

A MULTI-PRODUCT COST FUNCTION FOR PHYSICIAN PRIVATE PRACTICES

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Abstract

This paper provides a comprehensive empirical analysis of the production of physician services in a multi-product cost setting. We specify a four-product generalized Leontief cost function for physician services that recovers measures of marginal cost, scale, scope, and elasticity. Our study is based on physician survey data from the 1998 American Medical Association Physician Socioeconomic Monitoring Survey and motivates a scientific framework for developing a reimbursement fee schedule. Our analysis shows that physician services are priced well above marginal cost, providing evidence of market power in physician private practices.

Keywords: physician, multi-product cost function, Medicare reimbursement
JEL: C30, D24, I12

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1 Introduction

The production of physician services relies heavily upon revenue reimbursements from third-party payers. The most recent figures reported by the American Medical Association in 2006, revealed that 560,000 physicians billed Medicare for \$54 billion in federal reimbursements, accounting for seventeen percent of all Medicare payouts. It has recently been reported that approximately forty-five percent of physicians in the American Medical Association plan to decrease or stop their acceptance of new Medicare beneficiaries, due to the general belief that existing reimbursement schedules poorly approximate the marginal cost of services.¹ The Bush administration has reduced government payments to physicians as a means for slowing the spending growth of Medicare. This has not been a policy without detractors, however, particularly those in political parties in the opposition who have suggested that continued cuts in spending will destabilize government programs and risk the availability of patient health care. The Justice Department has inserted its position in this mix of perspectives on health care, arguing that large physician practices exhibit within- and between-network market power, resulting in fee schedules pricing well above marginal cost.²

There are widely acknowledged differences among the political parties and health care providers, with respect to the effectiveness of the existing reimbursement schedule. This paper attempts to reconcile much of that disparity by proposing an econometric framework that could be used in a service-based fee setting. It has been noted that most estimates of physician practice costs are not developed by formal econometric modeling.³ Instead they rely upon an inspection of accounting data that examines measures of interest.

¹ <http://seniorjournal.com/NEWS/Medicare/6-07-19-ReductionInMedicare.htm>. See 2006 American Medical Association report on Medicare physician payments.

² See Haas-Wilson and Gaynor (1998) for an examination and summary of competition in physician markets.

³ Escarce and Pauly (1998)

Our analysis employs and expands upon many of the theoretical contributions in the literature to examine the issue empirically.

Escarce and Pauly (1998) provided a seminal contribution to the physician cost function literature by specifying a theoretical framework for the production process of physician services. This extended previous work by Gaynor and Pauly (1990). Prior physician cost studies, such as Pope and Burge (1995), were limited due to a lack of available data and the inability of the functional form to adhere to well-established properties consistent with economic theory. The production study by Reinhardt (1973) provided the motivation for economic studies of cost and scale; however it preceded many of the theoretical advancements in functional form flexibility, most notably, those of Diewert (1971). The recent work by Thurston and Libby (2002) revisited the earlier contributions of Reinhardt (1973) by specifying a production function framework that permits substitutability between various inputs in the physician production process. Gaynor and Vogt (2000) summarized many of the production specifications for health services. Escarce and Pauly (1998) suggested physician private practices exhibit regional market power, while Gunning and Sickles (2006) showed evidence of regional monopolies. Our study applies the theoretical contributions of Escarce and Pauly (1998) to recover significant economic measures that could be used in a resource-based fee setting. In addition, we examine the revenues received by physicians for their services and assess to what degree the existing fee schedules for physician reimbursements accurately reflect physician costs at the margin.

As noted by Li and Rosenman (2001), there are both critics and supporters of the use of production functions that exhibit flexibility as opposed to other more restricted approaches used in policy discussions (Cowing et. al, 1983). Fischer et al (2006) provided evidence of nonlinearities in measures of cost and scale of health services, suggesting the

need of a functional form that exhibits local flexibility. Elbasha and Messonnier (2004) questioned the notion of constant returns to scale in health technologies due to the potential inability to replicate essential resources that are fixed in the short run. The primary empirical advantage of functional flexibility is the measurements of scale, scope, and elasticity. In addition, it is essential that any representation of the underlying production technology contains the microeconomic characteristics that ensure theoretical soundness. A multi-product cost specification that is locally flexible and places no *a priori* restrictions on factor substitution elasticities would be a substantial step toward that pursuit. In the next section, we provide the motivation for our empirical study. This is followed by section 3, where we present our model. The data is described in section 4 and the results are presented in section 5. Section 6 provides concluding remarks.

2 Motivation

Before one can begin an empirical study of cost or economic behavior, it is first necessary to present the theoretical approach that motivates it. The specification by Escarce and Pauly (1998) relied upon the observation that physician labor supply is the result of a utility maximization problem by the physician. Therefore, the level of physician labor supply is presumed to be quasi-fixed; an assumption contained within the model. Formally, Escarce and Pauly (1998) specified a two-stage utility-maximization problem by the physician, yielding a system of two equations. In the first stage, the outputs of production and the supply of physician labor are treated as parametric, resulting in the physician choosing the quantity of nonphysician inputs that maximize utility, yielding the conditional nonphysician input demands. The conditional nonphysician input demands are the quantities of

nonphysician inputs the physician purchases as a function of total output, input prices, and labor supply.⁵ The first stage is represented by a traditional cost function, which has a dependent cost variable that is the sum of all the costs incurred by the practice. In the second stage, outputs are taken as parametric and the physician selects the optimal supply of labor that maximizes the utility function of the physician, yielding the conditional demand for physician labor, which is equivalent to the level of physician labor supply produced, subject to the price of nonphysician inputs and the quantity of outputs. The second stage is represented empirically by a physician labor supply equation.⁶

There are differing opinions as to how a multi-output cost function should be specified, including what outputs to consider.⁷ The primary output of a general practice physician is a single office visit. Office visits often constitute detailed consultations with new patients or regular examinations with established patients. Depending on the specialty of interest, physicians may also spend a considerable amount of time in a hospital setting, including regular emergency room trips and scheduled hospital rounds. Therefore, our four outputs of interest are established patient office visits, new patient office visits, emergency room visits, and hospital visits.⁸

The most popular functional form in a multi-product cost setting is the transcendental logarithmic (translog).⁹ The generalized translog in its original form is a second-order Taylor-series approximation to an arbitrary cost function (Caves et al, 1980). The translog is desirable in an empirical setting due to its relative ease to impose the restrictions required by economic theory, in addition to the degree of interpretability of its

⁵ Examples of nonphysician inputs include nurses, clerical support, malpractice rents, and office supplies.

⁶ We refer the reader to Escarce and Pauly (1998) for a formal derivation and a detailed discussion.

⁷ See McFadden (1978).

⁸ Other miscellaneous outputs such as x-rays, test interpretations, and phone calls are sparse, resulting in approximately 10% of total cost to the practice. Data limitations prevented their inclusion.

⁹ Or a variety of its extensions. See Berndt and Christensen (1979) or Christensen et al (1971).

reported coefficients. Escarce and Pauly (1998) specified a translog with Box-Cox transformations on the outputs. The Box-Cox transformation was designed to address the issue of many physicians reporting zero outputs.¹⁰ In their illustration, many of the higher-order terms and cross-product terms were dropped to preserve degrees of freedom in their limited sample, leading to bias in their estimates and destroying the flexibility of the cost function.¹¹ We consider the generalized Leontief cost function proposed by Diewert (1971). Li and Rosenman (2001) used a multi-product generalized Leontief cost function for their two-product study of the hospital industry. They noted that the generalized Leontief has traditionally been used in a single output setting; however its extension to the multi-output setting has been seen in studies dating back to Hall (1973). As further noted by Li and Rosenman (2001), the formal study of flexible functional forms undertaken by Guilkey, Lovell, and Sickles (1983), concluded that it was often the data and the underlying technology that determines the most appropriate specification, not the functional form itself.

The most advantageous feature of the generalized Leontief in a physician services setting, is its response to zero outputs. In the past, many studies of cost have transformed the translog into a “small-value translog”, where the researcher arbitrarily assigns small values to those outputs that report zeros. However that approach has a history of producing erratic measures (Berger et al, 1999; Weninger, 2003). Alternatively, Roller (1990) specified a proper quadratic cost function that was extended by Pulley and Braunstein (1992) to study production technologies in the U.S. banking industry. It has since been referred to as the composite cost function. A similar approach in spirit is the generalized hybrid Diewert (1971) multi-product cost function, which implements a square root transformation.

¹⁰ We note these are true zero measures and not missing values.

¹¹ The work by Escarce and Pauly (1998) was primarily theoretical. The authors themselves note that their results were intended to be purely illustrative and not to be viewed as a reliable empirical measure.

However, most of the functional specifications noted above are extensions or modifications of the translog or the Leontief.¹² The generalized Leontief of Diewert (1971) provides a direct theoretical representation of the physician data and the underlying production technology, due to its treatment of the outputs and the ability to determine input substitutabilities with little difficulty.

3 Model

We estimate the structure of production in the physician services market by jointly estimating the *cost function* and the *physician labor function*. Our motivation to estimate the entire system, rather than the cost function in isolation, is due to the theoretical contributions of Escarce and Pauly (1998) and the empirical evidence of potential endogeneity bias in physician practice cost functions (Escarce, 1996). The resulting specification is a restricted (variable) cost function, reminiscent of Sickles and Streitweiser (1998). The quasi-fixed input of physician labor is based on the underlying assumption that the physician is always at (or close to) their optimal level of labor supply, conditional upon peripheral market conditions. We note that the empirical interpretation of the theoretical model of Escarce and Pauly (1998), essentially allows for the existence of temporary disequilibria due to the presence of the quasi-fixed input. Temporary disequilibria may simply be due to unexpected demand shocks in the market, a presumption implicitly preserved in the model.

The objective of the physician is to minimize a cost function of physician and nonphysician inputs, subject to a technological constraint,

$$(1) \quad \min \sum W_i X_i \quad \text{subject to} \quad G(Y, X, t) \leq 0$$

¹² See McFadden (1979) for a summary.

where G represents the transformation function of the production technology. The solution to equation (1) yields the cost function, represented by:

$$(2) \quad C = C(Y, W, T)$$

In equation (2), C is the summation of practice costs incurred by the physician for his or her production of services. Y represents the measures of output, measured in annual office visits with established patients, new patients, emergency room trips, and hospital rounds. W are input prices for office rent, nonphysician employee payments, and malpractice premiums.¹³ C is homogeneous of degree one and symmetric in factor prices (W), non-increasing and convex in the levels of the quasi-fixed factor (T), and non-negative and non-decreasing in output (Y). We approximate C by a multi-product generalized Leontief cost function, including practice-level characteristics that are believed to influence practice cost and dummy variables to control for differences in physician specialties.

The physician labor supply equation is represented by:

$$(3) \quad T = T(Y, W)$$

where T is the annual hours of labor provided by the physician. Output (Y) and input prices (W) are defined in C . In addition to practice-level characteristics and dummy variables to control for heterogeneity in specialties, we include physician-level characteristics that are expected to influence the supply of physician services, independent of their effects on nonphysician costs. We follow the framework of Escarce and Pauly (1998) by specifying the physician labor supply function in the same manner as the cost function, in our case, a multi-

¹³ We use office visits as physician output. There are other measures of physician output that are more comprehensive but less easily observed and measured. For a discussion of these alternatives, health outcomes that can be constructed for these alternatives, and their use in static and intertemporal models of health production see, for example, Sickles and Taubman (1997), Berhman et al. (1998), and Sickles and Yazbeck (1998).

output generalized Leontief. However, we note that T is a representation of physician labor and does not satisfy the traditional properties of a cost function.

The econometric specification for the cost equation faced by the physician is represented by a non-homothetic generalized Leontief:

$$(4) \quad C(Y, W, T) = \alpha_T T + \sum_{i=1}^4 \left(\sum_{j=1}^3 \sum_{k=1}^3 \alpha_{i,j,k} W_j^{\frac{1}{2}} W_k^{\frac{1}{2}} \right) Y_i + \sum_{i=1}^4 \sum_{j=1}^3 \beta_{i,j} W_j Y_i + \sum_{i=1}^4 \left(\sum_{j=1}^3 \varphi_{i,j} W_j \right) Y_i^2 + \sum_{1 \leq i < l \leq 4} \sum_{j=1}^3 \varphi_{j,il} W_j Y_{il} + \sum_{j=1}^3 \gamma W_j + \Gamma + \Psi$$

where Γ are practice controls, that include binary variables for whether the physician practices in a metropolitan location and if the physician is board-certified. In addition, we include the percentage of patients that pay with Medicaid and the number of physicians in the practice. Ψ represents four physician-reported dummy variables that describe the practice setting: general practice, medical specialty, surgical specialty, or other.

Differentiating the cost function with respect to each input price, yields the unconditional factor demands for the inputs. Hence, the factor demand function for any price (W_j) is:

$$(5) \quad X_k = \frac{\partial C}{\partial W_k} = \frac{1}{2} \sum_{i=1}^4 \sum_{j \neq k} \alpha_{i,j,k} \frac{W_j^{\frac{1}{2}}}{W_k^{\frac{1}{2}}} Y_i + \sum_{i=1}^4 \sum_{k=1}^3 \beta_{i,k} Y_i + \sum_{i=1}^4 \varphi_i Y_i^2 + \sum_{1 \leq i < l \leq 4} \varphi_{il} Y_{il} + \gamma W_k$$

Escarce and Pauly (1998) used the specification of C to define the labor equation, which implicitly presumes the interaction of input prices and outputs determines the optimal supply of labor. The physician labor equation is specified as a non-homothetic generalized Leontief, yielding:

$$\begin{aligned}
(6) \quad T(Y, W) = & \sum_{i=1}^4 \left(\sum_{j=1}^3 \sum_{k=1}^3 \alpha_{i,j,k} W_j^{\frac{1}{2}} W_k^{\frac{1}{2}} \right) Y_i + \sum_{i=1}^4 \sum_{j=1}^3 \beta_{i,j} W_j + \sum_{i=1}^4 \left(\sum_{j=1}^3 \varphi_{i,j} W_j \right) Y_i^2 \\
& + \sum_{1 \leq i < l \leq 4} \sum_{j=1}^3 \varphi_{j,il} W_j Y_{il} + \sum_{j=1}^3 \gamma W_j + \Gamma + \Psi + \zeta
\end{aligned}$$

where ζ are physician-specific heterogeneity controls. We include linear and quadratic terms for age and years of experience.

Our specification of (4) is advantageous because it maintains desirable theoretical characteristics. The generalized Leontief is homogeneous in input prices by construction and symmetry is imposed prior to estimation. It is a second-order approximation that is locally flexible and imposes no *a priori* restrictions on the elasticities of factor inputs. The flexible nature of the cost function allows our model to capture the degree of scale and scope economies, in addition to the potential non-linearity of marginal costs.

4 Data

The data for this study comes from the 1998 American Medical Association (AMA) Physician Socioeconomic Monitoring Survey (SMS) and the 1998 Geographic Practice Cost Index (GPCI) originally proposed by Zuckerman et al. (1990). Table I summarizes the data. The SMS is a telephone survey to 3,700 private practice physicians that are members of the AMA and practice in the United States. The SMS is a geographically comprehensive and occupationally detailed survey that provides physician, practice, and demographic characteristics for the physician private practice setting. Total cost is the sum of nonphysician employee payments, insurance expenses related to malpractice, and office expenses. Nonphysician employee payments include secretarial support, nurses, and assistants. Insurance expenses consist of malpractice premiums and any additional

malpractice costs associated with the practice.¹⁴ Office expense is the cost of leasing, renting, or owning the infrastructure that the practice is located in. The office expense variable also includes any rents related to the lease or ownership of technological equipment. The physician labor variable is constructed by multiplying the average hours worked per week, as reported by the physician, by the number of hours practiced in the 1998 calendar year. We use the same methodology to construct the four outputs, via multiplying reported weekly outputs by the number of weeks worked in 1998. All demographic and sociological characteristics are reported by the physician and were detailed in the previous section.

The SMS does not contain information on input prices. The GPCI is a Laspeyres index that is designed to control for price fluctuations in health markets by assigning weighted values to three input categories: office rent, nonphysician wages, and malpractice rents. Pope and Burge (1990) suggested deflating the dependent cost variable by the GPCI to preserve linear homogeneity in prices. However, that method has a number of limitations.¹⁵ Escarce and Pauly (1998) used two sub-components of the index; office rent and nonphysician wages, allowing the malpractice subcomponent to be the numeraire. We use all three subcomponents of the GPCI for our input prices. Our study examines the demographic variables of the SMS to determine the geography of the practice and assigns geographic prices to the practice accordingly. Since there is reasonable variation in malpractice premiums by location, we include the malpractice subcomponents as a unique measure of price, rather than presume it as the implicit numeraire.

Our sample considered only those physicians who practiced at least 20 hours or more a week. Those respondents who spent the majority of their time in a hospital or a

¹⁴ Malpractice insurance may include legal fees associated with malpractice cases.

¹⁵ The method by Pope and Burge (1990) is rather problematic, since it precludes measurement of share equations, economies of scale and scope, and the interaction of second-order prices. The result is a functional form that does not adhere to economic theory.

school setting were not considered for this study. Our final sample consists of 939 private practice physicians that practice strictly in the United States.

5 Estimation

The four-equation system consists of the cost equation (4), the physician labor equation (5), and two of the three demand equations (6).¹⁶ We append additive error terms to the cost, labor, and demand equations. The system is estimated via three-stage least squares (3SLS). Table II provides parameter estimates with standard errors in parentheses. Escarce and Pauly (1998) have showed that the physician characteristics unique to the physician labor equation but excluded from the cost equation, identify the cost function. In our case, those are linear and quadratic terms for age and experience (ζ).¹⁷ Linear homogeneity in prices is achieved by construction, while symmetry is imposed prior to estimation. The cost function is concave in prices and in the quasi-fixed factor. We test the null hypothesis of non-homotheticity of the cost equation and the labor supply equation, and reject it at the 99% confidence level, implying there is significant evidence of price/output interaction.

Table III reports our measures for marginal cost for each of the four outputs. We also report the marginal opportunity cost of an hour of physician labor. As noted by Li and Rosenman (2001), there are two common approaches for determining marginal cost estimates at the mean. The traditional approach is to use the mean estimates of the data and the estimated coefficients from the cost equation to derive a point estimate for the four outputs of interest. Since the marginal costs are non-linear in our model, we prefer the method by Li and Rosenman (2001), which consists of using the estimated coefficients from the cost equation to recover the marginal costs for each observation, yielding a unique

¹⁶ One of the demand functions is dropped to avoid singularity.

¹⁷ A regression test of the overidentifying restrictions found that these restrictions could not be rejected ($\chi^2 = 2.60$; $p = 0.63$).

marginal estimate for our 939 observations. The marginal costs are then averaged over the sample, with standard errors appearing in parentheses below the estimates.¹⁸ All four of our reported measures of outputs are significant at the 1% level. The marginal cost to the physician for an additional visit with an established patient is \$27.83, while the additional cost of an office visit with a new patient is \$75.05. The cost of an emergency room visit at the margin is \$27.73, yet the additional cost of a hospital visit is only \$16.02. Table III also compares our estimates to Escarce and Pauly after inflating their 1987 estimates to 1998 dollars with the Consumer Price Index (CPI). The reported measure for hospital visits and emergency room visits is almost the same. Our measure for new patient visits is noticeably lower, while our marginal cost measure for established patient office visits is slightly below the estimate reported by Escarce and Pauly.¹⁹

Since the labor variable and cost variable are entered into the cost specification linearly, the labor coefficient is the marginal cost for an additional hour of physician labor, holding all other factors constant. The labor coefficient is negative, consistent with theory, implying that the physician would have to substitute his or her own labor to lower total practice costs while maintaining the same level of productivity. Our estimate for the marginal cost of an additional hour of physician labor is \$53.51.

We test the null hypothesis of constant returns to scale. Escarce and Pauly found evidence of increasing returns with respect to physician outputs.²⁰ The literature in health services is reviewed in Gaynor and Vogt (2000), with Kass (1987) finding little evidence of

¹⁸ Standard errors are calculated by taking the square root of the variance for all four measures of output and then dividing by the square root of the sample size. We note that using the coefficients to estimate a marginal cost measure “at the mean”, obtaining standard errors by the “Delta Method”, produced roughly the same results.

¹⁹ The limited sample size and inflexibility of the Escarce and Pauly specification is most likely a contributing factor in the reported differences.

²⁰ In theory, physician private practices exhibit returns based on outputs and practice size. Our study focuses on the former.

economies of scale in the market for home health services and scale economies in the market for hospital production being found by Vita (1990) and Cowing and Holtmann (1983).²¹ Economies of scale are measured by inverting the sum of the elasticities of output. Panzar and Willig (1977) showed that economies of scale for a production process with a quasi-fixed factor reduces to:

$$(7) \quad SCALE = \frac{C(W, Y, T^*) - t^* \left(\frac{\partial C}{\partial T} \right)}{\sum_{i=1}^4 \frac{\partial C}{\partial Y_i} \cdot Y_i}$$

A value $>$, $<$, or $=$ to unity, implies increasing, decreasing, or constant returns. Pauly and Escarce (1998) found a point estimate of 1.67 for the degree of ray economies of scale. Our results yielded a point estimate of 2.95 ($z=18.66$, $p<0.001$), indicating increasing returns to scale.²² Thus a 10% increase in output requires only a 3.4% increase in practice cost.

Economies of scope can be computed a number of ways. Li and Rosenman (2001) suggest the method by Vita (1990), which indicates that weak cost complementarities are a sufficient condition for economies of scope (i.e. if $\frac{\partial^2 C}{\partial Y_i \partial Y_j} < 0$ for all $i \neq j$). However, summing the coefficients of the cross-product terms provides little economic interpretation for the sensitivity that private practices exhibit with respect to specialization. We favor a more traditional approach, that is

$$(8) \quad SCOPE = \frac{\sum_{i=1}^4 C(y_i, 0) - C(Y)}{C(Y)}$$

²¹ See Elbasha and Messonnier (2004) for a summary.

²² It is well-known that these measures, as ratios of terms whose denominator is not bounded away from zero, do not have finite moments. We use a standard trimming proportion of 2.5% in each tail of the empirical distribution in calculating the mean and standard deviation of the sample statistics for scale.

²⁴ This result is most likely attributable to long-term contractual obligations on office rent and office equipment, in addition to a high demand for specialized assistants

The above percentage describes the additional cost to the practice for producing the outputs separately, rather than together. Expression (8) yielded a modest measure of 0.007 and was not statistically significant from zero, implying that costs could increase 0.7% if the practice produced the outputs separately. We note that our cost function controlled for fields of specialty. Hence our result implies there is little advantage *within* a specialty to produce outputs separately, but does not necessarily imply that physician practices can not exhibit scope economies *across* specialties.

Allen partial own-price and cross-price elasticities are reported in Table IV (Allen, 1938). Table V reports Allen-Uzawa partial elasticities of substitution (Uzawa, 1962). Due to symmetry in prices, we report only the upper triangular matrix. The own-price elasticities for nonphysician wages and office rent have the correct sign (-) and are statistically significant at the 1% level. Nonphysician wages and office rents are relatively inelastic, implying physician private practices are rather unresponsive to a change in price.²⁴ The own-price elasticity for malpractice insurance is incorrectly signed (+), but statistically insignificant. Cross-price elasticities associated with nonphysician wages are positive and significant at the 1% level, implying that practices substitute nonphysician employees for office rent and malpractice premiums. Malpractice premiums are typically determined by the level of skill and duties of the physician. Hence a decrease in nonphysician labor requires an increase in physician labor, resulting in higher demand for malpractice associated inputs. The cross-price elasticity on office rent and malpractice is positive, but barely achieved significance at the 10% level.

Table VI reports the difference in price and marginal cost for three of the four outputs in 1998 dollars.²⁵ The markup over cost is substantial. Our figures are based on

²⁵ Our data does not report the price of an emergency room visit.

statistically significant marginal cost estimates and the average revenue the physician receives for their service. It is essential to compare the marginal cost estimates to the *actual* revenue received, rather the price *billed*, since physicians typically receive a negotiated lower rate. There appears to be the greatest advantage in the hospital market, with an average markup of 390% over cost. Visits with new patients are priced 46% above cost and office visits with existing patients are approximately 135% over cost. Our results are consistent with many of the charges brought by the Department of Justice in 1998, when they claimed that large physician groups exhibited collusive behavior that led to inflated prices and misappropriated reimbursements by the federal government. Our measures are consistent with Escarce and Pauly (1998) and Gunning and Sickles (2006), suggesting that physicians are compensated well above their cost of providing service.

6 Conclusion

This paper has examined the physician production process in a multi-product cost setting. We found the generalized Leontief functional form responds well to our physician-level data. Gaynor and Pauly (1990) and Escarce and Pauly (1998) made substantial steps in developing a theoretical model for physician private practices with the primary motivation being the potential endogeneity bias of physician labor. This paper demonstrates how to use much of the theoretical motivation of the literature to derive plausible estimates of the marginal cost for a variety of outputs that a private practice physician performs on a regular basis. Our results indicate that marginal costs are the highest for office visits with new patients and lowest for visits in a hospital setting. We found significant evidence of increasing returns to scale. However, it does not appear there are economies of scope within specialties. In addition, our elasticity findings revealed that physicians rely heavily upon the inputs of

production and are relatively insensitive to changes in price. Our results could be viewed as a motivation for the development of a resource-based fee schedule that relies on formal econometric modeling, rather than a study of accounting data.

As noted in our introduction, it has been a contentious debate as to whether physicians are compensated above or below marginal cost. Our results clearly support the former and suggest there is a substantial loss in social welfare from excess payouts and third-party supported market power. In 1998, the Justice Department brought a number of charges against large private practices for participating in anti-competitive behavior.²⁶ Our empirical findings appear to support their claims and suggest the need for a more in-depth study on the impact of collusion in physician private practices.

²⁶ For example, see *The United States of America vs. The Marshfield Clinic*

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TABLE I

	Mean	Standard Deviation
Total Cost	\$270,972	\$255,537
Annual Labor Hours	2,336	724
Office Visits (Established Patients)	4,174	2492
Office Visits (New Patients)	637	620
ER Visits	243	586
Hospital Visits	693	1028
Nonphysician Price	1.02	0.03
Office Price	1.07	0.13
Malpractice Price	1.14	0.53
Metropolitan	0.83	0.37
Number of Physicians	3.08	2.98
Percentage of Patients paying with Medicaid	0.12	0.14
Board Certified School	0.79	0.41
Experience	6.81	1.04
Age	2.52	1.03
General Practice	0.25	0.43
Medical Specialty	0.61	0.48
Surgical Specialty	0.07	0.25
Other Specialty	0.07	0.26

TABLE II

	Cost	Physician Labor
Labor	-53.511 (35.494)	-
P1	848933 (777956)	-4014.2 (3675.6)
P2	228677 (238845)	151.05 (1149.2)
P3	63100 (33380)	270.48* (154.5)
P1Y1	-327.18 (967)	2.325 (4.61)
P2Y1	-19.57 (899.4)	2.546 (4.29)
P3Y1	-6.56 (20.3)	-0.055 (0.097)
P1P2Y1	363.24 (1862)	-4.77 (8.89)
P1P3Y1	339.85* (185.8)	0.052 (0.09)
P2P3Y1	-336.56** (170.6)	-0.006 (0.818)
P1Y2	-84383* (4930.9)	-22.44 (23.20)
P2Y2	-5400.6 (4342.3)	-16.27 (20.59)
P3Y2	37.78 (125.98)	-0.162 (0.604)
P1P2Y2	14129 (9231.6)	39.3 (43.59)
P1P3Y2	988.15 (1066.1)	3.01 (5.06)
P2P3Y2	-1201.9 (944.2)	-3.3 (4.48)
P1Y3	11533.13** (5111)	32.69 (23.7)
P2Y3	9219.9** (4843.7)	30.32 (22.6)
P3Y3	149.87 (173.68)	-0.589 (0.827)
P1P2Y3	-20554.6** (9876.6)	-63.3 (45.92)
P1P3Y3	-276.09 (1287.4)	-0.423 (6.18)
P2P3Y3	-63.79 (1160.2)	1.487 (5.574)

P1Y4	-1812.7 (2211.7)	-7.34 (10.49)
P2Y4	-843.22 (2132.15)	-6.916 (10.159)
P3Y4	-7.367 (72.63)	-0.102 (0.348)
P1P2Y4	2691.3 (4333.5)	14.672 (20.61)
P1P3Y4	636.71 (538.3)	-0.563 (2.572)
P2P3Y4	-623.63 (447.3)	0.651 (2.136)
P1Y1Y1	-0.022 (0.016)	-0.00007 (0.00007)
P2Y1Y1	0.008 (0.009)	0.00011 (0.00008)
P3Y1Y1	-0.001 (0.126)	-0.00005 (0.00004)
P1Y2Y2	-0.165 (0.185)	-0.00093 (0.00087)
P2Y2Y2	0.127 (0.259)	0.0011 (0.0012)
P3Y2Y2	-0.001 (0.126)	-0.00024 (0.0006)
P1Y3Y3	-0.107 (0.33)	-0.0017 (0.0016)
P2Y3Y3	0.197 (0.46)	0.0022 (0.0022)
P3Y3Y3	-0.095 (0.169)	-0.00051 (0.00081)
P1Y4Y4	0.078 (0.062)	0.00036 (0.00029)
P2Y4Y4	-0.099 (0.088)	-0.0005 (0.00041)
P3Y4Y4	0.016 (0.038)	0.0001 (0.0002)
P1Y1Y2	0.134*** (0.057)	0.00025 (0.00027)
P1Y1Y3	-0.054 (0.567)	-0.0004 (0.0003)
P1Y1Y4	-0.006 (0.034)	0.00031** (0.00015)
P1Y2Y3	-0.161 (0.34)	0.0037 (0.0015)
P1Y2Y4	0.335* (0.196)	-0.0012 (0.0009)

P1Y3Y4	0.087 (0.119)	0.0004 (0.0006)
P2Y1Y2	-0.122*** (0.052)	-0.0003 (0.0002)
P2Y1Y3	0.052 (0.51)	0.0003 (0.00024)
P2Y1Y4	0.005 (0.031)	-0.0003 (0.0001)
P2Y2Y3	0.225 (0.305)	-0.0034*** (0.0013)
P2Y2Y4	-0.395** (0.175)	0.001 (0.0008)
P2Y3Y4	-0.059 (0.123)	-0.0004 (0.0006)
P3Y1Y2	0.002 (0.006)	0.0002 (0.00003)
P3Y1Y3	-0.005 (0.008)	0.000003 (0.00039)
P3Y1Y4	0.003 (0.004)	-0.000003 (0.0002)
P3Y2Y3	0.003 (0.036)	0.0002 (0.0002)
P3Y2Y4	0.023 (0.025)	0.0002 (0.0001)
P3Y3Y4	-0.007 (0.024)	-0.00003 (0.0001)
SPEC1	-37178** (19265)	5749.1** (2882.7)
SPEC2	78361*** (17338)	5856.27** (2885.6)
SPEC3	-	5876.9** (2884.4)
SPEC4	820.65 (22955)	5779** (2890.2)
METRO	-25434* (15889)	-1.244 (76.39)
DOCNUM	1938.4 (1514.1)	-8.532 (7.132)
MEDCAD	-127.9 (309.6)	-0.861 (1.478)
CERT	1548.6 (11082)	-99.42* (53.69)
AGE	-	129.36 (120.19)
AGESQ	-	-30.13 (22.19)

EXP	-	-200.3 (306)
EXPSQ	-	17.39 (22.33)
CONSTANT	853515 (591736)	-

Standard errors appear in parentheses.

*p<0.10

**p<0.05

***p<0.01

TABLE III

Outputs	1998 G&S	1998 E&P (adjusted for inflation)
Established Patient	\$27.83*** (1.43)	\$32.12*** (0.69)
New Patient	\$75.05*** (3.30)	\$87.03* (35.71)
Emergency Room	\$27.73*** (3.00)	\$29.55 (59.91)
Hospital	\$16.02*** (2.05)	\$17.61** (9.62)

Standard errors appear in parentheses

*p<0.10

**p<0.05

***p<0.01

TABLE IV**OWN-PRICE AND CROSS-PRICE ELASTICITIES**

INPUTS	NONPHYSICIAN WAGES	OFFICE RENT	MALPRACTICE
NONPHYSICIAN WAGES	-0.222***	0.175***	0.047***
OFFICE RENT	0.450**	-0.237***	-0.214*
MALPRACTICE	1.250	-1.287	0.037

Standard errors appear in parentheses.

*p<0.10

**p<0.05

***p<0.01

TABLE V**ALLEN-UZAWA OWN-PRICE AND CROSS-PRICE ELASTICITIES OF SUBSTITUTION**

INPUTS	NONPHYSICIAN WAGES	OFFICE RENT	MALPRACTICE
NONPHYSICIAN WAGES	-0.419***	0.463***	0.506***
OFFICE RENT	-	-0.626***	-2.310*
MALPRACTICE	-	-	0.405

Standard errors appear in parentheses.

*p<0.10

**p<0.05

***p<0.01

TABLE VI

PRICE MARKUPS

OUTPUTS	1998 Price	1998 MC	% Markup
Established Patient	\$65.30	\$27.83***	135%
New Patient	\$110.00	\$75.05***	46%
Hospital Visit	\$78.52	\$16.02***	390%

Standard errors appear in parentheses.

*p<0.10

**p<0.05

***p<0.01