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Federal health care policy and the geographic diffusion of physicians: A macro-scale analysis

STUART A. FOSTER[1] & WILPEN L. GORR[2]
[1]*Department of Geography and Geology, Western Kentucky University, Bowling Green, KY 42101, U.S.A.*; [2]*The School of Urban and Public Affairs, Carnegie Mellon University, Pittsburgh, PA 15213, U.S.A.*

Abstract. The federal government passed legislation in the 1960's and 70's to increase physician supplies and reduce spatial inequalities in access to physicians. A major policy was to aggressively continue increasing the overall supply of physicians on the assumption that market forces would eventually divert physicians from areas of high physician density to those of low density. Using state-level, annual data collected over a 21-year period, this paper investigates the macro-scale spatial diffusion of physicians as an essential element in evaluating this policy. The results provide evidence of the policy impacting locational trends relating to primary care physicians, but not specialists. They also indicate that the Medicaid/Medicare programs may have adversely affected the maldistribution problem.

Introduction

The physician is the central figure in the United States health care industry, being both the traditional entry point for and primary provider of health care services. Thus the supply level and geographic distribution of physicians are important determinants of the public's access to health care.

Rapid population growth and increasing prosperity after World War II caused rapid growth in the demand for health care services and a widespread perception of a physician shortage. Furthermore, it soon became apparent that the problem of physician supply was complicated by a geographic dimension. Not only was there an overall shortage of physicians; in addition, physicians were not distributed in proportion to need. Maldistribution was evident among states (e.g., favoring coastal states over those in the South or Midwest), among sub-state regions such as counties (favoring urban over rural counties), and within cities or counties (favoring middle- and upper-class over poor neighborhoods). Acknowledgement of maldistribution was accompanied by a growing opinion that access to needed health care services was a right, not a privilege.

The problem of overall supply level was attributed to existing constraints in the medical education system. Federal policy was designed to remove these constraints by providing incentives and contributing funds to expand existing schools and build new ones and by providing financial assistance for medical school students. Accepted wisdom held that if the problem of national supply could be resolved, then the problem of distribution would resolve itself in the market place. Hence, with a few exceptions, federal policy addressing distribution represented a vote of confidence that the market would respond by geographically allocating physicians according to expressed need. The exceptions applied mainly to sparsely populated markets. Loan-foregiveness programs were offered to students in exchange for service commitments in underserved areas.

The policy effort to increase supply was immensely successful. As illustrated in Figures 1 and 2, rapid growth in the supply of physicians began during the 1960's and continued into the 80's. From 1964 to 1983 primary care physician density increased 35% from 58 to 78 physicians per 100,000 population and specialist density increased 73% from 54 to 94. By the late 1970's the pendulum had swung from a perception of shortage to one of an oversupply of physicians.[1] Subsequently, the federal role in physician manpower planning has been reduced greatly, signaling the end of an era in federal health care policy.

The effectiveness of federal policy in producing a more equitable geographic distribution of physicians is less evident. Different locational trends may appear at different geographic scales of analysis. Because the distributional problem has been viewed predominantly as an urban-rural dichotomy, operating at the meso scale, and an inner city-suburb dichotomy, operating at the micro scale, most investigations have focused at these scales.[2] However, the efficiency of markets and policies allocating physicians at these fine scales is broadly constrained by the efficiency of markets and policies allocating physicians at a broader geographic scale. The purpose of this paper, therefore, is to evaluate to what extent this federal policy era led to a more or less equitable interstate, or macro scale, allocation of physicians. Therein, this study com-

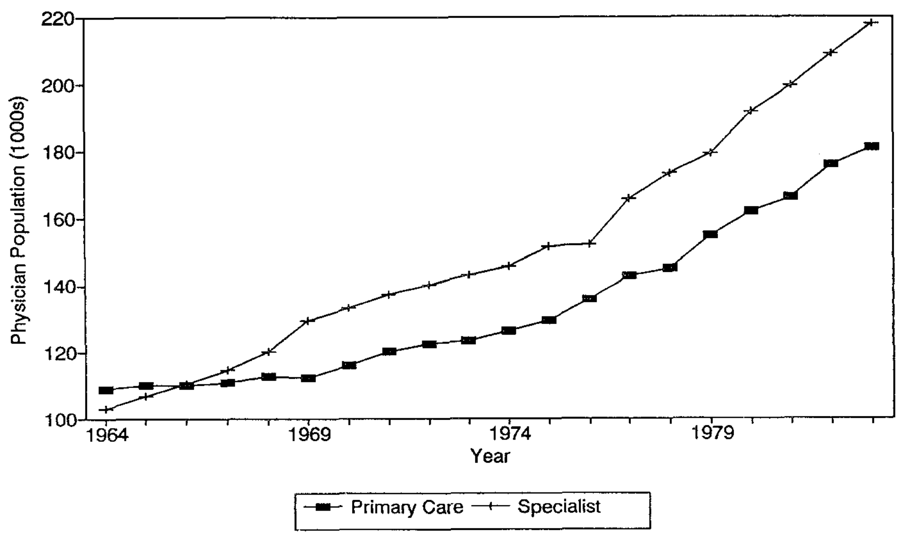

Fig. 1. Time trend of physician populations (contiguous 48 states).

plements previous studies carried out at finer scales of geographic resolution.

Ideally, one could assess the impact of a policy to influence locational choice by identifying the locational decisionmaking process used by a physician and then determining the role that a given policy program played in that process. While this procedure has strong conceptual appeal, it is not realistic for the case at hand. Decisionmaking processes have proven extremely difficult to uncover, and evidence indicates that they are quite complex.[3] Furthermore, given that this study centers on locational decisions made in the rapidly changing environment of medical education and practice during the 1960s, 70s, and 80s, the information required at the level of the individual is simply not available and could not realistically be collected, except for possibly a small nonrandom sample of recently located physicians.

While it is not possible to investigate directly locational decisions made several years ago, it is possible to analyze the aggregate outcomes of these locational decisions. We estimate a time-varying parameter model using the method of window regression with annual, state-level data. Empirical patterns of variation in parameter 'time paths' are compared with patterns expected on the basis of policy. Conclusions are based upon the degree of consistency between empirical and expected patterns, recognizing that evaluations of causation are drawn from the strength of theory and quality of the available data.

This paper consists of six sections. Following the introduction, the second section reviews federal policy efforts of the expansionist era. The third section concerns physician location models, reviewing both static and dynamic elements as a prelude to developing the time-varying parameter formulation

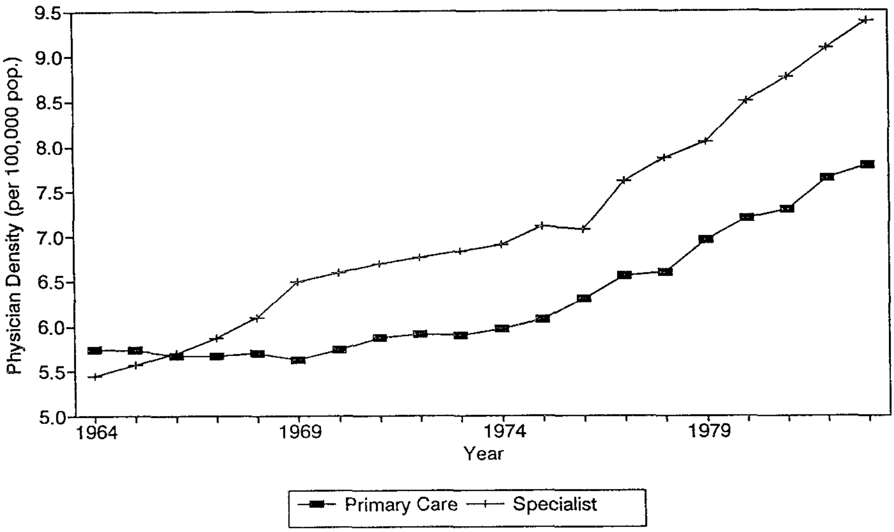

Fig. 2. Time trend of physician densities (contiguous 48 states).

of the policy-analysis model. The fourth section provides a brief discussion of the data. The fifth section presents the analysis, carried out in two phases. The sixth section states conclusions from the analysis.

The federal initiative in physician personnel policy

Several important legislative acts trace the rise and fall of the federal expansionist era of health personnel policy. This section provides an overview of these acts.

In 1963, after more than a decade of failure to act, concern about the perceived physician shortage became sufficient to enable passage by Congress of the Health Professions Educational Assistance Act (PL 88-129). This Act, coupled with later amendments in 1965 (PL 89-290), directed efforts to increase the supply of physicians along two fronts. It enacted a program making federal loans and scholarships available to medical students, and it provided construction grants for medical schools along with improvement grants for existing schools. The Health Manpower Act of 1968 (PL 90-490) extended the provisions of the 1963 Act through 1971. Another act, the Emergency Health Personnel Act of 1970 (PL 91-623), established the National Health Service Corps in an effort to attract more physicians into underserved areas.

Passage of the Comprehensive Health Manpower Training Act of 1971 (PL 92-157) increased the federal role in health manpower planning. This act continued assistance for medical school construction in the form of grants, interest subsidies, and loan guarantees. Aid to existing institutions came in the form of special project grants and a system of capitation grants based on class enrollment criteria. These were tied to incentives to increase the number of residency positions in family medicine. This support also included various incentives, such as loans, scholarships, and a loan repayment program, to entice students to enter practice in physician-poor areas.

Large gains in the production of physicians were realized by the middle 1970s. In passing the Health Professions Educational Assistance Act of 1976 (PL 94-484), Congress indicated that concern no longer existed about a shortage of physicians. Hence, programs concerned with physician supply received reduced funding, and attention was centered on the problem of geographic maldistribution of physicians. In addition, the influx of graduates from foreign medical schools was severely curtailed by enacting tougher immigration requirements.

The Omnibus Budget Reconciliation Act of 1981 (PL 97-35) clarified the changing role of federal policy. It clearly signaled the end of federal efforts of increase the national supply of physicians. Overall funding for health manpower was cut by more than half in fiscal 1982 from 1980. No funding was provided for the construction or expansion of medical schools. Certain programs concerned with maldistribution, for example the National Health Service Corps, were continued, though with less support.

Physician location models

For a given point in time, it is possible to estimate the distribution of physicians using existing, well-developed static models. Over time, however, variations in the parameters of these models are expected as the population of physicians in a region goes through the S-shaped growth curve predicted by diffusion theory.[4] This section reviews the literature on static model factors influencing physician location decisions and then develops dynamic model relationships for assessing the aggregate locational behavior of physicians during this federal policy era.

Static factors

Potential medical practice sites can be characterized by three broad factors: professional climate, social amenities, and market conditions. One assumes that physicians assign various degrees of importance of site attributes according to individual preferences, and then use certain decision rules to select a practice site from among a subset of the potential sites.

The professional climate of medical practice has become an increasingly important influence in shaping locational preferences. Professional concerns generally fall into the categories of sufficient access to hospital and other support facilities, and interaction with colleagues. Attitudinal surveys of physicians and residents provide some indication of the relative importance attributed to professional concerns in the choice of a practice location.[5] The overriding effect, barring the impacts of other forces shaping physician distribution patterns, appears to strongly favor the spatial concentration of physicians.

The social amenities associated with practice locations often play an important role in the location choice process. Social amenities include the social and cultural aspects of a community such as educational facilities, entertainment and recreational opportunities, and shopping facilities. They also include aspects of physical geography, particularly the climate and topography of an area.

The primary focus of research into the effects of social amenities on location choice has been on community-size preferences. Social and cultural characteristics are largely a function of community size. Studies from a wide variety of geographic contexts have shown that physicians exercise preferences for community-size in choosing a practice location, and these preferences are largely determined by a physician's previous life experiences.[6] Hence, physicians from large cities tend to prefer practice locations in large cities, and physicians from small communities are more likely to practice in small communities.

Market characteristics constitute the third important locational factor. The simplest indicator for this factor is income potential, however, there is little direct evidence regarding the importance of this variable in the location choice.[7] Some have argued that physicians' incomes are so high that variations in income potential among places are not perceived as important.[8] The role of market conditions in physician location decisions is in fact poorly understood, but we believe that as markets for physicians become tighter, market characteristics are likely to play a more significant role in this process.

Dynamic factors

We turn now to consideration of the dynamics of medical practice markets and the location decisions of physicians. The two major factors governing changes in practice markets, as we argue in this section, are changes in total population and physician density (e.g., physicians per 100,000 population).

First, population is by far the greatest determinant of physician distribution, being a direct measure of market size. So physicians are quite responsive to variations in population growth.[9] Thus a dynamic model of physician population change, which has the purpose of evaluating the distributional impacts of the federal expansionist policy, needs to include population growth as a control. Population growth also serves as a surrogate for social amenities at the macro level; e.g., the Frostbelt/Sunbelt phenomenon is manifested in differential population growth rates for the two belts.

The attractiveness of the professional environment is some positive function of the supply of physicians in an area. As the supply of physicians increases, opportunities for professional interaction among physicians also increase. Hence, there is a positive feedback process wherein an increase in physician supply makes the professional environment of an area even more attractive to physicians. This represents an agglomerative force.

Consider now market conditions. Due to competition among physicians, at some point the income potential for physicians decreases as physician density increases. At the same time, the number of practice opportunities for additional physicians decreases. This represents a negative feedback process wherein an increase in physician supply results in a decrease in the economic attractiveness of an area. Thus, the economic component in the location choice process exerts a deglomerative force that may cause the geographic distribution of physicians to move toward an equilibrium state.

In summary, in the early stages of physician supply development in a region, when physician density is small, physician population growth is self-reinforcing due to its positive effect on the professional environment. But as density further increases, growth decelerates due to increasing competition.

Time-Varying parameter formulation

A dynamic model of physician growth and locational behavior, given the considerations of the previous section, is expected to have time-varying parameters reflecting different phases of the life cycle of practice markets; e.g.,

$$\begin{aligned} GPHYS_t(c,q) = {} & \beta_{0t}(c,q) + \beta_{1t}(c,q) \cdot LDENS_t(c) + \\ & \beta_{2t}(c,q) \cdot GPOP_t(q) + \varepsilon_t . \end{aligned} \tag{1}$$

where

t	= the year denoting the start of the time interval of study;
c	= physician type (e.g., primary care (P) or specialty (S));
q	= time interval in years over which growth (decline) is calculated;
GPHYS	= percentage growth in physician population;
LDENS	= lagged physician population/100,000 general population;
GPOP	= percentage growth in general population; and
ε	= classical disturbance term.

LDENS is the physician density at the start of the period for calculating GPHYS. The parameter estimate for LDENS at any given time is the resultant of the two opposing locational tendencies. To the extent that LDENS reflects the professional climate, it should enter into the model with a positive sign, indicating an overall agglomerative trend. To the extent that it reflects competitive market forces, it should enter with a negative sign, indicating an overall deglomerative trend. Regardless of its sign, however, an increasing time trend in β_{1t} suggests that agglomerative forces are becoming more important relative to deglomerative ones, while a decreasing trend indicates the opposite case.

A parameter estimate for GPOP of one indicates that population growth has a proportional effect on physician supply, an estimate exceeding one indicates a more than proportional response (so that population growth contributes to an increase in physician density), and an estimate of less than one indicates the opposite result. The time path of the population growth parameter, β_{2t}, may be quite informative. When opportunities for physicians are plentiful then physicians may not be highly responsive to population growth, when opportunities are relatively scarce they may be more responsive. Moreover, market expansion can reduce competition among physicians (at least temporarily), and therefore reduce the relative strength of deglomerative forces.

Temporal variation in the intercept, β_{0t}, reflects the changing growth rate in the supply of physicians, modified by the impacts of the other terms in the model. Its time path is difficult to interpret, however, because it covaries in a mechanical fashion with the paths of the two independent variable parameters.

Data

The analyses of this paper use annual data for the 48 contiguous states from 1963 through 1983.[10] Data on physicians comes from the American Medical Association (AMA) master file for physicians as presented in annual publications. Separate analyses are carried out for primary care and specialty physicians. Primary care is defined to include doctors of medicine practicing in the areas of general practice (includes family practice), internal medicine, pediatrics, and obstetrics/gynecology. Specialists are defined as those practicing in other areas. Note that data for the years prior to 1968 have been transformed so that figures approximately represent the current definitions of physician classifications used by the AMA.[11] Table 1 contains descriptive statistics for the two available ten-year periods, corresponding roughly to 'before' and 'during' periods of federal policy implementations. For example, primary care physician densities increased only 13.9% over the 1963–1973 period, however, they increased by 52.3% over the latter period. Other variables had less dramatic changes.

Analyses

The analyses are carried out in two phases. Phase I is a coarse-grained examination of physician locational dynamics including ordinary least squares estimates of model (1) over the two non-overlapping ten-year periods, 1963–1973 and 1973–1983. Phase II is a fine-grained study using three-year length, annual moving window regression estimates for model (1). Window regression provides nonparametric 'drift analysis' estimates.[12] An alternative not employed in this paper is 'functional expansions,' employing polynomials or other functions of time.[13]

Phase I results

Table 2 contains ordinary least squares estimates computed separately for 1963–1973 and 1973–1983 growth rates ($q = 10$) in primary care and specialty physician populations.[14] All variables are highly significant at the 0.0001 level except LDENS(P) for 1963–1973, which is positive but only significant with a two-sided p-value of 0.11 For 1973–1983, however, the coefficient of LDENS(P) is negative and significantly different from zero at the 0.0001 level. A dummy variable for time period interacted with LDENS(P) in the combined data set of 1963–1973 and 1973–1983 is significant at the 0.0001 level, indicating that LDENS(P)'s parameter varies significantly over the two periods. This is evidence of a change in the spatial behavior of physicians that is consistent with the expected effect of increasing competition reducing the relative attractiveness of high-density states.

Table 1. Descriptive statistics: variables for model (1) with a ten year interval.

Variable	N	Mean	Standard deviation	Minimum	Maximum
			1963–1973		
GPHYS(P,10)	46	13.9	15.1	−16.2	61.2
GPHYS(S,10)	46	51.3	17.1	21.6	105.5
LDENS(P)	46	53.0	9.1	38.7	80.2
LDENS(S)	46	44.1	13.2	20.7	76.4
GPOP	46	12.2	9.4	−4.0	43.1
			1973–1983		
GPHYS(P,10)	47	52.3	15.5	22.3	88.8
GPHYS(S,10)	48	62.0	20.3	22.0	119.2
LDENS(P)	47	54.1	10.9	37.3	87.2
LDENS(S)	48	59.8	17.5	33.7	108.6
GPOP	48	13.8	13.5	−2.8	57.6

Table 2. Estimates of initial model (1) for 1963–1973 and 1973–1983 physician growth rates (t-statistics are in parentheses).

		Primary care physicians				
1963–1973	GPHYS(P,10)	= −11.37	+	0.177 LDENS(P)	+	1.266 GPOP
		(−1.96)		(1.63)		(13.64)
		Adjusted R-Square = 0.81, F = 97.8				
		n = 46 (NM and MD excluded as outliers)				
1973–1983	GPHYS(P,10)	= 72.61	−	0.564 LDENS(P)	+	0.790 GPOP
		(9.30)		(−4.22)		(6.50)
		Adjusted R-Square = 0.61, F = 36.5				
		n = 47 (NV excluded as an outlier)				
		Specialist physicians				
1963–1973	GPHYS(S,10)	= 51.92	−	0.482 LDENS(S)	+	1.686 GPOP
		(10.60)		(−4.10)		(10.29)
		Adjusted R-Square = 0.70 F = 53.0				
		n = 46 (NY and NV excluded as outliers)				
1973–1983	GPHYS(S,10)	= 70.39	−	0.407 LDENS(S)	+	1.153 GPOP
		(13.74)		(−5.38)		(11.74)
		Adjusted R-Square = 0.81, F = 98.6				
		n = 48				

A similar dummy variable interacted with LDENS(S) for the specialist physicians is also significant at the 0.0001 level indicating parameter variation. In this case, however, high-density states were already relatively unattractive for physician location for 1963–1973 and remained so for 1973–1983, but became significantly more attractive. Thus there is evidence that competitive forces are operating, but that they are becoming less effective with time.

The coefficient of GPOP is 1.266 and 1.686 for primary care and specialist physicians respectively in 1963–1973, indicating that physicians were more than proportionally responsive to population growth. For 1973–1983, this coefficient decreased to 0.790 for primary care physicians, but a dummy variable interacted with GPOP and period is not significantly different from zero at conventional levels. Hence, the relationship does not show significant variation over time. During the same period, GPOP's coefficient for specialists significantly decreased for 1.153 (p-value = 0.0001), indicating a decreasing responsiveness of physicians to population growth with time. While some interpretation is possible of these results for GPOP's parameter, we shall hold discussion until after the fine-grained patterns have been presented in the next section.

We conclude that model (1) has statistically significant components and shows substantial parameter variation over time consistent with our dynamic model theories for primary care physicians. The task now is to pin down the timing and shape of this model's parameter variation, yielding a fine-grained policy evaluation.

Phase II results

The time interval of growth in model (1) is reduced to one year (q = 1) to provide for the maximum amount of resolution in the data. We estimate this time-varying-parameter model using moving window regressions containing three years data each from the contiguous 48 states, centered on each year from 1965 through 1982.

First we examine the estimated model for primary care physicians. Table 3 provides time-varying-parameter estimates and statistical significance levels for the model intercept and two independent variables, LDENS(P) and GPOP. Figure 3 displays the corresponding time paths of the window-regression estimates.

The parameter path for physician density is initially stable around zero. In 1970 it becomes strongly positive, it peaks in 1971 and remains positive through 1973, after which it decreases to a negative level. Based upon expected impacts of federal health manpower policies, we did not expect the positive maximum in the early 1970s. If anything, the time path should have remained stable or declined.

Upon closer investigation however, this period of anomalous behavior coincides with two potentially important factors. The Medicare and Medicaid programs began in 1966 and federal expenditures for these programs increased rapidly in the years following, resulting in a dramatic increase and

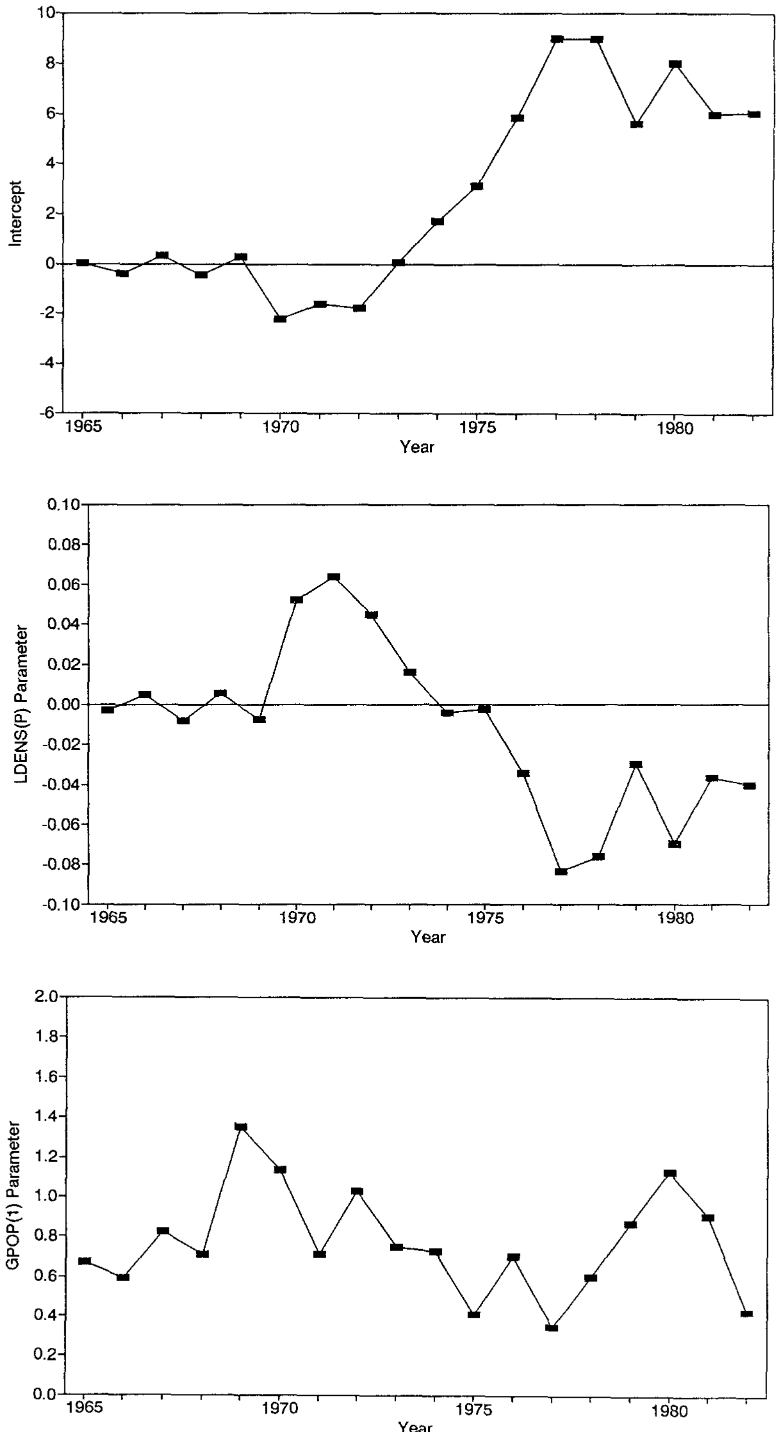

Fig. 3. Estimated parameter paths for primary care physician population growth model.

Table 3. Three-year-moving-average window regression estimates for model (1), primary physicians.

Year	Adj. R^2	F Value	Intercept	t Stat.	LDENS(P)	t Stat.	GPOP	t Stat.
1965	0.19	17.5	0.04	0.0	−0.0028	−0.2	0.671	5.6
1966	0.14	12.6	−0.41	−0.5	0.0048	0.3	0.592	4.7
1967	0.16	14.5	0.33	0.3	−0.0082	0.4	0.823	5.2
1968	0.10	8.6	−0.46	−0.4	0.0055	0.2	0.710	3.8
1969	0.18	16.2	0.28	0.2	−0.0074	−0.3	1.351	5.5
1970	0.17	14.9	−2.23	−1.4	0.0521	1.7	1.136	4.9
1971	0.12	10.5	−1.60	−1.3	0.0639	2.8	0.714	3.8
1972	0.17	15.8	−1.78	−1.3	0.0446	1.9	1.030	5.6
1973	0.13	11.5	0.08	0.1	0.0161	0.8	0.750	4.8
1974	0.10	9.4	1.70	1.4	−0.0041	−0.2	0.728	4.1
1975	0.02	2.7	3.13	2.5	−0.0025	−0.1	0.410	2.1
1976	0.07	6.7	5.86	3.6	−0.0341	−1.3	0.702	2.6
1977	0.11	10.1	8.97	5.6	−0.0835	−3.4	0.349	1.4
1978	0.13	11.6	8.98	5.3	−0.0760	−3.0	0.601	2.6
1979	0.14	12.4	5.63	3.4	−0.0297	−1.2	0.869	4.2
1980	0.28	28.8	8.01	5.4	−0.0699	−3.3	1.131	5.6
1981	0.16	14.6	5.99	4.2	−0.0364	−1.8	0.907	4.4
1982	0.08	6.8	6.04	5.0	−0.0403	−2.5	0.428	2.1

restructuring of demand for physician services. Also, the relative shortage of primary care physicians peaked at about this time (see Figure 1). Together, these factors acted to increase the practice opportunities for physicians everywhere. Thus one might expect physicians to concentrate in those areas attractive to them: places that already had high physician densities.

After 1971, the physician density parameter estimates follow a decreasing trend, suggesting that the deglomerative market forces were becoming relatively more important. This trend persists through 1977, with the sign becoming negative in 1974. The decreasing trend is consistent with expectations associated with strengthening competitive effects in physician-rich areas, and the negative signs of the estimates suggest a tendency for the proportional distribution of physicians to become more equitable. (Note that absolute differences in physician supply may still be increasing.) During the remainder of the study period the estimates are stable at a negative level, indicative of a new equilibrium behavior of primary care physicians in response to LDENS(P).

The parameter time path associated with GPOP in Figure 3 appears stable, though noisy, over the period. For the most part, the value is between zero and one, indicating a less than proportional response to population growth. The lack of systematic temporal variation in the estimates suggests that the responsiveness of physicians to market size has not been affected by the changing context of American medicine.

Finally, the time path of the intercept in Figure 3 shows a distinct pattern of variation. It begins near zero but becomes clearly negative in 1970. After

1972 it rises dramatically, peaking with strong positive values in 1977 and 1978, and remaining positive thereafter. If the parameter time paths for the independent variables were stable then the intercept time path would follow roughly the pattern for growth in primary care physicians shown in Figure 1. As indicated however, the parameter time path associated with LDENS(P) varies systematically. Thus when the slope of the regression plane increases along the LDENS(P) dimension the intercept of the plane on the y-axis dips. Conversely, when the slope decreases the intercept moves up the y-axis. The parameter time paths for the intercept and LDENS(P) are inversely related.

Now consider the model for specialty care physicians. Table 4 shows the corresponding time-varying-parameter estimates and statistical significance levels. First, let us examine the estimated parameter time path for LDENS(S), shown in Figure 4. The parameter estimates appear to be stationary over time, though the estimates are noisy. The negative sign that persists until the final time period is indicative of a weak tendency for the geographic distribution of specialists to become proportionately more equitable, and suggests that deglomerative economic considerations are relatively more important than other factors. From the perspective of dynamic modeling, however, the important result is the stability of the estimates with respect to time. There is no evidence of a systematic shift in the locational behavior of specialists with respect to physician density and, therefore, no evidence that tighter markets for specialists are affecting locational behavior.

Next consider the time path of the responsiveness of specialists to population growth, shown in Figure 4. Systematic variation in this parameter is evi-

Table 4. Three-year-moving-average window regression estimates for model (1), specialists physicians.

Year	Adj. R^2	F Value	Intercept	t Stat.	LDENS(S)	t Stat.	GPOP	t Stat.
1965	0.05	4.6	4.09	6.0	−0.0123	−0.8	0.489	3.0
1966	0.12	10.7	4.47	7.4	−0.0269	−2.0	0.842	4.6
1967	0.09	8.3	4.11	7.0	−0.0102	−0.8	0.724	3.9
1968	0.15	13.6	4.75	6.6	−0.0052	−0.4	1.097	4.9
1969	0.10	8.6	5.11	6.4	−0.0215	−1.4	1.125	4.2
1970	0.11	9.8	5.98	6.9	−0.0402	−2.7	0.917	3.9
1971	0.37	43.7	4.12	5.8	−0.0434	−3.9	1.419	8.5
1972	0.29	29.8	3.54	4.2	−0.0313	−2.5	1.151	6.9
1973	0.35	39.5	2.56	3.2	−0.0216	−1.8	1.230	8.2
1974	0.11	9.6	2.16	1.6	−0.0061	−0.3	1.109	4.2
1975	0.15	13.0	3.17	2.3	−0.0278	−1.4	1.223	4.3
1976	0.11	10.0	6.26	3.1	−0.0422	−1.5	1.534	3.6
1977	0.11	8.5	8.21	4.9	−0.0571	−2.5	0.833	2.6
1978	0.15	13.3	9.17	6.4	−0.0623	−3.2	0.882	3.5
1979	0.10	8.9	4.77	4.6	−0.0063	−0.5	0.688	4.1
1980	0.16	14.2	5.80	5.6	−0.0236	−1.8	0.851	4.8
1981	0.13	11.9	6.59	7.2	−0.0245	−2.2	0.669	4.0
1982	0.06	5.7	3.61	5.8	0.0020	0.3	0.451	3.4

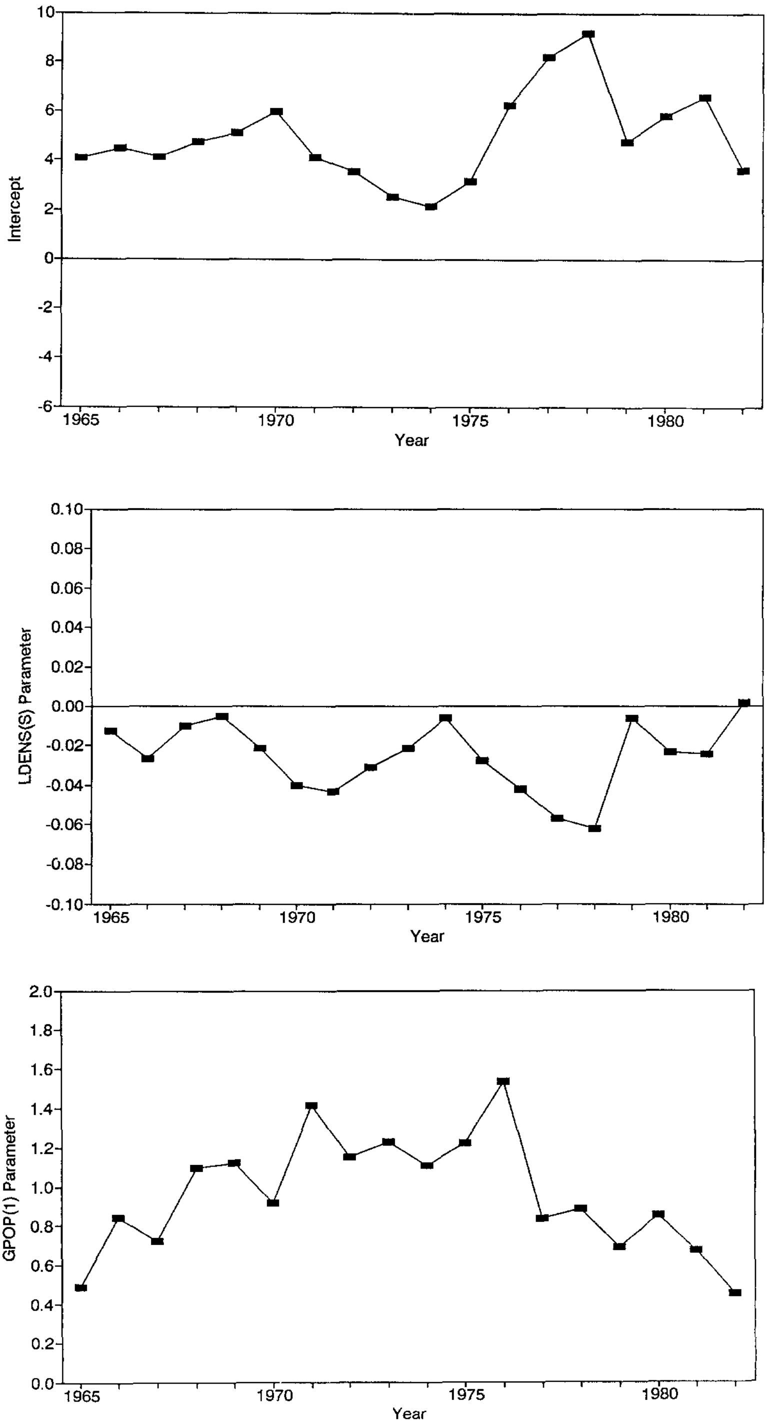

Fig. 4. Estimated time parameter paths for specialist physician population growth model.

dent. The responsiveness of specialists to GPOP is initially quite low. A low value is consistent with both the low rate of production of specialists in the early and mid 1960s and locational inertia that tends to retard physician mobility. As production increases, however, the responsiveness to GPOP shows a broadly increasing trend. The GPOP parameter exceeds one for the first time in 1968, rises to a peak in 1971 and again in 1976, and then reverses to a decreasing trend for the remainder of the period, dropping below one in 1977.

This time path is consistent with a lagged response of specialists to practice opportunities materializing before the increased production of specialists was able to fill them. Hence, as supply began to grow rapidly, specialists not only responded to current shifts in population, but also to population growth in the same states from, say, a decade earlier. It follows that, as the supply of specialists continued to increase, the response to population would start to return to an equilibrium value, and the time path for GPOP is consistent with this response.

The intercept time path shown in Figure 4 displays sporadic behavior. Here, as in the previous model, the intercept covaries with the other parameter time paths.

Discussion

Having considered the cases for macro-level spatial diffusion of primary care and specialist physicians separately, we can draw some comparative conclusions. Apparently, the two types of physicians responded quite differently to policies implemented in the 1960's and 70's.

The model for primary care physicians produces results consistent with a trend toward a more equitable geographic redistribution of physicians based upon competitive economic forces. The parameter time paths for LDENS(P) and GPOP are indicative of a switch from agglomerative to deglomerative macro-scale locational trends, as predicted by diffusion theory. During the latter portion of the study period, states with lower densities of primary care physicians experienced higher physician percentage growth rates, all other things being equal, than states with higher densities. This was not the case in the early years of the study period. Hence, this trend is interpretable as evidence that the federal policy was successful at the macro scale, at least to some degree. Of course higher percentage growth rates do not immediately translate into larger absolute increases in the supply of primary care physicians. Thus absolute inequalities may continue to increase for some time before they begin decreasing.

In an unexpected finding, some healthcare programs implemented during the study period may have conflicted with the goal of reducing physician maldistribution. In particular, the introduction of Medicare and Medicaid in 1966 dramatically increased primary care physician demand as federal funds became available to pay for healthcare services. This permitted primary physicians to locate in physician-rich states, to maximize professional development and social amenity goals, that otherwise would have provided poor economic opportunities. The timing of Medicare and Medicaid, while certainly benefitting people throughout the country, appears to have been unfortunate for the maldistribution problem. They came just at the start of the period in which we expected some shift of physicians to physician-poor states, and may have postponed and reversed intended redistribution effects for about five years.

The results are different for specialty care physicians. The expected shift from an agglomerative to a deglomerative trend is not evident. Instead, the parameter time paths of LDENS(S) and GPOP indicate a weak but persistent response by specialty care physicians to market characteristics throughout the period. From the perspective of diffusion theory, the invariance of this deglomerative trend over time is surprising, and it suggests that federal policy has not had any real impact upon the macro-scale locational behavior of specialty physicians.

In summary, results from this study contribute to a broad range of research interests concerning the locational behavior of geographic distribution of physicians. First, they provide direct evidence concerning the macro-scale diffusion of physicians that constrains the efficiency of diffusion processes at finer scales of geographic resolution. Second, they provide evidence that the Medicare and Medicaid programs, while improving financial access to medical care, may have had an adverse effect on efforts to alleviate the geographic maldistribution of physicians. Third, they contribute more evidence that the locational choice behavior of primary and specialty physicians are motivated by different goals and objectives.

Notes

1. See Ernst and Yett (1985), Ginzberg (1986), and Starr (1982) for an overview of this era.
2. Several studies have been reported in the literature. A sampling of these includes Brown (1974), Brown and Reid (1983), Fruen and Cantwell (1982), and Schwartz et al. (1980). An article by Eisenberg and Cantwell (1976) illustrates the emphasis on the meso and micro scale dimensions of the maldistribution issue.
3. Reviews of the literature include Einhorn and Hogarth (1981), Golledge and Timmerman (1990), and Timmerman and Golledge (1990).
4. See Mahajan, Muller, and Bass (to appear) for an extensive review of diffusion models as applied to new product growth models and Hagerstrand (1967) for perspectives on geographic dimensions of diffusion.
5. See for example, Diseker and Chappell (1976), Cooper et al. (1975), Steinwald and Steinwald (1975), Champion and Olson (1972), Parker and Tuxill (1967), Parker and Sorensen (1978), and Parker and Sorensen (1979).
6. See for example, Parker and Tuxill (1967), Parker and Sorensen (1978), Cooper et al. (1975), Steinwald and Steinwald (1975), Coombs et al. (1985), and Diseker and Chappell (1976).

7. See for example, Cooper et al. (1975), Diseker and Chappell (1976), and Parker and Sorensen (1978).
8. See Lave et al. (1975).
9. In contrast, they are not responsive at the state level to changing income levels. See S. A. Foster (1989).
10. Alaska, Hawaii, and the District of Columbia are omitted on the basis that they are not representative in comparison with the 48 states.
11. See American Medical Association (1968).
12. For an overview of drift analysis methods see Foster et al. (1991). A variety of methods is available to estimate time-varying parameters for implicit expansions, including window regressions and adaptive filters. See Carbone and Longini (1977) and Makridakis and Wheelwright (1977).
13. Casetti (1972) introduced functional-expansions in model building. Walker and Hannan (1989) provide a recent example using polynomials in time.
14. Note that diagnostics described in Belsley et al. (1980) have been employed in these and all other regression results in this paper to remove overly influential data points and outliers.

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