# Poder del Mercado y Fusiones: Evidencia del Laboratorio

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*Resumen*

En este trabajo, usamos el laboratorio para determinar las causas de precios más altos que el nivel del equilibrio competitivo. Los participantes en el experimento fueron estudiantes que tuvierion el papel de vendedor en un mercado oligopólico. Cada vendedor tenía un número fijo de "unidades" del producto para vender, y cada unidad tenía un costo determinado en el caso de que fuera vendido. Los participantes ganaban dinero por venta a precios mayores que los costos. Pagamos estas ganancias en efectivo, y de esta manera, los participantes tenían un incentivo económico.

Los costos de las unidades determinan la estructura de la oferta, y las ventas de los vendedores dependen de los precios. El experimento consiste en tres diseños, cada uno con el mismo conjunto de oferta, demanda, y precio competitivo. En el primer diseño, la capacidad de produción está dividido entre los cinco vendedores de una manera que el precio competitivo tambien es un equilibrio en el sentido de Nash. Creamos poder de mercado en el segundo diseño a traves de una tranferencia de capacidad de los vendedores más pequeños a los vendedores más grandes. Esta creación de poder de mercado, manteniendo fijo el número de vendedores, resulta en percios más altos en todos los mercados observados en el laboratorio. En el tercer diseño, hay una fusión entre los tres vendedores más pequeños de una manera que no cambia el poder de mercado de los dos vendedores más grandes (con más capacidad de producción). Este cambio en el número de vendedores (de cinco a tres), manteiniendo fijo el poder de mercado, no tiene mucho efecto en los percios. Así concluímos que el poder de mercado tiene un papel más importante que el número de vendedores en estos mercados olipopólicos.

Aunque los participantes en este tipo de investigación no tienen experiencia en determinar la política de precios en empresas en el mundo real, el método de investigación tiene varias ventajas. Normalmente, una fusión puede cambiar el número de vendedores y la condición de poder de mercado a la misma vez, y es difícil distinguir los efectos de las dos cosas. Aún peor, es difícil medir los costos y la capacidad de empresas que normalmente venden varios productos en distinctos mercados. En el laboratorio, los costos y las capacidades están determinados por las instruciones que reciben los participantes, y es posible cambiar una condición de mercado,

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mientras otra condición se mantiene constante. Y como sabemos la estructura de oferta y demanda, podemos calcular las implicaciones de las teorías que nos interesan: equilibrio competitivo y equilibrio en el sentido de Nash. Si una teoría o una política antimonopólio no functiona bien en el laboratorio, debemos tener cuidado en usarla fuera del laboratorio.

## I. Introduction

In evaluating the consequences of a proposed merger or capacity acquisition, antitrust authorities are hampered by the lack of relevant cost and transactions price information. Even when reliable data are available, too many theoretically relevant factors change at once to allow for a clean "natural experiment." A merger that subsequently generated supra-competitive prices, for example, might have simultaneously decreased the number of sellers, increased market concentration, decreased industry capacity and reduced product heterogeneity. Any one of these effects might have caused the noncompetitive performance.

The careful application of laboratory methods can allow some insight into the appropriate theoretical basis for antitrust policy, by cleanly isolating the effects of alternative determinants of price increases. This paper investigates two of these determinants. Specifically, we examine behavior in an experiment that isolates the effects of *market power*, which is usually indicated by the capacity of a single seller to profit from a unilateral price increase above a common competitive price. We also examine a *pure numbers effect* arising from a reduction in the number of competitors. All treatments involve an identical market supply, market demand, and competitive price. Market power is altered in a first pair of treatments by reallocating capacity among a group of 5 sellers. The pure numbers effect is examined by reducing the number of sellers from 5 to 3 in a manner that increases measured concentration without altering market power in a theoretical sense.

Despite the wide chasm between the laboratory markets and the complex markets of antitrust concern, the experiment is designed to address issues of economic policy. Although we cannot hope to make claims from the laboratory regarding the competitiveness of particular markets in the economy, antitrust policy can be (and has been) based on a variety of different economic models. Laboratory methods can be used to distinguish among competing models in starkly simple environments. If the predictions of a theory fail to organize and explain data in a very simple environment, the burden of proof for a particular explanation of behavior should shift to the proponent of the theory.

We will say that *market power* exists in theory if the noncooperative equilibrium for the market game yields prices that exceed the competitive level. In most market structures, this type of power is indicated if at least one seller can profit from a unilateral price increase above a common competitive price level (which
implies that the competitive equilibrium is not a noncooperative equilibrium). This conception of market power is consistent with the notion of market power implicit in the 1984 U.S. Department of Justice Horizontal Merger Guidelines, which assess market power in terms of the profitability of a small unilateral price increase. As will be shown below, changing the allocation of industry capacity can have the theoretical effect of creating market power, since larger sellers with more inframarginal units may have a greater incentive to trade off sales of marginal units to obtain supra-competitive prices. Therefore, acquisitions that have no effect on supply, demand, the number of sellers, or the competitive price can nevertheless create market power.

If sellers recognize and respond strategically to unilateral incentives, then the addition of market power will (by definition) yield supra-competitive prices, even in the absence of cooperative behavior. Still larger price increases may be observed if sellers behave cooperatively, in the sense that they resist unilateral incentives to cut price. When prices exceed the levels determined by a unique noncooperative equilibrium, we will say that this is due to collusion, *overt collusion* if sellers are able to communicate directly, and *tacit collusion* otherwise. Since overt collusion is illegal, an evaluation of a proposed merger often revolves around assessing the likelihood of tacit collusion. A clear behavioral assessment of market power should distinguish between price increases due to noncooperative behavior and price increases due to tacit collusion.

We also consider the effects of changes in the number of sellers that change measured concentration, because structural measures are often used to evaluate the likelihood of supra-competitive pricing. One issue is whether the concept of market power is more useful as a means of predicting noncompetitive behavior than standard alternative indicators.

## II. Experimental Design

Our designs are illustrated by the 3 aggregate supply and demand arrays shown in the

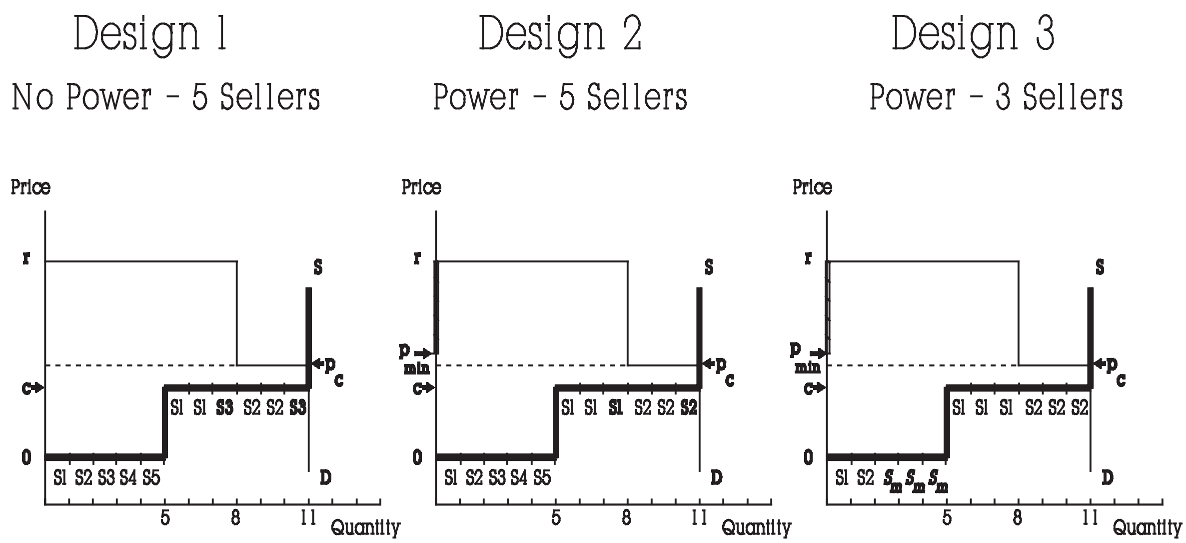


**Figure 1.** Supply and Demand Arrays

three panels of figure 1. The left and center panels involve 5 subjects, who are identified as sellers *S1*, *S2*, *S3*, *S4*, and *S5*. The panel on the right involves 3 subjects, identified as *S1*, *S2* and $S_m$. The identities of sellers holding various units are listed below the corresponding units on each supply curve. The 3 designs in figure 1 share many common features. In each case, sellers as a group have the capacity to offer up to 11 units, arrayed in a two-step configuration of 5 low-cost units and 6 high-cost units. Similarly, each design uses the same two-step demand function, composed of 8 high value units and 3 low value units. The high reservation value is denoted by $r$, the low reservation value is denoted by $P_c$, the high cost is denoted by $c$, and the low cost is normalized to 0. The competitive equilibrium in each design involves a quantity of 11 and any price in the range $[c, P_c]$ of vertical overlap of the demand and supply functions.

The focus of our analysis is on oligopoly situations in which a few sellers face passive buyers with no countervailing power. To ensure that buyers fully reveal demand (i.e. to ensure that no buyer forgoes profitable purchases in an attempt to influence pricing decisions in subsequent periods), the demand side of the market in each design is represented by a simulated price-taking buyer. The simulated buyer makes all profitable purchases, buying first from the seller(s) with the lowest price, then from the seller(s) with the next lowest price, and so forth. In the event of identical prices, the buyer equalizes purchases among the tied sellers as much as possible. When equal purchases are not possible, residual units are assigned randomly.

The designs in figure 1 differ in the manner in which the units with bold-faced seller identities are assigned. In design 1, shown on the left side of figure 1, capacities are limited in the sense that no seller has a capacity that exceeds 3 units. This feature, combined with the excess supply of 3 units at supra-competitive prices, makes the highest competitive price, $P_c$, a pure-strategy Nash equilibrium. If all sellers post this price and offer all units for sale, no seller may unilaterally increase profits, since a unilateral price increase would result in no sales and a unilateral decrease would not increase sales.

Design 2, in the center of figure 1, involves a reassignment of units of capacity from seller *S3* to sellers *S1* and *S2*, a relatively minor change that separates the predictions of Nash and competitive theories. Sellers *S1* and *S2* may each offer up to 4 units in design 2, while *S3*, *S4*, and *S5* may offer only 1 unit each. Unlike design 1, sellers *S1* and *S2* are each certain to sell at least 1 of their 4 units in design 2. Starting at a common price of $P_c$, a unilateral increase to $r$ will be profitable for these large sellers if the increased revenue on the sale of the first unit, $r - P_c$, exceeds the lost profit of $3(P_c - c)$ on the 3 marginal units. This condition reduces to a requirement that the top of the competitive price range, $P_c$, be below a price, $p_{min}$, defined in (1):

$$p_{min} = .75c + .25r . \qquad \textbf{(1)}$$

The selection of parameter values for which $P_c < p_{min}$ will ensure that a common competitive price of $P_c$ is not a Nash equilibrium in design 2. It follows from the way that $p_{min}$ was calculated that it is the lower bound of an "Edgeworth cycle" for sellers *S1* and *S2*. The range of the Edgeworth cycle is illustrated by the darkened section of the vertical axis in the graph for design 2.

Design 3, shown on the right side of figure 1, differs from design 2 in that the 3 low cost units given to sellers *S3*, *S4* and *S5* are consolidated into a single seller, $S_m$. This alteration is emphasized by the bolded italic seller identifier numbers shown under the supply function in design 3. Importantly, large sellers *S1* and *S2* retain the characteristic that they are each certain to sell at least one unit in design 3, so that $P_c$ is not a Nash equilibrium in design 3 whenever

$P_c$ is not a Nash equilibrium in design 2. Despite tripling in size, $S_m$ is still not assured of selling any units in design 3. Rather, as was the case for each of the small sellers in design 2, seller $S_m$ must price below at least one of the large sellers to realize any sales. It will be shown below that the consolidation of units from *S3*, *S4* and *S5* into a single firm does not affect the noncooperative equilibrium.

To summarize, aggregate supply, aggregate demand and the number of sellers remain fixed across designs 1 and 2, but the reallocation of units among sellers from design 1 to design 2 creates market power. Comparison of behavior across these designs will allow assessment of a "pure-power" effect. Similarly, comparison of behavior across designs 2 and 3 will allow assessment of a "pure-numbers" effect. Although the consolidation of low cost units from *S3*, *S4* and *S5* into a single seller, $S_m$, reduces the number of sellers, aggregate supply, aggregate demand and the noncooperative equilibrium remain fixed across designs 2 and 3.

Concentration, of course, increases from design 1 to design 2, and then again from design 2 to design 3. To provide a frame of reference for concentration in our markets with those considered typically to be of policy concern in antitrust analysis, it is instructive to report concentration relative to the Herfindal-Hershmann Index (HHI), calculated as the sum of the squared market shares for each firm, multiplied by 10,000. The HHI (based on capacity) for design 1 is 2397. The reallocation of units among sellers in design 2 increases concentration by 496 points to 2893. The consolidation of capacity among S3, S4 and S5 in further increases concentration by 495, to 3388. Under the 1984 DOJ Horizontal Merger Guidelines, consolidations which change HHI values by at least 100 points, and which generate a post-consolidation HHI value in excess of 1800, are considered to be highly concentrated and are likely to be challenged. Thus, either consolidation examined here (from design 1 to design 2, or from design 2 to design 3) would quite likely be challenged under the Guidelines.

A distinct advantage of our designs is that, despite the asymmetry of sellers' capacities, the noncooperative equilibria can be calculated in the power designs, and can be used as a basis for evaluating performance and measuring tacit collusion. These equilibria randomization over the range of the Edgeworth cycle when market power is present. For brevity, the equilibrium calculations are omitted in this summary.

## III. Procedures

We conducted twelve two-hour sessions, each with a different cohort of 5 subjects. Six sessions involved designs 1 and 2 (5 seller power/ 5 seller no-power), and six sessions involved designs 2 and 3 (5 seller power/ 3 seller power). Each session lasted for 60 periods, with a change of treatment at the midpoint. Sequence effects were controlled with a "block" procedure, i.e. by reversing the order of treatments in every other session.

Sessions were conducted at Virginia Commonwealth University using a networked-PC implementation of a posted-offer institution, written by Davis. Fully revealing demand behavior was simulated by the experiment monitor. Participants were undergraduate business students with previous experience as sellers in posted-offer markets. Participants were paid a standard $3.00 appearance fee, plus earnings from trades in the sessions. Participants earned money by selling units at prices above their costs. In sessions using the design 3 treatment, the two idle sellers were paid $6.00 for monitoring the 30 periods in which they were inactive. Session earnings ranged from $15 to $55 per subject.

Parameter choices were made to avoid focal numbers and to ensure reasonable earnings for small sellers in competitive outcomes. If $r$ were 434 and $c$ were 154, then $p_{\min}$ would be 224 and $p^*$ would be 242. Since the low-cost step has been normalized to zero, a parameter-shifting constant of 105 was added to all of the above parameters to raise the low cost step above 100; this ensures that all possible price choices involve the entry of three digits on the subject's keyboard. (Parameters were presented to subjects in dollar rather than penny form. Three digit entries avoid the problems that arise when participants forget to enter a decimal in a 2 digit entry). With this shift, $r = 539$, $c = 259$, $p_{\min} = 329$, and $p^* = 347$. Recall that the choice of the competitive price demand step, $P_c$, is arbitrary, subject to the constraint implied by (1) that it be between the high cost, $c$, and the lower bound of the Edgeworth cycle, $p_{\min}$. We selected $P_c = 309$, a value in the upper end of the acceptable range, to enhance competitive earnings.

## IV. Results

As indicated in Table 1, prices were uniformly higher in the power treatment than in the no-power treatment. This is seen in the left half of the table, which summarizes the average price for the last 15 periods of each treatment sequence. The bottom row of table 1 also presents the difference in mean prices across treatments, by session. As is evident from inspection of the fourth row of table 1, the power treatment raised average prices in all 6 sessions. The uniform incidence of the treatment effect allows us to feel fairly confident of a market power effect from these data. The magnitude of the power treatment effect also deserves comment. While the effect of power varies widely across sessions, on average it is quite large. The average of the 6 differences listed in the bottom row on the left side of table 1 is 83 cents, more than one third of the entire range between $p_c$ and $r$. On the basis of these observations, we draw our first conclusion. *All other things constant, the creation of market power tends to raise prices substantially.*

| | No-Power/Power Sessions (with 5 sellers) | | | | | | 5-Seller/3-Seller Sessions (with power) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Session | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| No Power (5 sellers) | 338 | 307 | 341 | 410 | 310 | 396 | - | - | - | - | - | - |
| Power (5 sellers) | 411 | 468 | 430 | 455 | 397 | 441 | 415 | 475 | 391 | 401 | 392 | 512 |
| Power (3 sellers) | - | - | - | - | - | | 425 | 471 | 413 | 436 | 434 | 517 |
| Mean Treatment Effect | 73 | 161 | 89 | 45 | 87 | 45 | 10 | -4 | 22 | 35 | 32 | 5 |

**Table 1**. Average prices over the last 15 periods of treatments in each session.

Consider next the effect of reducing the number of sellers from 5 to 3, holding other factors (including power) constant. From inspection of the right side of table 1, it is evident that a reduction in the number of sellers exerts a much less pronounced effect than the pure-power effect discussed above. Although there is a rather large difference in prices from one session to another, price performance within sessions appears largely unchanged by the alteration in the number of sellers. But inspection of average price differences across the 5 person and 3 person treatments in the right half of table 1 suggests that the reduction in the number of sellers raises prices to some extent. Average prices over the last 15 periods of each treatment sequence increased with the reduction in sellers, in 5 of the 6 sessions. Using the data summarized on the right side of table 1. This effect, however, is very small. The average price increase observed in the power/ no-power sessions (83 cents) is nearly 5 times greater than the average increase observed in 5-seller/3-seller sessions (17.3 cents). Moreover, the smallest price change observed in a power/no-power sessions exceeds the largest price change observed in the 5 seller/3-seller sessions. These observations motivate our second conclusion. *All other things constant, a reduction in the number of sellers from 5 sellers to 3 sellers increases prices somewhat. The effect, however, is very small compared to the effect of introducing market power.*