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Productivity vs. Training in Primary Care: Analysis of Hospitals and Health Centers in New York City

This paper examines the indirect costs of primary care residency in terms of ambulatory care site productivity and the influence of graduate medical education (GME) subsidies on the employment of primary care residents. Using a sample of hospitals and health centers in New York City (NYC), we find that most facilities employ significantly more primary care residents relative to nonresident primary care physicians than would be dictated by cost-minimizing behavior in the production of primary care. We also find evidence that New York's GME subsidy encourages the ''overemployment'' of residents, while the Medicare GME subsidy does not. We conclude that the trade-off between productivity and teaching is more serious in primary care than in inpatient settings, and that facilities heavily involved in ambulatory care teaching will be at a competitive disadvantage if GME subsidies are not targeted specifically for primary care.

Resident physicians take on the dual roles of professional trainees who are improving their skills, and of health care providers who are serving the needs of patients. This duality creates unique challenges for the institutions that train and support them. Perhaps the greatest challenge involves the management of costs associated with teaching. These include direct costs, such as salaries of attending physicians and administrative overhead, as well as indirect costs stemming from additional tests and procedures used for pedagogic purposes and general inefficiency that comes from using residents in place of more experienced nonresident physicians.

In the past, teaching hospitals were able to shift these costs onto third-party payers by charging higher fees. Today, the ability to cost shift has diminished greatly as payers have moved away from cost-based reimbursement in favor of prospective payment and competitive pricing of services. It might be possible for some prestigious hospitals to negotiate a premium for their services that would offset the costs of teaching. However, even their ability to do so would depend on several factors outside their control—most significantly, the level of competition in the local hospital and health insurance markets.

When Medicare switched to the prospective payment system (PPS) in 1983, explicit recognition of Medicare's share of graduate medical education (GME) costs was written into legislation with separate payment adjustments to

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cover ''direct medical education'' (DME) costs and ''indirect medical education'' (IME) costs. Since its inception, this part of the PPS has been a source of political as well as analytical controversy. The political controversy stems from questions about the appropriate role of government in subsidizing resident training as well as from the wide variation across hospitals in the amount of GME funds they receive per resident. For example, in 1995, the average per-resident payment was $62,700, but the average payment among the lowest 10% of hospitals receiving GME funds was only $37,400 compared to a payment of $98,800 among the top 10% (Iglehart 1998).

The analytic controversy stems from the regression model used by the former Health Care Financing Administration (HCFA) to determine the IME payment (Pettengill and Vertrees 1982). Follow-up studies later found evidence of significant bias from omitted variables (Anderson and Lave 1986; Welch 1987; Thorpe 1988) and functional misspecification (Thorpe 1988; Rogowski and Newhouse 1992). Also of note is the way in which Congress supplemented the empirically derived basis for the IME adjustment. The original analysis by Pettengill and Vertrees (1982) found that hospital operating costs increased by 5.69% for every .1 increase in their measure of teaching intensity, which is equal to one plus the ratio of interns and residents per bed. However, Congress doubled this amount in determining the percentage increase in PPS payments that would be required for the IME adjustment. This decision was justified as a way of imperfectly compensating for unmeasured case mix and the provision of charity care that often are associated with major teaching hospitals.

Continuing financial stress on the Medicare Hospital Insurance Trust Fund has rekindled earlier concerns about the Medicare GME adjustments and has led to even more questioning of the role played by Medicare in the support of resident training. The key issue is the distinction between social and private benefits that flow from medical residency and, consequently, who should bear the costs. A recent report by the Medicare Payment Advisory Commission (MedPAC) draws on the theory of human capital and on-the-job training to argue against Medicare's support of resident training (MedPAC 1999). Since residents eventually can take the on-the-job training they receive to earn higher incomes elsewhere, residents have an incentive to bear the costs of training on their own, presumably through salaries that are below market value. Therefore, there is no reason for Medicare to support the training of residents per se, although the report argues that additional payments made by Medicare to teaching facilities still should be supported to the degree that they compensate facilities for enhanced patient care that Medicare beneficiaries receive in academic settings.

Studies of actual and proposed GME reform provide general support for the idea that residents pay (through below-market wages) for much of the on-the-job training they receive. Thorpe (1990) found that mandated limits on the working hours of residents in New York led to significant cost increases for hospitals that had to hire additional physicians and other providers to replace the work formerly done by the resident staff. In a simulation model of various resident reduction strategies, Stoddard, Kindig, and Libby (1994) estimated *net* per resident costs equal to $58,000 to $77,000 depending on the types of providers that would serve as substitutes for house staff. Both studies showed that residents provide services at a cost that is much lower than the amount their employers would incur if they had to pay market wages to alternative providers.

In 1996, HCFA (now the Centers for Medicare and Medicaid Services) began a demonstration project in New York designed to reduce the number of residents trained, particularly in specialized medicine. Participating hospitals agreed to reduce their total resident staff by 25% while holding constant the proportion of residents in primary care. In exchange, the hospitals would continue to receive GME payments for the foregone residents, with payments gradually phasing out over six years. Hospitals also had the option of reducing their total number of residents by 20% while increasing their primary care residents by 25%. Although hospitals were initially eager to participate in the demonstration, most of them soon dropped out. Three years into the demonstration the total reduction in residents was only 5% (Salsburg 2001). Ultimately, most hospitals preferred the use of residents to other alternatives even when these alternatives were initially subsidized.

The GME reduction demonstration and the two related studies focused primarily on inpatient residents. Comparable research on ambulatory care residents is less common. This research gap is important for at least two reasons. First, it has been recommended for some time that greater emphasis be placed on training the future health care workforce for general primary care instead of specialized inpatient care, and that this training should be done more often in ambulatory care settings (Rivo, Jackson, and Clare 1993; Cantor et al. 1991). Second, the ability of residents to pay for their training through lower-than-market wages is likely to differ significantly between ambulatory and inpatient residents. In inpatient settings, residents are harder to replace because nonphysician providers often are not trained to provide many of the specialized services offered by residents, and nonresident physicians are generally reluctant to work the long and irregular hours that residents do. Since ambulatory care is typically less medically complex and is conducted during common working hours, there are fewer barriers involved in the substitution of other providers for residents. Teaching responsibilities can have a large adverse impact on the productivity of attending physicians in ambulatory settings (Kuttner 1999). Moreover, the lower complexity of primary care suggests that any reputational advantages a facility would obtain from offering cutting edge academic medicine are unlikely to occur in ambulatory facilities. The extensive role played by ambulatory care facilities in providing care to the poor and the uninsured compounds the concern that ambulatory care residents may not ‘‘pay for themselves’’ (Forrest and Whelan 2000). This paper begins to fill in this research gap by addressing two interrelated questions.

1. How does the marginal patient care productivity of residents compare with that of nonresident physicians?
2. In light of growing cost consciousness in the health sector, how are changes in GME subsidy policy likely to alter incentives for ambulatory care providers to support outpatient-oriented training of residents?

We address these questions using a survey of free-standing diagnostic and treatment centers (DTCs) and hospital outpatient departments (OPDs) in New York City along with publicly available data on state and federal GME subsidies. New York provides an interesting case study because many residents are trained there and many GME dollars flow through the city. This makes New York City a good test case, as well as a place of policy importance in its own right.

Conceptual Framework

We draw on the economic theory of the firm to determine the productivity of residents relative to nonresident physicians. We then use this framework to determine the impact of GME subsidies on the use and productivity of residents. In particular, we view DTCs and OPDs as firms employing various inputs to produce their desired level of output. Throughout the analysis, we assume that these provider firms are concerned only with the production of patient care and wish to produce care at minimum cost. Although this assumption is clearly unrealistic in light of the teaching and other missions of facilities in our sample, we make it to isolate the consequences of residency on site-level efficiency and the role played by public subsidies in the employment of residents.

An efficient firm will employ inputs so that that the ratio of marginal costs is equal to the ratio of marginal productivities for every pair of inputs. In the case of residents versus nonresident physicians, this principle is written as

$$(MP_r/MP_n) = (W_r/W_n) \qquad (1)$$

where MP_r is the marginal productivity of the last resident hired, W_r is the marginal cost of hiring the last resident, and MP_n and W_n are defined analogously for nonresident physicians.[1]

While the costs of inputs are generally observable from market data and regulatory cost reports, the measurement of marginal productivities associated with provider inputs must be estimated econometrically. Using a regression framework, we compare total primary care output to the total number of primary care providers employed across a sample of facilities. We then use the estimated equation to derive marginal productivity estimates for the various provider inputs. This technique has been used previously by Reinhardt (1972) and later by Brown

(1988) to study the production process in private physician offices. While our approach is similar, our analysis is unique in that it focuses on institutional primary care providers. Once we derive the marginal productivity estimates, we can estimate the degree to which the productivity of residents is commensurate with their costs and the extent to which GME subsidies affect the employment and productivity of residents.

We expect residents, like most factors of production, to exhibit diminishing marginal productivity. That is, as more residents are employed, the productivity gains from each additional resident become smaller and smaller. We also expect facilities receiving the most generous GME subsidies per resident to be the most likely to employ residents along ‘‘the flat of the curve’’ and well beyond the level recommended by equation 1. Before describing our econometric specification, we briefly outline federal and New York state subsidies for GME.

GME Subsidies

The federal GME subsidy is paid through the Medicare program. Medicare DME payments are made to facilities based on the number of residents, the share of inpatient days attributable to Medicare patients, and operating costs in 1984, which are updated annually for inflation. Since the share of Medicare days and 1984 costs vary significantly across hospitals, per-resident DME payments vary significantly as well. Hospitals are reimbursed for resident training that takes place in ambulatory settings if the sponsoring hospital assumes a substantial portion of the costs. With the passage of the Balanced Budget Act (BBA) of 1997, free-standing health centers that assumed most resident training costs became eligible for DME reimbursement from which they previously were excluded.

Medicare IME payments are made through adjustments to hospitals’ base PPS rates. In 1997, hospitals received an additional 7.7% for every .1 increase in the number of interns and residents per bed, which serves as a measure of teaching intensity rather than total teaching output. Originally, ambulatory care residents were excluded from the interns-and-residents-to-beds (IRB) ratio, but later those working within the hospital setting were added to the formula (Counsel on Graduate Medical Education 2000a). In 1997, the BBA permitted hospitals to include in the IRB ratio ambulatory care residents working outside the hospital, provided the hospital assumes most of the costs for these residents. Currently, Medicare does not reimburse IME costs incurred by nonaffiliated health centers.

In New York, GME also is supported by extensive subsidies at the state level. These subsidies were introduced in 1983 in the form of reimbursement rate enhancements under the state’s former all-payer hospital rate-setting system, the New York prospective hospital reimbursement methodology (NYPHRM). When the state formally dismantled NYPHRM under the New York Health Care Reform Act (NYHCRA) of 1996, state support for GME continued through the use of GME pools that were introduced during the evolution of the NYPHRM system. Revenue from the pools is derived from taxes paid by third-party payers with exceptions for Medicare—which makes separate contributions to GME support—as well as Medicaid and worker’s compensation/no fault insurance, which continue to pay GME add-ons to state-administered rates.

GME collections are distributed to teaching hospitals and teaching consortia across the state.[2] Distributions are made on the basis of eight geographic regions originally developed under NYPHRM, so that all revenue collected within a particular region is distributed to teaching facilities within that region only. Each facility receives a percentage of the regional GME collection based on its percentage of the total GME ‘‘need’’ in the region. This percentage is based on a modified version of Medicare’s DME and IME payment formulas. A particularly important modification is the weighting of residents by specialty, which allows greater payments to be made for residents receiving training in primary care, preventative care, and emergency medicine.

Empirical Specification and Estimation Issues

We model the production of primary care visits using the following production function model:

$$\text{Primary care visits} = f(\text{labor, capital}). \quad (2)$$

Primary care visits are defined as the sum of all visits for general internal medicine, family practice, pediatrics and adolescent medicine, geriatrics, and obstetrics and gynecology services.[3] The primary labor inputs are primary care providers measured in full-time equivalent (FTE) units. Specifically, we include FTE totals for the following mutually exclusive categories: nonresident primary care physicians (excluding those specializing in obstetrics or gynecology), obstetric/gynecology physicians, nurse practitioners, physician assistants, and medical residents. FTE computations for all providers including residents are based on the number of hours worked in primary care and the length of the standard work week. The primary capital input for this analysis is the number of exam rooms available at the site.

We also include a dummy variable to indicate whether a site is a hospital outpatient department.[4] This serves as a very crude adjustment for case mix, as OPDs tend to attract more complicated illnesses than free-standing clinics (Forrest and Whelan 2000). While we would have preferred to use a more detailed ambulatory case-mix adjuster, there is none available for our analysis.

Our econometric specification is derived from the microeconomic theory of the firm. We begin with the following translog production function, which is considered a flexible form because it makes very few behavioral assumptions about the production process (Berndt and Christensen 1973). Using y to denote primary care visits and x_i to denote input i, the translog function is written as:

$$\log(y) = \alpha_0 + \sum_i \alpha_i \log(x_i) + \frac{1}{2} \sum_i \sum_j \beta_{ij} \log(x_i)\log(x_j) + \varepsilon \quad (3)$$

This is a common approach in production analysis, because it can be viewed as a good approximation of a general functional form like equation 2 and is easy to estimate using linear regression. It is also useful because several well-accepted models of production (e.g., Cobb-Douglas) are nested within the translog form, and assumptions about these models can be tested in this framework. A drawback of the translog model is that it does not allow for the possibility of production without using positive amounts of all inputs (i.e., the log of zero is undefined). This drawback is an important one for our analysis, because it is possible to produce visits using physicians but not physician assistants, or by using physician assistants without nurse practitioners, and so on.

As an alternative, we turn to the generalized translog production function. Instead of taking the logarithm of all variables, we use a Box-Cox transformation (Box and Cox 1964). The Box-Cox transformation for a variable Z is defined as $(Z^\lambda - 1)/\lambda$, which adds a new parameter λ to the estimation procedure. As λ approaches zero the Box-Cox transformation approaches $\log(Z)$, which would reduce the generalized translog function to the ordinary translog function. If $\lambda = 1$, the transformation is reduced to a linear one, which simplifies the production function even further.

Although the generalized production function is nonlinear in the parameters, it can be estimated by linear regression for any given value of λ. Following the procedure outlined in Greene (1997), we use a grid search to find the value of λ that minimizes the sum of the squared residuals of the model. Greene suggests searching among values of λ between -2 and 2 as long as the transformed variables are never less than or equal to 0. Otherwise, the search is restricted to the interval between 0 and 2. Our search begins at increments of .1 and then is refined to increments of .01.

As we explain subsequently, our data set contains observations of facilities across two years. As a result, some facilities appear in the data set more than once while others do not. To account for the lack of independence of errors among sites with repeated observations, we estimate an ordinary least squares (OLS) model with standard errors that are calculated using the cluster option in Stata 7.0. As a check on the robustness of our method, we also estimated a random-effects model, which treats the data as if it were a full panel of observations. The results are very similar; therefore we present estimates from the OLS model only.

We derive an estimate of the marginal productivity ratio in equation 1 using the estimated coefficients from the production function. We calculate an average value for the ratio and a 95% confidence interval based on standard errors that are calculated using the bootstrap method (Davison and Hinkley 1997). Finally, we estimate simple regression models to esti-

Table 1. Description of sample facility characteristics and teaching subsidies

Variable	Mean	Standard deviation	Minimum	Maximum
Primary care visits	22,940	28,217	1,000	184,818
Full-time equivalent providers				
Nonresident physicians	5.63	9.87	0	88
OB/GYN physicians	1.02	2.28	0	25
Nurse practitioners	.87	1.86	0	16
Physician assistants	.80	2.18	0	22
Primary care residents	3.09	8.71	0	97
Other variables				
Exam rooms	19.88	28.83	1	195
Indicator for 1998	.67	.47	0	1
Indicator for OPD	.17	.38	0	1
NY GME subsidy per resident ($)	23,506	13,733	1,325	59,722
Medicare GME subsidy per resident ($)	107,103	32,941	49,110	151,708
Annual salary for nonresident physician ($)[a]	134,056	NA	NA	NA
Annual salary for resident ($)[a]	42,076	NA	NA	NA

[a] Medians.

mate the impact of GME subsidies on the marginal productivity ratio.

Data Sources and Definitions

The data for this study came from the 1997 and 1999 New York City Ambulatory Care Provider Surveys sponsored by the United Hospital Fund of New York and the Robert F. Wagner Graduate School of Public Service at New York University. The surveys collected information about provider characteristics and auspices, scope and volume of services provided, staffing, managed care arrangements, and payer mix during the prior fiscal year. The survey could not obtain detailed case mix information, as suggested earlier, which leaves only an OPD indicator as a rough proxy for case mix. The survey was mailed to 226 hospital-sponsored and free-standing ambulatory care sites or to the sites' sponsoring organizations in New York City in 1997, and to 284 of these sites in 1999. The response rate was 80% in 1997 and 75% in 1999. Due to item nonresponse, the pooled data provided 204 observations (site years) for 155 distinct sites.

To compare our estimates of marginal productivity to marginal cost, we relied on two other data sources for provider compensation. For compensation of residents, we used the 1998 Institutional Cost Reports for hospitals in New York City. For physician compensation, we used income of general family practitioners as reported in 1997 by the American Medical Association, adjusted to 1998 dollars using the Consumer Price Index (American Medical Association 1999). Due to the presence of outliers and other data anomalies in the cost report data, we used median values of salaries to estimate the salary ratio in equation 1.

Table 1 shows the diversity of primary care providers used by the sample facilities as well as descriptive statistics for other variables. Of particular significance is the widespread employment of primary care residents who rank second only to nonresident physicians as the most common provider in the average facility.

Data regarding Medicare GME payments were obtained from Medicare Cost Reports, while data for New York GME payments were obtained from the New York State Department of Health. For each hospital, we divided total GME receipts by the total number of residents (inpatient and outpatient). At the time of this analysis, we could obtain reliable GME data at both the state and federal level for 1997 only, which is the year in between our two cross sections of input and output data. Any bias this entails should be minor, since most variation in per resident payment amounts is across facilities rather than within facilities over time. GME data were linked directly to hospitals. For analytic purposes, free-standing facilities that were hos-

Table 2. Primary care production function

Variable	Coefficient	*P*-value[a]	LB[b]	UB[c]
Physicians	2,512.14	.00	1,502.75	3,521.54
Physicians squared	−66.97	.02	−122.57	−11.37
OB/GYN	5,993.78	.00	3,610.65	8,376.91
OB/GYN squared	−97.35	.02	−177.28	−17.41
NP	124.11	.91	−1,960.35	2,208.56
NP squared	509.30	.21	−285.58	1,304.17
PA	848.90	.47	−1,451.51	3,149.31
PA squared	−735.77	.00	−1,193.03	−278.50
Residents	532.38	.11	−127.96	1,192.73
Residents squared	−4.42	.13	−10.09	1.26
Rooms	426.59	.01	131.34	721.85
Rooms squared	−1.66	.37	−5.26	1.95
Physicians × OB/GYN	214.04	.51	−418.77	846.84
Physicians × NP	107.74	.53	−228.91	444.40
Physicians × PA	39.32	.68	−150.56	229.19
Physicians × Residents	11.50	.81	−80.37	103.37
Physicians × Rooms	7.36	.47	−12.54	27.25
OB/GYN × NP	130.29	.82	−992.95	1,253.52
OB/GYN × PA	−1,628.36	.07	−3,419.65	162.93
OB/GYN × Residents	131.85	.40	−178.61	442.31
OB/GYN × Rooms	−157.18	.02	−291.72	−22.65
NP × PA	−267.06	.53	−1,094.72	560.60
NP × Residents	−212.83	.17	−515.00	89.35
NP × Rooms	−13.68	.70	−83.73	56.38
PA × Residents	−565.74	.00	−934.02	−197.47
PA × Rooms	297.76	.00	174.77	420.74
Residents × Rooms	−1.38	.92	−28.60	25.83
OPD indicator	−2,100.98	.51	−8,411.42	4,209.46
Year 1998 indicator	−1,085.77	.29	−3,087.59	916.05
Constant	−483.46	.65	−2,606.50	1,639.58
Observations		204		
Groups (*N*)		155		
R^2		.95		

Notes: Physicians refer to nonresident, nonobstetric, nongynecological physicians. OB/GYN refers to nonresident, obstetric or gynecological physicians. NP refers to nurse practitioners. PA refers to physician assistants. Rooms refers to exam rooms available on site.

[a] *P*-values based on standard errors that are adjusted for site-level clustering.

[b] LB = lower 95% confidence bound.

[c] UB = upper 95% confidence bound.

pital-affiliated were assumed to receive the same per resident amounts as their sponsoring institutions.

Results

Initial analysis supported the use of a simplified empirical model. The grid search produced an optimal value for the Box-Cox parameter λ equal to 1.08, which is close to the value that reduces the generalized translog function to the linear form ($\lambda = 1$). Using the nonlinear analogue to the usual linear F test described in Greene (1997), we could not reject the hypothesis that $\lambda = 1$ at the 5% significance level ($F = 2.99$, df1 = 1, df2 = 198). Therefore, we reestimated the model using the variables themselves instead of Box-Cox transformations.

The simplified model fit the data well, with an overall $R^2 = .95$ (Table 2). The key inputs for our analysis, namely residents and nonresident physicians, exhibited diminishing marginal productivity. Specifically, the coefficients of the linear terms were positive and the coefficients for the squared terms were negative. Although the coefficients for resident FTEs exhibited the predicted pattern, they were not statistically significant in this model. However, in alternative models, including random effects and OLS without adjustment for clustering, the coefficients did reach statistical significance. Overall,

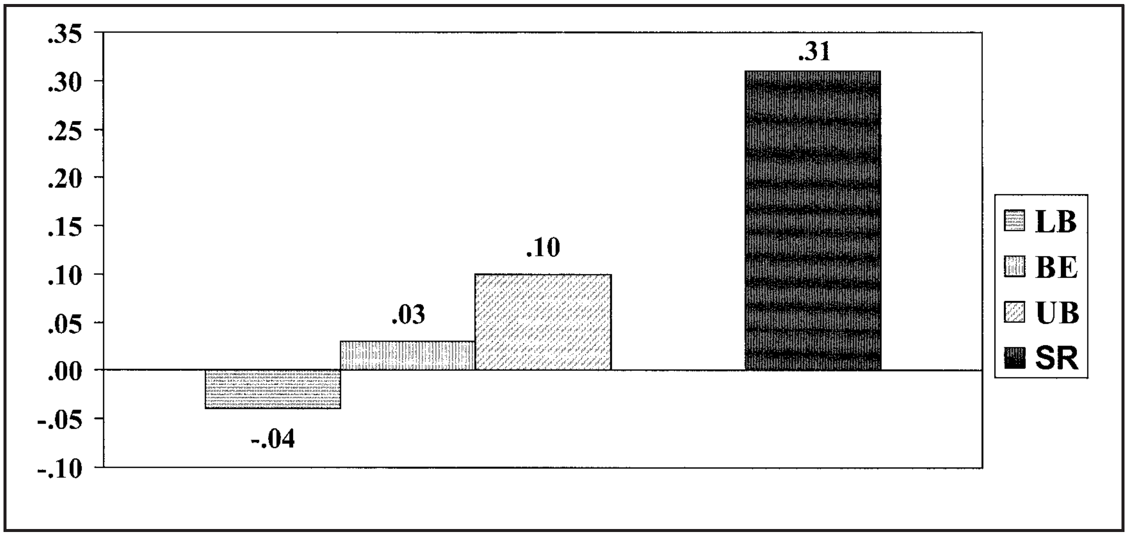

Figure 1. Marginal productivity and salary ratios: residents vs. nonresident physicians (Lower bound [LB] and upper bound [UP] for marginal productivity ratio estimates are based on a 95% bootstrapped confidence interval. Best estimate [BE] of marginal productivity ratios is based on production function estimates in Table 2. Salary ratio [SR] is computed from Table 1.)

some of the individual parameters, including those for squared and interaction variables, were not significant. However, joint significance tests for subgroups of variables suggest that the current specification should be maintained.[5]

For each facility in the sample, we used the estimated model in Table 2 along with the input values for each facility to compute the marginal productivity of residents relative to the marginal productivity of nonresident physicians. We then calculated the average value of the marginal productivity ratio and the corresponding 95% confidence interval.[6] These values, along with the salary ratio calculated from Table 1, are shown side by side in Figure 1. All values within the confidence interval are well below the salary ratio. This provides fairly strong evidence that from the perspective of cost minimization, residents are significantly overutilized.

In Table 3, we provide estimates of the association between GME subsidies and the marginal productivity ratio. We find that the total GME subsidy per resident has a small but statistically significant association with the marginal productivity ratio, which suggests the role of GME in encouraging the ''overemployment'' of residents. Since the GME subsidy in New York contains explicit incentives to encourage the training of primary care residents, we tested for differential impacts between the state and federal-level subsidies. An *F*-test confirms that the two subsidies have different effects. In particular, it is the New York subsidy that has a significant impact, while the Medicare subsidy does not. Nevertheless, the impact of the New York subsidy is still small in magnitude.

Discussion

America's current medical education and research infrastructure traces its origins to several federal actions designed to ensure an adequate supply of physicians, hospitals, and innovative medical treatments in the aftermath of World War II. The key initiatives include the Hill-Burton Act of 1946, funding increases for the National Institutes of Health, and partnerships between medical schools and hospitals run by the Department of Veterans Affairs (Ebert and Ginsburg 1988). The Medicare and Medicaid programs built on these commitments by covering a large part of the costs of graduate medical education through enhanced reimbursement rates for teaching facilities. By 1998, teaching hospitals received an average of $92,000 per

Table 3. Relationship between relative productivity of residents and graduate medical education subsidies

Variable	Coefficient	*P*-value	LB[a]	UB[b]
Restricted model				
Total GME subsidy per resident	−1.06E−06	.07	−2.21E−06	8.60E−08
Constant	.26	.00	.13	.39
Unrestricted model				
NY GME subsidy per resident	−3.85E−06	.01	−6.80E−06	−9.03E−07
Medicare GME subsidy per resident	−2.91E−07	.61	−1.43E−06	8.49E−07
Constant	.24	.00	.12	.37
Test of restricted model				
$F(1, 84)$			5.36	
P-value			.02	

Notes: Dependent variable is the marginal productivity ratio of residents versus nonresident physicians. Models based on 111 observations of 85 hospitals.
[a] LB = lower 95% confidence bound.
[b] UB = upper 95% confidence bound.

resident from these two programs alone (Salsburg 2001).

However, as more and more public funds have flowed into academic medical institutions, observers have questioned the role of government in the financing of physician training in general, and GME subsidies in particular. Medicine has become one of the most secure and highly paid professions in the nation, as state and federal governments have dealt with growing fiscal pressures, many stemming from exploding health care costs. Moreover, by encouraging hospitals to train more residents than they otherwise would have, GME subsidies (particularly those financed by Medicare) have played a role in increasing health care costs at the federal level (Newhouse and Wilensky 2001). By tying payments to institutions instead of students, the GME subsidies have allowed academic facilities to pursue their own goals, which involve expensive technology-driven care instead of general public goals, which involve less technology-intensive primary care. These concerns made Medicare GME payments a clear target for balancing the federal budget under the Balanced Budget Act of 1997 (Inglehart 1998), although some of the cuts were later reduced or phased in more slowly as a result of the Balanced Budget Refinement Act of 1999.

In the years ahead, subsidies for GME will continue to face increased scrutiny. Therefore, it is important to assess the likely consequences of further reductions or even elimination of these subsidies. Evidence suggests that little would change with regard to the training and employment of inpatient residents. According to the literature cited earlier, hospitals find it difficult to replace inpatient residents. It appears that any loss in productivity associated with the use of residents instead of nonresident physicians is more than offset by the reduction in costs due to residents' lower salaries. In other words, residents already are paying the cost of their training. Therefore, the main impact of a reduction or elimination of GME subsidies most likely would fall on hospitals in the form of an income transfer from teaching hospitals back to the public.

Our analysis suggests that the response would be quite different with regard to ambulatory care residents. Unlike the case for inpatient residents, primary care residents do not appear to pay for their training through salaries that are well below the value of their production. According to our best estimate, the marginal resident is only 3% as productive as the marginal nonresident physician. Even at the upper end of our 95% confidence interval, this figure is only 10%. Based on this upper bound, the marginal nonresident physician is 10 times as productive as the marginal resident. Since one nonresident physician can replace 10 residents, a facility could pay the salary of a nonresident physician ($134,056) in exchange for saving the salary expense of 10 resident FTEs, which is $42,076 × 10, or $420,760, for a net savings of $286,704 (i.e., $420,760 − $134,056). Therefore, the net marginal productivity cost is approximately $28,670 (i.e., $286,704/10) per resident. If the average facility behaved like a profit-maximizing firm, it would rationally seek to charge the marginal resident a fee equal to $28,670 to cover the costs of training. At some facilities, resident marginal productivity is close to zero, which implies that an even larger ''tuition'' would be sought.

Our analysis of the *marginal* productivity of residents forms an interesting contrast to previous work regarding the *average* productivity of residents. Using visit-level data from an ambulatory care clinic, Jones, Culpepper, and Shea (1995) found that first-year residents were only 25% as productive as physicians on average, and second- and third-year residents were only 50% as productive. After allocating fixed overhead costs and accounting for the lost revenue due to residents' lower average productivity, the researchers estimate that ''a total of $6,171 per resident would be saved annually if staff physicians replaced residents to provide the same level of services''—an estimate that is much lower than the one we have derived here. Differences in study settings and research methods prevent detailed comparisons. Nevertheless, the two estimates together do suggest that the marginal cost of residency rises significantly with the number of residents, a result consistent with our finding of diminishing marginal productivity of residents.

The current total GME subsidy received by the average facility in our sample is $130,609 per resident. This amount is much more than enough to cover the sum of direct salary costs and the indirect productivity costs of residents (approximately $70,746). This may explain why so many facilities use residents beyond the point where marginal productivity exceeds marginal cost.

We found some evidence that GME subsidies do encourage the use of residents well into the flat of the productivity curve. After further testing, we found that the New York subsidy is the one that drives this result for the facilities in New York City. This may reflect the targeted nature of the New York subsidy with respect to primary care residency. It also may reflect the lower variation in the Medicare subsidy per resident among New York facilities. Facilities in New York are at the upper tail of the Medicare GME distribution and as a result there is less variation in the Medicare GME data. Specifically, the coefficient of variation for the Medicare subsidy (.27) is only half as large as it is for the New York subsidy (.53).

We note also that the impact of the New York subsidy, though significant, is small in magnitude. This might be a result of measurement error in the data. Specifically, our subsidy measures take the ratio of total GME payments to total residents. However, it is not known how subsidies are allocated across residency programs of varying specialties within institutions. A large per resident subsidy may not affect decisions about how many residents to train in primary care if most of the funds are allocated to other specialties. Moreover, data on the level of subsidy is available only at the corporate level. Therefore, when several sites report their financial data in one combined statement, it is not clear how the subsidy is allocated across sites. If subsidies for primary care residents were more specifically targeted and measured, the behavioral response we examine here might be stronger.

From the perspective of efficiency in the delivery of patient care, the GME subsidy appears to create an undesirable distortion. However, if policymakers' goal is to encourage more primary care training, then our findings suggest that GME subsidies are having their desired effect. Furthermore, if mounting competitive pressures lead to greater emphasis on improving primary care productivity, then the level and structure of future subsidies are likely to figure even more prominently in determining facilities' future commitment to ambulatory care training. We also note that our measure of subsidy per resident is equal to total dollars received for GME divided by the total number of residents. If GME subsidies were tied more closely to primary care, the response by ambulatory care facilities likely would be stronger, making the subsidies themselves more efficient at achieving a more desirable specialty mix in the future physician workforce.

As discussed earlier, it is believed that inpatient residents ''pay for themselves.'' Therefore, current GME subsidies generate surplus income for most teaching hospitals, which can be used for other purposes. Since many of these facilities are important members of the health care safety net for the poor and the uninsured, GME subsidies serve as an indirect vehicle for covering part of the costs associated with charity care (Commonwealth Fund 2001). While GME subsidies may not be the most efficient way of supporting the safety net, changes in GME policy could have important consequences for the provision of charity care.

Recently, GME policies have been in a state of flux. At the federal level, GME policy appears to be reinforcing the advantages of specialty training over primary care training. The Balanced Budget Act of 1997 reduced GME subsidies under Medicare, but did not distinguish between primary care and inpatient or specialty residents. Because it is easier to find substitutes for ambulatory instead of specialty residents, hospitals most likely will seek to reduce ambulatory training more than inpatient training, an incentive that runs counter to projected physician workforce needs. This impact may be mitigated somewhat by other BBA provisions. The BBA allows payment for ambulatory care residents trained at community health centers but employed by hospitals. Nevertheless, our analysis suggests that this provision may not be sufficient to encourage hospitals to train ambulatory care residents. The BBA also creates a new direct medical education subsidy for residents whose salaries are paid by free-standing ambulatory care centers; given the relatively small role played by these facilities in training primary care residents, this policy is not likely to encourage a significant amount of new outpatient graduate training.

Public policy at the state level in New York places more emphasis on primary care training than that at the federal level. Under New York's hospital rate-setting system, primary care residents have been given greater weight than other residents in determining rate add-ons for teaching hospitals. When the rate-setting system was formally dismantled by the New York Health Care Reform Act of 1996, the state established regionally based ''professional education pools'' to continue support for GME.[7] Distributions from the pools are based on resident counts that retain the prior upweighting of primary care residents. The NYHCRA also set aside money from the professional education pools to support a separate GME incentive pool. To be eligible for distributions from the incentive pool, hospitals had to comply with certain policy goals, which included downsizing of residency programs, increases in the amount of training that takes place in ambulatory care settings and underserved areas, and increases in the proportion of residents training in primary care and other shortage specialties.

New York's GME subsidies were restructured further under the NYHCRA of 2000.[8] Total funding for the professional education pools and funding for the GME incentive pool were both reduced. However, in response to shortfalls in prior years, funding for the GME pools was guaranteed and a new supplemental indigent care pool was created to offset the costs of charity care provided by teaching hospitals. Moreover, some of the incentives designed to favor the training of primary care residents were weakened. Eligibility for receipts from the GME incentive pool no longer was conditioned on a reduction in the total number of residents trained. Moreover, although hospitals still were encouraged to provide more training in ambulatory care settings, the goal of increasing the proportion of residents training in primary care also was removed from the GME incentive pool. Therefore, hospitals that continue to emphasize specialty over primary care training are eligible for distributions from the incentive pool provided they meet other program goals. While New York still retains incentives to train residents for careers in primary care, the legislative changes under the NYHCRA of 2000 appear to have undermined the incentives that were already in place.

Like other observational studies, this one must be viewed in light of some limitations. Lacking data on patient outcomes, we relied on a visit-based measure of health care output. Although we controlled for average case-mix differences between hospital OPDs and free-standing health centers, there may be systematic unmeasured case mix for which we were not able to control. In particular, if the use of residents were linked to higher average case mix, then our estimates of resident productivity would be biased downward. Also, our measure of resident providers did not distinguish year of residency. Since resident productivity increases with experience, the minimum subsidy required to encourage the training of ambulatory care residents likely would be smaller for residents with more ambulatory experience. Finally, New York City is fairly unique with regard to graduate medical education and the subsidies that support it. Therefore, it is important for future research to examine resident productivity and subsidy issues in other parts of the nation.

Correcting the perceived imbalances in the physician workforce requires a clear understanding of the costs and benefits of training new physicians in different specialties. As Reinhardt (1994) has argued, the most efficient tool for shaping the future physician workforce may involve holding aspiring physicians responsible for the full cost of medical school and then steering them appropriately through loan forgiveness incentives. Our analysis suggests that as the health system becomes more competitive and GME subsidies are restructured, any such policy—to the degree that it seeks to influence the primary care physician workforce—will have to recognize the net costs to health care facilities of primary care residency. The current policy trend to tighten reimbursement for training residents overall may be good public policy, but our findings suggest that strengthening the primary care workforce will require well-targeted subsidies for training in primary care.

Notes

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1 If, for example, $(MP_r/MP_n) < (W_r/W_n)$, then the gain in productivity from employing an additional resident instead of a nonresident physician is not justified by the additional cost. In other words, the firm could increase productivity and/or decrease costs by reducing the employment of residents relative to nonresident physicians.

2 Teaching consortia are state-approved groups of providers, payers, medical networks, medical schools, and consumer groups devoted to medical training.

3 Ideally, we would treat the different types of primary care visits as separate outputs and use a distance function approach to model the production process (Färe and Grosskopf 1990). Unfortunately, the data become significantly less reliable at the disaggregated level. The nature of the problem is that, for example, some facilities report family medicine and general internal medicine in one combined category. Therefore, we can reliably analyze total but not disaggregated primary care visits.

4 Although the production process may vary between the two site types, we do not have a large enough sample to estimate separate production functions.

5 Three separate joint significance tests based on Wald's Chi-square for linear variables, squared variables, and interaction variables all rejected the null hypothesis at 1% or better.

6 The standard error used to calculate the confidence interval converged to the third decimal place after 1,000 replications.

7 We obtained information on the NYHCRA of 1996 from the Healthcare Association of New York State (1996).

8 We obtained information on the NYHCRA of 2000 from the Healthcare Association of New York State (2000).

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