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MORAL HAZARD IN PARTNERSHIPS

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ABSTRACT

In this paper, we investigate incentive structures within partnerships. Partnerships provide a classic example of the tradeoff between risk spreading and moral hazard. The degree to which firms choose to spread risk and sacrifice efficiency incentives depends upon risk preferences, for which data are typically unavailable. We are able to overcome this difficulty due to the existence of a unique data set on a prominent form of professional partnership; medical group practice.

We consider a two-stage model in which agents choose effort in response to incentives and in which the firm can choose two different instruments to affect incentives and to spread risk: the compensation method and the number of members. There are two new theoretical results. First, relative to the compensation method or group size which would be chosen in the absence of risk or risk aversion, the best compensation method will be one which sacrifices efficiency incentives in order to spread risk, and the best membership size will exceed the first best size for the same reasons. Second, a further increase in risk or risk aversion leads the firm to sacrifice more efficiency incentives in order to spread more risk. Hence, firms who are more risk averse or face greater uncertainty pay larger risk premiums in terms of sacrificed output due to shirking.

The empirical results are striking and consistent with the theory. Firms which report more risk aversion have greater departures from first-best organizational incentive structures. Specifically, increased risk aversion leads to compensation arrangements which spread more risk through greater sharing of output and to decreased group size in order to counteract diminished incentives. We also find that compensation arrangements that have greater degrees of sharing of output across physicians significantly reduce each physician's productivity, whereas reductions in group size significantly increase productivity. The estimated premium associated with risk aversion accounts for almost eleven percent of gross income, comparing the most risk averse to the least risk averse physicians in the sample.

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I. INTRODUCTION

One of the primary contributions of economic theory in the last twenty years is the recognition that first-best efficiency incentives must be compromised in order to spread risk in the presence of imperfect information. This was first realized in the study of insurance[1], and has been extended to a wide variety of situations. One prominent area of analysis has been the structure of incentives within an organization.[2] In this paper, we focus on the incentive structure within partnerships. Partnerships provide a classic example of the tradeoff between risk spreading and moral hazard. They form in order to split fixed costs and spread risk due to uncertainty. Risk is spread through some degree of sharing of output among firm members. The greater the degree of output sharing, however, the stronger is the incentive for members to shirk and thus free ride on the effort of other members.

Although there has been extensive theoretical analysis of this point, the corresponding empirical literature is sparse. The existing empirical literature has focused mainly on the impact of compensation method on firm performance, and has not typically examined the determinants of compensation method. The studies in this area have covered executive compensation, compensation of workers, and employee profit-sharing.[3] With the exception of Seiler (1984), however, these papers do not consider the impact of risk aversion on compensation method and efficiency.

In this paper we theoretically and empirically analyze the tradeoff between risk spreading and efficiency incentives in partnerships. The degree to which firms

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[1] The classic reference is Zeckhauser (1970).

[2] See Holmström and Tirole (1989) for an excellent survey.

[3] For example, on executive compensation see Jensen and Murphy (1990), Abowd (1990), Gibbons and Murphy (1989, 1990), Leonard (1990). On worker compensation, see Pencavel (1977), Seiler (1984), Brown (1990). On employee profit-sharing, see Fitzroy and Kraft (1987).

choose to spread risk and sacrifice efficiency incentives depends upon risk preferences, for which data are typically unavailable. It is this data limitation which has heretofore stymied attempts at empirical analysis. We are able to overcome this difficulty due to the existence of a unique data set on a prominent form of professional partnership; medical group practice. These data are unique in that they contain detailed information on risk aversion, compensation arrangements, physician productivity, and other aspects of the internal organization of these firms.

We model partnerships as firms who use two instruments to affect incentives and to spread risk: the compensation method and the number of members. To our knowledge, this case has not been previously examined. Previous models of the choice of incentives under risk have considered the case where the firm has only one choice variable: either compensation or membership. The agency literature has examined the case in which the firm chooses compensation method, given a fixed number of agents (e.g., Holmström, 1982). These are models of team production, which implies that the agents in an organization are jointly subject to a single random shock. The consequence of this is that risk cannot be spread by adding members; only by compromising incentives, or by diversifying production activities. The literature on labor-managed firms (e.g., Ireland and Law, 1982) has concerned itself with the opposite case; fixed compensation method (equal sharing) and variable membership. The result here is that risk can be spread if members' random shocks are not perfectly correlated.

Professional partnerships share some aspects of both these models. Production in professional partnerships is typically non-joint across members of the firm, i.e., the members produce independently of one another. Partners also face demand curves for their individual services. Consequently there is less than perfect correlation between individuals' stochastic shocks, implying that risk can be spread by adding members. Professional partnerships also employ a variety of compensation methods.

These institutional features imply a model which leads to two new theoretical results. First, relative to the compensation method or group size which would be chosen in the absence of risk or risk aversion, the best compensation method will be one which sacrifices efficiency incentives in order spread risk, and the best membership size will exceed the first best size for the same reasons. Second, a further increase in risk or risk aversion leads the firm to sacrifice more efficiency incentives in order to spread more risk. Hence, firms who are more risk averse or face greater uncertainty pay larger risk premiums in terms of sacrificed output due to shirking. The specific way in which the compensation method and group size are adjusted, however, is indeterminate. Both mechanisms could be used to spread risk, or only one could be used to spread risk and the other used to mitigate the inefficiency incentives.

Our empirical results are striking and consistent with the theory. Firms which report more risk aversion have greater departures from first-best organizational incentive structures. Increased risk aversion leads to compensation arrangements which spread more risk through greater sharing of output and to decreased group size in order to counteract diminished incentives. We also find that compensation arrangements that have greater degrees of sharing of output across physicians significantly reduce each physician's productivity, whereas reductions in group size significantly increase productivity. The estimated premium associated with risk aversion accounts for almost eleven percent of gross income, comparing the most risk averse to the least risk averse physicians in the sample.

II. MEDICAL GROUP PRACTICE

Currently over 61% of U.S. physicians practice in some type of group setting, (Gonzalez and Emmons, 1988) and this percentage has been increasing over time.

Variation in practice setting and incentive structure have been shown to significantly affect physician behavior.[4] This is of specific interest to policymakers because of concern that the financial incentives used in Health Maintenance Organizations (HMOs) will encourage physicians to limit medical services. Indeed, Congress is considering specific aspects of a law scheduled to go into effect in 1990 that would prohibit Medicare participating HMOs from adopting financial incentives which would reduce the availability of medical care to enrollees (U.S. General Accounting Office, 1988).

Medical group practices tend to be relatively horizontal in structure. Most physicians are owners of the group practice, and ownership rights tend to be undifferentiated (Freidson, 1975). Held and Reinhardt (1979) report that 93% of the medical groups in their sample are owned by the physicians, and Lee (1990) states that 84% of physicians in another survey of group practices participate in ownership. Most of these groups have some non-owner physicians, but these are typically recent hires who are rapidly promoted to ownership. Indeed, Lee reports that 87% of the firms permit ownership after two years, and none have a probationary period longer than four years.

Decision-making typically occurs collectively, rather than independently. In fact, the empirical evidence shows that groups rather than individuals set fees and make resource decisions. Held and Reinhardt find that individual physicians set their own fees in only 10% of groups, hire nurses in 8%, and can purchase capital equipment in less than 2%. Kralewski, Pitt, and Shatin (1985) report even lower figures for independent physician decision-making: 1% set their own fees, 4% hire their own nurses and less than 1% purchase their own equipment. Lee also confirms

[4]For example, see Newhouse (1973), Sloan (1974), Held and Reinhardt (1979), Gaynor (1989), Gaynor and Pauly (1990).

these findings.

The institutional literature suggests several reasons why physicians organize in partnerships: to spread fixed costs and exploit economies of scale, to smooth work schedules, and to exploit reputational economies of scale. Optimal scale in medical practice has been studied extensively.[5] Most of these studies conclude that, while economies of scale exist in the production of physician services, they are exhausted at relatively low levels. Nonetheless, the empirical distribution of group sizes appears to be inconsistent with these findings, in that groups are much larger on average than is necessary to fully exploit (estimated) scale economies. Some economies may also be achieved by combining different specialties in order to minimize referral costs. In addition, anecdotal evidence suggests that physicians form groups to smooth out irregularities in work schedules by covering for one another. Finally, the importance of reputational economies of scale for medical practices has been documented anecdotally in Getzen (1984).

In this paper we argue that risk aversion is another major reason for physicians to form partnerships. Partnerships allow physicians to spread risk through some degree of output sharing. One would expect more risk averse groups to have greater output sharing and larger memberships in order to better spread risk. The greater the degree of output sharing and the larger the group size, however, the greater the incentive for individual members to shirk. Thus risk aversion is likely to be a major factor in the organization and efficiency of medical group practices.

We investigate these issues using data from a survey of 6353 physicians in 957 medical group practices collected in 1978 by Mathematica Policy Research for the National Center for Health Services Research. These data are unique in that they

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[5]For example, see Frech and Ginsburg (1974), Kimbell and Lorant (1977), Reinhardt, Pauly, and Held (1979), Marder and Zuckerman (1985).

contain measures of physicians attitudes towards risk, group compensation methods and organizational structures, and individual physician productivity. Risk aversion is measured by physician responses to a question about the importance of regular income. The possible responses ranged from one to four, increasing with the importance of regular income. The compensation scale varies between one and ten, where one indicates no relationship between compensation and individual productivity, and ten indicates a perfect relationship. Group size measures the number of full time equivalent physicians in the firm, reported in six intervals. We use the group mean of each value of the compensation scale and group size in the analysis. Figures 1, 2 and 3 present the frequency distributions of these variables. They show substantial variation in risk preferences, compensation methods, and group sizes.

We get a preliminary idea of how risk preferences influence the organization of medical group practices from Table 1, where the means of the compensation scale and of group size are reported for physicians by their rankings of the importance of regular income. The compensation scale is monotonically decreasing as the importance of regular income increases, and group size moves in the same direction, although non-monotonically. Thus, physicians that report themselves to be more risk averse are in groups which have compensation methods with a greater degree of sharing of output and which are smaller in size. This suggests that physicians use the compensation method and group size to spread risk. In the rest of the paper we investigate the degree to which partnerships use output sharing and group size to trade off efficiency incentives for risk spreading.

III. THEORY

We now present a formal model of partnerships. The theory concerning choice of incentives for an organization facing risk is well established. In this version, partners individually choose their own actions (which we call effort) in response to firm wide incentives, whereas firm incentives are collectively chosen by the partners, given each individual's reaction function. This is modeled as a two stage game in which the firm is the leader, and individual partners are the followers. Reaction functions for the partners are derived in section A, and the firm's choice of incentives is analyzed in section B. Comparative statics are considered in section C.

A. The Partners

The partners in the firm are assumed to be utility maximizing agents who make decisions over "work effort" in response to the incentives present in the firm's compensation method. The compensation structure is treated as fixed by any partner, although it is endogenous as far as the group as a whole is concerned. Work effort is defined as the total input to production by an individual partner. This encompasses both time and intensity, where intensity can be thought of as how hard an individual works. In the medical model, work effort can be thought of as spending more time with a patient and paying more attention to diagnosis and treatment. More work effort, therefore, results in higher quality care, and higher quality care raises the demand for physician services. There is a nonpecuniary (disutility) cost to effort, since effort is the opposite of leisure on the job. The benefit to additional effort is that it produces additional quality, which attracts customers. Additional customers bring the partner additional income.

Uncertainty is present in that each partner faces a demand curve for his services which is subject to a stochastic shock. In the medical example, the number of patients who demand a physician's services fluctuates with factors which cannot be perfectly observed by the physician. These factors include variations in patterns, types, or severity of illness (e.g., seasonal or epidemiological effects), variations in insurance coverage, problems in collecting revenues, and unexpected reputational effects of events such as medical malpractice suits. A partner's demand is affected in a deterministic way by the price charged by the firm, the quality supplied by the individual partner, and other factors. Formally, partner i's demand is

$$q_i = q(P, z_i \mid X) + \varepsilon_i, \quad \varepsilon_i \sim F(0, \sigma_i^2), \tag{1}$$

where

q_i ≡ the quantity of output demanded from partner i,

P ≡ the price per unit charged by the firm,

z_i ≡ the quality per unit of output supplied by partner i,

X ≡ exogenous factors affecting demand, such as consumer characteristics, the qualities and prices of other firm members, and market level factors[6], and

ε_i ≡ the stochastic shock, which has distribution function F with mean zero and variance σ_i^2. The ε_i are assumed to be uncorrelated across partners.[7]

The deterministic portion of the partner's demand depends negatively on

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[6]This can be thought of as a residual demand function, which is conditional on these "other factors." Thus, exogenous factors which determine the level of market demand, the firm's market share, and the agent's share of firm demand are expressed as X.

[7]The crucial assumption is that the error terms not be perfectly correlated within groups. Extension to imperfectly correlated errors does not affect the qualitative results.

price and positively on the quality produced by the partner[8].

Quality per unit of service is produced by the individual partner with his own effort, e_i, and with other fixed factors, θ_i (e.g., other labor, capital, ability),

$$z_i = z(e_i \mid \theta_i), \qquad (2)$$

where z_i is quality per unit of output[9], and z is assumed strictly concave.[10]

Effort shifts the partner's demand function via its effect on quality, and is the only means by which the partner can influence demand. The partner is assumed to choose effort to maximize utility, which depends directly on the partner's net income and therefore on the level of effort applied.

A mean-variance utility function is used to represent preferences in the presence of uncertainty. This model highlights the tradeoff between efficiency and risk-spreading in a simple way, and is consistent with a broad range of preference structures. Meyer (1987) shows that utility can be represented as a function of the first two moments of the distribution of the random variable when the outcome variable depends linearly on the random variable, as is the case in our model. As

[8]The partner's quality will affect demand in two ways: by increasing his quality relative to that of others in the firm and thereby increasing his share of firm demand, and by increasing the firm's quality and therefore its market share. See Schmalensee (1977) for a complete exposition.

[9]It is assumed that there are constant returns to scale in the production of quality over units of quantity, i.e., total quality equals the product of per unit quality and total output, $q_i \cdot z_i$.

[10]In practice, partners' quality production functions may not be completely independent. While the independence assumption does not affect the qualitative results, it is testable. We develop a formal test in the section on empirical specification.

we demonstrate later, this is a testable assumption.[11]

The mean-variance utility function is further assumed to be additively separable in money and actions (effort). Let partner i's utility be given by

$$u_i = \bar{y}_i - B\sigma_{yi}^2 - v_i(e_i), \tag{3}$$

where

u_i ≡ i's utility,

$\bar{y}_i$ ≡ the expectation of i's net income,

B ≡ a parameter indicating the impact of variation in income on utility. B is equal to one-half the measure of (constant) absolute risk aversion.

σ_{yi}^2 ≡ the variance of i's net income, and

v_i ≡ the private non-monetary cost of effort. v_i is assumed to be strictly convex in e_i.

A partner's income is determined by the compensation structure and the random shock ε_i. The compensation structure is represented[12] by

$$y_i = \alpha P q_i + (1/n)(1 - \alpha)P \sum_{j=1}^{n} q_j - (1/n)FC, \tag{4}$$

where

[11]In addition, Chamberlain (1983) has shown that any member of the class of symmetric, spherical distributions will generate the mean-variance model as an exact representation of preferences. Epstein (1985) employs a formulation of decreasing absolute risk aversion (DARA) to show that the mean-variance functional form of a non-expected utility model is consistent with the postulates which follow from DARA.

[12]This form is highly simplified: in particular, the issue of cost sharing has been treated in an extremely stark manner, and linearity is imposed. Nonetheless, real world compensation structures are often extremely simple, and linearity is the norm, rather than the exception (see Holmstrom and Milgrom, 1987 for an analysis of the optimality of linear incentives). This is the case with physician practices, which we analyze in this paper.

α = the proportion of revenue generated by i that he "keeps," $\alpha \in [0,1]$,

P = the price of output,

n = the number of members of the firm, and

FC = fixed costs.

Fixed costs are assumed increasing and concave in group size (e.g., the cost of name plaques, offices, or examining rooms) so FC=FC(n), $\partial FC/\partial n>0$, $\partial^2 FC/\partial n^2<0$. The first term in (4) is the portion of revenue generated by i which he keeps, the second term is his share from the firm's revenue sharing pool, and the third is his portion of the firm's fixed costs.

The objective function is obtained by substituting (2) into (1), then into (4), and then into (3). Maximization yields the first order condition,

$$\partial u_i/\partial e_i = [\alpha + (1/n)(1 - \alpha)]P(\partial q/\partial z_i)(\partial z/\partial e_i) - \partial v_i/\partial e_i = 0. \quad (5)$$

The solution to (5) for all partners i in the firm is a Nash equilibrium. Equation (5) can be interpreted as indicating that the utility maximizing level of effort is where the marginal revenue product of effort (the first term in (5)) is equal to its marginal disutility (the second term in (5)). The second order condition also holds, given the concavity of the function z and the convexity of v_i. Equation (5) implicitly defines an effort supply function for each partner,

$$e_i^* = e_i(\alpha, P, n, X, \theta_i), \quad (6)$$

where effort is a function of the compensation scale (α), price (P), group size (n), demand factors (X), and other fixed factors (θ_i). Table 2 contains comparative static derivatives for the effort supply function for the effects of changes in α, P, n, X, or θ_i on the optimal (for the partner) choice of e_i. Factors which increase the expected return to effort, α and P, increase its supply. The number of members in the group decreases the return to effort by decreasing the size of an individual share from the revenue sharing pool, and thus decreases effort. Neither risk (as represented by the variance of income) nor risk aversion affects the supply of effort. This result is directly due to the assumption of the additive separability of demand into its deterministic and stochastic components. We specify a test for this assumption in Section IV.

B. The Group

The group, or firm, makes a collective decision on the choice of incentives, given the effort reaction functions of all the members of the firm. Since the choice of incentive systems directly affects the variance of income, the group must make an explicit tradeoff between incentives and risk spreading.

Let there be a representative partner i whose preferences are decisive in the collective decision-making process.[13] Then the group's utility function can be written as this partner's utility function. This welfare function is written as

$$W = u_i = \alpha Pq(\bullet) + (1/n)(1-\alpha)P\Sigma q(\bullet) - (1/n)FC - B\alpha^2P^2\sigma_i^2 - B(1/n)^2(1-\alpha)^2P^2\Sigma\sigma_j^2 - v_i(\bullet), \qquad (7)$$

where the explicit expression for σ_{yi}^2 is incorporated.

[13]For example, the median voter under majority rule. Cave and Salant (1987) prove the existence of a unique majority rule equilibrium for a game such as the one examined here, even if preferences are not single-peaked. We employ this simple representation since our data do not allow us to distinguish between alternative models of group decision making. We do not assume that partners are identical within groups since evidence from our data does not support such a conjecture.

The group chooses α and n to maximize (7), subject to the effort reaction functions of the n partners, as summarized in (5).[14,15] Let the model be symmetric.[16] Then the representative partner's utility function simplifies to

$$u_i = [\alpha+(1/n)(1-\alpha)]Pq+((n-1/n)(1-\alpha)Pq$$
$$-(1/n)FC(n)-[\alpha^2+(1/n)(1-\alpha)^2]BP^2\sigma_i^2 - v_i. \qquad (8)$$

Substituting for the partners' effort supply functions and the quality production functions[17], the first-order conditions for α and n are

$$\partial u_i/\partial\alpha = [P(\partial q/\partial z_i)(\partial z/\partial e_i) - (\partial v_i/\partial e_i)](\partial e_i/\partial\alpha)$$
$$- 2BP^2\sigma_i^2[\alpha + (1/n)(1-\alpha)] = 0, \qquad (9)$$

and

$$\partial u_i/\partial n = [P(\partial q/\partial z_i)(\partial z/\partial e_i) - (\partial v_i/\partial e_i)](\partial e_i/\partial n)+ (1/n^2)FC$$
$$- (1/n)(\partial FC/\partial n) + (B/n^2)(1-\alpha)^2P^2\sigma_i^2] = 0. \qquad (10)$$

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[14]We treat price as exogenous in order to focus on the choice of compensation method and group size. The results derived in this section follow through when price is treated as endogenous. The first-order conditions with α, n, and P chosen by the firm are contained in the technical appendix.

[15]This is the first-order approach. See Jewitt (1988) for a justification of this approach which does not rely on convexity of the distribution function of output.

[16]If the distribution of preferences/abilities across agents in the firm is symmetric, then the median agent is the mean agent. The first-order conditions when the model is not necessarily symmetric are contained in the technical appendix. The qualitative results are identical to those obtained with the symmetric model.

[17]We assume that an individual rationality or participation constraint is satisfied so that no agent's utility is below his reservation level.

The first terms in both equations indicate the incentive effects associated with α and n, incorporating the reactions of the partners. The terms which are preceded by B, the risk aversion parameter, indicate the risk spreading effects of α and n. These indicate that α and n are set where the marginal utility of the marginal revenue generated by the effort supply response to α or n is equal to the marginal disutility of the same effort supply response plus the marginal utility of the effect on risk. These tradeoffs imply that the optimal $\alpha \in (0,1)$ and the optimal $n \in (0, +\infty)$.[18]

C. Comparative Statics

Consider the choices of α and n in the absence of risk aversion (or risk). A risk neutral collective of agents would choose α equal to one and set membership at the size which fully exploits all scale economies, denoted n*. To see this, set the risk preference parameter, B, equal to zero in equations (9) and (10). The resulting first-order condition for the choice of α is equal to the partner's first-order condition for choice of effort (equation (5)) when $\alpha=1$, thus implying that the optimal α equals one when B=0 or $\sigma_i^2 = 0$. The first-order condition for the choice of n reduces to $(1/n)FC = \partial FC/\partial n$, thus group size is set so that marginal cost equals average cost.

When partners are risk averse (B>0), the α and n chosen by the firm will always be respectively less than and greater than the α and n chosen by risk neutral partners. When B>0, additional terms related to risk are included in the first order conditions. Since the term related to risk in (9) is negative, the α which is optimal in the presence of risk aversion is less than the first-best α under risk

[18]See the technical appendix for proofs.

neutrality. Similarly, the risk aversion term in equation (10) is positive, thus the presence of risk aversion implies increased membership in the firm.[19]

Figure 4 illustrates the result that risk aversion leads to $\alpha<1$ and $n>n^*$. The combinations of α and n which satisfy the first-order conditions (FOC) evaluated at $B=0$ and $B>0$ are depicted. Since the α and n chosen are those which simultaneously solve these equations, the equilibrium is located at the intersection of these curves. A_oA_o represents the locus of points at which the FOC for α is satisfied when $B=0$, and N_oN_o is the locus for which the FOC for n is satisfied when $B=0$. When $B=0$ the FOC for α does not depend on n and the FOC for n does not depend on α. Therefore A_oA_o is horizontal and N_oN_o is vertical. A_1A_1 and N_1N_1 are the loci of the FOC for α and n when $B>0$. Since the values of α which satisfy the FOC for α when $B>0$ are less than those which satisfy it when $B=0$, A_1A_1 lies everywhere beneath A_oA_o. Similarly, N_1N_1 lies everywhere to the right of N_oN_o because the values of n which satisfy the FOC for n when $B>0$ are greater than the n which satisfy it when $B=0$. Taken together, this implies that the firm will choose $\alpha<1$ and $n>n^*$ in the presence of risk aversion.

It does not necessarily follow, however, that further increases in risk aversion generate further decreases in α and further increases in n. Table 3 contains the comparative static derivatives of the choice variables for the group. The comparative static effects of B (risk aversion) on α and n are indeterminate. The reason is that increases in α generate increased efficiency incentives, but decrease risk spreading. Analogously, increasing group size decreases incentives, but increases risk spreading. In general, any combination of effects on α and n are

[19] We have assumed that $\sigma_{i,-i} \equiv cov(\varepsilon_i, \varepsilon_{-i}) = 0$ for ease of exposition. All that is needed for this conclusion, however, is that $\sigma_{i,-i} < 1$. Obviously, however, the greater is $\sigma_{i,-i}$ the less effective is group size at spreading risk.

possible which result in an increased tradeoff of incentives for risk-spreading. An increase in α and decrease in n due to increased risk aversion is not possible, however, since this implies a decreased tradeoff of incentives for risk-spreading.

The possible combinations of an increase in risk aversion on α and n can be fruitfully examined by inspection of a diagram showing how the curves representing the FOC shift in response to a change in B. Figure 5 illustrates the three outcomes which are possible. An increase in risk aversion always shifts both curves down and to the right (to the "southeast" of the original equilibrium point). If there is a larger effect on the FOC for n, then both α and n can increase. This is illustrated in panel A. Panel B shows the case when there is a larger effect on the α FOC: both α and n fall. Panel C illustrates the result if an increase in risk aversion has roughly equal effects on the FOC for α and for n. In this case the classic result obtains: α falls and n rises. The one outcome which does not obtain is an increase in α and a decrease in n, since this would involve a point in the northwest quadrant, which is impossible in the diagram. This would imply an attenuated tradeoff of incentives for risk-spreading in the presence of increased risk aversion, which is inconsistent with the model.

IV. EMPIRICAL SPECIFICATION AND ESTIMATION METHODS

For the empirical work the theoretical framework is generalized to take account of two important institutional factors: (1) that physician groups are not really price takers, but rather participate in an imperfectly competitive market, and (2) that the physician production of medical services involves more than just physician input. Moreover, consistent with the institutional facts presented in section II, we assume that the group rather than the physician makes decisions over price and non-physician inputs.

The theoretical framework implies a five equation empirical model. Four equations will represent the group's decisions about α, n, P and h (non-physician labor), and one equation will represent the physician's output. The rest of this section is used to derive the specification and present the estimation strategy. We begin by specifying the group's decisions and then present the physician's problem.

The first order conditions for the group's optimization problem can be solved for the equilibrium values of the compensation system (α), group size (n), price (p), and non-physician labor (h):

$$\alpha^* = \alpha(B, X, \theta_i, W, FC, \sigma_i^2), \quad (13)$$

$$n^* = n(B, X, \theta_i, W, FC, \sigma_i^2), \quad (14)$$

$$P^* = P(B, X, \theta_i, W, FC, \sigma_i^2), \quad (15)$$

$$h^* = h(B, X, \theta_i, W, FC, \sigma_i^2). \quad (16)$$

Thus, the compensation system, group size, price, and non-physician labor are functions of risk aversion (B), the variance of the fluctuations in physicians' residual demand functions (σ_i^2), variables that shift the residual demand functions (X), prices of inputs (W), fixed costs (FC), and characteristics of the physician that may influence their productivity, such as experience or training (θ_i).

Given the group's decisions over the organization of the firm, the individual physician then chooses effort. Since quality and effort are unobserved, the demand function cannot be estimated directly.[20] Instead, we substitute the effort supply function into the quality production function, and then substitute that equation

[20]Note that the parameters of the structural demand function cannot be recovered, because they enter the demand function both directly and indirectly through the functions z and e_i. This implies that when incentives affect unobservable behavior, structural parameters cannot in general be recovered from observed data. Gaynor and Pauly (1990) and Spulber (1989) have shown that this point is also true with respect to the parameters of the technology of production.

into the demand function to obtain a demand function conditional on the firm level variables:

$$q_i = g(P, \alpha, n, h, X, \theta_i) + \varepsilon_i. \quad (17)$$

The conditional demand function, then, is a function of price, the compensation scale, group size, exogenous demand factors, and physician characteristics.

Linear functional representations of equations (13) - (16) and (17) form the empirical model. The conditional demand function and the expressions for the firm's choices of α, n, P, and h establish the link between risk preferences, incentives, and production (and consequently, income). Risk preferences influence the firm's choices of α, n, P, and h, and these choices influence the physician's productivity. Thus, equations (13) - (16) identify how risk preferences influence the group's choice of incentive and organizational structure, and equation (17) permits estimation of the effect of the incentive and organizational structure on productivity.

Since α, n, P and h are collectively chosen by the firm based in part on physicians' effort responses to these choices, they may be correlated with the error term in the conditional demand function. Therefore, least squares estimates of the conditional demand function may suffer from simultaneous equations bias. Rather than making arbitrary assumptions, we employ the exogeneity test of Hausman (1978) and Wu (1973) to examine whether these variables can be treated as uncorrelated with the error term in the regression. The model is estimated by two-stage least squares, instrumenting for those variables for which exogeneity is rejected.

The empirical model is identified with a set of exclusion restrictions implied by the theory. Specifically, the firm's choices of α, n, P, and h depend on risk preferences, the variance in income, input prices, and fixed costs, whereas the physician's choice of effort does not. As the empirical results indicate below, these identifying variables are significant predictors in the first-stage regressions, adding power to the exogeneity tests.

The assumption that demand is additively separable into deterministic and stochastic components implies that neither risk aversion (B) nor risk (σ_i^2) enter the conditional demand function (18). Since the model is overidentified, this assumption is testable. The assumption of an additive shock to demand is rejected if the variables representing risk aversion and risk are significantly different from zero in the conditional demand function. Recall that additivity of the random component is also a test of the mean-variance representation of utility.

The assumption that production is non-joint in other partners' effort is also testable. This assumption implies the null hypothesis that the characteristics of other physicians in the group should have no impact on physician i's output. This hypothesis is rejected if these variables are collectively significant in the conditional demand function.

V. DATA

A. Sources

The data utilized for this study come from a nationwide survey of medical group practices conducted in 1978. The sample includes 957 groups and 6353 physicians practicing in those groups. The sample was stratified by group size, type of group (multispecialty or single specialty), physician specialty, and prepaid vs. fee-for-service. Large group practices were oversampled in an effort to supply a reasonable number of observations, and a census was taken of pre-paid groups, for the same purpose. Further, five medical practice specialties were sampled: general practice, internal medicine, pediatrics, general surgery, and obstetrics/gynecology.

Approximately 60 percent of all office-based physicians practice in these specialties.

This data set also includes data measuring characteristics of the area in which the group practiced and data on the hospital with which the group is affiliated. The data on area characteristics were obtained from many sources, including the American Medical Association, The County and City Data Book, and various other sources. The hospital data were obtained from the American Hospital Association Guide for 1978. For a complete description of all these data sources see Boldin, Carcagno, Held, Jamieson, and Wooldridge (1979).

B. Variables

The model consists of five equations. The unit of observation for the compensation system, group size, price and non-physician input equations is the group, and the unit of observation for the conditional demand function is the physician. We begin by describing the measurement of the dependent variables for all five equations and then discuss the independent variables. Exact definitions of the variables are reported in Table A1 in the Appendix, and descriptive statistics are reported in Table A2.

The measure of α is the "compensation scale," which takes on values one through ten. A value of one indicates that the physician's compensation is completely unrelated to productivity and a value of ten indicates a perfect relationship.[21] The variable is divided by ten in order have it correspond directly to α, which is theoretically bounded by zero and one. We impose these bounds by taking a logit transformation, $\ln(\alpha/(1-\alpha))$, as the dependent variable in equation (13). The

[21]The compensation scale is highly correlated with other measures of the compensation system. The simple correlation between the compensation scale and the percent of compensation which is based on productivity is 0.91. The correlation between the compensation scale and the change in net income per $1000 of patient billings is 0.96.

dependent variable is retransformed into a predicted value of α for the second-stage estimation of the conditional demand function.[22]

Physician output is taken to be the number of office visits per week for primary care physicians,[23] for whom office visits are a large proportion of total practice. The number of full-time equivalent physicians in the group corresponds to the theoretical variable for group size, n. The log of the group's reported price for an office visit is used to measure price, and the log of hours of non-physician medical labor is used to measure non-physician input. The logarithmic transformations of price and hours are taken because their distributions are heavily skewed to the right.

The most important independent variable is the measure of physician preferences for risk. For this, we use responses to a question on the importance of regular income to the physician. The possible responses take on values from 1 to 4, with 4 representing the greatest importance attached to regular income. We use the within group average of the responses to this question as a measure of the group's risk preferences.

Such self-reported measures have proven to be valid and reliable in a number of other studies. Wolf and Pohlman (1983) show that self-reported risk preferences are consistent with estimated risk preferences derived from actual choices. Granbois and Summers (1975) demonstrate that self-reported preferences are good predictors of actual choices. Finally, Shaw (1989) reports that self-reported risk preferences are important determinants of labor market choices.

The other independent variables in the compensation, group size, price, and non-physician hours equations include physician characteristics that influence their

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[22]We employ the retransformation suggested by Goldberger (1968), based on the assumption that α is distributed lognormal.

[23]General surgeons were excluded from the analysis, since office visits are not one of their primary outputs.

productivity, the prices of other factors of production, fixed factors, residual demand shifters, and the variance of demand. Characteristics that influence productivity are the average experience of group physicians, experience squared, the proportion of members who are foreign medical graduates, and the proportion of members in each of several medical specialties. The prices of non-physician inputs are captured by the hourly wage rates of the various categories of non-physician labor. Fixed factors are proxied by the number of examining rooms. Residual demand shifters are represented by market area characteristics such as per capita income and physicians per capita, among others. We do not have a direct measure of the variance of demand but dichotomous variables indicating whether the group is an HMO or a multispecialty group may serve as proxies, as well as specialty and the market area characteristics.

The exogenous independent variables in the conditional demand function include exogenous determinants of physician demand and physician productivity characteristics. The productivity characteristics include the physician's experience and a set of dichotomous variables indicating the physician's specialty and whether he is a foreign medical school graduate or practices in a subspecialty. Demand shifters in both the group level equations and the conditional demand function are measured by various indicators of market demand such as population density, hospital beds per capita, income per capita, etc. The same variables that measure shifts in demand across markets, however, also represent differences in the variance in demand across markets. The variance belongs only in the group level equations and not in the conditional demand function. Therefore, if these variables only represent variance, then they will be important determinants of the firm's choices of α, n, p, and h, but will not be significant in the conditional demand function.

VI. RESULTS

A. Specification Tests

A number of the independent variables in the conditional demand function are potentially endogenous. Specifically, we tested the exogeneity of the compensation scale, group size, non-physician hours, and price. The exogeneity of the compensation scale was rejected at the 1% level. The exogeneity of the other variables could not be rejected.

The specification test for additivity of the random shock consists of a test for the joint significance of the variables representing risk aversion and the variance of demand. The importance of regular income is our measure of risk aversion, but we have no direct measure of the variance of demand. The market area characteristics such as per capita income or physicians per capita may affect demand variance as well as the level of demand. Consequently we tested for the significance of the importance of regular income alone in the conditional demand regression, and jointly with the market area variables. The importance of regular income is not significantly different from zero at conventional confidence levels ($t = -1.28$), nor is it jointly significant with the area characteristics ($F = 0.84$). Therefore we cannot reject the hypothesis that demand is additively separable in its deterministic and stochastic components. This result also implies that the mean-variance utility model cannot be rejected.

The market area variables potentially represent the level of demand across markets as well as the variance in demand. Recall that the variables that indicate the levels enter both the group level equations as well as the conditional demand function, while the variance enters only the group level equations. The hypotheses that the individual and joint effects of these variables are zero in the conditional demand function could not be rejected. Therefore, we conclude that they represent indicators of variance as opposed to levels of demand.

The variables representing characteristics of physicians in the group are not (jointly) statistically significant ($F=0.89$) in the individual physicians' conditional demand function. Therefore we cannot reject the hypothesis that production is non-joint across physicians.

Last, we checked for evidence of the desire to smooth work schedules by including a variable measuring the importance of regular hours as a regressor in the reduced form regressions for compensation scale, group size, price, and non-labor hours. It was never significant, and was therefore ultimately deleted. The values of the other coefficients were unaffected by the deletion.

B. Discussion

The estimation results for the group level regressions are presented in Table 4 and the results for the conditional demand function are contained in Table 5. The signs of the coefficients in all regressions are generally as expected. In addition, the estimates are quite precise, as indicated by the t-statistics.

The results of the first-stage estimations are as predicted by the theory. The variable which serves as the measure of risk preferences is the importance of regular income. Here "importance" is interpreted as the physician's subjective assessment of the weight attached to these factors. The importance of regular income is negatively related to the compensation scale, indicating that the more important is regular income to a physician, the more strongly related to productivity is his group's compensation structure. This is consistent with the interpretation of this measure as a metric for risk preferences, and indicates the impact of risk aversion on compensation method.[24]

Group size is also negatively related to the importance of regular income. This accords with the theoretical result that increased risk aversion leads to a smaller group size if the incentive effects of decreased group size outweigh the decreased risk spreading. Thus, variation in risk preferences can lead to an equilibrium with many different group sizes, regardless of the nature of returns to scale. This is compatible with the observed wide range of sizes of physician practices.

Physician experience has a negative and decreasing effect on the compensation scale and a positive and decreasing effect on group size, non-physician hours, and price. The effect of experience on the closeness of the relation between compensation and individual productivity is negative up to 3.54 years of experience. Beyond that it is positive, although the total effect is negative. The negative quadratic effect is consistent with findings of both a positive relationship between age and the performance-relatedness of compensation for corporate CEO's (Gibbons and Murphy, 1989) and a negative relationship (Barro and Barro, 1990). The positive effect could be due to the presence of career concerns, as hypothesized by Gibbons

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[24]An alternative interpretation is that this variable is measuring variance due to sorting rather than risk preferences. Suppose all physicians have identical risk preferences, but are of different qualities which are unobservable to the analyst. Suppose further that physicians sort themselves among groups according to their quality. High quality physicians will locate in groups with high α in order to retain the returns to their quality, and low quality physicians will locate in groups with low α in an attempt to free ride on others of higher quality. Thus, the observed distribution of α represents the distribution of physician quality rather than a distribution of preferences toward risk. Since the variance of income is increasing in α (see equation (7)), those in groups with a high value of α will be subject to a greater variance of income, ceteris paribus, and vice versa for those in groups with a low value of α. Physicians who are subject to a higher variance of income may report a greater importance of regular income, and physicians with a lower variance of income would report a lesser importance of regular income. This scenario generates a positive correlation between the importance of regular income variable and α. Since we find a negative relation to be the case, this alternative interpretation cannot be true.

and Murphy. The overall negative effect may be a way of compensating more senior colleagues for providing "public goods" to the firm at the expense of their own productivity. The positive effect of experience on non-physician hours may indicate that experience allows physicians to utilize labor more efficiently. The positive effect on price may reflect consumers' valuations of experience.

The other variables in the firm level regressions also have interesting interpretations. Fixed costs, as represented by the number of examining rooms, lead to increased group size to spread the increased fixed costs, more sharing of output, fewer non-physician hours, and lower price. An increase in the number of competitors, as measured by the number of physicians per capita, has positive effects on both group size and price. The presence of more competitors could lead physicians to try and "cartelize" by forming larger groups, which could increase prices. Alternatively, more competitors may lead to increased non-price competition, and higher prices. If reputational economies of scale exist, increased non-price competition will also increase group size. Multispecialty groups and HMO's have compensation more strongly related to individual productivity, and have higher prices. The average physician characteristics in the group did not affect compensation method, but did have significant impacts in some cases on group size, non-physician hours, or price.

The estimates of the parameters of the conditional demand function in Table 5 are also strongly consistent with our theoretical hypotheses. The coefficient for one of the main variables of interest, the compensation scale (α), is positive and significant, as hypothesized. An increasingly strong link between compensation and productivity leads to an increased number of office visits per week. Specifically, unit increases in the compensation scale cause output to increase by ten percent. Additionally, the number of physicians in the group has a negative and strongly significant effect. A ten person increase in group size decreases output by six percent. This lends support to the hypothesis that, ceteris paribus, incentives are diminished with increased group size. These are estimates of the effect of incentives on moral hazard. An alternative interpretation is that these results are due to physician self-selection by quality, however, there is little support in the data for the sorting across groups implied by this hypothesis.[25]

The estimates of the coefficients for some of the other variables are intuitively appealing. The effect of price on output is negative, and statistically significant. This indicates that the direct (and negative) effect of price on demand outweighs its positive impact through supply of quality. A ten percent increase in price decreases quantity demanded by 3.2 percent. Whether or not the group is multispecialty or largely prepaid seems to have little effect on output.

The number of examining rooms has a positive and significant impact on quantity, consistent with its increasing the marginal product of effort in the quality production function. The same is true of hours of non-physician personnel. Experience has a positive but diminishing effect, consistent with greater experience

[25]As stated earlier, the observed negative relation between the compensation scale and the reported importance of regular income is inconsistent with a situation in which physicians have identical risk preferences and sort themselves among groups based on their quality. In addition, if there were extensive sorting, then physicians should be relatively homogenous within groups and therefore most of the variation in the data should be across (between) groups. We examined the within and between group variation in observed physician characteristics. In no case was the variation within groups less than the variation between groups. Table A3 in the appendix contains these results. As a further check on the degree of sorting, we compared the variation in residuals from the conditional demand function within and between groups. The residuals represent unmeasured or unobserved characteristics plus noise. The variation within groups is almost identical to the variation between groups. Last, we could not reject the hypothesis that the distribution of the group means (i.e., the distribution between groups) was drawn from the same distribution as the sample distribution (Kolmogorov-Smirnov statistic = 0.093). If there were extensive sorting then the distribution between groups should differ from the sample distribution. Therefore we conclude that the data do not support an hypothesis of pervasive sorting by physicians among groups.

leading to greater productivity, but being counteracted by loss of skill with increasing age.

Table 6 contains calculations of the effects of changes in the measures of risk preferences on production, thus providing an initial look at the tradeoff between incentives and risk-spreading. Varying the importance of regular income over its full range (1 to 4) leads to an decrease in the number of annual office visits by 872 (based on a 50 week year), or 22.64% at the mean. Evaluated at the mean price for an office visit ($13.20), the result is decreased revenues of $11,999. This means that the most risk averse physicians in the sample sacrifice this amount compared to the least risk averse physicians. This is a measure of the risk premium in these partnerships. It is not a complete measure, however, because physicians in these groups earn income from other sorts of services sold by these groups. Consequently this figure serves as a lower bound. It does account, however, for 10.76% of mean physician gross income in the U.S. in 1978, indicating that the tradeoff between incentives and risk-spreading in these firms is substantial.

Breaking the effect of risk aversion down by the source of the effect, it can be seen that most of the impact on output (and consequently income) comes via the compensation method. Groups do appear to attempt to compensate for the worsened incentives by having fewer members and hiring more non-physician inputs, but the magnitudes of the impacts of these variables is small. We hypothesize that the reason is that they can only substitute in a partial, and very limited way, for compensation method as an incentive device.

VII. SUMMARY AND CONCLUSIONS

Our goal in this paper has been to analyze the determinants of the internal organization of partnerships and the consequent impacts on performance. We focus specifically on the impact of risk aversion on the choice of compensation method and membership size in a partnership firm and the resultant effects on productivity. Consistent with the institutional facts about professional partnerships, our theoretical model allows the firm to choose both the compensation method and the membership size. The predictions are that risk aversion will cause incentives to be sacrificed. The effect of risk aversion relative to risk neutrality is to cause groups to adopt compensation methods which are less closely related to individual productivity, and to choose group sizes which exceed optimal scale. Further increases in risk aversion, however, have different combinations of effects on compensation method and group size, depending on the relative magnitudes of the incentive versus the risk spreading effects of those variables. These combined effects, however, all lead to a tradeoff of incentives for risk spreading.

This is the first empirical study of incentives in organizations which incorporates risk aversion. The evidence is highly consistent with the theory of incentives and moral hazard for a partnership firm. We estimate a two-stage model of the impact of risk aversion on medical partnerships' choices of compensation method, group size, non-member labor, and price, and consequently on output. The results are strongly supportive of theory that argues that firms adopt second-best incentive structures in order to spread risk. Increased risk aversion leads partnerships to choose compensation methods which are less closely related to individual productivity and to decrease the number of members. Productivity based compensation has a substantial positive effect on physician productivity, and group size has a negative impact. Last, our findings indicate that there is a substantial premium paid to risk aversion: the most risk averse physicians in the sample sacrifice almost 11% of gross income relative to those who are least risk averse.

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TABLE 1

MEANS OF THE COMPENSATION SCALE AND GROUP SIZE BY

IMPORTANCE OF REGULAR INCOME[a]

Importance of Regular Income[b]	Compensation Scale	Group Size
1	7.33 (0.32)	24.22 (1.76)
2	6.27 (0.16)	24.42 (0.83)
3	6.02 (0.12)	23.11 (0.60)
4	5.38 (0.20)	22.79 (0.94)

[a] Standard errors reported in parentheses below means.

[b] 4=Very Important, 3=Important, 2=Somewhat Important, 1=Of Little or No Importance

TABLE 2

COMPARATIVE STATIC EFFECTS ON e_i

Variable	Comparative Static Derivative[a]	Sign
α	$\partial e_i/\partial\alpha = -\{[1 -(1/n)]P\partial q/\partial z_i)(\partial z/\partial e_i)\}D$	+
P	$\partial e_i/\partial P = -\{[\alpha + (1/n)(1 - \alpha)]\partial q/\partial z_i)(\partial z/\partial e_i)\}/D$	+
n	$\partial e_i/\partial n = \{(1/n^2)(1 - \alpha)P\partial q/\partial z_i)(\partial z/\partial e_i)\}/D$	-
β	0	0[b]
σ_{yi}^2	0	0[b]

[a]D is the determinant of the matrix forming the second order condition.

[b]Neither risk aversion nor risk (variance of income) affect the supply of effort. This is due to the demand function being additively separable in its deterministic and stochastic components.

TABLE 3

COMPARATIVE STATIC EFFECTS FOR THE FIRM

Comparative Static Derivative

$$\partial\alpha/\partial B = (-(\partial^2 u_i/\partial n^2)(\partial^2 u_i/\partial\alpha\partial B) + (\partial^2 u_i/\partial\alpha\partial n)(\partial^2 u_i/\partial n\partial B)) \div |J| \gtrless 0$$

$$\partial\alpha/\partial\sigma_i^2 = (-(\partial^2 u_i/\partial\alpha^2)(\partial^2 u_i/\partial n\partial\sigma_i^2) + (\partial^2 u_i/\partial n\partial\alpha)(\partial^2 u_i/\partial\alpha\partial\sigma_i^2)) \div |J| \gtrless 0$$

$$\partial\alpha/\partial P = (-(\partial^2 ui/\partial n^2)(\partial^2 u_i/\partial\alpha\partial P) + (\partial^2 u_i/\partial\alpha\partial n)(\partial^2 u_i/\partial n\partial P)) \div |J| \gtrless 0^1$$

$$\partial n/\partial B = (-(\partial^2 ui/\partial\alpha^2)(\partial^2 u_i/\partial n\partial B) + (\partial^2 u_i/\partial n\partial\alpha)(\partial^2 u_i/\partial\alpha\partial B)) \div |J| \gtrless 0$$

$$\partial n/\partial\sigma_i^2 = (-(\partial^2 u_i/\partial\alpha^2)(\partial^2 u_i/\partial n\sigma_i^2) + (\partial^2 u_i/\partial n\partial\alpha)(\partial^2 u_i/\partial\alpha\partial\sigma_i^2)) \div |J| \gtrless 0$$

$$\partial n/\partial P = (-(\partial^2 u_i/\partial\alpha^2)(\partial^2 u_i/\partial n\partial P) + (\partial^2 u_i/\partial n\partial\alpha)(\partial^2 u_i/\partial\alpha\partial P)) \div |J| \gtrless 0$$

TABLE 4

FIRST-STAGE OLS COEFFICIENT ESTIMATES AND T-STATISTICS[a,b]

Independent Variables	Logit (Compensation scale)[c]	Group size	Ln(Non-Physician hours)	Ln(Price)
Constant	6.47*** (4.65)	22.15*** (6.10)	3.93*** (22.90)	2.09*** (26.43)
Importance of regular income[d]	-0.61*** (5.36)	-0.66** (2.15)	0.03** (2.03)	0.003 (0.45)
Preferred size[d]	-0.04*** (4.58)	0.76*** (35.65)	0.003*** (2.59)	0.003*** (7.68)
Experience[d]	-0.12*** (2.81)	0.40*** (3.57)	0.01** (2.49)	0.01*** (5.67)
Experience, squared[d]	0.003*** (2.60)	-0.01*** (4.85)	-0.0005*** (3.61)	- 0.0003** (4.65)
Foreign medical graduate[d]	-0.39 (0.67)	-4.73*** (3.07)	-0.32*** (4.50)	- 0.03 (1.03)
Subspecialty[d]	-0.19 (0.76)	2.36*** (3.58)	-0.17*** (5.53)	0.04*** (2.71)
Percent general surgery	-0.04*** (5.53)	-0.21*** (9.73)	-0.0008 (0.83)	- 0.002*** (3.48)
Percent pediatrics	-0.004 (1.36)	-0.02*** (2.63)	-0.002*** (5.40)	0.0009*** (5.51)
Percent obstetrics/ gynecology	-0.01*** (3.59)	-0.01 (1.44)	-0.001*** (2.67)	0.003*** (18.91)

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a t-statistics are reported in parentheses below the parameter estimates.
b* - Significant at 10% confidence level or better.
** - Significant at 5% confidence level or better.
*** - Significant at 1% confidence level or better.
c The dependent variable is the logit transformation of the compensation scale
d These are averages taken over physicians in each group.

TABLE 4 (Cont'd.)

FIRST-STAGE OLS COEFFICIENT ESTIMATES AND T-STATISTICS[a,b]

Independent Variables	Logit (Compensation scale)[c]	Group size	Ln(Non-Physician hours)	Ln(Price)
Percent internal medicine	0.01*** (4.57)	-0.08*** (10.67)	0.001*** (4.26)	0.002*** (15.71)
Percent board certified	-0.002 (0.58)	0.03*** (4.40)	0.002*** (5.38)	-0.00000[illegible] (0.03)
Wage of a registered nurse	-0.10 (1.38)	0.61*** (3.06)	0.009 (0.94)	0.01** (2.46)
Wage of a licensed practical nurse	-0.41*** (3.54)	0.04 (0.12)	-0.08*** (5.40)	0.03*** (4.07)
Wage of a business administrator	0.05*** (3.64)	0.07*** (2.22)	0.0008 (0.52)	-0.003*** (4.27)
Wage of a certified lab technician	0.03 (0.37)	-0.13 (0.64)	0.05*** (5.39)	0.02*** (4.13)
Wage of an uncertified lab technician	-0.45*** (2.99)	-0.71* (1.74)	-0.08*** (4.53)	-0.02* (1.78)
Wage of a graduate physician assistant	0.04 (0.59)	1.55*** (8.79)	0.009 (1.16)	-0.01*** (2.83)
Examining rooms	-0.003** (2.36)	0.06*** (16.46)	-0.001*** (7.08)	-0.0005** (6.63)
HMO	1.27** (2.00)	1.34 (0.79)	0.34*** (4.72)	0.08** (2.10)
Multispecialty	1.51*** (7.74)	0.20 (0.37)	0.03 (1.19)	0.05*** (4.67)

TABLE 4 (Cont'd.)

FIRST-STAGE OLS COEFFICIENT ESTIMATES AND T-STATISTICS[a,b]

Independent Variables	Logit (Compensation scale)[c]	Group size	Ln(Non-Physician hours)	Ln(Price)
Beds per capita	-0.14** (2.52)	0.15 (0.98)	0.001 (0.21)	-0.02*** (6.38)
Physicians per capita	0.05 (0.30)	0.72* (1.77)	0.02 (1.25)	0.02** (2.30)
Rent	-0.02*** (4.97)	0.03*** (2.20)	-0.0007 (1.16)	-0.002** (6.12)
AFDC	0.20*** (3.92)	0.71*** (5.29)	-0.03*** (4.34)	0.07*** (22.80)
Population density	0.0004*** (2.96)	-0.0002 (0.65)	0.00001 (0.71)	0.00002 (2.15)
Per capita income	0.00009 (1.01)	0.0005** (2.26)	-0.000005 (0.51)	0.00002 (3.37)
Education	0.20** (1.97)	-0.93*** (3.33)	0.02 (1.44)	0.005 (0.81)
R^2	0.10	0.60	0.11	0.45
F	11.49***	144.88***	12.05***	80.37***
N	419	419	419	419

TABLE 5

INSTRUMENTAL VARIABLE ESTIMATES OF THE CONDITIONAL DEMAND FUNCTION[a,b]

Independent Variables	Dependent Variable: Ln(Office Visits)
Constant	3.86***
	(9.18)
Compensation Scale[c]	0.10***
	(3.24)
Group size	-0.006***
	(3.67)
Ln(Hours of non-physician personnel)	0.11***
	(2.32)
Ln(Price)	-0.32***
	(3.50)
Exam Rooms	0.001***
	(2.52)
Experience	0.04***
	(5.06)
Experience, squared	-0.001***
	(6.00)
Foreign Medical Graduate	-0.11
	(1.25)
Sub Specialty	-0.16***
	(2.95)
Pediatrics	0.19***
	(2.83)
Obstetrics/gynecology	-0.05
	(0.60)
Internal Medicine	-0.30***
	(4.78)
Board Certified	0.02
	(0.35)
HMO	0.11
	(0.59)
Multispecialty Practice	-0.02
	(0.39)
N	1249

[a] t-statistics are reported in parentheses below the parameter estimates. The standard errors have been corrected for the use of instrumental variables.

[b] * - Significant at 10% confidence level or better.
** - Significant at 5% confidence level or better.
*** - Significant at 1% confidence level or better.

[c] Instrumental variable.

TABLE 6

THE TRADEOFF BETWEEN MORAL HAZARD AND RISK SPREADING:

ESTIMATES OF THE EFFECT ON AN INCREASE IN THE IMPORTANCE OF REGULAR INCOME ON PHYSICIAN PRODUCTIVITY.[a]

Source of Effect[b]	Annual Change	Office Visits Percent Change	Value[c,d]	Percent of Annual Income[c,d]
Compensation Scale	-992	-25.75%	-$13,094	-11.70%
Group Size	+ 46	+ 1.19%	+ 607	+ 0.54%
Non-Physician Inputs	+ 37	+ 0.96%	+ 488	+ 0.40%
TOTAL	-872	-22.64%	-$11,999	-10.76%

[a] Effect of change in importance of regular income from 1 to 4.
[b] Evaluated at the means.
[c] Calculated based on a 50 week year.
[d] Calculated based on a mean price of $13.20 per office visit in the data.
[e] Calculated based on a mean annual gross income for physicians of $111,900 in 1978 (Glandon and Shapiro, 1980).

FIGURE 1

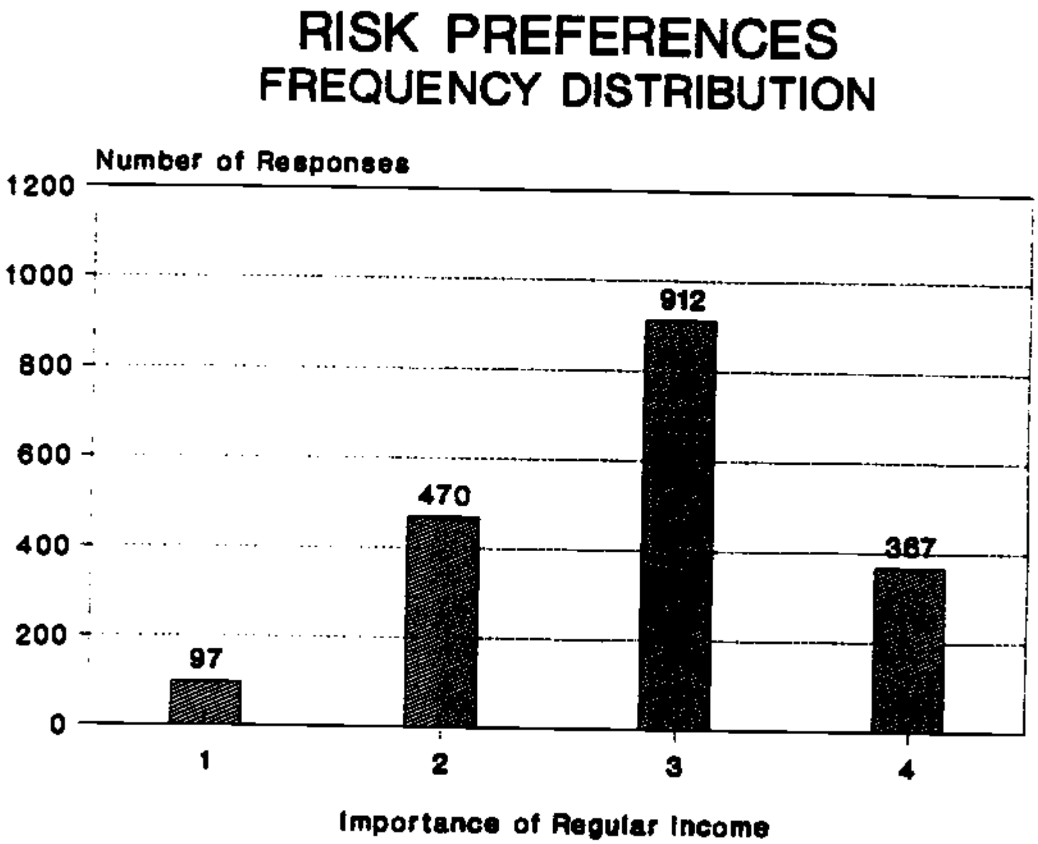

RISK PREFERENCES
FREQUENCY DISTRIBUTION
Number of Responses
1200
1000
800
600
400
200
0
97
470
912
367
1
2
3
4
Importance of Regular Income

FIGURE 2

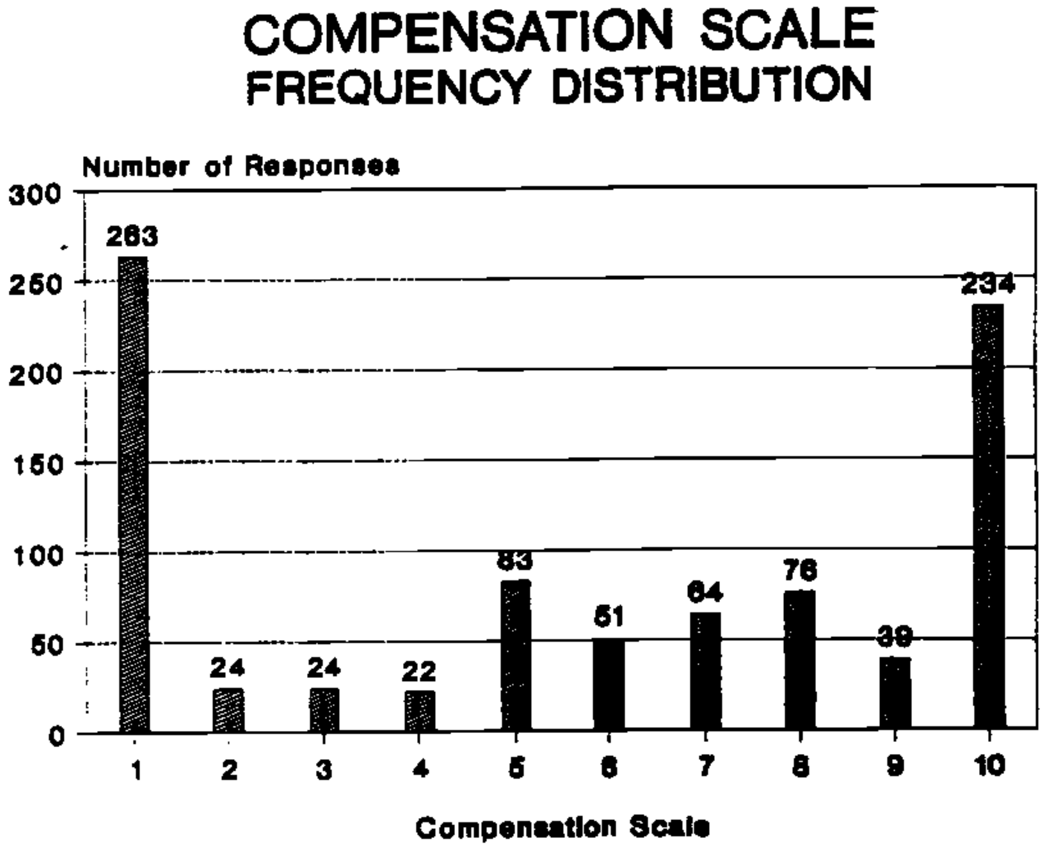

COMPENSATION SCALE
FREQUENCY DISTRIBUTION
Number of Responses
300
250
200
150
100
50
0
263
24
24
22
83
51
64
76
39
234
1
2
3
4
5
6
7
8
9
10
Compensation Scale

FIGURE 3

GROUP SIZE
FREQUENCY DISTRIBUTION

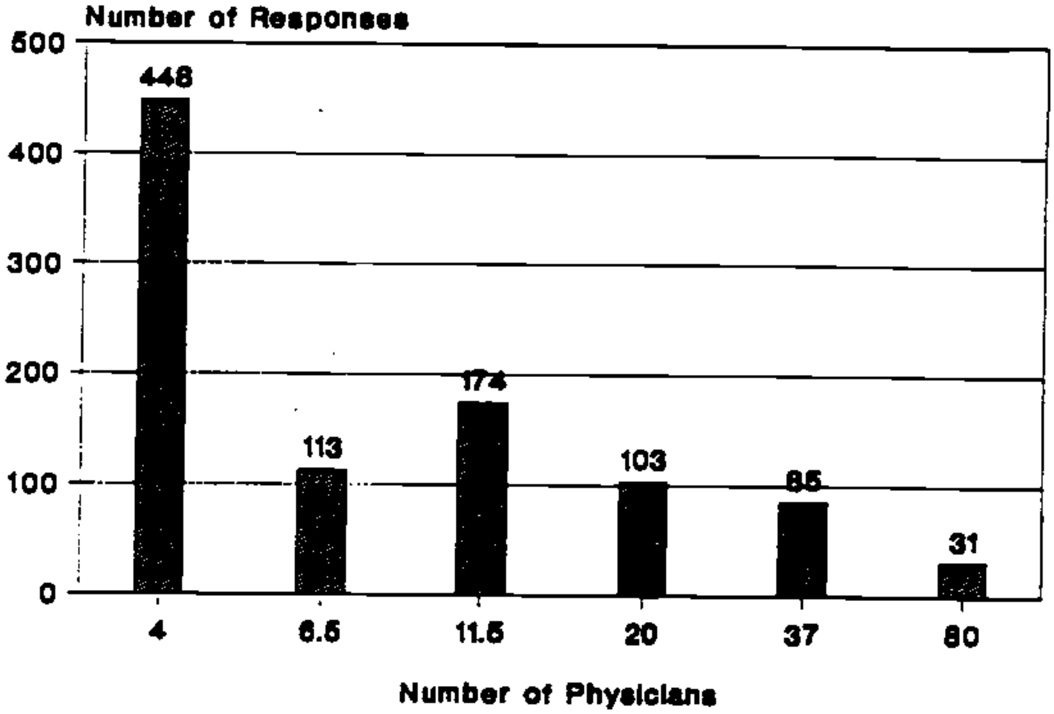


FIGURE 4

COMPARING THE FIRM'S CHOICE OF COMPENSATION METHOD AND GROUP SIZE UNDER RISK NEUTRALITY AND UNDER RISK AVERSION

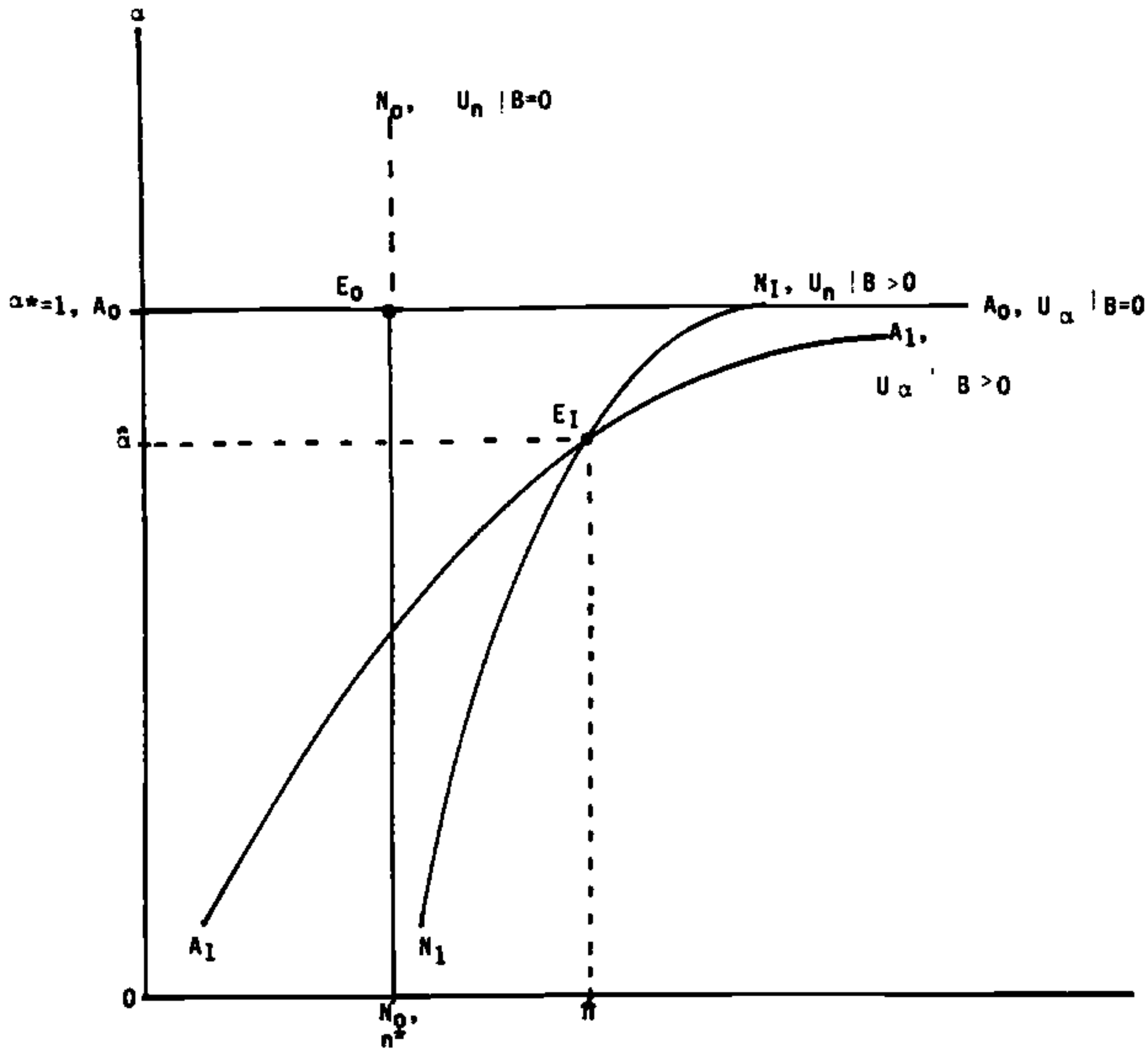
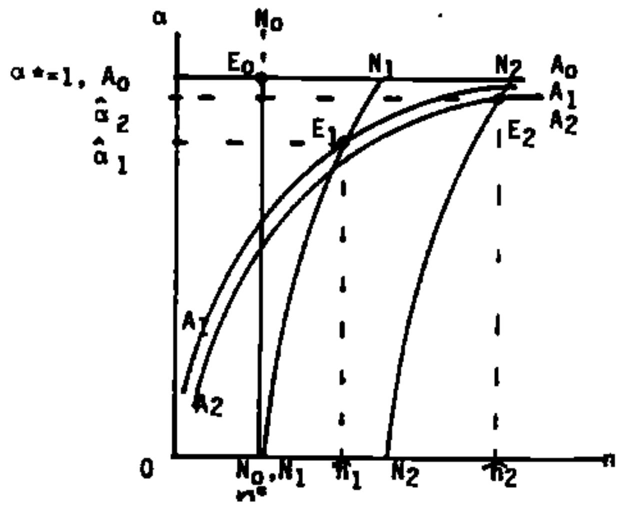
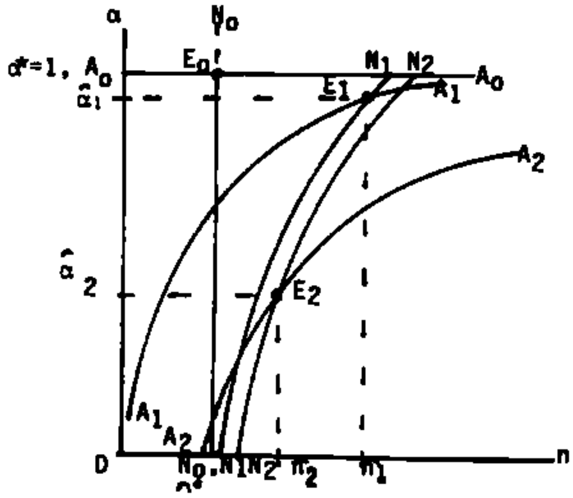


FIGURE 5

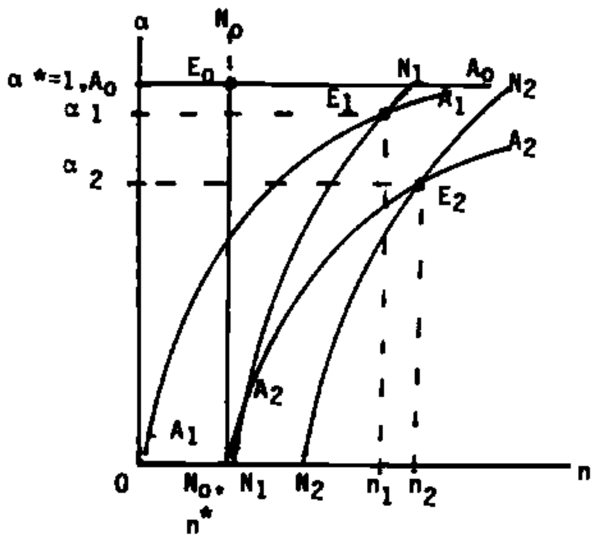
THE EFFECTS OF INCREASES IN RISK AVERSION ON THE CHOICE OF COMPENSATION METHOD AND GROUP SIZE



A. α↑, n↑



B. α↓, n↓



C. α↓, n↑

APPENDIX

TABLE A1

VARIABLE ACRONYMS AND DEFINITIONS

Variable	Definition
Office Visits	The number of office visits by the physician per week
Compensation Scale	A scale varying between 1 and 10, increasing with strength of relation between compensation and productivity
Price	The usual, customary and reasonable price charged for an office visit by the group
Wage of a Registered Nurse	The mean wage paid to registered nurses in the group
Wage of a Licensed Practical Nurse	The mean wage paid to licensed practical nurses in the group
Wage of a Business Administrator	The mean wage paid to business administrators in the group
Wage of a Certified Technician	The mean wage paid to certified laboratory technicians in the Lab group
Wage of an Uncertified Lab Technicians	The mean wage paid to uncertified lab technicians in the group
Wage of a Graduate Physician Assistant	The mean wage paid to graduate physician assistants in the group
Group Size	The number of full time equivalent physicians in the group
HMO	Dummy variable indicating if 50 percent or more of the group's revenues are prepaid
Examining Rooms	The number of examining rooms per FTE M.D.
Hours of Non-Physician Medical Personnel	Total hours of non-physician medical personnel per week
Experience	Number of years since the physician graduated from medical school
General Practice, Pediatrics, Obstetrics/Gynecology	Physician specialty dummies for general practice, pediatrics, and obstetrics/gynecology, respectively - internal medicine is excluded.

TABLE A1 (Cont'd.)

VARIABLE ACRONYMS AND DEFINITIONS

Variable	Definition
Multispecialty Group	Dummy variable for whether the group is multi- or single-specialty
Presence of Graduate Physician Assistant	Dummy variable for whether there a graduate physician assistant
Importance of Regular Income to Physician	Varies between one and four, increasing with importance
Preferred Size	The group size preferred by the physician
Board Certified	Dummy variable indicating if the physician is board certified
Foreign Medical Graduate	Dummy variable indicating if the physician graduated from a foreign medical school
Subspecialty	Dummy variable indicating if the physician practices on a subspecialty
Percent general surgery, percent pediatrics, percent obstetrics/gynecology, percent internal medicine	Percent of physicians in the group in these specialties
Percent board certified	Percent of the group who are board certified
Beds per capita	Hospital beds per 1,000 population in the county in which the group is located. Takes on integer values $\epsilon[1,6]$
Rent	The median gross rent in the group's county
AFDC	Percent of the population on AFDC in the group's county. Takes on integer values $\epsilon[1,6]$
Population density	Population per square mile in the group's county
Per Capita Income	Per capita income in the group's county
Education	Median number of years of education of the over 25 population in the group's county
Physicians per capita	Non-federal active physicians per 1,000 population in the group's county

TABLE A2

VARIABLE MEANS AND STANDARD ERRORS

Variable	Mean	Standard Error
Office visits	94.23	58.65
Compensation scale	6.16	2.18
Group size	21.13	8.73
Price	13.20	2.30
Importance of regular income	2.78	0.37
Hours of non-physician medical personnel	55.65	13.97
Examining rooms	56.40	49.55
Experience	19.88	10.70
Foreign medical graduate	0.09	0.28
Subspecialty	0.29	0.45
Pediatrics	0.17	0.38
Obstetrics/gynecology	0.13	0.33
Internal/medicine	0.36	0.48
Board certified	0.69	0.46
HMO	0.08	0.28
Multispecialty	0.65	0.48
Preferred size	12.13	6.88
Percent general surgery	7.68	6.62
Percent pediatrics	13.63	16.95
Percent obstetrics/gynecology	12.12	15.53
Percent internal medicine	28.37	17.88
Percent board certified	77.39	16.05
Wage of a registered nurse	4.87	0.57
Wage of a licensed practical nurse	3.68	0.44
Wage of a business administrator	12.23	3.47
Wage of a certified lab technician	4.82	0.69
Wage of an uncertified lab technician	3.65	0.29
Wage of a graduate physician assistant	6.94	0.64
Beds per capita	3.43	0.74
Physicians per capita	1.52	0.32
Rent	103.76	14.19
AFDC	2.86	0.87
Population density	524.35	423.57
Per capita income	4735.66	736.97
Education	11.81	0.55

TABLE A3

THE VARIATION IN INDIVIDUAL PHYSICIAN PREFERENCES AND CHARACTERISTICS WITHIN VERSUS BETWEEN GROUPS

Variable	Standard Deviations	
	Within	Between
Importance of regular income	0.61	0.583
Importance of regular hours	0.59	0.589
Preferred group size	17.724	17.34
Experience	8.929	6.801
Foreign medical graduate	0.208	0.127
Board certified	0.345	0.339
Subspecialty	0.323	0.334

TECHNICAL APPENDIX

I. First Order Conditions for the Asymmetric Model

The group objective function is:

$$W = u_i = \alpha Pq(\bullet) + (1/n)(1 - \alpha)P\Sigma q(\bullet) - (1/n)FC$$
$$- B\alpha^2P^2 \sigma_i^2 - B(1/n)^2(1 - \alpha)^2P^2 \Sigma\sigma_j^2$$
$$- V_i(\bullet), \qquad \text{(A1)}$$

The FOC are:

$$\partial u_i/\partial\alpha = Pq - (1/n)P\Sigma q + \alpha P(\partial q/\partial z_i)(\partial z/\partial e_i)(\partial e_i/\partial\alpha) +$$
$$(1/n)(1 - \alpha)P\Sigma(\partial q/\partial z_i)(\partial z/\partial e_i)(\partial e_i/\partial\alpha)$$
$$- 2B[\alpha P^2 \sigma_i^2 - (1/n^2)(1 - \alpha)P^2 \Sigma\sigma_j^2]$$
$$- (\partial v_i/\partial e_i)(\partial e_i/\partial\alpha) = 0, \qquad \text{(A2)}$$

and

$$\partial u_i/\partial n = \alpha P(\partial q/\partial z_i)(\partial z/\partial e_i)(\partial e_i/\partial n) +$$
$$(1/n)(1 - \alpha)P\Sigma(\partial q/\partial z_i)(\partial z/\partial e_i)(\partial e_i/\partial n) + (1/n)(1-\alpha)Pq_{n'}$$
$$+ (1/n^2)FC$$
$$- (1/n^2)(1 - \alpha)P\Sigma q) + (2B/n^3)(1 - \alpha)^2P^2 \Sigma\sigma_i^2]$$
$$- B(1/n)^2 (1-\alpha)^2 \sigma_{n'}^2$$
$$- (\partial v_i/\partial e_i)(\partial e_i/\partial n) = 0, \qquad \text{(A3)}$$

where $q_{n'}$ and $\sigma_{n'}^2$ are the output and variance associated with the additional member.

The basic results of this model are the same as those of the symmetric model. The variables α and n are set so that marginal revenue, and marginal cost (including disutility), and marginal risk are balanced. If there is no risk or risk aversion (e.g., $B=0$) these reduce to conditions for the first-best, thus $\alpha=1$ and $n=n^*$. Moving from risk neutrality ($B=0$) to risk aversion ($B>0$) leads to $\alpha<1$ and $n>n^*$. This can be seen by inspection of (A2) and (A3). Further increases in risk aversion can have any effect which leads to increased risk-spreading and decreased incentives. The illustrations in Figure 5 apply regardless of assumptions regarding symmetry.

II. <u>First Order Conditions with Price Endogenous (Symmetric Model)</u>

$$\partial u_i/\partial \alpha = [P(\partial q/\partial z_i)(\partial z/\partial e_i) - (\partial v_i/\partial e_i)](\partial e_i/\partial \alpha) - 2BP^2 \sigma_i^2[\alpha + (1/n)(1 - \alpha)] = 0, \quad \text{(A4)}$$

and

$$\partial u_i/\partial n = [P(\partial q/\partial z_i)(\partial z/\partial e_i) - (\partial v_i/\partial e_i)](\partial e_i/\partial n) + (1/n^2)FC - (1/n)\partial FC/\partial n + (B/n^2)(1 - \alpha)^2 P^2 \sigma_i^2] = 0. \quad \text{(A5)}$$

and

$$\partial u_i/\partial P = [P(\partial q/\partial z_i)(\partial z/\partial e_i) - (\partial v_i/\partial e_i)]\partial e_i/\partial P + q + P(\partial q/\partial P) - 2BP\sigma_i^2[\alpha^2 + (1/n)(1-\alpha)^2] = 0. \quad \text{(A6)}$$

The first order condition for price equates the marginal revenue from quality supply effects, marginal revenue from price effects, marginal (disutility) cost from quality supply effects and marginal risk effects to zero. Since the marginal risk effects are negative, when risk effects are absent, price will be higher. The effects of further increases in risk aversion are also indeterminate here, but the combination of $\partial\alpha/\partial B>0$, $\partial n/\partial B<0$, and $\partial P/\partial B>0$ cannot occur, since this results in increased incentives and less risk spreading in the presence of increased risk aversion.

III. Proofs That $\alpha^* \in (0, 1)$, $n^* \in (1, +\infty)$, and $P^* > \in(o, +\infty)$.[1]

A. Proposition A1: $\alpha^* \in (0, 1)$.

Proof: By contradiction.

1. $\alpha = 1$.

$$\partial u_i/\partial\alpha|_{=1} = -2BP^2\sigma_i^2 < 0, \therefore \alpha^* < 1$$

2. $\alpha = 0$.

$$\partial u_i/\partial\alpha|_{=0} = ((n-1)/n)P(\partial q/\partial z_i)(\partial z/\partial e_i)(\partial e_i/\partial\alpha) + (2/n)BP^2\sigma_i^2 > 0, \therefore \alpha^* > 0$$

So, $\alpha^* \in (0,1)$. ‖

B. Corollary A1: If B or $\sigma_i^2 = 0$, then $\alpha^* = 1$

Proof: If B or $\sigma_i^2 = 0$ then

$$\partial U_i/\partial\alpha|_{B=0}\ (1-\alpha)((n-1)/n)P(\partial\rho/\partial z_i)(\partial z_i/\partial e_i)(\partial e_i/\partial\alpha) > 0$$

for all $\alpha < 1$,

$\therefore \alpha^* = 1$. ‖

C. Proposition A2: $n^* \in (1, +\infty)$.

Proof: By contradiction.

1. $n=1$.

$$\partial u_i/\partial n|_{n=1} = FC - (\partial F/\partial n) + (1-\alpha)^2 BP^2\sigma_i^2 > 0, \therefore n^* > 1.$$

[1]We thank Rob Porter for suggesting these proofs.

2. $n = +\infty$

$\partial u_i/\partial n|_{n=+} = (1-\alpha)P(\partial q/\partial \alpha_i)(\partial z_i/\partial e_i)(\partial e_i/\partial n)<0,$

$\therefore n^* < +\infty$

So, $n^* \in (1, +\infty)$. ‖

D. <u>Corollary A2</u>: If B or $\sigma_i^2 = 0$, then n is set to achieve optimal scale.

<u>Proof</u>: When B or $\sigma_i^2 = 0$, $\alpha = 1$, So

$\partial u_i/\partial n|_{B=0} = (1/n^2)FC-(1/n)(\partial FC/\partial n) = 0.$ ‖

E. <u>Proposition A3</u>: $P^* \in (0, +\infty)$

<u>Proof</u>: By contradiction.

$\partial u_i/\partial P|_{P=0} = q > 0,$

So $P^* > 0$.

$\partial u_i/\partial P|_{P=\infty} = +\infty$

So $P^* < +\infty$. ‖