Supplemental Materials for Pankaj Ghemawat and Tarun Khanna, "The Nature of Diversified Business Groups: A Research Design and Two Case Studies," *The Journal of Industrial Economics* 46 (1), March 1998, pp. 35-61

APPENDIX

We model group scope as a function of ambient competitive intensity. We assume that groups have access to a resource, $R > 1$, that confers some advantage on them relative to non-group firms. In line with the case studies, we model the resource as providing preferential access to bureaucrats, translating into an ease in influencing the allocation of licenses or permits to group companies in the context of a simple multi-market bidding model. The model parametrizes the extent of asymmetry between groups and non-groups, R, and the degree of competition in each market, m. Consistent with the Indian context, where large groups seldom confronted each other in head-to-head competition, we use the models to investigate competition between a group and a set of non-group entrants rather than competition among groups. A primary conclusion of the analysis is that a reduction in the extent of asymmetry between groups and non-groups (i.e. a lowering of R) results in a narrowing of group scope. Holding R constant, so does an increase in competitive intensity.

The competition between a group and non-group competitors is formalized in a model where the probability that a firm wins a license in a given market is related not only to its own resource allocation to that market but also to those of its rivals. This is intended as an abstraction for the process that has traditionally been used to influence the awarding of a license or a permit by the bureaucracy.[1] By assumption, a group is more likely to win the license than a non-group given comparable resource allocation, and this increased likelihood is increasing in R. We develop an understanding of how the group chooses to allocate R across multiple markets in the face of such competition.[2] i.e. how optimal group scope varies with R and m. To build intuition, we consider several cases in sequence: a group (G) allocating R across two markets when there is no competition, G allocating R across two markets when each has an entrant also competing for the license, G allocating R across multiple markets when each has an entrant and, finally, the most general case where both the number of potential markets and the competition per market are allowed to vary.

[1] Several of the new market opportunities opening up in India are still subject to firms bidding for licenses to get the right to compete in them. The case studies discuss RPG's aggressive moves into telecommunications and power, and Ballarpur's efforts in infrastructure.

[2] Though we do not explicitly model the interaction between the firms and the bureaucrats, one can think of the advantage that groups have as being the result of favors that they receive from the bureaucrats. One mechanism is the following: the bureaucrat may auction off a finite number of multiple-use favors to the highest bidder. If groups have greater opportunities to utilize such favors than do non-group-affiliated firms (because of the range of businesses in which these favors might be used), then groups would be most likely to bid high values for such favors and to disproportionately be the recipients of such favors. One reason why only a finite number of favors might be dispensed (i.e. why R is scarce in our models) is that favor-dispensers might be increasingly likely to be caught the greater the number of favors they (illegally) dispense. They would thus trade-off this "cost" of dispensing more favors against the benefits of allocating them to potential beneficiaries. See Shleifer and Vishny's [1993] model of interactions between politicians and firms for a different context in which finite numbers of favors obtain.

The notation used throughout is that G and the other firms respectively choose x and y_i, i=1, .., m, levels of resources which are directed at non-productive "influence" activities aimed at convincing the bureaucrat in each market to award the license; these resources are non-productive in the sense that they do not intrinsically increase the value of the license, V, in each market. R acts to magnify, in a sense made precise below, the effect of G's choice of x relative to the effect of a comparable choice of y_i by a non-group rival. The bureaucrat in each market derives no utility from the award of the license, only from the resources expended in trying to influence it.

Accordingly, first consider a stylized world where licenses are being awarded in two symmetric and independent markets. The bureaucrat in each market chooses either to award the license to G or not to do so. The probability of obtaining a license in a particular market when access resources r < R, and “regular” resources x, are directed to the bureaucrat in charge, is given by p(rx), p’>0, p(0)=0. Then, G’s problem is simply to choose r, x_1 and x_2 to maximize $p(rx_1)V + p((R-r)x_2)V - x_1 - x_2$. Under some assumptions regarding concavity of p(.), the trivial solution is to set r=R/2 and x_i = value of resources that will maximize G's return in each market separately, and G will operate in both markets.

Now imagine that each market has a competitor introduced which does not have access to R, but can still expend “regular” resources to acquire the license. In this model, G has to choose whether to focus on one or both markets. In the former case, all of R is allocated to the market in question. In the latter, restricting ourselves to equilibria in which R is allocated symmetrically across both markets, let R/2 be allocated to each market.

Consider first the case where G allocates all of R to one market and where G and a potential entrant E allocate, respectively, x and y “regular resources” to influence activities. Assume that the probability that G will be awarded a license is given by Rx/(Rx+y). G maximizes RxV/(Rx+y)-x, while E maximizes yV/(Rx+y)-y. The first order conditions for an interior maximum are given by $yRV=(Rx+y)^2$, $xRV=(Rx+y)^2$, which can be solved to obtain $x = y = RV/(1+R)^2$ (and it can be shown that both G and E make positive profits at this level of allocation, so that any participation constraint is satisfied). G’s equilibrium expected profits can then be shown to be $V(R/1+R)^2$, from participating in just one market.

Now consider G’s expected profits when it allocates R/2 to each of two markets, in each of which it faces a potential entrant that has access only to “regular” resources. In a manner similar to that above, one can show that G’s total expected profits from a similar interaction in each of two markets (each of which gets R/2 of its scarce resource), are given by $2V(R/(2+R))^2$. A simple comparison of this expression to the profit from one market shows that, if $R < \sqrt{2}$, then G will prefer to retrench to only one market, i.e. we can derive a reduction in scope as the value of R decreases, after accounting for the possibility of entry.

More generally, an extension of this argument to the case where G has to allocate resources to n markets shows that, in a symmetric equilibrium with R/n in each market and with one entrant possible in each market, G’s expected profits are given by $nV(R/(n+R))^2$. Neglecting the integer constraint problem, this expression is maximized at n=R. It follows that, in a model where G faces competition from a potential (albeit disadvantaged) entrant, the optimal number of markets that G will opt to compete in is given by R. As such, as R declines, optimal group scope will shrink.

For the most general case, we now parametrize the intensity of competition faced by G in each market by m, the number of entrants, and inquire as to the optimal number of markets over which G will choose to spread its scarce resource, R. Similar to the case where m is fixed at 2 in each market, imagine that G first chooses the number of markets, n, in which it will compete and the allocation of R across these markets. Subsequent to this choice, G chooses x in each of the n markets, while each of m rivals in each of the n markets choose y_i, i = 1, .., m. (For ease of notation, and since the markets are assumed symmetric, we do not use separate notation for each of the n markets.) The y_i's and x are all chosen simultaneously. Finally, the license in each market is awarded to either G or one of its m rivals in a manner similar to that introduced earlier.

Solving by backwards induction, first consider that in each of the n markets that G decides to operate in, it maximizes

$$\frac{R'x}{(R'x + y_1 + y_2 + \ldots + y_m)}V - x$$

where R' denotes the level of resources that G allocates to the market in consideration, y_i represents the level of regular resources of the i'th entrant, none of whom have access to R', and x represents G's level of regular resources in the market. The first term is the expected value of "winning" V, and the second term is the cost of regular resources. Similarly, each entrant maximizes

$$\frac{y_i}{(R'x + y_1 + y_2 + \ldots + y_m)}V - y_i$$

Manipulating the first order conditions allows us to show that $y_i = y$ for all i, and that, in equilibrium, y = R'x/[mR' - (m-1)]. Substituting this back in the first order conditions allows us to solve for $y = mR'V/(mR'+1)^2$. Substituting this back into the expression for G's profits and the entrant's profits gives

$$\pi_G = \frac{V(R'm-(m-1))^2}{(R'm+1)^2}, \quad \pi_E = \frac{V}{(R'm+1)^2}$$

To build some intuition regarding the effect of R' and m on equilibrium profits for G, note that

$$\lim_{m\to\infty} \pi_G = V(R'-1)^2/(R'+1)^2, \quad \lim_{R'\to\infty} \pi_G = V$$

so that G's profits as competition increases to very high levels is determined by the extent of asymmetry over its rivals and, in fact, falls to zero as the asymmetry becomes small (R' → 1). Further, when the extent of asymmetry is very high (R' → ∞), effectively the bidding is always decided in G's favor and its expected profits equal the entire value of the license in question. We also note that

$$\frac{\partial \pi_G}{\partial R'} = \frac{2Vm^2(R'm - m + 1)}{(R'm + 1)^3} > 0$$

$$\frac{\partial^2 \pi_G}{\partial R'^2} = \frac{2Vm^3(-2R'm + 3m - 2)}{(R'm + 1)^4} < 0 \text{ for } R' > 1.5 - \frac{1}{m}$$

$$\frac{\partial^2 \pi_G}{\partial R' \partial m} = \frac{2Vm(2R'm - 3m + 2)}{(R'm + 1)^4} > 0 \text{ for } R' > 1.5 - \frac{1}{m}$$

The marginal benefit of increased asymmetry (increased R') declines in each market, but the marginal benefit of increased asymmetry is increasing in the degree of competition in the bidding process, for R' above a certain threshold.

Some intuition for why there is such a threshold can be derived as follows. We can show that G's optimal choice of x in each market is given by $x = mV(mR'-m+1)/(mR'+1)^2$ suggesting that x decreases with R' once R' is beyond a certain threshold which turns out to be 2-1/m. i.e. $\partial x/\partial R'$ is positive for $R' < 2-1/m$ and negative thereafter. What this suggests is a complementarity relationship between x and R' for low R' and a substitutability relation beyond that level. This makes sense since, for low R', we are in a steep part of the probability function, $R'x/(R'x + y_1 + .. + y_m)$, and the marginal returns from increasing x are high, whereas for high R' we are in a relatively flat part of the probability function where the marginal returns for incremental x are lower. Further, increases in x cost the same in our approach regardless of the level of R'. It follows that the marginal benefits of an increase in x, less the marginal costs, decrease as R' increases. The increasing returns part of the π_G function (for $R' < 1.5 - 1/m$) follows from the observation that optimal x increases with R' in this region and that such increases apply to all the infra-marginal R'.

Now consider the choice of number of markets, n, across which R should be spread. Symmetric equilibria yield closed form solutions and illustrate the intuition behind the model. As such, we restrict attention to equilibria where G allocates R symmetrically across all chosen markets, i.e. $R' = R/n$. Then G, given the above situation in each market, maximizes

$$\frac{nV\left(\frac{mR}{n} - (m-1)\right)^2}{\left(\frac{mR}{n} + 1\right)^2}$$

With some algebraic manipulation, one can show that the optimal n is given by

$$n = \frac{mR}{2(m-1)}[\sqrt{9m^2 - 8m} - 3m + 2]$$

a quantity that decreases with m and increases with R. Thus the optimal group scope decreases as the value of its scarce resource decreases (in this case, the value of access to the bureaucracy decreases) and as competitive intensity (parametrized by the increase in number of potential entrants) increases.