International Journal of Health Care Finance and Economics, 2, 171–188, 2002
© 2002 Kluwer Academic Publishers. Manufactured in The Netherlands.

Spillover Effects of Medicare Fee Reductions: Evidence from Ophthalmology

JEAN M. MITCHELL* mitchejm@georgetown.edu

Professor, Georgetown Public Policy Institute, Georgetown University

JACK HADLEY

Principal Research Associate, The Urban Institute and Senior Fellow, The Center for Studying Health System Change

DARRELL J. GASKIN

Associate Professor, Bloomberg School of Public Health, Johns Hopkins University

Relatively little research has examined physicians' supply responses to Medicare fee cuts especially whether fee reductions for specific procedures have "spillover" effects that cause physicians to increase the supply of other services they provide. In this study we investigate whether ophthalmologist changed their provision of non-cataract services to Medicare patients over the time period 1992–1994, when the Medicare Fee Schedule (MFS) resulted in a 17.4% reduction in the average fee paid for a cataract extraction.

Following the McGuire-Pauly model of physician behavior (McGuire and Pauly, 1991), we estimated a supply function for non-cataract procedures that included three price variables (own-price, a Medicare cross-price and a private cross-price) and an income effect. The Medicare cross-price and income variables capture spillover effects. Consistent with the model's predictions, we found that the Medicare cross-price is significant and negative, implying that a 10% reduction in the fee for a cataract extraction will cause ophthalmologists to supply about 5% more non-cataract services. Second, the income variable is highly significant, but its impact on the supply of non-cataract services is trivial. This suggests that physicians behave more like profit maximizing firms than target income seekers. We also found that the own-price and the private cross-price variables are highly significant and have the expected positive and negative effects on the volume of non-cataract services respectively.

Our results demonstrate the importance of evaluating volume responses to fee changes for the array of services the physician performs, not just the procedure whose fee has been reduced. Focusing only on the procedure whose fee has been cut will yield an incomplete picture of how fee reductions for specific procedures affect physician supply decisions.

Keywords: physician fee reductions, spillover effects, supply response

*Address correspondence to: Jean M. Mitchell, Ph.D., Georgetown Public Policy Institute, 3600 N St., NW, Suite 200, Washington, DC 20007, Tel.: 202-687-7038; Fax: 202-687-5544.

I. Introduction

The Medicare Fee Schedule (MFS), which was phased in over the period 1992 through 1996, replaced Medicare's Customary, Prevailing, and Reasonable (CPR) reimbursement system for paying physicians. The CPR methodology was thought to be both inflationary and distorted, compensating physicians too much for surgical procedures but too little for primary care services. The MFS addressed these problems because payment levels are determined by relative value units and conversion factors that translate relative values into dollar amounts for each service.

How physicians responded to changes in fees implemented through the MFS is an area of considerable controversy. Some studies have analyzed changes in the supplies of specific procedures whose fees were reduced (Mitchell, Hadley and Gaskin, 2000; Yip, 1998). Much less is known about possible "spillovers" to both the Medicare and private insurance markets. We define "spillovers" as changes in the supplies of services the physician provides other than the specific procedure whose fee was reduced.

Most of the recent studies of physicians' responses to Medicare fee reductions analyzed cuts that were implemented under OBRA 87, 89 and 90. Although some of these recent studies attempted to examine spillover effects of the Medicare fee reductions associated with OBRA 87, 89 and 90, their analyses have some inherent limitations. To our knowledge, no previous research has investigated whether the fee cuts that were implemented under the MFS had spillover effects and thereby caused physicians to alter the supply of other services rendered to all Medicare patients within their practice.

In this study, we investigate whether ophthalmologists changed their provision of non-cataract services to Medicare patients over the time period 1992–1994, when the MFS resulted in a 17.4% reduction in the average fee paid for a cataract extraction. Did physicians respond to the MFS reduction in the cataract fee by changing the quantities of other services provided to their Medicare patients?

Understanding how physicians respond to fee changes is important for assessing whether the MFS can be used as a policy tool to influence either the mix of services provided or total spending for physicians' services. Even if the fee reductions led ophthalmologists to perform fewer cataract operations, they may have substituted and increased the supply of other services to their Medicare patients. If payments for the increase in non-cataract services supplied to Medicare patients outweighs the decline in payments linked to the provision of fewer cataract surgeries, then Medicare payments to ophthalmologists would increase despite the cataract fee reduction. Evaluating the effects of the MFS on the supply of physician services other than those procedures whose fees have been reduced will indicate whether the MFS is an appropriate mechanism for controlling spending on physician services. If the MFS fails to control Medicare spending on physician services, then alternative policies such as service "bundling," volume controls and capitation would need to be considered.

To address these important policy questions, we develop empirical models of the supply of non-cataract services based on the McGuire-Pauly (M-P) theoretical model of physician behavior. The M-P model shows that changes in volume depend on changes in profit margins associated with each service, and that margins may well vary across different classes of patients. By restricting our analyses to procedures performed by physicians in one specialty, we avoid possible biases that tend to arise when data is aggregated across medical specialties.

Our analysis also addresses some of the other shortcomings that hampered prior recent studies, such as endogeneity of price variables and omitted variables.

The remainder of this paper is organized as follows. The second section contains a review of the recent studies that have attempted to examine spillover effects associated with physician fee reductions. The third section outlines the McGuire-Pauly theoretical model, which provides the conceptual framework for our analysis regarding spillover effects of Medicare fee reductions. In section four, we outline the specification for the supply function. Section five describes the construction of the analysis sample and variables, followed by a brief overview of our estimation strategy. The results are reported in section six. The final section contains concluding remarks.

II. Recent Prior Research Evaluating Medicare Fee Reductions

Recent research evaluating physicians' supply responses to Medicare fee reductions is sparse. These studies include: McCall (1993), Rice et al. (1999), Tai-Seale et al. (1998), Yip (1998), Nguyen and Derrick (1997), Zuckerman et al. (1998) and Mitchell et al. (2000). With the exception of the study by Mitchell et al. (2000), each of these recent studies evaluated fee reductions mandated under OBRA 1987, 1989 and 1990. The study by Mitchell and colleagues analyzed fee reductions for cataract extractions and joint procedures associated with the implementation of the Medicare Fee Schedule. The studies by McCall (1993), Nguyen and Derrick (1997), Zuckerman et al. (1998) and Mitchell et al. (2000) examined physicians' supply responses for the procedure whose fee had been reduced. The other three studies by Rice et al. (1999), Tai-Seale et al. (1998) and Yip (1998) each attempted to evaluate spillover effects associated with fee reductions mandated under OBRA. We present a brief synopsis of prior research on spillover effects below.

Rice et al. (1999) analyzed hospital discharge data drawn from a nonrandom sample of hospitals to examine whether the volume of hospital surgical procedures changed in response to Medicare physician fee reductions for overvalued procedures mandated under OBRA89 and OBRA90. Their results suggest that reductions in Medicare fees cause physicians to increase the volume of overvalued procedures delivered to persons covered by private insurance. In contrast, Medicare physician fee reductions appear to have negligible effects on the supply of hospital surgical volumes rendered to Medicare patients. While their findings provide some insights regarding spillover effects associated with reductions in Medicare fees paid to physicians, their research design has some limitations. The most serious problem with their analysis is the use of hospital discharge data to examine the behavior of physicians. Because they do not analyze physician behavior directly, the increase in volume of procedures rendered to privately insured patients could have occurred because of changes in physicians' admitting patterns, and/or changes in hospitals' market areas or physician staffs.[1]

Using the same data as the Rice study, Tai-Seale et al. (1998) analyzed the effects of Medicare payment reductions for overvalued procedures in four markets: the Medicare overvalued procedures market (OM), the Medicare substitute procedures market (MS), private overvalued procedures, and private non-overvalued procedures deemed to be substitutes (SP). Their findings indicate that relative margins have a significant influence on

volume response in both the Medicare and private markets. In contrast, relative market size appears to have negligible effects on physicians' volume response to fee cuts. This study shares many of the shortcomings of the Rice study, most specifically that they employ data on procedure volume measured at the hospital level to evaluate physicians' responses to Medicare fee reductions.

In a more recent study, Yip (1998) analyzed longitudinal data on coronary bypass grafts (CABG) procedures performed by thoracic surgeons in New York and Washington states to evaluate physicians' volume responses to Medicare fee reductions for overpriced procedures mandated under OBRA87. Her findings indicate that physicians whose incomes dropped significantly as a result of Medicare fee reductions responded by performing significantly higher volumes of CABGs. Further, her results also indicate that Medicare fee reductions have both spillover effects and a negative income effect, which in turn causes physicians to perform more surgical procedures on privately insured patients. Although Yip's analyses provide new evidence on spillover effects of Medicare fee reductions on the private market, her findings are limited for at least three reasons. First, because CABG procedures are performed in response to potential life-threatening circumstances, surgeons are likely to find that it is difficult to reduce the supply of CABG procedures in response to fee reductions. Second, because her dataset lacked information on payments made to individual physicians, she constructed the fee variable from locality-level Medicare prevailing charges. The own-price variable is therefore measured with error because it is not a physician-specific fee. Similarly, the variable used to measure the income effect is measured with error. A third problem is that the specification excludes the cross-price, that is, the relative price of other procedures; this exclusion is a source of omitted variables bias.

In summary, the three recent studies which analyzed spillover effects associated with Medicare fee reductions mandated under OBRA87, OBRA89 and OBRA90 have some shortcomings that limit the implications of their findings. In this study, we attempt to address some of the deficiencies of prior research by employing a physician level data base to analyze spillover effects of MFS reductions on the supply of non-cataract procedures rendered to Medicare beneficiaries, irrespective of whether they had cataract surgery.

III. Theoretical Framework

The theoretical framework underlying our empirical analyses is based on the McGuire-Pauly (1991) model of physician behavior which views each physician as a utility-maximizing multiproduct firm. Physician utility is a function of leisure and net revenue, which yield positive utility, and subjective inducement costs; the latter represents a source of disutility. The standard profit-maximizing theory predicts that when the fee for a specific procedure is cut, the physician will respond by reducing the supply of that procedure. In contrast, the McGuire-Pauly model recognizes the possibility that physicians may respond to fee reductions by increasing the supply of services. Their model accommodates this situation by allowing subjective inducement to affect the physician's utility. Specifically, McGuire and Pauly (1991) argue that there are actually two alternative models of inducement, along with a no-inducement model that one may observe. In the "modified target income" model there are both income and substitution effects. If the income effect of an own-price reduction

is large enough, then one might find the anomalous case of an increase in quantity which some have used as evidence for inducement and target income behavior.[2] On the other hand, there might be a zero or small income effect in a different model (the neo-classical inducement model) which would lead to inducement of more quantity when prices rise and less quantity when prices fall. There would still be inducement, but quantities would move in the opposite direction of the target income model when own price changes. The problem with the neo-classical inducement model is that it is much harder to distinguish it from a no-inducement model with excess demand or quality inducement. The point to emphasize is that both price and income effects can occur in an inducement model.

In essence, the McGuire-Pauly model recognizes that physicians may "induce demand" in order to maintain a target level of income. Under standard profit-maximization, price and quantity move in the same direction, whereas according to the target income theory, price and quantity move in opposite directions. The McGuire-Pauly model accommodates both benchmark cases.

A. The Model

The arguments of the physician utility function are net revenue (profit), leisure, and the level of inducement for the procedure whose fee has been cut as well as the level of inducement for other services. In formal terms, this single payer model with multiple services is represented as:

$$U = U(\pi, L, l_1, l_2)$$

where

$$\pi = X_1(l_1)m_1 + X_2(l_2)m_2$$
$$L = 24 - X_1(l_1)t_1 - X_2(l_2)t_2$$

The quantity of the procedure whose fee has been cut is represented by X_1, while the quantity of other services provided to Medicare patients is measured by X_2. Importantly, the supply of each type of service may be affected by a different level of inducement (l_1 and l_2). While the costs of physician inputs are assumed to be constant, each service requires "t" units of physician time. Although leisure is a "good" which yields positive utility, additional requirements of physician time exhibit increasing marginal disutility. The profit margins, defined as fees minus costs, for the two categories of Medicare services are m_1 and m_2 respectively. Since the costs of non-physician time inputs are assumed to be constant, an increase in the fee translates directly into a higher margin. In this single payer, two service framework where X_1 is the supply of the lower priced procedure, and X_2 is the supply of all other services provided to Medicare patients, X_1 and X_2 differ along several dimensions: margins, physician time input, extent of inducement required, and the level of disutility or unpleasantness generated by inducement.

We use this framework to analyze "spillovers"—how a decline in m_1, the fee for cataract extraction for example, affects X_2, the volume of non-cataract services provided by each ophthalmologist to Medicare patients. The direction of this cross-price effects depends on the relative sizes of the income effect, the marginal utility of leisure, and marginal disutility

of inducement. There are no spillover effects when the income effect is zero and the marginal utility of leisure is unchanged by the fee reduction.

On the other hand, in the presence of a strong income effect, the number of other services that physicians provide to Medicare beneficiaries is predicted to increase. Changes in the marginal utility of leisure may also result in spillover effects. Suppose the fee cut and its subsequent lower margin causes the physician to reduce the supply of cataract procedures. As a consequence, the amount of time the physician spends performing cataract operations falls and this in turn increases the marginal utility of leisure. To restore equilibrium, the physician has the incentive to induce demand for non-cataract procedures, and/or to shift the supply curve of non-cataract services (since the implicit price of his/her time input has been reduced.) If so, the fee cut for cataract extraction will result in an increase in the supply of non-cataract procedures and services. Below we outline empirical models we estimate in order to test these hypotheses.

IV. Specification of the Supply Function

Standard economic theory postulates that quantity supplied is a function of the price of the good and input prices. Quantity supplied is expected to increase as the price of the good rises whereas supply should decline as input prices rise. To evaluate whether the MFS fee reductions for cataract surgery had spillover effects on other services that ophthalmologists provided to their Medicare patients, we use the McGuire-Pauly framework and thus alter the standard specification of the supply function to recognize specific attributes of the market for physician services. First, the physician firm produces multiple outputs. Second, physicians may "induce" demand for their services. Finally, physicians have a dual role as sellers of physicians' services and as suppliers of the primary input, physician time, into the production process.

In the context of an analysis of spillover effects, we specify a supply function for other, non-cataract services provided to Medicare patients. This supply function should contain three price variables: the *own-price,* the *Medicare cross-price,* and the *private cross-price*. While potential spillover effects are only captured by the Medicare cross-price, it is important to control for other price variables (the own-price and private cross-price) in order to obtain unbiased coefficients on the Medicare cross-price variables.

The *own-price* measures the MFS fee for non-cataract services provided by each ophthalmologist to Medicare patients. Own-price is expected to have a positive sign, implying that as the price of other Medicare services rises, ophthalmologists will provide more non-cataract services to their Medicare patients.

The *Medicare cross-price* effect captures reductions in the MFS fee for cataract extractions. We hypothesize that the Medicare cross-price variable will have a negative sign. In essence, when the Medicare fee for cataract extractions is reduced, physicians will respond by increasing the supply of non-cataract services rendered to their Medicare patients.

The third price variable is the *private cross-price* effect, which recognizes that physicians have the option of providing services to non-Medicare patients. We anticipate that the private cross price will have a negative sign. This implies that when the relative prices of services

rendered to non-Medicare patients rises, physicians will respond and reduce the supply of non-cataract procedures rendered to Medicare patients.

Spillover effects may also be evident via physicians' level of inducement. Whether the physician decides to induce demand for services is contingent on the potential change in income that may occur as a consequence of all of the fee changes associated with the MFS. If the fee reductions result in substantial income losses and physicians attempt to offset such income losses by inducing demand for non-cataract services, then the variable we use to measure inducement should have a negative sign, that is, a large decrease in expected income should prompt an increase in supply.

The other variables in the supply function include physician attributes and a proxy variable for the price of inputs the physician purchases to produce physician services. The physician attributes include age and whether the physician is a member of a group practice. Age is used to capture the labor-leisure tradeoff that varies over the work life. The supply of physician labor and services are expected to increase over the lifecycle as they accumulate wealth, and then taper off in later years as they substitute leisure time and unearned income for annual hours of work. We anticipate that physicians who are associated with group practices will be more productive than those not in groups. This enhanced productivity arises as a result of economies of scale in production and also the ability to share resources with other members of the practice.

The price of purchased inputs is represented by a variable that measures the average salary per FTE employee in the hospital industry in the physician's market area. Although we cannot measure input prices for non-physician personnel directly, we expect that this proxy indicator is closely linked to the inputs physicians employ because physicians must compete with hospitals in purchasing non-physician personnel and medical supplies.

V. The Data and Variable Construction

A. Sample Construction

The unit of analysis for this study is the individual physician-year. The analysis file was compiled from several sources: the Medicare physician provider file, National Claims History files for the years 1991 through 1994, the Area Resource File, and AHA Annual Hospital Surveys. First, we identified all physicians specializing in ophthalmology by selecting all individuals from the Medicare provider files with this specialty code. We then extracted Medicare paid claims for each year with the physicians' UPIN (unique physician identification numbers). Following this, we aggregated the claims by physician UPIN number and beneficiary to construct the following variables: (1) the number of non-cataract procedures (expressed in relative value units) rendered by each ophthalmologist to Medicare beneficiaries; (2) total allowed amounts approved for payment by Medicare for cataract extractions; (3) total allowed amounts approved for payment by Medicare for non-cataract procedures; (4) total billed charges for all non-cataract procedures and services.

We then merged the file containing physicians' supply of services and payments with other physician characteristics obtained from the HCFA provider file—age, foreign medical school graduate, board certification status, membership in a group practice and zip code.

Finally, we attached information from the Area Resource file on characteristics of the market area by linking zip codes with county codes. A proxy for input prices was constructed from data obtained from the American Hospital Association's Annual Surveys for the years 1991–1994.

This process yielded 47,022 physician-year observations of ophthalmologists. From this initial population, we excluded physicians who were under age 30 or over age 70, and those who graduated after 1987. Physicians under age 30 are likely to be in residency training and thus their supply of procedures does not reflect full-time practice. A similar argument holds for older physicians (over age 65); this age cohort is approaching retirement and thus is more apt to be working part-time. We consulted with a practicing ophthalmologist to obtain advice on defining further exclusion criteria for our sample of ophthalmologists. Based on this expert advice, we also eliminated the following outlier cases: (1) physicians who performed more than 500 cataract operations during a specific year; (2) average allowed charges for cataract surgeries that either fell below the 5th percentile or that exceeded the 99th percentile of the distribution; (3) non-cataract services rendered by each ophthalmologist to Medicare beneficiaries that exceeded the 99th percentile of the distribution; (4) allowed charges for non-cataract procedures per RVU that fell below the 1st percentile of the distribution. Finally, 8850 physician-observations for 1991 were lost in constructing the variable to measure the potential size of the income effect; this variable required lagged data from the prior year. The final database used to estimate the models that included all the price and income variables contains 36,754 physician-year observations during the years 1992 through 1994.

B. Variable Construction

The quantity and price variables for the supply function were constructed from all claims submitted to the Medicare program by all ophthalmologists during the period 1991 through 1994. Because non-cataract services are comprised of heterogeneous outputs, we applied the Medicare relative value scale to each service or procedure to transform the services into homogenous relative value units. We then aggregated across these weighted non-cataract services to construct a single measure of non-cataract output expressed in uniform units.

The own-price variable is the Medicare allowed amount, that is, the amount actually paid to each ophthalmologist by Medicare. This variable is hypothesized to be a proxy for the price that physicians command from rendering non-cataract services to Medicare beneficiaries. We contend that own-price is exogenous for two reasons. First, own-price is a combination of the MFS and a historical area-wide average fee trended forward. Second, irrespective of what the physicians bill Medicare for their services, they must accept whatever Medicare pays.[3] The own-price is measured as the average amount paid by Medicare per relative value unit for non-cataract services.

The Medicare cross-price variable in the model represents the price of a cataract extraction, the procedure whose fee has been reduced. This variable measures the contemporaneous physician-specific average amount reimbursed by Medicare for a cataract extraction, and is also exogenous because the fee is determined by Medicare through the MFS.[4]

The private cross-price variable is constructed from information on the amounts *billed* by physicians for all non-cataract procedures and services rendered to Medicare beneficiaries.

This variable is defined as total billings for non-cataract services divided by the total quantity of non-cataract services expressed in relative value units. It is hypothesized to represent the prices that physicians could receive from providing services to non-Medicare patients.

Constructing the private-cross price variable in this way entails two assumptions. First, physicians' billed charges, as opposed to actual payments received, for various services do not vary substantially across alternative insurance sources. Second, physicians who charge higher prices will be paid higher prices in comparison to physicians with relatively low billed charges. We contend this variable is a reasonable proxy for physicians' alternative stream of revenue form providing services to non-Medicare patients.

The income effect recognizes the possibility that physicians may induce demand for their services. This variable, which is designed to capture the potential size of the income effect, measures the change in the *total amount* that would have been paid by Medicare for *all Medicare services* provided by the physician if there was no change in quantity between the current period and the previous period. It is important to note that the income effect reflects how physicians anticipate their incomes will change as a result of all of the fee changes implemented by the MFS. It is constructed by multiplying the lagged quantities of individual procedures and services from period $t - 1$ by the corresponding changes in Medicare fees between periods $t - 1$ and t. Since the income variable is constructed from data on lagged quantities and exogenous MFS fees, it is assumed to be exogenous.

Although the McGuire-Pauly model highlights the importance of the expected change in income from a single payer's fee changes relative to income from all payers, we cannot evaluate fully this dimension of their model because we only have information on reimbursements from Medicare. We do not have any information on payments for services delivered to non-Medicare patients. Lacking such information, we make the assumption that larger changes in the income variable will have corresponding greater effects on physicians' total income. Large changes in the income variable could occur if the total quantity of services supplied to Medicare patients is large and/or if the fee reductions implemented between periods t and $t - 1$ are substantial. In other words, larger potential income losses should generate larger volume responses if physicians induce demand.

The dummy variables indicating each physician's age category and whether he/she is a member of a group practice were constructed from information reported in the Medicare provider file. All variables included in the models are described in Table 1.

C. Estimation Issues

In our analyses we addressed two estimation issues that could bias our results. The first concern relates to the correct specification of the physician supply function. The second issue arises from the possible endogeneity of physicians' private-cross price, which is constructed from their billed charges for non-cataract services.

The first challenge in estimation of the physician supply function is to avoid specification bias that arises from the omission of key variables. A regression that only includes prices is misspecified because the price variables capture both income and price effects. Recognizing this point, we adopt the following estimation approach in an attempt to assess the degree of specification bias linked to the omission of price and income variables. First, we estimate

Table 1. Variable definitions.

Dependent Variables	
Volume of non-cataract services	The number of non-cataract services provided by each ophthalmologist per year to Medicare patients; expressed in relative value units
Independent variables	
Own price	Total Medicare allowed amounts paid to each ophthalmologist for all services other than the "procedures of interest" divided by the total quality of other procedures expressed in relative value units
Med-cross	The average amount paid to each ophthalmologist under the Medicare Fee Schedule for a cataract extraction; expressed in relative value units
Priv-cross	Total Medicare billings for non-cataract services divided by the total quantity of non-cataract services expressed in relative value units
Income	The magnitude of the potential income effect is measured as total procedures supplied in period $t - 1$, expressed in relative value units multiplied by the change in average billed charge per relative value unit between periods t and $t - 1$
Wage index	An estimate of input prices faced by physician's firms
Age 35–44	Dummy variable equal to one if physician's age
Age 45–54	Dummy variable equals one if physician's age is between 45 and 54
Age 55–64	Dummy variable equals one if physician's age is between 55 and 64
Age 65–70	Dummy variable equals one if physician's age is between 65 and 70 (The reference category is under age 35)
Group	Dummy variable equals one if physician is a member of a group practice
Year 92[a]	Dummy variable equals one if the physician year observation is from 1992; this is the reference category in the models with income variables
Year 93	Dummy variable equals one if the physician year observation is from 1993
Year 94	Dummy variable equals one if the physician year observation is from 1994

Note: [a]In the models that exclude the "INCOME" variable, the year 1991 is the reference category.

a model that only includes the own-price. Second, we add the two cross-price variables. Third, we estimate the full model that includes the own-price variable, both cross-price variables and the income variable.

To address the potential endogeneity of the private-cross price for non-cataract services, we employ instrumental variables estimation. The explanatory variables used to predict the private-cross price (billed charges) for non-cataract services include the exogenous variables in the supply function plus a set of identifying variables from the demand function: income per capita, population density, the percentage of the population over age 65, and dummy variables indicating whether the physician is board certified and if he/she graduated from a foreign medical school. To assess the degree of endogeneity bias, we compared the model with the exogenous cross-price to the model with the IV for cross-price.[5]

VI. Empirical Results

Table 2 contains descriptive data on changes in Medicare fees and physicians' supply of non-cataract procedures. The Medicare fee for cataract extraction (the Medicare cross-price) fell from $1293 to $1068 between 1991 and 1994, a decline of 17.4%. In contrast, the average

Table 2. Levels and percentage changes, medicare fees and volumes for non-cataract procedures and services.

	Cataract Fee	Non-Cataract Change/RVU	Non-Cataract Allowed Amount/RVU	Volume of Non-Cataract Services in RVUs
1991 Actual	$1293.00	$47.87	$32.66	3312
Percent ◇ 91–92	−0.16%	2.27%	−2.1%	17.1%
Percent ◇ 92–93	−2.6%	2.55%	2.1%	6.3%
Percent ◇ 93–94	−0.9%	2.93%	4.5%	−0.001%
1994 Actual	$1068.00	$51.66	$34.13	4118
Percent ◇ 91–94	−17.4%	7.95%	4.5%	24.3%

charge per RVU for non-cataract services (the private cross-price), which reflects what ophthalmologists could earn by treating patients covered by private insurance, increased by almost 8% from $47.87 to $51.68. Allowed amounts for non-cataract services per RVU (the own-price for non-cataract services) increased as well but only by 4.5% ($32.66 to $34.15). The volume of non-cataract procedures rendered to Medicare patients increased by 17% between 1991 and 1992. Although the volume of non-cataract services increased further by about 6% between 1992 and 1993, there was essentially no change in volume between 1993 and 1994. On net, the volume of non-cataract services delivered to Medicare patients increased by 24% over the period.

Table 3 reports mean values of the variables used in the regression model for the full sample of ophthalmologists. The average volume of non-cataract procedures (expressed in RVUs) rendered by each ophthalmologist to Medicare patients was 3864. The mean allowed amount of non-cataract procedures and services per RVU (the own price) during the three year period was $32.85. The average cataract fee (the Medicare cross price)

Table 3. Descriptive statistics.

	Non-Cataract Services
Total volume of non-cataract services	3864
Independent variables	
Own-price	$32.85
Med-price	$1070
Priv-cross	$49.96
Induce	−2659.37
Wage index	$31,942
Group	0.856
Age 30–34	0.071
Age 35–44	0.350
Age 45–54	0.318
Age 55–64	0.209
Age 65–70	0.052
Year 91	0.25
Year 92	0.25
Year 93	0.25
Year 94	0.25

was $1070 while the mean charge per RVU for non-cataract services (the proxy for the private cross price) was $49.96. The average level of income change was −$2659. Our data do not include information on physicians' average medical practice income, which is the appropriate benchmark for gauging the magnitude of the potential income effect. However, published data indicate that ophthalmologists' median income in 1995 was $200,000 (AMA, reported in BLS, 1998–1999 Occupational Outlook Handbook), which suggests that the inducement incentive may have been relatively small.

A. Supply Functions for Non-Cataract Procedures and Services

Table 4 reports the estimated parameters from the physician supply functions for non-cataract procedures (measured in logs) rendered to Medicare beneficiaries. Following the estimation strategy outlined above, Model 1 includes only the own-price variable. The second model includes the own-price and the exogenous values for both cross-price variables. The third specification includes the own-price, the exogenous values for both cross-price variables and the income variable. Models 4 and 5 recognize the possible endogeneity of the private cross-price. Model 4 is analogous to Model 2 except we use an instrument for the private cross-price in lieu of its actual value. In Model 5, we estimate the full model with an instrument for the private cross-price. All models are highly significant and the regressors account for 9–11% of the variation in the supply of non-cataract services provided to Medicare patients. In general, the parameter estimates are highly significant and are in accordance with theoretical expectations.

Examining the own-price effects, we find that an increase in the price of non-cataract services (the allowed charge per RVU) causes physicians to supply more non-cataract services. Comparing the coefficient on own-price in Model 1 (0.030) to the corresponding coefficients in Models 2 and 3, we find that the own-price coefficient is larger, especially in Model 3 (0.044) which includes all three price variables and the income variable. Note that the use of an IV for the private cross-price rather than its actual value has little impact on the coefficients of own-price.

The Medicare cross-price variable, which measures the Medicare payment for a cataract extraction—the procedure subject to the fee reduction—has a negative sign as hypothesized. This implies that when the Medicare fee for cataract extraction is reduced, physicians will respond by increasing the supply of non-cataract services they render to Medicare beneficiaries.

The private cross price variable is highly significant and has the expected negative sign irrespective of whether it is assumed to be exogenous or endogenous. This implies that as the relative price of services that physicians provide to non-Medicare patients increases, ophthalmologists will reduce the supply of non-cataract procedures delivered to Medicare patients. Nevertheless, the coefficient on the exogenous private cross-price variable in Model 2 is one-third the magnitude of the coefficient on the IV for the private cross-price in Model 4. An analogous comparison of Models 3 and 5 shows that the coefficient on the exogenous private cross-price variable in Model 3 is less than half the size of the coefficient on the IV price variable in Model 5.

The income variable, which controls for potential income effects associated with the fee reductions, has the expected negative sign, irrespective of whether the private cross-price is

Table 4. Physician supply of non-cataract services to medicare patients.

	Model 1	Model 2	Model 3	Model 4	Model 5
Variable	Own Price Only	Own Price and Actual Cross Prices	Own Price, Actual Cross Prices and Income	Own Price, IV Private Cross Price, and Medicare Cross	Own Price, IV Private Cross Price, Actual Medicare Cross, and Income
Own-price	0.030***	0.034***	0.044***	0.033***	0.043***
Med-cross price	—	−0.00055***	−0.00053***	−0.00049***	−0.00046***
Priv-cross	—	−0.0008***	−0.00086***	−0.022***	−0.019***
Income	—	—	$-0.59 \times 10-5$***	—	$-0.55 \times 10-5$***
Wage index	−0.00003***	−0.000025***	−0.00002***	−0.000014***	−0.000012***
Group	0.086***	0.077***	0.105***	0.146***	0.159***
Age 35–44	0.406***	0.436***	0.308***	0.427***	0.298***
Age 45–54	0.533***	0.573***	0.421***	0.508***	0.363***
Age 55–64	0.360***	0.401***	0.268***	0.254***	0.143***
Age 65–70	0.137***	0.164***	0.036	−0.055	−0.148***
Year 92	0.353***	0.233***	—	0.269***	—
Year 93	0.427***	0.284***	0.115***	0.325***	0.128***
Year 94	0.407***	0.259***	0.115***	0.321***	0.132***
Adjusted R^2	0.09	0.10	0.11	0.11	0.11
F-Statistic	479	453	327	410	329

***Significant at the 1% level ($p < 0.01$).

exogenous.[6] This finding suggests that when ophthalmologists anticipate a relatively large income drop attributable to reduced Medicare fees, they will attempt to partially offset these income losses by delivering more non-cataract services to Medicare beneficiaries. Although highly significant, the inclusion of the income variable does not significantly alter the magnitudes of the coefficients on the own-price and cross-price variables. In contrast, the inclusion of the income variable reduces the size of the coefficients on the year dummy variables by about one half.

The other variables in the model have the predicted effects. The wage index has the anticipated negative sign, implying that as input prices rise, ophthalmologists will render fewer non-cataract services. Further, as hypothesized, it appears that physicians who are affiliated with group practices render greater number of non-cataract procedures and services compared to solo practitioners. The age variables exhibit a pattern consistent with the life-cycle theory of labor supply. The supply of non-cataract procedures and services increases with physician age and peaks for physicians aged 45–54. After age 55, the volume of non-cataract services declines as physicians reduce work effort to have more leisure time.

B. Elasticities

In order to gauge the quantitative significance of spillover effects associated with Medicare fee reductions, we calculated elasticities for the Medicare cross-price and the income variables. We also calculated elasticities for the two other price variables in the model: the own-price and the private cross-price. These elasticities were calculated using the coefficients from Model 5, which includes the income variable as well as the IV for the private cross-price, and the means of each variable reported in Table 3.

First, we consider the spillover effects associated with the Medicare fee reduction for cataract extraction. The calculated elasticity is −0.49; this implies that if the cataract fee (the Medicare cross price) is cut by 10%, then the volume of non-cataract procedures and services rendered by ophthalmologists to Medicare patients would rise by 4.9%. The income variable reflects another dimension of spillover effects. While the income variable is highly significant, its impact on the supply of non-cataract services rendered to all Medicare beneficiaries is small. A doubling of the mean value of the income variable would result in a 1.5% increase in the supply of non-cataract services delivered to Medicare patients. This income elasticity suggests that within the range of observed fee changes, demand inducement has little impact on physicians' product supply decisions.

As noted above, we also controlled for other price variables in order to obtain unbiased estimates of potential spillover effects. The own-price elasticity (allowed amounts per RVU) calculated at the sample mean is 1.41. Thus, if the own-price of non-cataract services increases by 10%, ophthalmologists will increase the supply of non-cataract procedures and services rendered to Medicare patients by about 14%. The private cross-price elasticity calculated at the sample mean is −0.949. To illustrate, if the private cross-price (the average charge per RVU for non-cataract services) were to increase by 10%, ophthalmologists would reduce the volume of non-cataract services provided to Medicare patients by almost 9.5%.

In summary, the own-price effect appears to be larger than both cross-price effects. Given the small magnitude of the income effects, these findings suggest that physicians' supply

behavior is closer to the profit maximizing version of the M-P model than to the pure inducement extreme.

VII. Concluding Remarks

Medicare fee reductions implemented under the MFS were designed to adjust physicians' payments for each service according to the amount of work involved in performing the service. Economic theory predicts that such fee reductions may cause physicians to alter the volume of the procedure whose fee has been cut. Yet, a fee reduction for a specific procedure may also have spillover effects and cause physicians to increase the supply of other services they provide to both Medicare and privately insured patients. In this study we examined whether spillover effects occur in the Medicare market in response to fee reductions for cataract extractions mandated under the MFS. To our knowledge, this is the first study to examine spillover effects that have occurred under the MFS.

Spillover effects are captured by the Medicare cross-price and the income variables. In general, our results are in line with the predictions of the McGuire-Pauly model of physician behavior. First, the Medicare cross-price has the expected negative sign, implying that reductions in the fee for cataract extractions will likewise cause ophthalmologists to supply more non-cataract procedures. Second, the income variable is highly significant, but the magnitude of its impact is trivial. This implies that physicians behave as profit maximizing firms rather than engaging in demand inducement in order to achieve a target level of income. Third, we find that the own-price effect—allowed amounts for non-cataract procedures per RVU—is positive and highly significant. This implies that as the relative price of non-cataract procedures increases, ophthalmologists will perform more non-cataract services on Medicare patients. Also consistent with the predictions of the McGuire-Pauly model is the finding that the private cross-price is negative. This means that increases in the relative price of non-Medicare services will yield a decline in the volume of non-cataract procedures rendered to Medicare patients.

While our findings provide new insights regarding physicians' responses to Medicare fee changes that were implemented under RBRVS, our analyses have some limitations. First, we do have the necessary data to examine spillover effects of cataract fee reductions on the provision of services to the non-Medicare population covered by private insurance. Second, the variable we construct to capture inducement effects may be measured with error because we lack information on the volume of services and revenues that ophthalmologists render to privately insured patients. Nevertheless, when we exclude this variable from the model, it has no impact on the other parameter estimates. Third, our supply equations should include a second income variable that would measure changes in income arising from price changes that occur in the private market. Given that data on services provided to privately insured patients is not available, the private cross-price may capture both the income and substitution effects in the private market.

Our findings have important implications regarding the ramifications of the MFS. First, the existence of spillover effects associated with cataract fee reductions implies that one will obtain an incomplete picture of how fee reductions for specific procedures affect physicians' behavior by only examining the volume of the procedure whose fee has been reduced.

Second, we find little evidence of inducement or income targeting. According to McGuire-Pauly, when income effects are trivial, it appears that the substitution effect dominates the income effect. Third, although we find large spillover effects for ophthalmologists, this may not be the case across all specialties. If this is the case and one were to analyze physicians' supply responses to fee reductions by aggregating across all medical specialties, one may mask important differences that exist across specialties in physicians' volume response to fee changes. Finally, these results complement the findings of a recent analysis of the supply of cataract extractions by Mitchell et al. (2000), which also found positive own-price and negative cross-price effects, and a small inducement effect.

Taken together, the findings of these studies reinforce the importance of looking at more than just simple comparisons of trends in the quantities and prices of a single procedure when attempting to gauge the effects of the MFS. To evaluate whether reductions in the Medicare fee for cataract extraction reduced the supply of cataract surgeries and helped constrain total Medicare spending for ophthalmologic services, one must control for the effects of changes in other fees, and at the same time look at the supply of non-cataract services. If spillover effects are large, then failing to recognize the impact on non-cataract services would tend to understate the effects of cataract fee reductions on total spending.

Acknowledgment

Financial support for this research was provided by the Agency for Health Care Policy and Research under grant R01 HS08689-01S1. The opinions expressed in this paper are solely the authors and do not reflect the positions of either Georgetown University or the Agency for Health Care Policy and Research.

Notes

1. The study has other shortcomings as well. These include: a short time period of observation following the fee cuts; the focus on only inpatient services and exclusion of outpatient services; selection bias attributable to the inability to completely match hospital procedures categorized by ICD-9 codes with physician services identified by CPT codes; only a small number of the hospitals analyzed rendered many of the overvalued procedures; and endogeneity of private insurance payments.
2. See Rice et al. (1999) and Yip (1998).
3. During the implementation of the MFS, which began on January 1, 1992, the amount paid to each physician was based on a comparison of the fee schedule amount and the "adjusted historical amount" (AHP). The latter was equal to the average Medicare allowance for the service in the locality in 1991, updated in 1992 in accordance with a fixed percentage reduction of 5.5% chosen to achieve budget neutrality. If the AHP was within 15% of the fee schedule amount, the physician received the fee schedule payment. If the AHP fell outside the 15% band, then the payment was a blend of the AHP and the fee schedule amount, with weight given to the AHP going to zero over the five-year transition period. Thus, payments to individual physicians were clearly exogenous since they were a combination of the fee schedule amount (which was based on relative value units, a local geographic cost index, and an exogenous conversion factor) and an historical area-wide average fee trended forward.
4. One concern is the possibility that both the Medicare cross-price and the own-price may be endogenous because physicians may be able to manipulate the types of services they provide. To investigate this possibility, we estimated a specification which included the average Medicare fees in each physician's zip code area for both the own-price and the Medicare cross-price. The results from these models were consistent with the specifications which included each of these fee variables measured at the individual physician level. In light of

these findings, we opted to report the results that included fees measured at the individual physician level rather than at the zip code level, because the former specification recognizes that physician fees may be influenced by exogenous factors that vary within zip codes other than the array of service they provide. Such other factors include rent, the cost of inputs and experience.

5. The first stage regressions predicting private cross-price are available from the authors upon request.
6. Recognizing that the income variable may be subject to measurement error, we also estimated a model which excludes the inducement variable. Making this exclusion has trivial effects on the coefficients of the other variables in the model. Thus, even if the income variable is measured with error, its exclusion from the supply function does not result in omitted variables bias. In addition, we also estimated a model which included the income variable and its square term to capture possible non-linear effects associated with demand inducement. The coefficient on the square term is highly significant and negative; however, the magnitude of the coefficient is so small that it has no impact on the elasticity associated with the income effect. These results are available from the author upon request.

References

McCall, N. T. (1993). "Physician Responses to Relative Medicare Price Changes." Unpublished doctoral dissertation, Harvard University.

Mitchell, J. M., J. Hadley and D. Gaskin. (2000). "Physician Responses to Medicare Fee Schedule Reductions." *Medical Care* 38(10), 1029–1039.

McGuire, T. G. and M. V. Pauly. (1991). "Physician Responses to Fee Changes with Multiple Payers." *Journal of Health Economics* 10(4), 385–410.

Nguyen, X. N. and F. W. Derrick. (1997). "Physician Behavioral Response to a Medicare Price Reduction." *Health Services Research* 32(3), 283–298.

Rice, T., S. C. Stearns, D. E. Pathman, S. DesHarnais, M. Brasure and M. Tai-Seale. (1999). "A Tale of Two Bounties: The Impact of Competing fees on Physician Behavior." *Journal of Health Politics, Policy and Law* 24(6), 1307–1330.

Tai-Seale, M., T. H. Rice and S. C. Stearns. (1998). "Volume Responses to Medicare Payment Reductions with Multiple Payers: A Test of the McGuire-Pauly Model." *Health Economics* 7(3), 199–219.

Yip, W. C. (1998). "Physician Response to Medicare fee Reductions: Changes in the Volume of Coronary Artery Bypass Graft (CABG) Surgeries in the Medicare and Private Sectors." *Journal of Health Economics* 17(4), 675–699.

Zuckerman, S., S. A. Norton and D. Verrilli. (1998). "Price Controls and Medicare Spending: Assessing the Volume Offset Assumption." *Medical Care Research and Review* 55(4), 457–478.

Jean M. Mitchell, Ph.D., is an economist and a professor of public policy at the Georgetown Public Policy Institute, Georgetown University. Her areas of research and expertise are health economics, health services research and applied econometrics. Dr. Mitchell was a member of the Health Systems Research Study Section for the Agency for Health Care Research and Quality (AHRQ) from 1998–2002. She also served as a member of the Social Science and Population Study Section for the NIH from 1993–1997.

Jack Hadley, Ph.D., is a principal research associate with The Urban Institute's Health Policy Center and a senior fellow at the Center for Studying Health System Change in Washington DC. He was formerly a professor of Health Services Research with Georgetown University's Institute for Health Care Research and Policy. Dr. Hadley is also a past president of the Association for Health Services Research and a former editor of *Inquiry*.

Darrell J. Gaskin is a research scientist at the Johns Hopkins Bloomberg School of Public Health in the Department of Health Policy and Management. His primary research interests are the hospital safety net and access to health care for vulnerable populations. His other research interests include the effects of market forces and public policy on providers' behavior, mental health economics and the treatment decisions of terminally ill patients. Dr. Gaskin recently received the Academy of Health Services Research and Health Policy 2002 Article-of-the-Year Award for his *Health Services Research* article entitled, "Are Urban Safety-Net Hospitals Losing Low-Risk Medicaid Maternity Patients?"