper). They concluded that, for certain ranges of fixed costs, the production of non-perfect substitutes to compete with an existing n-sized bundle (with n being as large as hundreds or thousands) of information goods would not be worthwhile if those non-perfect substitutes could not also be offered as a bundle. Under these circumstances, entry may become quite unattractive and bundling much more profitable than selling the same goods separately since bundling may reduce competition.

Nalebuff (1999), first applying his basic model to two-good bundles, then extending it to larger bundles, and also assuming that consumer valuations were independent and uniformly distributed over [0, 1], showed that:

(i) Gains provided by the entry-deterrent effect of bundling under an oligopoly environment can be higher than a monopolist's with unbundled sales.

(ii) Bundling is able to reduce potential entrants' profits.

(iii) If entry occurs, the incumbent's post-entry profit loss is reduced when compared to the profit loss that would result from selling the same information goods separately.

That is, bundling is capable of reducing the impact of entry on the incumbent side, while making entry difficult for the potential entrant.

Because theory alone is not enough to explain an incumbent firm's pricing strategy and/or a challenger's entry behavior, empirical evidence must be found to support theoretical assumptions and implications (Gilbert 1989). Therefore, the main purpose of this study is to empirically test theoretical findings on the profitable bundling entry-deterrent effect.

Since it is quite hard to determine firms' pricing strategies (not usually revealed) and consumers' valuations for information goods or their bundles (e.g., records on what consumers buy on the Internet are quite difficult to get), we chose to gather the empirical data from a laboratory setting. Also, determining the motives behind multiproduct producers bundling decisions and what might cause changes in a market's structure, e.g., are usually quite difficult to figure out in field studies. Under a laboratory setting, the behavior of economic agents can be observed under controlled conditions so that (Mason and Phillips 2000):

(i) Producers' payoffs are clearly known under selected market options.

(ii) There are no doubts about how potential entrants' profits might be diminished.

(iii) Possible gains from bundling are know in advance.

(iv) Demand and costs are known and completely controlled.

However, strategic uncertainty seems to be present in laboratory settings since, initially, the degree of subjects' rationality (i.e., "foresighted agents") is not known and "cannot be controlled for" (Mason and Phillips 2000).

Nalebuff's (1999) basic model seemed to be more appropriate and tractable for a laboratory setting than, e.g., one of Bakos and Brynjolfsson's (2000, 1999) models, since the latter ones deal with bundles of hundreds, or even thousands, of information goods. Hence Nalebuff's (1999) basic model furnished the theoretical foundations for this study.

Our search of the literature for works that might help provide insights on how to design an experiment capable of faithfully reproducing Nalebuff's (1999) basic model produced several notable contributions, including studies by Mason and Phillips (2000), Mason and Nowell (1998), Harrison (1986), Isaac and Smith (1985). Each of these works notes that when an experimental design closely conforms to a theoretical model, the latter's results and predictions should be observed in the lab if the theory is appropriate for predicting the behavior of economic actors. Another common feature to all of these studies is that their experimental designs operationalize oligopoly environments where an incumbent firm is being challenged by other firm(s) in the market or considering entry into the market.

For instance, Mason and Nowell (1998) analyzed subjects' tendencies to follow subgame perfect equilibria in an experimental environment based on Dixit's (1979) entry deterrence game. The latter model "formalizes the incentives for an incumbent firm to deter entry in the presence of sunk costs". According to Mason and Nowell (1998), an incumbent firm's unique subgame perfect equilibrium would be to deter entry. But their study revealed that entry accommodation was relatively frequent with low entry costs and the percentage of subjects playing subgame perfect equilibrium increased with entry costs.

As previously discussed, there are usually large sunk costs attached to the production of information goods, and Nalebuff's (1999) work shows that entry deterrence with bundling might be more effective over a wider interval of entry costs than the independent pricing strategy. Hence it seemed plausible to adapt Mason and Nowell (1998) experimental design to this study.

This study's theoretical and experimental backgrounds and experimental design are further described in the chapters that follow.

Chapter 4: Theoretical Background –Nalebuff's Basic Model

Nalebuff's basic model has the format of a non-repeated game of perfect information that is played by two strategic players –an incumbent and a potential challenger, in an oligopoly market where only two goods –A and B, can be sold. Entry costs (determined by the environment) although of common knowledge, are only faced by one player – the challenger. The following assumptions apply to those who participate in the game:

(i) The incumbent:

- produces both A and B goods, each at zero marginal cost;
- sets its prices prior to the challenger's entry decision, and the incumbent's prices remain fixed for the rest of the game;
- must anticipate a possible entry in either A or B;

(ii) The challenger:

- is assumed to have a perfect substitute for A or B (but not both; whether A or B is random and equally likely), also produced at zero marginal cost;
- has no capacity constraints to production (nor does the incumbent, implying that they will always meet demand);

- will make a decision to enter the market based on whether the expected profits in the game cover its entry costs;

(iii) The consumer:

- is interested in purchasing exactly one unit of A and/or B;
- has no budget constraints, meaning that his/her income does not affect valuations of the goods and therefore he/she can buy one or both goods if he/she wants to;
- values good A at α_A and good B at α_B;
- has valuations drawn from a distribution given by $f(\alpha_A, \alpha_B)$, with $f(\alpha_A, \alpha_B)$ being uniform over the unit square and thus consumer valuations of A and B are independent and uniformly distributed over [0, 1], so $F(\alpha_A) = \alpha_A$, and $F(\alpha_B) = \alpha_B$;
- s' total market is normalized to be of size 1, i.e., N (number of consumers) = 1;

During the whole game, incumbent's price(s) are fixed for the following reasons. First, fixing the price was considered to be the most favorable toward the challenger[8]. Second, in oligopolies where challenger's good is a perfect substitute for the incumbent's (i.e., product differentiation does not exist, or is not significant), the challenger may regard pre-entry price "as an indicator both of the character of industry demand and of

[8] No one would enter the market if the incumbent could deter entry without having to lower prices following entry. Also, entry would costlessly be deterred if firms could engage in a Bertrand-Nash pricing game post entry, since prices and profits would be driven to zero, which under this perfect information game setting would make the incumbent earn monopoly profits (Nalebuff 1999).

the probable character of rival policy after his entry". Third, the challenger might be able to offer some customers a better deal, gathering enough profits to cover its entry cost, both before the incumbent can react and firms engage in a price war that could destroy subsequent profitability. (Since this is not a repeated game, the incentives that this might create to engage in a price war in order to deter future entry are not taken into account.) Finally, the challenger could enter only one of several incumbent's geographic markets and if the incumbent was constrained to charge the same price across its markets (e.g., by a "most-favored customer clause" (Nalebuff 1999)), reducing the price might not be a good strategy for the incumbent to recover a limited number of stolen customers.

The basic model's algebraic structure and description can be divided into three experimental treatments and they are 'independent pricing', 'pure bundling', and 'independent pricing or pure bundling'.

4.1 Independent pricing

In this treatment the incumbent only sells the goods A and B separately. If the incumbent chooses not to deter entry, as a monopolist (i.e., being alone in the market) and a profit maximizing firm it will try to maximize total revenues from both goods A and B. That is:

a) since consumers' utility functions U_j (with j = A, B) for A and B goods are of the form $U_j = \alpha_j - p_j$; consumers who will buy j are those whose α_j satisfy $\alpha_j - p_j > 0 \Rightarrow \alpha_j > p_j$ which will occur with probability $1 - F(p_j) = 1 - p_j$; and because N (number of consumers) = 1, the market demand for each good will be given by $q_j = 1 - p_j$,

b) the incumbent firm will then try to maximize a function of the form $\pi_i = \Sigma TR_j = \Sigma(q_j p_j)$ so that MR_j (good *j*'s marginal revenue) = MC_j (good *j*'s marginal cost), with $MC_j = 0$, which implies $\delta TR_j / \delta p_j = 0 \Leftrightarrow [(1 - p_j)p_j]' = 0 \Leftrightarrow p_j^* = 1/2$

(i) <u>If entry does not occur</u> –the incumbent would price the two goods independently at $p_A^* = p_B^* = 1/2$ (optimal monopoly independent pricing) in order to maximize its profits, which would be $\pi_i^* = 1/4 + 1/4 = 1/2$ (optimal monopoly independent profits). Depending on entry costs, this could make it easy for a challenger to enter the market.

(ii) <u>If entry occurs</u> –the challenger could enter the market with product B (or product A), charge p_B^* *(or* p_A^**)* $= 1/2 - \varepsilon$ for it, steal all the market in whichever product it has, and, consequently, reduce incumbent's profits by half. That is, π_c^* (challenger's profits) = $TR_B = q_B p_B = \pi_i^*/2$. Challenger and incumbent's independent profits would then be $\pi_c^* = \pi_i^* = 1/4$, respectively. Following entry incumbent's best strategy would be to continue charging the price of *1/2* in the other good's market that is left for it.

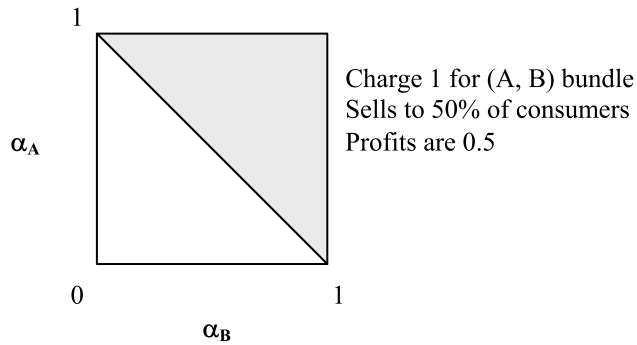
Since the challenger can take fifty percent of the incumbent's market and profits if entry occurs, the incumbent might be better off if it tries to deter entry. Under these circumstances, and assuming challenger's entry costs – *E*, the incumbent's best strategy will be to choose (instead of a price directly) a profit level that translates back into a price, i.e., the incumbent should price at a point $p = (p_A, p_B)$ such that $\pi_i^* = 2E$. Because the incumbent has to choose between deterring entry and earning $\pi_i^* = 2E$, or accepting entry and earning $\pi_i^* = 1/4$, entry will only be deterred if $E > 1/8$ (i.e., $E > 0.125$).

4.2 Pure Bundling

In this treatment it is assumed that the incumbent has to sell its products (i.e., A and B goods) as part of a two-good bundle. The explanation that follows will begin with an example in which both incumbent and challenger's pricing decisions are sub-optimal. That is, incumbent and challenger simply translate their independent pricing strategy into the bundle treatment without re-optimizing (i.e., "pure bundling effect at equivalent prices"). The incumbent monopolist would then be pricing the bundle at $p_t = 1$ (with $p_t = p_A^* + p_B^*$, with p_A^* and p_B^* being good A and B's optimal independent prices, respectively):

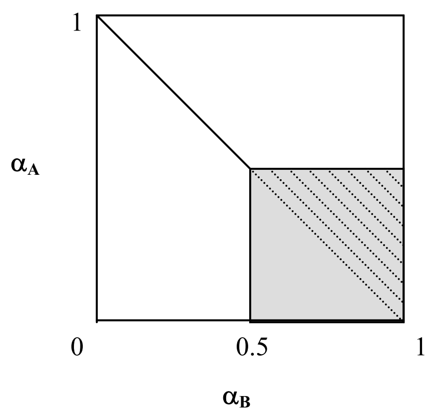
(i) If entry does not occur –the incumbent would sell to half the market and its profits would be $\pi_t = 1/2$ (see Figure 4.1, where the axes represent consumers' valuations for both goods A and B, and the shaded area represents the demand for the bundled good).

Figure 4.1 "Pure bundling effect at equivalent prices" (absent entry)



(ii) If entry occurs at zero entry costs (i.e., $E = 0$) –suppose that the challenger comes into the market pricing good B, e.g., at $1/2$ (not an optimal price), and sells only to those consumers with $\alpha_B > 1/2$ and $\alpha_A \leq 1/2$. This implies that the challenger would only get 25% of the market (represented by the square-shaded area of Figure 4.2). (Consumers with $\alpha_A > 1/2$ would prefer to buy the bundle). The incumbent would then lose those consumers who simultaneously value the bundle at above 1 and have an $\alpha_A < 1/2$. That is, it would lose 25% of the market for the two-good bundle (see lined-triangular area in Figure 4.2), which would be equivalent of losing 50% on one of the product sales.

Figure 4.2 "Pure bundling effect at equivalent prices" (following entry)



(iii) If entry occurs at non-zero entry costs (i.e., $E > 0$) –in trying to maximize its profit function – π_e, the challenger would charge $p_e < 0.5$, such as, $p_e^* = 1/3$ (optimal price). It would then capture 4/9 of the market, while the incumbent would lose 2/9ths of the market and 2/9ths of its profits.

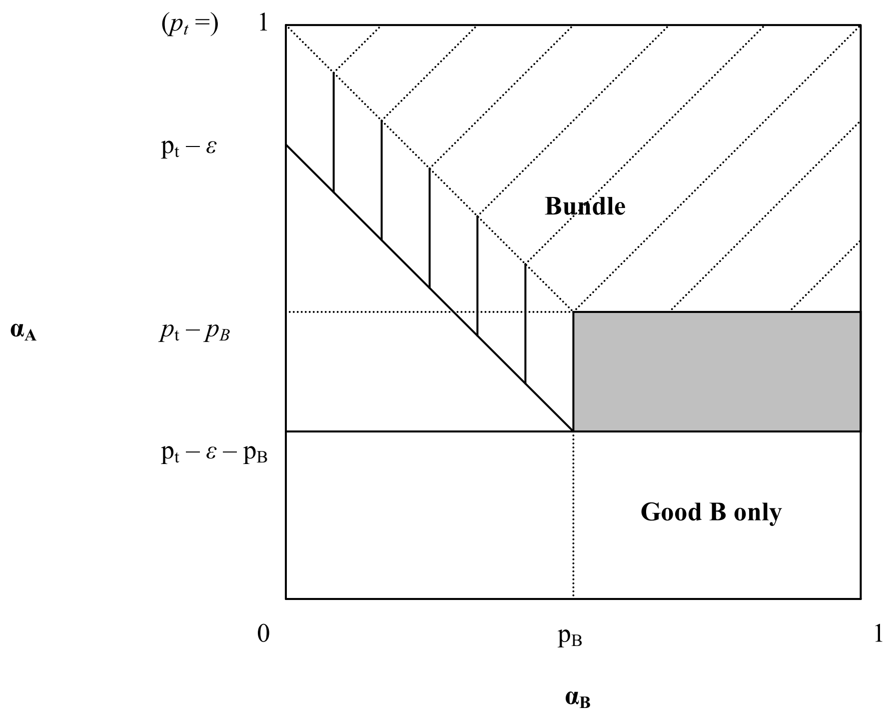
However, and according to McAfee et al. (1989), if the multiproduct monopolist marginally lowered the bundle's price – p_t by a positive infinitesimal amount ε, it could induce some consumers to buy the two-good bundle instead of only one of the goods included in it, which would strictly increase its profits. The intuition behind this result will be better explained with the help of Figure 4.3 which is taken from McAfee et al. (1989). Starting at an initial position where $p_t = p_A^* + p_B^*$, (where p_A^* and p_B^* are good A and B's optimal independent prices, respectively), and then marginally decreasing p_t, for independently distributed consumer valuations the multiproduct monopolist would (McAfee et al. 1989):

1) Lose ε from consumers in the diagonal-lined area;

2) Get consumers in the shaded area to buy the bundle instead of good B only;

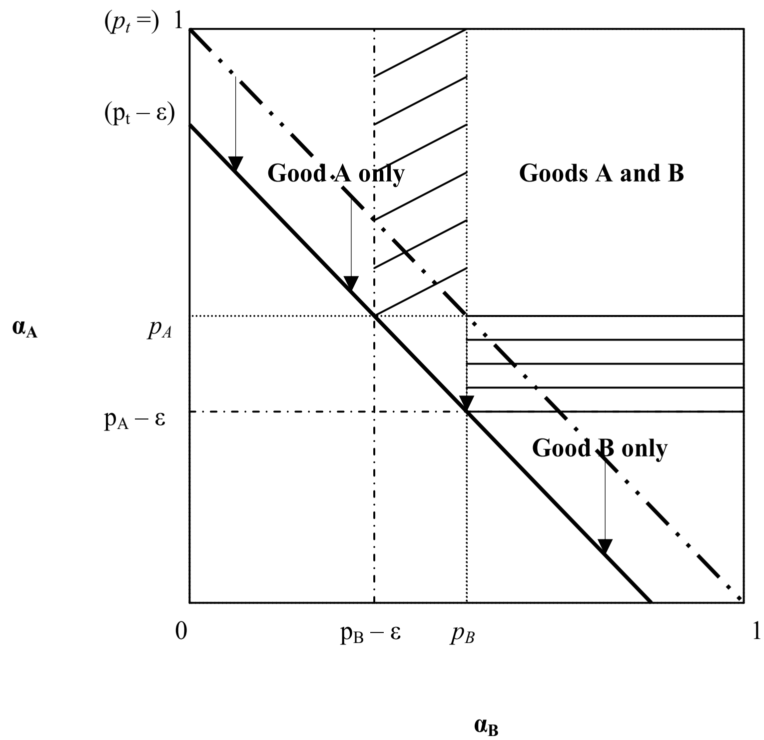
3) Get new consumers in the vertical-lined area to buy the bundle.

Figure 4.3 (adapted from McAfee et al. (1989))



Even if the multiproduct monopolist, selling goods A and B separately, was able to slightly diminish the price of good j only to those consumers with valuations, α_h, greater than p_h^* (where $h \neq j$, and $h = j$ = A, B), he/she would have to lower p_A by ε for all $\alpha_B > p_B^*$ and p_B by ε for all $\alpha_A > p_A^*$ in order to get consumers to buy both goods instead of only good B (i.e., consumers in the horizontal-lined area, see Figure 4.4) or good A (i.e., consumers in diagonal-lined area, see Figure 4.4), respectively. This means that the multiproduct monopolist would lose 2ε from consumers in the shaded area (see Figure 4.4) since it would have to decrease, not only one (e.g., the price of the bundle – p_t) but two prices, each by ε. That is, lowering the price of a bundle is more profitable than lowering, by the same amount, the price of each good being sold independently (McAfee et al. 1989).

Figure 4.4 "Bundling discount effect"



Hence it can be said that there are relatively more marginal consumers which create an incentive to cut the bundle's price (i.e., "bundling discount effect") (Nalebuff 1999) since a marginal discount in the bundle's price – p_t might lead to a marginal increase in the consumption of the bundle.

This price cut might be viewed as a low-cost (even costless) entry deterrence strategy since entry becomes less and less profitable compared to entry with a bundled price of $p_t = 1$ (Nalebuff 1999). Thus, if the incumbent decides to price the bundle at $p_t \leq 1$, and anticipates entry:

(i) <u>If entry does not occur</u> –"selling the bundle at a discount to the optimal independent pricing provides an opportunity to raise the incumbent's profits, while making entry even less profitable". Incumbent's profits, given by $\pi_t = p_t(1 - p_t^2/2)$ and having $3p_t^2 - 2 = 0$ as first order condition, would then be maximized at the optimal monopoly bundled price $p_t^* = \sqrt{2/3} \approx 0.80$, and be $\pi_t^* \approx 0.544$. The incumbent would capture 68% of the market (see Figure 4.5's lined area, i.e., demand for the two-good bundle). Therefore, if the incumbent reduces its bundled price from 1 to 0.8, then the potential challenger's profits will also be reduced, and the incumbent's profits will rise, assuming no entry. If the bundled price is reduced below 0.8 this will further reduce the potential challenger's profits, while also lowering incumbent's profits relative to the monopoly case (both with bundled and unbundled sales) assuming no entry. Entry is more likely to be deterred if the challenger's entry costs are greater than 0.035 (i.e., $E > 0.035$). Still, since the incumbent's price is near an optimum, its profits will fall slowly while potential challenger's profits will fall rapidly (see Tables 4.1 and 4.2). Therefore, under these circumstances, it is profitable to strategically deter entry.

Figure 4.5 (from Nalebuff's (1999) Figure 1, page 8)

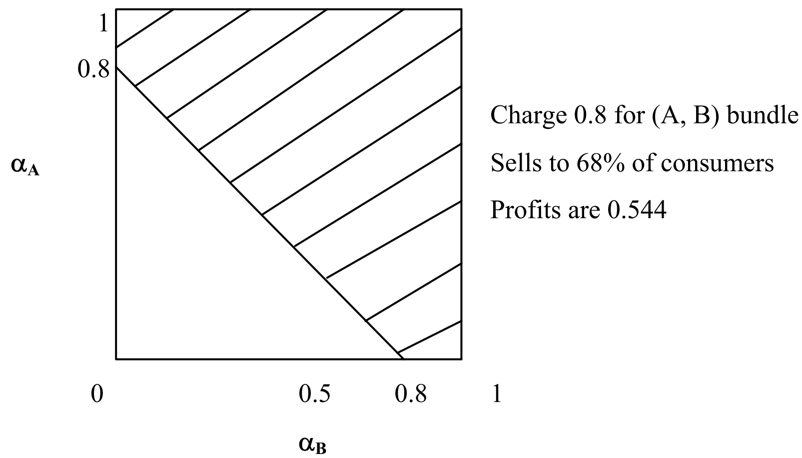


Table 4.1–"Pure bundling effects" and "bundling discount effects" on incumbent's profits, absent entry

Incumb. charges p_t	% reduction in price if $p_t = 1$	% increase/ reduction in price if $p_t = 0.8$	Incumbent's profits (π_t)	π_t % increase/ reduction if $p_t = 1$	π_t % reduction if $p_t = 0.8$
1	—	25.0%	0.5	—	(8.088)%
0.8	**(20)%**	—	**0.544**	**8.800%**	—
0.66	(34)%	(17.5)%	0.516252	3.250%	(5.101)%
0.42	(58)%	(47.5)%	0.382956	(23.409)%	(29.604)%

Table 4.2–"Pure bundling effects" and "bundling discount effects" on potential challenger's profits

(calculations based on the challenger's optimal price response, see item (ii) of this treatment)

Incumb. charges p_t	% reduction in price if $p_t = 1$	% increase/ reduction in price if $p_t = 0.8$	Potential challenger's profits (π_e)	π_e % reduction if $p_t = 1$	π_e % increase/ reduction if $p_t = 0.8$
1	—	25.0%	0.148148148	—	41.056%
0.8	**(20)%**	—	**0.1050276086**	**(29.106)%**	—
0.66	(34)%	(17.5)%	0.0769600454	(48.052)%	(26.724)%
0.42	(58)%	(47.5)%	0.0354342672	(76.082)%	(66.262)%

(ii) <u>If entry occurs</u> –which can happen when the challenger's entry costs $E \leq 0.1$, the challenger, with profit function $\pi_e = p_B(1 - p_B)(p_t - p_B)$ that has $3p_B^2 - 2(1 + p_t)p_B + p_t = 0$ by first order condition, would price good B (or A) at $p_B^* = (1 + p_t)/3 - 1/3\sqrt{(1 - p_t + p_t^2)} < 0.5$, capturing the set of consumers whose $\alpha_B > p_B^*$ and $\alpha_A \leq (p_t^* - p_B^*)$ (see shaded area of Figure 4.6). The incumbent's loss would be significantly reduced relative to the independent pricing case, and its post-entry profits would now be given by $\pi_{pt} = p_t(1 - p_t + p_B - p_B^2/2)$, with first order condition $1 - 2p_t + (1 - p_B/2)p_B = 0$, being maximized at $p_t^* \approx 0.66$, which leads to $\pi_{pt}^* \approx 0.38$ (see Table 4.3 bold cells). In response to this price, the challenger would charge, e.g., $p_B^* \approx 0.26$ (substituting $p_t \approx 0.66$ in the previous p_B^* formula) and would earn $\pi_e \approx 0.08$ (substituting $p_t \approx 0.66$ and $p_B \approx 0.26$ in the previous π_e formula). That is, the incumbent should attempt to deter entry only if it can earn profits above *0.38*, which can be effective when challenger's entry costs fall in the interval $]0.035, 0.1]$. It should be noticed that incumbent's post-entry profits π_{pt}^*, at $p_t^* = 0.66$, are similar to incumbent's profits π_t (absent entry) at price $p_t = 0.42$ (refer to Table 4.3), at which the challenger can only earn a low profit of *0.035*.

Figure 4.6 (from Nalebuff's (1999) Figure 2, page 9)

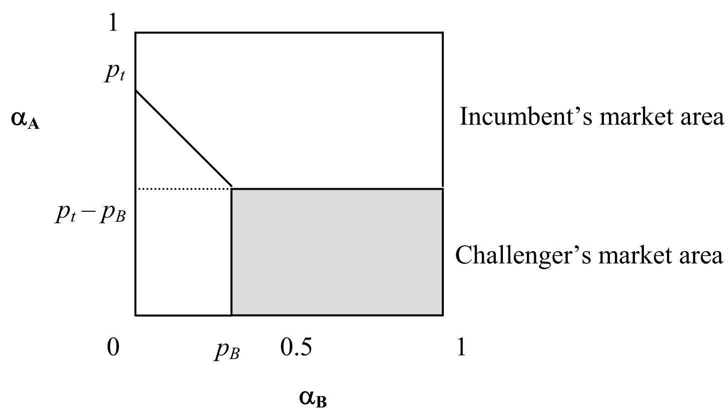


Table 4.3 shows incumbent's bundled versus independent prices and profits with entry and no entry, alongside with the opportunities presented to a potential challenger.

Table 4.3–Incumbent's bundled vs. independent prices and profits (with entry and no entry), and potential challenger's profits

Incumbent charges	Incumbent's profits with entry	Incumbent's profits with no entry	Potential challenger's profits
1 (bundle)	0.2777777778	0.5	0.148148148
0.8 (bundle)	0.3609050519	**0.544**	0.1050276086
0.66 (bundle)	**0.373581026**	0.516252	0.0769600454
0.42 (bundle)	0.3135745246	*0.382956*	*0.0354342672*
0.5 (each good)	**0.25**	**0.5**	0.25

4.3 Independent Pricing or Pure Bundling

This treatment compares benefits/losses for both incumbent and challenger under an incumbent's independent pricing strategy or an incumbent's pure bundling strategy (which includes "pure bundling effects" and "bundling discount effects").

So, every time the incumbent decides not to bundle, and adopts an independent pricing strategy:

(i) If the challenger's entry costs $E \leq 0.125$ –the incumbent accepts entry, should charge price $p_A = p_B = 0.5$ for both goods prior entry, and keep on charging the same price for the good at which it remains a monopolist, after entry has occurred.

(ii) If the challenger's entry costs $E > 0.125$ –the incumbent should try to deter entry pricing at a point $p = (p_A, p_B)$ so that its profits would be $\pi_i \leq 2E$, with $E > 1/8$, since the challenger can take half of the incumbent's market and profits. Still, entry might occur while $E \leq 0.25$.

When the incumbent adopts the pure bundling strategy but charges the non-optimal price $p_t = 1$ for the bundle, the challenger will capture 4/9 of the market if its entry costs are positive and it comes in at $p_B^* = 1/3$ (i.e., optimal price). The incumbent would, consequently, lose 2/9ths of the market and of its profits but, although, it will always lose 1/2 of what the challenger captures, these losses are considerably lower than both market loss (e.g., of all of the B market) and profits loss (equal to l/2) with independent pricing.

However, the incumbent can get further benefits from pure bundling, especially if it charges a discounted price for the bundle (e.g., $p_t = 0.8$), since:

(i) If the challenger's entry costs $E \leq 0.035$ –the incumbent accepts entry and should charge a price $p_t^* = 0.66$. Bundling mitigates the cost of entry (making entry less costly for the incumbent) since when the incumbent bundles and entry occurs the incumbent's profits rise 49% (from 0.25 to 0.37, see Table 4.5). Still, bundling can be used to deter entry since if the incumbent charges a bundled price, entry only occurs if $E \leq 0.035$ opposed to 0.125 of independent pricing. It is also argued that, although most firms would feel less threatened if their rivals' profits were lower, bundling gives no reason, in this model, for the incumbent to worry about challenger's profits once entry is accommodated (a benefit some how hard to quantify). That is, the challenger comes into the market with $\pi_e \approx 0.08$ (69% less than when it enters against unbundled sales, see Table 4.6) facing the optimal bundle price previously noted. Against $p_t^* = 0.66$, the challenger would charge, approximately, $p_B^* = 0.26$ and would earn $\pi_e \approx 0.08$. Furthermore:

- If the challenger's entry costs $E = 0$, the incumbent charged a bundled price $p_t = 1$ and the challenger entered at $p_B = 0.5$, the latter would only sell to 25% of the market and have its profits reduced by 50%, when compared to its profits with independent sales.

(ii) If the challenger's entry costs $E > 0.035$ –the incumbent should set a bundled price p_t just low enough to prevent the challenger from entering the market (with $p_t \leq \sqrt{2}/3 \approx 0.80$, since beyond this point there is no further gain from raising the price). Furthermore:

- If the challenger's entry costs $E \leq 0.1$, incumbent's profits rapidly rise with entry costs in the curved section of Figure 4.8's "Profits w/ Bundled Pricing" curve, which demonstrates that bundled pricing is an effective way to deter entry. Also, with $E = 0.1$ incumbent's profits from bundled pricing ($\pi_t \approx 0.544$) more than double the profits of an incumbent that sells its products independently ($\pi_i = 0.25$). It can be argued that, although the price-discrimination effect can be valuable, bundling larger gains come from entry-mitigation effect (noted above).

- Once the challenger's entry costs satisfy $E > 0.1$, the incumbent no longer worries about entry because it recovers its unconstrained monopoly profits. Tables 4.4, 4.5, and 4.6 show percentage increases and/or reductions of incumbent and challenger's profits absent and following entry induced by incumbent's bundled and independent pricing. Therefore, bundling can be considered an effective tool to deter entry.

Table 4.4–Selling each good independently vs. "pure bundling and bundling discount effects" on incumbent's profits, absent entry

Incumb. charges p_t/p_j w/ j = A/B	**% increase/ reduction in price if $p_j = 0.5$**	**Incumbent's profits if it bundles (π_t)**	**Incumbent's profits if it does not bundle (π_i)**	**% increase/ reduction in profits if $p_j = 0.5$**
1(bundle)	0%	0.5	—	0%
0.8(bundle)	(20)%	0.544	—	8.8%
0.66(bundle)	(34)%	0.516252	—	3.25%
0.5(each good)	—	—	0.5	—
0.42(bundle)	(58)%	0.382956	—	(23.409)%

Table 4.5–Selling each good independently vs. "pure bundling and bundling discount effects" on incumbent's profits, following entry

Incumb. charges p_t/p_j w/ j = A/B	**% increase/ reduction in price if $p_j = 0.5$**	**Incumbent's profits (π_{pt}) if it bundles**	**Incumbent's profits (π_i) if it does not bundle**	**% increase in profits if $p_j = 0.5$**
1(bundle)	0%	0.2777777778	—	11.112%
0.8(bundle)	(20)%	0.3609050519	—	44.362%
0.66(bundle)	(34)%	0.373581026	—	49.432%
0.5(each good)	—	—	0.25	—
0.42(bundle)	(58)%	0.3135745246	—	25.429%

Table 4.6–Selling each good independently vs. “pure bundling and bundling discount effects” on challenger’s profits

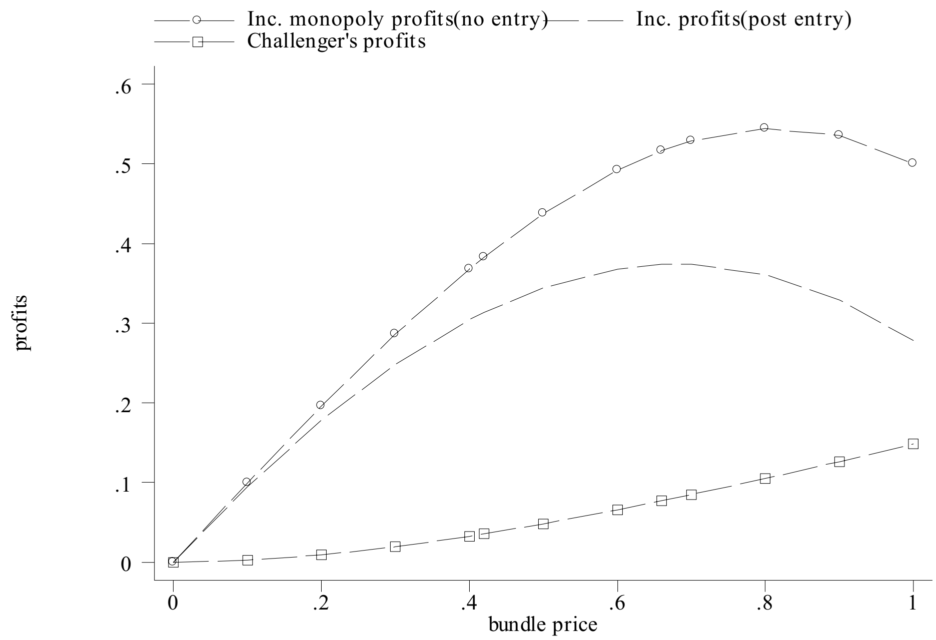
Incumb. charges p_t/p_j w/ j = A/B	% increase/ reduction in price if $p_j = 0.5$	Challenger’s profits (π_e) if incumbent bundles	Challenger’s profits (π_c) if incumbent does not bundle	% reduction in profits if $p_j = 0.5$
1(bundle)	0%	0.148148148	—	(40.741)%
0.8(bundle)	(20)%	0.1050276086	—	(57.989)%
0.66(bundle)	(34)%	0.0769600454	—	(69.216)%
0.5(each good)	—	—	0.25	—
0.42(bundle)	(58)%	0.0354342672	—	(85.826)%

- If the challenger’s entry costs satisfy $E > 0.25$, “Profits w/ Bundled Pricing” reach the value of 0.54, as opposed to the value of 0.5 attained as “Profits w/ Independent Pricing” (i.e., “bundling discount effect”, see Figure 4.8). This indicates a gain from price discrimination and thus bundling can also be used as a price-discrimination device, as frequently noted in the bundling literature. However, if the incumbent charged a bundled price $p_t = 1$ (i.e., “pure bundling effect”), incumbent’s profits would equal incumbent’s optimal monopoly independent profits.

Figure 4.7 summarizes what happens to both incumbent and challenger’s profits absent and following entry when the incumbent bundles its products. The incumbent can always achieve its maximum profits of $\pi_{pt} \approx 0.38$ following entry. But, it can only make sense for the incumbent to deter entry if the “Inc. monopoly profits(no entry)” curve (which represents incumbent’s monopoly profits assuming no entry) lies above 0.38, i.e., when entry deterring profits can be higher than 0.38.

Figure 4.7 Profits with bundled prices

(from Nalebuff's (1999) Figure 4, page 14)



Assuming optimal play by all, Figures 4.8 and 4.9 show the same results Figure 4.7 does for the corresponding entry costs with the latter being displayed in the horizontal axes.

Figure 4.8 Incumbent's Profits

(from Nalebuff's (1999) Figure 5, page 14)

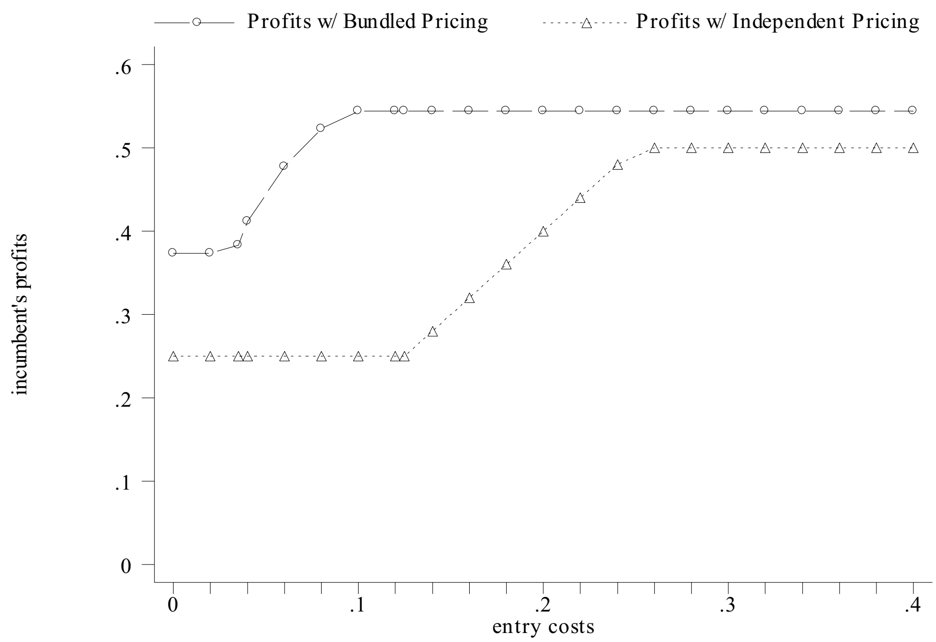
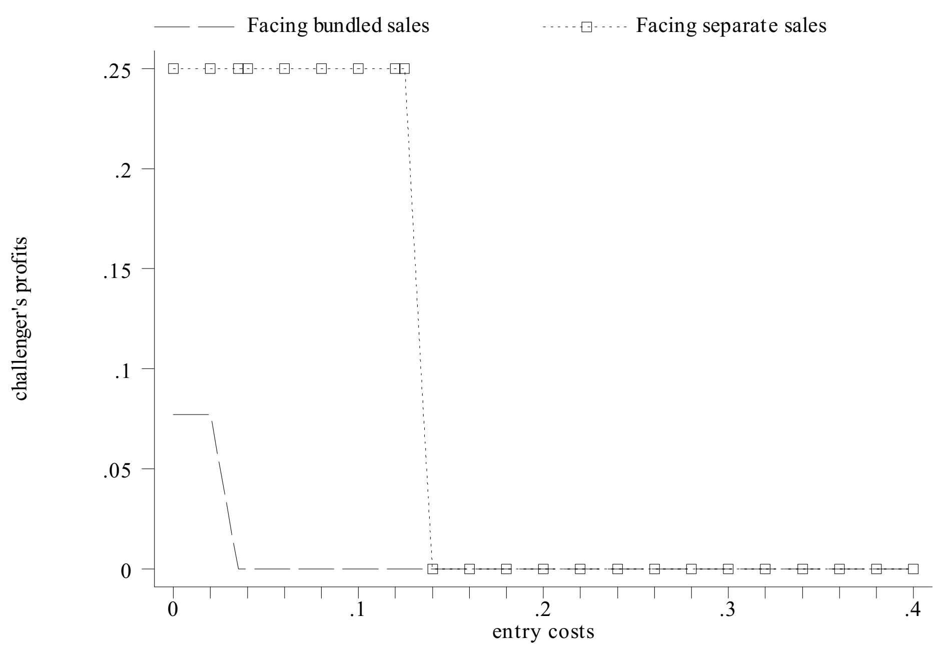


Figure 4.9 Challenger's profits with bundled and separate sales



Figures 4.10 and 4.11 summarize fluctuations on both incumbent and challenger's prices, respectively, according to incumbent's choice of selling the two-good bundle or goods A and B separately.

Looking at Figures 4.8 and 4.10 it seems that no matter the entry costs a potential challenger may face, the incumbent is better off bundling and selling the two-good bundle at a discount relative to the component prices. When the incumbent bundles and accommodates entry (Figure 4.10's straight section of "Bundled Sales" line, for $E \leq 0.035$), although the bundle price is reduced below its optimal monopoly price of about *\$0.8* (and below the sum of the same optimal monopoly independent price of about *\$0.5* for each good A and B when the incumbent accommodates entry selling such goods separately –Figure 4.10's straight section of "Separate Sales" line, for $E \leq 0.125$) it is still near an optimum. As entry costs increase, the incumbent who bundles rapidly recovers and exceeds (see Figure 4.10's curved section of "Bundled sales" line, for $0.035 < E \leq 0.1$) the price charged when accommodating entry (of about *\$0.66*) reaching the optimal monopoly bundled price at $E = 0.1$, which will be maintained for higher entry costs. Thus, the entry deterrence effect seems much more effective under bundling since by engaging in limit pricing and independent sales, the incumbent would slowly recover the optimal monopoly independent price (see Figure 4.10's curved section of "Separate sales" line, for $0.125 < E \leq 0.25$). And, this price will only be maintained for E values greater than 0.25.

Figure 4.10 Incumbent's prices with bundled and separate sales

(with "Separate Sales" line representing the sum of prices being charged for good A and good B, i.e., $p_A + p_B$)

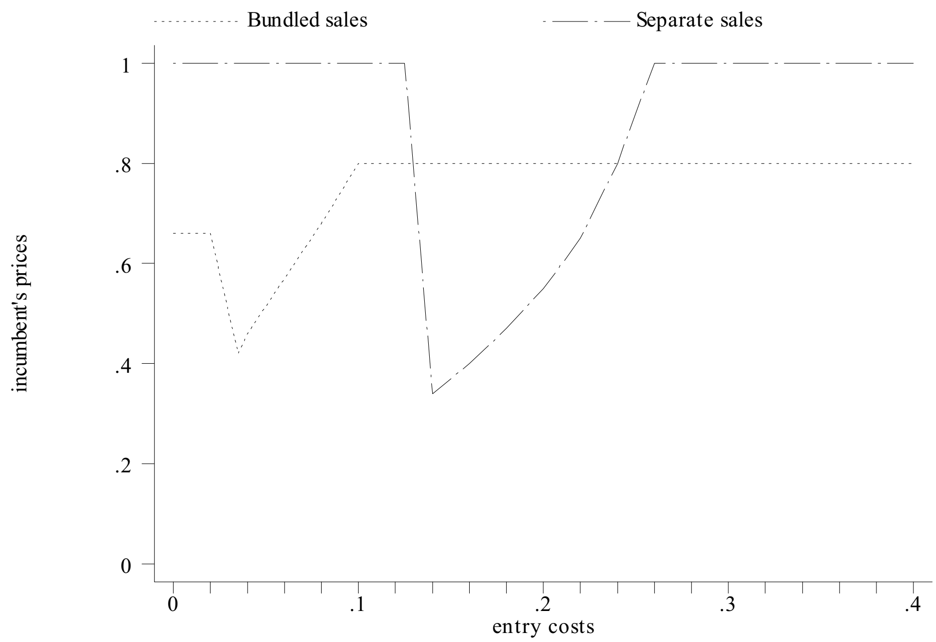
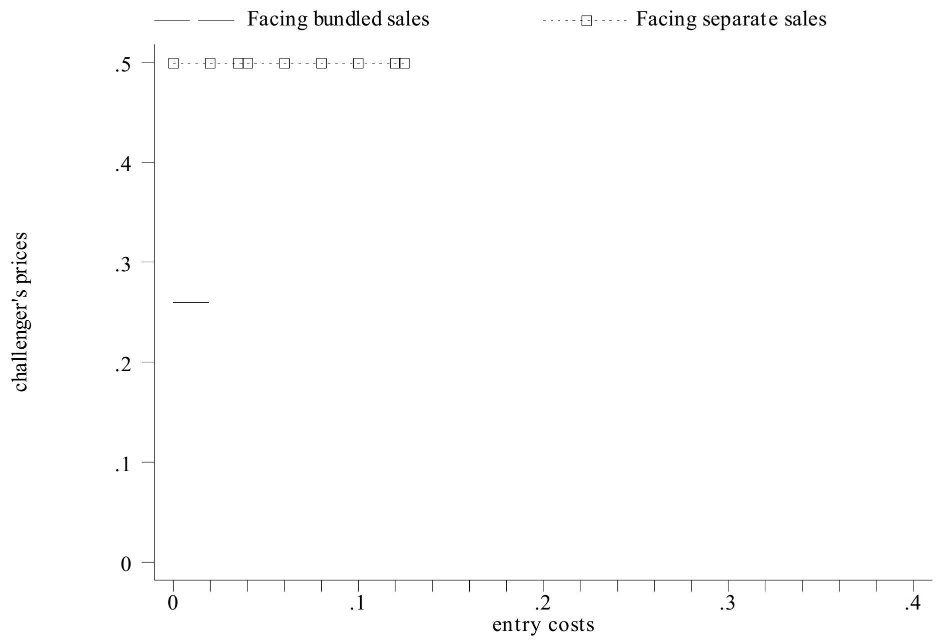


Figure 4.11 shows that if the incumbent bundles the potential challenger will charge considerably lower prices (of about *$0.26*) for the competing good than it would if the incumbent did not bundle. Furthermore, bundling seems to keep the challenger from entering one of the incumbent's markets in a wider entry cost interval. That is, bundling will make the challenger stay out of the market for *E* values greater than *0.035*, while unbundled sales might only prevent the challenger from entering one of the incumbent's markets for *E* values greater than *0.125*.

Figure 4.11 Challenger's prices with bundled and separate sales



Chapter 5: Experimental Background –Literature Review of Experimental Studies

Since this study's experimental design tries to examine whether Nalebuff's (1999) basic model assumptions and implications (with respect to bundling profitable entry-deterrent effect) perform as expected, it will try to conform as closely as possible to the theory. That is, if both the structural[9] and behavioral[10] assumptions of the Nalebuff's (1999) basic model are operationalized by the experimental design then the experiment should be able to show whether the theory accurately predicts the behavior of economic actors. Such experimental designs usually involve the imposition of a few behavioral assumptions that, although being minimal to any plausible theory, may not be present in actual markets. Determining which competitor moves first and whether firms commit to prices are two examples of those behavioral assumptions (Gilbert 1989).

A review of the experimental literature in the field of Industrial Organization revealed that some of the work done under, e.g., contestable markets and predatory pricing areas of research could provide some useful guidance for this study's

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[9] Structural assumptions characterize features of the available technologies (e.g., production or cost), limitations (e.g., market) on the potential number of the producing firms, and trading institutions (i.e., "formal or informal rules under which exchange contracts are negotiated") (Coursey et al. 1984b).

[10] Behavioral assumptions describe, e.g., sellers' risk attitudes and interfirm expectations (Coursey et al. 1984b).

experimental design. For instance, experimental studies by Mason and Phillips (2000), Mason and Nowell (1998), Harrison (1986), and Isaac and Smith (1985) operationalize oligopoly markets (usually two-firm) where there exists an incumbent (e.g., a monopolist or dominant firm) being challenged by other firm(s) already in the market, or potential entrant(s). This scenario closely resembles Nalebuff's (1999) basic model environment. A description of these studies will be provided in the paragraphs that follow, with emphasis being given to their experimental design elements.

In their work, Mason and Phillips (2000) searched for evidence of manipulation of industry costs to deter entry, and/or efforts to drive rivals out of an incumbent's market. To begin with, their experimental design consisted of the designated incumbent having to privately choose among three different "cost structures". Each "cost structure" was associated with two sets of possible payoffs –one for the incumbent and another for the rival; incumbent sellers were supposed to select the most favorable "cost structure" by analyzing those six payoff sets. Once chosen, the "cost structure" was publicly posted. Incumbent and rival's simultaneous output choices (according to each possible set of corresponding payoffs given by the previously selected "cost structure") followed. The "cost structures" consisted of three pairs of constant marginal costs faced by incumbent and rival –one featuring equal costs for both firms and the remaining two featuring increasingly different costs, which made the incumbent have a cost advantage over the rival. Subjects got to play both "incumbent" and "rival" roles (to develop experience), being paired with an unknown different opponent every trading period (to avoid repeated game effects). Demand was linear.

Mason and Nowell (1998), operationalizing Dixit's (1979) entry deterrence game in the presence of sunk costs, examined subjects' tendencies to follow subgame perfect equilibria in an experimental environment that allowed for learning and adaptation. In their experimental design (featuring a perfect information environment), the incumbent posted a quantity (that remained unchanged for a whole trading period), and the entrant decided whether entry was profitable. Every time an entrant decided to participate in the market and post a quantity it had to pay an amount (i.e., a participation fee, which simulated the cost of entry) that was varied to be 'low', 'medium', or 'high' according to the experiment at hand. Just as in Mason and Phillips's (2000) work, subjects got to play both "incumbent" and "entrant" roles, while being matched with a different unknown opponent every period, and demand was also linear.

Harrison (1986) operationalized the theory of market contestability in a series of experiments where the sellers designated as incumbents were first-movers, publicly posting their price offers (and quantities, with the latter being private) before any potential entrant did. Such offers remained unchanged throughout each trading period, i.e., after entrants' offers were posted. Potential entrants (facing zero entry costs and having perfect knowledge of the incumbent's price offer) were then able to evaluate the profitability of entry and post their prices accordingly[11].

This series of experiments used computer simulated buyer behavior, with buyers always choosing to purchase the lowest price units available until demand was completely satisfied, or the maximum quantity offered had been reached.

[11] These experimental design features were the major modifications introduced by Harrison (1986) to Coursey et al. (1984a) and Harrison and Mckee (1985)'s experimental designs in order to implement all the theoretical aspects related to the contestable markets' "Bertrand-Nash" assumption.

Searching for predatory pricing in the lab, Isaac and Smith (1985), in a series of experiments, featured a two-firm (i.e., large (predator) vs. small (prey)) environment with the following design elements:

i) A posted-offer market, in which each seller independently posted a non negotiable price and a corresponding quantity every period;

ii) "Induced seller marginal cost schedules" (shown in figure1*a* of their paper, page 325), which implements a cost asymmetry favoring the potential predator over the prey;

iii) Up-front capital endowments (with the potential predator being given a higher up-front capital endowment when compared to the one provided to the prey), in order to operationalize predator firms' capital market advantages;

iv) Purchase of an "entry permit" (valid for only five consecutive trading periods) by every seller entering the market, to introduce sunk (entry) costs. The potential predator was required to purchase two permits to cover periods one to ten (emulating the incumbency advantage), while the potential prey was only given the opportunity of deciding whether to enter the market in period six[12];

v) Subjects played both "large" and "small" firm roles in different experiments with perfect information.

[12] Coursey et al. (1984b) used a similar design feature in their series of "boundary experiments on the evaluation of the contestable markets hypothesis" (Harrison 1986), where they have tested for conjectures regarding the way in which deviations from the strict assumptions of perfect contestability, particularly positive finite sunk (entry) costs, might affect the performance of an otherwise contestable market.

Although Isaac and Smith's (1985) series of experiments also used computer simulated buyer behavior it was different from Harrison's (1986). Isaac and Smith (1985) had each computer-simulated buyer randomly ordered into a buying sequence by PLATO's computerized buyer subroutine. Harrison (1986) had computer-simulated buyers ordered according to their marginal valuations in a strictly declining way, i.e., highest marginal valuation buyers purchased "from the lowest-price seller, leaving buyers with lower marginal valuations for the next lowest-price seller, and so on".

Isaac and Smith (1985) were unable to observe predatory pricing behavior in their experiments. However, Harrison (1988) introducing two major changes to the former authors' design, by (1) defining four different types of predatory pricing, and (2) running five concurrently experimental markets, was able to observe a limited amount of predatory pricing[13] (Jung et al. 1994).

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[13] Harrison (1988)'s experimental design was later replicated by Capra et al. (2000) and modified in three major ways. First, Capra et al. make potential prey sellers publicly announce their entry decisions before everybody else's price and quantity decisions (to implement entry decision's low flexibility when compared to the pricing decision). Second, they use a three-step demand curve instead of the five-step one that has been used since Isaac and Smith (1985)'s work. Third, they let potential predator firms know potential preys' cost structures but not the other way around (to make it easier for the former to predate without incurring any losses). The main aim of the latter authors' work was to explain and adapt (for the purpose of teaching) Harrison (1988)'s study to illustrate theoretical orientations in Industrial Organization courses.

Chapter 6: Experimental Design

Employing Nalebuff's (1999) basic model for theoretical guidance, this study's experimental design can be characterized as a set of three non-cooperative games (or treatments[14]) –'independent pricing', 'pure bundling', and 'independent pricing or pure bundling', with each game being played by two strategic players (or sellers). Six sessions[15] will be reported –one of 'high' and another of 'low' entry costs per 'independent pricing', 'pure bundling', and 'independent pricing or pure bundling' treatments.

A single market with simulated buyers spans each session actual round. There are two types of sellers: seller 1 (the incumbent) selling goods A and B separately or bundled; and seller 2 (the challenger) that may be selling either good A or B. Both types of sellers have complete and symmetric information about each other's costs structures. Seller 1 is always the first to move and its decision(s) remain unchanged throughout a session round. After seller 1's choice(s) is(are) made public just to the seller 2 with whom he/she is paired with, the latter decides whether to 'enter the market'.

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[14] A treatment reflects a unique environment that is characterized by a specific configuration of information, experience, incentives and rules (Davis and Holt 1993).

[15] A session consists of events, games, or other decision tasks performed by the same group of subjects during a sequence of rounds, which occur in the time span between subjects' arrival and the moment they receive their payment (Davis and Holt 1993, Fischbacher 1999).

If seller 2 chooses to enter, he/she has to post a price for either good A or B that is randomly chosen for him/her (i.e., the good that seller 2 may be selling is randomly determined by the computer every session round). Payoffs are then calculated based on seller 1's choice(s) and seller 2's response, and are then reported to the sellers.

Every subject that participates in a session receives a $5 show-up fee independent of his/her performance. Besides this $5 participation fee, each subject playing seller 2 receives a one time initial endowment of $10 to cover possible losses that might occur throughout the fifteen actual rounds of each session. There is no constraint on losses in any round and the bankruptcy rule forgives any losses in excess of $10.

Demand is simulated and each buyer, in a one-time purchasing decision, has the ability to acquire one unit of the two-good bundle – (A, B) or one unit of either good A or B, if seller 1 bundles; otherwise each buyer has the ability to purchase one unit of good A, one unit of good B, or both. The subsections that follow describe demand and how monetary payoffs are calculated, per treatment, for both seller 1 and seller 2.

6.1 Independent Pricing Treatment

Demand is simulated such that all buyers valuing goods A and B above their corresponding prices will buy from the lowest-price seller. Prices charged by both sellers for goods A and/or B range from 0 to 1.

In the 'independent price' treatment, monetary payoffs are based on the demand curve $q_h = 1 - p_h$ (with h = A or B good, i.e., with $q_A = 1 - p_A$ being the demand for good A, and $q_B = 1 - p_B$ for good B). Only when both sellers charge the same price for the same good, e.g., B, demand for this particular good is equally distributed between the sellers, i.e., half of the buyers valuing good B above its price will buy from seller 1 and the other half from seller 2. In this case, monetary payoffs resulting from the sale of good B will be based on the demand curve $q_B = 1/2(1 - p_B)$.

Variable and fixed costs are both set to zero for goods A and B. Thus, the monetary payoff functions for sellers 1 and 2 participating in a given session round are:

(i) $\pi_i = (1 - p_h)p_h + (1 - p_{1j})p_{1j}$ for seller 1 (with $h \neq j$ and j = A or B), if 'no entry' (or if 'entry' and $p_{1j} < p_{2j}$);

(ii) $\pi_i = (1 - p_h)p_h$ for seller 1 and $\pi_c = (1 - p_{2j})p_{2j}$ for seller 2 (with $h \neq j$), if 'entry' and $p_{1j} > p_{2j}$;

(iii) $\pi_i = (1 - p_h)p_h + 1/2(1 - p_{1j})p_{1j}$ for seller 1 and $\pi_c = 1/2(1 - p_{2j})p_{2j}$ for seller 2 (with $h \neq j$), if 'entry' and $p_{1j} = p_{2j}$.

Prior to entry, seller 2's potential (monetary) payoff function is $\pi_c - E$ (with E being seller 2's entry costs). Therefore, the optimal one-shot response for seller 2 (i.e., p_{2j}^*) to seller 1's price (i.e., p_{1j}) is:

a) To 'enter the market' and price good j at $p_{2j}^* = p_{1j} - \varepsilon$ if $E \leq 0.125$;

b) Not to 'enter the market'

otherwise;

with seller 1's equilibrium price being:

i) $p_{1j}^* = 0.5$, if $E \leq 0.125$ or $E > 0.25$;

ii) $0 < p_{1j}^{d} \leq 0.5$, if $0.125 < E \leq 0.25$, where p_{1j}^{d} is the deterrence price given by the following equation $p_{1j}^{d} = 1/2 - 1/2\sqrt{(1 - 4E)}$. In this case, seller 1's optimal behavior is to engage in limit pricing which will make him/her earn $\pi_i = 2E$, while making seller 2 earn $\pi_c = E$.

Equilibrium earnings are $(1 - p_h^{*})p_h^{*} + (1 - p_{1j}^{*})p_{1j}^{*}$ (with $p_h^{*} = p_{1j}^{*}$ and $h \neq j$) for seller 1. If seller 2 chooses to enter, his/her earnings will be $(1 - p_{2j}^{*})p_{2j}^{*} - E$ (with $p_{2j}^{*} = p_{1j}^{*} - \varepsilon$, where ε is 0.1 since payoffs were made discrete for the experiments); if he/she opts not to enter, his/her earnings will be 0.

6.2 Pure Bundling Treatment

If only the two-good bundle is offered, demand is simulated such that all buyers valuing the two-good bundle – (A, B) above its price (i.e., $\alpha_A + \alpha_B > p_t$) will purchase it. With the two-good bundle and good j (e.g., with j = B) being offered, demand is simulated in a way that all buyers valuing good A and the two-good bundle such that $\alpha_A > p_t - p_B$ and $\alpha_A + \alpha_B > p_t$, respectively, will purchase the two-good bundle; and all buyers valuing good A such that $\alpha_A < p_t - p_B$ and good B above its price (i.e., $\alpha_B > p_B$), will purchase good B but not the bundle.

In each session round prices charged by seller 2 for either good A or B may range from 0 to 1. However, prices charged by seller 1 for the two-good bundle – (A, B) may range from 0 to 2 in order to provide seller 1 with an extended range of possible price choices since maximum buyer's valuation for the two-good bundle is 2 (i.e., with α_A and

α_B each ranging from 0 to 1, max $\alpha_A + \alpha_B = 2$). If both sellers price their goods in the [0, 1] interval, 'pure bundling' treatment monetary payoffs are based on the following demand curves:

(i) $q_t = q_{pt} = 1 - p_t^2/2$ for the bundle,

if 'no entry' or (if 'entry' and $p_t \leq p_j$) (with j = A, or j = B);

(ii) $q_{pt} = 1 - p_t + p_j - p_j^2/2$ for the bundle and $q_j = (1 - p_j)(p_t - p_j)$ for good j,

if 'entry' and $p_t > p_j$.

Variable costs and fixed costs are set to zero for both A and B goods. Hence, the corresponding monetary payoff functions for sellers 1 and 2 participating in a given session round are:

(i) $\pi_t = \pi_{pt} = (1 - p_t^2/2)p_t$ for seller 1,

if 'no entry' or (if 'entry' and $p_t \leq p_j$);

(ii) $\pi_{pt} = (1 - p_t + p_j - p_j^2/2)p_t$ for seller 1 and $\pi_e = (1 - p_j)(p_t - p_j)p_j$ for seller 2,

if 'entry' and $p_t > p_j$.

If seller 1 charges a price in the interval]1, 2] for the two-good bundle, 'pure bundling' treatment monetary payoffs are based on the following demand curves:

(i) $q_t = q_{pt} = 1/2[(2 - p_t)^2]$ for the bundle,

if 'no entry' or (if 'entry' and $p_j = 1$);

(ii) $q_j = 1 - p_j$ for good j,

if 'entry' and [($1 \leq p_t - p_j \leq p_t$ and $1 < p_t < 2$) or ($0 \leq p_j \leq 0.9$ and $p_t = 2$)];

(iii) $q_{pt} = 1/2(1 - p_t + p_j)(3 - p_t - p_j)$ for the bundle and $q_j = (1 - p_j)(p_t - p_j)$ for good j,

if 'entry' and $0.2 \leq p_t - p_j \leq 0.9$.

And the corresponding monetary payoff functions for sellers 1 and 2 (also with variable costs and fixed costs set to zero for both goods A and B) that participate in a given session round are:

(i) $\pi_t = \pi_{pt} = 1/2[(2 - p_t)^2]p_t$ for seller 1,

if 'no entry' or (if 'entry' and $p_j = 1$);

(ii) $\pi_e = (1 - p_j)p_j$ for seller 2,

if 'entry' and ($1 \leq p_t - p_j \leq p_t$ and $1 < p_t < 2$) or ($0 \leq p_j \leq 0.9$ and $p_t = 2$);

(iii) $\pi_{pt} = 1/2(1 - p_t + p_j)(3 - p_t - p_j)p_t$ for seller 1 and $\pi_e = (1 - p_j)(p_t - p_j)p_j$ for seller 2,

if 'entry' and $0.2 \leq p_t - p_j \leq 0.9$.

Prior to entry, seller 2's potential (monetary) payoff function is $\pi_e - E$. Therefore, the optimal one-shot response for seller 2 (i.e., p_j^*) to seller 1's bundle price (i.e., p_t) is:

a) To 'enter the market' and price good j at $p_j^* = (1 + p_t)/3 - 1/3\sqrt{(1 - p_t + p_t^2)}$ if $E \leq 0.035$

b) Not to 'enter the market' otherwise,

with seller 1's equilibrium price being:

i) $p_t^* = 0.66$, if $E \leq 0.035$;

ii) $0.42 < p_t^d \leq 0.8$, if $0.035 < E \leq 0.1$, where p_t^d is the deterrence price that can be extracted from the following equation $27E = p_t^d[3 + 3p_t^d - 2(p_t^d)^2] - 2\{1 - [1 - p_t^d + (p_t^d)^2] \sqrt{(1 - p_t^d + (p_t^d)^2]}\}$. The latter can be found substituting $p_j^* = (1 + p_t)/3 - 1/3 \sqrt{(1 - p_t + p_t^2)}$ in π_e and making $\pi_e = E$ since, in this case, seller 1's optimal behavior is to engage in limit pricing;

iii) $p_t^* = 0.8$, if $E > 0.1$.

Equilibrium earnings are $(1 - p_t^{*2}/2)p_t^*$ for seller 1, absent entry, and $(1 - p_t^* + p_j^* - p_j^{*2}/2)p_t^*$ if entry occurs. If seller 2 opts to enter, his/her earnings will be $(1 - p_j^*)(p_t^* - p_j^*)p_j^* - E$; if he/she chooses not to enter, his/her earnings will be 0.

6.3 Independent Pricing or Pure Bundling Treatment

The difference between this and the other two treatments resides in the number of decisions seller 1 has to make. While seller 1 only makes a pricing decision in both 'independent pricing' and 'pure bundling' treatments, in this one seller 1 has to choose whether to bundle goods A and B prior making a pricing decision.

Depending on seller 1's bundling choice, simulated buyers, demand, and payoff functions are identical to those previously described for 'independent pricing' and 'pure bundling' treatments (see sections 6.1 and 6.2, respectively).Therefore, in each session round:

(i) If seller 1 chooses to sell goods A and B separately, the optimal one-shot response for seller 2 to seller 1's price will be equal to the one previously described in the ‘independent pricing’ treatment; and so will be seller 1’s equilibrium prices and sellers’ earnings.

(ii) If seller 1 opts to sell the two-good bundle, the optimal one-shot response for seller 2 to seller 1’s price will be equal to that previously described in the ‘pure bundling’ treatment; and so will be seller 1’s equilibrium price and sellers’ earnings.

Chapter 7: Hypotheses and Predictions

The purpose of 'independent pricing', 'pure bundling', and 'independent pricing or pure bundling' treatments is to answer the following questions:

I. Does an incumbent selling two goods (e.g., A and B) separately engage in limit pricing to prevent a potential one-product competitor (selling a perfect substitute to either good A or B) from entering the market when entry costs are 'high'? Is entry successfully deterred?

II. Does an incumbent selling a two-good bundle – (A, B) charge the optimal monopoly price for it, which prevents a potential one-product competitor (selling a perfect substitute to either good A or B) from entering the market when entry costs are 'high'? Is entry successfully deterred?

III. If facing a potential one-product competitor (selling a perfect substitute to either good A or B), does an incumbent selling two goods (e.g., A and B) separately accommodate entry charging the same optimal monopoly price for both goods when entry costs are 'low'? Does entry occur?

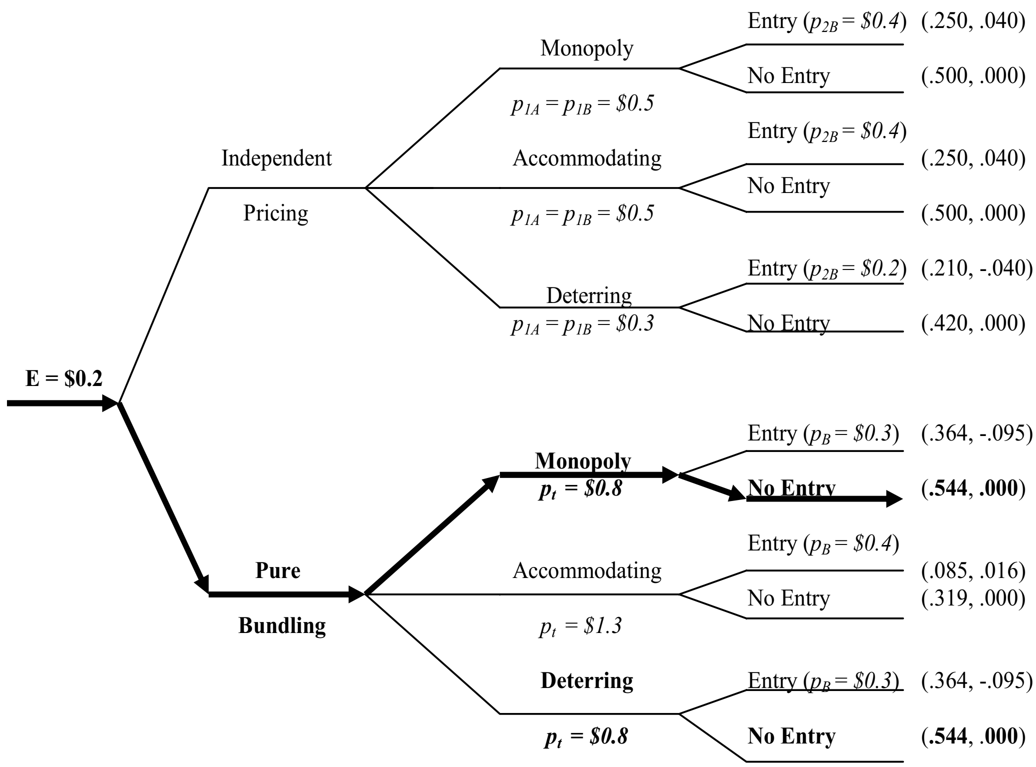
IV. Does an incumbent selling a two-good bundle – (A, B) engage in limit pricing to prevent a potential one-product competitor (selling a perfect substitute to either good A or B) from entering the market when entry costs are ‘low’? Is entry successfully deterred?

The ‘Independent pricing or pure bundling’ treatment is also done with the purpose of answering another question, which follows:

V. Are two-good bundled sales (of, e.g., A and B goods) preferred to unbundled ones by an incumbent in terms of profits and as an entry-deterrent strategy against a potential one-product competitor selling a perfect substitute to either good A or B?

According to theoretical predictions, seller 1, as a profit-maximizing incumbent firm, is supposed to engage in monopoly pricing, limit pricing (to deter entry), or pricing to accommodate entry, depending on entry costs being ‘high’ or ‘low’. The values of $0.2 and $0.07 represent ‘high’ and ‘low’ entry costs, respectively, for all of the study treatments. Figures 7.1 and 7.2 outline simplified versions of the extensive form of ‘independent pricing or pure bundling’ game for each of those entry costs; ‘independent pricing’ and ‘pure bundling’ are subgames of the former.

Figure 7.1 Extensive form game with 'high' entry costs



With 'high' entry costs of \$0.2 (i.e., $E = \$0.2$):

i) If seller 1 is selling goods A and B separately, the 'independent pricing' subgame perfect equilibrium is for:

a) Seller 1 to engage in limit pricing at *\$0.28* (entry barring price), i.e., $p_{1A}^{d*} = p_{1B}^{d*} = 1/2 - 1/2\sqrt{(1-4E)} \approx \$0.3$ and earn profits of $(1-p_{1A}^{d*})p_{1A}^{d*} + (1-p_{1B}^{d*})p_{1B}^{d*} = 2E = \$0.42$ per round.

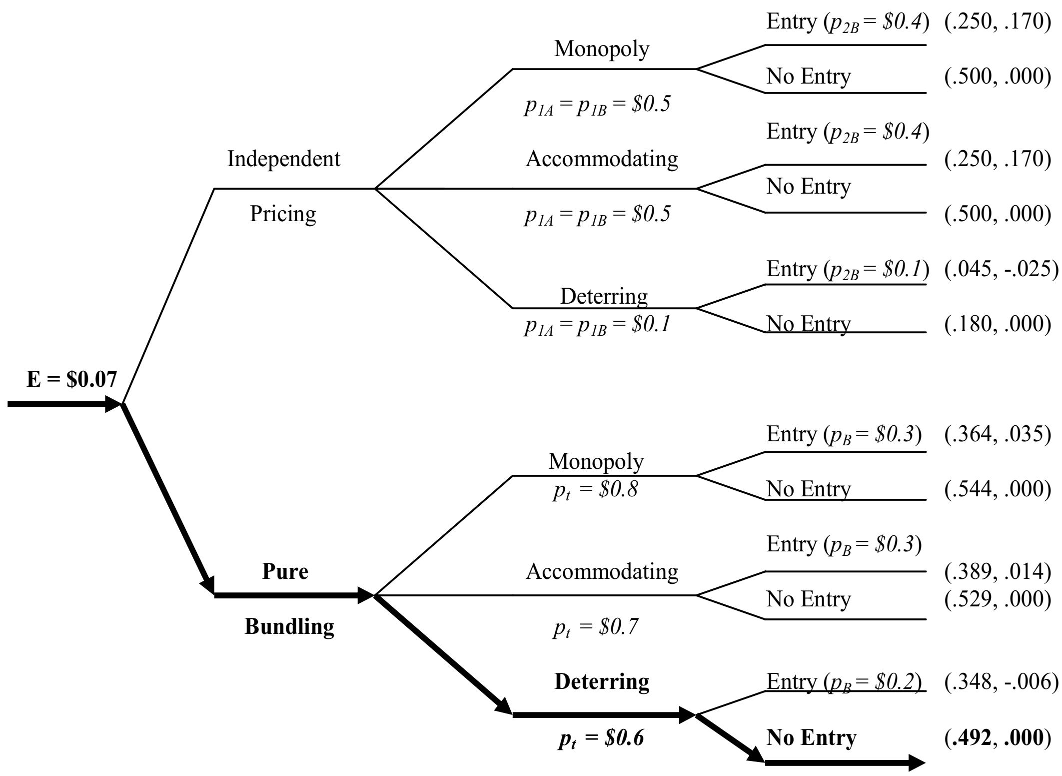
b) Seller 2 (as challenger or potential one-product competitor that might sell either good A or B) not to 'enter the market' no matter what good he/she may sell and therefore earn *$0* per round. (If seller 1 selects the entry barring price but seller 2 enters anyway, seller 2's best response yields $(1 - p_{2j})p_{2j} - E = -0.04$, since $p_{2j} = p_{1j} - \varepsilon$ (where ε is 0.1) $= 0.3 - 0.1 = 0.2$, making seller 1 earn a payoff of *$0.21* in that round.)

ii) If seller 1 is selling the two-good bundle – (A, B), the 'pure bundling' subgame perfect equilibrium is for:

c) Seller 1 to charge the monopoly optimal bundle price of *$0.8* (which works as an entry barring price in this case), i.e., $p_t^* \approx \$0.8$ and earn profits of $(1 - p_t^2/2)p_t \approx \$0.54$ per round.

d) Seller 2 (as challenger or potential one-product competitor that might sell either good A or B) not to 'enter the market' no matter what good he/she may sell and therefore earn *$0* per round. (If seller 1 selects the entry barring price but seller 2 enters anyway, seller 2's best response yields $(1 - p_j)(p_t - p_j)p_j - E \approx -0.1$, since $p_j = (1 + p_t)/3 - 1/3\sqrt{(1 - p_t + p_t^2)} \approx 0.3$, making seller 1 earn a payoff of $(1 - p_t + p_j - p_j^2/2)p_t \approx \$0.36$ in that round.)

Figure 7.2 Extensive form game with 'low' entry costs



With 'low' entry costs of \$0.07 (i.e., $E = \$0.07$):

iii) If seller 1 is selling goods A and B separately, the 'independent pricing' subgame perfect equilibrium is for:

a) Seller 1 to accommodate entry at *\$0.5* (monopoly optimal independent price), i.e., $p_{1A}^* = p_{1B}^* = \$0.5$ and earn profits of $(1 - p_{1h}^*)p_{1h}^* = \$0.25$ per round (with $h \neq j$, h = A or B, and j = A or B).

b) Seller 2 (as challenger or potential one-product competitor that might sell either good A or B) to 'enter the market' pricing good j at *\$0.4*, i.e., $p_{2j}^* = p_{1j}^* - \varepsilon$ (where ε is 0.1) and therefore earning profits of $(1 - p_{2j}^*)p_{2j}^* -$

$E = \$0.17$ per round. (If seller 2 chooses not to enter, seller 1 will earn a payoff of $\$0.5$ in that round.)

iv) If seller 1 is selling the two-good bundle – (A, B), the 'pure bundling' subgame perfect equilibrium is for:

c) Seller 1 to engage in limit pricing at $\$0.59$ (entry barring price), i.e., $p_t^{d*} \approx \$0.6$ and earn profits of $(1 - p_t^{d*2}/2)p_t^{d*} \approx \$0.49$ per round.

d) Seller 2 (as challenger or potential one-product competitor that might sell either good A or B) not to 'enter the market' no matter what good he/she may sell and therefore earn $\$0$ per round. (If seller 1 selects the entry barring price but seller 2 enters anyway, seller 2's best response yields $(1 - p_j)(p_t - p_j)p_j - E \approx -0.01$, since $p_j = (1 + p_t)/3 - 1/3 \sqrt{(1 - p_t + p_t^2)} \approx 0.2$, making seller 1 earn a payoff of $(1 - p_t + p_j - p_j^2/2)p_t \approx \$0.35$ in that round.)

'Independent pricing or pure bundling' subgame perfect equilibrium with either 'high' or 'low' entry costs is for seller 1 to sell the two-good bundle – (A, B) engaging in monopoly or limit pricing as previously referred in points **ii-c)** and **iv-c)**, respectively; and for seller 2 to stay out of the market.

Theory suggests that, for seller 1, bundling both goods A and B seems to be more attractive than not to bundle them because the expected profits that he/she might get from selling the two-good bundle with either 'high' or 'low' entry costs are higher than the ones seller 1 might get from selling the same two goods independently (i.e., for ‘high’ entry costs, $\pi_t^* \approx \$0.54$ are higher than $\pi_i^* = \$0.42$ and, for ‘low’ entry costs, $\pi_t^* \approx \$0.49$ are higher than $\pi_i^* = \$0.25$). Also, every time seller 1 bundles and engages in limit pricing (with ‘low’ entry costs), entry should be successfully deterred since seller 2, having to pay a certain amount *E* to ‘enter the market’, is more likely to stay out; otherwise seller 2 earns non-positive profits (the optimal monopoly price charged by seller 1 for the bundle when entry costs are ‘high’ works the same way, i.e., as an entry barring price). Thus, for seller 1, bundled sales of goods A and B seem to be preferred to unbundled sales since the former strategy seems to be able to profitably prevent a one-product competitor selling a perfect substitute to A or B from ‘entering the market’ with entry costs being either ‘high’ or ‘low’.

Chapter 8: Conducting the Experiments

Each session of 'independent pricing', 'pure bundling' and 'independent pricing or pure bundling' treatments took place at the University of South Carolina's (USC) Beam-Lab which has a network infrastructure connecting twenty computer terminals. The network infrastructure made it possible for all sessions to be coded and run under the z-Tree software environment[16] for economic experiments. Each terminal is separated from other terminals by three privacy screens covering left, right, and front sides. Subjects were recruited from the general student population and included both graduate and undergraduate students primarily from the Moore School of Business and the College of Social Sciences. Twenty subjects participated in each of the six sessions.

At the beginning of a session, each subject was randomly assigned a seat which he/she kept throughout the session. After all subjects had been seated they were tested for their risk attitude[17]. (The payment from the risk attitude test[18] was done at the end of the

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[16] The z-Tree software was developed by Urs Fischbacher at the University of Zurich, Switzerland, and can be downloaded freely from the following web site: http://www.iew.unizh.ch/ztree.

[17] For subjects playing the incumbent role (i.e., seller 1), risk attitude may reveal their "toughness" (or "aggressive attitude") towards a potential challenger (i.e., seller 2) in a round. For example, a risk-loving seller 1 may be more prone to engage in limit pricing trying to deter entry. For subjects playing the challenger role, it may be more likely for a risk-loving seller 2, e.g., to 'enter the market' even though his/her earnings may not be positive in that round.

[18] Each subject was basically asked to choose between a fixed payoff of $2.50 and a variable one that could be either $0 or $5 depending on the outcome of a roll of a ten-sided dice.

session along with all other payments to avoid a wealth effect.)

A session consisted of fifteen rounds. Subjects did not know what role (either seller 1 or seller 2[19]) they would be playing throughout the session before the actual rounds began. After having read all of the instructions, subjects completed two practice rounds in which each subject has an opportunity to play both the incumbent (seller 1) and the challenger (seller 2) roles. After this, subjects were assigned roles as either seller 1 or seller 2. Ten students played seller 1 and ten others seller 2. The two types of sellers were then randomly paired (not knowing who their opponent was) and re-matched between each actual round to avoid repeated game effects, which might occur by playing against the same opponent during the whole game, and so each session could be regarded as a series of one-shot games (Mason and Nowell 1998, Mason and Phillips 2000).

Each 'independent pricing' and 'pure bundling' treatment session round can be broken into three stages at most. In both games during the first stage, seller 1 players were asked to select two prices –one for each good A and B, or a price for the two-good bundle, respectively. Such price(s) remained for the duration of the round. In the second stage, seller 1's price choice(s) were made available along with the information about the identity of the good (i.e., A or B) with which seller 2 could be participating, and the latter was asked whether he/she wanted to participate in that good's market. If seller 2's answer was 'Yes', this type of seller was asked to select a price for the good he/she was participating with during the third stage.

[19] Each subject was assigned a role type that never changed throughout the session.

‘Independent pricing or pure bundling’ treatment session rounds can be broken into four stages at most. Under this treatment, seller 1 was asked whether he/she wanted to sell the two-good bundle in the first stage. In the second stage, Seller 1 was asked to either select a price for the two-good bundle (if his/her answer was ‘Yes’ in the first stage) or to select a price for good A and another for good B (if his/her answer was ‘No’ in the first stage). Both stage one and stage two decisions last for the whole round. In the third stage, seller 1’s decisions were made common knowledge, with stages three and four being similar to the two previous games stages two and three, respectively.

After all the decisions have been made by both sellers, net earnings for that round were computed (i.e., calculated based on seller 1’s first stage(s) choice(s) and seller 2’s response) and reported to the subjects.

Net earnings from the theory were multiplied by ten and summarized in payoffs tables that were handed out to subjects. For ‘independent pricing’ and ‘pure bundling’ treatments each subject was given two tables –one showing seller 1’s and another showing seller 2’s payoffs. For ‘independent pricing or pure bundling’ treatments each subject was given four tables –two showing seller 1’s payoffs for unbundled and bundled sales (equal to those handed out in ‘independent pricing’ and ‘pure bundling’ games, respectively) and the other two reflecting seller 2’s payoffs for unbundled and bundled sales (equal to those handed out in ‘independent pricing’ and ‘pure bundling’ games, respectively). Appendix A has a copy of all payoffs tables for both sellers. In each table, and depending on the role being played, a subject’s payoff per round was determined from the subject’s (i.e., either seller 1 or seller 2) table of payoffs at the intersection of the row corresponding to his/her price choice and the column representing his/her opponent’s price choice. Therefore, the cost of entry was common knowledge when price choices were taken.

For 'independent pricing' with 'low' entry costs treatment session, equilibrium consists of seller 1 players selecting prices for goods A and good B to accommodate entry, with seller 2 players entering one of those two markets undercutting seller 1's price for the corresponding good. Either for 'pure bundling' with 'low' entry costs, or for 'independent pricing' and 'pure bundling' with 'high' entry costs treatment sessions, equilibria consist of seller 1 players selecting the best price (for each good or the two-good bundle) that guarantees seller 2 non-positive profits, with the latter player choosing not to enter. For 'independent pricing or pure bundling' with either 'high' or 'low' entry costs treatment sessions, equilibria consist of seller 1 players choosing to sell the two-good bundle for the best price that guarantees seller 2 non-positive profits, with the latter player also opting out.

The set of instructions coded in z-Tree that was given to the subjects during the sessions is also presented in Appendix A. Each session lasted at between ninety minutes and two hours. Table 8.1 presents the average earnings (including earnings from the risk attitude test, the $5 show-up fee, seller 2's one time $10 initial endowment[20], and profits from a session) per subject playing seller 1 or seller 2 in each of the six sessions. After a session, all subjects were required to fill in a questionnaire, asking about their demographics.

[20] This served as a protection against any loss seller 2 could incur during the session. In fact, two subjects playing the 'pure bundling' game with 'high' entry costs incurred net losses in excess of the one time $10 initial endowment but, these losses were forgiven (in accordance with the specified design).

Table 8.1–Average earnings for a subject playing seller 1 or seller 2 in each session of 'independent pricing', 'pure bundling', and 'independent pricing or pure bundling' treatments

Treatment:	**Independent Pricing**		**Pure Bundling**		**Independent Pricing or Pure Bundling**	
Entry Costs:	**'High'**	**'Low'**	**'High'**	**'Low'**	**'High'**	**'Low'**
Seller 1	*$58*	*$43.68*	*$69.18*	*$66.48*	*$82.6*	*$66.9*
Seller 2	*$20.03*	*$40.58*	*$14.18*	*$19.2*	*$18.5*	*$19.78*

Chapter 9: Basic Results and Econometric Analysis

The following subsections present basic results and corresponding econometric analysis for each session of 'high' and 'low' entry costs conducted under 'independent pricing', 'pure bundling', and 'independent pricing or pure bundling' treatments.

9.1 Independent Pricing Treatment –'High' Entry Costs Session

According to theory predictions, the equilibrium for separate sales of goods A and B with entry costs of *$0.2* should be: (1) subjects playing seller 1 engaging in limit pricing (i.e., choosing a lower than monopoly price) to deter entry and charging the same price of *$0.3* for both goods –A and B; and (2) subjects playing seller 2 not entering either of those two markets.

Table 9.1–Variables and explanations

Variable	Explanation
Y4	Seller 1 chooses a price of *$0.3* for both goods A and B in a given round = 1; Otherwise = 0
S2	Seller 2 chooses not to enter one of the two markets in a given round = 1; Otherwise = 0
eqPlaY	Seller 1 chose a price of *$0.3* for both goods A and B and seller 2 chose not to enter one of the two markets in the previous round = 1; Otherwise = 0
eqPlayH	Seller 1 chose a price greater than or equal to *$0.3* for one of the two goods (e.g., good A) and a price strictly greater than *$0.3* for the other good (e.g., good B) in the previous round. In response, seller 2 chose not to enter the market if seller 1's price for the corresponding good was equal to *$0.3*; or seller 2 entered the market, either undercutting seller 1's price by 0.1 if the latter's price for the corresponding good was strictly greater than *$0.3* and lower than or equal to *$0.6*, or choosing a price of *$0.5* if seller 1's price for the corresponding good was strictly greater than *$0.6* = 1; Otherwise = 0
eqPlayL	Seller 1 chose a price lower than or equal to *$0.3* for one of the two goods (e.g., good A) and a price strictly lower than *$0.3* for the other good (e.g., good B) in the previous round. In response, seller 2 chose not to enter the market = 1; Otherwise = 0
R6_15	Rounds that range from 6 to 15 (i.e., the last 10 rounds, since 15 is the maximum number of rounds that were played in this treatment) = 1; Otherwise = 0
Y4R6_15	= Y4 * R6_15
eqPlaYR6_15	= eqPlaY * R6_15
eqPlayHR6_15	= eqPlayH * R6_15
Age	Subject (playing seller 1 or seller 2)'s age
Major	Economics or business major = 1; Other majors = 0
GPA	GPA choices from the questionnaire
Risk	Risk attitude ("negative" = risk loving; "0" = risk neutral; "positive" = risk averse)

Note: **1)** GPA = 1 means GPA between 3.75 and 4.00, GPA = 2 means GPA between 3.25 and 3.74, GPA = 3 means GPA between 2.75 and 3.24, GPA = 4 means GPA between 2.25 and 2.74, GPA = 5 means GPA between 1.75 and 2.24, GPA = 6 means GPA between 1.25 and 1.74, GPA = 7 means GPA less than 1.25. **2)** Risk attitude reflects a measurement of the threshold certainty equivalent for choosing the risky lottery.

Table 9.2–Descriptive statistics for variables[21]

Variable	Mean	Std. Dev.	N
Y4	0.41	0.49	150
S2	0.51	0.50	150
Y4R6_15	0.29	0.45	150
R6_15	0.67	0.47	150
eqPlaY	0.36	0.48	140
eqPlayH	0.41	0.49	140
eqPlaYR6_15	0.28	0.45	140
eqPlayHR6_15	0.26	0.44	140
Y4*	0.43	0.50	140
S2*	0.54	0.50	140
Y4R6_15*	0.31	0.46	140
R6_15*	0.71	0.45	140

Table 9.3–Descriptive statistics for seller 1 and seller 2 players' demographic variables

	Seller 1		Seller 2		
Variable	Mean	Std. Dev.	Mean	Std. Dev.	N
Age	25.00	6.16	20.90	1.66	10
GPA	2.10	0.88	2.10	1.20	10
Major	0.70	0.48	0.50	0.53	10
Risk	0.10	0.88	-0.50	0.85	10

- Seller 1 Players:

There were 103 cases (68.67%) where a subject playing seller 1 selected equal prices for both goods A and B (out of 150 possible ones; 150 = 10 subjects playing seller 1 * 15 rounds each); subjects playing seller 1 charged an average price of $0.384 for good A and good B (with a standard deviation of 0.106). In the remaining 47 cases (31.33%) where seller 1 players chose a different price for good A and good B, they charged an average price of $0.385 (with a standard deviation of 0.129) for good A and an average price of $0.419 (with a standard deviation of 0.119) for good B;

[21] First round observations were dropped for Y4*, S2*, Y4R6_15*, and R6_15* independent variables.

Table 9.4 summarizes means, medians, and standard deviations of different price offers for goods A and B in each round.

Table 9.4–Number of seller 1 players charging different prices for goods A and B and corresponding mean, median, and standard deviation per round

Round	# of Seller 1 Players Charging $p_{1A} \neq p_{1B}$	Mean p_{1A}	Median p_{1A}	SD p_{1A}	Mean p_{1B}	Median p_{1B}	SD p_{1B}
1	4	0.425	0.45	0.171	0.475	0.5	0.126
2	2	0.4	0.4	0.141	0.4	0.4	0.141
3	2	0.35	0.35	0.212	0.35	0.35	0.071
4	2	0.4	0.4	0.141	0.3	0.3	0.141
5	3	0.4	0.3	0.173	0.467	0.5	0.058
6	4	0.425	0.45	0.096	0.4	0.4	0.115
7	3	0.433	0.5	0.115	0.4	0.4	0.1
8	4	0.4	0.4	0.115	0.4	0.4	0.115
9	4	0.375	0.4	0.15	0.425	0.4	0.15
10	3	0.4	0.5	0.173	0.4	0.3	0.173
11	2	0.35	0.35	0.071	0.5	0.5	0
12	2	0.45	0.45	0.212	0.5	0.5	0
13	4	0.35	0.3	0.1	0.375	0.35	0.206
14	4	0.325	0.3	0.126	0.475	0.5	0.126
15	4	0.325	0.25	0.189	0.4	0.4	0.115

Given that subjects playing seller 1 charged the same price for goods A and B, Table 9.5 summarizes means, medians, standard deviations, and test results[22] of price offers in each round.

[22] Hypothesis:

H_0: Mean of price offers in a given round = 0.3

H_a: Mean of price offers in a given round ≠ 0.3

P-values from the test indicate that the mean of price offers is equal to the theoretically predicted equilibrium price of *$0.3* for both goods A and B but for the first four rounds, rounds 7, 11, and 12 at the 5% level of significance.

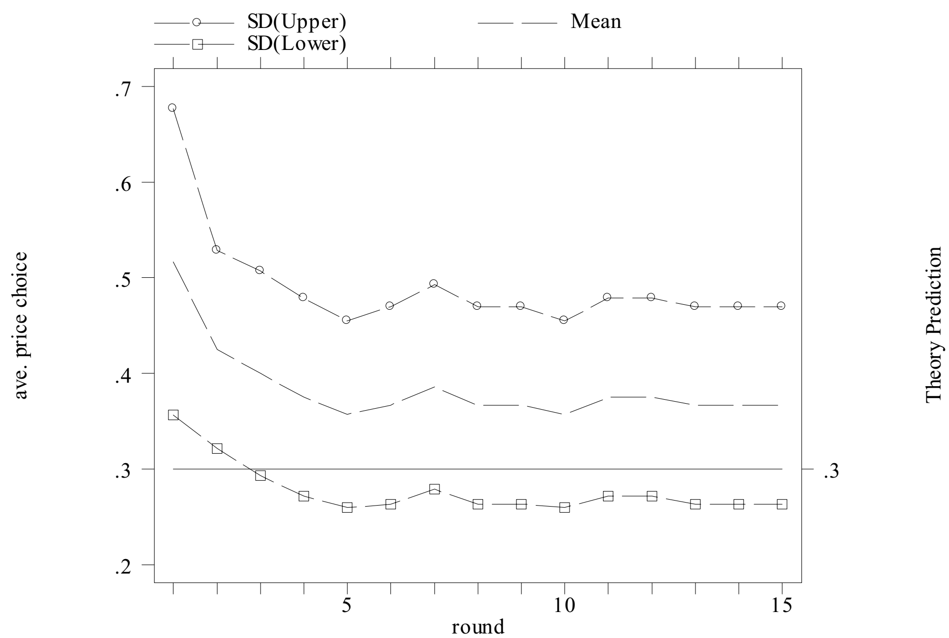
Table 9.5–Number of seller 1 players charging the same price for goods A and B and corresponding mean, median, standard deviation, and p-value per round

Round	# of Seller 1 Players Charging $p_{1A} = p_{1B}$	Mean	Median	SD	P-value
1	6	0.517	0.5	0.160	0.002
2	8	0.425	0.5	0.104	0.004
3	8	0.4	0.4	0.107	0.016
4	8	0.375	0.3	0.104	0.048
5	7	0.357	0.3	0.098	0.099
6	6	0.367	0.3	0.103	0.070
7	7	0.386	0.3	0.107	0.032
8	6	0.367	0.3	0.103	0.070
9	6	0.367	0.3	0.103	0.070
10	7	0.357	0.3	0.098	0.099
11	8	0.375	0.3	0.104	0.049
12	8	0.375	0.3	0.104	0.049
13	6	0.367	0.3	0.103	0.070
14	6	0.367	0.3	0.103	0.070
15	6	0.367	0.3	0.103	0.070

From round 4 onward, 6 to 8 (out of 10 seller 1 players) or 60% to 80% of the subjects playing seller 1 in each round charged the same average price for good A and good B, which ranged between *$0.357* and *$0.386*, approaching the predicted price value (see also Figure 9.1 that presents seller 1 player's average price choice and corresponding theoretical prediction in each round); the median price matched the predicted equilibrium value.

Figure 9.1 Average seller 1 player's price choice for goods A and B: Conditional on seller 1 player charging the same for both goods

Note: SD(Upper) and SD(Lower) are one standard deviation from the mean in each round



o Seller 1 Players' Equilibrium:

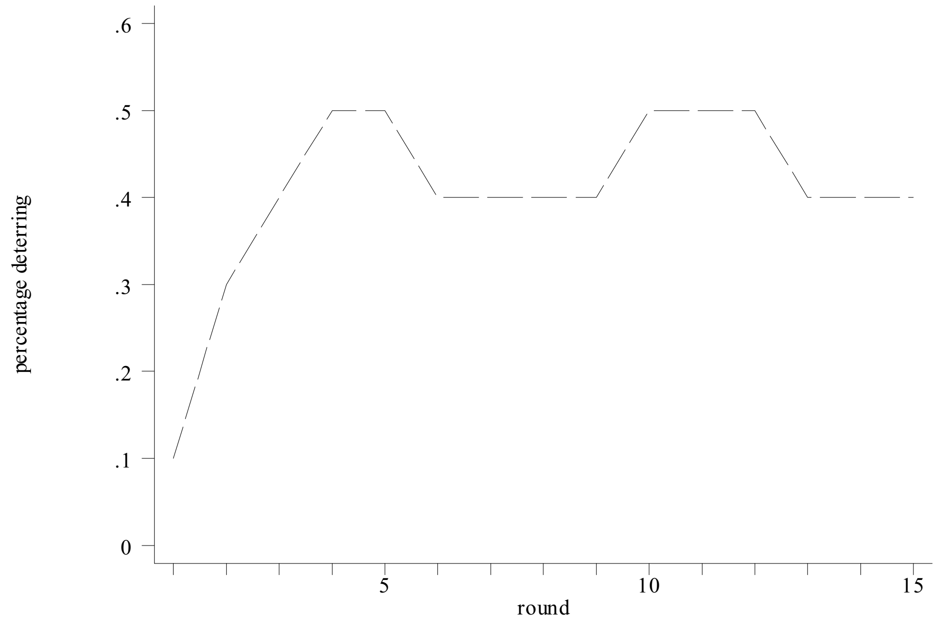
Out of the 150 possible pricing decisions, in 61 cases (40.67%) subjects playing seller 1 chose to price goods A and B at exactly *$0.3*, the value predicted by the theory. Table 9.6 shows, for each round, the number of times such equilibrium pricing decision was reached and corresponding percentage.

Table 9.6–Number of seller 1 players deterring entry and corresponding percentage in each round

Round	Equilibrium Pricing Decisions by Seller 1, i.e., $p_{1A}^{d*} = p_{1B}^{d*} = \$0.3$	Percentage of Equilibrium Pricing Decisions by Seller 1
1	1	10%
2	3	30%
3	4	40%
4	5	50%
5	5	50%
6	4	40%
7	4	40%
8	4	40%
9	4	40%
10	5	50%
11	5	50%
12	5	50%
13	4	40%
14	4	40%
15	4	40%

In the last 13 rounds, there were 57 entry deterring pricing decisions (out of 130 possible ones; 130 = 10 subjects playing seller 1 * 13 rounds), which means that 43.85% of the subjects playing seller 1 satisfied the predicted equilibrium. Pricing decisions to deter entry were observed in higher percentages (of, e.g., 40% and 50%) from round 3 on, meaning that learning might have some impact on seller 1 players engaging in limit pricing (see also Figure 9.2, which presents the percentage of seller 1 players engaging in limit pricing to deter entry in each round).

Figure 9.2 Percentage of seller 1 players deterring



- Econometric Analysis for Seller 1 Players:

Our primary interest is to analyze the tendency for subjects playing seller 1 to engage in limit pricing to deter entry and charge the same price of *$0.3* for both goods – A and B. Figure 9.2 suggests that the equilibrium for separate sales of goods A and B with high entry costs is more likely to occur in the later rounds than in the first few ones. Also, one might conjecture that, in a given round, subjects playing seller 1 are influenced by previous player 1 price choices for goods A and B, and opposing seller 2 players' decisions to enter or stay out of one of those two markets.

In order to evaluate the evolution of the tendency of subjects playing seller 1 to play

the predicted equilibrium pricing strategy, binomial probit[23] models were estimated. Acronyms of all variables and their explanations are presented in Table 9.1. Table 9.2 presents means and standard deviations of the variables.

The dependent variable, Y4, is coded one if seller 1 players charge the same price of *$0.3* for both goods A and B, and zero otherwise. Independent variables include the R6_15 dummy variable that represents the last 10 rounds to help explain the evolution of choices over time, especially, towards the end of the session; another dummy variable indicating that both subjects playing seller 1 and seller 2 chose their corresponding equilibrium strategies in the previous round (i.e., eqPlaY); and a dummy variable reflecting seller 1 players' previous-round deviations that involved higher than equilibrium price choices and corresponding opposing seller 2 players' optimal responses (i.e., eqPlayH[24]) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlayHR6_15[25]). Four demographic variables (see Table 9.7) are used for the purpose of controlling for variations in seller 1 players' behavior that might possibly occur.

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[23] Since the dataset has repeated observations on both subjects playing seller 1 and seller 2, all binomial probit estimations assume independence of observations across subjects but not necessarily independence across observations belonging to the same subject.

[24] Due to the small sample size of 10 subjects (either playing seller 1 or seller 2), the number of times both type of players engaged in the actions described by eqPlayL (see Table 9.1 for the definition) was less than seven. Therefore, this explanatory variable was not included in the models. Also, seller 1 players never chose a price lower than or equal to *$0.2* for one of the two goods (e.g., good A) and a price greater than or equal to *$0.4* for the other good (e.g., good B).

[25] eqPlayHR6_15 ended up being dropped since this explanatory variable turned out to be consistently insignificant. The interaction term eqPlaYR6_15 could not be included in the models since when such strategies were played during the last ten rounds, on-equilibrium strategies are played by seller 1 players in a given round most of the time. Thus, eqPlaYR6_15 predicts, almost perfectly, the dependent variable (i.e., Y4) on-equilibrium outcome for subjects playing seller 1 almost perfectly.

(Refer to Table 9.1 for detailed definitions of all explanatory variables.)

Table 9.7–Probit estimates of probability of seller 1 players adopting limit pricing entry-deterrent strategy

Variable				
Age				-0.065
				(0.041)
				[-0.026]
Major				0.617
				(0.804)
				[0.239]
GPA				0.111
				(0.343)
				[0.044]
Risk				-0.646
				(0.402)
				[-0.258]
eqPlayHR6_15			-0.345	
			(0.722)	
			[-0.135]	
eqPlayH			-0.556	-0.938
			(0.459)	(0.603)
			[-0.217]	[-0.358]
eqPlaY		3.393*	3.003*	2.971*
		(0.494)	(0.392)	(0.426)
		[0.880]	[0.848]	[0.837]
R6_15	0.182	-0.500*	-0.502	-0.584*
	(0.184)	(0.175)	(0.460)	(0.202)
	[0.070]	[-0.197]	[-0.198]	[-0.229]
Constant	-0.358	-0.904*	-0.512	0.695
	(0.346)	(0.367)	(0.546)	(1.440)
χ^2-Test (p-value)		0.000	0.000	0.000

Note: N = 150 for the first model. N = 140 for the last three models. Y4 is the dependent variable. Numbers in parentheses are robust standard errors. Numbers in brackets are the marginal effects on the probability of seller 1 players engaging in limit pricing at $p_{1A}^{d*} = p_{1B}^{d*} = \$0.3$. (Marginal effects are calculated at the means of the independent variables; and for dummy variables (e.g., eqPlaY) they are calculated for the discrete change as the dummy changes from zero to one.) * P-value < 0.05. † P-value < 0.10. χ^2-Test compares the last three models to the first one but with N reduced to 140.

Looking at Table 9.7 one can see that the explanatory variable indicating that both seller 1 players and corresponding opponents playing seller 2 engaged in the predicted equilibrium outcome in the previous round (i.e., eqPlaY), and the one representing the last 10 rounds of this treatment (i.e., R6_15) have statistically significant coefficients at the 5% level (in the last three and in two of the four models, respectively). The coefficient associated with eqPlaY is positive. For the fourth model this suggests that when both seller 1 players and corresponding opponents playing seller 2 engage in their predicted equilibrium strategy in the previous round, subjects playing seller 1 are more likely to engage in the same kind of play in a given round. The coefficient associated with R6_15 is negative, which indicates that during the last 10 rounds seller 1 players' behavior adjusts in ways that are not captured by both types of players' previous actions and player 1 demographics. In particular, ceteris paribus, there is a diminishing tendency in the later rounds for subjects playing seller 1 to choose their predicted equilibrium outcome. During this session subjects playing seller 1 chose the predicted equilibrium pricing strategy 61 times.

In summary, findings suggest that throughout the game there is an increasing tendency for subjects playing seller 1 to engage in limit pricing or play "aggressively" (i.e., lowering both A and B goods' prices to keep a potential one-product competitor out of the market, which offers the largest payoff compared to other price choices), which is stronger than seller 1 players tendency to deviate from their optimal response. That is, with high entry costs of *\$0.2*, seller 1 players are more likely to deter entry and charge the same price of *\$0.3* for goods A and B in a given round, if they have played the same strategy and corresponding opponents playing seller 2 also engaged in their equilibrium play in the previous round. (It should be noted that the payoffs for deterring entry at *\$0.3* are only large if opposing subjects playing seller 2 do not enter any of the two markets undercutting seller 1 players' price.) In the later rounds, however, Table 9.7 fourth model also predicts a smaller tendency for seller 1 players to deviate from their corresponding equilibrium pricing strategy for both goods A and B.

- Seller 1 Players' Demographics and Risk Attitudes

The demographic composition of the subjects playing seller 1 will be discussed next since some behavioral variations in this game might be correlated with demographics. Table 9.3 has the descriptive statistics on the demographic characteristics of subjects playing seller 1. (See Appendix B for the questionnaire answered by the subjects.)

Results from an estimation which includes demographic variables are reported in the fourth column of Table 9.7. In that estimation no demographic variable has a statistically significant coefficient at the 5% and/or 10% levels.

- Seller 2 Players:

Given that seller 2 players entered the market conditional on subjects playing seller 1 pricing the same for both goods –A and B, there were 48 decisions by seller 2 players to enter the market (out of 103 equal pricing decisions by subjects playing seller 1) at an average price of *$0.385* for either good A or B (with a standard deviation of 0.117). That is, 46.60% of the seller 2 players entered one of the two markets when subjects playing seller 1 charged the same for both goods. Figure 9.3 shows the seller 2 players' average price choices for either good A or B given that he/she chose to enter the market when the opposing seller 1 player charged the same for both goods in each round.

Figure 9.3 Seller 2 player's average price choice: Conditional on entry occurring and on seller 1 player pricing the same for goods A and B

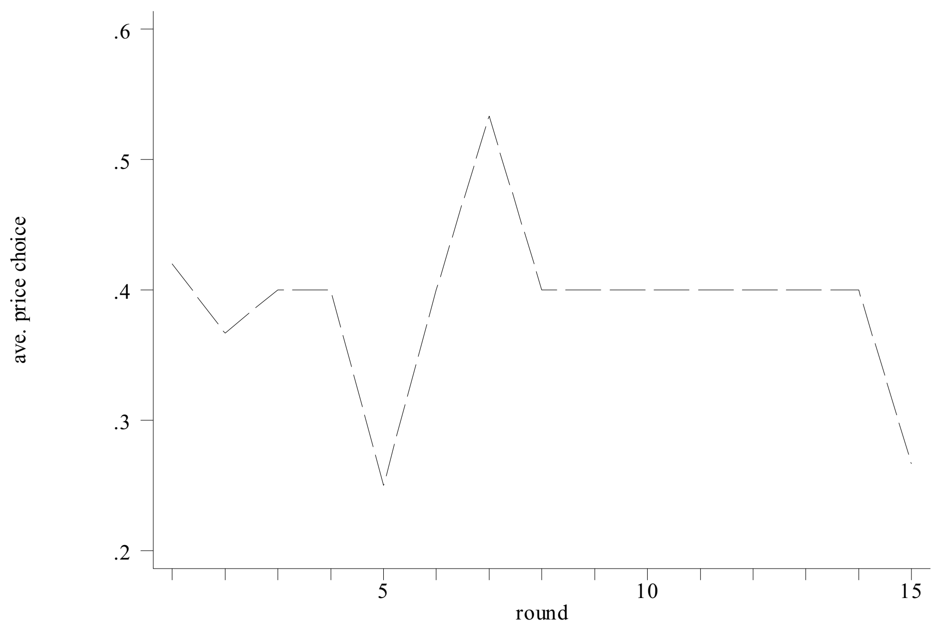
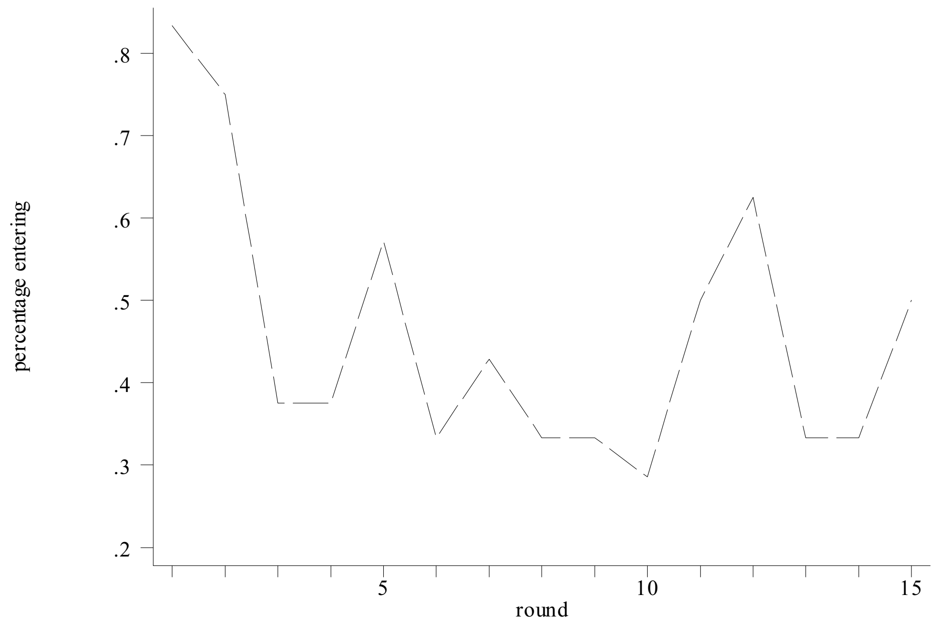


Figure 9.4 shows the percentage of seller 2 players entering one of the two markets when subjects playing seller 1 charge the same average price for both goods in each round.

Figure 9.4 Percentage of seller 2 players entering: Conditional on seller 1 players charging the same for goods A and B



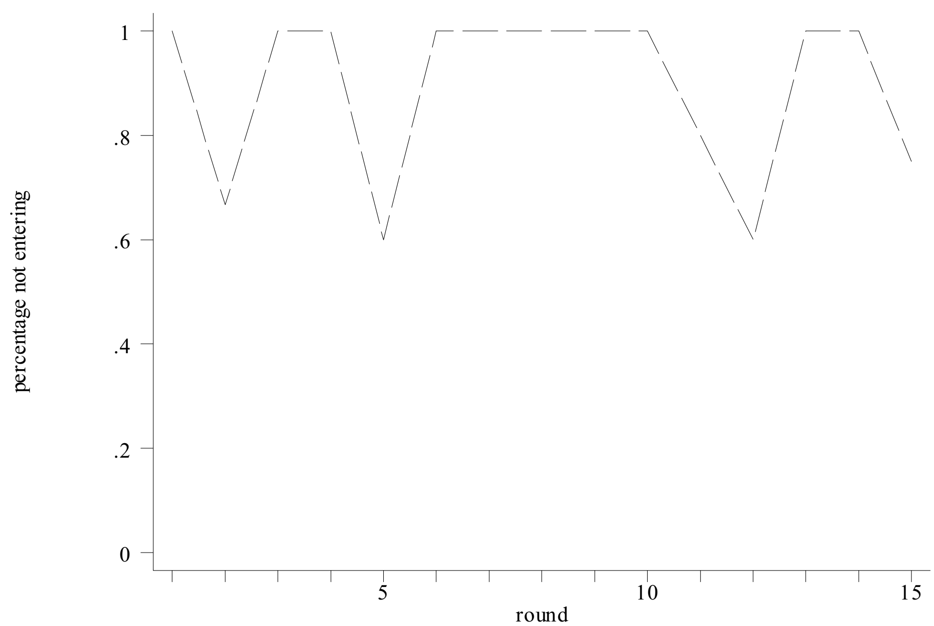
Throughout the 15 rounds (but for rounds 5 and 15) it looks like there is a decreasing tendency for seller 2 players to enter the market as subjects playing seller 1 lower their average price for goods A and B in their attempts to deter entry.

- Seller 2 Players' Equilibrium:

Results show that 11.48% (i.e., average equals 0.115 with a standard deviation of 0.321) of seller 2 players chose to enter the market when subjects playing seller 1 were attempting to deter entry (i.e., playing the predicted equilibrium price of $p_{1A}^{d*} = p_{1B}^{d*} = \$0.3$). However, in the remaining cases, seller 2 players satisfied the equilibrium prediction of staying out of the market when the corresponding opponent playing seller 1 was deterring entry.

Figure 9.5 shows the percentage of seller 2 players not entering the A and B markets when subjects playing seller 1 charge the price of *\$0.3* for both goods in each round.

Figure 9.5 Percentage of seller 2 players not entering: Conditional on seller 1 players charging *\$0.3* for good A and good B



It was observed that in rounds 2, 5, 11, 12, and 15 seller 2 players entered one of the two markets even though subjects playing seller 1 charged their equilibrium price. A closer look at the data reveals that in these five rounds there were seven (out of 22 times) when seller 2 players, facing entry deterrence, entered the market anyway.

- Econometric Analysis for Seller 2 Players:

For subjects playing seller 2, our primary concern is to analyze the likelihood of not entering one of the two markets. Figure 9.5 suggests that conditional on seller 1 players charging *$0.3* for good A and good B, entry (for separate sales of goods A and B with high entry costs) by subjects playing seller 2 is less likely to occur in the later rounds than in the first ones. Also, one might hypothesize that seller 2 players' behavior would be influenced by (1) seller 1 players' choices in a given round, and/or (2) the previous player 1 price choices for goods A and B, and opposing seller 2 players' decisions to enter or not.

To evaluate the evolution of the tendency of subjects playing seller 2 to stay out of the A and B markets, binomial probit[26] models were estimated. The dependent variable, S2, is coded one if entry does not occur and zero otherwise.[27] Independent variables include the R6_15 dummy variable that represents the last 10 rounds to help explain the evolution of choices over time, especially, towards the end of the session; another dummy variable representing seller 1 players limit pricing to deter entry and charging the same price of *$0.3* for goods A and B in a given round (i.e., Y4) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., Y4R6_15); a dummy variable indicating that both subjects playing seller 1 and seller 2 chose their corresponding equilibrium strategies in the previous round (i.e., eqPlaY) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlaYR6_15); and another dummy variable reflecting seller 1 players' previous-round deviations that involved higher than equilibrium price choices and

[26] Since the dataset has repeated observations on both subjects playing seller 1 and seller 2, all binomial probit estimations assume independence of observations across subjects but not necessarily independence across observations belonging to the same subject.

[27] Acronyms of all variables and their explanations are presented in Table 9.1. Table 9.2 presents means and standard deviations of the variables.

corresponding opposing seller 2 players' optimal responses (i.e., eqPlayH[28]) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlayHR6_15[29]). Four demographic variables (see Table 9.8) are used for the purpose of controlling for variations in seller 2 players' behavior that might possibly occur. (Refer to Table 9.1 for detailed definitions of all explanatory variables.)

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[28] Due to the small sample size of 10 subjects (either playing seller 1 or seller 2), the number of times both type of players engaged in the actions described by eqPlayL (see Table 9.1 for the definition) was less than seven. Therefore, this explanatory variable was not included in the models.

[29] Y4R6_15, eqPlaYR6_15, eqPlayH, and eqPlayHR6_15 ended up being dropped since these explanatory variables turned out to be consistently insignificant.

Table 9.8 –Probit estimates of probability of seller 2 players not entering either market A or B

Variable					
Age					-0.061
					(0.077)
					[-0.024]
Major					0.315
					(0.267)
					[0.123]
GPA					-0.174†
					(0.099)
					[-0.068]
Risk					0.154
					(0.156)
					[0.060]
eqPlayHR6_15				-0.081	
				(0.571)	
				[-0.032]	
eqPlaYR6_15			0.079	-0.037	
			(0.271)	(0.493)	
			[0.031]	[-0.014]	
eqPlayH				0.427	
				(0.305)	
				[0.165]	
eqPlaY			0.299	0.597†	0.375*
			(0.271)	(0.312)	(0.186)
			[0.116]	[0.226]	[0.144]
Y4R6_15		-0.316	0.038	-0.013	
		(0.800)	(0.796)	(0.772)	
		[-0.126]	[0.015]	[-0.005]	
Y4		2.118*	1.886*	1.952*	2.043*
		(0.680)	(0.713)	(0.715)	(0.402)
		[0.694]	[0.632]	[0.645]	[0.666]
R6_15	0.482*	0.671*	0.371	0.509	0.480*
	(0.221)	(0.248)	(0.247)	(0.506)	(0.220)
	[0.190]	[0.262]	[0.147]	[0.200]	[0.189]
Constant	-0.305†	-1.150*	-1.043*	-1.365*	0.390
	(0.165)	(0.338)	(0.389)	(0.499)	(1.565)
χ^2-Test (p-value)		0.000	0.000	0.000	0.000

<u>Note</u>: N = 150 for the first two models. N = 140 for the last three models. S2 is the dependent variable. Numbers in parentheses are robust standard errors. Numbers in brackets are the marginal effects on the probability of seller 2 players not entering the A and B markets. (Marginal effects are calculated at the means of the independent variables; and for dummy variables (e.g., Y4) they are calculated for the discrete change as the dummy changes from zero to one.) * P-value < 0.05. † P-value < 0.10. χ^2-Test compares the last four models to the first one, but with N reduced to 140 for the last three models.

Table 9.8 results show that the variable representing the last 10 rounds of this

treatment (i.e., R6_15) and the one indicating seller 1 player's choice of the equilibrium pricing strategy in a given round (i.e., Y4) have positive and statistically significant coefficients at the 5% level in three of the five models and in the last four models, respectively. For the fifth model, and for R6_15 explanatory variable, this suggests that subjects playing seller 2 are more likely to opt out of the market in the later 10 rounds than in the first ones in ways that are not captured by both types of players previous decisions and seller 2 players' demographics. For Y4 independent variable, it indicates that when seller 1 players engage in limit pricing and charge the same price of *$0.3* for good A and good B, seller 2 players are more likely to stay out of the market in a given round. eqPlaY explanatory variable also has a positive and statistically significant coefficient at the 5% level, which suggests that when both seller 1 and seller 2 players engage in their equilibrium strategies in the previous round, seller 2 players are more likely to stay out of the A and B markets in a given round. During this session subjects playing seller 2 chose to play the predicted equilibrium strategy 76 times.

In summary, findings suggest that throughout the game there is an increasing tendency for seller 2 players to stay out of the market, when their opposing seller 1 players choose the same entry-barring price of *$0.3* for goods A and B. This is indicated by the positive relationship between the choice of subjects playing seller 2 to stay of the market and (1) the round variable, (2) seller 1 players' equilibrium pricing strategy in a given round, and (3) both subjects playing seller 1 and seller 2 choices of their corresponding equilibrium play in the previous round.

- Seller 2 Players' Demographics and Risk Attitudes

The demographic composition of the subjects playing seller 2 will be discussed next since some behavioral variations in this game might be correlated with demographics. Table 9.3 has the descriptive statistics on the demographic characteristics of subjects playing seller 2. (See Appendix B for the questionnaire answered by the subjects.)

Results from an estimation which includes demographic variables are reported in the fifth column of Table 9.8. In that estimation one demographic variable – GPA, has a negative and statistically significant coefficient at the 10% level. This indicates that high GPA seller 2 players (compared to low) are less likely to play the equilibrium strategy.

- Successfully Deterring Entry:

In this game, pricing goods A and B at *$0.3* (i.e., limit pricing) provides a way for subjects playing seller 1 (i.e., incumbents) to keep seller 2 players (i.e., challengers) from entering either the A or the B market; that is, seller 1 players were able to get higher profits when deterring as opposed to accommodating entry (by charging $p_{1A} = p_{1B} =$ *$0.5*) and were able to make the seller 2 players earn non-positive profits. Actual behavior frequently follows the theoretical prediction for this case.

For all the 15 rounds there were only seven times (in rounds 2, 5, 11, 12, and 15) when subjects playing seller 2 decided to enter the market with seller 1 players engaging in limit pricing (i.e., $p_{1A}^{d*} = p_{1B}^{d*} =$ *$0.3*). In three of these seven times (and for rounds 2, 5, and 12), seller 2 players undercut their corresponding seller 1 player by 0.1 charging a price of *$0.2* for the good with which they entered the market and got a *$0.04* loss while their opponent playing seller 1 got a profit of *$0.21*, in each round. In two of the above noted seven times (and for rounds 5 and 15), seller 2 players entered the market charging *$0* which granted them the maximum possible loss of *$0.2*, while their corresponding opponent playing seller 1 got a profit of *$0.21*, in each round. In the remaining two cases (and for rounds 11 and 12), subjects playing seller 2 charged a price above their corresponding seller 1 player's price which make them lose *$0.2* granting their opponent the maximum profit of *$0.42* per round (the same profit seller 1 player would get if his/her opponent playing seller 2 had not entered the market).

Table 9.9 presents average profits for subjects playing seller 1 and seller 2 in each round.

Table 9.9–Average profits for seller 1 and seller 2 players per round

Round	Seller 1 Player's Ave. Profit	Seller 2 Player's Ave. Profit
1	0.259	0.021
2	0.272	0.024
3	0.379	0.012
4	0.339	0.001
5	0.309	-0.011
6	0.334	0.012
7	0.372	-0.016
8	0.352	0.016
9	0.347	0.017
10	0.367	0.012
11	0.355	-0.004
12	0.359	-0.012
13	0.337	0.016
14	0.346	0.013
15	0.341	-0.008

While seller 1 players who priced to deter entry engaged in this behavior very early in the game (between rounds 1 and 4) and maintained it throughout the session (there was only one exception to this), the remaining seller 1 players never seemed to learn how to engage in limit pricing or play "aggressively" (i.e., lowering both A and B goods' prices to keep a potential one-product competitor out of the market). Each of those who played "aggressively" was able to get an average profit per round of *$0.382* against *$0.294* of those who did not price to deter entry. The subjects playing seller 2 took advantage of the opportunity to earn positive profits most of the time (by entering one of the two possible markets).

Although some of the subjects playing seller 1 did not play the equilibrium strategy for this game, when entry costs are 'high' engaging in limit pricing was frequently observed for an incumbent selling two goods (e.g., A and B) separately to prevent a potential one-product competitor (selling a perfect substitute to either good A or B) from entering the market.

9.2 Independent Pricing Treatment –'Low' Entry Costs Session

According to theory predictions, the equilibrium for separate sales of goods A and B with entry costs of *$0.07* should be: (1) for subjects playing seller 1 to accommodate entry and charge the same monopoly price of *$0.5* for both goods –A and B; and (2) for subjects playing seller 2 to enter one of those two markets undercutting their opponent seller 1 by 0.1 and charging a price of *$0.4* for either good A or good B.

Table 9.10–Variables and explanations

Variable	Explanation
Y4	Seller 1 chooses a price of *\$0.5* for both goods A and B in a given round = 1; Otherwise = 0
S2	Seller 2 enters the market choosing a price of *\$0.4* for the corresponding good in a given round = 1; Otherwise = 0
eqPlaY	Seller 1 chose a price of *\$0.5* for both goods A and B, and seller 2 entered the market choosing a price of *\$0.4* for the corresponding good in the previous round = 1; Otherwise = 0
eqPlayM	Seller 1 chose a price lower than or equal to *\$0.4* for one of the two goods (e.g. good A), and chose a price greater than or equal to *\$0.6* for the other good (e.g., good B) in the previous round. In response, seller 2 chose not to enter the market if seller 1's price for the corresponding good was strictly lower than *\$0.2*; or seller 2 entered the market, either undercutting seller 1's price by 0.1 if seller 1's price for the corresponding good was lower than or equal to *\$0.6* and strictly greater than *\$0.1*, or choosing a price of *\$0.5* if seller 1's price for the corresponding good was strictly greater than *\$0.6* = 1; Otherwise = 0
eqPlayL	Seller 1 chose a price lower than or equal to *\$0.5* for one of the two goods (e.g., good A) and chose a price strictly lower than *\$0.5* for the other good (e.g., good B) in the previous round. In response, seller 2 chose not to enter the market if seller 1's price for the corresponding good was strictly lower than *\$0.2*; or seller 2 entered the market undercutting seller 1's price by 0.1 if seller 1's price for the corresponding good was lower than or equal to *\$0.5* and strictly greater than *\$0.1* = 1; Otherwise = 0
eqPlayH	Seller 1 chose a price greater than or equal to *\$0.5* for one of the two goods (e.g., good A) and a price strictly greater than *\$0.5* for the other good (e.g., good B) in the previous round. In response, seller 2 entered the market, either undercutting seller 1's price by 0.1 if seller 1's price for the corresponding good was lower than or equal to *\$0.6*, or choosing a price of *\$0.5* if seller 1's price for the corresponding good was strictly greater than *\$0.6* = 1; Otherwise = 0
R6_15	Rounds that range from 6 to 15 (i.e., the last 10 rounds, since 15 is the maximum number of rounds that were played in this treatment) = 1; Otherwise = 0
eqPlaYR6_15	= eqPlaY * R6_15
eqPlayMR6_15	= eqPlayM * R6_15
eqPlayLR6_15	= eqPlayL * R6_15
eqPlayHR6_15	= eqPlayH * R6_15
Age	Subject (playing seller 1 or seller 2)'s age
Major	Economics or business major = 1; Other majors = 0
GPA	GPA choices from the questionnaire
Risk	Risk attitude ("negative" = risk loving; "0" = risk neutral; "positive" = risk averse)

Note: **1)** GPA = 1 means GPA between 3.75 and 4.00, GPA = 2 means GPA between 3.25 and 3.74, GPA = 3 means GPA between 2.75 and 3.24, GPA = 4 means GPA between 2.25 and 2.74, GPA = 5 means GPA between 1.75 and 2.24, GPA = 6 means GPA between 1.25 and 1.74, GPA = 7 means GPA less than 1.25. **2)** Risk attitude reflects a measurement of the threshold certainty equivalent for choosing the risky lottery.

Table 9.11–Descriptive statistics for variables[30]

Variable	Mean	Std. Dev.	N
Y4	0.43	0.50	150
S2	0.62	0.49	150
R6_15	0.67	0.47	150
eqPlaY	0.42	0.50	140
eqPlayM	0.17	0.38	140
eqPlayL	0.31	0.47	140
eqPlayH	0.07	0.26	140
eqPlaYR6_15	0.31	0.47	140
eqPlayMR6_15	0.12	0.33	140
eqPlayLR6_15	0.22	0.42	140
eqPlayHR6_15	0.05	0.22	140
Y4*	0.44	0.50	140
S2*	0.62	0.49	140
R6_15*	0.71	0.0.45	140

Table 9.12–Descriptive statistics for seller 1 and seller 2 players' demographic variables

	Seller 1		Seller 2		
Variable	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**N**
Age	23.20	3.05	26.40	8.93	10
GPA	2.40	0.97	2.40	1.35	10
Major	0.60	0.52	0.40	0.52	10
Risk	0.10	1.10	0.50	1.78	10

- Seller 1 Players:

There were 68 cases (45.33%) where a subject playing seller 1 selected equal prices for both goods A and B (out of 150 possible ones; 150 = 10 subjects playing seller 1 * 15 rounds); subjects playing seller 1 charged an average price of *$0.485* for good A and good B (with a standard deviation of 0.065). In the remaining 82 cases (54.67%) where seller 1 players chose a different price for good A and good B,

[30] First round observations were dropped for Y4*, S2*, and R6_15* independent variables.

they charged an average price of *$0.404* (with a standard deviation of 0.144) for good A and an average price of *$0.489* (with a standard deviation of 0.198) for good B; Table 9.13 summarizes means, medians, and standard deviations of different price offers for goods A and B in each round.

Table 9.13–Number of seller 1 players charging different prices for goods A and B and corresponding mean, median, and standard deviation per round

Round	# of Seller 1 Players Charging $p_{1A} \neq p_{1B}$	Mean p_{1A}	Median p_{1A}	SD p_{1A}	Mean p_{1B}	Median p_{1B}	SD p_{1B}
1	6	0.483	0.45	0.172	0.55	0.5	0.259
2	6	0.45	0.45	0.055	0.583	0.6	0.299
3	5	0.3	0.4	0.187	0.44	0.5	0.182
4	5	0.44	0.4	0.114	0.5	0.5	0.212
5	6	0.383	0.5	0.184	0.383	0.4	0.160
6	5	0.4	0.5	0.141	0.56	0.6	0.230
7	6	0.45	0.5	0.198	0.45	0.45	0.187
8	6	0.467	0.45	0.175	0.567	0.55	0.258
9	6	0.333	0.35	0.137	0.517	0.55	0.172
10	5	0.36	0.4	0.167	0.46	0.5	0.167
11	5	0.38	0.4	0.084	0.54	0.6	0.207
12	5	0.36	0.4	0.152	0.48	0.5	0.164
13	6	0.417	0.5	0.160	0.433	0.4	0.197
14	5	0.36	0.3	0.089	0.46	0.5	0.152
15	5	0.44	0.5	0.089	0.4	0.4	0.158

Given that subjects playing seller 1 charged the same price for goods A and B, Table 9.14 summarizes means, medians, standard deviations, and test results[31] of price offers in each round.

[31] Hypothesis:

H_0: Mean of price offers in a given round = 0.5

H_a: Mean of price offers in a given round ≠ 0.5

P-values from the test indicate that the mean of price offers is equal to the theoretically predicted equilibrium price of *$0.5* for both goods A and B in every round at the 5% level of significance.

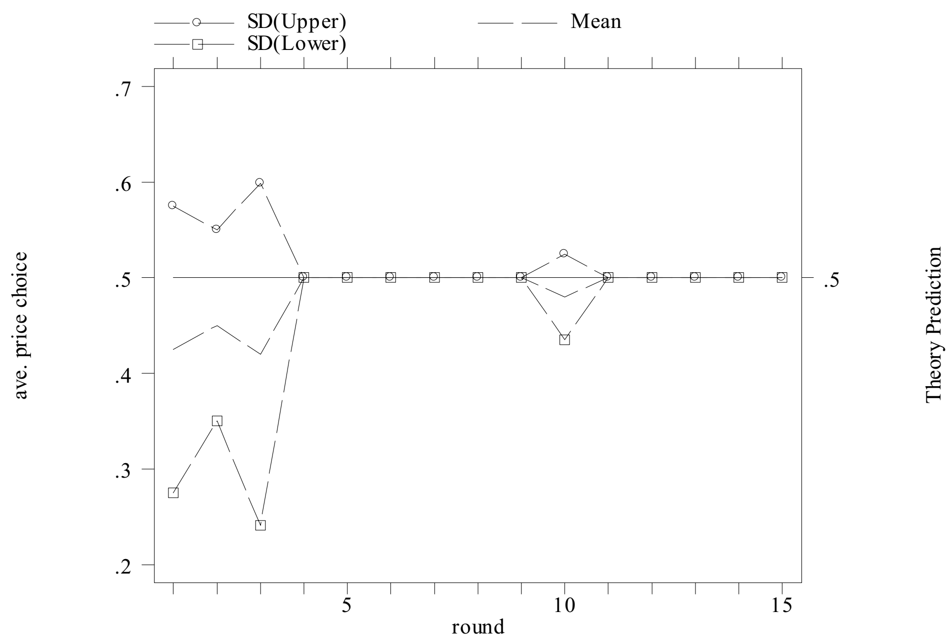
Table 9.14–Number of seller 1 players charging the same price for goods A and B and corresponding mean, median, standard deviation, and p-value per round

Round	# of Seller 1 Players Charging $p_{1A} = p_{1B}$	Mean	Median	SD	P-value
1	4	0.425	0.5	0.15	0.148
2	4	0.45	0.5	0.1	0.148
3	5	0.42	0.5	0.179	0.191
4	5	0.5	0.5	0	1.000
5	4	0.5	0.5	0	1.000
6	5	0.5	0.5	0	1.000
7	4	0.5	0.5	0	1.000
8	4	0.5	0.5	0	1.000
9	4	0.5	0.5	0	1.000
10	5	0.48	0.5	0.045	0.194
11	5	0.5	0.5	0	1.000
12	5	0.5	0.5	0	1.000
13	4	0.5	0.5	0	1.000
14	5	0.5	0.5	0	1.000
15	5	0.5	0.5	0	1.000

It was observed that 4 to 5 (out of 10 seller 1 players) or 40% to 50% of the subjects playing seller 1 in each round charged the same average price for good A and good B. From round 4 on, these players chose the same average price of *$0.5* (except for round 10) for both goods, matching the predicted price value (see also Figure 9.6 that presents seller 1 player's average price choice and corresponding theoretical prediction in each round). The median price matched the predicted equilibrium value.

Figure 9.6 Average seller 1 player's price choice for goods A and B: Conditional on seller 1 player charging the same for both goods

Note: SD(Upper) and SD(Lower) are one standard deviation from the mean in each round



o Seller 1 Players' Equilibrium:

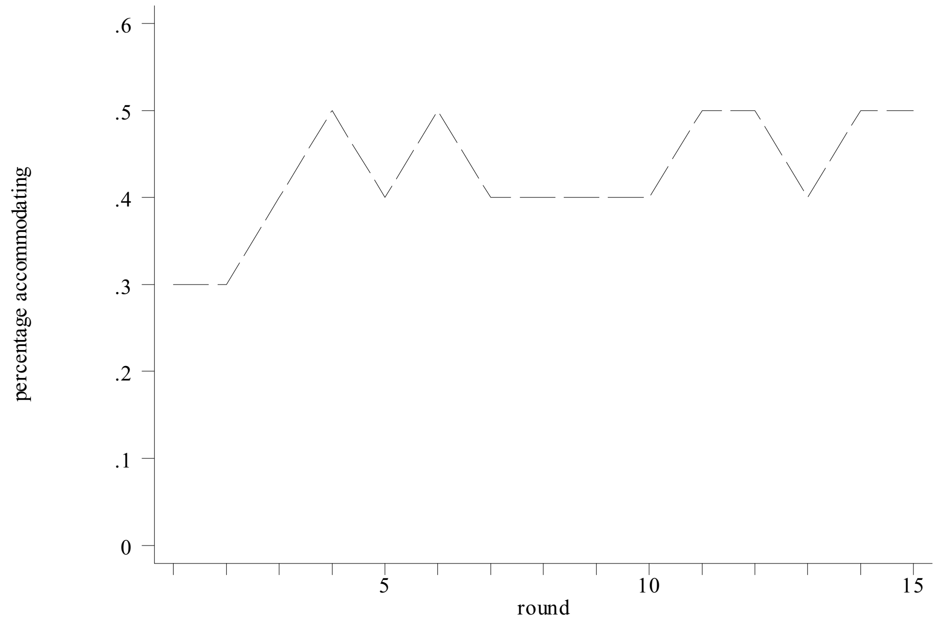
Out of the 150 possible pricing decisions, in 64 cases (42.67%) subjects playing seller 1 chose to price goods A and B at exactly *$0.5*, the value predicted by the theory. Table 9.15 shows, for each round, the number of times such equilibrium pricing decision was reached and corresponding percentage.

Table 9.15–Number of seller 1 players charging the monopoly price to accommodate entry and corresponding percentage in each round

Round	Equilibrium Pricing Decisions by Seller 1, i.e., $p_{1A}^* = p_{1B}^* = \$0.5$	Percentage of Equilibrium Pricing Decisions by Seller 1
1	3	30%
2	3	30%
3	4	40%
4	5	50%
5	4	40%
6	5	50%
7	4	40%
8	4	40%
9	4	40%
10	4	40%
11	5	50%
12	5	50%
13	4	40%
14	5	50%
15	5	50%

In the last 13 rounds, there were 58 entry accommodating decisions at monopoly price (out of 130 possible ones; 130 = 10 subjects playing seller 1 * 13 rounds), which means that 44.62% of the subjects playing seller 1 satisfied the predicted equilibrium. Although higher percentages (of, e.g., 40% and 50%) of entry accommodating decisions at monopoly price were observed from round 3 on, the highest percentage reached in this game (50%) occurred more frequently in the last 5 rounds. This means that learning might have some impact on seller 1 players charging monopoly price to accommodate entry (see also Figure 9.7, which presents the percentage of seller 1 players accommodating entry at monopoly price in each round).

Figure 9.7 Percentage of seller 1 players accommodating at monopoly price



- Econometric Analysis for Seller 1 Players:

Our primary interest is to analyze the tendency for subjects playing seller 1 to accommodate entry and charge the same monopoly price of *$0.5* for both goods – A and B. Figure 9.7 suggests that the equilibrium for separate sales of goods A and B with low entry costs is more likely to occur in the later rounds than in the first few ones. Also, one might conjecture that, in a given round, subjects playing seller 1 are influenced by previous player 1 price choices for goods A and B, and opposing seller 2 players' decisions to enter or stay out of one of those two markets.

In order to evaluate the evolution of the tendency of subjects playing seller 1 to play

the predicted equilibrium pricing strategy, binomial probit[32] models were estimated. Acronyms of all variables and their explanations are presented in Table 9.10. Table 9.11 presents means and standard deviations of the variables.

The dependent variable, Y4, is coded one if seller 1 players charge the same price of *$0.5* for both goods A and B, and zero otherwise. Independent variables include the R6_15 dummy variable that represents the last 10 rounds to help explain the evolution of choices over time, especially, towards the end of the session; another dummy variable indicating that both seller 1 players and corresponding opponents playing seller 2 engaged in the predicted equilibrium outcome in the previous round (i.e., eqPlaY) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlaYR6_15); a dummy variable representing seller 1 players' previous-round deviations that involved mixed (i.e., both higher and lower) off-equilibrium price choices and corresponding opposing seller 2 players' optimal responses (i.e., eqPlayM) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlayMR6_15); and another dummy variable reflecting seller 1 players' previous-round deviations that involved lower than equilibrium price choices and corresponding opposing seller 2 players' optimal responses (i.e., eqPlayL[33]) plus its corresponding interaction term to capture the effect of this variable during the last 10

[32] Since the dataset has repeated observations on both subjects playing seller 1 and seller 2, all binomial probit estimations assume independence of observations across subjects but not necessarily independence across observations belonging to the same subject.

[33] Due to the small sample size of 10 subjects (either playing seller 1 or seller 2), the dummy variable eqPlayH (see Table 9.10 for the definition) could not be included in the models since when such strategies were played in the previous round, only off-equilibrium strategies are played by seller 1 players in a given round. Thus, eqPlayH perfectly predicts the dependent variable (i.e., Y4) off-equilibrium outcome for subjects playing seller 1.

rounds (i.e., eqPlayLR6_15[34]). Four demographic variables (see Table 9.16) are used for the purpose of controlling for variations in seller 1 players' behavior that might possibly occur. (Refer to Table 9.10 for detailed definitions of all explanatory variables.)

Table 9.16–Probit estimates of probability of seller 1 players adopting monopoly pricing entry accommodation strategy

Variable						
Age						-0.039
						(0.102)
						[-0.015]
Major						2.162*
						(1.077)
						[0.657]
GPA						0.253
						(0.347)
						[0.096]
Risk						0.874†
						(0.475)
						[0.333]
eqPlayLR6_15					-0.322	
					(0.248)	
					[-0.122]	
eqPlayMR6_15			-1.199*	-1.191*	-1.352*	-1.155*
			(0.247)	(0.242)	(0.379)	(0.222)
			[-0.368]	[-0.365]	[-0.395]	[-0.340]
eqPlaYR6_15		0.411	0.055	0.063		
		(0.261)	(0.335)	(0.315)		
		[0.162]	[0.021]	[0.025]		
eqPlayL				0.424	0.658	
				(0.467)	(0.491)	
				[0.166]	[0.256]	
eqPlayM			0.655	0.994	1.112†	1.081
			(0.672)	(0.649)	(0.577)	(0.816)
			[0.257]	[0.379]	[0.418]	[0.411]
eqPlaY		1.836*	2.063*	2.401*	2.451*	1.870*
		(0.673)	(0.833)	(0.925)	(0.892)	(0.835)
		[0.641]	[0.697]	[0.770]	[0.779]	[0.644]
R6_15	0.180	-0.156	0.201†	0.192†	0.353	0.296*
	(0.163)	(0.206)	(0.119)	(0.115)	(0.243)	(0.108)
	[0.070]	[-0.061]	[0.077]	[0.074]	[0.134]	[0.110]
Constant	-0.305	-0.994*	-1.221*	-1.560*	-1.678*	-2.438
	(0.336)	(0.319)	(0.437)	(0.538)	(0.521)	(2.372)
χ^2-Test (p-value)		0.005	0.000	0.000	0.000	0.000

34 eqPlayL, eqPlayLR6_15, and eqPlaYR6_15 ended up being dropped since these explanatory variables turned out to be consistently insignificant.

Note: N = 150 for the first model. N = 140 for the last five models. Y4 is the dependent variable. Numbers in parentheses are robust standard errors. Numbers in brackets are the marginal effects on the probability of seller 1 players engaging in monopoly pricing at $p_{1A}^{*} = p_{1B}^{*} = \$0.5$. (Marginal effects are calculated at the means of the independent variables; and for dummy variables (e.g., eqPlaY) they are calculated for the discrete change as the dummy changes from zero to one.) * P-value < 0.05. † P-value < 0.10. χ^2-Test compares the last five models to the first one but with N reduced to 140.

Looking at Table 9.16 one can see that the variable indicating that both seller 1 players and corresponding opponents playing seller 2 engaged in the predicted equilibrium outcome in the previous round (i.e., eqPlaY) and the one representing the last 10 rounds of this treatment (i.e., R6_15) have positive and statistically significant coefficients at the 5% level (in the last five models and in the last model, respectively). For the sixth model, and for eqPlaY explanatory variable, this suggests that when both seller 1 players and corresponding opponents playing seller 2 engage in their predicted equilibrium strategy in the previous round, subjects playing seller 1 are more likely to engage in the same kind of play in a given round. For R6_15 independent variable, it indicates that during the last 10 rounds seller 1 players' behavior adjusts in ways that are not captured by both types of players' previous actions and player 1 demographics. In particular, there is an increasing tendency in the later rounds for subjects playing seller 1 to choose their predicted equilibrium outcome. Still, the interaction term eqPlayMR6_15 has a negative and statistically significant coefficient at the 5% level, which suggests that the effects noted above are partially offset; and when seller 1 players' deviate choosing mixed off-equilibrium pricing strategies and corresponding opposing seller 2 players respond with the optimum in the previous round, subjects playing seller 1 are less likely to play the predicted equilibrium pricing strategy in a given round for the last 10 rounds. During this session subjects playing seller 1 chose the predicted equilibrium pricing strategy 64 times.

In summary, findings suggest that throughout the game there is an increasing tendency for subjects playing seller 1 to engage in the predicted monopoly pricing strategy, which offers the largest payoff (compared to other price choices). That is, with low entry costs of *$0.07*, seller 1 players are more likely to accommodate the entry of a potential one-product competitor and choose the same monopoly price of *$0.5* for goods A and B in a given round, if they have previously played the same strategy and their opposing seller 2 players entered one of the two markets undercutting seller 1 players price by 0.1 (i.e., at *$0.4* for the corresponding good). In the later rounds, however, there is a tendency for seller 1 players to deviate from the predicted equilibrium pricing strategy, particularly if they have previously played a mixed off-equilibrium pricing strategy and their opposing seller 2 players responded with the optimum.

- Seller 1 Players' Demographics and Risk Attitudes

The demographic composition of the subjects playing seller 1 will be discussed next since some behavioral variations in this game might be correlated with demographics. Table 9.12 has the descriptive statistics on the demographic characteristics of subjects playing seller 1. (See Appendix B for the questionnaire answered by the subjects.)

Results from an estimation which includes demographic variables are reported in the sixth column of Table 9.16. In that estimation two demographic variables have positive and statistically significant coefficients at the 5% and the 10% levels. They are major and risk, respectively. This indicates that business or economic major seller 1 players (compared to other majors) are more likely to play the equilibrium strategy. The latter may come as no surprise since subjects who are studying business or taking economics courses have been trained to better understand price competition; and it also suggests that risk-averse seller 1 players are more likely to engage in the predicted equilibrium strategy.

- Seller 2 Players:

Given that seller 2 players entered the market conditional on subjects playing seller 1 pricing the same for both goods –A and B, there were 67 decisions by seller 2 players to enter the market (out of 68 equal pricing decisions by subjects playing seller 1) at an average price of *$0.391* for either good A or B (with a standard deviation of 0.045). That is, 98.53% of the seller 2 players entered one of the two markets when subjects playing seller 1 charged the same for both goods; Table 9.17 summarizes means, medians, standard deviations, and test results[35] of such price offers by subjects playing seller 2 in each round.

[35] Hypothesis:
$\mathbf{H_0}$: Mean of price offers in a given round = 0.4
$\mathbf{H_a}$: Mean of price offers in a given round ≠ 0.4
P-values from the test indicate that the mean of price offers is equal to the theoretically predicted equilibrium price of *$0.4* for either good A or B in every round at the 5% level of significance.

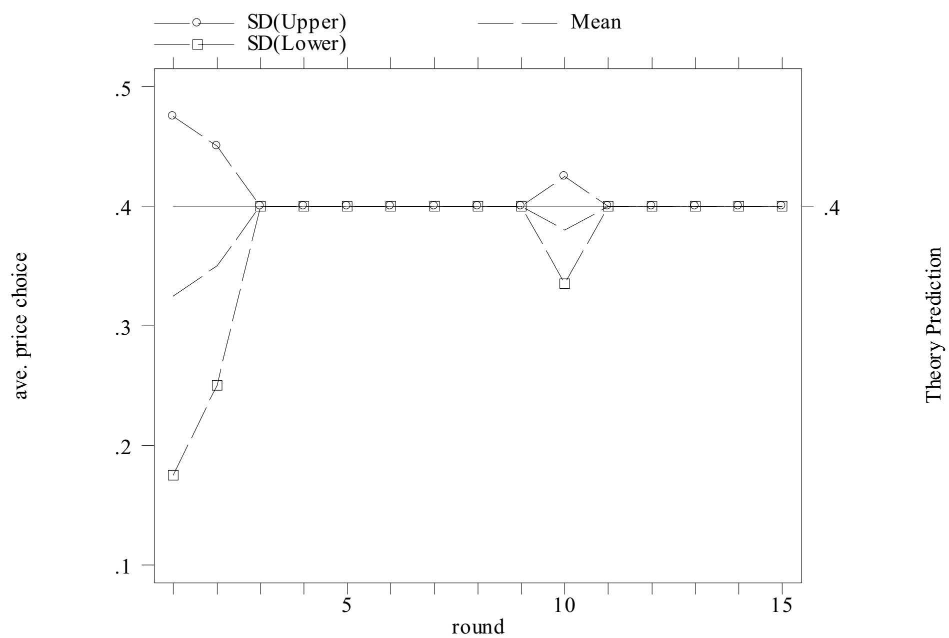
Table 9.17–Number of seller 2 players entering either market A or B (with seller 1 players charging the same for goods A and B) and corresponding price mean, median, standard deviation, and p-value per round

Round	# of Seller 2 Players Entering	Mean	Median	SD	P-value
1	4	0.325	0.4	0.15	0.148
2	4	0.35	0.4	0.1	0.148
3	4	0.4	0.4	0	1.000
4	5	0.4	0.4	0	1.000
5	4	0.4	0.4	0	1.000
6	5	0.4	0.4	0	1.000
7	4	0.4	0.4	0	1.000
8	4	0.4	0.4	0	1.000
9	4	0.4	0.4	0	1.000
10	5	0.38	0.4	0.045	0.194
11	5	0.4	0.4	0	1.000
12	5	0.4	0.4	0	1.000
13	4	0.4	0.4	0	1.000
14	5	0.4	0.4	0	1.000
15	5	0.4	0.4	0	1.000

It was observed that 100% of the seller 2 players (except for round 3 with 80%) entered one of the two markets when subjects playing seller 1 charge the same price for goods A and B in each round. From round 3 on, the former players chose to enter the market at an average price of *$0.4* (except for round 10), matching the predicted price value. Figure 9.8 shows seller 2 players' average price choices and corresponding theoretical prediction for either good A or B given that they chose to enter the market when the opposing seller 1 player charged the same for both goods in each round. The median price matched the predicted equilibrium value.

Figure 9.8 Seller 2 player's average price choice: Conditional on entry occurring and on seller 1 player pricing the same for goods A and B

Note: SD(Upper) and SD(Lower) are one standard deviation from the mean in each round



In the third round it was observed that subjects playing seller 1 charged the lowest average price of this game for goods A and B and this might have prevented some seller 2 players from entering the market. In fact, one out of the five (20%) subjects playing seller 2 decided not to enter the market since his/her opponent playing seller 1 (perhaps in an attempt to deter entry) charged a price of *$0.1* (i.e., the entry deterring price for this game) for both goods, which would have made the former player earn a non-positive profit in this round.

o Seller 2 Players' Equilibrium:

Results show that 100% of subjects playing seller 2 chose to undercut their opponent's price by 0.1, entering the market at an average price of *$0.4* for either good A or B (with a standard deviation of 0) when subjects playing seller 1 were accommodating entry at monopoly price (or playing the predicted equilibrium pricing at $p_{1A}^{*} = p_{1B}^{*} =$ *$0.5*).

- Econometric Analysis for Seller 2 Players:

For subjects playing seller 2, our primary concern is to analyze the likelihood for subjects playing seller 2 to enter either market A or B charging a price of *$0.4* for the corresponding good.

One might hypothesize that seller 2 players' behavior would be influenced by (1) seller 1 players' choices in a given round, and/or (2) the previous player 1 price choices for goods A and B, and opposing seller 2 players' decisions to enter or not.

To evaluate the evolution of the tendency of subjects playing seller 2 to enter either A or B market charging a price of *$0.4* for the corresponding good, binomial probit[36] models were estimated. The dependent variable, S2, is coded one if entry occurs at a price of *$0.4* in one of the two goods market and zero otherwise.[37] Independent variables include the R6_15 dummy variable that represents the last 10 rounds to help explain the

[36] Since the dataset has repeated observations on both subjects playing seller 1 and seller 2, all binomial probit estimations assume independence of observations across subjects but not necessarily independence across observations belonging to the same subject.

[37] Acronyms of all variables and their explanations are presented in Table 9.10. Table 9.11 presents means and standard deviations of the variables.

evolution of choices over time, especially, towards the end of the session; another dummy variable reflecting that both subjects playing seller 1 and seller 2 chose their corresponding equilibrium strategies in the previous round (i.e., eqPlaY) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlaYR6_15); a dummy variable representing seller 1 players' previous-round deviations that involved mixed off-equilibrium price choices and corresponding opposing seller 2 players' optimal responses (i.e., eqPlayM) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlayMR6_15); another dummy variable indicating seller 1 players' previous-round deviations that involved lower than equilibrium price choices and corresponding opposing seller 2 players' optimal responses (i.e., eqPlayL) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlayLR6_15); and a dummy variable reflecting seller 1 players' previous-round deviations that involved higher than equilibrium price choices and corresponding opposing seller 2 players' optimal responses (i.e., eqPlayH) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlayHR6_15[38]). Four demographic variables (see Table 9.18) are used for the purpose of controlling for variations in seller 2 players' behavior that might possibly occur. (Refer to Table 9.10 for detailed definitions of all explanatory variables.)

[38]eqPlaYR6_15, eqPlayM, eqPlayMR6_15, eqPlayL, eqPlayLR6_15, eqPlayH, and eqPlayHR6_15 ended up being dropped since these explanatory variables turned out to be consistently insignificant.

Table 9.18–Probit estimates of probability of seller 2 players entering either market A or B at *$0.4*

Variable						
Age						0.007
						(0.015)
						[0.003]
Major						-0.150
						(0.250)
						[-0.059]
GPA						0.024
						(0.059)
						[0.009]
Risk						-0.010
						(0.040)
						[-0.004]
eqPlayHR6_15					-0.523	
					(1.243)	
					[-0.205]	
eqPlayLR6_15				0.047		
				(0.894)		
				[0.018]		
eqPlayMR6_15			-0.704	-0.656		
			(0.967)	(1.278)		
			[-0.274]	[-0.256]		
eqPlaYR6_15		0.383	0.177	0.224		
		(0.466)	(0.456)	(0.814)		
		[0.140]	[0.066]	[0.083]		
eqPlayH					0.636	
					(0.827)	
					[0.209]	
eqPlayL				0.157		
				(0.605)		
				[0.058]		
eqPlayM			0.320	0.433		
			(0.637)	(0.579)		
			[0.115]	[0.153]		
eqPlaY		0.481	0.570	0.684	0.781*	0.726*
		(0.413)	(0.438)	(0.463)	(0.230)	(0.206)
		[0.177]	[0.209]	[0.248]	[0.282]	[0.263]
R6_15	0.234	0.095	0.301	0.253	0.272	0.233
	(0.224)	(0.307)	(0.358)	(0.795)	(0.292)	(0.259)
	[0.090]	[0.036]	[0.115]	[0.097]	[0.104]	[0.089]
Constant	0.150	-0.050	-0.140	-0.253	-0.206	-0.307
	(0.166)	(0.201)	(0.270)	(0.463)	(0.195)	(0.509)
χ^2-Test (p-value)		0.001	0.003	0.004	0.003	0.000

Note: N = 150 for the first model. N = 140 for the last five models. S2 is the dependent variable. Numbers in parentheses are robust standard errors. Numbers in brackets are the marginal effects on the probability of seller 2 players entering either A or B market at a price of *$0.4* for the corresponding good. (Marginal effects are calculated at the means of the independent variables; and for dummy variables (e.g., eqPlaY) they are calculated for the discrete change as the dummy changes from zero to one.) * P-value < 0.05. † P-value < 0.10. χ^2-Test compares the last five models to the first one but with N reduced to 140.

Due to the small sample size of 10 subjects (either playing seller 1 or seller 2), it was observed that when seller 1 players choose to accommodate entry at the same monopoly price of *$0.5* for both goods A and B in a given round (i.e., Y4), seller 2 players always enter the market undercutting seller 1 players' price by 0.1, i.e., at a price of *$0.4* (64 observations out of a total of 150 follow this pattern). This means that this explanatory variable perfectly predicts the dependent variable (i.e., S2) equilibrium outcome for subjects playing seller 2, and therefore, Y4 – the dummy variable representing seller 1 players' equilibrium pricing decision in a given round, could not be included in the models.

The results in Table 9.18 show that the dummy variable indicating that both players chose equilibrium strategies in the preceding round (i.e., eqPlaY) has a positive and statistically significant coefficient at the 5% level in the last two models. For the sixth model this suggests that when both seller 1 and seller 2 players engage in their equilibrium strategies in the previous round, seller 2 players are more likely to enter the market at a price of *$0.4* in a given round. During this session subjects playing seller 2 chose to play the predicted equilibrium strategy 93 times.

In summary, findings suggest that throughout the game there is an increasing tendency for seller 2 players to choose the equilibrium strategy when their opposing sellers 1 players choose the same monopoly price of *$0.5* for goods A and B. This is indicated by the positive relationship between the choices of seller 2 players to enter the market at a price of *$0.4* in a given round, and both seller 1 and seller 2 players' choices of their corresponding predicted equilibrium strategies in the previous round.

- Seller 2 Players' Demographics and Risk Attitudes

The demographic composition of the subjects playing seller 2 will be discussed next since some behavioral variations in this game might be correlated with demographics. Table 9.12 has the descriptive statistics on the demographic characteristics of subjects playing seller 2. (See Appendix B for the questionnaire answered by the subjects.)

Results from an estimation which includes demographic variables are reported in the sixth column of Table 9.18. In that estimation no demographic variable has a statistically significant coefficient at the 5% and/or 10% levels.

- Successful Entry Accommodation:

In this game pricing goods A and B at *$0.5* (i.e., monopoly price) provides a way for subjects playing seller 1 (i.e., incumbents) to get higher profits (of *$0.25* per round) when accommodating as opposed to deterring entry (by charging $p_{1A}^{d} = p_{1B}^{d} = \$0.1$ and having a profit of *$0.18* per round). Entry by seller 2 players (i.e., challengers) occurred at *$0.4* in either market A or B when their opponents playing seller 1 charged the predicted equilibrium price for those goods, making the former earn the maximum possible profit of *$0.17* per round. Actual behavior usually follows the theoretical prediction for this case.

Out of the 10 subjects playing seller 1 there was only one time (in round 3) when the entry deterring price for this game was played, granting him/her the predicted profit of *$0.18* in that round, and keeping the opposing seller 2 player out of the market with a

$0 profit. Table 9.19 presents average profits for subjects playing seller 1 and seller 2 in each round.

Table 9.19–Average profits for seller 1 and seller 2 players per round

Round	Seller 1 Player's Ave. Profit	Seller 2 Player's Ave. Profit
1	0.226	0.158
2	0.201	0.15
3	0.246	0.098
4	0.243	0.145
5	0.23	0.15
6	0.218	0.171
7	0.237	0.150
8	0.214	0.159
9	0.215	0.165
10	0.222	0.153
11	0.232	0.157
12	0.247	0.155
13	0.249	0.135
14	0.241	0.144
15	0.236	0.16

While seller 1 players who charged the optimal monopoly price to accommodate entry engaged in this behavior very early in the game (between rounds 1 and 3) keeping it throughout the session (there was only one exception to this), the remaining seller 1 players never seemed to learn how to reach such pricing decision. Each of those who played the predicted equilibrium price value was able to get an average profit per round of *$0.248* against *$0.213* of those who did not price that way. The subjects playing seller 2 took advantage of the opportunity to earn positive profits almost all the time (by entering one of the two possible markets undercutting by 0.1 their opponent seller 1's price).

Although some of the subjects playing seller 1 did not play the equilibrium strategy for this game, when entry costs are 'low' monopoly pricing was frequently observed for an incumbent selling two goods (e.g., A and B) separately and accommodating the entry of a potential one-product competitor (selling a perfect substitute to either good A or B). Under these circumstances, entry by seller 2 players happened in every case (also at the predicted optimal price) in one of the two markets.

9.3 Pure Bundling Treatment –'High' Entry Costs Session

According to theory predictions, the equilibrium for bundled sales of goods A and B with entry costs of *$0.2* should be: (1) for subjects playing seller 1 to charge the monopoly price of *$0.8* (which also works as an entry-barring price) for the two-good bundle – (A, B); and (2) for subjects playing seller 2 not to enter any of those two markets.

Table 9.20–Variables and explanations

Variable	Explanation
Y4	Seller 1 chooses a price of *$0.8* for the two-good bundle – (A, B) in a given round = 1; Otherwise = 0
S2	Seller 2 chooses not to enter the A and B markets in a given round = 1; Otherwise = 0
eqPlaY	Seller 1 chose a price of *$0.8* for the two-good bundle – (A, B) and seller 2 chose not to enter one of the two markets in the previous round = 1; Otherwise = 0
eqPlayL	Seller 1 chose a price strictly lower than *$0.8* for the two-good bundle – (A, B) and seller 2 chose not to enter the market in the previous round = 1; Otherwise = 0
eqPlayH	Seller 1 chose a price strictly greater than *$0.8* for the two-good bundle – (A, B) in the previous round. In response, seller 2: (1) chose not to enter the market if seller 1's price for the two-good bundle was strictly lower than *$1.3*, (2) entered the market, either choosing a price of *$0.4* if seller 1's price for the two-good bundle was greater than or equal to *$1.3* and lower than or equal to *$1.4*, or choosing a price of *$0.5* if seller 1's price for the two-good bundle was strictly greater than *$1.4* = 1; Otherwise = 0
R6_15	Rounds that range from 6 to 15 (i.e., the last 10 rounds, since 15 is the maximum number of rounds that were played in this treatment) = 1; Otherwise = 0
Y4R6_15	= Y4 * R6_15
eqPlaYR6_15	= eqPlaY * R6_15
eqPlayLR6_15	= eqPlayL * R6_15
eqPlayHR6_15	= eqPlayH * R6_15
Age	Subject (playing seller 1 or seller 2)'s age
Major	Economics or business major = 1; Other majors = 0
GPA	GPA choices from the questionnaire
Risk	Risk attitude ("negative" = risk loving; "0" = risk neutral; "positive" = risk averse)

Note: **1)** GPA = 1 means GPA between 3.75 and 4.00, GPA = 2 means GPA between 3.25 and 3.74, GPA = 3 means GPA between 2.75 and 3.24, GPA = 4 means GPA between 2.25 and 2.74, GPA = 5 means GPA between 1.75 and 2.24, GPA = 6 means GPA between 1.25 and 1.74, GPA = 7 means GPA less than 1.25. **2)** Risk attitude reflects a measurement of the threshold certainty equivalent for choosing the risky lottery.

Table 9.21–Descriptive statistics for variables[39]

Variable	Mean	Std. Dev.	N
Y4	0.56	0.50	150
S2	0.57	0.50	150
Y4R6_15	0.39	0.49	150
R6_15	0.67	0.47	150
eqPlaY	0.31	0.47	140
eqPlayL	0.21	0.41	140
eqPlayH	0.11	0.32	140
eqPlaYR6_15	0.25	0.43	140
eqPlayLR6_15	0.15	0.36	140
eqPlayHR6_15	0.08	0.27	140
Y4*	0.56	0.50	140
S2*	0.59	0.49	140
R6_15*	0.71	045	140

Table 9.22–Descriptive statistics for seller 1 and seller 2 players' demographic variables

	Seller 1		Seller 2		
Variable	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**N**
Age	20.30	1.16	23.00	3.50	10
GPA	2.40	1.07	2.50	1.58	10
Major	0.30	0.48	0.40	0.52	10
Risk	-0.10	0.74	0.70	0.95	10

- Seller 1 Players:

Overall, subjects playing seller 1 charged an average price of *\$0.813* for the two-good bundle – (A, B) (with a standard deviation of 0.168). Table 9.23 summarizes means, medians, standard deviations, and test results[40] of price offers for the two-good bundle in

[39] First round observations were dropped for Y4*, S2*, and R6_15* independent variables.
[40] Hypothesis:
$\mathbf{H_0}$: Mean of price offers in a given round = 0.8
$\mathbf{H_a}$: Mean of price offers in a given round ≠ 0.8
P-values from the test indicate that the mean of price offers is equal to the theoretically predicted equilibrium price of *\$0.8* for the two-good bundle – (A, B) in every round at the 5% level of significance.

each round.

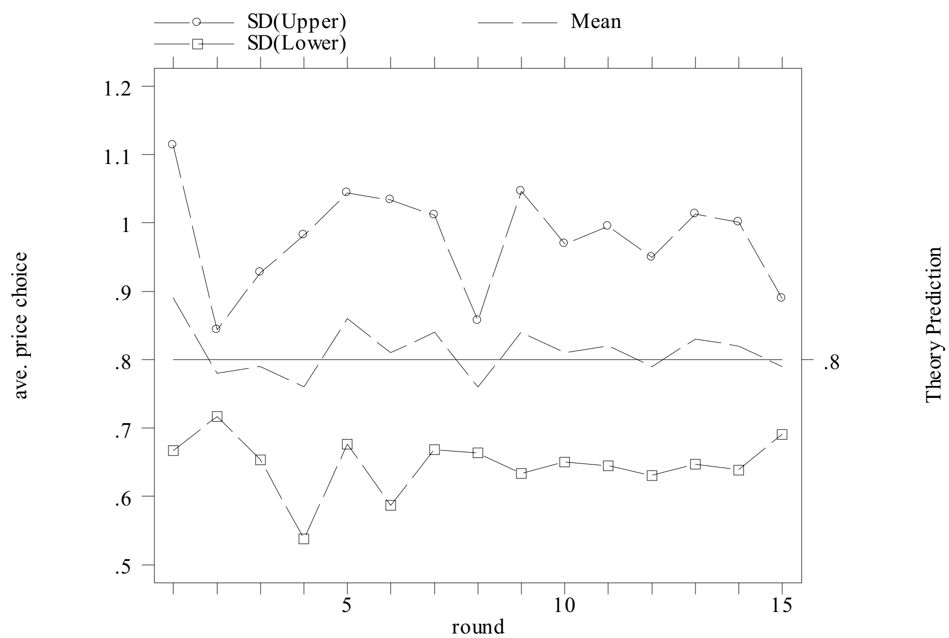
Table 9.23–Mean, median, standard deviation and p-value of price offers for the two-good bundle per round

Round	Mean	Median	SD	P-value
1	0.89	0.8	0.223	0.235
2	0.78	0.8	0.063	0.343
3	0.79	0.8	0.137	0.823
4	0.76	0.75	0.222	0.583
5	0.86	0.8	0.184	0.329
6	0.81	0.8	0.223	0.891
7	0.84	0.8	0.171	0.479
8	0.76	0.8	0.097	0.223
9	0.84	0.8	0.207	0.555
10	0.81	0.8	0.160	0.847
11	0.82	0.8	0.175	0.726
12	0.79	0.8	0.160	0.847
13	0.83	0.8	0.183	0.616
14	0.82	0.8	0.181	0.735
15	0.79	0.8	0.099	0.758

Throughout the game it was observed that the average price charged for the two-good bundle – (A, B) by subjects playing seller 1 evolved around the predicted value with a tendency to more closely approach it in the last six rounds (i.e., from round 10 onward); Figure 9.9 presents seller 1 player's average price choice and corresponding theoretical prediction in each round. Except for round 4, the median price matched the predicted equilibrium price value.

Figure 9.9 Average seller 1 player's price choice for the two-good bundle

<u>Note</u>: SD(Upper) and SD(Lower) are one standard deviation from the mean in each round



o Seller 1 Players' Equilibrium:

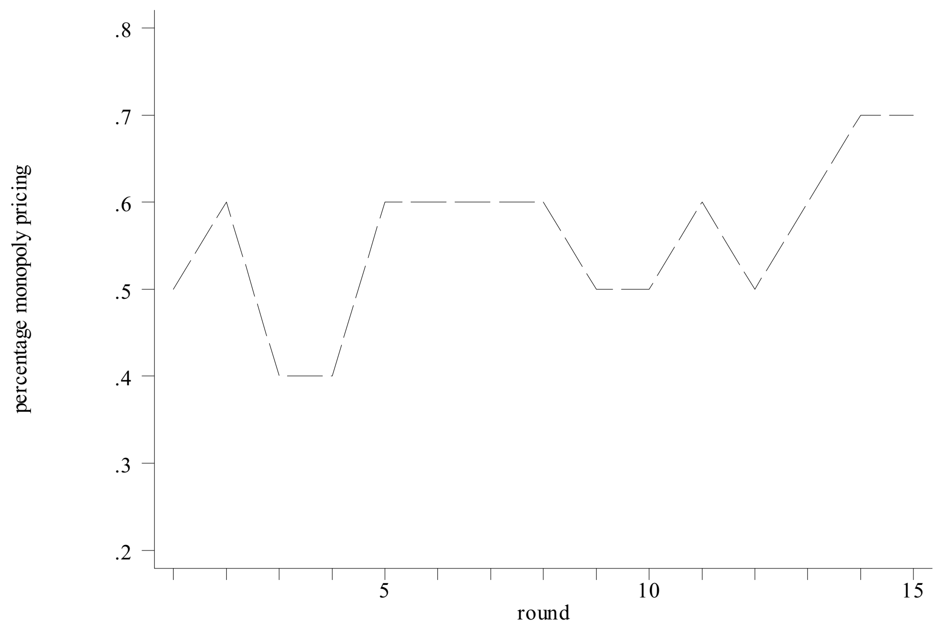
Out of the 150 possible pricing decisions (150 = 10 subjects playing seller 1 * 15 rounds), in 84 cases (56%) subjects playing seller 1 chose to price the two-good bundle – (A, B) at exactly *$0.8*, the value predicted by the theory. Table 9.24 shows, for each round, the number of times such equilibrium pricing decision was reached and corresponding percentage.

Table 9.24–Number of seller 1 players charging monopoly price and corresponding percentage in each round

Round	Equilibrium Pricing Decisions by Seller 1, i.e., $p_t^* \approx \$0.8$	Percentage of Equilibrium Pricing Decisions by Seller 1
1	5	50%
2	6	60%
3	4	40%
4	4	40%
5	6	60%
6	6	60%
7	6	60%
8	6	60%
9	5	50%
10	5	50%
11	6	60%
12	5	50%
13	6	60%
14	7	70%
15	7	70%

In the last 11 rounds, there were 65 monopoly pricing decisions (out of 110 possible ones; 110 = 10 subjects playing seller 1 * 11 rounds), which means that 59.09% of the subjects playing seller 1 satisfied the predicted equilibrium. Such pricing decisions were observed in higher percentages (of, e.g., 60% and 70%) from round 5 on, with 70% being reached in the last two rounds. This means that learning might have some impact on seller 1 players engaging in monopoly pricing (see also Figure 9.10, which presents the percentage of seller 1 players charging the monopoly price for the two-good bundle – (A, B) in each round).

Figure 9.10 Percentage of seller 1 players charging monopoly price



- Econometric Analysis for Seller 1 Players:

Our primary interest is to analyze the tendency for subjects playing seller 1 to engage in monopoly pricing and charge a price of *$0.8* for the two-good bundle – (A, B). Figure 9.10 suggests that the equilibrium for bundled sales of goods A and B with high entry costs is more likely to occur in the later rounds than in the first few ones. Also, one might conjecture that, in a given round, subjects playing seller 1 are influenced by previous player 1 price choices for the two-good bundle and opposing seller 2 players' decisions to enter or stay out of the market.

In order to evaluate the evolution of the tendency of subjects playing seller 1 to play

the predicted equilibrium pricing strategy, binomial probit[41] models were estimated. Acronyms of all variables and their explanations are presented in Table 9.20. Table 9.21 presents means and standard deviations of the variables.

The dependent variable, Y4, is coded one if seller 1 players charge a price of *$0.8* for the two-good bundle – (A, B), and zero otherwise. Independent variables include the R6_15 dummy variable that represents the last 10 rounds to help explain the evolution of choices over time, especially, towards the end of the session; another dummy variable indicating that both seller 1 players and corresponding opponents playing seller 2 engaged in the predicted equilibrium outcome in the previous round (i.e., eqPlaY) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlaYR6_15); a dummy variable representing seller 1 players' previous-round deviation that involved lower than equilibrium price choices and corresponding opposing seller 2 players staying out of the market (i.e., eqPlayL) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlayLR6_15); and another dummy variable reflecting seller 1 players' previous-round deviations that involved higher than equilibrium price choices and corresponding opposing seller 2 players' optimal responses (i.e., eqPlayH) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlayHR6_15[42]). Four demographic variables (see Table 9.25) are used for the purpose of controlling for variations in seller 1 players' behavior that might possibly occur. (Refer

[41] Since the dataset has repeated observations on both subjects playing seller 1 and seller 2, all binomial probit estimations assume independence of observations across subjects but not necessarily independence across observations belonging to the same subject.

[42] eqPlaYR6_15, eqPlayH, and eqPlayHR6_15 ended up being dropped since these explanatory variables turned out to be consistently insignificant.

to Table 9.20 for detailed definitions of all explanatory variables.)

Table 9.25–Probit estimates of probability of seller 1 players adopting monopoly pricing entry-deterrent strategy

Variable					
Age					-0.530* (0.098) [-0.205]
Major					0.401 (0.595) [0.150]
GPA					-0.211 (0.226) [-0.081]
Risk					-0.823* (0.277) [-0.318]
eqPlayLR6_15				-1.420* (0.626) [-0.506]	-0.972 (0.667) [-0.372]
eqPlayHR6_15			-0.103 (0.841) [-0.040]	-0.587 (0.879) [-0.231]	
eqPlaYR6_15		0.613 (0.436) [0.222]	0.596 (0.506) [0.217]	0.111 (0.535) [0.043]	
eqPlayL				0.083 (0.522) [0.032]	0.520 (0.611) [0.189]
eqPlayH			-0.059 (0.785) [-0.023]	-0.030 (0.759) [-0.012]	
eqPlaY		0.968† (0.565) [0.342]	0.958† (0.567) [0.339]	0.988† (0.582) [0.351]	0.965* (0.417) [0.339]
R6_15	0.228 (0.228) [0.090]	-0.010 (0.211) [-0.004]	0.007 (0.270) [0.003]	0.492 (0.369) [0.193]	0.385 (0.317) [0.150]
Constant	-1.8e-16 (0.251)	-0.204 (0.252)	-0.194 (0.225)	-0.223 (0.314)	10.785* (2.122)
χ^2-Test (p-value)		0.000	0.000	0.000	0.000

Note: N = 150 for the first model. N = 140 for the last four models. Y4 is the dependent variable. Numbers in parentheses are robust standard errors. Numbers in brackets are the marginal effects on the probability of seller 1 players engaging in monopoly pricing at $p_t^* = \$0.8$. (Marginal effects are calculated at the means of the independent variables; and for dummy variables (e.g., eqPlaY) they are calculated for the discrete change as the dummy changes from zero to one.) * P-value < 0.05. † P-value < 0.10. χ^2-Test compares the last four models to the first one but with N reduced to 140.

Looking at Table 9.25 one can see that the coefficient on the variable indicating that both seller 1 players and corresponding opponents playing seller 2 engaged in the predicted equilibrium outcome in the previous round (i.e., eqPlaY) has a positive and statistically significant coefficient at the 10% level in three of the five models and at the 5% level in the fifth model. For the fifth model this suggests that when both seller 1 players and corresponding opponents playing seller 2 engage in their predicted equilibrium strategy in the previous round, subjects playing seller 1 are more likely to engage in the same kind of play in a given round. During this session subjects playing seller 1 chose the predicted equilibrium pricing strategy 84 times.

In summary, findings suggest that throughout the game there is an increasing tendency for subjects playing seller 1 to engage in monopoly pricing (which offers the largest payoff compared to other price choices). That is, with high entry costs of *$0.2*, seller 1 players are more likely to deter entry at the monopoly price of *$0.8* for the two-good bundle in a given round, if they played the same strategy and their opposing seller 2 players stayed out of the market in the previous round. (It should be noted that the payoffs for charging the monopoly price, which also works as an entry-barring price, for the two-good bundle are only large if opposing subjects playing seller 2 do not enter any of the two markets undercutting seller 1 players' price.)

- Seller 1 Players' Demographics and Risk Attitudes

The demographic composition of the subjects playing seller 1 will be discussed next since some behavioral variations in this game might be correlated with demographics.

Table 9.22 has the descriptive statistics on the demographic characteristics of subjects playing seller 1. (See Appendix B for the questionnaire answered by the subjects.)

Results from an estimation which includes demographic variables are reported in the fifth column of Table 9.25. In that estimation two demographic variables have negative and statistically significant coefficients at the 5% level. They are age and risk. This suggests that older subjects playing seller 1 (compared to younger) are less likely to choose the predicted equilibrium strategy; and that risk-averse seller 1 players are also less likely to play the equilibrium strategy.

- Seller 2 Players:

There were 64 decisions by seller 2 players to enter the market (out of 150 possible ones; 150 = 10 subjects playing seller 2 * 15 rounds) at an average price of *$0.222* for either good A or B (with a standard deviation of 0.157). That is, 42.67% of the seller 2 players decided to enter one of the two markets.

- Seller 2 Players' Equilibrium:

Results show that 42.86% (i.e., average equals 0.429 with a standard deviation of 0.498) of seller 2 players chose to enter the market when subjects playing seller 1 were charging the monopoly price for the two-good bundle – (A, B) (i.e., playing the predicted equilibrium value $p_t^* \approx \$0.8$). Figure 9.11 shows seller 2 players' average price choices for either good A or B, conditional on entry occurring when subjects playing seller 1 charged the monopoly price for the two-good bundle in each round.

Figure 9.11 Seller 2 player's average price choice: Conditional on entry occurring and on seller 1 player charging the equilibrium price for the two-good bundle

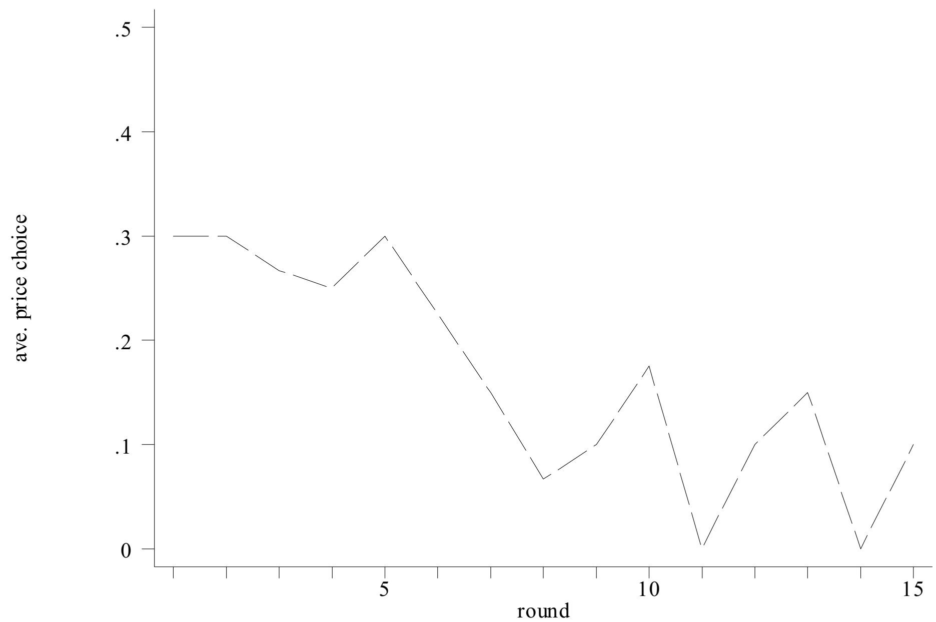
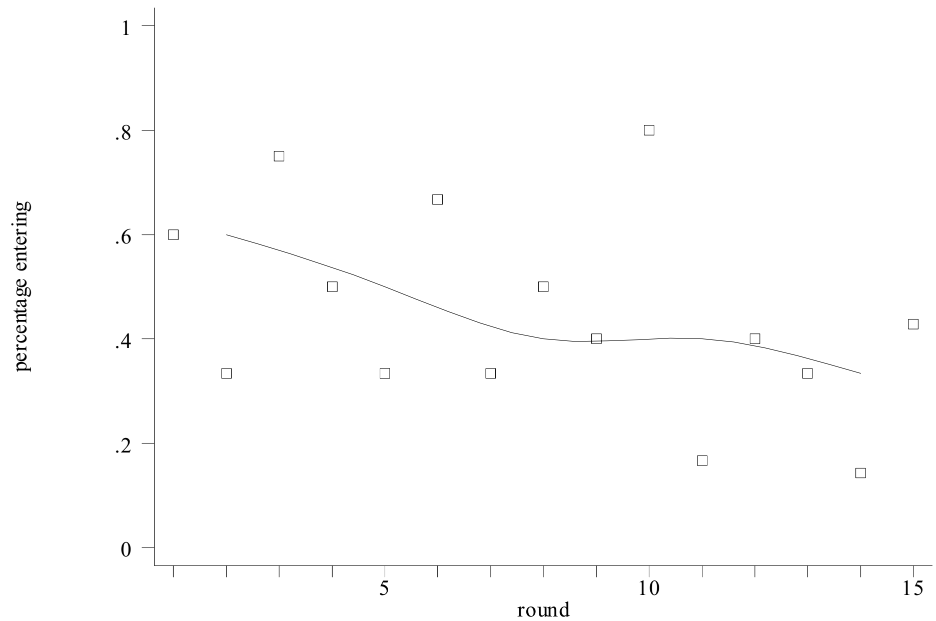


Figure 9.12[43] shows the percentage of seller 2 players entering one of the two markets when subjects playing seller 1 charged the monopoly price of *$0.8* for the two-good bundle – (A, B) in each round.

[43] A cubic spline fit line is provided.

Figure 9.12 Percentage of seller 2 players entering: Conditional on seller 1 players charging the equilibrium price for the two-good bundle



Throughout the 15 rounds (but for rounds 9, 10, and 11) there is a decreasing tendency for seller 2 players to enter the market, as subjects playing seller 1 engage in monopoly pricing. In the remaining 48 cases (57.14%), seller 2 players satisfied the equilibrium prediction of staying out of the market when the corresponding opponent playing seller 1 charged the equilibrium price.

It was observed that throughout this session there were five (out of 10) seller 2 players who seemed never to learn how to play the game since each of those players has entered the market at least 44.44% of the time (and at most 100%) when subjects playing seller 1 were charging the monopoly price for the two-good bundle – (A, B) (i.e., seller 1's equilibrium price).

- Econometric Analysis for Seller 2 Players:

For subjects playing seller 2, our primary concern is to analyze the likelihood of not entering one of the two markets. Figure 9.12 suggests that conditional on seller 1 players charging *$0.8* for the two-good bundle – (A, B), entry (for bundled sales of goods A and B with high entry costs) by subjects playing seller 2 is less likely to occur in the later rounds than in the first ones. Also, one might hypothesize that seller 2 players' behavior would be influenced by (1) seller 1 players' choices in a given round, and/or (2) the previous player 1 price choice for the two-good bundle – (A, B) and opposing seller 2 players' decisions to enter or not.

To evaluate the evolution of the tendency of subjects playing seller 2 to stay out of the A and B markets, binomial probit[44] models were estimated. The dependent variable, S2, is coded one if entry does not occur and zero otherwise.[45] Independent variables include the R6_15 dummy variable that represents the last 10 rounds to help explain the evolution of choices over time, especially, towards the end of the session; another dummy variable representing seller 1 players choosing to deter entry at the monopoly price of *$0.8* for the two-good bundle in a given round (i.e., Y4) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., Y4R6_15); a dummy variable reflecting that both subjects playing seller 1 and seller 2 chose their corresponding equilibrium strategies in the previous round (i.e., eqPlaY) plus

[44] Since the dataset has repeated observations on both subjects playing seller 1 and seller 2, all binomial probit estimations assume independence of observations across subjects but not necessarily independence across observations belonging to the same subject.

[45] Acronyms of all variables and their explanations are presented in Table 9.20. Table 9.21 presents means and standard deviations of the variables.

its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlaYR6_15); another dummy variable representing seller 1 players' previous-round deviation that involved lower than equilibrium price choices and corresponding opposing seller 2 players staying out of the market (i.e., eqPlayL) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlayLR6_15); and a dummy variable reflecting seller 1 players' previous-round deviations that involved higher than equilibrium price choices and corresponding opposing seller 2 players' optimal responses (i.e., eqPlayH[46]) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlayHR6_15[47]). Four demographic variables (see Table 9.26) are used for the purpose of controlling for variations in seller 2 players behavior' that might possibly occur. (Refer to Table 9.20 for detailed definitions of all explanatory variables.)

[46] Y4, Y4R6_15, eqPlaYR6_15, eqPlayL, and eqPlayLR6_15 ended up being dropped since these explanatory variables turned out to be consistently insignificant.

[47] Due to the small sample size of 10 subjects (either playing seller 1 or seller 2), the models could not include the interaction term eqPlayHR6_15 (see Table 9.20 for the definition) since the number of times both type of players engaged in the actions described by this variable was less than twelve.

Table 9.26–Probit estimates of probability of seller 2 players not entering either market A or B

Variable						
Age						-0.114
						(0.077)
						[-0.043]
Major						0.033
						(0.411)
						[0.012]
GPA						-0.297†
						(0.153)
						[-0.112]
Risk						-0.168
						(0.218)
						[-0.064]
eqPlayLR6_15					-0.003	
					(0.712)	
					[-0.001]	
eqPlaYR6_15			-0.097	-0.071	-0.028	
			(0.725)	(0.735)	(0.857)	
			[-0.037]	[-0.027]	[-0.011]	
eqPlayL					0.992	
					(0.962)	
					[0.326]	
eqPlayH				1.145*	1.541*	1.032†
				(0.563)	(0.784)	(0.602)
				[0.338]	[0.405]	[0.310]
eqPlaY			1.261†	1.419*	1.782*	1.225*
			(0.654)	(0.659)	(0.801)	(0.387)
			[0.418]	[0.456]	[0.541]	[0.402]
Y4R6_15		-0.043				
		(0.476)				
		[-0.017]				
Y4		-9.9e-16				
		(0.347)				
		[-4.4e-16]				
R6_15	0.203	0.229	-0.056	-0.082	-0.125	-0.040
	(0.164)	(0.325)	(0.189)	(0.207)	(0.326)	(0.213)
	[0.080]	[0.090]	[-0.021]	[-0.031]	[-0.047]	[-0.015]
Constant	0.050	0.050	-0.040	-0.198	-0.561	3.310†
	(0.328)	(0.294)	(0.345)	(0.369)	(0.482)	(1.721)
χ^2-Test (p-value)		0.989	0.002	0.001	0.000	0.000

Note: N = 150 for the first two models. N = 140 for the last four models. S2 is the dependent variable. Numbers in parentheses are robust standard errors. Numbers in brackets are the marginal effects on the probability of seller 2 players not entering the A and B markets. (Marginal effects are calculated at the means of the independent variables; and for dummy variables (e.g., eqPlaY) they are calculated for the discrete change as the dummy changes from zero to one.) * P-value < 0.05. † P-value < 0.10. χ^2-Test compares the last five models to the first one, but with N reduced to 140 for the last four models.

Surprisingly, results show that the coefficient on seller 1 players' equilibrium pricing decisions in a given round (i.e., Y4) and its corresponding interaction term (i.e., Y4R6_15) are consistently insignificant when estimated as part of the six models in Table 9.26, and therefore, the variable was dropped in the last four models.

Looking at Table 9.26 one can see that the coefficient on the dummy variable representing the choice of subjects playing seller 1 of the monopoly price for the two-good bundle – (A, B) and corresponding opposing seller 2 players' decision to stay out of the A and B markets in the previous round (i.e., eqPlaY) has a positive and statistically significant coefficient at the 10% level in the third model and at the 5% level in the last three models. For the sixth model this suggests that when both seller 1 and seller 2 players engage in their equilibrium strategies in the previous round, seller 2 players are more likely to opt out of the market in a given round. The explanatory variable eqPlayH also has a positive and statistically significant coefficient at the 10% level, which indicates that when subjects playing seller 1 deviate and choose higher than equilibrium prices for the two-good bundle – (A, B) and corresponding opposing seller 2 players respond with the optimum in the previous round, seller 2 players are more likely to stay out of the A or B markets in a given round. During this session subjects playing seller 2 chose to play the predicted equilibrium strategy 86 times.

In summary, findings suggest that throughout the game there is an increasing tendency for seller 2 players to stay out of the market when their opposing sellers 1 players choose the monopoly price of *$0.8* for the two-good bundle – (A, B). This is indicated by the positive relationship between the choice of subjects playing seller 2 to stay out of the market and: (1) both seller 1 and seller 2 players' choice of their corresponding predicted equilibrium strategies in the previous round; and (2) seller 1 players' previous-round deviations that involved higher than equilibrium price choices and corresponding opposing seller 2 players' optimal responses.

- Seller 2 Players' Demographics and Risk Attitudes

The demographic composition of the subjects playing seller 2 will be discussed next since some behavioral variations in this game might be correlated with demographics. Table 9.22 has the descriptive statistics on the demographic characteristics of subjects playing seller 2. (See Appendix B for the questionnaire answered by the subjects.)

Results from an estimation which includes demographic variables are reported in the sixth column of Table 9.26. In that estimation one demographic variable – GPA, has a negative and statistically significant coefficient at the 10% level. This suggests that high GPA seller 2 players (compared to low) are less likely to play the equilibrium strategy.

- Successfully Deterring Entry:

In this game pricing the two-good bundle – (A, B) at *\$0.8* (i.e., monopoly pricing) usually provided a way for subjects playing seller 1 (i.e., incumbents) to keep seller 2 players (i.e., challengers) from entering either the A or B market; that is, former players were able to get higher profits when charging monopoly price as opposed to accommodating entry (by charging $p_t \approx \$1.3$, i.e., the lowest price seller 1 is able to charge that is high enough to make entry profitable for seller 2) and were able to make the latter players earn non-positive profits. Actual behavior usually follows the theoretical prediction for this case.

Among the 10 subjects playing seller 2 there were five who decided to frequently enter the market when seller 1 players engaged in monopoly pricing (i.e., $p_t^* \approx \$0.8$). One of those five seller 2 players entered the market 44.44% of the time charging an average price per round of *$0.175* (with standard deviation of 0.126), which granted him/her the average loss of *$0.126* and his/her opponents playing seller 1 an average profit of *$0.283* per round. Two others (out of the above mentioned five seller 2 players) entered the market 62.5% and 85.71% of the time charging average prices per round of *$0.28* and *$0.23* (with standard deviations of 0.045 and 0.052, respectively), which granted them the corresponding average losses of *$0.097* and *$0.101* and their opponents playing seller 1 average profits of *$0.352* and *$0.324* per round, respectively. The remaining two subjects playing seller 2 entered the market 100% of the time charging average prices per round of *$0.125* and *$0.15* (with standard deviations of 0.155 and 0.160, respectively). (In the first five/six rounds these two subjects playing seller 2 entered one of the two markets at a price of *$0.3* and charged a price of *$0* for either good A or B in the remaining rounds.) This granted them average losses of *$0.156* and *$0.148* making their corresponding seller 1 players earn average profits of *$0.245* and *$0.262* per round, respectively. Under these circumstances, the maximum profit the above noted five seller 2 players were able to get was a loss of *$0.095*.

Table 9.27 presents average profits for subjects playing seller 1 and seller 2 in each round.

Table 9.27–Average profits for seller 1 and seller 2 players per round

Round	Seller 1 Player's Ave. Profit	Seller 2 Player's Ave. Profit
1	0.359	-0.044
2	0.503	-0.039
3	0.408	-0.059
4	0.420	-0.034
5	0.427	-0.023
6	0.366	-0.057
7	0.406	-0.048
8	0.430	-0.050
9	0.373	-0.040
10	0.354	-0.079
11	0.423	-0.038
12	0.426	-0.031
13	0.390	-0.048
14	0.421	-0.038
15	0.424	-0.061

While seller 1 players who charged the monopoly price engaged in this behavior very early in the game (between rounds 1 and 2) keeping it throughout the session (there was only one exception to this), the remaining seller 1 players never seemed to learn how to engage in monopoly pricing (and to keep a potential one-product competitor out of the market). Each of those who played the monopoly price was able to get an average profit per round of *$0.44* against *$0.362* of those who did not charge the equilibrium price. The subjects playing seller 2 took advantage of the opportunity to earn positive profits most of the time (by entering one of the two possible markets). However, half of these seller 2 players never seemed to learn how to avoid non-positive profits by staying out of the market when their opponent playing seller 1 charged prices between *$0* and *$1.2* for the two-good bundle – (A, B). Each of those seller 2 players who stayed out of the market to prevent non-positive profits was able to get an average loss per round of *$0.001* against *$0.091* of those who did not play that way.

Although some of the subjects playing seller 1 did not play the equilibrium strategy for this game, when entry costs are 'high' engaging in monopoly pricing was frequently observed for an incumbent selling a two-good bundle – (A, B), which also frequently prevented a potential one-product competitor (selling a perfect substitute to either good A or B) from entering the market.

9.4 Pure Bundling Treatment –'Low' Entry Costs Session

According to theory predictions, the equilibrium for bundled sales of goods A and B with entry costs of *$0.07* should be: (1) subjects playing seller 1 engaging in limit pricing to deter entry and charging the entry-barring price of *$0.6* for the two-good bundle – (A, B); and (2) subjects playing seller 2 not entering either of those two markets.

Table 9.28–Variables and explanations

Variable	Explanation
Y4	Seller 1 chooses a price of *$0.6* for the two-good bundle – (A, B) in a given round = 1; Otherwise = 0
S2	Seller 2 chooses not to enter the A and B markets in a given round = 1; Otherwise = 0
eqPlaY	Seller 1 chose a price of *$0.6* for the two-good bundle – (A, B) and seller 2 chose not to enter one of the two markets in the previous round = 1; Otherwise = 0
eqPlayL	Seller 1 chose a price strictly lower than *$0.6* for the two-good bundle – (A, B) and seller 2 chose not to enter the market in the previous round = 1; Otherwise = 0
eqPlayH	Seller 1 chose a price strictly greater than *$0.6* for the two-good bundle – (A, B) in the previous round. In response, seller 2 chose to enter the market at a price of: (1) *$0.3* if seller 1's price for the two-good bundle was lower than or equal to *$1.1*, (2) *$0.4* if seller 1's price for the two-good bundle was greater than or equal to *$1.1* and lower than or equal to *$1.4*, or (3) *$0.5* if seller 1's price for the two-good bundle was strictly greater than *$1.4* = 1; Otherwise = 0
R6_15	Rounds that range from 6 to 15 (i.e., the last 10 rounds, since 15 is the maximum number of rounds that were played in this treatment) = 1; Otherwise = 0
Y4R6_15	= Y4 * R6_15
eqPlaYR6_15	= eqPlaY * R6_15
eqPlayHR6_15	= eqPlayH * R6_15
Age	Subject (playing seller 1 or seller 2)'s age
Major	Economics or business major = 1; Other majors = 0
GPA	GPA choices from the questionnaire
Risk	Risk attitude ("negative" = risk loving; "0" = risk neutral; "positive" = risk averse)

Note: **1)** GPA = 1 means GPA between 3.75 and 4.00, GPA = 2 means GPA between 3.25 and 3.74, GPA =

3 means GPA between 2.75 and 3.24, GPA = 4 means GPA between 2.25 and 2.74, GPA = 5 means GPA between 1.75 and 2.24, GPA = 6 means GPA between 1.25 and 1.74, GPA = 7 means GPA less than 1.25. **2)** Risk attitude reflects a measurement of the threshold certainty equivalent for choosing the risky lottery.

Table 9.29–Descriptive statistics for variables[48]

Variable	Mean	Std. Dev.	N
Y4	0.50	0.50	150
S2	0.33	0.47	150
Y4R6_15	0.33	0.47	150
R6_15	0.67	0.47	150
eqPlaY	0.28	0.45	140
eqPlayH	0.38	0.49	140
eqPlaYR6_15	0.21	0.41	140
eqPlayHR6_15	0.26	0.44	140
Y4*	0.50	0.50	140
S2*	0.34	0.48	140
Y4R6_15*	0.36	0.48	140
R6_15*	0.71	0.45	140

Table 9.30–Descriptive statistics for seller 1 and seller 2 players' demographic variables

	Seller 1		Seller 2		
Variable	Mean	Std. Dev.	Mean	Std. Dev.	N
Age	23.90	6.37	22.70	4.62	10
GPA	2.80	1.48	2.10	0.74	10
Major	0.60	0.52	0.50	0.53	10
Risk	-0.40	0.84	-0.20	0.79	10

- Seller 1 Players:

Overall, subjects playing seller 1 charged an average price of *$0.692* for the two-good bundle – (A, B) (with a standard deviation of 0.162). Table 9.31 summarizes means,

[48] First round observations were dropped for Y4*, S2*, Y4R6_15*, and R6_15* independent variables.

medians, standard deviations, and test results[49] of price offers for the two-good bundle in each round.

Table 9.31–Mean, median, standard deviation, and p-value of price offers for the two-good bundle per round

Round	Mean	Median	SD	P-value
1	0.75	0.65	0.190	0.034
2	0.72	0.7	0.148	0.030
3	0.71	0.7	0.110	0.012
4	0.66	0.6	0.108	0.111
5	0.64	0.6	0.052	0.037
6	0.63	0.6	0.048	0.081
7	0.69	0.65	0.110	0.029
8	0.65	0.65	0.053	0.015
9	0.7	0.7	0.189	0.128
10	0.72	0.65	0.290	0.223
11	0.75	0.65	0.276	0.120
12	0.76	0.7	0.272	0.095
13	0.65	0.6	0.071	0.052
14	0.67	0.6	0.125	0.111
15	0.68	0.6	0.132	0.087

It was observed that the average price charged for the two-good bundle – (A, B) by subjects playing seller 1 approached the predicted value in the first half of the game between rounds 4 and 8, and at its end from round 13 on; the two-good bundle average price ranged from *$0.63* to *$0.69* and the median price matched the predicted equilibrium price value except for rounds 7 and 8. Figure 9.13 presents seller 1 player's average price choice and corresponding theoretical prediction in each round.

[49] Hypothesis:

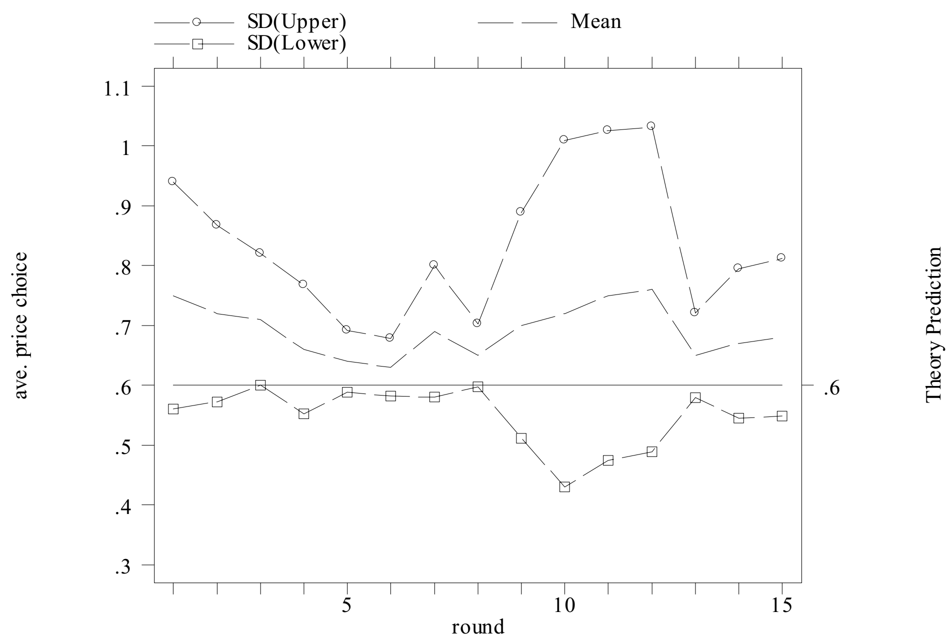
H_0: Mean of price offers in a given round = 0.6

H_a: Mean of price offers in a given round ≠ 0.6

P-values from the test indicate that the mean of price offers is equal to the theoretically predicted equilibrium price of *$0.6* for the two-good bundle – (A, B) but for the first three rounds, rounds 5, 7, and 8 at the 5% level of significance.

Figure 9.13 Average seller 1 player's price choice for the two-good bundle

Note: SD(Upper) and SD(Lower) are one standard deviation from the mean in each round



- Seller 1 Players' Equilibrium:

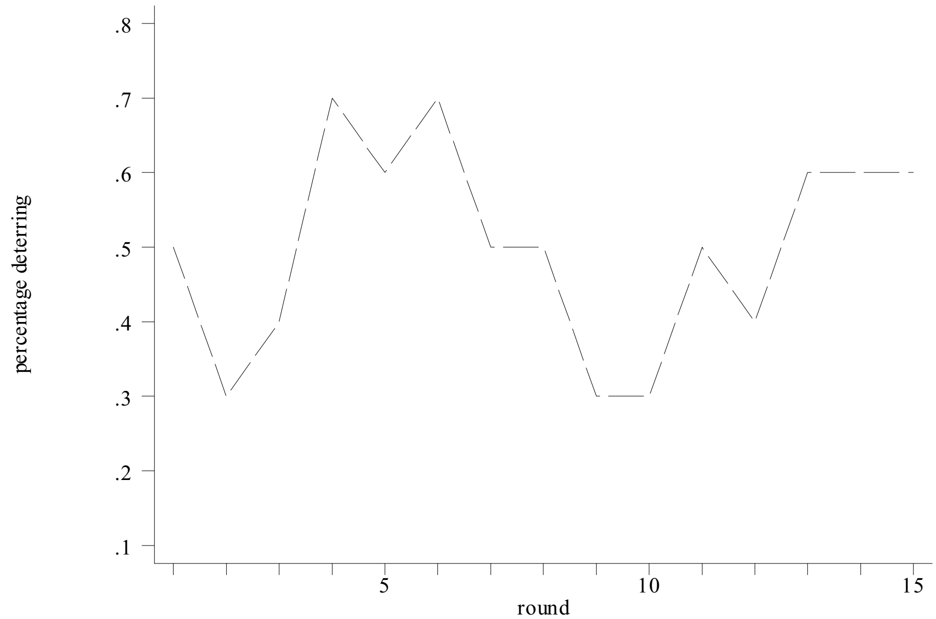
Out of the 150 possible pricing decisions (150 = 10 subjects playing seller 1 * 15 rounds), in 75 cases (50%) subjects playing seller 1 chose to price the two-good bundle – (A, B) at exactly *$0.6*, the value predicted by the theory. Table 9.32 shows, for each round, the number of times such equilibrium pricing decision was reached and corresponding percentage.

Table 9.32–Number of seller 1 players deterring entry and corresponding percentage in each round

Round	Equilibrium Pricing Decisions by Seller 1, i.e., $p_t^{d*} \approx \$0.6$	Percentage of Equilibrium Pricing Decisions by Seller 1
1	5	50%
2	3	30%
3	4	40%
4	7	70%
5	6	60%
6	7	70%
7	5	50%
8	5	50%
9	3	30%
10	3	30%
11	5	50%
12	4	40%
13	6	60%
14	6	60%
15	6	60%

Between rounds 4 and 8, and in the last 3 rounds, there were 48 entry deterring pricing decisions (out of 80 possible ones; 80 = 10 subjects playing seller 1 * 8 rounds), which means that 60% of the subjects playing seller 1 satisfied the predicted equilibrium. Such pricing decisions to deter entry were observed in higher percentages (of, e.g., 60% and 70%) between rounds 4 and 6, and in the last three rounds. This means that learning might have some impact on seller 1 players engaging in limit pricing (see also Figure 9.14, which presents the percentage of seller 1 players engaging in limit pricing to deter entry in each round).

Figure 9.14 Percentage of seller 1 players deterring



- Econometric Analysis for Seller 1 Players:

Our primary interest is to analyze the tendency for subjects playing seller 1 to engage in limit pricing to deter entry and charge a price of *$0.6* for the two-good bundle – (A, B). Figure 9.14 suggests that the equilibrium for bundled sales of goods A and B with low entry costs is more likely to occur in the later rounds than in the first few ones. Also, one might conjecture that, in a given round, subjects playing seller 1 are influenced by previous player 1 price choices for the two-good bundle and opposing seller 2 players' decisions to enter or stay out of the market.

In order to evaluate the evolution of the tendency of subjects playing seller 1 to play

the predicted equilibrium pricing strategy, binomial probit[50] models were estimated. Acronyms of all variables and their explanations are presented in Table 9.28. Table 9.29 presents means and standard deviations of the variables.

The dependent variable, Y4, is coded one if seller 1 players charge a price of *$0.6* for the two-good bundle – (A, B), and zero otherwise. Independent variables include the R6_15 dummy variable that represents the last 10 rounds to help explain the evolution of choices over time, especially, towards the end of the session; another dummy variable indicating that both seller 1 players and corresponding opponents playing seller 2 engaged in the predicted equilibrium outcome in the previous round (i.e., eqPlaY) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlaYR6_15); and a dummy variable reflecting seller 1 players' previous-round deviations that involved higher than equilibrium price choices and corresponding opposing seller 2 players' optimal responses (i.e., eqPlayH[51]) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlayHR6_15[52]). Four demographic variables (see Table 9.33) are used for the purpose of controlling for variations in seller 1 players' behavior that might possibly occur. (Refer to Table 9.28 for detailed definitions of all explanatory variables.)

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[50] Since the dataset has repeated observations on both subjects playing seller 1 and seller 2, all binomial probit estimations assume independence of observations across subjects but not necessarily independence across observations belonging to the same subject.

[51] Due to the small sample size of 10 subjects (either playing seller 1 or seller 2), the number of times seller 1 players chose prices described by eqPlayL (see Table 9.28 for the definition) was less then five. Therefore, this explanatory variable was not included in the models.

[52] eqPlayH and eqPlayHR6_15 ended up being dropped since these explanatory variables turned out to be consistently insignificant.

Table 9.33–Probit estimates of probability of seller 1 players adopting limit pricing entry-deterrent strategy

Variable				
Age				0.058*
				(0.028)
				[0.023]
Major				0.832†
				(0.446)
				[0.323]
GPA				0.355*
				(0.127)
				[0.141]
Risk				0.400
				(0.291)
				[0.159]
eqPlayHR6_15			-0.270	
			(0.555)	
			[-0.107]	
eqPlaYR6_15		0.757*	0.624	0.584
		(0.321)	(0.390)	(0.438)
		[0.285]	[0.239]	[0.222]
eqPlayH			-0.235	
			(0.561)	
			[-0.094]	
eqPlaY		0.968†	0.848	0.939†
		(0.502)	(0.550)	(0.529)
		[0.359]	[0.320]	[0.347]
R6_15	-2.8e-17	-0.240	-0.107	-0.167
	(0.211)	(0.191)	(0.381)	(0.209)
		[-0.095]	[-0.043]	[-0.066]
Constant	0	-0.204	-0.084	-2.902*
	(0.282)	(0.287)	(0.383)	(0.958)
χ^2-Test (p-value)		0.001	0.000	0.000

Note: N = 150 for the first model. N = 140 for the last three models. Y4 is the dependent variable. Numbers in parentheses are robust standard errors. Numbers in brackets are the marginal effects on the probability of seller 1 players engaging in limit pricing at $p_t^{d*} = \$0.6$. (Marginal effects are calculated at the means of the independent variables; and for dummy variables (e.g., eqPlaY) they are calculated for the discrete change as the dummy changes from zero to one.) * P-value < 0.05. † P-value < 0.10. χ^2-Test compares the last three models to the first one but with N reduced to 140.

Looking at Table 9.33 one can see that the coefficient on the variable representing both seller 1 players and corresponding opponents playing seller 2 engaging in their predicted equilibrium outcome in the previous round (i.e., eqPlaY) is positive and statistically significant at the 10% level in two of the four models. For the fourth model this suggests that when both seller 1 and seller 2 players engage in their equilibrium strategies in the previous round, subjects playing seller 1 are more likely to engage in the same kind of play in a given round. During this session subjects playing seller 1 chose the predicted equilibrium pricing strategy 75 times.

In summary, findings suggest that throughout the game there is an increasing tendency for subjects playing seller 1 to engage in limit pricing or play "aggressively" (i.e., lowering the price of the two-good bundle – (A, B) in order to keep a potential one-product competitor out of the market, which offers the largest payoff compared to other price choices). That is, with low entry costs of *$0.07*, seller 1 players are more likely to deter entry and charge a price of *$0.6* for the two-good bundle in a given round, if they played the same strategy and their opposing seller 2 players stayed out of the market in the previous round. (It should also be noted that the payoffs for deterring entry at *$0.6* are only large if opposing subjects playing seller 2 do not enter any of the two markets undercutting seller 1 players' price.)

- Seller 1 Players' Demographics and Risk Attitudes

The demographic composition of the subjects playing seller 1 will be discussed next since some behavioral variations in this game might be correlated with demographics. Table 9.30 has the descriptive statistics on the demographic characteristics of subjects playing seller 1. (See Appendix B for the questionnaire answered by the subjects.)

Results from an estimation which includes demographic variables are reported in the fourth column of Table 9.33. In that estimation three demographic variables have positive and statistically significant coefficients, the first two at the 5% level and last one at the 10% level. They are age, GPA, and major, respectively. This suggests that older subjects playing seller 1 (compared to younger) are more likely to play the equilibrium strategy; high GPA seller 1 players (compared to low) are more likely to engage in the predicted equilibrium strategy; and business or economic major subjects playing seller 1 (compared to other majors) are also more likely to play the equilibrium strategy. The latter may come as no surprise since subjects who are studying business or taking economics courses have been trained to better understand price competition.

- Seller 2 Players:

There were 100 decisions by seller 2 players to enter the market (out of 150 possible ones; 150 = 10 subjects playing seller 2 * 15 rounds) at an average price of *$0.241* for either good A or B (with a standard deviation of 0.108). That is, 66.67% of the seller 2 players decided to enter one of the two markets.

o Seller 2 Players' Equilibrium:

Results show that 41.33% (i.e., average equals 0.413 with a standard deviation of 0.496) of seller 2 players chose to enter the market when subjects playing seller 1 were attempting to deter entry (i.e., playing the predicted equilibrium value $p_t^{d*} \approx \$0.6$). Figure 9.15 shows seller 2 players' average price choices for either good A or B, conditional on entry occurring when subjects playing seller 1 charged the entry-barring price for the two-good bundle – (A, B) in each round.

Figure 9.15 Seller 2 player's average price choice: Conditional on entry occurring and on seller 1 player charging the equilibrium entry-barring price for the two-good bundle

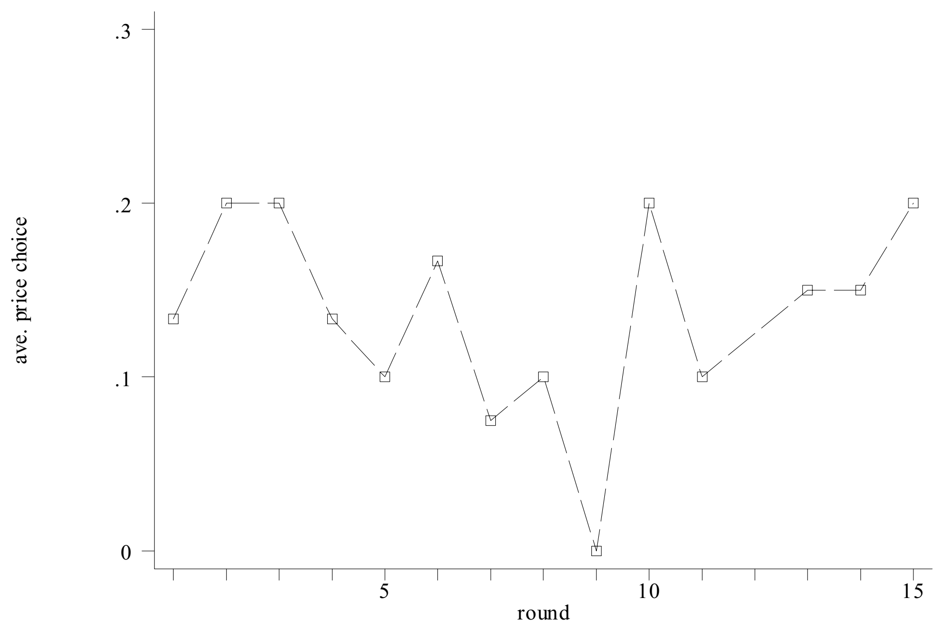
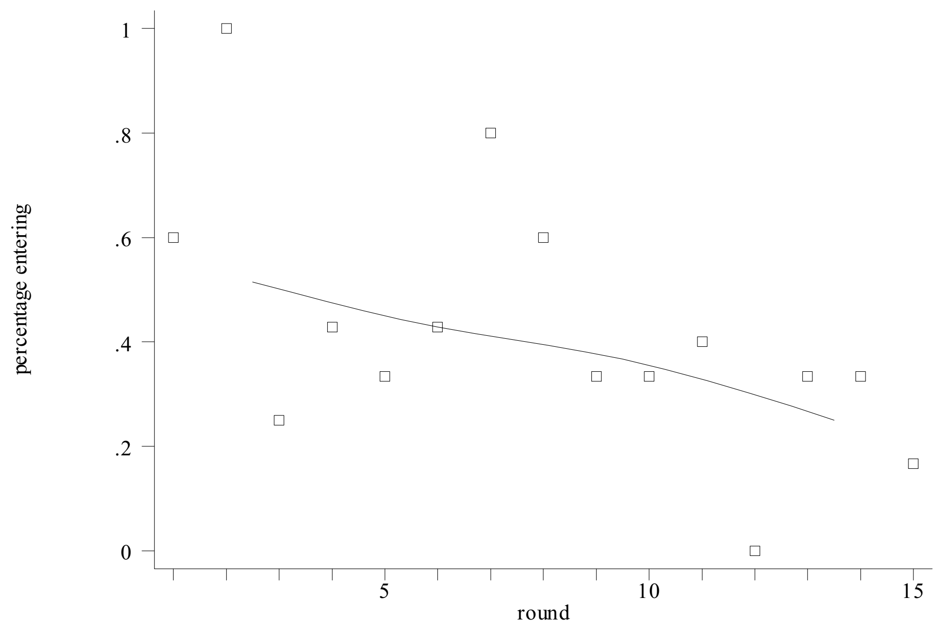


Figure 9.16[53] shows the percentage of seller 2 players entering one of the two markets when subjects playing seller 1 engaged in limit pricing charging the entry-barring price of *$0.6* for the two-good bundle – (A, B) in each round.

[53] A cubic spline fit line is provided.

Figure 9.16 Percentage of seller 2 players entering: Conditional on seller 1 players charging *$0.6* for the two-good bundle



Throughout the 15 rounds there is a decreasing tendency for seller 2 players to enter the market, as subjects playing seller 1 charge the entry-barring price for the two-good bundle – (A, B) on their attempt to deter entry. In the remaining 44 cases (58.67%), seller 2 players satisfied the equilibrium prediction of staying out of the market when the corresponding opponent playing seller 1 charged the equilibrium price.

It was observed that throughout this session there were four (out of 10) seller 2 players who seemed never to learn how to play the game since each of those players has entered the market at least 50% of the time (and at most 100%) when subjects playing seller 1 were trying to deter entry (i.e., charging seller 1's equilibrium price).

- Econometric Analysis for Seller 2 Players:

For subjects playing seller 2, our primary concern is to analyze the likelihood of not entering one of the two markets. Figure 9.16 suggests that conditional on seller 1 players charging *$0.6* for the two-good bundle – (A, B), entry (for bundled sales of goods A and B with low entry costs) by subjects playing seller 2 is less likely to occur in the later rounds than in the first ones. Also, one might hypothesize that seller 2 players' behavior would be influenced by (1) seller 1 players' choices in a given round, and/or (2) the previous player 1 price choice for the two-good bundle – (A, B) and opposing seller 2 players' decisions to enter or not.

To evaluate the evolution of the tendency of subjects playing seller 2 to stay out of the A and B markets, binomial probit[54] models were estimated. The dependent variable, S2, is coded one if entry does not occur and zero otherwise.[55] Independent variables include the R6_15 dummy variable that represents the last 10 rounds to help explain the evolution of choices over time, especially, towards the end of the session; another dummy variable representing seller 1 players choosing the optimal entry-barring price of *$0.6* for the two-good bundle – (A, B) in a given round (i.e., Y4) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., Y4R6_15); a dummy variable indicating that both subjects playing seller 1 and seller 2 chose their corresponding equilibrium strategies in the previous round (i.e., eqPlaY) plus

[54] Since the dataset has repeated observations on both subjects playing seller 1 and seller 2, all binomial probit estimations assume independence of observations across subjects but not necessarily independence across observations belonging to the same subject.

[55] Acronyms of all variables and their explanations are presented in Table 9.28. Table 9.29 presents means and standard deviations of the variables.

its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlaYR6_15); and another dummy variable reflecting seller 1 players' previous-round deviations that involved higher than equilibrium price choices and corresponding opposing seller 2 players' optimal responses (i.e., eqPlayH[56]) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlayHR6_15[57]). Three[58] demographic variables (see Table 9.34) are used for the purpose of controlling for variations in seller 2 players' behavior that might possibly occur. (Refer to Table 9.28 for detailed definitions of all explanatory variables.)

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[56] Due to the small sample size of 10 subjects (either playing seller 1 or seller 2), the number of times seller 1 players chose prices described by eqPlayL (see Table 9.28 for the definition) was less then five. Therefore, this explanatory variable was not included in the models.

[57] Y4R6_15 and eqPlayHR6_15 ended up being dropped since these explanatory variables turned out to be consistently insignificant.

[58] Due to the small sample size of 10 subjects (either playing seller 1 or seller 2), the models could not be estimated with all four demographic variables; and thus, Major ended up being excluded since it turned out to be consistently insignificant.

Table 9.34–Probit estimates of probability of seller 2 players not entering either market A or B

Variable					
Age					-0.140*
					(0.057)
					[-0.036]
GPA					0.699*
					(0.168)
					[0.180]
Risk					-0.943*
					(0.211)
					[-0.243]
eqPlayHR6_15				0.174	
				(0.865)	
				[0.052]	
eqPlaYR6_15			$0.818^{\dagger}$	1.194	1.476*
			(0.478)	(0.858)	(0.529)
			[0.299]	[0.411]	[0.483]
eqPlayH				2.000*	1.943*
				(0.589)	(0.385)
				[0.614]	[0.560]
eqPlaY			-0.038	1.069*	0.226
			(0.496)	(0.531)	(0.454)
			[-0.013]	[0.354]	[0.061]
Y4R6_15		-0.214	-0.008	-0.367	
		(0.643)	(0.768)	(0.944)	
		[-0.069]	[-0.003]	[-0.102]	
Y4		1.801*	1.767*	2.464*	2.545*
		(0.457)	(0.528)	(0.706)	(0.466)
		[0.549]	[0.546]	[0.649]	[0.618]
R6_15	0.224	0.469	0.006	-0.022	-0.112
	(0.258)	(0.593)	(0.765)	(1.423)	(0.417)
	[0.080]	[0.147]	[0.002]	[-0.006]	[-0.030]
Constant	-0.583*	-1.751*	-1.635*	-3.232*	-1.721
	(0.254)	(0.457)	(0.578)	(0.935)	(1.074)
χ^2-Test (p-value)		0.000	0.000	0.000	0.000

Note: N = 150 for the first two models. N = 140 for the last three models. S2 is the dependent variable. Numbers in parentheses are robust standard errors. Numbers in brackets are the marginal effects on the probability of seller 2 players not entering the A and B markets. (Marginal effects are calculated at the means of the independent variables; and for dummy variables (e.g., Y4) they are calculated for the discrete change as the dummy changes from zero to one.) * P-value < 0.05. † P-value < 0.10. χ^2-Test compares the last four models to the first one, but with N reduced to 140 for the last three models.

Looking at Table 9.34 one can see that the coefficient on the dummy variable indicating that subjects playing seller 1 chose the predicted entry-barring price of *$0.6* for the two-good bundle – (A, B) in a given round (i.e., Y4) is positive and statistically significant at the 5% level in the last four models. For the fifth model this suggests that when seller 1 players engage in their equilibrium pricing strategy, seller 2 players are more likely to opt out of the market in a given round. The eqPlayH and eqPlaYR6_15 explanatory variables also have positive and statistically significant coefficients at the 5% level. For eqPlayH it indicates that when subjects playing seller 1 deviate and choose a higher than equilibrium price for the two-good bundle – (A, B), and corresponding opposing seller 2 players respond with the optimum in the previous round, seller 2 players are more likely to stay out of the market in a given round; and for the interaction term eqPlaYR6_15 it suggests that, in the last 10 rounds, when both seller 1 and seller 2 players engage in their equilibrium strategies in the previous round, seller 2 players are more likely to stay out of the A and B markets in a given round. During this session subjects playing seller 2 chose to play the predicted equilibrium strategy only 50 times.

In summary, findings suggest that throughout the game there is an increasing tendency for seller 2 players to stay out of the market when their opposing sellers 1 players choose the entry-barring price of *$0.6* for the two-good bundle – (A, B). This is indicated by the positive relationship between the choice of subjects playing seller 2 to stay of the market and: (1) seller 1 players' equilibrium pricing strategy in a given round; (2) both subjects playing seller 1 and seller 2 choices of their corresponding equilibrium play in the previous round, in particular, during the last 10 rounds; and (3) seller 1 players' previous-round deviations involving higher than equilibrium price choices and corresponding opposing seller 2 players' optimal responses.

- Seller 2 Players' Demographics and Risk Attitudes

The demographic composition of the subjects playing seller 2 will be discussed next since some behavioral variations in this game might be correlated with demographics. Table 9.30 has the descriptive statistics on the demographic characteristics of subjects playing seller 2. (See Appendix B for the questionnaire answered by the subjects.)

Results from an estimation which includes demographic variables are reported in the fifth column of Table 9.34. In that estimation three demographic variables have statistically significant coefficients at 5% level. They are age, GPA and risk. The coefficients associated with age and risk are negative, which suggests that older subjects playing seller 2 (compared to younger) are less likely to play the equilibrium strategy; and risk-averse seller 2 players are less likely to play the equilibrium strategy. The latter contradicts the intuitive expectation that risk-loving subjects playing seller 2 would be more likely to enter a market than those who are risk-averse. The coefficient associated with GPA is positive, which indicates that high GPA subjects playing seller 2 (compared to low) are more likely to play the equilibrium strategy.

- Successfully Deterring Entry:

In this game pricing the two-good bundle – (A, B) at *$0.6* (i.e., limit pricing) often provided a way for subjects playing seller 1 (i.e., incumbents) to keep seller 2 players (i.e., challengers) from entering the A and B markets; that is, former players were able to get higher profits when deterring as opposed to accommodating entry (by charging $p_t \approx$

\$0.7) and were able to make the latter players earn non-positive profits. Actual behavior usually follows the theoretical prediction for this case.

Among the 10 subjects playing seller 2 there were four who decided to frequently enter the market when seller 1 players engaged in limit pricing (i.e., $p_t^{d*} \approx \$0.6$). Two of those four seller 2 players entered the market 50% and 66.67% of the time charging average prices per round of *\$0* and *\$0.2* (both with standard deviations of 0), which granted them average losses of *\$0.07* and *\$0.006* and their opponents playing seller 1 average profits of *\$0.24* and *\$0.348* per round, respectively. The remaining two subjects playing seller 2 entered the market 100% of the time charging average prices per round of *\$0.175* and *\$0.1* (with standard deviations of 0.046 and 0, respectively), which granted them average losses of *\$0.011* and *\$0.025* and their corresponding seller 1 players average profits of *\$0.335* and *\$0.297* per round, respectively. Under these circumstances, the maximum profit the above noted four seller 2 players were able to get ranged between the losses of *\$0.006* and *\$0.07*.

Table 9.35 presents average profits for subjects playing seller 1 and seller 2 in each round.

Table 9.35–Average profits for seller 1 and seller 2 players per round

Round	Seller 1 Player's Ave. Profit	Seller 2 Player's Ave. Profit
1	0.322	0.009
2	0.363	0.014
3	0.396	0.018
4	0.398	0.005
5	0.412	0.001
6	0.427	-0.001
7	0.344	-0.002
8	0.376	-0.004
9	0.381	0.01
10	0.350	0.018
11	0.352	0.020
12	0.386	0.028
13	0.414	0.005
14	0.428	0.001
15	0.415	0.013

While seller 1 players who priced to deter entry engaged in this behavior very early in the game (between rounds 1 and 4) most of them keeping it throughout the session (there was only one exception to this), the remaining seller 1 players never seemed to learn how to engage in limit pricing (i.e., charging the entry-barring price for the two-good bundle to keep a potential one-product competitor out of the market). Each of those who played the entry-barring price was able to get an average profit per round of *\$0.408* against *\$0.349* of those who did not try to deter entry. The subjects playing seller 2 took advantage of the opportunity to earn positive profits most of the time (by entering one of the two possible markets). However, four out of the 10 seller 2 players seemed never to learn how to avoid non-positive profits by staying out of the market when their opponent playing seller 1 charged prices between *\$0* and *\$0.6* for the two-good bundle – (A, B); each of these seller 2 players was able to get an average profit per round of *\$0.001* against *\$0.015* of those who did not play this way. The former players' opportunities to make positive profits ended up compensating their small losses.

Although some of the subjects playing seller 1 did not play the equilibrium strategy for this game, when entry costs are 'low' engaging in limit pricing was frequently observed for an incumbent selling a two-good bundle – (A, B) to prevent a potential one-product competitor (selling a perfect substitute to either good A or B) from entering the market.

9.5 Independent Pricing or Pure Bundling Treatment – 'High' Entry Costs Session

According to theory predictions, the equilibrium for separate or bundled sales of goods A and B with entry costs of *$0.2* should be: (1) for subjects playing seller 1 to sell the two-good bundle – (A, B) and to charge the monopoly price of *$0.8* for it (which also works as an entry-barring price); and (2) for subjects playing seller 2 not to enter any of those two markets.

Table 9.36–Variables and explanations

Variable	Explanation
Y4	Seller 1 chooses to bundle at the price of *$0.8* for the two-good bundle – (A, B) in a given round = 1; Otherwise = 0
S2	Seller 2 chooses not to enter the A and B markets in a given round = 1; Otherwise = 0
eqPlaY	Seller 1 chose to bundle at the price of *$0.8* for the two-good bundle – (A, B) and seller 2 chose not to enter one of the two markets in the previous round = 1; Otherwise = 0
eqPlayH	Seller 1 chose to bundle at a price strictly greater than *$0.8* for the two-good bundle – (A, B) in the previous round. In response, seller 2: (1) chose not to enter the market if seller 1's price for the two-good bundle was strictly lower than *$1.3*, (2) entered the market, either choosing a price of *$0.4* if seller 1's price for the two-good bundle was greater than or equal to *$1.3* and lower than or equal to *$1.4*, or choosing a price of *$0.5* if seller 1's price for the two-good bundle was strictly greater than *$1.4* = 1; Otherwise = 0
eqPlayL	Seller 1 chose to bundle at a price strictly lower than *$0.8* for the two-good bundle – (A, B) and seller 2 chose not to enter the market in the previous round = 1; Otherwise = 0
plaInd	Seller 1 chose to sell both goods A and B separately at the same price of *$0.5* and seller 2 entered the market choosing a price of *$0.4* for the corresponding good (i.e., undercutting seller 1 players' price by 0.1) in the previous round = 1; Otherwise = 0
R6_15	Rounds that range from 6 to 15 (i.e., the last 10 rounds, since 15 is the maximum number of rounds that were played in this treatment) = 1; Otherwise = 0
eqPlaYR6_15	= eqPlaY * R6_15
Age	Subject (playing seller 1 or seller 2)'s age
Major	Economics or business major = 1; Other majors = 0
GPA	GPA choices from the questionnaire
Risk	Risk attitude ("negative" = risk loving; "0" = risk neutral; "positive" = risk averse)

Note: **1)** GPA = 1 means GPA between 3.75 and 4.00, GPA = 2 means GPA between 3.25 and 3.74, GPA = 3 means GPA between 2.75 and 3.24, GPA = 4 means GPA between 2.25 and 2.74, GPA = 5 means GPA between 1.75 and 2.24, GPA = 6 means GPA between 1.25 and 1.74, GPA = 7 means GPA less than 1.25. **2)** Risk attitude reflects a measurement of the threshold certainty equivalent for choosing the risky lottery.

Table 9.37–Descriptive statistics for variables[59]

Variable	Mean	Std. Dev.	N
Y4	0.70	0.46	150
S2	0.85	0.35	150
R6_15	0.67	0.42	150
eqPlaY	0.68	0.47	140
eqPlayL	0.12	0.33	140
plaInd	0.09	0.28	140
eqPlaYR6_15	0.53	0.50	140
Y4*	0.72	0.45	140
S2*	0.86	0.34	140
R6_15*	0.71	0.45	140

[59] First round observations were dropped for Y4*, S2*, and R6_16* independent variables.

Table 9.38–Descriptive statistics for seller 1 and seller 2 players' demographic variables

	Seller 1		Seller 2		
Variable	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**N**
Age	24.10	3.73	21.20	2.62	10
GPA	2.60	0.97	2.40	1.17	10
Major	0.50	0.53	0.50	0.53	10
Risk	-0.50	0.53	-0.30	1.16	10

- Seller 1 Players:

There were 132 cases (88%, i.e., average equals 0.88 with a standard deviation of 0.326) where a subject playing seller 1 chose to sell the two-good bundle – (A, B) (out of 150 possible ones; 150 = 10 subjects playing seller 1 * 15 rounds); in such cases, subjects playing seller 1 charged an average price of *$0.799* for the two-good bundle (with a standard deviation of 0.070). In the remaining 18 cases (12%) where a subject playing seller 1 chose to sell goods A and B separately, different prices were charged three times (in the first three rounds) – a price of *$0.5* for good A and an average price of *$0.533* (with a standard deviation of 0.208) for good B, and the same price of *$0.5* (i.e., monopoly price) was charged for both goods A and B 15 times (from round 4 on).

Table 9.39 summarizes the number and percentage of seller 1 players selling the two-good bundle – (A, B) plus corresponding means, medians, standard deviations, and test results[60] of price offers for it, in each round.

[60] Hypothesis:

$\mathbf{H_0}$: Mean of price offers for the two-good bundle in a given round = 0.8

$\mathbf{H_a}$: Mean of price offers for the two-good bundle in a given round ≠ 0.8

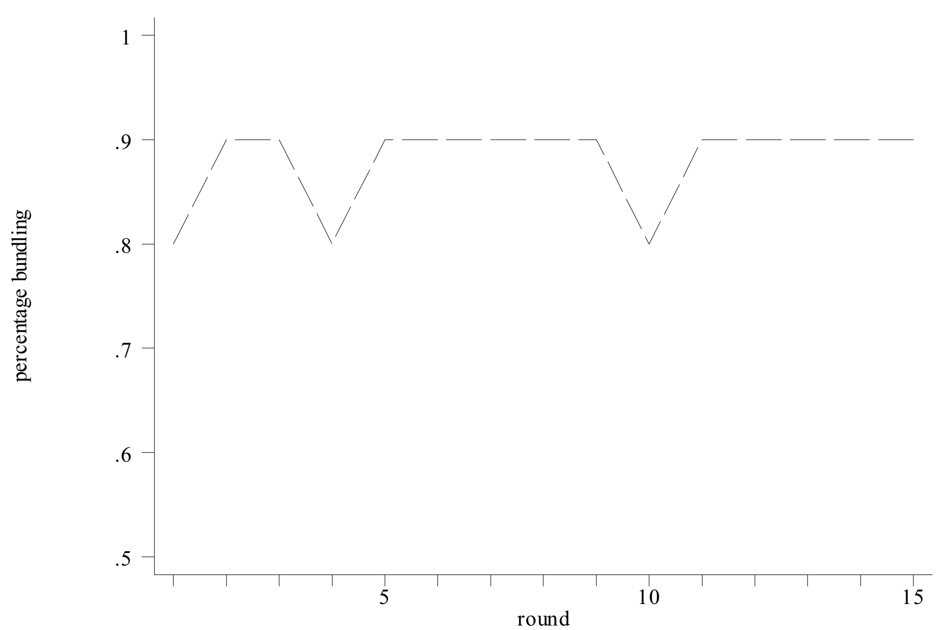
P-values from the test indicate that the mean of price offers is equal to the theoretically predicted equilibrium price of *$0.8* for the two-good bundle – (A, B) in every round at the 5% level of significance.

Table 9.39–Number and percentage seller 1 players bundling, and corresponding mean, median, standard deviation, and p-value of price offers for the two-good bundle per round

Round	# of Seller 1 Players Bundling	Percentage of Seller 1 Players Bundling	Price Mean	Price Median	Price SD	P-value
1	8	80%	0.838	0.8	0.160	0.528
2	9	90%	0.8	0.8	0.05	1.000
3	9	90%	0.789	0.8	0.06	0.594
4	8	80%	0.775	0.8	0.046	0.170
5	9	90%	0.822	0.8	0.109	0.559
6	9	90%	0.8	0.8	0.05	1.000
7	9	90%	0.8	0.8	0.05	1.000
8	9	90%	0.789	0.8	0.033	0.347
9	9	90%	0.789	0.8	0.033	0.347
10	8	80%	0.838	0.8	0.151	0.504
11	9	90%	0.8	0.8	0.05	1.000
12	9	90%	0.789	0.8	0.033	0.347
13	9	90%	0.789	0.8	0.033	0.347
14	9	90%	0.789	0.8	0.033	0.347
15	9	90%	0.789	0.8	0.033	0.347

It was observed that except for rounds 1, 4, and 10, 90% (9 out of 10) of the subjects playing seller 1 decided to sell the two-good bundle – (A, B). Figure 9.17 shows the percentage of seller 1 players choosing to bundle per round.

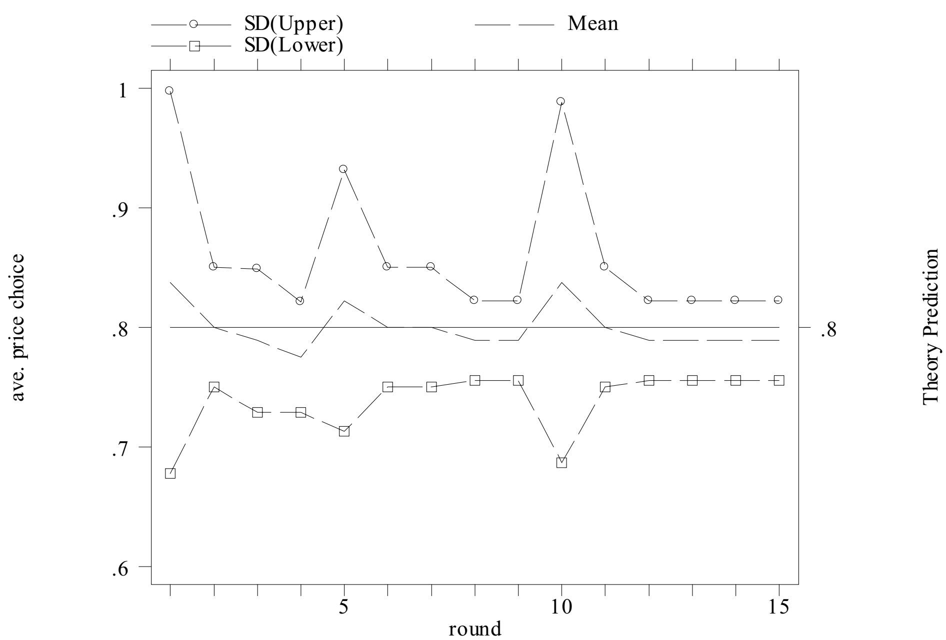
Figure 9.17 Percentage of seller 1 players bundling



Throughout the game (but for rounds 1 and 10) the average price seller 1 players charged for the two-good bundle closely evolved around the predicted value, with the median matching the predicted equilibrium price. Figure 9.18 presents seller 1 player's average price choice and corresponding theoretical prediction, in each round.

Figure 9.18 Average seller 1 player's price choice for the two-good bundle

Note: SD(Upper) and SD(Lower) are one standard deviation from the mean in each round



o Seller 1 Players' Equilibrium:

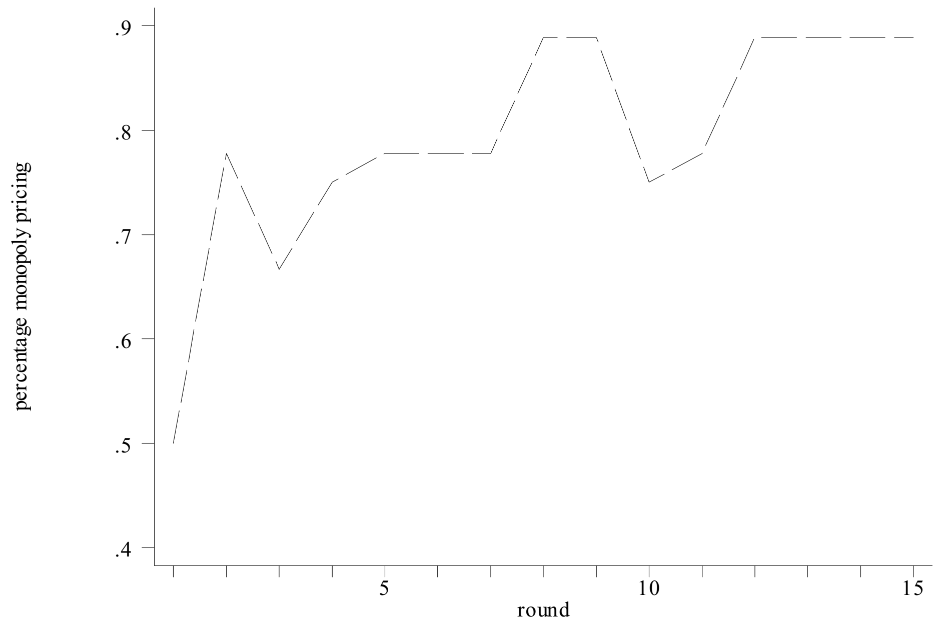
Out of the 132 observed bundling decisions by subjects playing seller 1, in 105 cases (79.55%) such players chose to price the two-good bundle – (A, B) at exactly *$0.8*, the value predicted by the theory. Table 9.40 presents the number of times such equilibrium pricing decision was reached and corresponding percentage of subjects playing seller 1 selling the two-good bundle in each round.

Table 9.40–Number of seller 1 players charging monopoly price and corresponding percentage in each round: Conditional on seller 1 players bundling

Round	Equilibrium Pricing Decisions by Seller 1 Players Bundling, i.e., $p_t^* \approx \$0.8$	Percentage of Equilibrium Pricing Decisions by Seller 1 Players Bundling
1	4 (out of 8)	50.00%
2	7 (out of 9)	77.78%
3	6 (out of 9)	66.67%
4	6 (out of 8)	75.00%
5	7 (out of 9)	77.78%
6	7 (out of 9)	77.78%
7	7 (out of 9)	77.78%
8	8 (out of 9)	88.89%
9	8 (out of 9)	88.89%
10	6 (out of 8)	75.00%
11	7 (out of 9)	77.78%
12	8 (out of 9)	88.89%
13	8 (out of 9)	88.89%
14	8 (out of 9)	88.89%
15	8 (out of 9)	88.89%

Throughout the game (but for rounds 1 and 3), there were 95 monopoly pricing decisions (out of 115 bundling ones; 115 = 132 observed bundling decisions by seller 1 players, minus eight observed bundling decisions by seller 1 players in round 1, minus nine observed bundling decisions by seller 1 players in round 3), which means that 82.61% of the subjects playing seller 1 satisfied the predicted equilibrium. Such pricing decisions were observed in higher percentages (of, e.g., almost 89%) in rounds 8, 9, and from round 12 on. This means that learning might have some impact on seller 1 players engaging in monopoly pricing (see also Figure 9.19 that presents the percentage of seller 1 players charging the two-good bundle – (A, B) at monopoly price in each round, conditional on seller 1 players bundling).

Figure 9.19 Percentage of seller 1 players charging monopoly price: Conditional on seller 1 players bundling



- Econometric Analysis for Seller 1 Players:

Our primary interest is to analyze the tendency for subjects playing seller 1 to choose to sell the two-good bundle – (A, B) at the monopoly price of *$0.8*. Figure 9.19 suggests that the equilibrium for separate or bundled sales of goods A and B with high entry costs is more likely to occur in the later rounds than in the first few ones. Also, one might conjecture that, in a given round, subjects playing seller 1 are influenced by previous player 1 bundle and price choice decisions, and opposing seller 2 players' decisions to enter or stay out of the A and B markets.

In order to evaluate the evolution of the tendency of subjects playing seller 1 to play

the predicted equilibrium strategy, binomial probit[61] models were estimated. Acronyms of all variables and their explanations are presented in Table 9.36. Table 9.37 presents means and standard deviations of the variables.

The dependent variable, Y4, is coded one if seller 1 players choose to bundle and to charge the predicted monopoly price of *$0.8* for the two-good bundle – (A, B), and zero otherwise. Independent variables include the R6_15 dummy variable that represents the last 10 rounds to help explain the evolution of choices over time, especially, towards the end of the session; another dummy variable indicating that both seller 1 players and corresponding opponents playing seller 2 engaged in their predicted equilibrium outcome in the previous round (i.e., eqPlaY) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlaYR6_15); a dummy variable representing seller 1 players' previous-round deviations that involved bundling and lower than equilibrium price choices, and corresponding opposing seller 2 players' optimal responses (i.e., eqPlayL[62]); and another dummy variable reflecting seller 1 players' previous-round deviations that involved the choice of separate sales at the same price of *$0.5* for goods A and B, and corresponding opposing seller 2 players' optimal responses

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[61] Since the dataset has repeated observations on both subjects playing seller 1 and seller 2, all binomial probit estimations assume independence of observations across subjects but not necessarily independence across observations belonging to the same subject.

[62] Due to the small sample size of 10 subjects (either playing seller 1 or seller 2), the interaction terms eqPlayLR6_15 and plaIndR6_15 could not be included in the models since when such strategies were played in the previous round, off-equilibrium strategies are mostly played by seller 1 players in a given round. Thus, these variables predict the dependent variable (i.e., Y4) off-equilibrium outcome for subjects playing seller 1. Also, the number of times seller 1 players made decisions described by eqPlayH (see Table 9.36 for the definition) was less than ten; therefore, this explanatory variable was not included in the models.

(i.e., plaInd[63]). Three[64] demographic variables (see Table 9.41) are used for the purpose of controlling for variations in seller 1 players' behavior that might possibly occur. (Refer to Table 9.36 for detailed definitions of all explanatory variables.)

Table 9.41–Probit estimates of probability of seller 1 players adopting bundled sales and corresponding monopoly pricing entry-deterrent strategy

Variable					
Age					0.365*
					(0.149)
					[0.045]
Major					-0.807
					(0.809)
					[-0.103]
GPA					0.938†
					(0.511)
					[0.116]
eqPlaYR6_15		2.183*	2.237*	2.231*	2.631*
		(0.656)	(0.657)	(0.678)	(0.750)
		[0.567]	[0.584]	[0.583]	[0.441]
plaInd				-0.033	1.071†
				(0.621)	(0.580)
				[-0.009]	[0.069]
eqPlayL			-0.585	-0.597	
			(0.777)	(0.819)	
			[-0.183]	[-0.187]	
eqPlaY		0.942	0.729	0.720	0.345
		(0.630)	(0.693)	(0.690)	(0.530)
		[0.279]	[0.213]	[0.211]	[0.047]
R6_15	0.421*	-1.132*	-1.187*	-1.181*	-1.127*
	(0.177)	(0.419)	(0.411)	(0.462)	(0.511)
	[0.150]	[-0.234]	[-0.246]	[-0.245]	[-0.103]
Constant	0.253	-0.066	0.147	0.156	-10.208*
	(0.299)	(0.446)	(0.535)	(0.499)	(3.899)
χ^2-Test (p-value)		0.000	0.000	0.000	0.000

Note: N = 150 for the first model. N = 140 for the last four models. Y4 is the dependent variable. Numbers in parentheses are robust standard errors. Numbers in brackets are the marginal effects on the probability of seller 1 players bundling and engaging in monopoly price at $p_t^* = \$0.8$. (Marginal effects are calculated at the means of the independent variables; and for dummy variables (e.g., eqPlaY) they are calculated for the

[63] eqPlayL ended up being dropped since this explanatory variable turned out to be consistently insignificant.

[64] Due to the small sample size of 10 subjects (either playing seller 1 or seller 2), the models could not be estimated with all four demographic variables; and thus, Risk ended up being excluded since it turned out to be consistently insignificant.

discrete change as the dummy changes from zero to one.) * P-value < 0.05. † P-value < 0.10. χ^2-Test compares the last four models to the first one but with N reduced to 140.

Looking at Table 9.41 one can see that the variable representing the last 10 rounds of this treatment (i.e., R6_15), and the interaction term indicating that, during the last 10 rounds, both seller 1 players and corresponding opponents playing seller 2 engaged in the predicted equilibrium outcome in the previous round (i.e., eqPlaYR6_15) have statistically significant coefficients at the 5% level for all models they are part of. The coefficient associated with R6_15 is negative (but for the first model) and the one associated with eqPlaYR6_15 is positive. For the fifth model this suggests that, during the last 10 rounds seller 1 players' behavior adjusts in ways that are not captured by both types of players' previous actions and player 1 demographics. In particular, there is a diminishing tendency in the later rounds for subjects playing seller 1 to choose their predicted equilibrium outcome. But this tendency ends up being compensated for by eqPlaYR6_15, meaning that from round 6 on when both seller 1 and seller 2 players engage in their equilibrium strategies in the previous round, subjects playing seller 1 are more likely to choose bundled sales and the monopoly price for the two-good bundle – (A, B) in a given round. The explanatory variable plaInd also has a positive and statistically significant coefficient but at the 10% level. This indicates that when seller 1 players deviate choosing separate sales at the same monopoly price of *$0.5* for goods A and B, and corresponding opposing seller 2 players respond with the optimum in the previous round, subjects playing seller 1 are more likely to bundle at the monopoly entry-barring price of *$0.8* in a given round. During this session subjects playing seller 1 chose the predicted equilibrium strategy 105 times.

In summary, findings suggest that throughout the game (and especially, during the last 10 rounds) there is an increasing tendency for subjects playing seller 1 to choose bundled sales (over separate sales) and the monopoly price of *$0.8* (which also works as an entry-barring price when bundling) for the two-good bundle – (A, B) (such strategy offers the largest payoff compared to other strategies). That is, with high entry costs of *$0.2*, seller 1 players are more likely to deter entry selling the two-good bundle at the monopoly price in a given round, if they have: (1) previously played the same strategy and their opposing seller 2 players stayed out of the market in the previous round; and (2) previously chosen separate sales at the same monopoly price for goods A and B, and their opposing seller 2 players gave an optimal response. (It should also be noted that the payoffs for bundled sales at monopoly price are only the largest, when compared to other strategies, if opposing subjects playing seller 2 do not enter any of the two markets undercutting seller 1 players' price.)

- Seller 1 Players' Demographics and Risk Attitudes

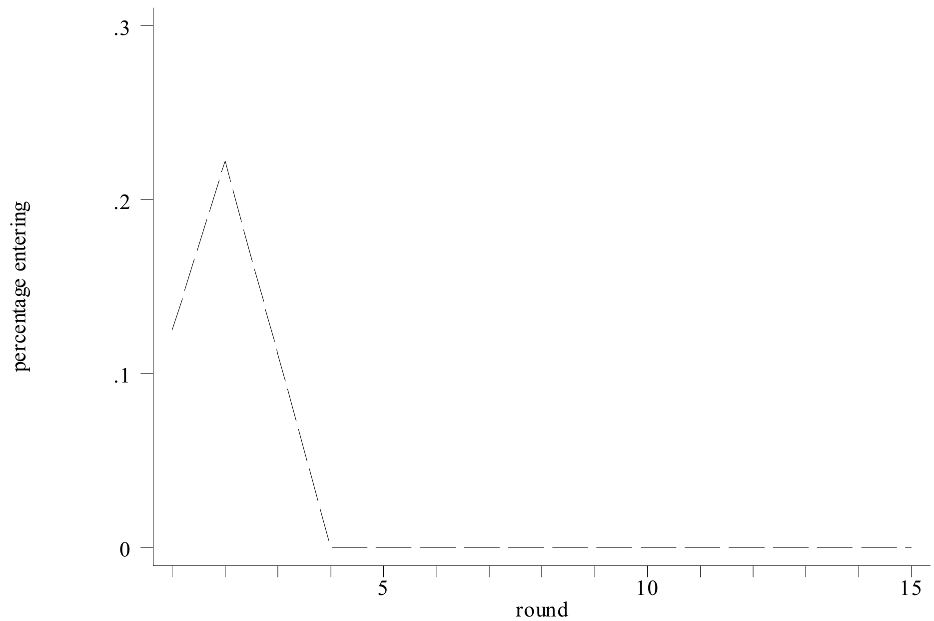
The demographic composition of the subjects playing seller 1 will be discussed next since some behavioral variations in this game might be correlated with demographics. Table 9.38 has the descriptive statistics on the demographic characteristics of subjects playing seller 1. (See Appendix B for the questionnaire answered by the subjects.)

Results from an estimation which includes demographic variables are reported in the fifth column of Table 9.41. In that estimation two demographic variables have positive and statistically significant coefficients at the 5% and the 10% levels. They are age and GPA, respectively. This suggests that older seller 1 players (compared to younger) are more likely to play the equilibrium strategy; and it also indicates that high GPA seller 1 players (compared to low) are more likely to engage in the predicted equilibrium strategy, respectively.

- Seller 2 Players:

Conditional on subjects playing seller 1 bundling, there were four decisions by seller 2 players to enter the market (out of 132 observed bundling ones by seller 1 players) at an average price of *$0.325* for either good A or B (with a standard deviation of 0.05). That is, 3.03% of the seller 2 players decided to enter one of the two markets when subjects playing seller 1 were selling the two-good bundle – (A, B). Out of those four entering decisions by seller 2 players, one was at a price of *$0.4* (in round 1) and the remaining three at *$0.3* (two in round 2 and one in round 3) for either good A or B. Figure 9.20 shows the percentage of seller 2 players entering one of the two markets when subjects playing seller 1 chose to sell the two-good bundle in each round.

Figure 9.20 Percentage of seller 2 players entering: Conditional on seller 1 players bundling

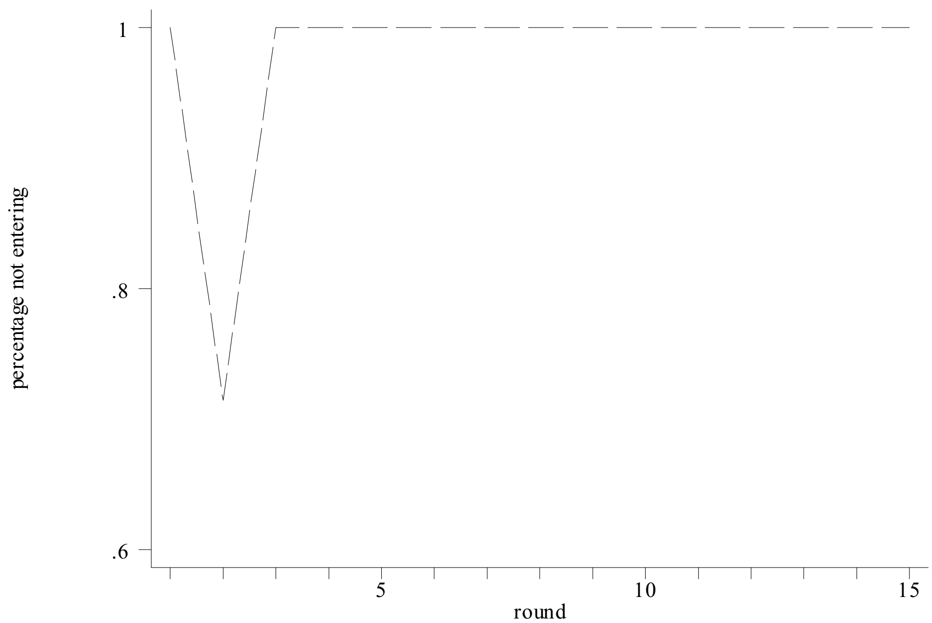


Throughout the 15 rounds (but for the first three) it looks like seller 2 players decided not to enter the market at all as subjects playing seller 1 sold the two-good bundle in their attempt to maximize profits.

- Seller 2 Players' Equilibrium:

Surprisingly, when compared to the 'pure bundling' treatment with 'high' entry costs session, results show that only in two cases (1.9%, i.e., average equals 0.019 with a standard deviation of 0.137) seller 2 players chose to enter the market with subjects playing seller 1 bundling and charging the two-good bundle – (A, B) at monopoly price (i.e., playing the predicted equilibrium value $p_t^* \approx \$0.8$ when bundling). In the remaining cases, seller 2 players satisfied the equilibrium prediction of staying out of the market when the corresponding opponent playing seller 1 was bundling at the monopoly price. Figure 9.21 shows the percentage of seller 2 players not entering the A and B markets when subjects playing seller 1 charged *$0.8* for the two-good bundle in each round.

Figure 9.21 Percentage of seller 2 players not entering: Conditional on seller 1 players bundling and charging *$0.8* for the two-good bundle



It was observed that there were only two seller 2 players in round 2 (opposed to five subjects playing seller 2 throughout the 15 rounds of the 'pure bundling' treatment with 'high' entry costs session) who entered the market even though subjects playing seller 1 were bundling and charging the corresponding equilibrium price for the two-good bundle.

- Econometric Analysis for Seller 2 Players:

For subjects playing seller 2, our primary concern is to analyze the likelihood of not entering one of the two markets. Figure 9.21 suggests that conditional on seller 1 players bundling and choosing a price of *$0.8* for the two-good bundle – (A, B), entry (for separate or bundled sales of goods A and B with 'high' entry costs) by subjects playing seller 2 is less likely to occur in the later rounds than in the first ones. Also, one might hypothesize that seller 2 players' behavior would be influenced by (1) seller 1 players' choices in a given round, and/or (2) the previous player 1 bundle and price choice decisions, and opposing seller 2 players' decisions to enter or not.

To evaluate the evolution of the tendency of subjects playing seller 2 to stay out of the A and B markets, binomial probit[65] models were estimated. The dependent variable, S2, is coded one if entry does not occur and zero otherwise.[66] Independent variables include the R6_15 dummy variable that represents the last 10 rounds to help explain the evolution of choices over time, especially, towards the end of the session; another dummy variable representing seller 1 players bundling and choosing the optimal monopoly price (which also works as an entry-barring price) of *$0.8* for the two-good bundle – (A, B) in a given round (i.e., Y4[67]); a dummy variable indicating that both seller

[65] Since the dataset has repeated observations on both subjects playing seller 1 and seller 2, all binomial probit estimations assume independence of observations across subjects but not necessarily independence across observations belonging to the same subject.

[66] Acronyms of all variables and their explanations are presented in Table 9.36. Table 9.37 presents means and standard deviations of the variables.

[67] Due to the small sample size of 10 subjects (either playing seller 1 or seller 2), the variable eqPlayL and the interaction terms Y4R6_15, eqPlayLR6_15, and plaIndR6_15 could not be included in the models since when these strategies were played, on-equilibrium strategies are also played by seller 2 players in a given round. Thus, these variables perfectly predict the dependent variable (i.e., S2) on-equilibrium outcome for subjects playing seller 2. Also, the number of times seller 1 players made decisions described by eqPlayH was less than ten; therefore, this explanatory variable was not included in the models. (Refer to Table 9.36 for definitions of these variables.)

1 players and corresponding opponents playing seller 2 engaged in their predicted equilibrium outcome in the previous round (i.e., eqPlaY); and another dummy variable reflecting seller 1 players' previous-round deviations that involved the choice of separate sales at the same price of *$0.5* for goods A and B, and corresponding opposing seller 2 players' optimal responses (i.e., plaInd). Four demographic variables (see Table 9.42) are used for the purpose of controlling for variations in seller 2 players' behavior that might possibly occur. (Refer to Table 9.36 for detailed definitions of all explanatory variables.)

Table 9.42–Probit estimates of probability of seller 2 players not entering either market A or B

Variable					
Age					-0.012
					(0.052)
					[-0.001]
Major					-0.308
					(0.211)
					[-0.031]
GPA					0.034
					(0.110)
					[0.003]
Risk					-0.114
					(0.125)
					[-0.011]
PlaInd				-0.697	-0.699
				(1.118)	(1.131)
				[-0.110]	[-0.109]
eqPlaY			-0.427	-0.704	-0.756
			(0.317)	(0.454)	(0.471)
			[-0.042]	[-0.059]	[-0.062]
Y4		1.931*	1.864*	1.909*	1.894*
		(0.327)	(0.362)	(0.327)	(0.332)
		[0.410]	[0.379]	[0.374]	[0.366]
R6_15	0.454†	0.377	0.556*	0.605*	0.608*
	(0.247)	(0.274)	(0.276)	(0.278)	(0.297)
	[0.110]	[0.051]	[0.074]	[0.076]	[0.075]
Constant	0.772*	-0.069	0.159	0.389	0.712
	(0.187)	(0.282)	(0.387)	(0.513)	(1.194)
χ^2-Test (p-value)		0.000	0.000	0.000	0.000

Note: N = 150 for the first two models. N = 140 for the last three models. S2 is the dependent variable. Numbers in parentheses are robust standard errors. Numbers in brackets are the marginal effects on the probability of seller 2 players not entering the A and B markets. (Marginal effects are calculated at the means of the independent variables; and for dummy variables (e.g., Y4) they are calculated for the discrete change as the dummy changes from zero to one.) * P-value < 0.05. † P-value < 0.10. χ^2-Test compares the last four models to the first one but with N reduced to 140 for the last three models.

Looking at Table 9.42 one can see that the dummy variable indicating that subjects playing seller 1 chose the predicted bundled sales strategy at the monopoly price (which also works as entry-barring price) of *$0.8* for the two-good bundle – (A, B) in a given round (i.e., Y4), and the independent variable reflecting the last 10 rounds of this treatment (i.e., R6_15), have positive and statistically significant coefficients at the 5% level (in the last four and in the last three models, respectively). For the fifth model, Y4 independent variable suggests that when seller 1 players engage in their predicted equilibrium strategy, seller 2 players are more likely to opt out of the market in a given round. R6_15 explanatory variable indicates that subjects playing seller 2 are more likely to stay out of the market in the last 10 rounds than in the first ones, with such behavioral adjustment being made in ways that are not captured by seller 1 players' equilibrium actions in a given round, both types of players' previous decisions, and/or seller 2 players' demographics. During this session subjects playing seller 2 chose to play the predicted equilibrium strategy 128 times.

In summary, findings suggest that throughout the game there is an increasing tendency for seller 2 players to stay out of the market when their opposing sellers 1 players choose to bundle at the entry-barring price of *$0.8* for the two-good bundle. This is indicated by the positive relationship between the choice of subjects playing seller 2 to stay of the market and: (1) seller 1 players' equilibrium strategy in a given round; and (2) the round variable.

- Seller 2 Players’ Demographics and Risk Attitudes

The demographic composition of the subjects playing seller 2 will be discussed next since some behavioral variations in this game might be correlated with demographics. Table 9.38 has the descriptive statistics on the demographic characteristics of subjects playing seller 2. (See Appendix B for the questionnaire answered by the subjects.)

Results from an estimation which includes demographic variables are reported in the fifth column of Table 9.42. In that estimation no demographic variable has a statistically significant coefficient at the 5% and/or 10% levels.

- Successfully Deterring Entry when Bundling:

In this game choosing to sell the two-good bundle – (A, B) and pricing it at *\$0.8* (i.e., monopoly price) provided a way for subjects playing seller 1 (i.e., incumbents) to profitably keep seller 2 players (i.e., challengers) from entering the A and B markets. That is, former players were able to get higher profits when bundling and charging monopoly price for the two-good bundle as opposed to not bundling and accommodating entry also at monopoly price (by charging $p_{1A} = p_{1B} = \$0.5$ for goods A and B when selling these goods separately) and were able to make seller 2 players earn non-positive profits. Actual behavior follows the theoretical prediction for this case.

For all the 15 rounds there were only two times (in round 2) when subjects playing seller 2 decided to enter the market with seller 1 players bundling and engaging in monopoly pricing (i.e., $p_t^* \approx \$0.8$). Both seller 2 players charged a price of *\$0.3* for the good with which they entered the market and got a *$0.095* loss while their opponent playing seller 1 got a profit of *$0.364* in this round.

Entry by seller 2 players (i.e., challengers) occurred at an average price of *$0.44* (with a standard deviation of 0.112) in either market A or B when their opponents playing seller 1 chose to sell goods A and B separately at *$0.5* (i.e., the monopoly or entry accommodation price for separate sales), making the former earn an average profit of *$0.008* and the latter an average profit of *$0.283*, per round.

Out of the 10 subjects playing seller 1, only one chose to sell goods A and B separately charging an equal price of *$0.5* for both goods A and B (i.e., accommodating entry) from round 4 on. Despite choosing to sell goods A and B separately, this seller 1 player seemed never to learn how to engage in limit pricing (i.e., play the equilibrium strategy for independent sales by charging $p_{1A}^* = p_{1B}^* = \$0.3$) in order to prevent seller 2 players from entering one of the two markets and get higher profits (when compared to separate sales entry accommodation). As a consequence, every seller 2 player opposing this particular subject playing seller 1 entered the market at an average price of *$0.433* (with a standard deviation of 0.129), which granted them an average profit of *$0.003* per round.

Conditional on seller 1 players choosing to bundle both goods A and B, Table 9.43 presents average profits for subjects playing seller 1 and seller 2 in each round.

Table 9.43–Average profits for seller 1 and seller 2 players per round: Conditional on seller 1 players bundling

Round	Seller 1 Player's Ave. Profit	Seller 2 Player's Ave. Profit
1	0.492	-0.001
2	0.501	-0.021
3	0.516	-0.008
4	0.540	0
5	0.531	0
6	0.541	0
7	0.541	0
8	0.542	0
9	0.542	0
10	0.522	0
11	0.541	0
12	0.542	0
13	0.542	0
14	0.542	0
15	0.542	0

Nine out of the 10 subjects playing seller 1 chose to sell the two-good bundle – (A, B) – eight of them charged monopoly price for it most of the time (there was only one exception to this) while the other player priced the two-good bundle at *$0.7* in all rounds. These nine players engaged in this behavior very early in the game (between rounds 1 and 2) and kept it throughout the session. The remaining seller 1 player never seemed to learn that bundled sales were more profitable than unbundled ones and was also unable to figure out how to engage in limit pricing when selling goods A and B independently, in order to keep a potential one-product competitor out of the market. Each of those who bundled and played the monopoly price was able to get an average profit per round of *$0.532* against *$0.281* of the one who chose to sell both goods separately and not even engage in limit pricing to deter entry. The subjects playing seller 2 took advantage of the opportunity to earn positive profits most of the time (by entering one of the two possible markets).

Although not every subject playing seller 1 decided to play the equilibrium strategy for this game, when entry costs are 'high' selling the two-good bundle – (A, B) and engaging in monopoly pricing was frequently observed for an incumbent selling two goods (e.g., A and B) as a way to get higher profits (when compared to unbundled sales of the same goods) and to prevent a potential one-product competitor (selling a perfect substitute to either good A or B) from entering the market.

9.6 Independent Pricing or Pure Bundling Treatment – 'Low' Entry Costs Session

According to theory predictions, the equilibrium for separate or bundled sales of goods A and B with entry costs of *\$0.07* should be: (1) subjects playing seller 1 choosing to sell the two-good bundle – (A, B), engaging in limit pricing to deter entry, and charging the entry-barring price of *\$0.6* for it; and (2) subjects playing seller 2 not entering any of those two markets.

Table 9.44–Variables and explanations

Variable	Explanation
Y4	Seller 1 chooses to bundle at the price of *$0.6* for the two-good bundle – (A, B) in a given round = 1; Otherwise = 0
S2	Seller 2 chooses not to enter the A and B markets in a given round = 1; Otherwise = 0
eqPlaY	Seller 1 chose to bundle at the price of *$0.6* for the two-good bundle – (A, B) and seller 2 chose not to enter one of the two markets in the previous round = 1; Otherwise = 0
eqPlayL	Seller 1 chose to bundle at a price strictly lower than *$0.6* for the two-good bundle – (A, B) and seller 2 chose not to enter the market in the previous round = 1; Otherwise = 0
eqPlayH	Seller 1 chose to bundle at a price strictly greater than *$0.6* for the two-good bundle – (A, B) in the previous round. In response, seller 2 chose to enter the market at a price of: (1) *$0.3* if seller 1's price for the two-good bundle was lower than or equal to *$1.1*, (2) *$0.4* if seller 1's price for the two-good bundle was greater than or equal to *$1.1* and lower than or equal to *$1.4*, or (3) *$0.5* if seller 1's price for the two-good bundle was strictly greater than *$1.4* = 1; Otherwise = 0
R6_15	Rounds that range from 6 to 15 (i.e., the last 10 rounds, since 15 is the maximum number of rounds that were played in this treatment) = 1; Otherwise = 0
Y4R6_15	= Y4 * R6_15
eqPlaYR6_15	= eqPlaY * R6_15
eqPlayHR6_15	= eqPlayH * R6_15
Age	Subject (playing seller 1 or seller 2)'s age
Major	Economics or business major = 1; Other majors = 0
GPA	GPA choices from the questionnaire
Risk	Risk attitude ("negative" = risk loving; "0" = risk neutral; "positive" = risk averse)

Note: **1)** GPA = 1 means GPA between 3.75 and 4.00, GPA = 2 means GPA between 3.25 and 3.74, GPA = 3 means GPA between 2.75 and 3.24, GPA = 4 means GPA between 2.25 and 2.74, GPA = 5 means GPA between 1.75 and 2.24, GPA = 6 means GPA between 1.25 and 1.74, GPA = 7 means GPA less than 1.25. **2)** Risk attitude reflects a measurement of the threshold certainty equivalent for choosing the risky lottery.

Table 9.45–Descriptive statistics for variables[68]

Variable	Mean	Std. Dev.	N
Y4	0.51	0.50	150
S2	0.45	0.50	150
Y4R6_15	0.36	0.48	150
R6_15	0.67	0.47	150
eqPlaY	0.32	0.47	140
eqPlayL	0.09	0.29	140
eqPlayH	0.24	0.43	140
eqPlaYR6_15	0.26	0.44	140
eqPlayHR6_15	0.19	0.39	140
Y4*	0.53	0.50	140
S2*	0.48	0.50	140
Y4R6_15*	0.39	0.49	140
R6_15*	0.71	0.45	140

[68] First round observations were dropped for Y4*, S2*, Y4R6_15* and R6_15* independent variables.

Table 9.46–Descriptive statistics for seller 1 and seller 2 players' demographic variables

	Seller 1		Seller 2		
Variable	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**N**
Age	20.30	2.54	21.20	3.65	10
GPA	2.00	0.94	2.60	1.65	10
Major	0.60	0.52	0.20	0.42	10
Risk	-0.70	1.16	-0.50	0.71	10

- Seller 1 Players:

There were 139 cases (92.67%, i.e., average equals 0.927 with a standard deviation of 0.262) where a subject playing seller 1 chose to sell the two-good bundle – (A, B) (out of 150 possible ones; 150 = 10 subjects playing seller 1 * 15 rounds); in such cases, subjects playing seller 1 charged an average price of *$0.650* for the two-good bundle (with a standard deviation of 0.130). In the remaining 11 cases (7.33%) where a subject playing seller 1 chose to sell goods A and B separately, different prices were charged four times (in the first two rounds) – an average price of *$0.325* (with a standard deviation of 0.126) for good A and an average price of *$0.5* (with a standard deviation of 0.258) for good B, and the same monopoly optimal price (i.e., the entry accommodating price) of *$0.5* was charged for both goods A and B seven times (in rounds 3, 4, 6, 10 and 11).

Table 9.47 summarizes the number and percentage of seller 1 players selling the two-good bundle – (A, B) plus corresponding means, medians, standard deviations and test results[69] of price offers for it, in each round.

Table 9.47–Number and percentage seller 1 players bundling, and corresponding mean, median, standard deviation, and p-value of price offers for the two-good bundle per round

Round	# of Seller 1 Players Bundling	Percentage of Seller 1 Players Bundling	Price Mean	Price Median	Price SD	P-value
1	8	80%	0.825	0.75	0.249	0.038
2	7	70%	0.671	0.6	0.138	0.220
3	9	90%	0.689	0.6	0.136	0.086
4	8	80%	0.613	0.6	0.035	0.351
5	10	100%	0.64	0.6	0.084	0.168
6	9	90%	0.711	0.7	0.162	0.073
7	10	100%	0.64	0.6	0.052	0.037
8	10	100%	0.65	0.6	0.172	0.381
9	10	100%	0.61	0.6	0.099	0.758
10	9	90%	0.622	0.6	0.083	0.447
11	9	90%	0.633	0.6	0.087	0.282
12	10	100%	0.61	0.6	0.088	0.726
13	10	100%	0.64	0.6	0.151	0.423
14	10	100%	0.61	0.6	0.088	0.726
15	10	100%	0.63	0.6	0.125	0.468

It was observed that except for rounds 1, 2, and 4, 90% to 100% (9 to 10 out of 10) of the subjects playing seller 1 decided to sell the two-good bundle – (A, B). Figure 9.22 shows the percentage of seller 1 players choosing to bundle per round.

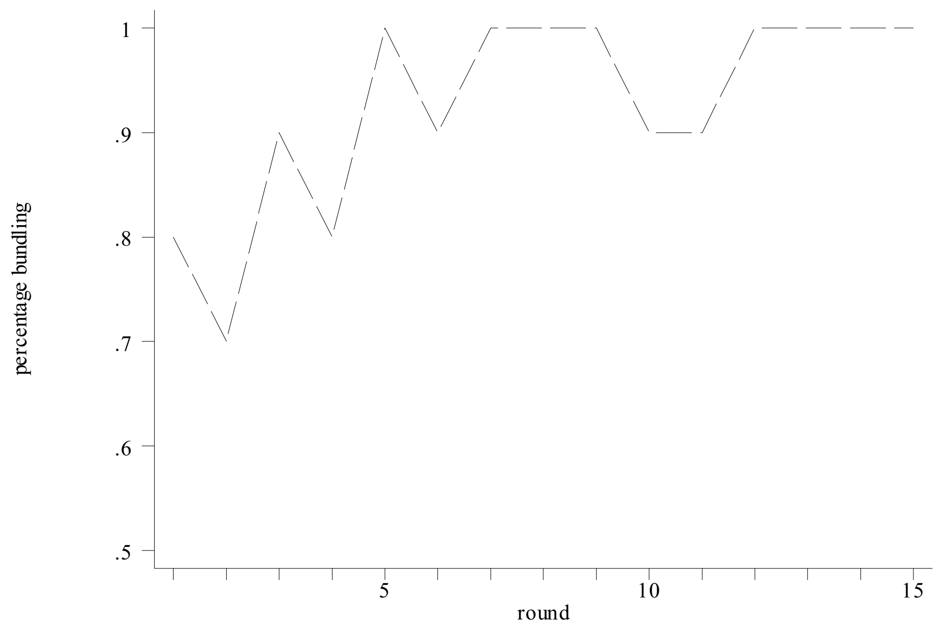
[69] Hypothesis:

H_0: Mean of price offers for the two-good bundle in a given round = 0.6

H_a: Mean of price offers for the two-good bundle in a given round ≠ 0.6

P-values from the test indicate that the mean of price offers is equal to the theoretically predicted equilibrium price of *$0.6* for the two-good bundle – (A, B) but for rounds 1 and 7 at the 5% level of significance.

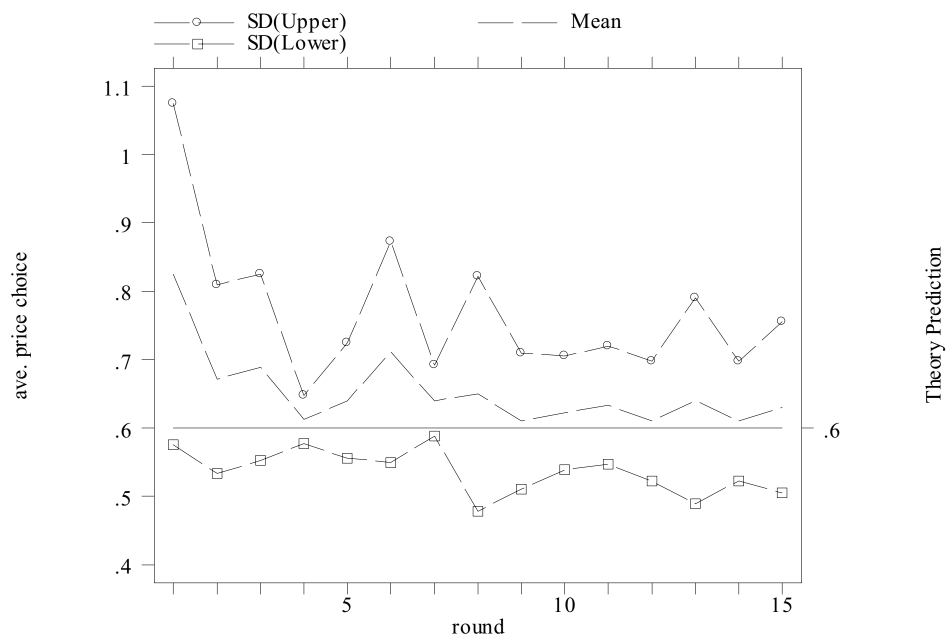
Figure 9.22 Percentage of seller 1 players bundling



As the game progressed (except for rounds 1 and 6) the average price seller 1 players charged for the two-good bundle showed a tendency to approach the theoretically predicted value, with the median matching the predicted equilibrium price. Figure 9.23 presents seller 1 player's average price choice and corresponding theoretical prediction, in each round.

Figure 9.23 Average seller 1 player's price choice for the two-good bundle

Note: SD(Upper) and SD(Lower) are one standard deviation from the mean in each round



o Seller 1 Players' Equilibrium:

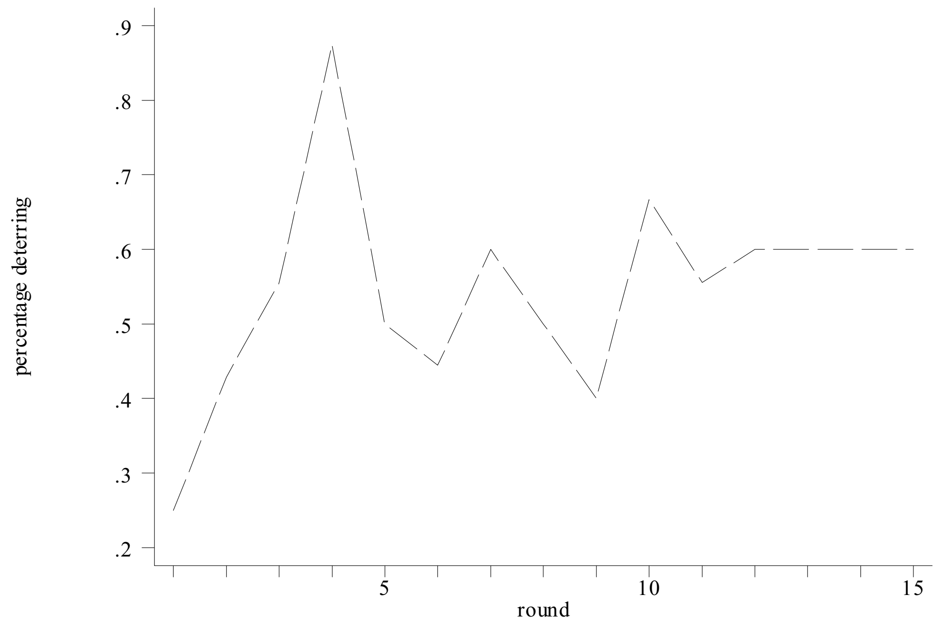
Out of the 139 observed bundling decisions by subjects playing seller 1, in 76 cases (54.67%) such players chose to price the two-good bundle – (A, B) at exactly *$0.6*, the value predicted by the theory. Table 9.48 presents the number of times such equilibrium pricing decision was reached and corresponding percentage for subjects playing seller 1 who decided to sell the two-good bundle in each round.

Table 9.48–Number of seller 1 players deterring entry and corresponding percentage in each round: Conditional on seller 1 players bundling

Round	Equilibrium Pricing Decisions by Seller 1 Players Bundling, i.e., $p_t^{d*} \approx \$0.6$	Percentage of Equilibrium Pricing Decisions by Seller 1 Players Bundling
1	2 (out of 8)	25.00%
2	3 (out of 7)	42.86%
3	5 (out of 9)	55.56%
4	7 (out of 8)	87.50%
5	5 (out of 10)	50.00%
6	4 (out of 9)	44.44%
7	6 (out of 10)	60.00%
8	5 (out of 10)	50.00%
9	4 (out of 10)	40.00%
10	6 (out of 9)	66.67%
11	5 (out of 9)	55.56%
12	6 (out of 10)	60.00%
13	6 (out of 10)	60.00%
14	6 (out of 10)	60.00%
15	6 (out of 10)	60.00%

Throughout the game (except for rounds 1 and 9), there were 70 entry deterring pricing decisions (out of 121 bundling ones; 121 = 139 observed bundling decisions by seller 1 players, minus eight observed bundling decisions by seller 1 players in round 1, minus 10 observed bundling decisions by seller 1 players in round 9), which means that 57.85% of the subjects playing seller 1 satisfied the predicted equilibrium. Such pricing decisions to deter entry were observed in higher percentages (of, e.g., 60% and above) in rounds 4, 7, 10, and from round 12 on. This means that learning might have some impact on seller 1 players engaging in limit pricing (see also Figure 9.24, which presents the percentage of subjects playing seller 1 engaging in limit pricing to deter entry in each round, conditional on seller 1 players bundling).

Figure 9.24 Percentage of seller 1 players deterring: Conditional on seller 1 players bundling



- Econometric Analysis for Seller 1 Players:

Our primary interest is to analyze the tendency for subjects playing seller 1 to choose to sell the two-good bundle – (A, B) at the entry-barring price of *\$0.6*. Figure 9.24 suggests that the equilibrium for separate or bundled sales of goods A and B with low entry costs is more likely to occur in the later rounds than in the first few ones. Also, one might conjecture that, in a given round, subjects playing seller 1 are influenced by previous player 1 bundle and price choice decisions, and opposing seller 2 players' decisions to enter or stay out of the A and B markets.

In order to evaluate the evolution of the tendency of subjects playing seller 1 to play

the predicted equilibrium strategy, binomial probit[70] models were estimated. Acronyms of all variables and their explanations are presented in Table 9.44. Table 9.45 presents means and standard deviations of the variables.

The dependent variable, Y4, is coded one if seller 1 players choose to bundle and to engage in limit pricing charging the predicted entry-barring price of *$0.6* for the two-good bundle – (A, B), and zero otherwise. Independent variables include the R6_15 dummy variable that represents the last 10 rounds to help explain the evolution of choices over time, especially, towards the end of the session; another dummy variable indicating that both seller 1 players and corresponding opponents playing seller 2 engaged in their predicted equilibrium outcome in the previous round (i.e., eqPlaY) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlaYR6_15); a dummy variable representing seller 1 players' previous-round deviations that involved bundling and lower than equilibrium price choices, and corresponding opposing seller 2 players' optimal responses (i.e., eqPlayL); and another dummy variable reflecting seller 1 players' previous-round deviations that involved bundling and higher than equilibrium price choices, and corresponding opposing seller 2 players' optimal responses (i.e., eqPlayH[71]) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlayHR6_15[72]). Four

[70] Since the dataset has repeated observations on both subjects playing seller 1 and seller 2, all binomial probit estimations assume independence of observations across subjects but not necessarily independence across observations belonging to the same subject.

[71] Due to the small sample size of 10 subjects (either playing seller 1 or seller 2) there were only 11 decisions (out of 150 possible ones) by seller 1 players to sell goods A and B separately. Therefore, explanatory variables covering these decisions were not included in the models.

[72] The variables eqPlayH and eqPlayL, and the interaction terms eqPlaYR6_15 and eqPlayHR6_15 ended up being dropped since these explanatory variables turned out to be consistently insignificant.

demographic variables (see Table 9.49) are used for the purpose of controlling for variations in seller 1 players' behavior that might possibly occur. (Refer to Table 9.44 for detailed definitions of all explanatory variables.)

Table 9.49–Probit estimates of probability of seller 1 players adopting bundled sales and corresponding limit pricing entry-deterrent strategy

Variable					
Age					-0.122
					(0.087)
					[-0.048]
Major					0.417
					(0.358)
					[0.165]
GPA					-0.097
					(0.162)
					[-0.038]
Risk					0.057
					(0.098)
					[0.023]
eqPlayHR6_15			-0.458	-0.507	
			(0.535)	(0.560)	
			[-0.181]	[-0.200]	
eqPlaYR6_15		0.102	-0.088	-0.137	
		(0.742)	(0.789)	(0.812)	
		[0.040]	[-0.035]	[-0.054]	
eqPlayL				-0.173	
				(0.259)	
				[-0.069]	
eqPlayH			-0.108	-0.115	
			(0.500)	(0.497)	
			[-0.043]	[-0.046]	
eqPlaY		1.388*	1.361*	1.354*	1.418*
		(0.606)	(0.605)	(0.601)	(0.240)
		[0.482]	[0.476]	[0.474]	[0.489]
R6_15	0.251	-0.150	0.040	0.089	-0.127
	(0.345)	(0.370)	(0.362)	(0.362)	(0.365)
	[0.100]	[-0.059]	[0.016]	[0.035]	[-0.050]
Constant	-0.151	-0.237	-0.210	-0.204	2.237
	(0.248)	(0.245)	(0.303)	(0.306)	(1.932)
χ^2-Test (p-value)		0.000	0.000	0.000	0.000

Note: N = 150 for the first model. N = 140 for the last four models. Y4 is the dependent variable. Numbers in parentheses are robust standard errors. Numbers in brackets are the marginal effects on the probability of seller 1 players bundling and engaging in limit pricing at $p_t^{d*} = \$0.6$. (Marginal effects are calculated at the means of the independent variables; and for dummy variables (e.g., eqPlaY) they are calculated for the discrete change as the dummy changes from zero to one.) * P-value < 0.05. † P-value < 0.10. χ^2-Test compares the last four models to the first one but with N reduced to 140.

Table 9.49 results show that the coefficient on the dummy variable indicating both seller 1 players and corresponding opponents playing seller 2 engaging in the predicted equilibrium outcome in the previous round (i.e., eqPlaY) is positive and statistically significant at the 5% level in the last four models. For the fifth model this suggests that when both seller 1 players and corresponding opponents playing seller 2 engage in their predicted equilibrium strategy in the previous round, subjects playing seller 1 are more likely to engage in the same kind of play in a given round. During this session subjects playing seller 1 chose the predicted equilibrium strategy 76 times.

In summary, findings suggest that throughout the game there is an increasing tendency for subjects playing seller 1 to choose bundled sales (over separate sales) and to engage in limit pricing or play "aggressively" (i.e., lowering the price of the two-good bundle – (A, B) in order to keep a potential one-product competitor out of the market, which offers the largest payoff compared to other strategies). That is, with low entry costs of *$0.07*, seller 1 players are more likely to deter entry selling the two-good bundle at the entry-barring price of *$0.6* in a given round, if they played the same strategy and their opposing seller 2 players stayed out of the market in the previous round. (It should also be noted that the payoffs for bundled sales at the entry-barring price of *$0.6* are only the largest, when compared to other strategies, if opposing subjects playing seller 2 do not enter any of the two markets undercutting seller 1 players' price.)

- Seller 1 Players' Demographics and Risk Attitudes

The demographic composition of the subjects playing seller 1 will be discussed next since some behavioral variations in this game might be correlated with demographics. Table 9.46 has the descriptive statistics on the demographic characteristics of subjects playing seller 1. (See Appendix B for the questionnaire answered by the subjects.)

Results from an estimation which includes demographic variables are reported in the fifth column of Table 9.49. In that estimation no demographic variable has a statistically significant coefficient at the 5% and/or 10% levels.

- Seller 2 Players:

Conditional on subjects playing seller 1 bundling, there were 73 decisions by seller 2 players to enter the market (out of 139 observed bundling ones by seller 1 players) at an average price of *$0.237* for either good A or B (with a standard deviation of 0.089). That is, 52.52% of the seller 2 players decided to enter one of the two markets.

o Seller 2 Players' Equilibrium:

Results show that 35.53% (i.e., average equals 0.355 with a standard deviation of 0.482) of seller 2 players chose to enter the market when subjects playing seller 1 were selling the two-good bundle – (A, B) and attempting to deter entry (i.e., playing the predicted equilibrium value $p_t^{d*} \approx \$0.6$ when bundling). Figure 9.25 shows seller 2 players' average price choices for either good A or B, conditional on entry occurring and on seller 1 players bundling and charging the equilibrium entry-barring price for the two-good bundle in each round.

Figure 9.25 Seller 2 player's average price choice: Conditional on entry occurring and on seller 1 player bundling and charging the entry-barring price

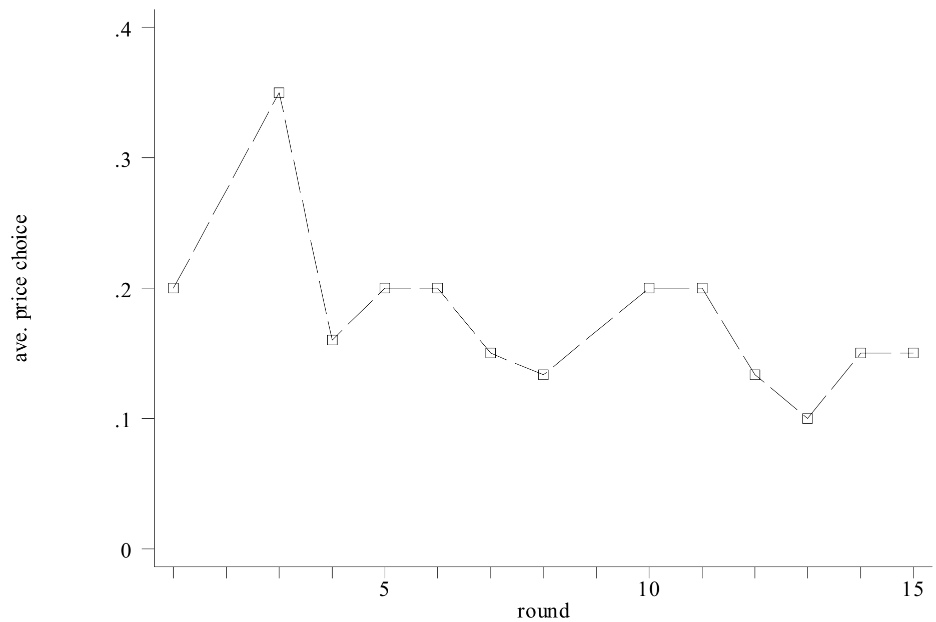
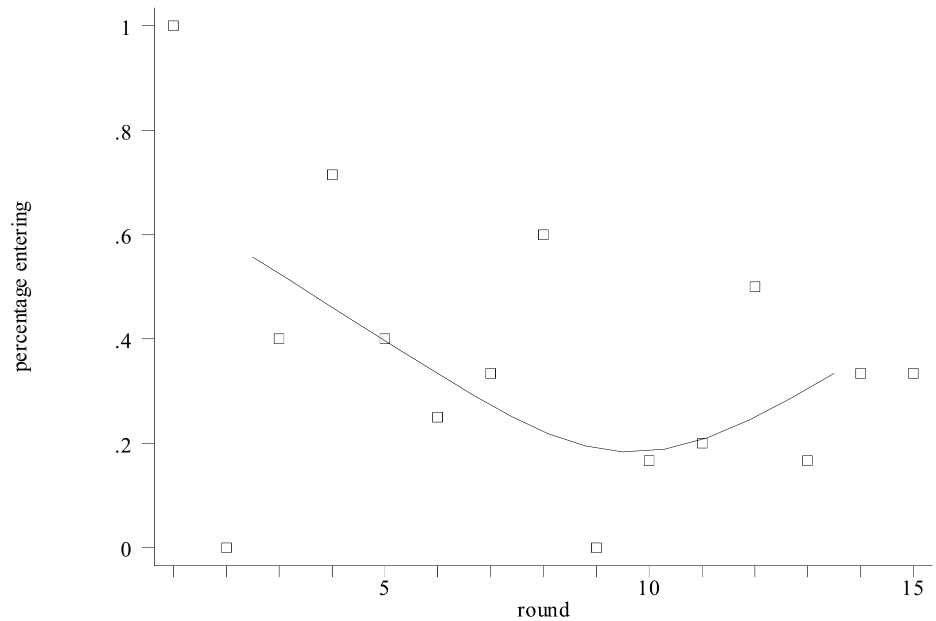


Figure 9.26[73] shows the percentage of seller 2 players entering one of the two markets with subjects playing seller 1 bundling and engaging in limit pricing charging the entry-barring price of *$0.6* for the two-good bundle – (A, B) in each round.

[73] A cubic spline fit line is provided.

Figure 9.26 Percentage of seller 2 players entering: Conditional on seller 1 players bundling and charging the equilibrium entry-barring price



From round 1 to round 9 there is a decreasing tendency for seller 2 players to enter the market, as subjects playing seller 1 sell the two-good bundle – (A, B) at the entry-barring price on their attempt to profitably deter entry; but, this tendency is inverted in the last six rounds. In the remaining 49 cases (64.47%), seller 2 players satisfied the equilibrium prediction of staying out of the market when the corresponding opponent playing seller 1 played the equilibrium strategy.

It was observed that throughout this session there were five (out of 10) seller 2 players who seemed never to learn how to play the game since each of those players has entered the market at least 44.44% of the time (and at most 100%) when subjects playing seller 1 were selling the two-good bundle – (A, B) and trying to deter entry (i.e., charging seller 1's equilibrium price when bundling).

- Econometric Analysis for Seller 2 Players:

For subjects playing seller 2, our primary concern is to analyze the likelihood of not entering one of the two markets. Figure 9.26 suggests that conditional on seller 1 players bundling and choosing the equilibrium entry-barring price of *$0.6* for the two-good bundle – (A, B), entry (for separate or bundled sales of goods A and B with 'low' entry costs) by subjects playing seller 2 is less likely to occur in the later rounds than in the first ones. Also, one might hypothesize that seller 2 players' behavior would be influenced by (1) seller 1 players' choices in a given round, and/or (2) the previous player 1 bundle and price choice decisions, and opposing seller 2 players' decisions to enter or not.

To evaluate the evolution of the tendency of subjects playing seller 2 to stay out of the A and B markets, binomial probit[74] models were estimated. The dependent variable, S2, is coded one if entry does not occur and zero otherwise.[75] Independent variables include the R6_15 dummy variable that represents the last 10 rounds to help explain the evolution of choices over time, especially, towards the end of the session; another dummy variable representing seller 1 players bundling and choosing the equilibrium entry-barring price of *$0.6* for the two-good bundle – (A, B) in a given round (i.e., Y4) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., Y4R6_15); a dummy variable indicating that both seller 1 players and corresponding opponents playing seller 2 engaged in their predicted equilibrium outcome

[74] Since the dataset has repeated observations on both subjects playing seller 1 and seller 2, all binomial probit estimations assume independence of observations across subjects but not necessarily independence across observations belonging to the same subject.

[75] Acronyms of all variables and their explanations are presented in Table 9.44. Table 9.45 presents means and standard deviations of the variables.

in the previous round (i.e., eqPlaY) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlaYR6_15[76]); another dummy variable representing seller 1 players' previous-round deviations that involved bundling and lower than equilibrium price choices, and corresponding opposing seller 2 players' optimal responses (i.e., eqPlayL); and a dummy variable reflecting seller 1 players' previous-round deviations that involved bundling and higher than equilibrium price choices, and corresponding opposing seller 2 players' optimal responses (i.e., eqPlayH) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlayHR6_15).

Two[77] demographic variables (see Table 9.50) are used for the purpose of controlling for variations in seller 2 players' behavior that might possibly occur. (Refer to Table 9.44 for detailed definitions of all explanatory variables.)

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[76] Y4R6_15 and eqPlaYR6_15 ended up being dropped since these explanatory variables turned out to be consistently insignificant.

[77] Due to the small sample size of 10 subjects (either playing seller 1 or seller 2), the models could not be estimated with all four demographic variables; and thus, Major and GPA ended up being excluded since they turned out to be consistently insignificant.

Table 9.50–Probit estimates of probability of seller 2 players not entering either market A or B

Variable						
Age						-0.043
						(0.041)
						[-0.017]
Risk						-0.496†
						(0.289)
						[-0.197]
eqPlayHR6_15				-0.809*	-0.419	-0.582
				(0.337)	(0.439)	(0.430)
				[-0.299]	[-0.163]	[-0.222]
eqPlaYR6_15			-0.323	-0.554		
			(0.576)	(0.513)		
			[-0.127]	[-0.214]		
eqPlayL					0.924*	0.743
					(0.406)	(0.480)
					[0.340]	[0.283]
eqPlayH				0.906*	0.837*	0.887*
				(0.388)	(0.405)	(0.430)
				[0.345]	[0.321]	[0.339]
eqPlaY			0.744	1.016†	0.811*	0.707*
			(0.619)	(0.554)	(0.331)	(0.274)
			[0.289]	[0.386]	[0.314]	[0.276]
Y4R6_15		-0.021	0.122	0.284		
		(0.491)	(0.612)	(0.606)		
		[-0.008]	[0.048]	[0.113]		
Y4		1.068*	0.930†	0.763	0.925*	1.034*
		(0.424)	(0.479)	(0.501)	(0.250)	(0.290)
		[0.401]	[0.357]	[0.296]	[0.355]	[0.392]
R6_15	0.575*	0.556†	0.309	0.445	0.245	0.349
	(0.242)	(0.322)	(0.469)	(0.441)	(0.274)	(0.264)
	[0.220]	[0.212]	[0.122]	[0.174]	[0.097]	[0.137]
Constant	-0.524†	-1.068*	-0.975*	-1.150*	-1.201*	-0.619
	(0.275)	(0.335)	(0.426)	(0.396)	(0.275)	(0.915)
χ^2-Test (p-value)		0.000	0.000	0.000	0.000	0.000

Note: N = 150 for the first two model. N = 140 for the last four models. S2 is the dependent variable. Numbers in parentheses are robust standard errors. Numbers in brackets are the marginal effects on the probability of seller 2 players not entering the A and B markets. (Marginal effects are calculated at the means of the independent variables; and for dummy variables (e.g., Y4) they are calculated for the discrete change as the dummy changes from zero to one.) * P-value < 0.05. † P-value < 0.10. χ^2-Test compares the last five models to the first one but with N reduced to 140 for the last four models.

Table 9.50 results show that the coefficient on the dummy variable indicating that subjects playing seller 1 chose the predicted bundled sales strategy at the entry-barring price of *$0.6* for the two-good bundle – (A, B) in a given round (i.e., Y4) is positive and statistically significant at the 5% level in three of the six models. For the sixth model this suggests that when seller 1 players engage in their equilibrium strategy, seller 2 players are more likely to opt out of the market in a given round. eqPlaY and eqPlayH explanatory variables also have positive and statistically significant coefficients at the 5% level. For eqPlaY dummy variable this indicates that when both seller 1 and seller 2 players engaged in their equilibrium strategies in the previous round, seller 2 players are more likely to opt out of the market in a given round; and for eqPlayH dummy variable it suggests that when subjects playing seller 1 deviate choosing bundled sales and higher than equilibrium prices for the two-good bundle, and corresponding opposing seller 2 players respond with the optimum in the previous round, seller 2 players are more likely to stay out of the market in a given round. During this session subjects playing seller 2 chose to play the predicted equilibrium strategy 67 times.

In summary, findings suggest that throughout the game there is an increasing tendency for seller 2 players to stay out of the market when their opposing sellers 1 players choose to bundle at the entry-barring price of *$0.6* for the two-good bundle. This is indicated by the positive relationship between the choice of subjects playing seller 2 to stay of the market and: (1) seller 1 players' equilibrium strategy in a given round; (2) both subjects playing seller 1 and seller 2 choices of their corresponding equilibrium play in the previous round; (3) seller 1 players' previous-round deviations that involved bundling and higher than equilibrium price choices, and corresponding opposing seller 2 players' optimal responses.

- Seller 2 Players' Demographics and Risk Attitudes

The demographic composition of the subjects playing seller 2 will be discussed next since some behavioral variations in this game might be correlated with demographics. Table 9.46 has the descriptive statistics on the demographic characteristics of subjects playing seller 2. (See Appendix B for the questionnaire answered by the subjects.)

Results from an estimation which includes demographic variables are reported in the sixth column of Table 9.50. In that estimation one demographic variable – risk, has a negative and statistically significant coefficient at the 10% level. This suggests that risk-averse seller 2 players are less likely to play the equilibrium strategy. The latter may come as some surprise since it contradicts the intuitive expectation that risk-loving subjects playing seller 2 would be more likely to enter a market (no matter what) than those who are risk-averse.

- Successfully Deterring Entry when Bundling:

In this game choosing to sell the two-good bundle – (A, B) and pricing it at *\$0.6* (i.e., entry-barring price) often provided a way for subjects playing seller 1 (i.e., incumbents) to profitably keep seller 2 players (i.e., challengers) from entering either of the A or B markets. That is, former players were able to get higher profits when bundling and deterring entry as opposed to not bundling and accommodating entry at monopoly price (by charging $p_{1A}^* = p_{1B}^* = \$0.5$ for goods A and B when selling them separately) and were able to make seller 2 players earn non-positive profits. Actual behavior frequently follows the theoretical prediction for this case.

Among the 10 subjects playing seller 2 there were five who decided to frequently enter the market when seller 1 players chose to bundle and engaged in limit pricing (i.e., $p_t^{d*} \approx \$0.6$). Three of those five seller 2 players entered the market 44.44%, 50% and 50% of the time charging average prices per round of *\$0.075*, *\$0.133*, and *\$0.2* (with standard deviations of 0.05, 0.116, and 0, respectively), which granted them the corresponding average losses of *\$0.036*, *\$0.027*, and *\$0.006* and their opponents playing seller 1 average profits of *\$0.283*, *\$0.312*, and *\$0.348* per round, respectively. The remaining two subjects playing seller 2 entered the market 83.33% and 100% of the time charging average prices per round of *\$0.26* and *\$0.2* (with standard deviations of 0.134 and 0, respectively), which granted them average losses of *\$0.014* and *\$0.006* and their corresponding seller 1 players average profits of *\$0.371* and *\$0.348* per round, respectively. Under these circumstances, the maximum profit the above noted five seller 2 players were able to get was a loss of *\$0.006*.

In seven cases (out of 11, i.e. 63.63%) where a subject playing seller 1 decided to sell goods A and B separately and charged them at the same monopoly price of *\$0.5* (i.e., the entry accommodating price), it was observed that 85.71% of the seller 2 players entered the market at an average price of *\$0.5* (with a standard deviation of 0.245). That is, most of the seller 2 players never seemed to learn how to undercut the price of their opponents playing seller 1 by 0.1 in order to make their entry more profitable (as opposed to the 'independent pricing' treatment with 'low' entry costs session). Consequently, seller 2 players were only able to get average profits of *\$0.111*, while their opposing seller 1 players got average profits of *\$0.321* per round.

Conditional on seller 1 players choosing to bundle both goods A and B, Table 9.51 presents average profits for subjects playing seller 1 and seller 2 in each round.

Table 9.51–Average profits for seller 1 and seller 2 players per round: Conditional on seller 1 players bundling

Round	Seller 1 Player's Ave. Profit	Seller 2 Player's Ave. Profit
1	0.272	0.030
2	0.447	0.013
3	0.391	0.006
4	0.376	-0.01
5	0.428	0.005
6	0.373	0.010
7	0.417	0.003
8	0.370	0.004
9	0.432	0.004
10	0.444	0.005
11	0.433	0.006
12	0.404	-0.003
13	0.419	0.008
14	0.414	0
15	0.417	0.006

Although every subject playing seller 1 chose to sell the two-good bundle – (A, B) on a regular basis, only half of these players priced to deter entry most of the time (there was only one exception to this) engaging in this behavior very early in the game (between rounds 1 and 4) and keeping it throughout the session. The other seller 1 players never seemed to learn how to engage in limit pricing when bundling (i.e., charging the entry-barring price for the two-good bundle to keep a potential one-product competitor out of the market). Each of those who played the equilibrium strategy was able to get an average profit per round of *$0.422* against *$0.384* of those who did not. The subjects playing seller 2 took advantage of the opportunity to earn positive profits most of the time (by entering one of the two possible markets). Despite five out of the 10 subjects playing seller 2 seemed never to learn how to avoid non-positive profits by staying out of the market when their opponent playing seller 1 bundled and charged prices between *$0* and *$0.6* for the two-good bundle, each of these seller 2 players was able to get an average profit per round of *$0.007* against *$0.004* of those who did not play this way. A closer look to the data reveals that these five seller 2 players got more (an average per player of 5 against 4.2) and better (an average maximum profit per player of *$0.082* against *$0.043*) opportunities to make positive profits, compensating for their small losses and making them earn a higher average profit per round than those who played the equilibrium strategy most of the time.

Although not every subject playing seller 1 decided to play the equilibrium strategy for this game, when entry costs are 'low' selling the two-good bundle – (A, B) and engaging in limit pricing was frequently observed for an incumbent selling two goods (e.g., A and B) as a way to get higher profits (when compared to unbundled sales of the same goods) and to prevent a potential one-product competitor (selling a perfect substitute to either good A or B) from entering the market.

9.7 Cross-Experiment Analysis

This series of experiments tries to provide empirical evidence on subjects' behavior when they are given the opportunity to act either as a two-product incumbent (selling, e.g., A and B goods) or as a one-product competitor selling a perfect substitute to either good A or B. One of these forms of empirical evidence concerns to the tendency for subjects playing the incumbent role (or seller 1) to prefer two-good bundled sales over unbundled ones, since they are more profitable and can also work as an entry-deterrent strategy (i.e., first stage(s) decision(s)), given the level of entry costs born by a potential one-product competitor. The other form of empirical evidence concerns to the tendency for subjects playing the challenger role (or seller 2) to either (1) stay out of those two markets if their opposing incumbent players' first stage(s) decision(s) is(are) to deter entry, or (2) enter one of those same two markets undercutting their opposing incumbents players by a positive infinitesimal amount ε, if the latter subject's first stage(s) decision(s) is(are) to accommodate entry (i.e., second and third stage decisions).

The described results suggest that differences in experimental conditions (e.g., 'high'/'low' entry costs and permitting only unbundled/bundled sales or both) might have influenced strategies chosen by seller 1 players and responses by their opposing seller 2 players. This section tries to come up with some explanations on how such experimental conditions might have led to differences in both types of players' behavior (whether or not consistent with theoretical predictions).

- Seller 1 Players:

Since seller 1 players' profits increase with entry costs and bundled sales (i.e., potential payoffs for this type of player's optimal decisions are larger than, e.g., when only independent sales were permitted), the frequencies of equilibrium strategies (such as, deterrence at an optimal price) will probably be higher under those circumstances. In fact, the highest percentages of optimal play by subjects playing seller 1 among the six games (see Table 9.53 on Seller 1 Players' Equilibrium play) were observed in ‘independent pricing or pure bundling’ and ‘pure bundling’ treatments with ‘high’ entry costs (79.55% and 56%, respectively, against, e.g., 40.67% of the ‘independent pricing’ with ‘high’ entry costs session). Also, if subjects playing seller 1 are given the opportunity to compare their profits and strategies with bundled against unbundled sales (as in ‘independent pricing or pure bundling’ treatment), they will probably be more likely to bundle and choose an optimal price for the two-good bundle – (A, B) (i.e., select an equilibrium strategy) than, e.g., selling those same goods independently. ‘Independent pricing or pure bundling’ with ‘high’ entry costs reached the largest frequency of equilibrium play by seller 1 players among all six sessions (refer to Table 9.53 on Seller 1 Players’ Equilibrium play). (That same treatment also reached the largest frequency of equilibrium play by seller 1 players among the ‘low’ entry costs sessions – 54.67% against, e.g., 50% of the ‘pure bundling’ treatment).

On the other hand, the sum of seller 1 and seller 2 players’ payoffs at the different equilibrium strategies is greater than the sum of those same players’ payoffs at off-equilibrium ones for all treatment sessions. Among the six games, ‘pure bundling’ and ‘independent pricing or pure bundling’ treatments actual industry pies are bigger (with the biggest being the one for ‘high’ entry costs sessions) than the ‘independent pricing’ ones. Thus, subjects playing seller 1 will probably be more inclined to choose off-equilibrium play (e.g., allowing entry, when deterrence is the optimal strategy to be played) as industry pies get smaller. That is, player 1’s “aggressiveness” will probably tend to increase as this type of seller seeks to share a bigger industry pie (Mason and Nowell 1998). When compared to the other treatments, subjects playing seller 1 chose off-equilibrium strategies more often (i.e., in percentages of above 50%) than equilibrium ones when only unbundled sales of goods A and B were permitted (i.e., in both sessions of the 'independent pricing' treatment). For instance, in the 'independent pricing' with 'high' entry costs game seller 1 players' deviations that involved higher than equilibrium price choices at the same average price of *\$0.51* for both goods A and B (i.e., the best entry accommodation strategy to seller 1 players) were more frequent than other off-equilibrium strategies (see Table 9.53 on Seller 1 Players' Higher-than-equilibrium play and corresponding Average price). (Out of curiosity, refer to Table 9.5 medians on seller 1 players same price choices for goods A and B; they seem to suggest a tendency for such players to start the game at the same monopoly price for both goods A and B, i.e., $p_{1A} = p_{1B} = \$0.5$, moving towards the same equilibrium entry-barring prices of $p_{1A}{}^{d*} = p_{1B}{}^{d*} = \$0.3$ as the game progressed.) Seller 1 players also allowed entry more often in 'low' entry costs sessions of both 'pure bundling' and 'independent pricing or pure bundling' treatments than in the 'high' entry costs sessions of those same treatments. That is, with 'low' entry costs, seller 1 players' deviations that involved higher than equilibrium price choices or both bundling and higher than equilibrium price choices, have frequencies of 48% and 33.09%, respectively; while with 'high' entry costs these deviations have frequencies of 16% and 6.82%, respectively (refer to Table 9.53 on Seller 1 Players' Higher-than-equilibrium play).

In contrast, the 'high' entry costs sessions of both 'pure bundling' and 'independent pricing or pure bundling' treatments revealed that seller 1 players' deviations involving lower than equilibrium price choices or both bundling and lower than equilibrium price choices (i.e., entry deterrence at even lower prices than the optimal monopoly and also entry-barring price of *\$0.8* for the two-good bundle) were more frequent than other off-equilibrium strategies (refer to Table 9.53 on Seller 1 Players' Lower-than-equilibrium play). It is interesting to note that in both 'pure bundling' and 'independent pricing or pure bundling' treatments there is almost no difference between off-equilibrium strategies average price choices (refer to Table 9.53 on both Seller 1 Players' Higher-than-equilibrium play and Lower-than-equilibrium play plus their corresponding Average prices).

In summary, results suggests that a "rational" player 1 selling two goods (e.g., A and B) and facing the entry of a potential one-product competitor (player 2) selling a perfect substitute to either good A or B chooses bundled sales at optimal discount prices in terms of profits more often than independent sales of those same goods when: (1) the entry costs born by player 2 are 'high' and only bundled sales are allowed, or (2) player 1 is aware of his/her earnings with both unbundled and bundled sales.

- Generic Results from Seller 1 Players' Estimations:

The econometric analysis that was run individually for each treatment session suggests that, no matter the experimental conditions, when player 1 has previously chosen his/her corresponding equilibrium strategy and player 2 responded with the optimum (eqPlay independent dummy variable), subjects playing seller 1 tend to engage in their predicted equilibrium strategy in a given round more often. Although results turned out to be inconclusive with respect to the variable representing the last 10 rounds of the treatment sessions (i.e., R6_15 independent variable), it is significant for some of the games. These variables both pick up trends on player 1's behavior.

In order to complement the analysis of the tendency for subjects playing seller 1 to engage in their equilibrium strategy, models were estimated with some player 1 demographic characteristics (e.g., age, major, GPA, and risk). The intuitive expectation is for risk-loving subjects playing seller 1 to play more "aggressively" than risk-averse ones, with the former preferring limit pricing entry-deterrent to other strategies (note that five out of the six treatment sessions are entry deterrence games). Also, subjects playing seller 1 have a more complex task than seller 2 players do – the former must forecast the latter players' behavior in order to figure out what should possibly be their own best play. Subjects playing seller 1 studying business or taking economics courses would probably tend to select equilibrium strategies more often than players studying other majors, since the former have been trained to better understand price competition.

Results on risk, major, and GPA demographic variables show no significant impact on seller 1 players' behavior in most of the six games. Although results turned out to be inconclusive on age, it has a significant impact in explaining subjects playing seller 1 behavior in most of the deterrence games.

- Seller 2 Players:

Since subjects playing seller 1 have a more complex task than seller 2 players do, optimal choices should be observed more often for subjects playing seller 2 than for seller 1 players across the six games. Frequencies of equilibrium play for seller 2 players in response to their corresponding opposing seller 1 players' optimal strategy, range from a minimum of 57.14% to a maximum of 100%; while for subjects playing seller 1 they range from a minimum of 40.67% to a maximum of 79.55% (see Table 9.53 on both Seller 1 Players' Equilibrium play and Given that seller 1 players choose the equilibrium strategy, Seller 2 Players' Equilibrium play). Under the same line of reasoning, optimal responses by subjects playing seller 2 to their opposing seller 1 players' different off-equilibrium strategies should also be observed frequently across all experiments. For instance, subjects playing seller 2 seem to have taken advantage of most opportunities to earn positive profits (i.e., whenever seller 1 players accommodated entry) entering either A or B market and choosing an optimal price for the corresponding good (refer to Table 9.53 on Seller 2 players' Entry, given seller 1's off-equilibrium play).

Table 9.52 summarizes some results for the five entry deterrence games (where subjects playing seller 1 are supposed to engage in limit pricing to prevent seller 2 players from entering the A and B markets). In these sessions, entry should be more likely to occur when subjects playing seller 1 choose entry accommodation strategies (e.g., prices above deterrence) more often, since entry is supposed to be seller 2 players' optimal response. In fact, the highest frequencies of entry (see Table 9.52 on Seller 2 Players' Entry) match the highest percentages of Seller 1 Players' Higher-than-equilibrium play in Table 9.52 – 52.67%, 48%, and 33.09%, for independent pricing' with 'high' entry costs session, and both 'pure bundling' and 'independent pricing or pure bundling' with 'low' entry costs sessions, respectively (see also Table 9.53 on Seller 1 Players' Higher-than-equilibrium play and Seller 2 Players' Entry, given seller 1's off-equilibrium play for those same games).

On the other hand, subjects playing seller 2 should be more likely to opt out of the A and B markets when seller 1 players choose entry-deterrent strategies more often. For ‘pure bundling’ with ‘high’ entry costs session and ‘independent pricing or pure bundling’ treatment, Table 9.52 results show that seller 2 players chose not to enter the market more frequently with seller 1 players’ more common attempts at deterrence (these results resemble some of Mason and Nowell’s (1998) on entry deterrence).

Table 9.52–Frequency for seller 1 and seller 2 players' different modes of behavior in the five entry deterrence games and test results[78] for proportions of equilibrium play

	High Entry Costs	**Low Entry Costs**		**High Entry Costs**	
Seller 1 Players'	**Independent Pricing**	**Pure Bundling**	**Independent Pricing or Pure Bundling**	**Pure Bundling**	**Independent Pricing or Pure Bundling**
Equilibrium play:	To deter at $p_{1A}^* = p_{1B}^* = \$0.3$ – 40.67% –	To deter at $p_t^* = \$0.6$ – 50.00% –	To bundle & deter at $p_t^* = \$0.6$ – 54.67% –	To deter at $p_t^* = \$0.8$ – 56.00% –	To bundle & deter at $p_t^* = \$0.8$ – 79.55% –
P-value (a):	*1.000*	*0.104*	*0.017*	*0.008*	*0.000*
P-value (b):		*1.000*	*0.427*	*1.000*	*0.000*
Higher-than-equilibrium play:	– 52.67% –	– 48.00% –	– 33.09% –	– 16% –	– 6.82% –
Lower-than-equilibrium play:	– 6.67% –	– 2.00% –	– 12.23% –	– 28% –	– 13.64% –
Seller 2 Players'					
No Entry:	– 50.67% –	– 33.33% –	– 47.48% –	– 57.33% –	– 96.97% –
P-value (c):	*1.000*	*0.002*	*0.589*	*0.247*	*0.000*
P-value (d):		*1.000*	*0.014*	*1.000*	*0.000*
Entry:	– 49.33% –	– 66.67% –	– 52.52% –	– 42.67% –	– 3.03% –

[78] Hypothesis (for *P-value (a)* and *(c)* lines):

H_0: The proportion of equilibrium play for seller 1 (seller 2) players in 'independent pricing' w/ 'high' entry costs session = The proportion of equilibrium play for seller 1 (seller 2) players in … session

H_a: The proportion of equilibrium play for seller 1 (player 2) players in 'independent pricing' w/ 'high' entry costs session ≠ The proportion of equilibrium play for seller 1 (seller 2) players in … session

P-values from the test indicate that the proportion of equilibrium play for seller 1 (seller 2) players in 'independent pricing' w/ 'high' entry costs session is numerically and statistically different from the proportions of *(a)* both 'independent pricing or pure bundling' treatment and 'pure bundling' w/ 'high' entry costs sessions (*(c)* both 'pure bundling' w/ 'low' entry costs and 'independent pricing or pure bundling' w/ 'high' entry costs sessions) at the 5% level of significance.

Hypothesis (for *P-value (b)* and *(d)* lines):

H_0: The proportion of equilibrium play for both types of players in 'pure bundling' w/ 'low' ('high') entry costs session = The proportion of equilibrium play for both types of players in 'independent pricing or pure bundling' w/ 'low' ('high') entry costs session

H_a: The proportion of equilibrium play for both types of players in 'pure bundling' w/ 'low' ('high') entry costs session ≠ The proportion of equilibrium play for both types of players in 'independent pricing or pure bundling' with 'low' ('high') entry costs session

P-values from the test indicate that the proportions of equilibrium play for both 'pure bundling' and 'independent pricing or pure bundling' treatments w/ 'low' entry costs sessions are *(b)* not statistically different from each other for player 1; *(d)* numerically and statistically different from each other for player 2 at the 5% level of significance. *P-values* from a similar test that compares proportions of equilibrium play for 'high' entry costs sessions of 'pure bundling' and 'independent pricing or pure bundling' suggest that the corresponding frequencies are numerically and statistically different from each other for both types of players at the 5% level of significance.

- Generic Results from Seller 2 Players' Estimations:

The econometric analysis that was run individually for each treatment session suggests that, no matter the experimental conditions, when player 1: (1) chooses his/her equilibrium strategy in a given round, and/or (2) has previously chosen his/her equilibrium outcome and player 2 responded with his/her corresponding optimum, subjects playing seller 2 tend to choose their predicted equilibrium strategy more often.

Also, seller 2 players tend to choose their equilibrium outcome more often: (1) when player 1's previous-round deviation involved higher than equilibrium price choices and corresponding opposing player 2's optimal responses (i.e., eqPlayH independent dummy variable), for most of the deterrence games; and (2) in the later rounds (i.e., R6_15 explanatory variable), for some experiments. The latter indicates that during the last 10 rounds player 2's behavior adjusts in ways that are not captured by both types of players' previous actions and player 2 demographics.

Demographic characteristics (e.g., age, major, GPA, and risk) were also studied to complement the analysis of the tendency for subjects playing seller 2 to choose their equilibrium strategy given player 1's actions.

Results on age, risk, and major demographic variables show no significant impact on seller 2 players' behavior in most of the six games. Although results turned out to be inconclusive on GPA, it has a significant impact in explaining player 2's behavior in some of the deterrence games.

Still results show that there was a "bias" towards entry, i.e., subjects playing seller 2 frequently entered either market A or B when seller 1 players chose an entry-barring strategy for most of the five deterrence games (refer to Table 9.53 on Given that seller 1 players choose the equilibrium strategy, Seller 2 Players' Off-equilibrium play). The highest frequencies of this kind of play were registered for the 'pure bundling' treatment and for 'independent pricing or pure bundling' with 'low' entry costs session; and the smallest ones for both 'independent pricing' and 'independent pricing or pure bundling' with 'high' entry costs experiments.

Some of the motives that might have led to such inconsistent play are probably: (1) the lack of an "active escape opportunity" (Harrison 1988) (e.g., the lack of an alternative market where player 2 always got to sell some other good rather than good A or good B), and/or (2) subjects playing seller 2 "signaling" their corresponding opposing seller 1 players that they were not willing to let them get away with player 1's maximum potential profits.

For 'independent pricing or pure bundling' with 'high' entry costs session, as opposed to 'pure bundling' with the same entry costs, seller 2 players were given enough information to make them realize that their earnings would not differ that much whether their opponents playing seller 1 chose to deter entry with unbundled or bundled sales. This indicates that seller 2 players' inconsistent behavior in 'pure bundling' with 'high' entry costs game might have been motivated, mainly, by their need to want to do something rather than nothing; e.g., instead of opting out whenever player 1 chose an entry-barring strategy (which occurred most of the time in both games), seller 2 players probably felt the need to enter one of the two markets no matter what.

As above noted, for 'pure bundling' and 'independent pricing or pure bundling' with 'low' entry costs sessions, seller 2 players were given plenty of opportunities to make positive profits; and, therefore, the very small losses that those players could possibly incur due to their inconsistent play would probably end up being compensated. In fact and on average, those subjects playing seller 2 who chose to enter the market more often in the latter two games ended up making positive profits, which literally compensated their small losses. Also, for the 'independent pricing or pure bundling' with 'low' entry costs session, subjects playing seller 2 were given enough information to make them realize that they would be getting positive profits (instead of zero earnings) in a round if their opposing seller 1 players chose unbundled sales (at the same optimal monopoly price for both goods A and B) instead of bundled ones (at the optimal entry-barring price). This suggests that seller 2 players' inconsistent behavior in the latter two games might have been motivated, mainly, by the above noted "signaling" concerns.

Overall, evidence does not seem to support Nalebuff's (1999) basic model findings with respect to entry deterrence since results suggest that entry by seller 2 players was not successfully prevented in most of the five entry deterrence games. In particular, bundling did not seem to work out very effectively as an entry-deterrence tool for an incumbent (player 1) selling two goods (e.g., A and B) and facing the entry of a potential one-product competitor (player 2) selling a perfect substitute to either one of those goods.

- 'Independent pricing' treatment with 'low' entry costs session:

This was the only experiment where seller 2 players always responded with their theoretically predicted strategy whenever subjects playing seller 1 chose their optimal play (refer to Table 9.53 on Given that seller 1 players choose the equilibrium strategy, Seller 2 Players' Equilibrium play, which equals 100%). 'Independent pricing' with 'low' entry costs game entails seller 1 players' accommodating the entry (at the same optimal monopoly price of *$0.5* for both goods A and B) of competing seller 2 players, which gives the latter a chance to make positive earnings when responding with their best play in a given round (i.e., to enter one of seller 1 players' markets undercutting the corresponding good's price by 0.1). Also, there are no substantive differences between both types of sellers' potential payoffs when they play their corresponding equilibrium strategies (as opposed to entry deterrence games). That is, none of the above referred motives that might possibly lead player 2 into inconsistent play seem to be present in this game; and thus, this type of player is more inclined to choose their optimal responses in this game than in the entry deterrence ones.

This suggests that, when entry costs are 'low' and facing a potential one-product competitor (selling a perfect substitute to either good A or B), entry accommodation at the same optimal monopoly price for both goods A and B by an incumbent selling these goods separately makes entry worthwhile for a one-product competitor undercutting the incumbent's price by a positive infinitesimal amount ε. And entry does occur.

Table 9.53–Frequency and average prices for seller 1 and seller 2 players' different modes of behavior

	Independent Pricing		Pure Bundling		Independent Pricing or Pure Bundling	
Seller 1 Players'	**High Entry Costs**	**Low Entry Costs**	**High Entry Costs**	**Low Entry Costs**	**High Entry Costs**	**Low Entry Costs**
Equilibrium play:	To deter at $p_{1A}^* = p_{1B}^* = \$0.3$ – ***40.67%*** –	To accommodate at $p_{1A}^* = p_{1B}^* = \$0.5$ – ***42.67%*** –	To deter at $p_t^* = \$0.8$ – ***56%*** –	To deter at $p_t^* = \$0.6$ – ***50%*** –	To bundle and deter at $p_t^* = \$0.8$ – ***79.55%*** –	To bundle and deter at $p_t^* = \$0.6$ – ***54.67%*** –
Higher-than-equilibrium play:	$P_{1A} = p_{1B}$ – ***28%*** –	– ***7.33%*** –	– ***16%*** –	– ***48%*** –	Bundling – ***6.82%*** –	Bundling – ***33.09%*** –
Average price:	*$0.51*	$p_{1A} = \$0.55$ $p_{1B} = \$0.73$	*$1.12*	*$0.80*	*$0.99*	*$0.79*
Lower-than-equilibrium play:	– ***6.67%*** –	– ***32.67%*** –	– ***28%*** –	– ***2.00%*** –	Bundling – ***13.64%*** –	Bundling – ***12.23%*** –
Average price:	$p_{1A} = \$0.23$ $p_{1B} = \$0.27$	$p_{1A} = \$0.36$ $p_{1B} = \$0.35$	*$0.66*	*$0.50*	*$0.70*	*$0.50*
Mixed play:	– ***0%*** –	– ***17.33%*** –				
Average price:		$p_{1A} = \$0.40$ $p_{1B} = \$0.61$				
Seller 2 Players'						
Entry, given seller 1's off-equilibrium play:	– ***27.33%*** –	– ***54.00%*** –	– ***18.67%*** –	– ***46.00%*** –	– ***1.52%*** –	– ***33.09%*** –
Average p_{2j}:	*$0.41*	*$0.36*	*$0.28*	*$0.29*	*$0.35*	*$0.27*
Given that seller 1 players choose the equilibrium strategy, Seller 2 Players'						
Equilibrium play:	Not to enter – ***88.52%*** –	Enter at $p_{2j}^* = \$0.4$ – ***100%*** –	Not to enter – ***57.14%*** –	Not to enter – ***58.67%*** –	Not to enter – ***98.10%*** –	Not to enter – ***64.47%*** –
Off-equilibrium play:	To enter – ***11.48%*** –	Non optimal – ***0%*** –	To enter – ***42.86%*** –	To enter – ***41.33%*** –	To enter – ***1.90%*** –	To enter – ***35.53%*** –
Average p_{2j}:	*$0.23*		*$0.18*	*$0.13*	*$0.00*	*$0.00*

Chapter 10: Concluding Remarks

According to Shapiro and Varian's (1999) work, computer and communications infrastructure or data networks (e.g., the Internet) might make it possible for today's entrepreneurs dealing in information goods to build new monopolies (e.g., Microsoft). Since the marginal cost of *reproducing* these goods has been considerably reduced and those entrepreneurs can take advantage of unprecedented economies of scale (both permitted nowadays by computer and communications infrastructure), information goods producers have been regarding bundled sales as a powerful and attractive pricing strategy. Based on differences in consumers' valuations over bundles of information goods, this strategy makes it possible for those producers to extract more revenue from consumers. In his work, Whinston (1990) showed that it is possible for a monopolist producing one information good facing non-perfect competition in the market for another to extend the firm's monopoly power from one product's market to the other by bundling them together (i.e., "bundling entry-deterrent effect"). That is, by choosing a price that maximizes its profits, an incumbent firm that bundles is selecting a better way to maintain its market share, while making entry unattractive for one-product producers that want to compete with one of the bundled products. Under oligopoly environments, Nalebuff (1999) first applying his basic model to two-good bundles and assuming that consumer valuations were independent and uniformly distributed over [0, 1], showed that a two-product incumbent possessing market power in both products and bundling them together would, e.g.: (1) make it harder for one-product rivals (producing a substitute for one of the incumbent's products) to enter the market; (2) keep the incumbent from lowering the price in each of its products; (3) make the two-product incumbent get higher profits than selling both goods separately; and (4) significantly reduce the potential one-product competitor's profits.

However, empirical support for these theoretical findings is still not regularly seen in the literature. This is probably due to the difficulty in determining, e.g., firms' pricing strategies, consumers' valuations for information goods and their bundles, motives behind multiproduct producers bundling decisions, and what might cause changes in a market's structure. That is why this study tried to come up with some empirical evidence for Nalebuff's (1999) basic model, and thus, provide some insight on firms' strategic behavior. With data being gathered under laboratory setting, three games –'independent pricing', 'pure bundling', and 'independent pricing or pure bundling', model both three-stage (the first two) and four-stage, two-person non-cooperative games where subjects face potential entry situations according to different entry costs – 'high' and 'low'. These are perfect information games and thus entry costs and payoffs are common knowledge. The equilibria for both 'independent pricing' and 'pure bundling' games entail the incumbent player selecting a price to: (1) deter entry in both 'independent pricing' and 'pure bundling' with 'high' entry costs, and also in the 'pure bundling' with 'low' entry costs sessions; (2) accommodate entry in the 'independent pricing' with 'low' entry costs session. As for both 'independent pricing or pure bundling' with 'high' and 'low' entry costs sessions, the equilibria entail the incumbent player choosing to bundle and selecting a price to deter entry.

Despite the differences in experimental conditions, results somewhat support the theoretical predictions in the sense that approximately half of the subjects playing seller 1 (i.e., the incumbent role) do select to play the different equilibria. Also the frequency of seller 1 players choosing equilibrium strategies increases over time, particularly towards the end of the experiments when both seller 1 and opposing seller 2 players (subjects playing the one-product competitor role) have also previously engaged in their corresponding equilibrium strategies. According to this outcome and given that subjects playing seller 1 have a more complex task to solve than seller 2 players do, one might conjecture that with regard to subjects playing seller 1 some learning takes place over the course of the experiments – a question for future research. That is, future experimental designs shall also feature an appropriate learning model that will possibly help explain the evolution of these players' choices over time (not discussed in Nalebuff's (1999) basic model). On the other hand, there is a small tendency for player 1 to deviate from equilibria in the later rounds, with player 1's behavior adjusting in ways that are not captured by both types of players' previous equilibrium decisions and/or player 1 demographics (an outcome not predicted at all). (Refer to Appendix C for estimations on the propensity to play equilibria by player 1.) For instance, off-equilibrium strategies entailing entry accommodation (when deterrence was the theoretically predicted equilibrium) were more frequently selected by subjects playing seller 1 in 'independent pricing' with 'high' entry costs, and both 'pure bundling' and 'independent pricing or pure bundling' with 'low' entry costs sessions. This behavior might probably be due to opposing player 2's frequent entry decisions in one of player 1's markets (especially in both 'pure bundling' and 'independent pricing or pure bundling' with 'low' entry costs sessions) when it yielded negative payoffs to the first player (i.e., player 2's "signaling" concerns). For both 'pure bundling' and 'independent pricing or pure bundling' with 'high' entry costs sessions, seller 1 players selected off-equilibrium strategies that entailed seeking deterrence at even lower prices than the ones predicted by the theory. Seller 1 players' willingness to lose some of their earnings to prevent one-product rivals from entering the market might be tied to player 1's larger potential payoffs (e.g., equilibrium outcomes involve large asymmetric payoffs) and bigger industry pies to be shared, which characterized the latter two games.

With respect to the effects of different experimental conditions, it appears that subjects playing seller 1 are more likely to choose equilibrium play when they participate in 'pure bundling' and 'independent pricing or pure bundling' treatments (rather than in 'independent pricing' ones). The increased tendency to play equilibrium strategies in the former two treatments might, again, be tied to those games bigger industry pies and payoff differential between both types of sellers. Thus, selling a two-product bundle of information goods at an optimal discount price appears to be a strategy frequently chosen (in terms of profits) by the two-product incumbent when facing the potential competition of one-product rivals selling a perfect substitute to one of the bundled goods.

Evidence supporting theoretical predictions was also found in the sense that subjects playing seller 2 do choose to play optimally in the 'independent pricing' treatment and 'independent pricing or pure bundling' with 'high' entry costs session.

Treatment effects point to a tendency for seller 2 players not to choose equilibrium strategies in the 'pure bundling' treatment and 'independent pricing or pure bundling' with ‘low’ entry costs session; with entry often occurring at levels that cause these players to bear losses. Plausible explanations for these facts might entail: (1) the lack of “active escape opportunities” in, e.g., the ‘pure bundling’ experiment with ‘high’ entry costs; and/or (2) “signaling” the opposing player 1 that player 2 was not willing to let player 1 get away with his/her maximum potential profits. (Although important for the latter three games, this behavior seems to be less pronounced in the ‘high’ entry costs session probably due to the potential big losses that player 2 might incur if he/she acts in an inconsistent way; refer to Appendix C for estimations on the propensity to play equilibria by player 2). Thus, bundling did not seem to work out very effectively as an entry-deterrence tool for an incumbent selling two goods and facing the entry of a potential one-product competitor selling a perfect substitute to either one of those goods.

Although not predicted by theory, there is an increasing tendency for subjects playing seller 2 to choose equilibrium strategies: (1) in response to their opposing player 1 equilibrium play; (2) when both types of players have previously chosen their corresponding equilibrium strategies; or (3) when player 1 previously deviates from his/her equilibrium strategies and opposing player 2 gives his/her optimal response (see Appendix C for estimations on the propensity to play equilibria by player 2).

Bibliography and References

Adams, W.J. and Yellen, J.L. (1976). "Commodity Bundling and the Burden of Monopoly". *Quarterly Journal of Economics* 90(August), pp. 475-498.

Bakos, Y. and Brynjolfsson, E. (2000). "Bundling and Competition on the Internet". *Marketing Science* 19(1), pp. 63-82. Available at URL http://www.stern.nyu.edu/~bakos

Bakos, Y. and Brynjolfsson, E. (1999). "Bundling Information Goods: Pricing, Profits, and Efficiency". *Management Science* 45(12), pp. 1613-1630. Available at URL http://www.gsm.uci.edu/~bakos/big/big.html

Capra, M.C., Goeree, J.K., Gomez, R. and Holt, C.A. (2000). "Predation, Asymmetric Information, and Strategic Behavior in the Classroom: An Experimental Approach to the Teaching of Industrial Organization". *International Journal of Industrial Organization* 18(1), pp. 205-225. Available at URL http://www.people.virginia.edu/~cah2k/vita.html

Chen, Y. (1997). "Equilibrium Product Bundling". *Journal of Business* 70(1), pp. 85-103.

Coursey, D., Isaac, R.M. and Smith, V.L. (1984a). "Natural Monopoly and Contested Markets: Some Experimental Results". *Journal of Law and Economics* 27(?), pp. 91-113.

Coursey, D., Isaac, R.M., Luke, M. and Smith, V.L. (1984b). "Market Contestability in the Presence of Sunk (Entry) Costs". *The RAND Journal Economics* 15(1), pp. 69-84.

Davis, D.D., and Holt, C.A. (1993). *Experimental Economics*, Princeton University Press.

Dixit, A. (1979). "A Model of Duopoly Suggesting a Theory of Entry Barriers". *Bell Journal of Economics* 10(Spring), pp. 20-32.

Fischbacher, U. (1999). "z-Tree – Zurich for Readymade Economic Experiments – Experimenter's Manual". Working Paper No. 21, Institute for Empirical Research in Economics, University of Zurich, Zurich, Switzerland. Available at URL http://www.iew.unizh.ch/ztree

Greene, W.H. (1997). *Econometric Analysis* – 3rd ed., Prentice Hall.

Gilbert, R.J. (1989). "The Role of Potential Competition in Industrial Organization". *Journal of Economic Perspectives* 3(3), pp. 107-127.

Gujarati, D.N. (1995). *Basic Econometrics* – 3rd ed., McGraw-Hill.

Harrison, G.W. (1986). "Experimental Evaluation of the Contestable Market Hypothesis". In Bailey, E., ed., *Public Regulation*: 191-225, Cambridge: MIT Press.

Harrison, G.W. (1988). "Predatory Pricing in a Multiple Market Experiment: A Note". *Journal of Economic Behavior and Organization* 9(4), pp. 405-417.

Harrison, G.W. and Mckee, M. (1985). "Monopoly Behavior, Decentralized Regulation, and Contestable Markets: An Experimental Evaluation". *The RAND Journal of Economics* 16(1), pp. 51-69.

Holt, C.A. (1995). "Industrial Organization: A Survey of Laboratory Research". In Kagel, J.H. and Roth, A.E., eds., *The Handbook of Experimental Economics*: 349-443, Princeton: Princeton University Press.

Isaac, R.M. and Smith, V.L. (1985). "In Search of Predatory Pricing". *Journal of Political Economy* 93(2), pp. 320-345.

Jehle, G.A. and Reny, P.J. (1998). *Advanced Microeconomic Theory*, Addison-Wesley.

Jung, Y.J., Kagel, J.H. and Levin, D. (1994). "On the Existence of Predatory Pricing: An Experimental Study of Reputation and Entry Deterrence in the Chain-Store Game". *The RAND Journal of Economics* 25(1), pp. 72-93.

MacKie-Mason, J., Riveros, J. and Gazzale, R. (1999). "Pricing and Bundling Electronic Information Goods: Field Evidence". Available at URL http://www-personal.umich.edu/~jmm/papers/peak-tprc99.pdf

Mason, C. and Nowell, C. (1998). "An Experimental Analysis of Subgame Perfect Play: the Entry Deterrence Game". *Journal of Economic Behavior & Organization* 37(4), pp. 443-462.

Mason, C. and Phillips, O. (2000). "An Experimental Evaluation of Strategic Preemption". *International Journal of Industrial Organization* 18(1), pp. 107-135.

McAfee, R., McMillan, J. and Whinston, M. (1989). "Multiproduct Monopoly, Commodity Bundling, and Correlation of Values". *The Quarterly Journal of Economics* 104(May), pp. 371-383.

Nalebuff, B. (1999). "Bundling". Working Paper, School of Management, Yale University, New Haven, CT. Available at URL http://papers.ssrn.com/paper.taf?abstract_id=185193

Shapiro, C., and Varian, H.R. (1999). *Information Rules: a Strategic Guide to the Network Economy*, Harvard Business School Press.

Tirole, J. (1997). *The Theory of Industrial Organization*, MIT Press.

Varian, H.R. (1996). “Differential Pricing and Efficiency”. Available at URL http://www.sims.berkeley.edu/~hal/people/hal/papers.html

Varian, H.R. (1995). “Pricing Information Goods”. Available at URL http://www.sims.berkeley.edu/~hal/people/hal/papers.html

Appendix A: General Instructions and Handouts

A.1 Independent Pricing Treatment –'High' Entry Costs Session

- Instructions (screen-shot format) for the whole session:

Welcome!

This is an experiment in the economics of decision making. Funding for this project has been provided by several research foundations. For your participation today we will pay you a $5 participation fee in cash at the end of the session. As will be described in these instructions, you may earn an additional amount of money depending on the decisions that you and other participants make. IT IS VERY IMPORTANT THAT YOU READ THE INSTRUCTIONS CAREFULLY. The $5 participation fee will be paid to you independent of your performance.

CONTINUE

You will be playing 1 of 2 possible roles and will remain in that role throughout 15 periods. The role that you will play is selected at random. You will be paired with somebody in this room. The person you are paired with will change from period to period. You will not be told which person you are paired with, either during or after the session. The person you are paired with is selected at random.

Your identity will be kept confidential throughout today's session and after.

At the end of the session you will be called up one by one to be paid in private. Nobody else will see how much you earn.

CONTINUE

Today's session comprises a series of **15 periods** and each of you is a **seller** for this series of periods.

There are **two** types of sellers - **Seller 1** and **Seller 2**. Each **Seller 2** will be given a **one time** initial endowment of $10 (**not** $10 in each of the 15 periods).

You will be assigned a role of either Seller 1 or Seller 2, and you will remain in this role throughout the 15 periods. In each period each seller is paired with a randomly selected seller of the other type.

On the next screens we will explain in more detail the behavior of the sellers.

CONTINUE

In each period **Seller 1** will be selling two goods - A - **and** - B -. At the beginning of a period **Seller 1** will be asked to select a **price** for good - A - **and** a **price** for good - B.

In each period Seller 2 will be informed about Seller 1's prices and will learn which **good** - A - **or** - B - he/she **may sell** in that period. The good with which Seller 2 can participate is selected at random and may vary from period to period. Seller 2 will then be asked whether he/she wants to participate in this good's market.

If **Seller 2** decides to **participate** he/she will have to choose a **price** for the good.

The computer will then simulate the buyers' behavior based on the price and participation decisions.

CONTINUE

Both you and the other seller will be making **price choices**. The selected prices together determine the earnings of both sellers.

The prices that **Seller 1** may pick for goods - A - **and** - B - are located on the **left side** of the **PINK** table of payoffs - **"Seller 1's Payoffs"**.

The price that **Seller 2** may be picking if he/she decides to **participate** is located on the **left side** of the **GREEN** table of payoffs - **"Seller 2's Payoffs"**.

You will find those tables in your handouts next to your computer.

Earnings take into account the sellers' price and participation choices, and the behavior of computer simulated buyers, as described on the next screen.

CONTINUE

The computer will simulate the behavior of a large number of buyers.

Each **buyer** has the ability to purchase **one** unit of good **A**, **one** unit of good **B**, or one unit of each. To every buyer, each unit of good A and good B is worth a value between **$0.00** and **$1.00**. Each buyer is equally likely to have any value in that interval for each good. Buyers choose to buy good **A**, good **B**, or a bundle of **A** and **B** that maximize their gains (that is, the excess of value over purchase price).

On the next screen we will explain in more detail how to use the tables of payoffs.

CONTINUE

Depending on the role you are playing, you will be picking a price for good - A - **and/or** a price for good - B -.

There is a **PINK** table of payoffs for **Seller 1** ("Seller 1's Payoffs") and a **GREEN** one ("Seller 2's Payoffs") for **Seller 2**.

The **prices** you may select for good - A - **and/or** - B - range from **$0.00** to **$1.00** and are on the **left side** of your **table** of payoffs. By making a price choice for one good you determine the **row** from which your payoff will be picked. The price selected by the other seller for this same good is written across the top of your table. Therefore, the other seller determines the **column** from which your payoff will be picked. The **intersection** of the row and column choices determines your earnings from your table for that period.

Your earnings from the sale of goods - A - and - B - will then be added and recorded for each period.

CONTINUE

You will now be led through a practice session. In the following, you will be given the opportunity to practice making decisions for both Seller 1 and Seller 2. In the actual session, however, you will be either Seller 1 or Seller 2.

Please closely follow the instructions that will be given to you on the next screens so you can better understand the game.

CONTINUE

First consider **Seller 1's** screen displayed below at the beginning of a period.

Seller 1 chooses and enters a price for each good - A - **and** - B -. To demonstrate this, look below at the screen display for Seller 1. By choosing a **price** for good - A - **and** good - B - on the **PINK** table of payoffs ("Seller 1's Payoffs") you are selecting the **row** from which **Seller 1's earnings** will be picked. These **prices** are on the **left** side of the **PINK** table of payoffs ("Seller 1's Payoffs").

Now we will be practicing entering prices. Pretend that you are **Seller 1** and enter a price of **$0.80** for good - A - **and** a price of **$0.50** for good - B - below. Please take a moment to locate the rows containing these prices on the left side of the **PINK** table of payoffs ("Seller 1's Payoffs").

ENTER THESE PRICES NOW. Press the **OK** button to confirm your choices.

PRACTICE

Pretend that you are **SELLER 1**.

You will soon pretend to be Seller 2 as well.

Please enter your price for good - A -:	Please enter your price for good - B -:	
○ $0.00	○ $0.00	
○ $0.10	○ $0.10	
○ $0.20	○ $0.20	
○ $0.30	○ $0.30	
○ $0.40	○ $0.40	To confirm, press OK
○ $0.50	● $0.50	
○ $0.60	○ $0.60	
○ $0.70	○ $0.70	**OK**
● $0.80	○ $0.80	
○ $0.90	○ $0.90	
○ $1.00	○ $1.00	

Next, **Seller 2** must decide whether to participate in this period. If Seller 2 does not participate he/she will get earnings of $0.00. If Seller 2 does participate his/her payoffs are in the **GREEN** table of payoffs ("Seller 2's payoffs"). Seller 1's price determines the **column** from which **Seller 2's earnings** will be picked and Seller 2's price determines the row.

We now switch to the first decision screen display for Seller 2, which is shown below. The prices entered by Seller 1 are in the middle section of this screen. The predetermined good with which Seller 2 may participate (good - A -) is listed after Seller 1's prices.

Pretend that you are **Seller 2** and decide that you **want** to **participate** in this period. Please take a moment to locate the column containing Seller 1's price for good A in the **GREEN** table of payoffs ("Seller 2's payoffs"). Then make your participation decision by clicking the **YES** button below.

DO THIS NOW.

PRACTICE

Now pretend that you are **SELLER 2**.

Seller 1's price for good - A - is: $0.80

Seller 1's price for good - B - is: $0.50

YOU MAY PARTICIPATE WITH GOOD - A - IN THIS PERIOD.

Please take a moment to locate Seller 1's price for good - A - in the GREEN table.

Do you want to participate in this period?

Yes

No

Finally, the second decision screen for Seller 2 is shown below. **Seller 2** must now choose a **price** (between $0.00 and $1.00) for good - A -. By choosing a **price** for this good on the **GREEN** table of payoffs ("Seller 2's Payoffs") you are selecting the **row** from which **Seller 2's earnings** will be picked. This **price** is on the **left side** of the **GREEN** table of payoffs ("Seller 2's Payoffs").

You will now continue to make decisions as Seller 2. A reminder of Seller 1's price decisions and the good with which Seller 2 is participating appear in the middle section of Seller 2's second decision screen shown below. Please take a moment to locate the payoff in the GREEN table ("Seller 2's Payoffs") corresponding to a price of $0.80 for Seller 1 and a price of $0.60 for Seller 2. Enter the price of **$0.60**.

ENTER THE PRICE NOW. Press the **OK** button to confirm your choices.

PRACTICE

This is the second step for **SELLER 2**.

Remember that:

Seller 1's price for good - A - is: $0.80.

Seller 1's price for good - B - is: $0.50.

YOU MAY ONLY SELL GOOD - A -

Please take a moment to locate Seller 1's price for good - A - across the top of the GREEN table. You must now choose a price between $0.00 and $1.00 for good - A - by picking a row on the left side of the GREEN table. Enter the selected price on the next box.	Please enter your price: ○ $0.00 ○ $0.10 ○ $0.20 ○ $0.30 ○ $0.40 ○ $0.50 ● $0.60 ○ $0.70 ○ $0.80 ○ $0.90 ○ $1.00	To confirm, press OK **OK**

When both sellers finish entering their price decisions, your **earnings** as **Seller 1** from the **PINK** table of payoffs ("Seller 1's Payoffs") and your **earnings** as **Seller 2** from the **GREEN** table of payoffs ("Seller 2's Payoffs") are computed. These earnings are shown below along with some explanations on how they could be found in the payoff tables.

Seller 1's results:

Seller 1's price for - A -	Seller 1's Earnings in - A -	Seller 1's price for - B -	Seller 1's Earnings in - B -	Seller 1's Earnings
$0.80	0.00	$0.50	2.50	2.50

"Seller 1's Earnings in - A -" are in the **PINK** table of payoffs at the **intersection** of **row $0.80** (the price Seller 1 selected) and **column $0.60** (the price Seller 2 selected); these earnings are **0.00**.

"Seller 1's Earnings in - B - " are in the **PINK** table of payoffs at the **intersection** of **row $0.50** (the price Seller 1 selected) and **column** "Seller 2 does not participate"; these earnings are **2.50**.

"Seller 1's Earnings" for this period are $2.50 (that is, 0.00 + 2.50).

Seller 2's results:

Seller 2 participated?	Seller 2's price for - A -	Seller 2's Earnings in - A -	Seller 2's Earnings
YES	$0.60	0.40	0.40

"Seller 2's Earnings in - A -" are in the **GREEN** table of payoffs at the **intersection** of **row $0.60** (the price Seller 2 selected) and **column $0.80** (the price Seller 1 selected); these earnings are **0.40**.

"Seller 2's Earnings in - B -" are 0.00 since Seller 2 is only participating in the - A - market.

"Seller 2's Earnings" for this period are $0.40 (that is, 0.40 + 0.00).

Please press the "CONTINUE" button when you are ready to proceed with the instructions.

CONTINUE

Let us now go back to the point where Seller 2 makes the participation decision for this period. The first decision screen displayed for Seller 2 is again shown below. Notice that neither Seller 1's prices nor the predetermined good (good - A -) with which Seller 2 may participate has changed.

This time pretend that you are **Seller 2** and decide that you **do not** want to **participate** in this period. Make your participation decision by clicking the **NO** button below.

DO THIS NOW.

PRACTICE

Now pretend that you are **SELLER 2**.

Seller 1's price for good - A - is: $0.80

Seller 1's price for good - B - is: $0.50

YOU MAY PARTICIPATE WITH GOOD - A - IN THIS PERIOD.

Please take a moment to locate Seller 1's price for good - A - in the GREEN table.

Do you want to participate in this period?

Yes

No

Since Seller 2 is not participating in the selected market there is no further decisions to be made in this period. Your **earnings** as **Seller 1** from the **PINK** table of payoffs ("Seller 1's Payoffs") and your **earnings** as **Seller 2** from the **GREEN** table of payoffs ("Seller 2's Payoffs") are computed and shown below along with some explanations on how these earnings can be found.

Seller 1's results:

Seller 1's price for - A -	Seller 1's Earnings in - A -	Seller 1's price for - B -	Seller 1's Earnings in - B -	Seller 1's Earnings
$0.80	1.60	$0.50	2.50	4.10

"Seller 1's Earnings in - A -" are in the **PINK** table of payoffs at the **intersection** of **row $0.80** (the price Seller 1 selected) and **column** "Seller 2 does not participate"; these earnings are **1.60**.

"Seller 1's Earnings in - B - " are in the **PINK** table of payoffs at the **intersection** of **row $0.50** (the price Seller 1 selected) and **column** "Seller 2 does not participate"; these earnings are **2.50**.

"Seller 1's Earnings" for this period are $4.10 (that is, 1.60 + 2.50).

Seller 2's results:

Seller 2 participated?	Seller 2's price for - A -	Seller 2's Earnings in - A -	Seller 2's Earnings
NO	$0.00	0.00	0.00

"Seller 2's Earnings in - A -" and "Seller 2's Earnings in - B -" would **both** be **0.00** since Seller 2 decided not to participate in this period.

"Seller 2's Earnings" for this period are $0.00 (that is, 0.00 + 0.00).

Please press the "CONTINUE" button when you are ready to proceed with the instructions.

CONTINUE

Before we proceed to the practice session, and given the **information** and **prices** that follow, locate (in the **PINK** table of payoffs - "Seller 1's payoffs") and enter **Seller 1's earnings** in good - A - **and** good - B -. Also, locate (in the **GREEN** table of payoffs -"Seller 2's payoffs") and enter **Seller 2's earnings** in good - A - **or** good - B -.

Seller 1 picks a price of **$0.70** for good - A - and a price of **$0.20** for good - B -. **Seller 2** participates and picks a price of **$0.30** for good - B -.

The correct answers, along with an explanation on how these earnings can be found, will be provided on the next screen.

Seller 1's Earnings in - A -	Seller 1's Earnings in - B -
2.1	2.1

Seller 2's Earnings in - B -
-1.2

Please press the "CONTINUE" button when you are ready to proceed with the instructions.

CONTINUE

The **correct earnings** for **Seller 1** from the **PINK** table of payoffs ("Seller 1's Payoffs") and the **correct earnings** for **Seller 2** from the **GREEN** table of payoffs ("Seller 2's Payoffs") are shown below along with some explanations on how these earnings can be found.

Seller 1's results:

Seller 1's price for - A -	Seller 1's Earnings in - A -	Seller 1's price for - B -	Seller 1's Earnings in - B -	Seller 1's Earnings
$0.70	2.10	$0.20	(2.10) INCORRECT	3.70

CORRECT ANSWER: "Seller 1's Earnings in - A -" are in the **PINK** table of payoffs at the **intersection** of **row $0.70** (the price Seller 1 selected) and **column** "Seller 2 does not participate"; these earnings are **2.10**.

CORRECT ANSWER: "Seller 1's Earnings in - B -" are in the **PINK** table of payoffs at the **intersection** of **row $0.20** (the price Seller 1 selected) and **column $0.30** (the price Seller 2 selected); these earnings are **1.60**.

"Seller 1's Earnings" for this period are $3.70 (that is, 2.10 + 1.60).

Seller 2's results:

Seller 2 participated?	Seller 2's price for - B -	Seller 2's Earnings in - B -	Seller 2's Earnings
YES	$0.30	(-1.20) INCORRECT	-2.00

CORRECT ANSWER: "Seller 2's Earnings in - A -" are 0.00 since Seller 2 is only participating in the - B - market.

CORRECT ANSWER: "Seller 2's Earnings in - B -" are in the **GREEN** table of payoffs at the **intersection** of **row $0.30** (the price Seller 2 selected) and **column $0.20** (the price Seller 1 selected); these earnings are **-2.00**.

"Seller 2's Earnings" for this period are $-2.00 (that is, 0.00 - 2.00).

Please press the "CONTINUE" button when you are ready to proceed with the instructions.

CONTINUE

Summary of procedures:

You will learn whether you are Seller 1 or 2 at the beginning of the actual session.

There will be **15 PERIODS** in the actual session. For each of 15 periods there are 3 steps as follows:

1. Seller 1 selects a price for good - A - from the PINK table, and a price for good - B - from the same table.

2. Seller 2 learns Seller 1's prices and the good Seller 2 may participate with, and decides whether or not to participate in the predetermined market. Seller 1's prices are shown across the top of the GREEN table.

3. If Seller 2 decides to participate, he/she selects a price for the predetermined good from the GREEN table. Otherwise Seller 2 takes no further action in this period.

The computer simulates the buying decisions.

CONTINUE

You will have a chance to practice these procedures further before the actual session begins. During the actual session the person you are paired with is selected at random. However, during the practice session you will be playing both Seller 1 and Seller 2 so you can get the opportunity to practice both roles.

There are **two** PRACTICE SESSIONS. YOU WILL NOT BE PAID FOR THESE TWO SESSIONS.

The PRACTICE SESSIONS are on the next screens. Please press the "CONTINUE" button when you are ready.

CONTINUE

- Instructions (screen-shot format) for the first period of practice:

PRACTICE SESSION

Pretend that you are **SELLER 1**. Your decisions as Seller 1 and the decisions made by you as **Seller 2** (to which you are paired with during this practice session) will be reported to you on the screens that follow.

Although you are in the **Practice Session, do your best** in order to see how the game works.

Please take a moment to locate the rows containing prices between $0.00 and $1.00 on the left side of the **PINK** table of payoffs ("Seller 1's Payoffs"). Below enter a price for good - A - **and** good - B -.

Please enter your price for good - A -:	Please enter your price for good - B -:	
○ $0.00	○ $0.00	
○ $0.10	○ $0.10	
○ $0.20	○ $0.20	
● $0.30	○ $0.30	To confirm, press OK
○ $0.40	○ $0.40	
○ $0.50	● $0.50	
○ $0.60	○ $0.60	
○ $0.70	○ $0.70	**OK**
○ $0.80	○ $0.80	
○ $0.90	○ $0.90	
○ $1.00	○ $1.00	

PRACTICE SESSION

Now pretend that you are **SELLER 2**.

Although you are in the **Practice Session, do your best** in order to see how the game works.

Seller 1's price for good - A - is: $0.30

Seller 1's price for good - B - is: $0.50

YOU MAY PARTICIPATE WITH GOOD - A - IN THIS PERIOD.

Please take a moment to locate Seller 1's price for good - A - in the GREEN table.

Do you want to participate in this period?

Yes

→ **No**

PRACTICE SESSION

Seller 1 and Seller 2's results for the Practice Session you have just played are shown below.

Seller 1's results for the Practice Session:

Seller 1's price for - A -	Seller 1's Earnings in - A -	Seller 1's price for - B -	Seller 1's Earnings in - B -	Seller 1's Earnings
$0.30	2.10	$0.50	2.50	4.60

Seller 2's results for the Practice Session:

Seller 2 participated?	Seller 2's price for - A -	Seller 2's Earnings in - A -	Seller 2's Earnings
NO	$0.00	0.00	0.00

On the next screen you will be able to simultaneously practice as - Seller 1 - and as - Seller 2 - different price decisions other than the ones you have just finished. Please press the "CONTINUE" button when you are ready to proceed.

CONTINUE

- Instructions (screen-shot format) for the second period of practice:

PRACTICE SESSION

Pretend that you are **SELLER 1**. Your decisions as Seller 1 and the decisions made by you as **Seller 2** (to which you are paired with during this practice session) will be reported to you on the screens that follow.

Although you are in the **Practice Session, do your best** in order to see how the game works.

Please take a moment to locate the rows containing prices between $0.00 and $1.00 on the left side of the **PINK** table of payoffs ("Seller 1's Payoffs"). Below enter a price for good - A - **and** good - B -.

Please enter your price for good - A -:	Please enter your price for good - B -:	
○ $0.00	○ $0.00	
○ $0.10	○ $0.10	
○ $0.20	○ $0.20	
○ $0.30	○ $0.30	
● $0.40	○ $0.40	To confirm, press OK
○ $0.50	○ $0.50	
○ $0.60	● $0.60	
○ $0.70	○ $0.70	**OK**
○ $0.80	○ $0.80	
○ $0.90	○ $0.90	
○ $1.00	○ $1.00	

PRACTICE SESSION

Now pretend that you are **SELLER 2**.

Although you are in the **Practice Session, do your best** in order to see how the game works.

Seller 1's price for good - A - is: $0.40

Seller 1's price for good - B - is: $0.60

YOU MAY PARTICIPATE WITH GOOD - B - IN THIS PERIOD.

Please take a moment to locate Seller 1's price for good - B - in the GREEN table.

Do you want to participate in this period?

→ **Yes**

No

PRACTICE SESSION

This is the second step for **Seller 2**.

Remember that:

Seller 1's price for good - A - is: $0.40.

Seller 1's price for good - B - is: $0.60.

YOU MAY ONLY SELL GOOD - B -

Please take a moment to locate Seller 1's price for good - B - across the top of the GREEN table. You must now choose a price between $0.00 and $1.00 for good - B - by picking a row on the left side of the GREEN table. Enter the selected price on the next box.	Please enter your price: ○ $0.00 ○ $0.10 ○ $0.20 ○ $0.30 ○ $0.40 ● $0.50 ○ $0.60 ○ $0.70 ○ $0.80 ○ $0.90 ○ $1.00	To confirm, press OK **OK**

PRACTICE SESSION

Seller 1 and Seller 2's results for the Practice Session you have just played are shown below.

Seller 1's results for the Practice Session:

Seller 1's price for - A -	Seller 1's Earnings in - A -	Seller 1's price for - B -	Seller 1's Earnings in - B -	Seller 1's Earnings
$0.40	2.40	$0.60	0.00	2.40

Seller 2's results for the Practice Session:

Seller 2 participated?	Seller 2's price for - B -	Seller 2's Earnings in - B -	Seller 2's Earnings
YES	$0.50	0.50	0.50

You have just finished the PRACTICE SESSION. Please press the "CONTINUE" button when you are ready to proceed.

CONTINUE

- Instructions (screen-shot format) for the actual session:

Round

1 out of 15

You have been randomly selected to be **Seller 1**. In each of the next **15** periods, you will be playing against a **different** randomly selected **Seller 2**.

We are now ready to begin the ACTUAL SESSION. If you have any questions at this point, please raise your hand and an experimenter will come and assist you.

Please press the "CONTINUE" button when you are ready!!!

CONTINUE

Round

1 out of 15

You have been randomly selected to be **Seller 2**. In each of the next **15** periods, you will be playing against a **different** randomly selected **Seller 1**.

You will be given a **one time** initial endowment of $10 (**not** $10 in each of the 15 periods). If you incur any loss, your loss will be deducted from this initial endowment. Any losses in excess of $10 will be forgiven.

We are now ready to begin the ACTUAL SESSION. If you have any questions at this point, please raise your hand and an experimenter will come and assist you.

Please press the "CONTINUE" button when you are ready!!!

CONTINUE

Round

1 out of 15

Remember that you are **Seller 1**.

Please take a moment to locate the rows containing prices between $0.00 and $1.00 on the left side of the **PINK** table of payoffs ("Seller 1's Payoffs"). Below enter a price for good - A - **and** good - B -.

Please enter your price for good - A -:	Please enter your price for good - B -:	
○ $0.00	○ $0.00	
○ $0.10	○ $0.10	
○ $0.20	○ $0.20	
○ $0.30	○ $0.30	
● $0.40	○ $0.40	To confirm, press OK
○ $0.50	○ $0.50	
○ $0.60	● $0.60	
○ $0.70	○ $0.70	**OK**
○ $0.80	○ $0.80	
○ $0.90	○ $0.90	
○ $1.00	○ $1.00	

At the same time, seller 2's instructions would be to:

Please wait patiently for Seller 1's decisions.

Round

1 out of 15

Remember that you are **Seller 2**.

Seller 1's price for good - A - is: $0.40

Seller 1's price for good - B - is: $0.60

YOU MAY PARTICIPATE WITH GOOD - B - IN THIS PERIOD.

Please take a moment to locate Seller 1's price for good - B - in the GREEN table.

Do you want to participate in this period?

→ **Yes**

No

At the same time, seller 1’s instructions would be to:

Please wait patiently for Seller 2's decisions.

Round

1 out of 15

Remember that you are **Seller 2**.

Remember also that:

Seller 1's price for good - A - is: $0.40.

Seller 1's price for good - B - is: $0.60.

YOU MAY ONLY SELL GOOD - B -

Please take a moment to locate Seller 1's price for good - B - across the top of the GREEN table.

You must now choose a price between $0.00 and $1.00 for good - B - by picking a row on the left side of the GREEN table. Enter the selected price on the next box.

Please enter your price:

- ○ $0.00
- ○ $0.10
- ○ $0.20
- ○ $0.30
- ○ $0.40
- ● $0.50
- ○ $0.60
- ○ $0.70
- ○ $0.80
- ○ $0.90
- ○ $1.00

To confirm, press OK

OK

Your results, and Seller 2's results, for this period, are shown below.

Your results for this period are:

Your Price for - A -	Your Earnings in - A -	Your Price for - B -	Your Earnings in - B -	Earnings
$0.40	2.40	$0.60	0.00	2.40

Your "CUMULATIVE EARNINGS" up until this period are $2.40

Seller 2's results for this period are:

Did Seller 2 participate?	Seller 2's price for - B -	Seller 2's Earnings in - B -	Earnings
YES	$0.50	0.50	0.50

*** This is the end of this period. ***

Please press the "OK" button when you are ready!!!

OK

- Handouts #1 – seller 1 and seller 2's payment tables:

PINK table – Seller 1's Payoffs

		Seller 2 does not participate	Seller 2's price for the good										
			$0.00	$0.10	$0.20	$0.30	$0.40	$0.50	$0.60	$0.70	$0.80	$0.90	$1.00
Seller 1's price for the good	$0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	$0.10	0.90	0.00	0.45	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
	$0.20	1.60	0.00	0.00	0.80	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
	$0.30	2.10	0.00	0.00	0.00	1.05	2.10	2.10	2.10	2.10	2.10	2.10	2.10
	$0.40	2.40	0.00	0.00	0.00	0.00	1.20	2.40	2.40	2.40	2.40	2.40	2.40
	$0.50	2.50	0.00	0.00	0.00	0.00	0.00	1.25	2.50	2.50	2.50	2.50	2.50
	$0.60	2.40	0.00	0.00	0.00	0.00	0.00	0.00	1.20	2.40	2.40	2.40	2.40
	$0.70	2.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.05	2.10	2.10	2.10
	$0.80	1.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.80	1.60	1.60
	$0.90	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.90
	$1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

GREEN table – Seller 2's Payoffs

		Seller 1's price for the good										
		$0.00	$0.10	$0.20	$0.30	$0.40	$0.50	$0.60	$0.70	$0.80	$0.90	$1.00
Seller 2's price for the good	$0.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00
	$0.10	-2.00	-1.55	-1.10	-1.10	-1.10	-1.10	-1.10	-1.10	-1.10	-1.10	-1.10
	$0.20	-2.00	-2.00	-1.20	-0.40	-0.40	-0.40	-0.40	-0.40	-0.40	-0.40	-0.40
	$0.30	-2.00	-2.00	-2.00	-0.95	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	$0.40	-2.00	-2.00	-2.00	-2.00	-0.80	0.40	0.40	0.40	0.40	0.40	0.40
	$0.50	-2.00	-2.00	-2.00	-2.00	-2.00	-0.75	0.50	0.50	0.50	0.50	0.50
	$0.60	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-0.80	0.40	0.40	0.40	0.40
	$0.70	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-0.95	0.10	0.10	0.10
	$0.80	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-1.20	-0.40	-0.40
	$0.90	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-1.55	-1.10
	$1.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00

A.2 Independent Pricing Treatment –'Low' Entry Costs Session

The instructions (screen-shot format) for this session are identical to the ones of 'independent pricing' treatment with 'high' entry costs, only the results that are presented to players change given the entry costs used to calculate seller 2's payoffs are now of \$0.7 instead of \$2.0.

- Handouts #2 – seller 1 and seller 2's payment tables:

Seller 1's payment table is the same for both 'high' and 'low' entry cost sessions of the 'independent pricing' treatment (see 'PINK table – Seller 1's Payoffs', handouts #1).

GREEN table – Seller 2’s Payoffs

Seller 2's price for the good		Seller 1's price for the good										
		$0.00	$0.10	$0.20	$0.30	$0.40	$0.50	$0.60	$0.70	$0.80	$0.90	$1.00
	$0.00	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70
	$0.10	-0.70	-0.25	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
	$0.20	-0.70	-0.70	0.10	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
	$0.30	-0.70	-0.70	-0.70	0.35	1.40	1.40	1.40	1.40	1.40	1.40	1.40
	$0.40	-0.70	-0.70	-0.70	-0.70	0.50	1.70	1.70	1.70	1.70	1.70	1.70
	$0.50	-0.70	-0.70	-0.70	-0.70	-0.70	0.55	1.80	1.80	1.80	1.80	1.80
	$0.60	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	0.50	1.70	1.70	1.70	1.70
	$0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	0.35	1.40	1.40	1.40
	$0.80	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	0.10	0.90	0.90
	$0.90	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.25	0.20
	$1.00	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70

A.3 Pure Bundling Treatment –'High' Entry Costs Sessions

- Instructions (screen-shot format) for the whole session:

Welcome!

This is an experiment in the economics of decision making. Funding for this project has been provided by several research foundations. For your participation today we will pay you a $5 participation fee in cash at the end of the session. As will be described in these instructions, you may earn an additional amount of money depending on the decisions that you and other participants make. IT IS VERY IMPORTANT THAT YOU READ THE INSTRUCTIONS CAREFULLY. The $5 participation fee will be paid to you independent of your performance.

CONTINUE

You will be playing 1 of 2 possible roles and will remain in that role throughout 15 periods. The role that you will play is selected at random. You will be paired with somebody in this room. The person you are paired with will change from period to period. You will not be told which person you are paired with, either during or after the session. The person you are paired with is selected at random.

Your identity will be kept confidential throughout today's session and after.

At the end of the session you will be called up one by one to be paid in private. Nobody else will see how much you earn.

CONTINUE

Today's session comprises a series of **15 periods** and each of you is a **seller** for this series of periods.

There are **two** types of sellers - **Seller 1** and **Seller 2**. Each **Seller 2** will be given a **one time** initial endowment of $10 (**not** $10 in each of the 15 periods).

You will be assigned a role of either Seller 1 or Seller 2, and you will remain in this role throughout the 15 periods. In each period each seller is paired with a randomly selected seller of the other type.

On the next screens we will explain in more detail the behavior of the sellers.

CONTINUE

In each period **Seller 1** will be selling a bundle of two goods - A **and** B -. At the beginning of a period **Seller 1** will be asked to select a **price** for the - Two Good Bundle -.

In each period Seller 2 will be informed about Seller 1's price and will learn which **good** - A - **or** - B - he/she **may sell** in that period. The good with which Seller 2 can participate is selected at random and may vary from period to period. Seller 2 will then be asked whether he/she wants to participate in this good's market.

If **Seller 2** decides to **participate** he/she will have to choose a **price** for the good.

The computer will then simulate the buyers' behavior based on the price and participation decisions.

CONTINUE

Both you and the other seller will be making **price choices**. The selected prices together determine the earnings of both sellers.

The price that **Seller 1** may pick for the - Two Good Bundle - is located on the **left side** of the **YELLOW** table of payoffs - **"Seller 1's Payoffs"**.

The price that **Seller 2** may be picking if he/she decides to **participate** is located on the **left side** of the **BLUE** table of payoffs - **"Seller 2's Payoffs"**.

You will find those tables in your handouts next to your computer.

Earnings take into account the sellers' price and participation choices, and the behavior of computer simulated buyers, as described on the next screen.

CONTINUE

The computer will simulate the behavior of a large number of buyers.

Each **buyer** has the ability to purchase **one** unit of the - Two Good Bundle -, or **one** unit of good **A**, or **one** unit of good **B**. To every buyer, each unit of the Two Good Bundle is worth a value between **$0.00** and **$2.00**; and each unit of good A and good B is worth a value between **$0.00** and **$1.00**. Each buyer is equally likely to have any value in those intervals for the bundle and for each good, respectively. Buyers choose to buy good **A**, or good **B**, or a Two Good Bundle (of **A** and **B**) that maximizes their gains (that is, the excess of value over purchase price).

On the next screen we will explain in more detail how to use the tables of payoffs.

CONTINUE

Depending on the role you are playing, you will be picking a price for the - Two Good Bundle - **or** a price for good - A - **or** good - B -.

There is a **YELLOW** table of payoffs for **Seller 1** ("Seller 1's Payoffs") and a **BLUE** one ("Seller 2's Payoffs") for **Seller 2**.

The **price** you may select for the - Two Good Bundle - range from **$0.00** to **$2.00**. The **price** you may select for good - A - **or** - B - range from **$0.00** to **$1.00**. These prices are on the **left side** of your **table** of payoffs. By making a price choice you determine the **row** from which your payoff will be picked. The price selected by the other seller is written across the top of your table. Therefore, the other seller determines the **column** from which your payoff will be picked. The **intersection** of the row and column choices determines your earnings from your table for that period.

CONTINUE

You will now be led through a practice session. In the following, you will be given the opportunity to practice making decisions for both Seller 1 and Seller 2. In the actual session, however, you will be either Seller 1 or Seller 2.

Please closely follow the instructions that will be given to you on the next screens so you can better understand the game.

CONTINUE

First consider **Seller 1's** screen displayed below at the beginning of a period.

Seller 1 chooses and enters a price for the - Two Good Bundle -. To demonstrate this, look below at the screen display for Seller 1. By choosing a **price** for the - Two Good Bundle - on the **YELLOW** table of payoffs ("Seller 1's Payoffs") you are selecting the **row** from which **Seller 1's earnings** will be picked. This **price** is on the **left** side of the **YELLOW** table of payoffs ("Seller 1's Payoffs").

Now we will be practicing entering prices. Pretend that you are **Seller 1** and enter a price of **$1.30** for the - Two Good Bundle - below. Please take a moment to locate the row containing this price on the left side of the **YELLOW** table of payoffs ("Seller 1's Payoffs").

ENTER THIS PRICE NOW. Press the **OK** button to confirm your choices.

PRACTICE

Pretend that you are **SELLER 1**.

You will soon pretend to be Seller 2 as well.

Please enter your price for the - Two Good Bundle -:		To confirm, press OK
	○ $0.00	
	○ $0.10	
	○ $0.20	
	○ $0.30	
	○ $0.40	
	○ $0.50	
	○ $0.60	
	○ $0.70	
	○ $0.80	
	○ $0.90	
	○ $1.00	**OK**
	○ $1.10	
	○ $1.20	
	● $1.30	
	○ $1.40	
	○ $1.50	
	○ $1.60	
	○ $1.70	
	○ $1.80	
	○ $1.90	
	○ $2.00	

Next, **Seller 2** must decide whether to participate in this period. If Seller 2 does not participate he/she will get earnings of $0.00. If Seller 2 does participate his/her payoffs are in the **BLUE** table of payoffs ("Seller 2's payoffs"). Seller 1's price determines the **column** from which **Seller 2's earnings** will be picked and Seller 2's price determines the row.

We now switch to the first decision screen display for Seller 2, which is shown below. The price entered by Seller 1 is in the middle section of this screen. The predetermined good with which Seller 2 may participate (good - A -) is listed after Seller 1's price.

Pretend that you are **Seller 2** and decide that you **want** to **participate** in this period. Please take a moment to locate the column containing Seller 1's price for the - Two Good Bundle - in the **BLUE** table of payoffs ("Seller 2's payoffs"). Then make your participation decision by clicking the **YES** button below.

DO THIS NOW.

PRACTICE

Now pretend that you are **SELLER 2**.

Seller 1's price for the - Two Good Bundle - is: $1.30

YOU MAY PARTICIPATE WITH GOOD - A - IN THIS PERIOD.

Please take a moment to locate Seller 1's price for the - Two Good Bundle - in the BLUE table.

Do you want to participate in this period?

Yes

No

Finally, the second decision screen for Seller 2 is shown below. **Seller 2** must now choose a **price** (between $0.00 and $1.00) for good - A -. By choosing a **price** for this good on the **BLUE** table of payoffs ("Seller 2's Payoffs") you are selecting the **row** from which **Seller 2's earnings** will be picked. This **price** is on the **left side** of the **BLUE** table of payoffs ("Seller 2's Payoffs").

You will now continue to make decisions as Seller 2. A reminder of Seller 1's price decision and the good with which Seller 2 is participating appear in the middle section of Seller 2's second decision screen shown below. Please take a moment to locate the payoff in the BLUE table ("Seller 2's Payoffs") corresponding to a price of $1.30 for Seller 1 and a price of $0.40 for Seller 2. Enter the price of **$0.40**.

ENTER THE PRICE NOW. Press the **OK** button to confirm your choices.

PRACTICE

This is the second step for **SELLER 2**.

Remember that:

Seller 1's price for the - Two Good Bundle - is: $1.30.

YOU MAY ONLY SELL GOOD - A -

Please take a moment to locate Seller 1's price for the - Two Good Bundle - across the top of the BLUE table. You must now choose a price between $0.00 and $1.00 for good - A - by picking a row on the left side of the BLUE table. Enter the selected price on the next box.	Please enter your price: ○ $0.00 ○ $0.10 ○ $0.20 ○ $0.30 ● $0.40 ○ $0.50 ○ $0.60 ○ $0.70 ○ $0.80 ○ $0.90 ○ $1.00	To confirm, press OK **OK**

When both sellers finish entering their price decisions, your **earnings** as **Seller 1** from the **YELLOW** table of payoffs ("Seller 1's Payoffs") and your **earnings** as **Seller 2** from the **BLUE** table of payoffs ("Seller 2's Payoffs") are computed. These earnings are shown below along with some explanations on how they could be found in the payoff tables.

Seller 1's results:

Seller 1's price for the - Two Good Bundle -	Seller 1's Earnings
$1.30	0.85

"Seller 1's Earnings" for this period are in the **YELLOW** table of payoffs at the **intersection** of **row $1.30** (the price Seller 1 selected) and **column $0.40** (the price Seller 2 selected); these earnings are **0.85**.

Seller 2's results:

Seller 2 participated?	Seller 2's price for - A -	Seller 2's Earnings
YES	$0.40	0.16

"Seller 2's Earnings" for this period are in the **BLUE** table of payoffs at the **intersection** of **row $0.40** (the price Seller 2 selected) and **column $1.30** (the price Seller 1 selected); these earnings are **0.16**.

Please press the "CONTINUE" button when you are ready to proceed with the instructions.

CONTINUE

Let us now go back to the point where Seller 2 makes the participation decision for this period. The first decision screen displayed for Seller 2 is again shown below. Notice that neither Seller 1's price nor the predetermined good (good - A -) with which Seller 2 may participate has changed.

This time pretend that you are **Seller 2** and decide that you **do not** want to **participate** in this period. Make your participation decision by clicking the **NO** button below.

DO THIS NOW.

PRACTICE

Now pretend that you are **SELLER 2**.

Seller 1's price for the - Two Good Bundle - is: $1.30

YOU MAY PARTICIPATE WITH GOOD - A - IN THIS PERIOD.

Please take a moment to locate Seller 1's price for the - Two Good Bundle - in the BLUE table.

Do you want to participate in this period?

Yes

No

Since Seller 2 is not participating in the selected market there is no further decisions to be made in this period. Your **earnings** as **Seller 1** from the **YELLOW** table of payoffs ("Seller 1's Payoffs") and your **earnings** as **Seller 2** from the **BLUE** table of payoffs ("Seller 2's Payoffs") are computed and shown below along with some explanations on how these earnings can be found.

Seller 1's results:

Seller 1's price for the - Two Good Bundle -	Seller 1's Earnings
$1.30	3.19

"Seller 1's Earnings" for this period are in the **YELLOW** table of payoffs at the **intersection** of **row $1.30** (the price Seller 1 selected) and **column** "Seller 2 does not participate"; these earnings are **3.19**.

Seller 2's results:

Seller 2 participated?	Seller 2's price for - A -	Seller 2's Earnings
NO	$0.00	0.00

"Seller 2's earnings" for this period are **0.00** since Seller 2 decided not to participate.

Please press the "CONTINUE" button when you are ready to proceed with the instructions.

CONTINUE

Before we proceed to the practice session, and given the **information** and **prices** that follow, locate (in the **YELLOW** table of payoffs - "Seller 1's payoffs") and enter **Seller 1's earnings**. Also, locate (in the **BLUE** table of payoffs -"Seller 2's payoffs") and enter **Seller 2's earnings**.

Seller 1 picks a price of **$0.60** for the - Two Good Bundle -. **Seller 2** participates and picks a price of **$0.80** for good - B -.

The correct answers, along with an explanation on how these earnings can be found, will be provided on the next screen.

Seller 1's Earnings
4.6

Seller 2's Earnings
-1.5

Please press the "CONTINUE" button when you are ready to proceed with the instructions.

CONTINUE

The **correct earnings** for **Seller 1** from the **YELLOW** table of payoffs ("Seller 1's Payoffs") and the **correct earnings** for **Seller 2** from the **BLUE** table of payoffs ("Seller 2's Payoffs") are shown below along with some explanations on how these earnings can be found.

Seller 1's results:

Seller 1's price for the - Two Good Bundle -	Seller 1's Earnings
$0.60	(4.60) INCORRECT

CORRECT ANSWER: "Seller 1's Earnings" for this period are in the **YELLOW** table of payoffs at the **intersection** of **row $0.60** (the price Seller 1 selected) and **column $0.80** (the price Seller 2 selected); these earnings are **4.92**.

Seller 2's results:

Seller 2 participated?	Seller 2's price for - B -	Seller 2's Earnings
YES	$0.80	(-1.50) INCORRECT

CORRECT ANSWER: "Seller 2's Earnings" for this period are in the **BLUE** table of payoffs at the **intersection** of **row $0.80** (the price Seller 2 selected) and **column $0.60** (the price Seller 1 selected); these earnings are **-2.00**.

Please press the "CONTINUE" button when you are ready to proceed with the instructions.

CONTINUE

Summary of procedures:

You will learn whether you are Seller 1 or 2 at the beginning of the actual session.

There will be **15 PERIODS** in the actual session. For each of 15 periods there are 3 steps as follows:

1. Seller 1 selects a price for the - Two Good Bundle - from the YELLOW table.

2. Seller 2 learns Seller 1's price and the good Seller 2 may participate with, and decides whether or not to participate in the predetermined market. Seller 1's price is shown across the top of the BLUE table.

3. If Seller 2 decides to participate, he/she selects a price for the predetermined good from the BLUE table. Otherwise Seller 2 takes no further action in this period.

The computer simulates the buying decisions.

CONTINUE

You will have a chance to practice these procedures further before the actual session begins. During the actual session the person you are paired with is selected at random. However, during the practice session you will be playing both Seller 1 and Seller 2 so you can get the opportunity to practice both roles.

There are **two** PRACTICE SESSIONS. YOU WILL NOT BE PAID FOR THESE TWO SESSIONS.

The PRACTICE SESSIONS are on the next screens. Please press the "CONTINUE" button when you are ready.

CONTINUE

- Instructions (screen-shot format) for the first period of practice:

PRACTICE SESSION

Pretend that you are **Seller 1**. Your decisions as Seller 1 and the decisions made by you as **Seller 2** (to which you are paired with during this practice session) will be reported to you on the screens that follow.

Although you are in the **Practice Session, do your best** in order to see how the game works.

Please take a moment to locate the rows containing prices between $0.00 and $2.00 on the left side of the **YELLOW** table of payoffs ("Seller 1's Payoffs"). Below enter a price for the - Two Good Bundle -.

Please enter your price for the - Two Good Bundle -:

○ $0.00
○ $0.10
○ $0.20
○ $0.30
○ $0.40
○ $0.50
○ $0.60
○ $0.70
○ $0.80
○ $0.90
● $1.00
○ $1.10
○ $1.20
○ $1.30
○ $1.40
○ $1.50
○ $1.60
○ $1.70
○ $1.80
○ $1.90
○ $2.00

To confirm, press OK

OK

PRACTICE SESSION

Now pretend that you are **SELLER 2**.

Although you are in the **Practice Session, do your best** in order to see how the game works.

Seller 1's price for the - Two Good Bundle - is: $1.00

YOU MAY PARTICIPATE WITH GOOD - A - IN THIS PERIOD.

Please take a moment to locate Seller 1's price for the - Two Good Bundle - in the BLUE table.

Do you want to participate in this period?

Yes

→ **No**

PRACTICE SESSION

Seller 1 and Seller 2's results for the Practice Session you have just played are shown below.

Seller 1's results for the Practice Session:

Seller 1's price for the - Two Good Bundle -	Seller 1's Earnings
$1.00	5.00

Seller 2's results for the Practice Session:

Seller 2 participated?	Seller 2's price for - A -	Seller 2's Earnings
NO	$0.00	0.00

On the next screen you will be able to simultaneously practice as - Seller 1 - and as - Seller 2 - different price decisions other than the ones you have just finished. Please press the "CONTINUE" button when you are ready to proceed.

CONTINUE

- Instructions (screen-shot format) for the second period of practice:

PRACTICE SESSION

Pretend that you are **Seller 1**. Your decisions as Seller 1 and the decisions made by you as **Seller 2** (to which you are paired with during this practice session) will be reported to you on the screens that follow.

Although you are in the **Practice Session, do your best** in order to see how the game works.

Please take a moment to locate the rows containing prices between $0.00 and $2.00 on the left side of the **YELLOW** table of payoffs ("Seller 1's Payoffs"). Below enter a price for the - Two Good Bundle -.

Please enter your price for the - Two Good Bundle -:		
	○ $0.00	
	○ $0.10	
	○ $0.20	
	○ $0.30	
	○ $0.40	
	○ $0.50	
	○ $0.60	To confirm, press OK
	○ $0.70	
	○ $0.80	
	○ $0.90	
	○ $1.00	**OK**
	○ $1.10	
	○ $1.20	
	○ $1.30	
	○ $1.40	
	● $1.50	
	○ $1.60	
	○ $1.70	
	○ $1.80	
	○ $1.90	
	○ $2.00	

PRACTICE SESSION

Now pretend that you are **SELLER 2**.

Although you are in the **Practice Session, do your best** in order to see how the game works.

Seller 1's price for the - Two Good Bundle - is: $1.50

YOU MAY PARTICIPATE WITH GOOD - B - IN THIS PERIOD.

Please take a moment to locate Seller 1's price for the - Two Good Bundle - in the BLUE table.

Do you want to participate in this period?

→ **Yes**

No

PRACTICE SESSION

This is the second step for **SELLER 2**.

Remember that:

Seller 1's price for the - Two Good Bundle - is: $1.50.

YOU MAY ONLY SELL GOOD - B -

Please take a moment to locate Seller 1's price for the - Two Good Bundle - across the top of the BLUE table. You must now choose a price between $0.00 and $1.00 for good - B - by picking a row on the left side of the BLUE table. Enter the selected price on the next box.	Please enter your price: ○ $0.00 ○ $0.10 ○ $0.20 ○ $0.30 ○ $0.40 ● $0.50 ○ $0.60 ○ $0.70 ○ $0.80 ○ $0.90 ○ $1.00	To confirm, press OK **OK**

PRACTICE SESSION

Seller 1 and Seller 2's results for the Practice Session you have just played are shown below.

Seller 1's results for the Practice Session:

Seller 1's price for the - Two Good Bundle -	Seller 1's Earnings
$1.50	0.00

Seller 2's results for the Practice Session:

Seller 2 participated?	Seller 2's price for - B -	Seller 2's Earnings
YES	$0.50	0.50

You have just finished the PRACTICE SESSION. Please press the "CONTINUE" button when you are ready to proceed.

CONTINUE

- Instructions (screen-shot format) for the actual session:

Round

1 out of 15

You have been randomly selected to be **Seller 1**. In each of the next **15** periods, you will be playing against a **different** randomly selected **Seller 2**.

We are now ready to begin the ACTUAL SESSION. If you have any questions at this point, please raise your hand and an experimenter will come and assist you.

Please press the "CONTINUE" button when you are ready!!!

CONTINUE

Round

1 out of 15

You have been randomly selected to be **Seller 2**. In each of the next **15** periods, you will be playing against a **different** randomly selected **Seller 1**.

You will be given a **one time** initial endowment of $10 (**not** $10 in each of the 15 periods). If you incur any loss, your loss will be deducted from this initial endowment. Any losses in excess of $10 will be forgiven.

We are now ready to begin the ACTUAL SESSION. If you have any questions at this point, please raise your hand and an experimenter will come and assist you.

Please press the "CONTINUE" button when you are ready!!!

CONTINUE

Round

1 out of 15

Remember that you are **Seller 1**.

Please take a moment to locate the rows containing prices between $0.00 and $2.00 on the left side of the **YELLOW** table of payoffs ("Seller 1's Payoffs"). Below enter a price for the - Two Good Bundle -.

Please enter your price for the - Two Good Bundle -:

- ○ $0.00
- ○ $0.10
- ○ $0.20
- ○ $0.30
- ○ $0.40
- ○ $0.50
- ○ $0.60
- ○ $0.70
- ● $0.80
- ○ $0.90
- ○ $1.00
- ○ $1.10
- ○ $1.20
- ○ $1.30
- ○ $1.40
- ○ $1.50
- ○ $1.60
- ○ $1.70
- ○ $1.80
- ○ $1.90
- ○ $2.00

To confirm, press OK

OK

At the same time, seller 2's instructions would be to:

Please wait patiently for Seller 1's decisions.

Round

1 out of 15

Remember that you are **Seller 2**.

Seller 1's price for the - Two Good Bundle - is: $0.80

YOU MAY PARTICIPATE WITH GOOD - B - IN THIS PERIOD.

Please take a moment to locate Seller 1's price for the - Two Good Bundle - in the BLUE table.

Do you want to participate in this period?

Yes

→ **No**

At the same time, seller 1's instructions would be to:

Please wait patiently for Seller 2's decisions.

Your results, and Seller 2's results, for this period, are shown below.

Your results for this period are:

Your Price for the - Two Good Bundle -	Your Earnings
$0.80	5.44

Your "CUMULATIVE EARNINGS" up until this period are $5.44

Seller 2's results for this period are:

Did Seller 2 participate?	Seller 2's price for - B -	Seller 2's Earnings
NO	$0.00	0.00

*** This is the end of this period. ***

Please press the "OK" button when you are ready!!!

OK

- Handouts #3 – seller 1 and seller 2's payment tables:

YELLOW table – Seller 1's Payoffs

		Seller 2 Does not participate	Seller 2's price for the good										
			$0.00	**$0.10**	**$0.20**	**$0.30**	**$0.40**	**$0.50**	**$0.60**	**$0.70**	**$0.80**	**$0.90**	**$1.00**
Seller 1's price for the two good bundle	**$0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	$0.10	1.00	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	$0.20	1.96	1.60	1.79	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96
	$0.30	2.87	2.10	2.39	2.64	2.87	2.87	2.87	2.87	2.87	2.87	2.87	2.87
	$0.40	3.68	2.40	2.78	3.12	3.42	3.68	3.68	3.68	3.68	3.68	3.68	3.68
	$0.50	4.38	2.50	2.98	3.40	3.78	4.10	4.38	4.38	4.38	4.38	4.38	4.38
	$0.60	4.92	2.40	2.97	3.48	3.93	4.32	4.65	4.92	4.92	4.92	4.92	4.92
	$0.70	5.29	2.10	2.77	3.36	3.89	4.34	4.73	5.04	5.29	5.29	5.29	5.29
	$0.80	5.44	1.60	2.36	3.04	3.64	4.16	4.60	4.96	5.24	5.44	5.44	5.44
	$0.90	5.36	0.90	1.76	2.52	3.20	3.78	4.28	4.68	5.00	5.22	5.36	5.36
	$1.00	5.00	0.00	0.95	1.80	2.55	3.20	3.75	4.20	4.55	4.80	4.95	5.00
	$1.10	4.46	0.00	0.00	0.94	1.76	2.48	3.08	3.58	3.96	4.24	4.40	4.46
	$1.20	3.84	0.00	0.00	0.00	0.90	1.68	2.34	2.88	3.30	3.60	3.78	3.84
	$1.30	3.19	0.00	0.00	0.00	0.00	0.85	1.56	2.15	2.60	2.93	3.12	3.19
	$1.40	2.52	0.00	0.00	0.00	0.00	0.00	0.77	1.40	1.89	2.24	2.45	2.52
	$1.50	1.88	0.00	0.00	0.00	0.00	0.00	0.00	0.67	1.20	1.58	1.80	1.88
	$1.60	1.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.96	1.20	1.28
	$1.70	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.68	0.76
	$1.80	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.36
	$1.90	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
	$2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

BLUE table – Seller 2's Payoffs

		Seller 1's price for the two good bundle																				
		$0.00	**$0.10**	**$0.20**	**$0.30**	**$0.40**	**$0.50**	**$0.60**	**$0.70**	**$0.80**	**$0.90**	**$1.00**	**$1.10**	**$1.20**	**$1.30**	**$1.40**	**$1.50**	**$1.60**	**$1.70**	**$1.80**	**$1.90**	**$2.00**
Seller 2's	**$0.00**	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00
price for	**$0.10**	-2.00	-2.00	-1.91	-1.82	-1.73	-1.64	-1.55	-1.46	-1.37	-1.28	-1.19	-1.10	-1.10	-1.10	-1.10	-1.10	-1.10	-1.10	-1.10	-1.10	-1.10
the good	**$0.20**	-2.00	-2.00	-2.00	-1.84	-1.68	-1.52	-1.36	-1.20	-1.04	-0.88	-0.72	-0.56	-0.40	-0.40	-0.40	-0.40	-0.40	-0.40	-0.40	-0.40	-0.40
	$0.30	-2.00	-2.00	-2.00	-2.00	-1.79	-1.58	-1.37	-1.16	-0.95	-0.74	-0.53	-0.32	-0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	$0.40	-2.00	-2.00	-2.00	-2.00	-2.00	-1.76	-1.52	-1.28	-1.04	-0.80	-0.56	-0.32	-0.08	0.16	0.40	0.40	0.40	0.40	0.40	0.40	0.40
	$0.50	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-1.75	-1.50	-1.25	-1.00	-0.75	-0.50	-0.25	0.00	0.25	0.50	0.50	0.50	0.50	0.50	0.50
	$0.60	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-1.76	-1.52	-1.28	-1.04	-0.80	-0.56	-0.32	-0.08	0.16	0.40	0.40	0.40	0.40	0.40
	$0.70	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-1.79	-1.58	-1.37	-1.16	-0.95	-0.74	-0.53	-0.32	-0.11	0.10	0.10	0.10	0.10
	$0.80	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-1.84	-1.68	-1.52	-1.36	-1.20	-1.04	-0.88	-0.72	-0.56	-0.40	-0.40	-0.40
	$0.90	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-1.91	-1.82	-1.73	-1.64	-1.55	-1.46	-1.37	-1.28	-1.19	-1.10	-1.10
	$1.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00

A.4 Pure Bundling Treatment – 'Low' Entry Costs Sessions

The instructions (screen-shot format) for this session are identical to the ones of 'pure bundling' treatment with 'high' entry costs, only the results that are presented to players change given the entry costs used to calculate seller 2's payoffs are now of \$0.7 instead of \$2.0.

- Handouts #4 – seller 1 and seller 2's payment tables:

Seller 1's payment table is the same for both 'high' and 'low' entry cost sessions of the 'pure bundling' treatment (see 'YELLOW table – Seller 1's Payoffs', handouts #3).

BLUE table – Seller 2’s Payoffs

		Seller 1's price for the two good bundle																				
		$0.00	$0.10	$0.20	$0.30	$0.40	$0.50	$0.60	$0.70	$0.80	$0.90	$1.00	$1.10	$1.20	$1.30	$1.40	$1.50	$1.60	$1.70	$1.80	$1.90	$2.00
Seller 2's	$0.00	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70
price for	$0.10	-0.70	-0.70	-0.61	-0.52	-0.43	-0.34	-0.25	-0.16	-0.07	0.02	0.11	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
the good	$0.20	-0.70	-0.70	-0.70	-0.54	-0.38	-0.22	-0.06	0.10	0.26	0.42	0.58	0.74	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
	$0.30	-0.70	-0.70	-0.70	-0.70	-0.49	-0.28	-0.07	0.14	0.35	0.56	0.77	0.98	1.19	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
	$0.40	-0.70	-0.70	-0.70	-0.70	-0.70	-0.46	-0.22	0.02	0.26	0.50	0.74	0.98	1.22	1.46	1.70	1.70	1.70	1.70	1.70	1.70	1.70
	$0.50	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.45	-0.20	0.05	0.30	0.55	0.80	1.05	1.30	1.55	1.80	1.80	1.80	1.80	1.80	1.80
	$0.60	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.46	-0.22	0.02	0.26	0.50	0.74	0.98	1.22	1.46	1.70	1.70	1.70	1.70	1.70
	$0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.49	-0.28	-0.07	0.14	0.35	0.56	0.77	0.98	1.19	1.40	1.40	1.40	1.40
	$0.80	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.54	-0.38	-0.22	-0.06	0.10	0.26	0.42	0.58	0.74	0.90	0.90	0.90
	$0.90	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.61	-0.52	-0.43	-0.34	-0.25	-0.16	-0.07	0.02	0.11	0.20	0.20
	$1.00	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70

A.5 Independent Pricing or Pure Bundling Treatment – 'High' Entry Costs Sessions

- Instructions (screen-shot format) for the whole session:

Welcome!

This is an experiment in the economics of decision making. Funding for this project has been provided by several research foundations. For your participation today we will pay you a $5 participation fee in cash at the end of the session. As will be described in these instructions, you may earn an additional amount of money depending on the decisions that you and other participants make. IT IS VERY IMPORTANT THAT YOU READ THE INSTRUCTIONS CAREFULLY. The $5 participation fee will be paid to you independent of your performance.

CONTINUE

You will be playing 1 of 2 possible roles and will remain in that role throughout 15 periods. The role that you will play is selected at random. You will be paired with somebody in this room. The person you are paired with will change from period to period. You will not be told which person you are paired with, either during or after the session. The person you are paired with is selected at random.

Your identity will be kept confidential throughout today's session and after.

At the end of the session you will be called up one by one to be paid in private. Nobody else will see how much you earn.

CONTINUE

Today's session comprises a series of **15 periods** and each of you is a **seller** for this series of periods.

There are **two** types of sellers - **Seller 1** and **Seller 2**. Each **Seller 2** will be given a **one time** initial endowment of $10 (**not** $10 in each of the 15 periods).

You will be assigned a role of either Seller 1 or Seller 2, and you will remain in this role throughout the 15 periods. In each period each seller is paired with a randomly selected seller of the other type.

On the next screens we will explain in more detail the behavior of the sellers.

CONTINUE

In each period **Seller 1** will be selling two goods - A - **and** - B -. At the beginning of a period **Seller 1** will be asked whether he/she wants to sell a bundle of those goods or sell each good separately.

If **Seller 1** decides to sell the - Two Good Bundle - he/she will have to select a **price** for it. This one price will be charged for the sale of both goods together. Otherwise, Seller 1 selects one **price** for good - A - **and** one, possibly different, **price** for good - B -.

In each period **Seller 2** will be informed about Seller 1's decision of whether to sell the goods as a bundle or to sell them separately, and which price(s) Seller 1 decided on. Seller 2 will also learn which **good** - A - **or** - B - he/she **may sell** in that period. The good with which Seller 2 can participate is selected at random and may vary from period to period. Seller 2 will then be asked whether he/she wants to participate in this good's market.

If **Seller 2** decides to **participate** he/she will have to choose a **price** for the good.

The computer will then simulate the buyers' behavior based on the bundling, price, and participation decisions.

CONTINUE

Both you and the other seller will be making **price choices**. The selected prices together determine the earnings of both sellers.

If **Seller 1** decides to sell the - Two Good Bundle - the prices that he/she may choose for it are located on the **left side** of the **YELLOW** table of payoffs - "Seller 1's Payoffs". The prices that **Seller 2** may pick if he/she decides to **participate** are located on the **left side** of the **BLUE** table of payoffs - "Seller 2's Payoffs".

If **Seller 1** decides to **sell** goods - A - **and** - B - separately the prices that he/she may choose for each good are located on the **left side** of the **PINK** table of payoffs - "Seller 1's Payoffs". The prices that **Seller 2** may pick if he/she decides to **participate** are located on the **left side** of the **GREEN** table of payoffs - "Seller 2's Payoffs".

You will find those tables in your handouts next to your computer.

Earnings take into account sellers' bundling, price, and participation choices, and the behavior of computer simulated buyers, as described on the next screen.

CONTINUE

The computer will simulate the behavior of a large number of buyers.

If the - Two Good Bundle - is offered, each **buyer** has the ability to purchase **one** unit of the - Two Good Bundle -, or **one** unit of good **A**, or **one** unit of good **B**. Otherwise, each **buyer** has the ability to purchase **one** unit of good **A**, **one** unit of good **B**, or one unit of each.

To every buyer, the - Two Good Bundle - is worth a value between **$0.00** and **$2.00**; and each unit of good A and good B is worth a value between **$0.00** and **$1.00**. Each buyer is equally likely to have any value in those intervals for the bundle and for each good, respectively. Buyers choose to buy good **A** and/or good **B**, or a bundle of **A** and **B** that maximize their gains (that is, the excess of value over purchase price).

On the next screen we will explain in more detail how to use the tables of payoffs.

CONTINUE

Depending on the role you are playing, you will be picking a price for the - Two Good Bundle - **or** a price for good - A - **and/or** a price for good - B -.

There are **YELLOW** and **PINK** tables of payoffs for **Seller 1** ("Seller 1's Payoffs"), and **BLUE** and **GREEN** tables of payoffs ("Seller 2's Payoffs") for **Seller 2**. By deciding to sell the - Two Good Bundle - **or** goods - A - **and** - B - separately Seller 1 determines the set of tables - YELLOW, BLUE - **or** - PINK, GREEN - from which you will be picking prices.

The **price** you may select for the - Two Good Bundle - range from **$0.00** to **$2.00**. The **prices** you may select for good - A - **and/or** - B - range from **$0.00** to **$1.00**. These prices are on the **left side** of your **table** of payoffs. By making a price choice for one good you determine the **row** from which your payoff will be picked. The price selected by the other seller for this same good is written across the top of your table. Therefore, the other seller determines the **column** from which your payoff will be picked. The **intersection** of the row and column choices determines your earnings from your table for that period.

If Seller 1 decides to sell goods - A - **and** - B - separately your earnings from the sale of each of these goods will be added for each period.

CONTINUE

You will now be led through a practice session. In the following, you will be given the opportunity to practice making decisions for both Seller 1 and Seller 2. In the actual session, however, you will be either Seller 1 or Seller 2.

Please closely follow the instructions that will be given to you on the next screens so you can better understand the game.

CONTINUE

First, at the beginning of a period **Seller 1** must decide whether to sell the - Two Good Bundle -. This decision determines the set of tables - YELLOW, BLUE - **or** - PINK, GREEN - that sellers will use in the remainder of the period.

If **Seller 1** decides to **sell** the - Two Good Bundle - then Seller 1's **prices** and **earnings** will be picked from the **YELLOW** table of payoffs ("Seller 1's Payoffs") and **Seller 2's** from the **BLUE** table of payoffs ("Seller 2's Payoffs") in this period. If **Seller 1** decides to **sell** goods - A - **and** - B - separately then Seller 1's **prices** and **earnings** will be picked from the **PINK** table of payoffs ("Seller 1's Payoffs") and Seller 2's from the **GREEN** table of payoffs ("Seller 2's Payoffs") in this period. As the experiment proceeds, you will be reminded about which tables to use.

Now you will be making decisions as **Seller 1**. Please look below at the first decision screen display for Seller 1 and take a moment to carefully look at the **YELLOW** and the **PINK** tables of payoffs (both "Seller 1's Payoffs"). Pretend that you are **Seller 1** and decide that you **want** to **sell** the - Two Good Bundle - in this period. Make your bundling decision by clicking the **"Two Good Bundle"** button below.

DO THIS NOW.

PRACTICE

Pretend that you are **SELLER 1**.

You will soon pretend to be Seller 2 as well.

Please take a moment to carefully look at the **YELLOW** table (containing the earnings for selling the **- Two Good Bundle -**) and the **PINK** table (containing the earnings for selling **goods** - A - **and** - B - **separately**).

Do you want to sell the - Two Good Bundle - **or** goods - A - **and** - B - separately in this period?

Two Good Bundle

A and B separately

Next, consider **Seller 1's** second decision screen displayed below. A reminder of Seller 1's decision to sell the - Two Good Bundle - appears in the upper section of this screen.

Seller 1 must now choose and enter a price for the - Two Good Bundle -. To demonstrate this, look below at the second screen display for Seller 1. By choosing a **price** for the - Two Good Bundle - on the **YELLOW** table of payoffs ("Seller 1's Payoffs") you are selecting the **row** from which **Seller 1's earnings** will be picked. This **price** is on the **left** side of the **YELLOW** table of payoffs ("Seller 1's Payoffs").

Now we will be practicing entering prices. Continue to pretend that you are **Seller 1** and enter a price of **$1.30** for the - Two Good Bundle - below. Please take a moment to locate the row containing this price on the left side of the **YELLOW** table of payoffs ("Seller 1's Payoffs").

ENTER THIS PRICE NOW. Press the **OK** button to confirm your choice.

PRACTICE

This is the second step for **SELLER 1**.

YOU ARE SELLING THE - Two Good Bundle - IN THIS PERIOD.

Please enter your price for the - Two Good Bundle -:		
	○ $0.00	
	○ $0.10	
	○ $0.20	
	○ $0.30	
	○ $0.40	
	○ $0.50	
	○ $0.60	To confirm, press OK
	○ $0.70	
	○ $0.80	
	○ $0.90	
	○ $1.00	
	○ $1.10	**OK**
	○ $1.20	
	● $1.30	
	○ $1.40	
	○ $1.50	
	○ $1.60	
	○ $1.70	
	○ $1.80	
	○ $1.90	
	○ $2.00	

Seller 2 must now decide whether to participate in this period. If Seller 2 does not participate he/she will get earnings of $0.00. If Seller 2 does participate his/her payoffs are in the **BLUE** table of payoffs ("Seller 2's payoffs"). Seller 1's price determines the **column** from which **Seller 2's earnings** will be picked and Seller 2's price determines the row.

We now switch to the first decision screen display for Seller 2, which is shown below. The decision of selling the - Two Good Bundle - and the price entered by Seller 1 are in the middle section of this screen. The predetermined good with which Seller 2 may participate (good - A -) is listed after Seller 1's price.

Pretend that you are **Seller 2** and decide that you **want** to **participate** in this period. Please take a moment to locate the column containing Seller 1's price for the - Two Good Bundle - in the **BLUE** table of payoffs ("Seller 2's payoffs"). Then make your participation decision by clicking the **YES** button below.

DO THIS NOW.

PRACTICE

Now pretend that you are **SELLER 2**.

Seller 1 is selling the - Two Good Bundle - in this period.

Seller 1's price for the - Two Good Bundle - is: $1.30

YOU MAY PARTICIPATE WITH GOOD - A - IN THIS PERIOD.

Please take a moment to locate Seller 1's price for the - Two Good Bundle - in the BLUE table.

Do you want to participate in this period?

Yes

No

Finally, the second decision screen for Seller 2 is shown below. **Seller 2** must now choose a **price** (between $0.00 and $1.00) for good - A -. By choosing a **price** for this good on the **BLUE** table of payoffs ("Seller 2's Payoffs") you are selecting the **row** from which **Seller 2's earnings** will be picked. This **price** is on the **left side** of the **BLUE** table of payoffs ("Seller 2's Payoffs").

You will now continue to make decisions as Seller 2. A reminder of Seller 1's bundling and price decisions, and the good with which Seller 2 is participating appear in the middle section of Seller 2's second decision screen shown below. Please take a moment to locate the payoff in the BLUE table ("Seller 2's Payoffs") corresponding to a price of $1.30 for Seller 1 and a price of $0.40 for Seller 2. Enter the price of **$0.40**.

ENTER THE PRICE NOW. Press the **OK** button to confirm your choices.

PRACTICE

This is the second step for **SELLER 2**.

Remember that:

Seller 1 is selling the - Two Good Bundle - in this period.

Seller 1's price for the - Two Good Bundle - is: $1.30.

YOU MAY ONLY SELL GOOD - A -

Please take a moment to locate Seller 1's price for the - Two Good Bundle - across the top of the BLUE table. You must now choose a price between $0.00 and $1.00 for good - A - by picking a row on the left side of the BLUE table. Enter the selected price on the next box.	Please enter your price: ○ $0.00 ○ $0.10 ○ $0.20 ○ $0.30 ● $0.40 ○ $0.50 ○ $0.60 ○ $0.70 ○ $0.80 ○ $0.90 ○ $1.00	To confirm, press OK **OK**

When both sellers finish entering their price decisions, your **earnings** as **Seller 1** from the **YELLOW** table of payoffs ("Seller 1's Payoffs") and your **earnings** as **Seller 2** from the **BLUE** table of payoffs ("Seller 2's Payoffs") are computed. These earnings are shown below along with some explanations on how they could be found in the payoff tables.

Seller 1's results:

Seller 1's price for the - Two Good Bundle -	Seller 1's Earnings
$1.30	0.85

"Seller 1's Earnings" for this period are in the **YELLOW** table of payoffs at the **intersection** of **row $1.30** (the price Seller 1 selected) and **column $0.40** (the price Seller 2 selected); these earnings are **0.85**.

Seller 2's results:

Seller 2 participated?	Seller 2's price for - A -	Seller 2's Earnings
YES	$0.40	0.16

"Seller 2's Earnings" for this period are in the **BLUE** table of payoffs at the **intersection** of **row $0.40** (the price Seller 2 selected) and **column $1.30** (the price Seller 1 selected); these earnings are **0.16**.

Please press the "CONTINUE" button when you are ready to proceed with the instructions.

CONTINUE

Let us now go back to the point where Seller 1 decides whether to sell the - Two Good Bundle - for this period. The first decision screen displayed for Seller 1 is again shown below.

This time pretend that you are **Seller 1** and decide that you **want** to **sell** goods - A - **and** - B - separately in this period. Seller 1's **prices** and **earnings** will now be picked from the **PINK** table of payoffs ("Seller 1's Payoffs") and Seller 2's from the **GREEN** table of payoffs ("Seller 2's Payoffs"). Make your decision by clicking the **"A and B separately"** button below.

DO THIS NOW.

PRACTICE

Again, pretend that you are **SELLER 1**.

You will soon pretend to be Seller 2 as well.

Please take a moment to carefully look at the **YELLOW** table (containing the earnings for selling the **- Two Good Bundle -**) and the **PINK** table (containing the earnings for selling **goods** - A - **and** - B - **separately**).

Do you want to sell the - Two Good Bundle - **or** goods - A - **and** - B - separately in this period?

Two Good Bundle

A and B separately

Next, consider the other **Seller 1's** second decision screen displayed below. A reminder of Seller 1's decision to sell goods - A - and - B - separately appears in the upper section of this screen.

Seller 1 must now choose and enter a price for each good - A - **and** - B -. To demonstrate this, look below at the second screen display for Seller 1. By choosing a **price** for good - A - **and** good - B - on the **PINK** table of payoffs ("Seller 1's Payoffs") you are selecting the **row** from which **Seller 1's earnings** will be picked. These **prices** are on the **left** side of the **PINK** table of payoffs ("Seller 1's Payoffs").

Now we will be practicing entering prices. Continue to pretend that you are **Seller 1** and enter a price of **$0.80** for good - A - **and** a price of **$0.50** for good - B - below. Please take a moment to locate the rows containing these prices on the left side of the **PINK** table of payoffs ("Seller 1's Payoffs").

ENTER THESE PRICES NOW. Press the **OK** button to confirm your choices.

PRACTICE

This is the second step for **SELLER 1**.

YOU ARE SELLING GOODS - A - AND - B - SEPARATELY IN THIS PERIOD.

Please enter your price for good - A -:		Please enter your price for good - B -:		
○	$0.00	○	$0.00	
○	$0.10	○	$0.10	
○	$0.20	○	$0.20	
○	$0.30	○	$0.30	
○	$0.40	○	$0.40	To confirm, press OK
○	$0.50	●	$0.50	
○	$0.60	○	$0.60	
○	$0.70	○	$0.70	**OK**
●	$0.80	○	$0.80	
○	$0.90	○	$0.90	
○	$1.00	○	$1.00	

Seller 2 must now decide whether to participate in this period. The first decision screen displayed for Seller 2 is again shown below. Notice that the decision of selling goods - A - and - B - separately, and the prices entered by Seller 1 are shown in the middle section of this screen; the predetermined good (good - A -) with which Seller 2 may participate has not changed.

This time pretend that you are **Seller 2** and decide that you **do not** want to **participate** in this period. Make your participation decision by clicking the **NO** button below.

DO THIS NOW.

PRACTICE

Now pretend that you are **SELLER 2**.

Seller 1 is selling goods - A - and - B - separately in this period.

Seller 1's price for good - A - is: $0.80

Seller 1's price for good - B - is: $0.50

YOU MAY PARTICIPATE WITH GOOD - A - IN THIS PERIOD.

Please take a moment to locate Seller 1's price for good - A - in the GREEN table.

Do you want to participate in this period?

Yes

No

Since Seller 2 is not participating in the selected market there are no further decisions to be made in this period. Your **earnings** as **Seller 1** from the **PINK** table of payoffs ("Seller 1's Payoffs") and your **earnings** as **Seller 2** from the **GREEN** table of payoffs ("Seller 2's Payoffs") are computed and shown below along with some explanations on how these earnings can be found.

Seller 1's results:

Seller 1's price for - A -	Seller 1's Earnings in - A -	Seller 1's price for - B -	Seller 1's Earnings in - B -	Seller 1's Earnings
$0.80	1.60	$0.50	2.50	4.10

"Seller 1's Earnings in - A -" are in the **PINK** table of payoffs at the **intersection** of **row $0.80** (the price Seller 1 selected) and **column** "Seller 2 does not participate"; these earnings are **1.60**.

"Seller 1's Earnings in - B -" are in the **PINK** table of payoffs at the **intersection** of **row $0.50** (the price Seller 1 selected) and **column** "Seller 2 does not participate"; these earnings are **2.50**.

"Seller 1's Earnings" for this period are $4.10 (that is, 1.60 + 2.50).

Seller 2's results:

Seller 2 participated?	Seller 2's price for - A -	Seller 2's Earnings in - A -	Seller 2's Earnings
NO	$0.00	0.00	0.00

"Seller 2's Earnings in - A -" and "Seller 2's Earnings in - B -" would **both** be **0.00** since Seller 2 decided not to participate in this period.

"Seller 2's Earnings" for this period are $0.00 (that is, 0.00 + 0.00).

Please press the "CONTINUE" button when you are ready to proceed with the instructions.

CONTINUE

Before we proceed to the practice session, and given the **information** and **prices** that follow, locate (in the **PINK** table of payoffs - "Seller 1's payoffs") and enter **Seller 1's earnings** in good - A - **and** good - B -. Also, locate (in the **GREEN** table of payoffs -"Seller 2's payoffs") and enter **Seller 2's earnings** in good - A - **or** good - B -.

Seller 1 decides to sell goods - A - **and** - B - separately and picks a price of **$0.70** for good - A - and a price of **$0.20** for good - B -. **Seller 2** participates and picks a price of **$0.30** for good - B -.

The correct answers, along with an explanation on how these earnings can be found, will be provided on the next screen.

Seller 1's Earnings in - A -	Seller 1's Earnings in - B -
2.1	2.1

Seller 2's Earnings in - B -
-1.2

Please press the "CONTINUE" button when you are ready to proceed with the instructions.

CONTINUE

The **correct earnings** for **Seller 1** from the **PINK** table of payoffs ("Seller 1's Payoffs") and the **correct earnings** for **Seller 2** from the **GREEN** table of payoffs ("Seller 2's Payoffs") are shown below along with some explanations on how these earnings can be found.

Seller 1's results:

Seller 1's price for - A -	Seller 1's Earnings in - A -	Seller 1's price for - B -	Seller 1's Earnings in - B -	Seller 1's Earnings
$0.70	2.10	$0.20	(2.10) INCORRECT	4.20

CORRECT ANSWER: "Seller 1's Earnings in - A -" are in the **PINK** table of payoffs at the **intersection** of **row $0.70** (the price Seller 1 selected) and **column** "Seller 2 does not participate"; these earnings are **2.10**.

CORRECT ANSWER: "Seller 1's Earnings in - B -" are in the **PINK** table of payoffs at the **intersection** of **row $0.20** (the price Seller 1 selected) and **column $0.30** (the price Seller 2 selected); these earnings are **1.60**.

"Seller 1's Earnings" for this period are $4.20 (that is, 2.10 + 2.10).

Seller 2's results:

Seller 2 participated?	Seller 2's price for - B -	Seller 2's Earnings in - B -	Seller 2's Earnings
YES	$0.30	(-1.20) INCORRECT	-2.00

CORRECT ANSWER: "Seller 2's Earnings in - A -" are **0.00** since Seller 2 is only participating in the - B - market.

CORRECT ANSWER: "Seller 2's Earnings in - B -" are in the **GREEN** table of payoffs at the **intersection** of **row $0.30** (the price Seller 2 selected) and **column $0.20** (the price Seller 1 selected); these earnings are **-2.00**.

"Seller 2's Earnings" for this period are $-2.00 (that is, 0.00 - 2.00).

Please press the "CONTINUE" button when you are ready to proceed with the instructions.

CONTINUE

Summary of procedures:

You will learn whether you are Seller 1 or 2 at the beginning of the actual session.

There will be **15 PERIODS** in the actual session. For each of 15 periods there are 4 steps as follows:

1. Seller 1 decides whether to sell the - Two Good Bundle - or goods - A - and - B - separately.

2. If Seller 1 decides to sell the - Two Good Bundle - he/she selects a price for it from the YELLOW table. Otherwise, Seller 1 selects a price for good - A - and a price for good - B - both from the PINK table.

3. Seller 2 learns Seller 1's bundling and price decisions, the good he/she may participate with, and decides whether or not to participate in the predetermined market. Seller 1's prices are shown across the top of the BLUE and GREEN tables.

4. If Seller 2 decides to participate: when Seller 1 is selling the - Two Good Bundle - Seller 2 selects a price for the predetermined good from the BLUE table; when Seller 1 is selling goods - A - and - B - separately Seller 2 selects a price from the GREEN table. Otherwise Seller 2 takes no further action in this period.

The computer simulates the buying decisions.

CONTINUE

You will have a chance to practice these procedures further before the actual session begins. During the actual session the person you are paired with is selected at random. However, during the practice session you will be playing both Seller 1 and Seller 2 so you can get the opportunity to practice both roles.

There are **two** PRACTICE SESSIONS. YOU WILL NOT BE PAID FOR THESE TWO SESSIONS.

The PRACTICE SESSIONS are on the next screens. Please press the "CONTINUE" button when you are ready.

CONTINUE

- Instructions (screen-shot format) for the first period of practice:

PRACTICE SESSION

Pretend that you are **SELLER 1**. Your decisions as Seller 1 and the decisions made by you as **Seller 2** (with whom you are paired with during this practice session) will be reported to you on the screens that follow.

Although you are in the **Practice Session, do your best** in order to see how the game works.

Please take a moment to carefully look at the **YELLOW** table (containing the earnings for selling the **- Two Good Bundle -**) and the **PINK** table (containing the earnings for selling **goods** - A - **and** - B - **separately**).

Do you want to sell the - Two Good Bundle - **or** goods - A - **and** - B - separately in this period?

Two Good Bundle

→ **A and B separately**

PRACTICE SESSION

This is the second step for **SELLER 1**.

YOU ARE SELLING GOODS - A - AND - B - SEPARATELY IN THIS PERIOD.

Please take a moment to locate the rows containing prices between $0.00 and $1.00 on the left side of the **PINK** table of payoffs ("Seller 1's Payoffs"). Below enter a price for good - A - **and** good - B -.

Please enter your price for good - A -:		Please enter your price for good - B -:		
○	$0.00	○	$0.00	To confirm, press OK
○	$0.10	○	$0.10	
○	$0.20	○	$0.20	
○	$0.30	○	$0.30	
●	$0.40	○	$0.40	
○	$0.50	○	$0.50	
○	$0.60	●	$0.60	**OK**
○	$0.70	○	$0.70	
○	$0.80	○	$0.80	
○	$0.90	○	$0.90	
○	$1.00	○	$1.00	

PRACTICE SESSION

Now pretend that you are **SELLER 2**.

Although you are in the **Practice Session, do your best** in order to see how the game works.

Seller 1 is selling goods - A - and - B - separately in this period.

Seller 1's price for good - A - is: $0.40

Seller 1's price for good - B - is: $0.60

YOU MAY PARTICIPATE WITH GOOD - B - IN THIS PERIOD.

Please take a moment to locate Seller 1's price for good - B - in the GREEN table.

Do you want to participate in this period?

→ **Yes**

No

PRACTICE SESSION

This is the second step for **Seller 2**.

Remember that:

Seller 1 is selling goods - A - and - B - separately in this period.

Seller 1's price for good - A - is: $0.40.

Seller 1's price for good - B - is: $0.60.

YOU MAY ONLY SELL GOOD - B -

Please take a moment to locate Seller 1's price for good - B - across the top of the GREEN table.

You must now choose a price between $0.00 and $1.00 for good - B - by picking a row on the left side of the GREEN table. Enter the selected price on the next box.

Please enter your price:

- ○ $0.00
- ○ $0.10
- ○ $0.20
- ○ $0.30
- ○ $0.40
- ● $0.50
- ○ $0.60
- ○ $0.70
- ○ $0.80
- ○ $0.90
- ○ $1.00

To confirm, press OK

OK

PRACTICE SESSION

Seller 1 and Seller 2's results for the Practice Session you have just played are shown below.

Seller 1's results for the Practice Session:

Seller 1's price for - A -	Seller 1's Earnings in - A -	Seller 1's price for - B -	Seller 1's Earnings in - B -	Seller 1's Earnings
$0.40	2.40	$0.60	0.00	2.40

Seller 2's results for the Practice Session:

Seller 2 participated?	Seller 2's price for - B -	Seller 2's Earnings in - B -	Seller 2's Earnings
YES	$0.50	0.50	0.50

On the next screen you will be able to simultaneously practice as - Seller 1 - and as - Seller 2 - different price decisions other than the ones you have just finished. Please press the "CONTINUE" button when you are ready to proceed.

CONTINUE

- Instructions (screen-shot format) for the second period of practice:

PRACTICE SESSION

Pretend that you are **SELLER 1**. Your decisions as Seller 1 and the decisions made by you as **Seller 2** (with whom you are paired with during this practice session) will be reported to you on the screens that follow.

Although you are in the **Practice Session, do your best** in order to see how the game works.

Please take a moment to carefully look at the **YELLOW** table (containing the earnings for selling the **- Two Good Bundle -**) and the **PINK** table (containing the earnings for selling **goods** - A - **and** - B - **separately**).

Do you want to sell the - Two Good Bundle - **or** goods - A - **and** - B - separately in this period?

→ **Two Good Bundle**

A and B separately

PRACTICE SESSION

This is the second step for **SELLER 1**.

YOU ARE SELLING THE - Two Good Bundle - IN THIS PERIOD.

Please take a moment to locate the rows containing prices between $0.00 and $2.00 on the left side of the **YELLOW** table of payoffs ("Seller 1's Payoffs"). Below enter a price for the - Two Good Bundle -.

Please enter your price for the - Two Good Bundle -:		
	○ $0.00	To confirm, press OK
	○ $0.10	
	○ $0.20	
	○ $0.30	
	○ $0.40	
	○ $0.50	
	○ $0.60	
	○ $0.70	
	○ $0.80	
	○ $0.90	
	● $1.00	**OK**
	○ $1.10	
	○ $1.20	
	○ $1.30	
	○ $1.40	
	○ $1.50	
	○ $1.60	
	○ $1.70	
	○ $1.80	
	○ $1.90	
	○ $2.00	

PRACTICE SESSION

Now pretend that you are **SELLER 2**.

Although you are in the **Practice Session, do your best** in order to see how the game works.

Seller 1 is selling the - Two Good Bundle - in this period.

Seller 1's price for the - Two Good Bundle - is: $1.00

YOU MAY PARTICIPATE WITH GOOD - A - IN THIS PERIOD.

Please take a moment to locate Seller 1's price for the - Two Good Bundle - in the BLUE table.

Do you want to participate in this period?

Yes

→ **No**

PRACTICE SESSION

Seller 1 and Seller 2's results for the Practice Session you have just played are shown below.

Seller 1's results for the Practice Session:

Seller 1's price for the - Two Good Bundle -	Seller 1's Earnings
$1.00	5.00

Seller 2's results for the Practice Session:

Seller 2 participated?	Seller 2's price for - A -	Seller 2's Earnings
NO	$0.00	0.00

You have just finished the PRACTICE SESSION.   Please press the "CONTINUE" button when you are ready to proceed.

CONTINUE

- Instructions (screen-shot format) for the actual session:

Round

1 out of 15

You have been randomly selected to be **Seller 1**. In each of the next **15** periods, you will be playing against a **different** randomly selected **Seller 2**.

We are now ready to begin the ACTUAL SESSION. If you have any questions at this point, please raise your hand and an experimenter will come and assist you.

Please press the "CONTINUE" button when you are ready!!!

CONTINUE

Round

1 out of 15

You have been randomly selected to be **Seller 2**. In each of the next **15** periods, you will be playing against a **different** randomly selected **Seller 1**.

You will be given a **one time** initial endowment of $10 (**not** $10 in each of the 15 periods). If you incur any loss, your loss will be deducted from this initial endowment. Any losses in excess of $10 will be forgiven.

We are now ready to begin the ACTUAL SESSION. If you have any questions at this point, please raise your hand and an experimenter will come and assist you.

Please press the "CONTINUE" button when you are ready!!!

CONTINUE

Round

1 out of 15

Remember that you are **Seller 1**.

Please take a moment to carefully look at the **YELLOW** table (containing the earnings for selling the **- Two Good Bundle -**) and the **PINK** table (containing the earnings for selling **goods** - A - **and** - B - **separately**).

Do you want to sell the - Two Good Bundle - **or** goods - A - **and** - B - separately in this period?

→ **Two Good Bundle**

A and B separately

At the same time, seller 2's instructions would be to:

Please wait patiently for Seller 1's decisions.

Round

1 out of 15

Remember that you are **Seller 1**.

YOU ARE SELLING THE - Two Good Bundle - IN THIS PERIOD.

Please take a moment to locate the rows containing prices between $0.00 and $2.00 on the left side of the **YELLOW** table of payoffs ("Seller 1's Payoffs"). Below enter a price for the - Two Good Bundle -.

Please enter your price for the - Two Good Bundle -:

- ○ $0.00
- ○ $0.10
- ○ $0.20
- ○ $0.30
- ○ $0.40
- ○ $0.50
- ○ $0.60
- ○ $0.70
- ● $0.80
- ○ $0.90
- ○ $1.00
- ○ $1.10
- ○ $1.20
- ○ $1.30
- ○ $1.40
- ○ $1.50
- ○ $1.60
- ○ $1.70
- ○ $1.80
- ○ $1.90
- ○ $2.00

To confirm, press OK

OK

Round

1 out of 15

Remember that you are **Seller 2**.

Seller 1 is selling the - Two Good Bundle - in this period.

Seller 1's price for the - Two Good Bundle - is: $0.80

YOU MAY PARTICIPATE WITH GOOD - B - IN THIS PERIOD.

Please take a moment to locate Seller 1's price for the - Two Good Bundle - in the BLUE table.

Do you want to participate in this period?

Yes

→ **No**

At the same time, seller 1’s instructions would be to:

Please wait patiently for Seller 2's decisions.

Your results, and Seller 2's results, for this period, are shown below.

Your results for this period are:

Your Price for the - Two Good Bundle -	Your Earnings
$0.80	5.44

Your "CUMULATIVE EARNINGS" up until this period are $5.44

Seller 2's results for this period are:

Did Seller 2 participate?	Seller 2's price for - B -	Seller 2's Earnings
NO	$0.00	0.00

*** This is the end of this period. ***

Please press the "OK" button when you are ready!!!

OK

- Handouts #5 – seller 1 and seller 2's payment tables:

There are four payment tables: (1) two concerning seller 1 and seller 2 players' payoffs for the 'independent pricing' game with 'high' entry costs, which are identical to the 'PINK table – Seller 1's Payoffs' and the 'GREEN table – Seller 2's Payoffs', respectively (see handouts #1); (2) two concerning seller 1 and seller 2 players' payoffs for the 'pure bundling' game with 'high' entry costs, which are identical to the 'YELLOW table – Seller 1's Payoffs' and the BLUE table – Seller 2's Payoffs', respectively (see handouts #3).

A.6 Independent Pricing or Pure Bundling Treatment – 'Low' Entry Costs Sessions

The instructions (screen-shot format) for this session are identical to the ones of 'independent pricing or pure bundling treatment' with 'high' entry costs, only the results that are presented to players change given the entry costs used to calculate seller 2's payoffs are now of \$0.7 instead of \$2.0.

- Handouts #6 – seller 1 and seller 2's payment tables:

There are four payment tables: (1) two concerning seller 1 and seller 2 players' payoffs for the 'independent pricing' game with 'low' entry costs, which are identical to the 'PINK table – Seller 1's Payoffs' (see handouts #1) and the 'GREEN table – Seller 2's Payoffs' (see handouts #2), respectively; (2) two concerning seller 1 and seller 2 players' payoffs for the 'pure bundling' game with 'low' entry costs, which are identical to the 'YELLOW table – Seller 1's Payoffs' (see handouts #3) and the BLUE table – Seller 2's Payoffs' (see handouts #4), respectively.

Appendix B: Risk and Demographics

B.1 Handout for the Risk Attitude Test

At the beginning of each session, all the subjects were asked to complete the task that follows so each player's risk attitude could be evaluated:

Name:

Here is a short task for which you will get paid. For each row, numbered 1 through 9, please choose which column you would prefer to be paid by. The column labeled ***constant*** is simply a fixed payoff of $2.50. In the column labeled ***varying*** your earnings will depend on the outcome of a roll of a ten-sided dice, which will be done at the end of the experiment today.

We ask that you make a choice between ***constant*** and ***varying*** for each row. On each row, clearly circle the choice you are making. At the end of the session today, you will roll a ten-sided dice two times. The first roll will determine which row you will be paid according to, as we are not paying you for all of your choices. The second roll will determine the outcome for the ***varying*** column.

We will collect these forms before we start the next task.

Row	***Constant***	***Varying***
1	$2.50	$5 if dice shows 1 $0 if dice shows 2 - 10
2	$2.50	$5 if dice shows 1 - 2 $0 if dice shows 3 - 10
3	$2.50	$5 if dice shows 1 - 3 $0 if dice shows 4 - 10
4	$2.50	$5 if dice shows 1 - 4 $0 if dice shows 5 - 10
5	$2.50	$5 if dice shows 1 - 5 $0 if dice shows 6 - 10
6	$2.50	$5 if dice shows 1 - 6 $0 if dice shows 7 - 10
7	$2.50	$5 if dice shows 1 - 7 $0 if dice shows 8 - 10
8	$2.50	$5 if dice shows 1 - 8 $0 if dice shows 9 - 10
9	$2.50	$5 if dice shows 1 - 9 $0 if dice shows 10

B.2 Questionnaire on Demographics

At the end of each session, all the subjects had to complete the following questionnaire concerning each player's demographics:

1. What is your age?
2. What is your sex?

   ○ Female ○ Male

3. What is your race?

   ○ White

   ○ African-American

   ○ African

   ○ Asian-American

   ○ Asian

   ○ Hispanic-American

   ○ Hispanic

   ○ Mixed race

   ○ Other

4. Which category best describes your current major? Please pick one:

   ○ Economics

   ○ Business Administration, other than Economics

○ Education

○ Engineering

○ Health Professions

○ Public Affairs or Social Services

○ Biological Sciences

○ Math, Computer Sciences, or Physical Sciences

○ Social Sciences or History

○ Humanities

○ Psychology

○ Other Fields

5. What is your student status?

○ Freshman

○ Sophomore

○ Junior

○ Senior

○ Honors

○ Masters

○ Doctoral

○ Non-student

6. What is the **highest** level of education you expect to **complete**? Please pick one:

○ Bachelor's degree

○ Master's degree

○ Doctoral degree

○ First professional degree

7. What was the highest level of education that your **father** (or male guardian) **completed**? Please pick one:

○ Less than high school

○ GED or High School Equivalency

○ High School

○ Vocational or trade school

○ College or university

8. What was the highest level of education that your **mother** (or female guardian) **completed**? Please pick one:

○ Less than high school

○ GED or High School Equivalency

○ High School

○ Vocational or trade school

○ College or university

9. In financing your current degree, have you received any financial aid from grants, scholarships or loans to help pay the costs?

○ Yes ○ No

10. What is your citizenship status in the United States?

○ U.S. Citizen

○ Resident Alien

○ Non-Resident Alien

○ Other Status

11. Are you a foreign student on a Student Visa?

○ Yes ○ No

12. Are you currently married?

○ Single and never married

○ Married

○ Separated, divorced or widowed

13. On a 4-point scale, what is your current GPA if you are doing a Bachelor’s degree, or what was it when you did a Bachelor’s degree? This GPA should refer to all of your coursework, not just the current year. Please pick one:

○ Between 3.75 and 4.0 GPA (mostly A's)

○ Between 3.25 and 3.74 GPA (about half A's and half B's)

○ Between 2.75 and 3.24 GPA (mostly B's)

○ Between 2.25 and 2.74 GPA (about half B's and half C's)

○ Between 1.75 and 2.24 GPA (mostly C's)

○ Between 1.25 and 1.74 GPA (about half C's and half D's)

○ Less than 1.25 (mostly D's or below)

○ Have not taken courses for which grades are given.

Appendix C: Pooled Data Analysis

This appendix includes estimations with pooled data from the six different treatment sessions. The estimations put together supposedly important explanatory variables reflecting strategic choices made by both subjects playing seller 1 and seller 2 (already studied under each game specific conditions in Chapter 9), and other dummy variables that identify different treatment sessions. The aim is (1) to uncover plausible general patterns that might possibly explain player 1 and player 2's behavior in support of theoretical predictions; and (2) find possible treatment and/or session effects that might significantly influence players' propensity to engage in equilibrium strategies.

Table C.1–Variables and explanations

Variable	Explanation
Y4	Seller 1 chooses his/her equilibrium strategy in a given round = 1; Otherwise = 0
S2	Seller 2 chooses his/her equilibrium strategy in a given round = 1; Otherwise = 0
eqPlaY	Seller 1 chose his/her equilibrium strategy and corresponding opposing seller 2 responded with his/her equilibrium strategy in the previous round = 1; Otherwise = 0
eqPlayH	Seller 1 selected a strategy involving higher than equilibrium price choices in the way they are described in Tables 9.1, 9.10, 9.20, 9.28, 9.36, and 9.44 in the previous round, and corresponding opposing seller 2 gave his/her optimal response = 1; Otherwise = 0
eqPlayL	Seller 1 selected a strategy involving lower than equilibrium price choices in the way they are described in Tables 9.1, 9.10, 9.20, 9.28, 9.36, and 9.44 in the previous round, and corresponding opposing seller 2 gave his/her optimal response = 1; Otherwise = 0
R6_15	Rounds that range from 6 to 15 (i.e., the last 10 rounds, since 15 is the maximum number of rounds that were played in each of the six treatments) = 1; Otherwise = 0
Y4R6_15	= Y4 * R6_15
eqPlaYR6_15	= eqPlaY * R6_15
eqPlayHR6_15	= eqPlayH * R6_15
eqPlayLR6_15	= eqPlayL * R6_15
High	'High' entry costs session = 1; Otherwise = 0
Bund	'Pure Bundling' treatment =1; Otherwise = 0
Ind_Bund	'Independent Pricing or Pure Bundling' treatment = 1; Otherwise = 0
H_Bund	= High * Bund
H_IndBund	= High * Ind_Bund
Age	Subject (playing seller 1 or seller 2)'s age
Major	Economics or business major = 1; Other majors = 0
GPA	GPA choices from the questionnaire
Risk	Risk attitude ("negative" = risk loving; "0" = risk neutral; "positive" = risk averse)

Note: **1)** GPA = 1 means GPA between 3.75 and 4.00, GPA = 2 means GPA between 3.25 and 3.74, GPA = 3 means GPA between 2.75 and 3.24, GPA = 4 means GPA between 2.25 and 2.74, GPA = 5 means GPA between 1.75 and 2.24, GPA = 6 means GPA between 1.25 and 1.74, GPA = 7 means GPA less than 1.25. **2)** Risk attitude reflects a measurement of the threshold certainty equivalent for choosing the risky lottery.

Table C.2–Descriptive statistics for variables[1]

Variable	Mean	Std. Dev.	N
Y4	0.52	0.50	900
S2	0.56	0.50	900
Y4R6_15	0.36	0.48	900
High	0.50	0.50	900
Bund	0.33	0.47	900
Ind_Bund	0.33	0.47	900
H_Bund	0.17	0.37	900
H_IndBund	0.17	0.37	900
R6_15	0.67	0.47	900
eqPlaY	0.40	0.49	840
eqPlayH	0.21	0.41	840
eqPlayL	0.13	0.34	840
eqPlaYR6_15	0.31	0.46	840
eqPlayHR6_15	0.15	0.35	840
eqPlayLR6_15	0.10	0.30	840
Y4*	0.53	0.50	840
S2*	0.57	0.49	840
Y4R6_15*	0.39	0.49	840
High*	0.50	0.50	840
Bund*	0.33	0.47	840
Ind_Bund*	0.33	0.47	840
H_Bund*	0.17	0.37	840
H_IndBund*	0.17	0.37	840
R6_15*	0.71	0.45	840

Table C.3–Descriptive statistics for seller 1 and seller 2 players' demographic variables

	Seller 1		Seller 2		
Variable	Mean	Std. Dev.	Mean	Std. Dev.	N
Age	22.80	4.49	22.50	4.67	60
GPA	2.35	0.99	2.35	1.27	60
Major	0.55	0.50	0.42	0.50	60
Risk	-0.25	0.91	-0.05	1.16	60

[1] First round observations were dropped for Y4*, S2*, Y4R6_15*, High*, Bund*, Ind_Bund*, H_Bund*, H_IndBund*, and R6_15* independent variables.

- Seller 1 Players Equilibria:

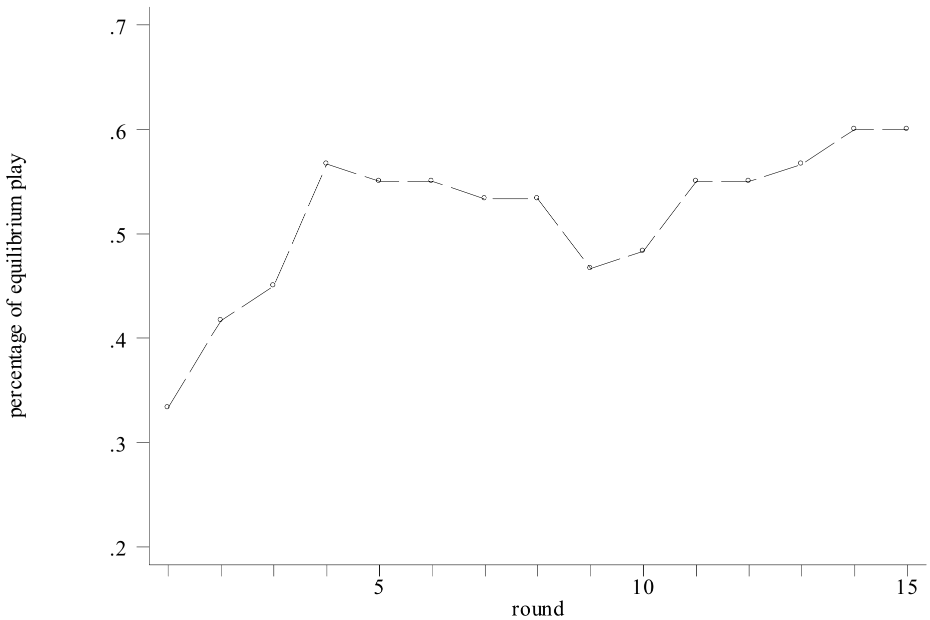
Out of the 900 possible equilibrium decisions, in 465 cases (51.67%) subjects playing seller 1 chose the theoretically predicted strategy. Table C.4 shows, for each round, the number of times such equilibrium decisions were reached and corresponding percentage.

Table C.4–Number of seller 1 players choosing equilibrium strategies and corresponding percentage in each round

Round	**Equilibrium Decisions by Seller 1**	**Percentage of Equilibrium Decisions by Seller 1**
1	20	33.33%
2	25	41.67%
3	27	45.00%
4	34	56.67%
5	33	55.00%
6	33	55.00%
7	32	53.33%
8	32	53.33%
9	28	46.67%
10	29	48.33%
11	33	55.00%
12	33	55.00%
13	34	56.67%
14	36	60.00%
15	36	60.00%

In the last 12 rounds, there were 393 equilibrium decisions (out of 720 possible ones; 720 = 60 subjects playing seller 1 * 12 rounds), which means that 54.58% of the subjects playing seller 1 satisfied predicted equilibria. The selection of equilibrium strategies was observed in higher percentages (of, e.g., 56.67% and 60%) from round 4 on (see also Figure C.1 that presents the percentage of seller 1 players engaging in equilibrium strategies in each round).

Figure C.1 Percentage of seller 1 players choosing equilibrium strategies



- Econometric Analysis for Seller 1 Players:

Our primary interest is to analyze the tendency for subjects playing seller 1 to engage in equilibria play. Figure C.1 suggests that equilibrium strategies are more likely to be played in the later rounds than in the first few ones. One might also conjecture that, in a given round, subjects playing seller 1 are influenced by: (1) the previous player 1 choices and opposing seller 2 players' decisions to enter or not; and (2) the type of treatment session they participate in (e.g., whether it is an 'independent pricing' or 'pure bundling' treatment with 'high' or 'low' entry costs).

In order to evaluate the evolution of the tendency of subjects playing seller 1 to play the predicted equilibrium strategies, binomial probit[2] models were estimated. Acronyms of all variables and their explanations are presented in Table C.1. Table C.2 presents means and standard deviations of the variables.

The dependent variable, Y4, is coded one if seller 1 players choose an equilibrium strategy, and zero otherwise. Independent variables the include R6_15 dummy variable that represents the last 10 rounds to help explain the evolution of choices over time, especially, towards the end of the sessions; another dummy variable indicating that both subjects playing seller 1 and seller 2 chose their corresponding equilibrium strategies in the previous round (i.e., eqPlaY[3]) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlaYR6_15); a dummy variable reflecting 'high' entry costs treatment sessions (i.e., High); another dummy variable representing 'pure bundling' treatment (i.e., Bund) plus its corresponding interaction term to capture the effect of 'pure bundling' with 'high' entry costs session (i.e., H_Bund); and a dummy variable indicating 'independent pricing or pure bundling' treatment (i.e., Ind_Bund) plus its corresponding interaction term to capture the effect of 'independent pricing or pure bundling' with 'high' entry costs session (i.e., H_IndBund[4]). The four demographic variables (see Table C.5) that were used in the econometric analysis of most of the six games are also included with the purpose of controlling for variations in seller 1

[2] Since the dataset has repeated observations on both subjects playing seller 1 and seller 2, all binomial probit estimations assume independence of observations across subjects but not necessarily independence across observations belonging to the same subject.

[3] eqPlayL and eqPlayH explanatory variables were not included in the models since in most of the six different treatment sessions they seem to have no significant effect on subjects playing seller 1 propensity to engage in equilibrium strategies.

[4] High, H_Bund, and H_IndBund ended up being dropped since these explanatory variables turned out to be consistently insignificant.

players' behavior that might possibly occur. (Refer to Table C.1 for detailed definitions of all explanatory variables.)

Table C.5–Probit estimates of probability of seller 1 players adopting their predicted equilibrium strategies

Variable						
Age						0.014 (0.017) [0.005]
Major						0.243 (0.196) [0.095]
GPA						0.025 (0.084) [0.010]
Risk						-0.031 (0.105) [-0.012]
H_IndBund					-0.202 (0.468) [-0.080]	
H_Bund				0.136 (0.378) [0.053]	0.009 (0.450) [0.004]	
Ind_Bund					0.567* (0.274) [0.215]	0.523* (0.250) [0.200]
Bund				0.273 (0.245) [0.106]	0.576* (0.288) [0.219]	0.645* (0.235) [0.243]
High			0.066 (0.190) [0.026]	-0.000 (0.232) [-0.000]	0.127 (0.337) [0.050]	
eqPlaYR6_15		0.694* (0.205) [0.259]	0.694* (0.204) [0.259]	0.710* (0.207) [0.265]	0.690* (0.217) [0.258]	0.714* (0.213) [0.266]
eqPlaY		1.389* (0.240) [0.490]	1.384* (0.242) [0.489]	1.439* (0.250) [0.505]	1.465* (0.263) [0.513]	1.415* (0.256) [0.498]
R6_15	0.201* (0.087) [0.080]	-0.255* (0.100) [-0.099]	-0.253* (0.100) [-0.098]	-0.270* (0.104) [-0.104]	-0.259* (0.107) [-0.100]	-0.259* (0.106) [-0.100]
Constant	-0.092 (0.116)	-0.403* (0.124)	-0.434* (0.140)	-0.536* (0.159)	-0.848* (0.227)	-1.319* (0.570)
χ^2-Test (p-value)		0.000	0.000	0.000	0.000	0.000

Note: N = 900 for the first model. N = 840 for the last five models. Y4 is the dependent variable. Numbers in parentheses are robust standard errors. Numbers in brackets are the marginal effects on the probability of seller 1 players engaging in their equilibrium strategy. (Marginal effects are calculated at the means of the independent variables; and for dummy variables (e.g., eqPlaY) they are calculated for the discrete change as the dummy changes from zero to one.) * P-value < 0.05. † P-value < 0.10. χ^2-Test compares the last five models to the first one but with N reduced to 840.

Looking at Table C.5 one can see that the explanatory variable representing the last 10 rounds of the treatment sessions (i.e., R6_15), and the one indicating that both seller 1 players and corresponding opponents playing seller 2 engaged in the predicted equilibrium outcome in the previous round (i.e., eqPlaY) have statistically significant coefficients at the 5% level for all the models they are included in. For the sixth model, the coefficient associated with R6_15 is negative, which suggests that during the last 10 rounds seller 1 players' behavior adjusts in ways that are not captured by both types of players' previous decisions and player 1 demographics. In particular, there is a diminishing tendency in the later rounds for subjects playing seller 1 to choose their predicted equilibrium outcomes. The coefficient associated with eqPlaY is positive, which indicates that when both seller 1 players and corresponding opponents playing seller 2 engage in their predicted equilibrium strategy in the previous round, subjects playing seller 1 are more likely to engage in the same kind of play in a given round. The interaction term eqPlaYR6_15 is also statistically significant at the 5% level and has a positive coefficient. This suggests that, during the last 10 rounds, when both seller 1 players and corresponding opponents playing seller 2 have previously chosen their predicted equilibrium strategy, subjects playing seller 1 are even more likely to engage in their equilibrium play in a given round; and player 1's tendency to choose strategies other than equilibrium is attenuated. The coefficients on Bund and Ind_Bund independent variables are positive and statistically significant at the 5% level. This indicates that seller 1 players are more likely to engage in equilibrium strategies when they participate in ‘pure bundling’ and ‘independent pricing or pure bundling’ treatments than in the ‘independent pricing’ one.

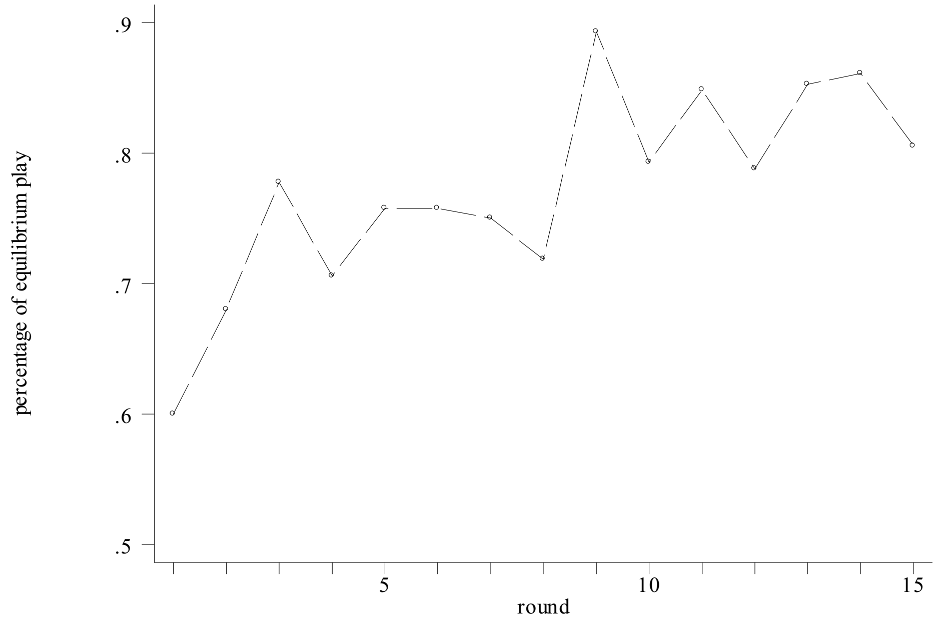
Table C.3 has the descriptive statistics on demographic characteristics for subjects playing seller 1. Results from an estimation which includes demographic variables are reported in the sixth column of Table C.5. In that estimation no demographic variable has a statistically significant coefficient at the 5% and/or the 10% levels. This suggests that demographic variables have no significant effect on subjects playing seller 1 propensity to choose equilibrium strategies. Overall, subjects playing seller 1 chose the predicted equilibrium strategies 465 times.

- Seller 2 Players Equilibria:

Results show that 77.85% (i.e., average equals 0.779 with a standard deviation of 0.416) of seller 2 players satisfied the equilibrium predictions, conditional on subjects playing seller 1 also engaging in their equilibrium strategies. However, in the remaining cases, seller 2 players deviated from the equilibrium predictions given that their corresponding opponents playing seller 1 haven’t.

Figure C.2 shows the percentage of seller 2 players choosing equilibrium play when corresponding subjects playing seller 1 engage in their equilibrium strategies in each round.

Figure C.2 Percentage of seller 2 players choosing equilibrium: Conditional on seller 1 players selecting their equilibrium strategies



- Econometric Analysis for Seller 2 Players:

For subjects playing seller 2, our primary concern is to analyze the likelihood for them to choose equilibrium strategies, conditional on seller 1 players also selecting their corresponding equilibrium ones; Figure C.2 suggests that this is more likely to occur in the later rounds than in the first few ones. Also, one might hypothesize that seller 2 players' behavior would be influenced by: (1) seller 1 players' equilibrium choices in a given round, (2) the previous player 1 choices of different strategies, and corresponding opposing seller 2 players' decisions to enter or not, and/or (3) the type of treatment session they participate in (e.g., whether it is an 'independent pricing' or 'pure bundling' treatment with 'high' or 'low' entry costs).

To evaluate the evolution of the tendency of subjects playing seller 2 to play their corresponding equilibrium strategies, binomial probit[5] models were estimated. The dependent variable, S2, is coded one if seller 2 players choose predicted equilibrium strategies and zero otherwise.[6] Independent variables include the R6_15 dummy variable that represents the last 10 rounds to help explain the evolution of choices over time, especially, towards the end of the session; another dummy variable representing seller 1 players engaging in their equilibria play in a given round (i.e., Y4) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., Y4R6_15); a dummy variable indicating that both subjects playing seller 1 and seller 2 chose their corresponding equilibrium strategies in the previous round (i.e., eqPlaY) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlaYR6_15); another dummy variable reflecting seller 1 players' previous-round deviations involving higher than equilibrium price choices and corresponding opposing seller 2 players' optimal responses (i.e., eqPlayH) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e., eqPlayHR6_15); a dummy variable representing seller 1 players' previous-round deviations involving lower than equilibrium price choices and corresponding opposing seller 2 players' optimal responses (i.e., eqPlayL) plus its corresponding interaction term to capture the effect of this variable during the last 10 rounds (i.e.,

[5] Since the dataset has repeated observations on both subjects playing seller 1 and seller 2, all binomial probit estimations assume independence of observations across subjects but not necessarily independence across observations belonging to the same subject.

[6] Acronyms of all variables and their explanations are presented in Table C.1. Table C.2 presents means and standard deviations of some variables.

eqPlayLR6_15[7]); another dummy variable reflecting 'high' entry costs treatment sessions (i.e., High); a dummy variable representing 'pure bundling' treatment (i.e., Bund) plus its corresponding interaction term to capture the effect of 'pure bundling' with 'high' entry costs session (i.e., H_Bund); and another dummy variable indicating 'independent pricing or pure bundling' treatment (i.e., Ind_Bund) plus its corresponding interaction term to capture the effect of 'independent pricing or pure bundling' with 'high' entry costs session (i.e., H_IndBund). The four demographic variables (see Table C.6) that were used in the econometric analysis of most of the six games are also included with the purpose of controlling for variations in seller 2 players' behavior that might possibly occur. (Refer to Table C.1 for detailed definitions of all explanatory variables.)

[7] Y4R6_15, eqPlaYR6_15, eqPlayHR6_15, and eqPlayLR6_15 ended up being dropped since these explanatory variables turned out to be consistently insignificant.

Table C.6–Probit estimates of probability of seller 2 players engaging in their equilibrium strategies

Variable								
Age								-0.027 (0.017) [-0.010]
Major								-0.087 (0.153) [-0.033]
GPA								-0.056 (0.061) [-0.021]
Risk								-0.003 (0.055) [-0.001]
H_IndBund							1.315* (0.274) [0.392]	1.485* (0.271) [0.422]
H_Bund							1.082* (0.382) [0.342]	1.270* (0.400) [0.382]
Ind_Bund							-0.538* (0.222) [-0.209]	-0.691* (0.220) [-0.267]
Bund							-0.967* (0.200) [-0.369]	-1.089* (0.217) [-0.412]
High						0.416* (0.163) [0.160]	-0.314† (0.184) [-0.120]	-0.469* (0.198) [-0.178]
eqPlayLR6_15					-0.082 (0.351) [-0.032]			
eqPlayHR6_15				-0.085 (0.233) [-0.033]	-0.029 (0.244) [-0.011]			
eqPlaYR6_15			0.131 (0.184) [0.051]	0.114 (0.206) [0.044]	0.167 (0.261) [0.064]			
eqPlayL					1.117* (0.374) [0.348]	1.075* (0.266) [0.339]	0.838* (0.261) [0.276]	0.788* (0.252) [0.263]
eqPlayH				0.401* (0.194) [0.149]	0.700* (0.208) [0.248]	0.709* (0.205) [0.251]	0.861* (0.205) [0.292]	0.827* (0.196) [0.282]
eqPlaY			0.554* (0.182) [0.209]	0.678* (0.193) [0.253]	0.986* (0.248) [0.357]	1.077* (0.194) [0.386]	0.974* (0.190) [0.350]	0.958* (0.185) [0.344]
Y4R6_15		0.050 (0.180) [0.020]	0.101 (0.215) [0.039]	0.099 (0.213) [0.038]	0.054 (0.215) [0.021]			
Y4		1.201* (0.176) [0.447]	1.208* (0.196) [0.446]	1.201* (0.200) [0.444]	1.276* (0.204) [0.467]	1.303* (0.153) [0.476]	1.332* (0.158) [0.483]	1.368* (0.162) [0.494]
R6_15	0.324* (0.082) [0.128]	0.256* (0.116) [0.101]	0.054 (0.172) [0.021]	0.072 (0.194) [0.028]	0.037 (0.238) [0.014]	0.111 (0.087) [0.043]	0.149 (0.094) [0.057]	0.150 (0.097) [0.058]
Constant	-0.075 (0.102)	-0.641* (0.127)	-0.740* (0.161)	-0.862* (0.185)	-1.199* (0.227)	-1.448* (0.210)	-0.954* (0.206)	-0.074 (0.484)
χ^2-Test (p-value)		0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: N = 900 for the first two models. N = 840 for the last six models. S2 is the dependent variable. Numbers in parentheses are robust standard errors. Numbers in brackets are the marginal effects on the probability of seller 2 players choosing their equilibrium strategies. (Marginal effects are calculated at the means of the independent variables; and for dummy variables (e.g., Y4) they are calculated for the discrete change as the dummy changes from zero to one.) * P-value < 0.05. † P-value < 0.10. χ^2-Test compares the last seven models to the first one, but with N reduced to 840 for the last six models.

Table C.6 results show that the coefficient on the variable indicating seller 1 player's choice of equilibrium strategies in a given round (i.e., Y4) is positive and statistically significant at the 5% level for the models it is included in. For the eighth model this suggests that when seller 1 players choose equilibrium strategies, seller 2 players are also more likely to choose their equilibrium play in a given round. The explanatory variable eqPlaY also has a positive and statistically significant coefficient at the 5% level, which indicates that when both seller 1 and seller 2 players engage in their equilibrium strategies in the previous round, seller 2 players are more likely to engage in the same kind of play in a given round. Independent variables eqPlayH and eqPlayL also have positive and statistically significant coefficients at the 5% level, which suggests that when subjects playing seller 1 deviate from their equilibrium strategies and corresponding opposing seller 2 players respond with the optimum in the previous round, seller 2 players are more likely to choose their equilibrium strategy in a given round. Variables High, Bund, and Ind_Bund have negative and statistically significant coefficients at the 5% level. This indicates that seller 2 players are less likely to choose their equilibrium strategies when they participate in 'high' entry costs sessions, and 'pure bundling' or 'independent pricing or pure bundling' treatments, respectively (when compared to 'independent pricing' with 'low' entry costs one). However, since the interaction terms H_Bund and H_IndBund have positive and statistically significant coefficients also at the 5% level, the negative effects noted above are partially offset for ‘independent pricing’, ‘pure bundling’, and ‘independent pricing or pure bundling’ with ‘high’ entry costs sessions.

Table C.3 has the descriptive statistics on demographic characteristics for subjects playing seller 2. Results from an estimation which includes demographic variables are reported in the eighth column of Table C.6. In that estimation no demographic variable has a statistically significant coefficient at the 5% and/or the 10% levels. This suggests that demographic variables have no significant effect on subjects playing seller 2 propensity to choose equilibrium strategies. Overall, subjects playing seller 2 chose the predicted equilibrium strategies 500 times.