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THE EFFECT OF GOVERNMENT POLICY CHANGES ON THE SUPPLY OF PHYSICIANS: EXPANSION OF A COMPETITIVE FRINGE

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1. INTRODUCTION AND BACKGROUND

The American Medical Association (AMA) has often been credited with effectively restricting the supply of physicians permitted to practice in the United States for the better part of the twentieth century.[1] Yet since 1965 the active physician population ratio has risen from about 1.4 to almost 2 (per 1,000

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[1] Two theories exist to explain the AMA's motivation for restricting physician supply. One, credited primarily to Milton Friedman, Occupational Licensure, in Capitalism and Freedom, (1962) at 137 and Reuben Kessel, Price Discrimination in Medicine, 1 Law and Economics 20 (1958), views the AMA as a profi maximizing cartel of physicians. The other, espoused by Kenneth Arrow, Uncertainty and the Welfare Economics of Medical Care, 53 American Economic Review 941 (1963) and Keith Leffler, Physician Licensure: Competition and Monopoly in American Medicine, 21 Journal of Law and Economics 165 (1978), suggests that the AMA exists primarily to assure a certain standard of quality across physicians. Both stories imply that the AMA has the market power to restrict the supply of physicians effectively. See Monica Noether, The Growing Supply of Physicians: Has the Market Become More Competitive? (FTC working paper, 1984) for a lengthier discussion of the two hypotheses.

population) in 1981 after remaining fairly stable since the end of World War II. The number of Foreign Medical Graduates (FMG) achieving initial U.S. licensure annually more than quadrupled between 1965 and 1972.[2] Similarly, U.S. medical school output doubled between 1965 and 1980. Can all of this growth in the number of physicians practicing in the U.S. be explained by an expansion of demand due to increased government expenditures for medical care (e.g., Medicare and Medicaid) as well as higher consumer incomes? Or is it also true that the AMA has become less effective at maintaining the entry barriers necessary to restrict the supply of physicians permitted to practice in the United States? Evidence exists to suggest that the return to physician training has decreased substantially over the last decade. Figure 1 portrays the ratio of physician income to opportunity cost[3] over the last 37 years. While some of that decline is undoubtedly attributable to a gradual return to equilibrium following a rapid and large increase in demand in the 1960's, the downward trend has continued long enough to arouse suspicions of permanent changes in market structure. Moreover, the popular and medical trade press provides numerous indications

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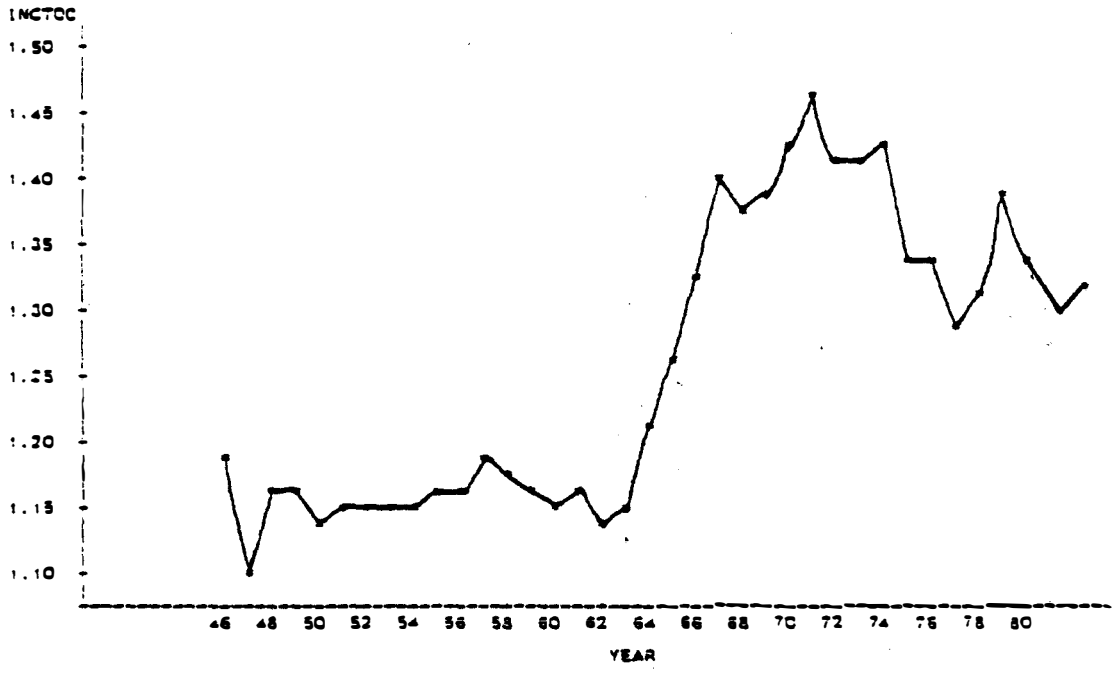
[2] FMG entry has fallen in the last eight years but is still double its 1965 level.

[3] Opportunity cost is measured with college graduate earnings adjusted for additional training time as the benchmark. Its derivation is described in detail in Noether, supra note 1.

FIGURE 1

Physician Income - Opportunity Cost Ratio
1946-1982



that physicians themselves feel that they are operating in a more competitive environment.[4]

AMA authority over the medical school accreditation process combined with mandatory state licensure of individual physicians has been cited as an effective restriction of the physician supply.[5] The AMA has not only controlled the supply of U.S. medical school spaces by making it difficult for new schools to enter and by preventing expansion of existing schools,[6] but has also worked to assure that state licensing statutes require graduation from AMA-accredited schools. Foreign entry has also been curtailed by restrictive licensing laws as well as a strict federal immigration policy. However, some of these policies have been modified in recent years. Have such changes led to increased entry into the medical profession?

Despite AMA protestations that the supply of U.S. graduates was adequate, public concern about a "physician shortage" developed during the 1950's. After several failures, in the mid-1960s both federal and state governments enacted funding programs to encourage expansion of existing and creation of new

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[4] See, for example, Coping with the Approaching Doctor Glut, New England Journal of Medicine (1982) cited in AMA to Help MD's Adjust to Market, American Medical News, 12 November 1982, at 1, and Doctors are Entering a Brave New World of Competition, Business Week, 16 July 1984, at 56-61.

[5] See, for example, Kessel, supra note 1; Friedman, supra note 1, and D. R. Hyde, P. Wolff, A. Gross, and E. L. Hoffman, The American Medical Association: Power, Purpose and Politics in Organized Medicine, 63 Yale Law Journal 938 (1954).

[6] Schools are accredited for a given size level.

medical schools.[7] At about the same time, the federal immigration law was eased and throughout the 1960's state licensing laws were relaxed. It appears that policies designed to inhibit growth in the supply of physicians practicing in the United States have been weakened. If these programs were effective, then we should be able to explain at least part of the recent expansion of the physician stock by the regulatory and funding changes that have occurred. Such evidence would suggest that AMA authority has diminished.[8]

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[7] The AMA's position on public funding of medical schools changed during the 1950's from one of total opposition to acknowledgment that a one-time grant to support construction, preferably donated by the private sector, would be beneficial. During this decade both medical schools, which came to rely increasingly on federal research funding, and hospitals, whose expansion increased demand for medical residents, favored strong federal support of medical schools. This pressure, coupled with that from the general public for increased physician supply, as well as rising physician incomes during the 1950's which signalled increased demand for medical services, perhaps led to the AMA's approval by 1960 of a controlled expansion of medical schools. The funding programs subsequently enacted at both federal and state levels, however, far exceeded the AMA's desires. For a detailed account of the AMA's efforts to thwart the enactment of federal programs to aid medical schools, see Elton Rayack, Professional Power and American Medicine: The Economics of the American Medical Association (1967).

[8] Thomas Hall and Cotton Lindsay, Medical Schools: Producers of What? Sellers to Whom?, 23 Journal of Law and Economics 55 (1980) at 58 and 78 cite the growth in U.S. licensing of FMG's as well as medical schools' positive enrollment response to donations, particularly federal, as evidence that the medical profession possesses no monopoly power. "Most notably, the profession [organized medicine] has been spectacuarly unsuccessful in preventing expansion of supply through immigration of foreign-trained physicians. . . ." "Have medical schools conspired with organized medicine to restrict the supply of practitioners? Our evidence suggests that they have not. Medical school output is

(footnote continued)

In this paper we model the stock of U.S. practicing physicians as composed of a dominant firm of AMA-sanctioned physicians and a competitive fringe whose entry is imperfectly restricted. Changes in the degree of competition in the physician market are measured by estimating the growth of the competitive fringe component due to the relaxation of various restrictions. As noted above, until the advent of large-scale federal involvement in medicine in the 1960's, it is possible to view U.S. physicians as a dominant firm that maintained entry barriers, promulgated by the AMA and enforced by federal and state governments, sufficiently high to prevent most competitive fringe physicians from entering. The tremendous growth in the physician-population ratio in the last 15 years, however, can perhaps be explained by the increased entry of the competitive fringe due to eroding entry barriers.

As suggested above, two sources of a growing competitive fringe seem likely. First, despite AMA efforts, substantial numbers of foreign medical graduates have been licensed in the United States, particularly in the last 15 years since many restrictive laws have been relaxed. They certainly provide a product similar enough to be considered a substitute. Second, the number of U.S. medical students graduating annually has risen

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(footnote continues)

positively related to demand by both donors and applicants." Interestingly, they never seem to consider the possibility that the AMA's power may have weakened over time.

sharply. While this may be explained solely by a growth in demand, it is also possible that the AMA's control over the number of medical school spaces weakened, leading to the creation of a "domestic competitive fringe." The Liaison Committee on Medical Education, established in 1942 by the AMA and the American Association of Medical Colleges,[9] now contains representatives for the public and federal government in addition to its founding organizations. While other factors, such as state funding programs, are also important, the federal subsidies granted to medical schools beginning in the mid-sixties for both new construction and expansion, and as a direct incentive to expand enrollment (per student capitation grants) may be viewed as a summary measure of forces weakening the AMA's control over U.S. medical schools. That is, if the AMA, as discussed earlier, provided one force which inhibited medical schools from expanding, then the federal government may have supplied an opposing influence.

Actual entry of the dominant firm (DFNL) in any given year t is posited to equal a proportion, γ, of the difference between the anticipated optimal stock in year t, MDS_t^*, and the sum of year t-1's anticipated actual stock, MDS_{t-1}, and the anticipated fringe entry in year t, CNL_t, plus a sufficient number to replace fully the anticipated depreciation of last year's stock.[10] That is:

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[9] Previously, each organization undertook separate school surveys.

[10] The rate of depreciation is assumed to be constant across time and known.

$$(1)\quad DFNL_t = \gamma(MDS^*_{t|t-5} - (MDS_{t-1|t-5} + CNL_{t|t-5}) + d\,MDS_{t-1|t-5}$$

Everything is expressed in 5-year expectation horizons due to the time required between entry into medical school and actual licensure. MDS^* is the optimal total stock determined by the dominant firm's equation of its residual marginal revenue and marginal cost curves. It depends on exogenous demand and cost parameters as well as entry barrier variables. Fringe entry is assumed to exhibit a supply curve that is upward sloping with respect to U.S. physician income and whose level is affected by both entry barriers ($\underline{R}$) and the fringe's own opportunity cost (FTOC), which together determine fringe marginal cost, as shown in (2):

$$(2)\quad CNL_t = b_0 + b_1\,MDINC_t + \underline{b}_2'\underline{R}_t + b_3 FTOC_t$$

Figure 2 portrays the market equilibrium given the simplifying assumptions of a linear market demand curve and horizontal dominant firm marginal cost curve.[11]

Section II analyzes the determinants of increased FMG entry, while Section III discusses the effect of U.S. medical school subsidies on the development of a "domestic fringe." Section IV provides a summary.

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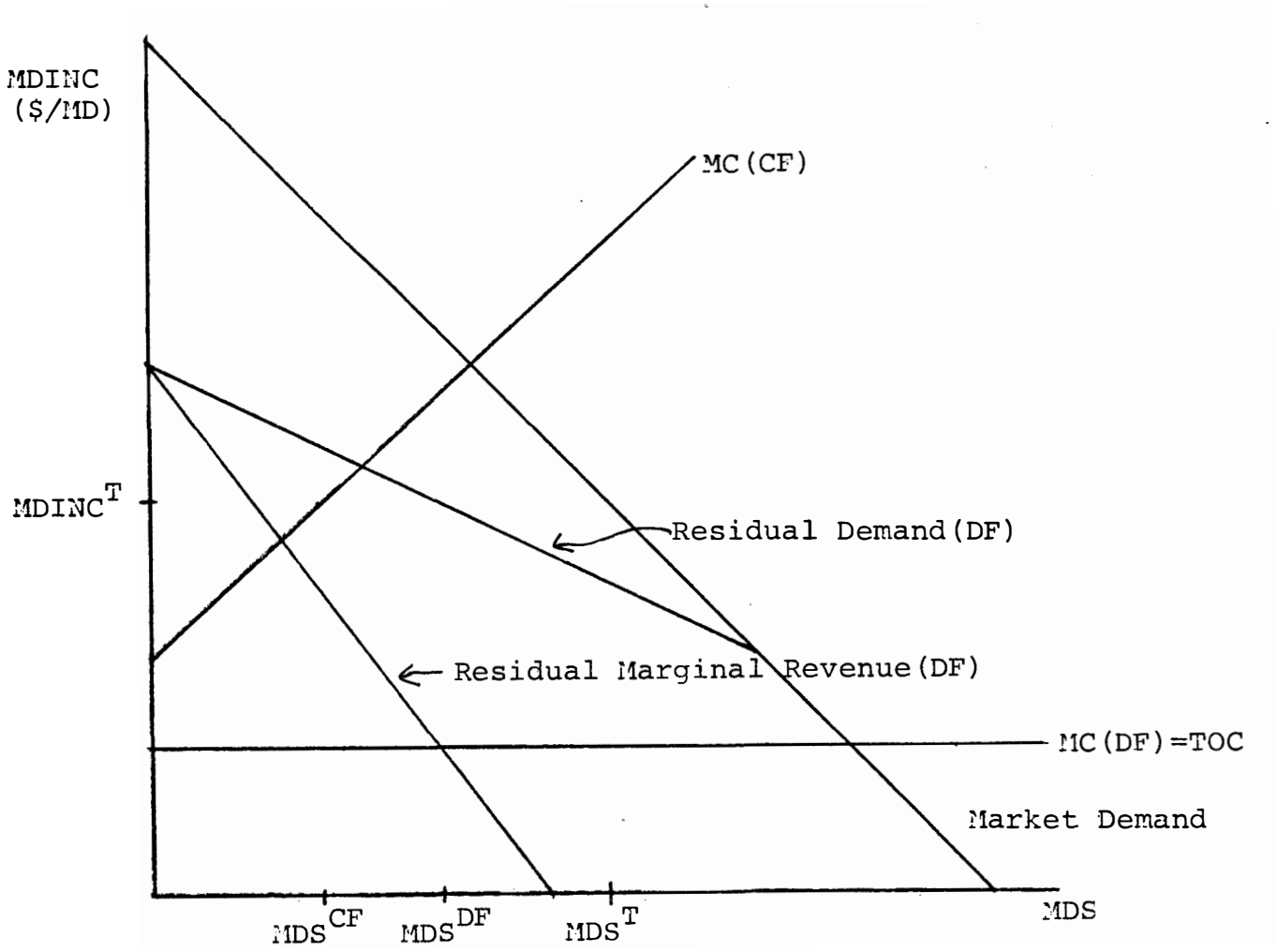
[11] A simple algebraic model using these assumptions can be found in Appendix A. For a complete derivation of reduced form stock, income, and fringe supply equations, see Monica Noether, The Growing Supply of Physicians: Are the Entry Barriers Breaking? (unpublished Ph.D. Dissertation, University of Chicago, 1983) or write to the author.

FIGURE 2

Equilibrium Physician Stock and Income
Under Dominant Firm - Competitive Fringe Model



DF: Dominant Firm
CF: Competitive Fringe
T: Total

II. FOREIGN MEDICAL GRADUATE FRINGE ENTRY

Figure 3 shows the annual proportion of total new U.S. licensees that FMG's have represented for the last 30 years. After rising slowly until the mid-1960's, this proportion increased rapidly in the late-1960's and early 1970's, reaching a peak of almost 50 percent in 1972. It then began to diminish, and in the last five years, has fallen sharply. From (2), we can isolate the FMG fringe supply curve as

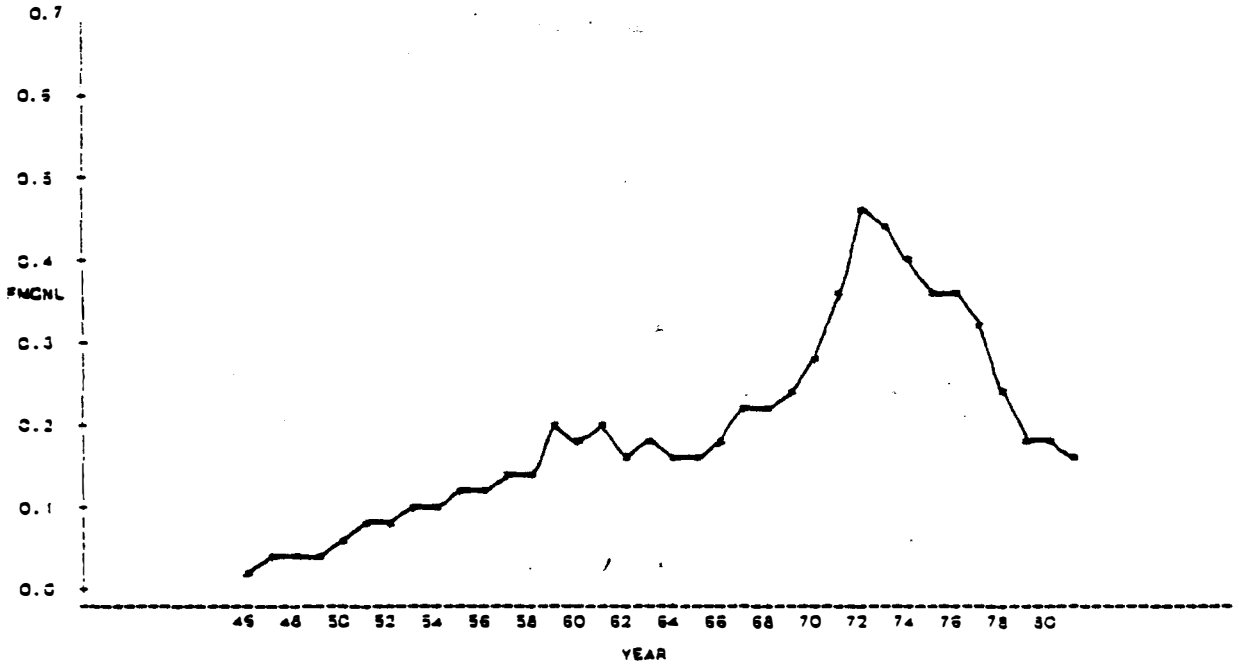
$$(3) \quad FMG_t = f_0 + f_1 \, MDINC_t + f_2' \underline{RF}_t + f_3 \, FMGTOC_t \, .$$

FMG supply is directly related to U.S. physician income (MDINC). It is inversely associated with a set of restrictive entry barriers aimed at foreign-trained physicians ($\underline{RF}$) and FMG opportunity cost (FMGTOC) which reduce the quantity supplied at any given income. Real U.S. physician incomes increased by almost 50 percent from 1963 to 1972, due, most probably, to the large, not completely anticipated, growth in demand occasioned by the enactment of federal insurance programs. Thus, growth in FMG entry in the late 1960's and early 1970's could have resulted entirely from higher U.S. physician incomes and have been due solely to movement along a single supply curve.

Alternatively, the increase in FMG entry may also be attributed to the relaxation of many entry barriers during this period which shifted the supply curve to the right. In 1968, the national origin quota system of the Immigration Act which favored Western Hemisphere countries was abolished, allowing many Eastern

Figure 3

FMG - New U.S. Licensees Ratio



Hemisphere physicians to emigrate. Additionally, preference categories for those with "exceptional ability" or with skills in short supply in the U.S. were created and given a special extra quota of 17,000 annually. Congress apparently recognized the U.S. "physician shortage," and allowed doctors to qualify for both of these categories. From 1965 to 1971, the number of FMG immigrants more than tripled, and the proportion emigrating from Asian nations rose from 13 to 73 percent.[12] In 1970, the Exchange Visitor program, established in 1948, was also broadened to allow anyone possessing an "exchange" or "J" visa, for example, foreign physicians training in U.S. residency programs, to apply for immediate change to immigrant status.[13] This expansion took effect on July 1, 1971.

Moreover, many state medical licensure requirements were relaxed during this time. In 1950, 15 states did not license FMG's under any circumstances; another 18 required U.S. citizenship. By 1960, only six states did not license FMG's but 21 required citizenship. In 1970, all states licensed FMGs and only eight required citizenship. In 1973, the Supreme Court ruled

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[12] Alfonso Mejia, Helena Pizurki and Erica Royston, Foreign Medical Graduates (1980) at 187.

[13] Formerly a two-year absence from the U.S. was required. As Mejia, et al., supra note 12, notes, the AMA opposed this policy change. -

citizenship requirements for licensure illegal.[14] The other constraint contained in many licensing statutes concerns internship and residency training. While most states now require at least one year even for U.S. medical graduates, and many have for several years, the graduate training requirements facing FMG's tend to be stricter.

Diminished entry of FMGs during the last few years is subject to the same potential explanations. Physician incomes fell during this period (causing movement along a supply curve). Moreover, in 1976 the Health Professional Educational Assistance Act was passed (to take effect in January, 1977) which reversed some of the liberal policies of the early 1970s.[15] Thus, the supply curve may also have shifted back to a more restrictive

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[14] Obviously, citizenship requirements do not affect U.S. citizens who go abroad to study and then return. Despite the amount of public attention these individuals currently receive, until recently the ones who actually completed medical school in another country were few. In 1972, the last year that citizenship requirements applied in any state, 240 U.S. citizen FMGs passed state licensure exams, 3.6 percent of all FMGs and 1.7 percent of all new licensee, according to American Medical Association, Medical Licensure Statistics for 1972 (1973) at 11.

[15] Prior to entry as immigrants, FMG's now must pass parts I and II of the National Board of Medical Examiners Exam and show competence in English. Additionally, J-category visas are granted for two years only, after which time the individual must return to his or her native country for two years before applying for permanent resident status in the U.S. Moreover, visas are granted only to those with a written promise from a residency program to provide training.

state. Since state licensing laws have not been tightened, it may not have shifted all the way back to its position in 1968.[16]

As outlined above, two types of entry barrier restrictions are relevant to foreign medical graduates. First, the immigration law was substantially relaxed in 1971 after some loosening in 1968. It was subsequently tightened in 1976. Thus two dummy variables are used to measure the effect of immigration policies. The first equals 1 before 1971 and 0 otherwise (D71); the second

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[16] A third possibility could be considered. If foreign medical graduates' opportunity cost (FMGTOC) fell during the late 1960's, increased entry could have resulted. The opportunity cost of immigration to the United States is probably best thought of as the income an FMG could have earned if he/she had remained in his/her native country plus any transportation costs to the United States. While international physician income data are not readily available, we can examine personal income around the world, assuming that it provides at least some relative information. While in the United States, real per capita personal income grew by 53 percent from 1950-1970, a comparable weighted-average income figure for the world grew by 138 percent in the same period when the weights used reflect the actual distribution of FMG immigrants in 1968, immediately prior to enactment of the new immigration law. Moreover, in a 1968 survey, the ratio of physician to personal income, was higher in Asian countries than in the U.S., equaling 16.9 in the Philippines, 34.9 in Thailand and 8.5 in the U.S. according to Mejia, et. al., supra note 12 at 131. Therefore it seems likely that the opportunity cost for foreign medical graduates rose during the period in question. It is true that the abolition of the national quota system in the Immigration Act in 1968 served to open the doors to physicians from poorer countries and hence, with lower opportunity costs. The concomitant expansion in emigration of Asian FMG's, however, is the result of easing regulation, not a lowering of their opportunity cost.

will be set to 1 after 1976 (D76).[17] If restrictions are effective, both dummy variables should have negative coefficients.

Three licensing variables are used. One measures the effect of states that did not license FMG's under any circumstances (NOLIC); the second takes account of statutes with citizenship requirements (CITIZ), and the third estimates the impact of graduate training time requirements (TNGTM). All licensing variables are measured as the weighted percentage of all states with the relevant restriction in each year.[18] Figure 4 shows the pattern of these three variables over time. The levels of NOLIC and CITIZ are highest in the 1950's and subsequently decline; their relaxation may explain some of the gradual increase in FMG entry during the 1950's and early 1960's. TNGTM, except for a dip in the 1970's, has risen.

The FMG-population ratio (FMGP) is used as a dependent variable.[19] Because of available data, the fringe is measured as

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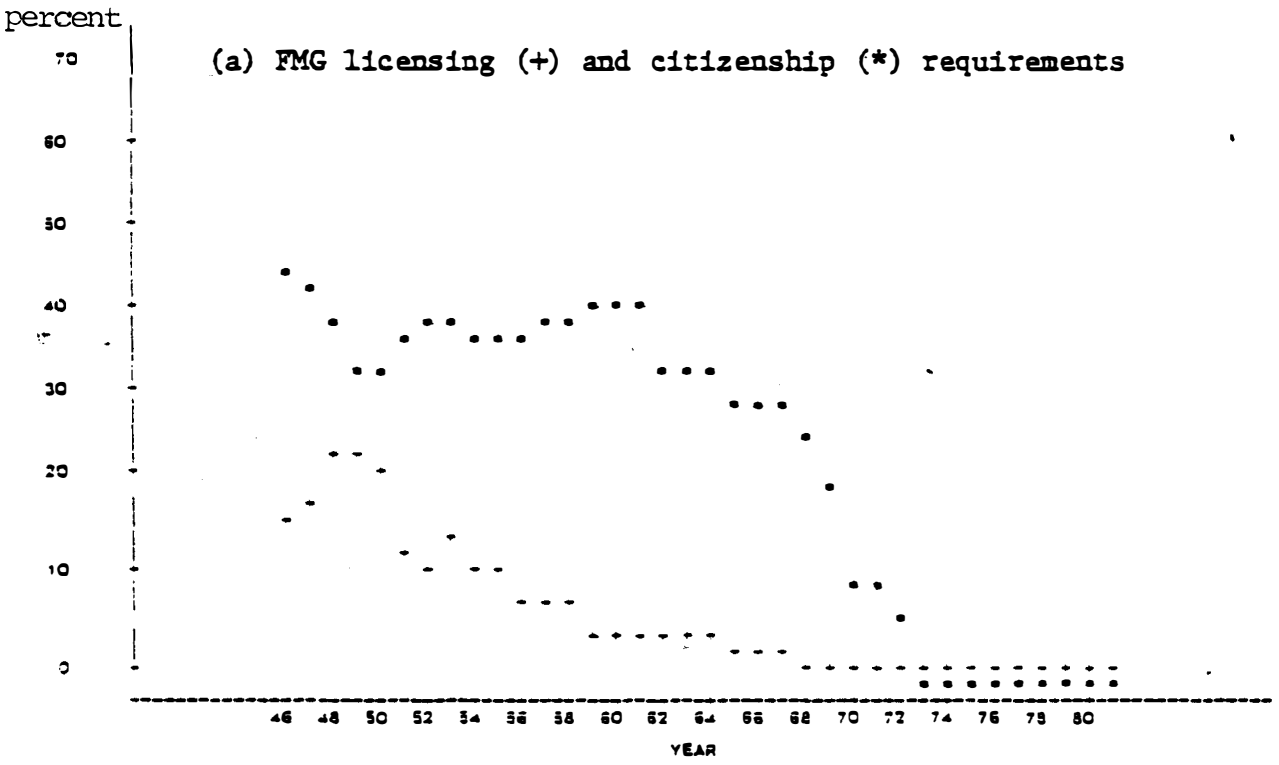
[17] A dummy variable equal to 1 before 1968 was substituted for D71 in some regressions. It was generally not significant, presumably either because the 1971 law change was more important or because the FMG entry response occurred with a lag. These result are not reported here. See Noether, supra note 11, for them.

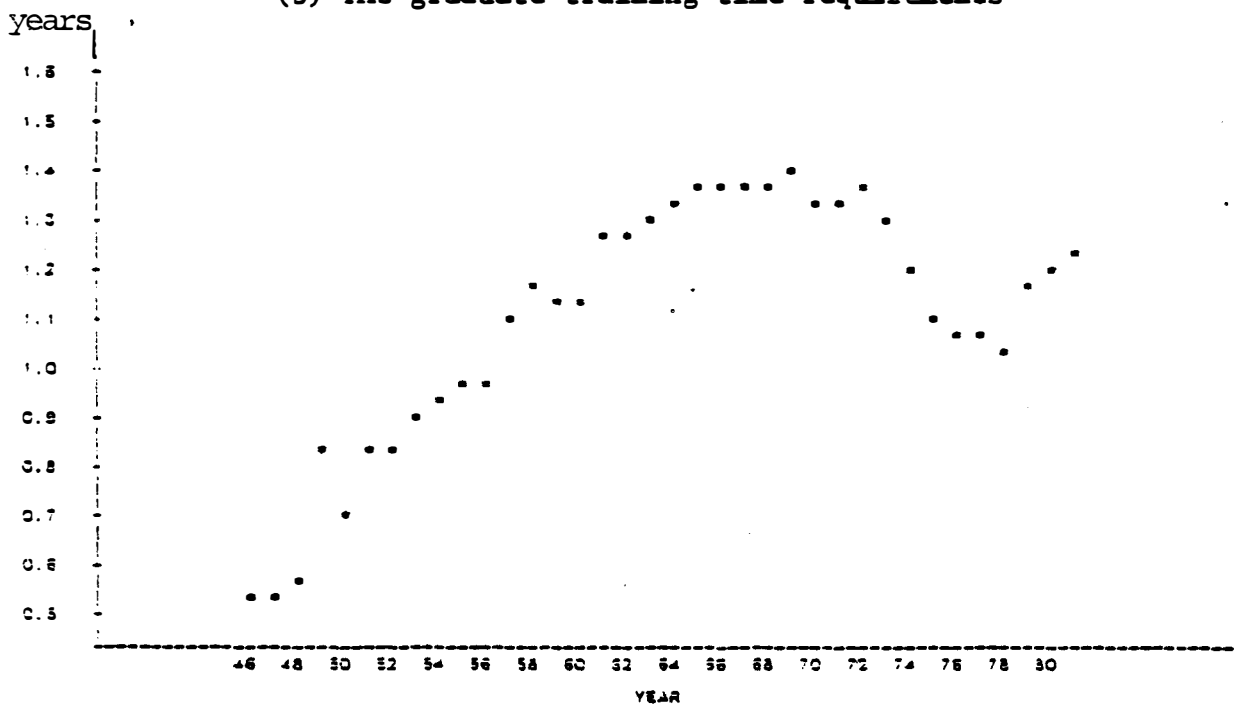
[18] Since the mid-1960's the weights used are the percentage of national personal health care expenditures contributed by each state. Prior to that time, state breakdowns of health expenditures are not available so personal income is used as a weighting factor instead. Using income as the weighting factor throughout produces similar results.

[19] Regressions were also run on the level number of FMGs as well as the FMG-new licensees ratio. Results did not differ significantly from those reported.

FIGURE 4

FMG Restrictions





a flow of new entrants (licensees) rather than as the stock existing each year. By cumulating the yearly flow magnitudes over the period in question, we can estimate the total impact of the fringe on U.S. physician supply. The FMG entry equation to be estimated is:

$$(4)\quad FMGP_t = f_0 + f_1 \hat{MDINC}_t + f_{21} D71_t + f_{22} D76_t + f_{23} NOLIC_t + f_{24} CITIZ_t + f_{25} TNGTM_t + \varepsilon_t^1 .^{20}$$

U.S. physician income is not a true exogenous variable since it is obviously affected by the number of FMG's that enter the United States. Therefore, two-stage least squares is used to estimate the system of (4) and a reduced form income equation to describe MDINC that contains variables to measure both foreign and domestic entry restrictions as well as demand parameters, and that accounts for gradual supply adjustments to equilibrium changes through inclusion of the lagged stock and a prediction error term.

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[20] In the estimation, no variable is used to account for FMG opportunity cost. Since foreign physician income data are not readily available, international income data were used to create a proxy for FMGTOC. A weighted average of various world areas' (e.g., Eastern Asia) per capita gross national product in constant dollars was calculated using the 1968 national proportions of FMG entrants as weights. A similar variable was also tried using 1965 weights. Both showed inappropriate positive effects on FMG entry and probably reflected factors not related to FMG opportunity cost of immigrating to the U.S.

This reduced form income equation is derived from demand and cost equations, the underlying model for which is described in greater detail in Appendix A. It uses per capita real income (INCM) and the percent of the population covered by public insurance (PUBINS) as demand variables.[21] They should both have a positive effect on physician income. Marginal cost is measured as the total opportunity cost (TOC) of becoming a physician, based on the assumption that the next best alternative is working following four years of college and adjusted for the time spent in medical school and residency programs.[22] It should also be positively correlated with physician income. Variables that measure federal subsidies granted to U.S. medical schools, both for construction (CONS8) and as capitation grants (CAPS5) are also incorporated and will be discussed further in Section III below. While a true restriction on a domestic fringe should raise physician income, since these are subsidies, they ease entry of the domestic fringe, and hence lower physician income. Finally, physician income is affected by differences between actual entry into the profession and that predicted by the dominant firm. As a related paper shows, this error can be

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[21] Other demand variables were also used in Noether, supra notes 1 and 11, and these appeared most significant. Hence, other variables, such as education and age, were omitted to avoid multi-collinearity problems with other independent variables.

[22] The derivation and measurement of TOC are fully described in Noether, supra note 11. Data sources for TOC and the other variables used are listed in Appendix B.

reduced to incorrect predictions about FMG entry, which we denote e^F.[23] Thus the estimated equation is as follows:

$$(5)\quad MDINC_t = \delta_0 + \delta_1 TOC_t + \delta_{21} INCM_t + \delta_{22} PUBINS_t + \delta_{31} D71_t + \delta_{32} D76_t + \delta_{33} NOLIC_t + \delta_{34} CITIZ_t + \delta_{41} CONS8_t + \delta_{42} CAPS5_t + \delta_5 MDSP_{t-1} + \delta_6 e_t^F + \varepsilon_t^2$$

Additionally, the reduced form equation describing FMG entry, derived by substituting (5) into (4), is also estimated as:

$$(6)\quad FMGP_t = \phi_0 + \phi_1 TOC_t + \phi_{21} INCM_t + \phi_{22} PUBINS_t + \phi_{31} D71_t + \phi_{32} D76_t + \phi_{33} NOLIC_t + \phi_{34} CITIZ_t + \phi_{35} TNGTM_t + \phi_{41} CONS8_t + \phi_{42} CAPS5_t + \phi_5 MDSP_{t-1} + \phi_6 e_t^F + \varepsilon_t^3$$

The effects of the FMG restrictions and opportunity cost on the reduced form of FMG are indeterminate. Their direct effect is obviously negative, but they have a positive influence on income which also affects the dependent variable positively. Presumably, the former effect is stronger so that the net impact is negative. The remaining variables have the same influence as they do on MDINC; i.e., the coefficients on TOC, INCM, PUBINS,

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[23] See Noether, supra note 11. The measurement of e^F is described in Appendix B.

CONS8 and CAPS5 are positive while those on $MDSP_{t-1}$ and e^F are negative.

Columns 1 and 2 of table 1 present the results from a 2SLS regression of the system containing the reduced form income equation (5) and the FMG supply curve (4). In the MDINC equation all the foreign and domestic restrictions show the predicted signs: the FMG entry restrictions increase physician income, while subsidies to U.S. medical schools decrease it. The prediction of physician income derived here is used as the MDINC variable in the FMG equations reported here in column 2. It has the expected positive effect. All of the restriction variables have the anticipated negative effect on FMG entry.[24]

While the relaxation of licensing and immigration laws apparently did shift the FMG supply curve to the right, the coefficient on the D76 variable also suggests that the curve has shifted back in recent years. In fact the coefficient on D76 is almost as large as that on D71. From the estimated FMG equations and the predictions of MDINC, we can trace the movement of the FMG supply curve over time. Figure 5 traces its movement. It shows that, after remaining relatively stationary until the late 1960's, the supply shifted out substantially in the first half of the 1970's. The outward movement continued until about 1975 due

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[24] Either including TNGTM in the income equation or not including it in the FMG equation does not change the results significantly. The simple correlation between TOC and TNGTM exceeds .9.

TABLE 1

FMG SUPPLY CURVE: STRUCTURAL (2SLS) ESTIMATION WITH INCOME EQUATION, (COLUMNS 1&2); REDUCED FORM ESTIMATION (COLUMN 3); 1946-1981

	Dependent Variable		
	MDINC (1)	FMGP (2)	FMGP (3)
INTERCEPT	-18.0632 (-1.37)	.246(-1) (2.96)	.6275(-1) (1.68)
TOC	1.039 (4.97)	--	.1744(-4) (.02)
INCM	6.950 (2.41)	--	.4913(-2) (.46)
PUBINS	.1618 (2.13)	--	.4892(-4) (.17)
MDSP(t-1)	-1.2289 (-.12)	--	-.2687(-1) (-.99)
e^F	22.4934 (2.20)	--	-.5113(-1) (-1.24)
CONS8	-17.9185 (-3.53)	--	-.5304(-2) (-.29)
CAPS5	-15.6545 (-.62)	--	--
D71	.4396 (.42)	-.1359(-1) (-4.49)	-.1467(-1) (-4.66)
D76	4.7531 (2.12)	-.1003(-1) (-4.64)	-.1037(-1) (-1.58)
NOLIC	.1269 (1.91)	-.3603(-3) (-1.86)	-.3676(-3) (-1.46)
CITIZ	.6768(-1) (1.62)	-.1029(-3) (-.91)	-.2295(-3) (-1.43)

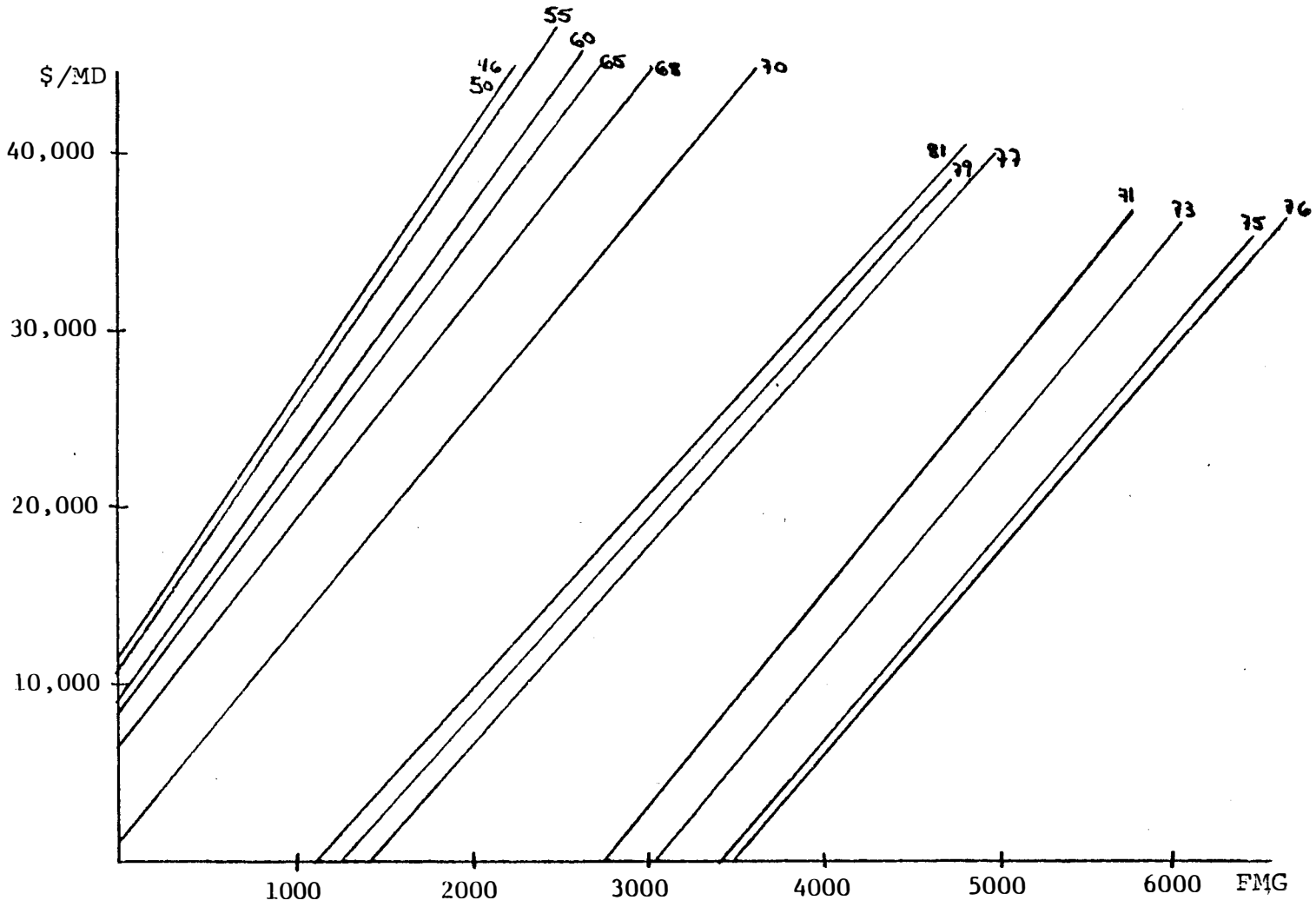
TABLE 1--Continued

	Dependent Variable		
	MDINC (1)	FMGP (2)	FMGP (3)
TNGTM	--	-.7997(-2) (-1.47)	-.7148(-1) (-1.00)
$\hat{MDINC}$	--	.4128(-3) (1.65)	--
SSE	12.53	.2395(-3)	.1686(-3)
R^2	.9929	.9283	.9428
D.W.	1.92	1.62	--
ρ	--	--	-.06

Notes: t-statistics in parentheses; (-n) implies that reported coefficent is 10^n times actual magnitude; MDINC in FMGP regression (2) is prediction from $\hat{MDINC}$ regressions (1); ρ = correlation coefficient used in Prais-Winsten estimation.

FIGURE 5

Estimated FMG Supply Curves for Selected Years
(from 2SLS Regressions, with years marked at top of curves)



to changing licensing laws, and implies an increase of 4000 FMGs at any given income level between 1968 and 1975. Finally, when the immigration law was tightened in 1977, the supply curve shifted back, but not all the way to its original position. The 1981 FMG supply curve lies about halfway between its late 1960's and early-1970's positions.[25]

Results from estimating the unrestricted reduced form equation (6) are presented in column 3 of Table 1. Medical school construction funding (CONS8) is used to represent the domestic fringe subsidy; CAPS5 was also used in some regressions but its high correlation with CONS8 (.91) as well as with the FMG restrictions created problems in identifying coefficient estimates. The regression was estimated using a Prais-Winsten transformation to correct autocorrelation. While it is impossible to determine the net effects of the restriction variables from the theoretical model because of the offsetting impacts of their influences on physician income, the empirical results show at least their signs (and often their coefficients) to be similar to the 2SLS results.

Finally, we can compare what our various estimates indicate has been the cumulative effect of changes in the licensing and

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[25] The time path derived using the unreported D68 regression is similar except that the outward expansion begins earlier and is more gradual.

immigration laws since 1965. We measure the effect of each variable in year t by taking the difference between its actual magnitude in year t and the value it had in 1965, times its estimated coefficient. Table 2 shows the cumulative effect, from 1966 through 1981, of the licensing and immigration regulations' effects for each of our regressions. The results suggest that relaxation of these laws enabled somewhere from 33,000 to 45,000 additional FMG's to obtain U.S. medical licenses during the fifteen year period. The equations suggest a lesser effect from the licensing variables, equaling 12,000-22,000, and a net positive impact (remember that the 1976 law restricted entry again) from immigration policy, of 21,000-24,000. The D71 immigration variable allowed about 3,000 entrants annually while D76 withheld about 2,000. Of the licensing variables, CITIZ is most influential. it accounts for 60 to 75 percent of the total licensing effect. The total effect since 1965 of loosened regulations on FMG entry has been substantial, equaling 45 to 65 percent of the approximately 70,000 FMG's that have become licensed in the U.S. since 1965.

Probably, the primary impetus for relaxation of the Immigrant and Visa laws came from the perceived shortage of physicians in the U.S. in the 1960's. Moreover, the large expansion of hospital internship and residency training positions following World War II, partly due to the Hill-Burton hospital construction program, created a demand for graduate medical students which the U.S. schools' graduates did not fill. The AMA

TABLE 2

IMPACT OF RELAXATION OF FMG ENTRY RESTRICTIONS FROM 1965 LEVEL ON NUMBER OF NEW FMG LICENSEES, 1966-1981 CUMULATIVE EFFECT

	2SLS	Reduced Form
Licensing	13,273	21,940
Immigration	21,310	23,516
Total	34,583	45,456

has certainly advocated exclusionary policies. It opposed relaxation of the immigration law in the 1960's, and back in 1938, the AMA House of Delegates resolved that U.S. citizenship be included as a prerequisite in all state medical licensing statutes.[26] The tightening of the immigration law in 1976 came at a time when U.S. schools were generating a substantially larger number of annual graduates than they had been at the beginning of the decade. Moreover, reimposition of strict state licensing laws has not occurred. Such action is perhaps too costly for the AMA, requiring 50 separate lobbying efforts.

The decline in FMG entry in the last few years does not imply that competition in the medical profession has abated. U.S. medical schools doubled their annual output between 1965 and 1980, and in the last few years, have more than made up for the reduced number of FMG's obtaining U.S. licenses. In the next section, we will examine the determinants of U.S. new licensees in order to isolate the domestic competitive fringe.

III. DOMESTIC COMPETITIVE FRINGE ENTRY

Measuring the second competitive fringe, the additional U.S. graduates resulting solely from federally subsidized medical school growth, is more complicated. To attribute all of the 100 percent growth between 1965 and 1980 in the annual number of

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[26] Irene Butter and Rebecca G. Sweet, Licensure of Foreign Medical Graduates: An Historical Perspective, 55 Milbank Memorial Fund Quarterly 315 (1977).

graduates to an entry barrier breakdown is surely an overstatement. The advent of the Medicaid and Medicare programs in 1965 increased demand as did higher consumer incomes until the late 1970's. Therefore, using the dominant firm model, part of the increase in medical school output can probably be attributed to the optimal adjustment of a cartel to growth in demand.[27] Since demand conditions changed after 1965, we cannot simply project growth in the dominant firm from its pre-1965 behavior.

If we posit the marginal cost curve for physicians as horizontal at the level of total opportunity cost up to a constraint determined by the number of medical school spaces,[28] and vertical thereafter, a growth in the domestic competitive fringe implies a rightward shift of the school capacity constraint. That is, in this case, neither a lowering of the opportunity cost nor a rise in physician income can lead to increased U.S. graduate entry unless the medical school capacity is increased. Conversely, the actual relaxation of the entry barrier does not lead to a reduced opportunity cost for those accepted into medical school, i.e., the horizontal segment of the curve is not lowered.

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[27] It is not clear that an existing number of (perfectly cartelized) physicians would want to permit entry of new physicians rather than expanding their own output. Such a desire can be rationalized as an attempt to prevent consumers from actively seeking substitutes.

[28] Given the small proportion of college graduates that each year's medical school class represents, this seems a reasonable assumption.

Using the model outlined in section I we can derive an equation that measures effects of government subsidies to medical schools on the number of annual new domestic licenses. We are viewing the federal grants as negative restrictions, a sort of entry inducement rather than entry barrier. The pool of total new domestic licensees (DNL) is composed of two groups: (1) a domestic competitive fringe (CDNL) and (2) the optimal adjustment of the cartel to changes in demand or cost (DFNL). As with the foreign fringe supply curve, entry of the domestic fringe can be described as:

$$(7) \quad CDNL_t = d_0 + d_1 MDINC_t + \underline{d}'_2 \underline{RD}_t + d_3 TOC_t$$

where $d_1 > 0$, $\underline{d}_2 < 0$ and $d_3 < 0$, since $\underline{RD}$ equals the vector of domestic restrictions, and, for the domestic fringe, FTOC is just the U.S. physician's opportunity cost, along the horizontal segment.

The $\underline{RD}$ vector is measured as the subsidies given to medical schools; these "negative restrictions" expand school capacity and weaken the hypothesized domestic entry barrier, enabling development of the fringe.[29] Federal grants to medical schools were

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[29] In our model of TOC, they shift to the right the vertical segment of the cost curve. That is, they weaken the AMA's ability to constrain medical school spaces. In that they may indirectly affect tuition fees, they also serve to lower the horizontal segment. This impact is measured in TOC, and therefore our estimated coefficients on the school subsidy variables will be biased downwards. We also do not include the effects of quite substantial state subsidies to medical schools.

distributed under two different programs. Beginning in 1965, construction funds (CONS) were given for expansion and building of new facilities. In 1966, capitation funding (CAPS) was also initiated; to be eligible for these grants schools were required to expand enrollment annually by 2 1/2 percent or five students, whichever was greater.[30] Since construction funds have a permanent impact (except for depreciation) on medical school capacity, they are entered as the cumulative sum in empirical tests. Moreover, both variables should affect new licensees with a lag; capitation funds are presumed to take five years, given the necessary training time, while construction funds are lagged for eight years, assuming the same five year training horizon plus an additional three for actual construction.[31]

Equation (1) represents the dominant firm portion of new domestic licensees[32] who are assumed to adjust partially to expected equilibrium stock changes net of fringe (both foreign and domestic) entry and adapt fully to the known and constant depreciation rate, d. Rewriting (1) to separate the domestic and foreign fringes yields:

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30 U.S. House of Representatives, Committee on Interstate and Foreign Commerce Current Health Manpower Issues, at 6-8.

31 Seven and nine year lags were tried as well and produced similar results.

32 Since all FMGs are assumed to be part of the fringe, all of the dominant firm is domestic.

$$(8)\quad DFNL_t = \gamma[MDS^{*}_{t|t-5} - (MDS_{t-1|t-5} + FMG_{t|t-5} + CDNL_{t|t-5})] + dMDS_{t-1|t-5}.$$

Summing equations (7) and (8) and making appropriate substitutions leads to the following estimatable equation measuring total domestic entry:

$$(9)\quad DNLP_t = n_0 + n_1 TOC_t + n_{21} INCM_t + n_{22} PUBINS_t + n_3 CITIZ_t + n_4 MDSP_{t-1} + n_5 e^{F}_{t} + n_{61} CONS8_t + n_{62} CAPS5_t + n_7 \hat{MDINC}_t + n_8 FMGP_{t|t-5} + \varepsilon^{4}_{t}$$

where DNLP is the domestic new licensee-population ratio. This is estimated as a 2SLS regression with (5) to measure MDINC.[33] n_1, n_3, n_4, n_5, and n_8 should be negative while n_{21}, n_{22}, n_{61}, n_{62} and n_7 should be positive.

We also develop the reduced form to derive the net effect of school subsidies. This includes not only the direct effect on the competitive fringe but its offsetting impact, due to its negative pull on income and the resultant direct influence due to lower income's negative effect on FMG entry. We estimate the reduced form as

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[33] $FMG_{t|t-5}$ is estimated using a Box-Jenkins first-order autoregressive five year forecast. CITIZ is used to represent the restriction determinants of FMG entry in the domestic licensee regression.

$$(10)\quad DNLP_t = m_0 + m_1 TOC_t + m_{21} INCM_t + m_{22} PUBINS_t + m_3 CITIZ_t + m_4 MDSP_{t-1} + m_5 e_t^F + m_{61} CONS8_t + m_{62} CAPS5_t + m_7 e_t^f + \varepsilon_t^5 .^{34}$$

Results from the 2SLS structural model regression are presented in Column 1 of Table 3. The income equation that forms the predictions is identical to that used for FMG's and reported in Table 2. It is not repeated here.

TOC, INCM and CITIZ have predicted effects and are mainly significant at the .025 level; PUBINS should be positive but is negative instead. The coefficients on $MDSP_{t-1}$ and e^F are constrained to sum to zero; they each take the appropriate signs but are insignificant. Predicted MDINC is correctly positive but not at all significant. The five-year FMG forecast is also totally insignificant. In lieu of the Box-Jenkins estimated $FMG_{t|t-5}$, we also used the FMG prediction generated by the estimation of (4) in the 2SLS regression discussed in the last section. The results were very similar and hence are not reported.

CONS8 and CAPS5 have a predicted positive effect. Neither are overly significant; however, they are highly correlated with

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[34] e_t^f represents the prediction error on year t's actual FMG entry, i.e. $FMG_t - FMG_{t|t-5}$. Initial use of a proxy for $FMGP_{t|t-5}$, based on a Box-Jenkins model, led to an inappropriately negative and significant coefficient on e_t^f. This suggests that the expecta-tions process was incorrectly modeled. No e^f term is used in the estimations reported.

TABLE 3

ESTIMATES OF NEW DOMESTIC LICENSEE EQUATION, STRUCTURAL (2SLS) ESTIMATES (9) AND REDUCED FORM ESTIMATES (10) 1946-1981

	Structural (1)	Reduced Form (2)
INTERCEPT	.2913(-1) (1.03)	.9411(-2) (.28)
TOC	-.3401(-2) (-2.56)	-.2396(-2) (-3.92)
INCM	.2235(-1) (2.59)	.2410(-1) (3.06)
PUBINS	-.3954(-3) (-1.26)	-.2920(-3) (-1.31)
MDSP(t-1)	-.7797(-2) (-.52)	.2209(-2) (.09)
e^F	.7797(-2) (.52)	.2413(-1) (1.01)
CITIZ	.2383(-3) (2.06)	.2650(-3) (2.29)
CONS8	.1789(-1) (.92)	.6490(-2) (.48)
CAPS5	.508(-1) (1.15)	.6757(-1) (1.50)
$\hat{MDINC}$	.8334(-3) (.72)	--
$FMGP_{t\|t-5}$	.1335(-1) (.09)	--
SSE	.1276(-3)	.1177(-3)
R^2	.9646	.9473
D.W.	1.42	--
ρ	--	-.253

Notes: See Table 2.

each other as well as with other variables in the regression including CITIZ and $FMG_{t|t-5}$. Regressions that included only one of the school subsidy variables or a weighted sum of the two were also run. The resulting t-statistics on the school subsidy variables were about 2. The effect that CONS8 and CAPS5 have on DNLP isolates the domestic competitive fringe. The regression suggests a cumulative effect, from 1971 when CAPS5 begins through 1981, of 20,000 additional new licensees.

To arrive at a true net measure of the effect of the medical school subsidies we also estimate the reduced form of the new domestic licensees supply curve specified by (10). The data have again been transformed to correct residual correlation. These results are outlined in Column 2 of Table 3. CITIZ is again used to measure foreign restrictions. They suggest a cumulative domestic fringe of about 13,000 from 1966 through 1981. As expected, this net figure is lower than the 20,000 suggested by the 2SLS estimate.

IV. SUMMARY

In this paper we have developed a model of the physician stock as a dominant firm of AMA-sanctioned physicians who, due to various government policies, are faced with a growing competitive fringe. Two sources of competition appear to exist. During the late 1960's and early 1970's, following the relaxation of various federal immigration and state licensing restrictions, foreign

medical graduates formed a large proportion of new U.S. licensees. As Table 4 shows, we estimate that since 1965, 35,000-45,000 have been able to enter because of less severe immigration and licensing restrictions. A domestic fringe has also arisen, particularly in very recent years, due to subsidies granted U.S. medical schools. By 1981, this source of competition has added about 13,000 to 20,000 physicians to the active stock. Thus, our estimates suggest that an additional 55,000 to 60,000 physicians, or 12-13 percent of the 1981 active stock, practice today because of increased competition since 1965.

These estimates are consistent with those derived by different methods in a related paper.[35] There, the actual physician stock was modeled as a weighted average of the supplies that would exist under the extreme conditions of pure monopoly and perfect competition. Changes in the degree of competition were measured as changes in the weight from its 1965 level. Those estimates attribute 9-14 percent, or 39,000 to 62,000, of the 1981 physician stock to increased competition. Income is likewise reduced by $7,000-$11,000 in 1972 after tax dollars.

In both the 2SLS and reduced form estimates, the increase due to the FMG fringe is larger than that attributable to the domestic competitive fringe, comprising 62-78 percent of the total. The estimates derived from cumulating yearly entry in the

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35 Noether, supra note 1.

TABLE 4

COMPARISON OF DIFFERENT ESTIMATES OF THE AMOUNT OF THE 1981 PHYSICIAN STOCK AND INCOME DUE TO INCREASED MARKET COMPETITION SINCE 1965

Model	Stock	Income
2SLS Estimates		
FMG Effect	34,583	2,120
Domestic Effect	20,074	-12,330
Total Effect	54,657	-10,210
Reduced Form-Estimates		
FMG Effect	45,456	
Domestic Effect	12,810	
Total Effect	58,266	n.a.

Notes: FMG effect is the fringe estimated from the FMG supply equation. Domestic effect is the fringe measured in the new domestic licensee equation.

dominant firm model are biased upwards slightly since depreciation has not been sub-stracted from the figures. The 2SLS regression provides an estimate of a $10,000 income loss from the income equations.[36] No estimate is derived in the reduced form fringe model.

In which estimates are we most confident? Theoretically, the reduced form equations should give correct estimates of the net effect of the relaxation of restrictions on fringe entry. The net effect should be smaller than that measured by the 2SLS process because of offsetting effects of the restriction variables on income which are incorporated into the MDINC term in the 2SLS estimation. This conclusion holds for the new domestic licensee curve. However, in estimating the FMG supply curve, the net estimate of the FMG fringe derived from the reduced form equation exceeds that estimated by 2SLS.[37] The reduced form equation does have a lower SSE and has been corrected for mild autocorrelation. The reduced form estimates suggest a total entry of competitive fringe of over 58,000.

We can also examine the yearly pattern of entry derived from the 2SLS and reduced form estimators. Table 5 provides these

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[36] The $10,210 decline can be decomposed into a $2,194 loss due to relaxation of FMG licensing restrictions, a $4,314 net gain from changes in immigration policy, and a $12,000 loss due to medical school subsidies. These numbers give a different view than the stock figures which attribute the majority of the growth of competition to the foreign medical graduate fringe.

[37] This is due to the CITIZ variable in the D71 regression.

TABLE 5

COMPARISON OF YEARLY ESTIMATES OF COMPETITIVE FRINCE ENTRY, 1966-1981

Year	Reduced Form			2SLS		
	Total	FMG	DNL	Total	FMG	DNL
1966	0	0	0	0	0	0
67	28	28	0	32	32	0
68	290	290	0	175	175	0
69	506	506	0	270	270	0
1970	1,153	1,153	0	638	638	0
71	4,350	4,234	116	3,577	3,490	87
72	4,612	4,285	327	3,729	3,483	246
73	5,186	4,749	437	4,299	3,778	521
74	5,458	4,944	514	4,709	3,982	727
75	5,811	5,147	662	5,352	4,196	1,156
76	6,043	5,246	797	5,818	4,289	1,529
77	4,966	3,020	1,946	4,806	2,127	2,679
78	5,245	3,115	2,130	5,353	2,221	3,132
79	5,214	2,941	2,273	5,516	2,013	3,503
1980	4,874	2,910	1,964	5,282	1,963	3,319
81	4,532	2,888	1,644	5,101	1,926	3,175
Total	58,266	45,456	12,810	54,657	34,583	20,074

Notes: See Table 4.

estimates. In both cases, entry of the FMG fringe is strongest in the early-1970's and has receded in recent years. On the other hand, the domestic competitive fringe did not exist until 1971,[38] and did not become substantial until the late 1970's. The domestic fringe has also receded slightly in the last two years as the school subsidy programs have been phased out. This suggests that a new equilibrium level of competition is being approached.

We have shown in this paper, that various policies promulgated by the AMA were effective in restricting the supply of physicians. Thus, their relaxation has led to increased competition among physicians. Unanswered, however, is the question of what factors caused the policy changes that have altered the medical market. Certainly, the AMA is one influencial actor that should be examined in the framework of a political support model as outlined by Peltzman.[39] Did its power weaken absolutely or only relative to ther interest groups? The answer to this question is beyond the scope of this paper but should provoke interesting future work.

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[38] The five-year lag of the capitation program which began in 1966 accounts for this.

[39] Sam Peltzman, Toward a More General Theory of Regulation, 19 Journal of Law and Economics 211 (1976).

APPENDIX A

MODEL OF PHYSICIAN STOCK AND INCOME USING DOMINANT FIRM--COMPETITIVE FRINGE FRAMEWORK

Demand for a stock of physicians in year t, MDS_t, is assumed to be positively related to a vector of demand shifters, $\underline{Z}_t$, including population characteristics such as number, personal income, insurance coverage, age distribution and other health status determinants, as well as the price of substitutes. It is negatively related to the "price" of physicians, their real earnings, $MDINC_t$.[40]

In this simplest case, then, a linear market demand curve for a stock of physicians can be written as:

$$(1a) \quad MDS_t = a_0 + a_1 MDINC_t + \underline{a}_2' \underline{Z}_t$$

where $\underline{a}_2'$ is a row vector with all elements greater than zero (the elements of $\underline{Z}_t$, the demand determinants, have been so defined) and _' indicates a row vector, while _ denotes a column vector.

The marginal cost to the dominant firm of supplying an an additional physician can be viewed as the total opportunity cost (TOC) of that individual not pursuing a next best career and can be measured as that income at which he/she is indifferent between becoming a physician or pursuing the alternative career. The

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[40] Noether, supra note 1, discusses the validity of translating what is truly a physician service demand into a demand for stock.

shape of this curve depends on the quality (opportunity cost) pattern across the pool of applicants to medical school. Since, by most accounts, the AMA-sanctioned dominant firm has restricted the supply of medical school spaces to the extent that many "highly qualified" applications are rejected each year, and since medical students represent such a small proportion of all college graduates, it seems reasonably accurate to posit the marginal cost curve as horizontal in the relevant range, that is:

$$(2a) \quad MC_t = TOC_t$$

where TOC_t is not a function of the number of physicians.

The marginal cost curve nevertheless should reflect any existent barriers to entry, due, for example, to restrictions on the number of medical school spaces. If the barrier to entry is totally binding, the cost curve becomes vertical when the constraint is reached.

The competitive fringe (CNL) has an upward sloping supply curve with respect to physician income (MDINC):

$$(3a) \quad CNL_t = b_0 + b_1 \, MDINC_t + \underline{b}_2 \, \underline{R}_t + b_3 \, FTOC_t$$

where FTOC, the fringe opportunity (marginal) cost, and $\underline{R}$, a vector of restrictions which the dominant firm imposes to impede competitive entry, are parameters determining the level of the supply curve. Thus $b_1 > 0$, while $\underline{b}_2 < 0$ and $b_3 < 0$.

In this case, the dominant firm faces a residual demand curve equaling the market demand (1a) less the fringe supply (3a).

The equilibrium dominant firm stock occurs where marginal revenue, derived from the residual demand curve, equals TOC. The total stock equals the sum of the dominant firm's optimum level and the competitive fringe, or:

$$(4a)\quad MDS_t^* = \frac{a_0+b_0}{2} + \frac{a_1-b_1}{2}\,TOC_t + \frac{\underline{a}_2'}{2}\,\underline{Z}_t + \frac{\underline{b}_2'}{2}\,\underline{R}_t + \frac{b_3}{2}\,FTOC_t + b_1\,MDINC_t.$$

Solving (1a) for MDINC, substituting it into (4a), and simplifying yields the reduced form:

$$(5a)\quad MDS_t^* = \left\{\frac{a_0}{2} - \frac{a_0b_1-a_1b_0}{2(a_1-b_1)}\right\} + \frac{a_1}{2}\,TOC_t + \left\{\frac{\underline{a}_2'}{2}\left(1 - \frac{b_1}{a_1-b_1}\right)\right\}\underline{Z}_t + \frac{a_1\underline{b}_2'}{2(a_1-b_1)}\,\underline{R}_t + \frac{a_1b_3}{2(a_1-b_1)}\,FTOC_t$$

where the coefficients on the $\underline{Z}$ vector are positive and those on TOC, FTOC, and the $\underline{R}$ vector are negative.

Due to uncertainty about future demand and/or cost conditions, possible shifts in the market structure, combined with costly adjustment due to the length of training time required to become a physician, it is likely that the observed stock of physicians differs from the equilibrium value at any given point in time. As in other work studying the determinants of an

occupation's supply,[41] we can posit a partial adjustment model where the change in actual stock from one year to the next represents only part of the difference between this year's equilibrium value and last year's actual stock. Moreover, since training requires four years of medical school and one to five more of a graduate program (usually five years until licensure from the beginning of medical school and then one to four more of residency training once licensed), the planning horizon is at least five years long so that:

$$(6a) \quad MDS_t - MDS_{t-1} = \gamma \, (MDS^*_{t|t-5} - MDS_{t-1|t-5})$$

where MDS_t = actual stock in year t

MDS^*_t = actual equilibrium stock in year t

$MDS_{t-1|t-5}$ = prediction made in t-5 of actual stock that will exist in t-1

$MDS^*_{t|t-5}$ = prediction made in t-5 of equilibrium stock for year t

γ = adjustment rate to changes in equilibrium perceived in year t-5.

If we assume that predictions from t-5, based only on forecasts of demand and cost variables, of the optimal stock, MDS^*_t, are unbiased, then $MDS^*_{t|t-5}$ is an unbiased estimator of MDS^*_t. How much uncertainty exists in year t-5 about the actual stock

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[41] B. Peter Pashigian, The Market for Lawyers: The Determinants of the Demand and Supply of Lawyers, 20 Journal of Law and Economics 53 (1977).

that exists in year t-1? It has been shown that this uncertainty can be reduced to ignorance about the exact number of FMG's entering in the intervening four year period.[42]

Incorporating these simplifications into (6a), the actual physician stock can be expressed as:

$$(7a) \quad MDS_t = \gamma MDS_t^* + (1-\gamma)\, MDS_{t-1} + \gamma e_t^F + u_t^1$$

where e_t^F represents uncertainty over FMG entry and is defined as

$$e_t^F \equiv \sum_{i=1}^{4} (1-d)^{i-1} (FMG_{t-1} - FMG_{t-i|t-5})$$[43]

where FMG = number of foreign medical graduates obtaining new U.S. medical licenses in year t

and d = yearly depreciation rate of licensed physicians and students, assumed to be constant over time.

u_t^1 represents the random error in predictions of the optimal stock.[44]

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[42] Noether, supra note 1.

[43] $E(e_t^F\, e_{t-1}^F)$, $i \neq 0$ is not necessarily zero if, for example, government policies with respect to immigration are not perfectly predicted and are autocorrelated (more than one period long) once enacted. More generally, e_t^F can be thought of as the result of any prediction errors in year t; for example, unexpected variations in the depreciation rate may also yield forecast errors.

[44] Actually it could be autocorrelated for up to five periods if information about permanent changes in demand or cost is released between t-5 and t.

Substituting for MDS_t^* from (5a) yields:

$$(8a)\quad MDS_t = \frac{\gamma}{2}\left\{\left(a_0 - \frac{a_0b_1-a_1b_0}{2(a_1-b_1)}\right) + a_1\,TOC_t + \left(1 - \frac{b_1}{a_1-b_1}\right)\underline{a}_2'\,\underline{Z}_t + \frac{a_1\underline{b}_2'}{(a_1-b_1)}\,\underline{R}_t + \frac{a_1b_3}{2(a_1-b_1)}\,FTOC_t\right\} + (1-\gamma)MDS_{t-1} + \gamma e_t^F.$$

Finally, assuming that physician earnings adjust to clear the market,

$$(9a)\quad MDINC_t' = \left\{\frac{a_0}{a_1}\left(\frac{\gamma}{2} - 1\right) - \frac{\gamma}{2}\left(\frac{a_0b_1-a_1b_0}{a_1(a_1-b_1)}\right)\right\} + \frac{\gamma}{2}\,TOC_t + \left[\frac{\gamma}{2}\left(1 - \frac{b_1}{a_1-b_1}\right) - 1\right]\frac{\underline{a}_2'}{a_1}\,Z_t + \frac{\gamma\,\underline{b}_2'}{2(a_1-b_1)}\,\underline{R}_t + \frac{\gamma b_3}{2(a_1-b_1)}\,FTOC_t + \frac{(1-\gamma)}{a_1}\,MDS_{t-1} + \frac{\gamma}{a_1}\,e_t^F.$$

The coefficients on TOC, $\underline{R}$, $\underline{Z}$, and FTOC are positive; on MDS_{t-1} and e^F they are negative.

APPENDIX B

DESCRIPTION OF THE DATA

This appendix describes the data used in estimating the model and depicted in the plots. It also cites their sources.

1. MDS: Stock of active U.S physicians.

   Sources: American Medical Association (hereafter AMA), Distribution of Physicians in the U.S., annual; U.S. Bureau of the Census, Historical Statistics of the United States from Colonial Times to 1970 (hereafter Historical Statistics) and U.S. Public Health Service, Health Manpower Sourcebook, v. 20.

   The number of active MD's is available only for selected years prior to 1963 (1950, 1955 and 1960). The other years' figures have been estimated by taking .95 of the total number of physicians, where .95 of the total number of physicians, where .95 is the average proportion that held for all years from 1950-1966 for which data were available.

2. DNL: Newly licensed physicians trained in domestic schools. Physicians who receive their initial U.S. license (are additions to the medical profession), who graduated from an accredited U.S. or Canadian school.

   Source: AMA, Medical Licensure Statistics, annual.

3. FMG: Foreign Medical Graduates. Newly U.S.-licensed graduates of foreign medical schools--they include both foreign-born and U.S. citizens who received their training abroad.

   Source: see DNL.

(The above three variables are all deflated by the U.S. resident population in the estimation.)

4. INCM: U.S. disposable personal income, in 1972 $.

   Source: Historical Statistics and U.S. Bureau of the Census, Statistical Abstract of the United States (hereafter Statistical Abstract), annual.

. PUBINS: Percentage of population enrolled in public insurance program; primarily composed of Medicare and Medicaid recipients.

Sources: U.S. House of Representatives, Data on the Medicaid Program (1977) and Health Care Financing Administration, The Medicare and Medicaid Data Book (1981).

6. TOC: Total Opportunity Cost--the calculation of TOC is derived elsewhere.[45] Only its components are described here.

a. College Graduate Earnings: To best hold quality constant, we look at earnings of full-time workers, with four years of college, over age 25, both sexes. (Mean, after tax, 1972 $.)

Sources: Current Population Reports, Series P-60, U.S. Bureau of the Census, various issues, and Historical Statistics.

b. Tax Rates: To derive after tax incomes, marginal tax rates are calculated from data on tax payments by income bracket found in the Internal Revenue Service publication, Statistics of Income, Individual Income Tax Returns, U.S. Department of the Treasury, annual.

c. Length of Medical Training Time, calculated as: four years of medical school + g years of graduate medical training - (4-c) years less than a full four years of college, where

g_t is calculated as $4 \times (\text{U.S. Residents \& Interns})_t /$

$$\sum_{i=0}^{3} \text{U.S. Med. graduates}_{t-i}$$

c is the average number of years spent in college prior to medical school.

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45 See Noether, supra notes 1 and 11.

Source: All data required for calculation of c and g are in annual Education number of the Journal of the AMA, (hereafter JAMA.)

d. Discount rate: .10 is used--the range of discount rates used in most studies is from .08 to .12.

e. Net Tuition: Calculated as (Total Tuition Payments to Medical Schools less Total Scholarships given to all Medical students from all sources)/number of students.

Source: Annual Education number of JAMA.

f. Income earned while in school: Following Becker,[46] it is assumed that medical students earn 1/4 of what a college degreed worker would earn (by working summers and/or part-time). This assumption is also used for the residency training period. Actual residency salaries have, at least since 1970, been considerably higher than 1/4 of the college wage, but hours worked average over 70 per week, thus bringing the hourly wage to about $4.22 in 1979.[47] Actual data on residency stipends are only available annually beginning in the early 1960's; it is also difficult to discern how much in in-kind payments has been given to residents.

7. e^F and e^f: 5-year forecast errors of FMG entry, where

$$e_t^f = FMGP_t - FMGP_{t|t-5}, \text{ and}$$

$$e_t^F = \sum_{i=1}^{4} (1-d)^{i-1} e_{t-i}^f$$

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46 Gary Becker, Human Capital, (2nd ed., 1975) at 153.

47 Douglas Hough, The Economic Status of Resident Physicians: Results from the Survey of Resident Physicians, in Profile of Medical Practice (American Medical Association, 1981) at 83-96.

The 5-year predictions ($FMGP_{t|t-5}$) were calculated from Box-Jenkins AR1 models based on the 15 years of data ending 5 years before the prediction. d is the FMG depreciation rate, assumed to be a constant 2%.

8. MDINC: Mean U.S. physician income in after-tax 72 $. The series is spliced from the four series listed below since no single one provides consistent numbers for the entire period.

Sources: AMA, Profile of Medical Practice and Reference Data on Profile of Medical Practice, various issues.
Medical Economics Company, Medical Economics, various issues.
U.S. Department of Commerce, Survey of Current Business, July 1951.
U.S. Department of the Treasury, Internal Revenue Service, Statistics of Income, Individual Income Tax Returns, various issues.

Tax data: see TOC.

9. CONS Cumulative sum, in billions of 1972 $, of construction funds given to medical schools under federal programs.

Source: U.S. House of Representatives, Health Manpower Data Book (1980).

10. CAPS: Capitation funds, in billions of 1972 $, given to medical schools under federal programs.

Source: See CONS.

11. NOLIC: Weighted percentage of states that refuse to license FMG's. States are weighted by their proportion of total national personal health care expenditures after 1965, and by personal income before 1965.

Sources: AMA, Medical Licensure Statistics, annual, and Historical Statistics and Statistical Abstract.

12. CITIZ: Weighted percentage of states that require U.S. citizenship of FMG licensees. For weights and sources, see NOLIC.

13. TNGTM: Weighted average number of years of graduate (residency) training required of FMG licensees. For weights and sources, see NOLIC.