Barriers to Entering Medical Specialties

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September 2003

Abstract

Non-primary care physicians earn considerably more than primary care physicians in the United States. I examine a number of explanations for the persistent high rates of return to medical specialization and conclude that barriers to entry may be creating a shortage of non-primary care physicians. Entry barriers exist due to cartel behavior by residency review committees, regulation that until recently required residents in all specialties to receive the same wage, and/or scarcity of teaching material. I estimate that medical students would be willing to pay teaching hospitals to obtain residency positions in dermatology, general surgery, orthopedic surgery, and radiology rather than receiving the mean residents' salary of $34,000. In the simulation, the quantity of residents in these four specialties would increase by an estimated six to 30 percent, rates of return would fall substantially, and teaching hospitals would save an estimated $0.6 to $1.0 billion per year in labor costs.

JEL Codes: I11, J31, J44, J51

Acknowledgements: I received helpful comments from Mark Pauly, Jonathan Ketcham, Patricia Danzon, Dan Polsky, Dan Kessler, and seminar participants at Brigham Young University and The Wharton School.

I. Introduction

Physicians who practice in the primary care specialties of general internal medicine, family practice, and pediatrics earn substantially less than physicians in non-primary care specialties. If one controls for the one to two years of additional residency training required in non-primary relative to primary care specialties, there are still substantial rates of return to specialization. In 1998, for example, the estimated rates of return to specializing in radiology, orthopedic surgery, general surgery, obstetrics/gynecology, and anesthesiology relative to entering family practice, exceeded 25 percent.[1] These rates of return are considerably larger than empirical estimates of the real discount rate, which is about three percent (Gramlich, 1990).

In theory these relatively high rates of return could be consistent with an equilibrium characterized by equalizing differences, variation in returns to ability by specialty, and/or liquidity constraints. Although these supply-side factors may be relevant, they cannot fully explain the high rates of return to specialization, because throughout the 1990s there have consistently been more medical students seeking entry into specialties with high rates of return than there are residency positions available. This implies that barriers to entry in the market for residents, a demand-side (for residents) factor, affect the realized supply and price of physician services, and help create rents for non-primary care physicians. The normative perception among many policymakers and health service researchers, on the other hand, is that there are too many non-primary care physicians, or specialists, in the United States (Physician Payment Review Commission, 1995). I propose in this paper that barriers to entry may be creating an economic shortage of non-primary care physicians. This suggests that welfare could possibly

[1] I describe the methodology for calculating the cross-section rates of return in Section II.

be improved if the number of non-primary care residency positions were allowed to increase, thereby increasing the supply of non-primary care physician services and reducing the price of those services.[2]

In Section II of this paper I estimate cross-section rates of return in six non-primary care specialties over the 1986-1998 time period using data from the American Medical Association's (AMA) annual physician survey. Although rates of return to specialization have fallen over time, they are still strikingly large. In the third section of the paper I examine a number of explanations for the persistence of high rates of return to specialization related to the supply of medical students to residency programs in different specialties, and teaching hospitals' demand for residents.

I offer three explanations for why the market for residents fails to clear. Residency Review Committees (RRCs), private organizations that consist primarily of physicians from a particular specialty, essentially have complete control over the number of residents who train in each specialty, and therefore control the flow of new physicians to a specialty. Like utility-maximizing labor unions that negotiate with firms in order to maximize employment and rents (Pencavel, 1984; MaCurdy and Pencavel, 1986), I show that RRCs could set the flow of residents in order to achieve their desired combination of licensed physicians and physician rents. In 2002 a group of physicians filed a class action lawsuit against seven medical organizations, including the Accreditation Council for Graduate Medical Education (ACGME), which oversees the 26 different RRCs. The lawsuit contends that the ACGME has created anti-competitive standards that restrict medical students' access to residency programs (Jung, 2002).[3]

I also offer two more benign explanations why the market for residents may not clear. The ACGME historically has required that teaching hospitals pay residents a reasonable wage and pay residents in all specialties the same amount. However, the wage that clears the market for residents in

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[2] The welfare implications of removing the barriers to entry are ambiguous if physicians induce demand for their services in response to an increase in the supply of physician services. McGuire (2000) examines the theoretical and empirical aspects of physician-induced demand.

pediatrics or family practice may be too high to clear the market for surgical residents. Finally, the market for residents may fail to clear if there is insufficient clinical raw material (patients) to train the number of non-primary care physicians who seek entry into these specialties and hospitals are unable to increase patient supply. I show that these later two explanations -- minimum wage regulation and scarcity of teaching material -- could have the same effect as conscious rent-seeking behavior by RRCs.

In the fourth section of the paper I simulate the set of residents' wages that would allow the market for residents to clear, and examine the implications of market clearing on the quantity of residents in each specialty, the rates of return to specialization, and teaching hospitals' labor expenses. I estimate that medical students would be willing to pay teaching hospitals for residency training in dermatology, general surgery, orthopedic surgery, and radiology. Since teaching hospitals currently pay residents about $34,000 per year, on average, this would result in $0.6 to $1.0 billion in annual savings for teaching hospitals, depending on the supply and demand parameters used in the simulation. Furthermore, the quantity of residents would increase by an estimated six to 30 percent in these four specialties, and the rates of return would fall substantially, toward empirical estimates of the real discount rate.

II. Rates of Return to Medical Specialization

Consider a medical student who graduates from medical school in year t=0 and expects to work for T years. Her expected present value of lifetime earnings in primary care (specialty j), which requires three years of residency training, will be:

$$(1)\quad E[Y_j] = \sum_{t=1}^{3} (1+r)^{-(t-1)}\, w^{res}{}_{jt} \;+\; \sum_{t=4}^{T} (1+r)^{-(t-1)}\, y_{jt}\ ,$$

[3] The lawsuit also claims that these seven organizations and teaching hospitals exchange information in the National Resident Matching Program in order to pay residents lower wages and require more hours worked than would occur in a competitive labor market, and the Match itself removes students' ability to negotiate wages.

where r is the discount rate, w^{res}_{jt} is a resident's salary in specialty j in year t, and y_{jt} is the expected earnings from practicing medicine in specialty j in year t. A similar expression could be written for the expected present value of lifetime income in non-primary care (specialty k), which requires four or five years of residency training. The rate of return to the incremental training in specialty k, relative to specialty j, is the discount rate r_k that equates the expected net present values in the two specialties. That is, r_k solves the following equation:

$$(2) \quad \sum_{t=1}^{T} (1+r_k)^{-(t-1)} (y_{kt} - y_{jt}) = 0$$

If students' earnings expectations are rational, one could measure the expected rate of return to specialization using a panel data set that contains the mean income that a cohort of physicians actually received throughout their careers. To analyze changes in expected rates of return over time, one would need panel data sets for successive cohorts of students. Panel data sets for even a single cohort of students are rare, and these data sets usually span only a small portion of a medical career. I adopt the more practical empirical strategy of estimating rates of return using repeated cross-section data sets that contain the earnings of physicians with different experience levels at a point in time. If students expect the contemporaneous experience-earnings profile of practicing physicians to remain constant in real terms in the future, the cross-section rate of return will be an accurate representation of medical students' expected returns to specialization.[4]

In order to calculate returns to specialization, one needs to establish a reference specialty that requires a minimum amount of training. I use family practice as the reference, benchmark specialty because it involves a relatively short residency period, is chosen by a large number of medical students, and the clinical training is general in nature. Eleven percent of U.S. medical students who entered the

[4] Nicholson and Souleles (2002) examine the determinants of medical students' subjective income expectations. Although students do condition their expectations on contemporaneous physician income in the specialty they plan to enter, they find that students also anticipate, to some extent, subsequent changes in specialty income.

2001 National Residency Matching Program ("the Match") received a position in family practice. Although internal medicine was a more popular specialty (25 percent of U.S. medical students), many of these individuals will eventually practice in an internal medicine sub-specialty such as cardiology or gastroenterology. Burstein and Cromwell (1985) define general practitioners as the baseline specialty, and Marder and Willke (1991) define the baseline specialty to be physicians with one or two years of years of experience who are not board certified and are practicing in a primary care specialty.[5] Although most states allow physicians with at least one year of residency training to obtain a license, almost all physicians receive at least three years of residency training. In the 1998 Community Tracking Study Physician Survey, for example, only 3.9 percent of physicians received fewer than three years of residency training.

Self-reported data on physician earnings and hours worked are available from the American Medical Association's (AMA) Socioeconomic Monitoring System (SMS) survey for 1986 to 1998. Each year the AMA surveys about 4,000 practicing physicians who are nationally representative by specialty, experience, board certification status, and membership in the AMA.[6] The AMA reports the mean income from medical practice, after medical expenses but before taxes, by specialty for the following age groups: physicians under 36 years old, between 36 and 45, between 46 and 55, between 56 and 65, and over 65 years old. I make a number of assumptions in order to estimate the cross-section age-income profile for each specialty in each year. First, I assume that the mean practice income for an age category corresponds to physicians at the midpoint of each age range. For example, the mean income of a 50-year old pediatrician is set equal to the reported mean income of pediatricians between 46 and 55 years of age. Second, I linearly interpolate between age-specific observations. Third, prospective physicians are

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[5] Most general practice residency programs were converted into family practice residency programs, with the changes beginning in the 1970s.

[6] The AMA publishes summary data from the Socioeconomic Monitoring Study surveys in the *Physician Socioeconomic Characteristics* publication. Each year the AMA surveys about 4,000 full-time, practicing

assumed to graduate from medical school when they are 26 years old, spend the number of years as a resident that is required for board certification, begin practicing medicine immediately after completing residency training, and retire when they are 65 years old.[7] The mean number of hours that physicians work per year ranged in 1997 from 2,300 in radiology to 3,100 in obstetrics/gynecology.[8] I perform a Laspareyes-type adjustment to account for differences in work effort. Specifically, the mean income in specialty k (Y_k) is multiplied by (H_j/H_k) to standardize leisure at the observed level in the benchmark specialty (specialty j).[9]

The discounted present values of lifetime earnings between 1986 and 1998 are presented in Table 1 for nine specialties.[10] I assume the real discount rate is three percent and I convert the earnings to 1998 dollars using the urban consumer price index. In 1986 the net present value of lifetime income ranged from $2.6 million in family practice, pediatrics, and general internal medicine to $5.7 million in orthopedic surgery. Physician lifetime income increased in real terms in all specialties between 1986 and 1992, and increased more substantially in the non-primary than primary care specialties (second to last

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physicians based on a nationally representative sample from the AMA Masterfile, which is a census of all physicians (whether or not they are members of the AMA).

[7] Data on the average residents' salary is available from surveys conducted by the Association of American Medical Colleges. I assume that the residents' salary does not differ across specialties, which is almost always the case within a teaching hospital and is very nearly true in national data. The number of years of residency training required in each specialty is taken from the *Graduate Medical Education Directory*, 1996-1997.

[8] I derive the mean hours worked per year in a specialty by multiplying the mean number of weeks worked per year by the mean number of hours worked in a typical week, as reported in the AMA surveys.

[9] Lindsay (1973) demonstrates that a Laspareyes-type adjustment may over or understate the rate of return to specialty training. However, if an investment in training in specialty j is worthwhile with a Laspareyes-type adjustment, it will always be worthwhile.

[10] The AMA reports combined data on earnings by age group for general internists and internal medicine sub-specialists, and combined earnings data for general surgeons and surgical sub-specialists. These two groupings include specialties that require different amounts of residency training. For example, cardiologists, gastroenterologists, and general internists are all included in the internal medicine category although they require different amounts of residency training. The AMA does report the *mean* earnings of general internists and general surgeons (without any sub-specialists includes), but not mean earnings by age group for these two specialties. To estimate the age-specific mean earnings of general internists, I multiply the ratio of the general internist to overall internal medicine (including sub-specialists) mean earnings by the age-group mean earnings for all internal medicine physicians. I assume, therefore, that the age-earnings profile of general internists has the same shape as the combined internal medicine physicians, but is shifted up or down. The same method is used to derive the age-group mean earnings for general surgeons.

column of Table 1). The net present value of lifetime income fell by at least seven percent in every non-primary specialty between 1992 and 1998. The incomes of family practitioners and general internists continued to increase in real terms during this time period, although the increases were modest. If the age-earnings profile remains constant in the future, medical students who entered radiology and orthopedic surgery in 1998 will earn almost $6 million during their careers, almost twice as much as students entering family practice, general internal medicine, and pediatrics.

I report rates of return to specialization in Table 2. In every year between 1986 and 1998 there was a positive return to an investment in specialized training, where family practice represents the benchmark specialty with only three years of residency training. The rates of return are strikingly large, especially between 1986 and 1992, and have persisted for a longer time period than could be explained by the lag between an income shock and an increase in the supply of newly trained physicians. The rates of return in anesthesiology and radiology, specialties that require only one additional year of training relative to family practice, often exceeded 100 percent. The rates of return in orthopedic and general surgery, specialties that require two extra years of training, were greater than 38 percent. Cross-section rates of return have fallen in all specialties since 1992 but still greatly exceed the empirical estimates of the real discount rate (Gramlich, 1990).

Investments in specialty training appear to have become more lucrative over the last two decades. Using income data from 1967 to 1980, Burstein and Cromwell (1985) estimate a cross-section rate of return for obstetricians/gynecologists and general surgeons of between 10 percent and 15 percent. Marder and Willke (1991) also estimate large cross-section rates of return to training in the non-primary care specialties using data from 1987: radiology (47 percent), anesthesiology (40 percent), ob/gyn (26 percent), psychiatry (24 percent), and general surgery (22 percent). These rates of return are smaller than the ones I estimate for 1986, probably because their benchmark specialty consists of primary care practitioners with fewer than three years of residency training, whereas my benchmark is dominated by board-certified family practitioners with three years of residency training.

III. Explanations for Persistently High Rates of Return to Specialization

I now examine reasons why the rates of return to specialization presented in Table 2 are so high. If medical students have the same preferences, ability, discount rates, and there are no liquidity constraints and barriers to entering specialties, the rate of return in each specialty should be equal to the discount rate (Willis, 1986). If any of these assumptions does not hold, the rate of return to specialty training could vary across specialties and differ from the discount rate.

I begin by examining four explanations why the rates of return to specialization might be so large that all relate to the supply of medical students to specialties: equalizing differences, heterogeneous ability, liquidity constraints, and the nature of medical students' income expectations. I then examine three explanations that relate to the demand for residents: restrictions on the number of residents due to cartel behavior, scarcity of teaching material, and restrictions on the residents' wage imposed by a private, accrediting organization.

When medical students choose a specialty they clearly care about more than just income and leisure. In a 1992 survey, medical students were asked to identify specialty attributes that had a strong or major influence on their specialty decision. The attributes receiving the largest number of affirmative responses were the intellectual content of the specialty (61 percent), the existence of challenging diagnostic problems (60 percent), and the degree of emphasis on people skills (39 percent). Only seven percent of the students indicated that the relative income of the specialty had a strong or major influence on their choice. Predictable working hours, prestige, and the presence of research opportunities were all considered to be more important than income.

When preferences for non-monetary attributes are heterogeneous, the compensating differential of the marginal student — the student exactly indifferent between family practice and an alternative specialty -- will determine the rate of return for that specialty. The larger is the compensating differential of a particular specialty relative to family practice, the higher will be the rate of return to that specialty because students will require "extra" compensation in order to enter. Large rates of return to specialization will exist if medical students believe that non-primary care specialties have relatively undesirable non-monetary attributes, such as inflexible work schedules or a higher incidence of malpractice suits.

A second possible explanation for large rates of return to specialization is the presence of liquidity constraints. A medical student who wants to maximize his lifetime income and smooth consumption over his lifetime might decide to forego a non-primary care specialty with a high rate of return for a primary care specialty if he is unable to borrow sufficient funds while a resident. If this occurs on a wide scale, non-primary physicians' incomes will be driven up. Smoothing consumption becomes more challenging when residents have substantial debt payments. The mean amount of debt among U.S. medical school graduates in 2001 was $82,000, up from $45,000 in 1992.[11]

A third possible explanation for high rates of return to specialization is that there are returns to ability in medicine, and these returns are particularly large in non-primary care specialties. In such a scenario, high-ability students would self-select into non-primary care specialties and low-ability students would become primary care physicians. When estimating cross-section rates of return, I assume implicitly that the returns to ability do not differ across specialties. If the returns to ability are higher in non-primary than primary care, the observed mean income of family practitioners would understate what a high-ability student would expect to earn in primary care, and I would estimate too high a rate of return to specialization.

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[11] Data on indebtedness is from the AAMC Medical School Graduation Questionnaire.

Bhattacharya (2000) estimates a model where a student's choice of specialty and her specialty-specific income are endogenous. A student's debt and age at the completion of medical school are assumed to affect her specialty choice but not her income conditional on the choice of specialty. Using data from 1990, Bhattacharya estimates the income that physicians in specialty A would make if they had chosen specialty B instead, and compares this estimated income with the actual incomes of physicians practicing in specialty B. Although he finds evidence that students who select non-primary care specialties would earn more as primary care physicians than primary care physicians actually earn, the annual wage premiums are usually less than five percent. If Bhattacharya's result from 1990 can be generalized, self-selection on the basis of ability does not appear to be the primary explanation for high rates of return to specialty training.[12]

A final supply-side explanation is that the cross-section rate of return calculation assumes that medical students have static income expectations; they expect the contemporaneous age-earnings profile in each specialty to remain constant in real terms. If students have forward-looking income expectations, then medical students' expected returns from training might diverge sharply from the cross-section rates of return. For example, although practicing radiologists and anesthesiologists are currently receiving large incomes, medical students might believe that managed care, technological changes such as digitized radiology, and the increased supply of nurse anesthetists will drive down physician incomes in these specialties in the future. In this case, the e*xpected* rate of return that is influencing students' specialty choices might be substantially lower than the 83 percent (radiology) and 47 percent (anesthesiology) figures reported in Table 2. Nicholson and Souleles (2002) find evidence that medical students do, to some extent, incorporate future trends in specialty income into their own income expectations.

[12] Nicholson and Souleles (2002) also find some evidence of selection according to ability; students who chose non-primary care specialties expected to earn more in those specialties than students who actually chose primary care specialties.

If students consider ability, debt, and equalizing differences when selecting the specialty that maximizes utility, and if a large number of students choose primary care as a result, then rates of return to specialization could certainly vary across specialties and exceed the discount rate. However, collectively these factors cannot fully explain the observed high rates of return. If supply-side considerations were the sole cause of high rates of return, the supply of medical students to each specialty would equal the demand for residents in that specialty. This is not the case; there is a persistent excess supply of residents to most specialties that have high rates of return, which indicates that medical are trying unsuccessfully to capture the perceived rents in non-primary care.

The method by which medical students choose residency positions offers a rare opportunity to separately observe the desired and realized supply of labor, and therefore to observe a market in disequilibrium. More than 80 percent of the students who graduate from a U.S. medical school apply for a residency position through the National Resident Matching Program ("the Match"). Each applicant ranks residency positions in the Match in descending order of his preference; each residency program ranks applicants in descending order of its preference; and a computer algorithm makes binding assignments. Ratios of the supply of to the demand for residents between 1991 and 2002 are presented in Figure 1 for nine specialties. The supply of residents to a specialty is defined as the number of applicants who rank a residency program from that specialty as their first choice in the Match; the demand for residents is defined as the number of first-year residency positions offered in the Match by teaching hospitals.

In 1991 there was an excess supply of residents in radiology, ob/gyn, and orthopedic surgery -- specialties with high rates of return according to Table 2 (column 3 and 4). In dermatology, which began offering residency positions through the Match in 1997, there are almost twice as many applicants as positions available. These ratios probably understate the imbalance between the number of students who want to get into specialties with high rates of return and those who are actually accepted. Nicholson

(2002) argues that there are costs of not receiving a position in the Match, so risk averse students with a relatively low probability of entering their desired specialty may choose an alternative as their first choice in the Match. Due to the excess supply of residents, forty percent of the U.S. medical graduates who ranked an orthopedic surgery program first in the Match did not receive an assignment in that specialty.[13] The unmatched rates in radiology (23 percent) and ob/gyn (17 percent) were smaller but still substantial. According to Figure 1, specialties with relatively low earnings such as family practice, internal medicine, pediatrics, and psychiatry were experiencing an excess demand for residents.[14]

Since disequilibrium in the market for residents may create an economic shortage of non-primary care physicians in the physician services market and create rents for non-primary care physicians, I now examine more closely how the market for residents functions. In 2002, residency programs were offered in 26 different specialties by over 1,200 U.S. teaching hospitals. Medical students must receive at least one year of residency training in order to practice medicine in the United States, and if a medical student wishes to become licensed to practice, he must attend an accredited residency program. Therefore, the market for residents is an intermediate market that largely determines the number and distribution of physicians in the United States, much as law schools are an intermediate market for determining the number of lawyers.

Consider a well functioning market for residents and physicians in the simple case where there is a single primary care (PC) and a single non-primary care (NPC) specialty. Consumers' aggregate demand for primary and non-primary care physician services is depicted in Panel B of Figure 2 as a downward function of the price of physicians' services, or the physicians' fee (P_{NPC} and P_{PC}). Residents are an input into the production of hospital patient care and perhaps also an argument in the utility function of a non-profit hospital. Teaching hospitals' aggregate demand for primary and non-primary care residents,

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[13] Data on match rates are from the NRMP (National Resident Matching Program) *Data Book*.

depicted in Panel A of Figure 2, is negatively related to the residents' wage (w^{PC} and w^{NPC}), as with all factors of production. Conditional on the residents' wage, the supply of physician services in a specialty (S_{NPC} and S_{PC} in Panel B) is an increasing function of the price of physicians' services in that specialty because more medical students will enter the specialty as expected lifetime earnings increase; conditional on the price of physicians' services, the supply of residents (S^r_{NPC} and S^r_{PC} in Panel A) is an increasing function of the residents' wage in a specialty for the same reason.[15]

The markets for residents and physicians are depicted in long-run equilibrium in Figure 2. Each year teaching hospitals hire Q^r_{NPC} non-primary care residents and Q^r_{PC} primary care residents and pay them wages W_{NPC} and W_{PC}, respectively. This flow of residents just offsets the number of physicians retiring in the two specialties each year, such that the supply of physician services remains unchanged at Q_{NPC} and Q_{PC}. The residents' wages and prices for physicians' services are such that the marginal medical student is indifferent between the two specialties. In this well-functioning market, non-primary and primary care residents may receive substantially different wages in equilibrium unless they are perfect substitutes in the hospital production function and the desired supply to the two specialties are identical.

According to Figure 1, in many specialties with high rates of return the supply of residents exceeds teaching hospital's demand for residents. In a well-functioning labor market, medical students who wanted to enter orthopedic surgery, radiology, ob/gyn, and dermatology -- specialties with high rates of return relative to family practice and an excess supply of residents in the Match -- would bid down the residents' wage in those specialties. As the cost of hiring these residents falls, teaching hospitals would move down their demand curve and offer more residency positions in these specialties. Over time, as

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[14] Although it had a high rate of return, anesthesiology also had an excess demand for residents. As mentioned above, however, during this time period medical students probably expected future anesthesiology incomes to be below their contemporaneous levels due to the advent and growth of nurse anesthetists.

[15] In Figure 2 the supply curves are upward-sloping rather than perfectly elastic because I assume there are heterogeneous preferences among medical students for the non-monetary attributes of the two specialties; it will take a large increase in the primary care fee, for example, to induce a student who places a high value on the prestige associated with non-primary care to switch specialties.

more residents complete training in non-primary care specialties, the supply of non-primary care physician services in Panel B of Figure 2 would shift out, and the price of non-primary care physician services and the rate of return to non-primary care would fall as well. Likewise, teaching hospitals would be expected to raise the residents' wage when necessary to fill vacancies, such as occurred in pediatrics, family practice, and internal medicine in the early 1990s.

I offer three possible explanations for why the market for residents does not clear. One explanation is that the Accreditation Council for Graduate Medical Education (ACGME), a private organization responsible for overseeing residency training, may purposefully limit residency positions in order to secure rents for practicing physicians. The ACGME is sponsored by five organizations: the American Medical Association, the American Board of Medical Specialties Specialties (e.g., American Board of Dermatology), the Association of American Medical Colleges, the American Hospital Association, and the Council of Medical Specialty Societies (e.g., American Academy of Dermatology) (Graduate Medical Education Directory, 1996). The ACGME sets overall policies and allows a separate Residency Review Committee (RRC) to review and accredit residency programs in each of the 26 specialties. Each of the five sponsoring organizations appoints four representatives to an RRC and the government appoints one non-voting representative.

A teaching hospital that wants to open a new residency program or increase the number of residents in an existing program must apply to the relevant RRC.[16] A RRC considers a number of factors when deciding whether to approve a program and how many residents may be trained at each program: "Those numbers (of residents who may be trained by a program) will be based primarily on the number, qualifications, and commitment of the faculty; the volume and variety of the patient population available

[16] The RRCs also periodically review established programs to ensure they are in compliance with the standards. Programs may be placed on probation and eventually closed if they do not address concerns of the RRC. For example, the Thoracic Surgery RRC reviewed 43 vascular surgery programs in 1990 and 1991. Twenty-six percent of the programs were cited for inadequacies in continuity of care, and 16 percent were cited for a lack of formal periodic evaluation of the residents (Barnes, 1993).

for educational purposes; the quality of the educational offering; and the totality of the institutional resources" (Accreditation Council for Graduate Medical Education, 1996). The current approval process for residency positions has the appearance of a "fox guarding the chicken coop." A Residency Review Committee consists primarily of physicians from the same specialty, and its decisions affect the future supply of physicians and physician income in that specialty.

A RRC essentially has complete control over the flow of physicians into a specialty because medical students who attend residency programs that are not certified by the ACGME are not eligible to take the licensing exam, and thus are not able to practice in the United States. In this sense, a RRC has the same power as a labor union that is the sole source of a certain type of labor and negotiates collectively with a firm or set of firms. Economists have modeled labor unions as maximizing a utility function whose arguments are the quantity of union members employed and either the workers' rents or the total wage bill, subject to the firms' labor demand (Pencavel, 1984; MaCurdy and Pencavel, 1986). The union chooses the wage and firms respond by hiring a quantity of union workers such that the marginal product equals the wage.

The relevant constraint for a RRC is consumers' aggregate demand for physician services (D_{NPC} in Figure 3 for the non-primary care RRC). The RRC's utility function has been drawn so that it is tangent to the demand curve at Point J. Whereas a union chooses the wage and allows a firm to choose the profit-maximizing quantity of labor conditional on that wage, a RRC would choose the flow of residents (Q^r_{NPC}) that will in the long run produce the desired, utility-maximizing quantity of physician services (Q_{NPC}) and price of those services (P_{NPC}).[17] In order to ensure that the optimal quantity of non-primary care services will be supplied, the RRC could place a cap of Q^r_{NPC} on the number of residency

[17] Although a residency review committee can control the number of physicians in a specialty, it cannot control the number of hours physicians work once they are licensed, and therefore cannot precisely determine the quantity of services supplied.

positions that could be approved. In Panel A of Figure 3, the effective demand for non-primary care residents would be truncated at Q^r_{NPC}.

Whether a RRC's imposition of restrictions on residency positions reduces welfare depends on whether physicians can induce demand for their services.[18] In Panel B of Figure 3, the shaded rectangle represents the rents that non-primary care physicians receive, where P^*_{NPC} is the price of physician services that would prevail if the market for residents cleared.[19] These rents represent a transfer from consumers to physicians and therefore do not represent a loss of social welfare. At Point J there will not appear to be a shortage of non-primary care physician services because supply equals demand at the prevailing price P_{NPC}. However, if the RRC allowed the market for non-primary care residents to clear and physicians were not able to or were unwilling to affect the demand for their services, the price for non-primary care physician services would fall to P^*_{NPC}, and the quantity of services would increase. Therefore, the black triangle in Figure 3 would represent the loss in consumer surplus due to the restrictive behavior of the RRC. The more elastic is the demand for physician services, the greater would be the welfare loss. If physicians are able to induce demand for their services, on the other hand, then increasing the flow of non-primary care residents from Q^r_{NPC} to Q^{r*}_{NPC} may actually reduce welfare because the physicians would perform services whose costs exceed their benefit.

If cartel behavior by RRCs explains the rents enjoyed by non-primary care physicians, then a logical question is why the primary care RRCs don't further reduce the flow of residents to increase the income of primary care physicians closer to the levels experienced by non-primary care physicians.[20] One explanation is that the demand for primary care services may be more elastic than for non-primary

[18] See McGuire (2000) for an extensive review of the role of physicians as agents, and their ability to induce demand for their services.

[19] Kleiner (2000) finds that workers in professions that require licensing, such as dentists, earn rents relative to workers of comparable human capital.

[20] It is possible that primary care physicians are capturing rents relative to students who enter a non-medical occupation. Weeks *et al*. (1994), however, find that primary care physicians experience lower rates of return to

care services, so the rents available to a primary care RRC would be much lower than for a non-primary care RRC. That is, a primary care RRC facing a flatter demand curve would choose a higher quantity of physicians and lower rents than a non-primary care RRC facing a steep demand curve if the two committees have the same preferences. It seems plausible that there are more substitute providers for primary than non-primary care, and therefore that the primary care demand curve will be relatively elastic.[21] A second explanation is that the primary care specialties are relatively populous, and it may be more difficult for a RRC representing a large constituency to restrict entry than one representing a small constituency. There are between 50,000 (pediatrics) and 98,000 physicians (general internal medicine) in each of the three primary care specialties, whereas the non-primary care specialties displayed in Table 1 have between 23,000 (orthopedic surgery) and 45,000 physicians (psychiatry). A third explanation is that primary care RRCs may have different preferences; they may place a greater weight on the quantity of physicians in the specialty relative to the rents received than non-primary care RRCs.

There is a second, more benign possible explanation for why the market for residents does not clear. In many procedural specialties, the RRCs have established a threshold for the minimum number of procedures that residents must complete during their training.[22] The RRC for Thoracic Surgery, for example, requires vascular surgery residents to perform at least 70 “major” cases (Barnes, 1993). A teaching hospital applying to expand an existing residency program or open a new program must show that there is a sufficient volume and variety of patients such that residents will meet these thresholds.[23] A minimum volume threshold could have the same impact on the market for residents as cartel behavior. In Figure 3, teaching hospitals’ demand for non-primary care residents would be truncated at Q^r_{NPC} if that is

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educational training than students who receive a masters in business administration from a highly-ranked school and attorneys – people who arguably face the same occupational choice sets as medical students.

[21] Nurse practitioners and specialists, for example, can perform many of the functions of a primary care physician.

[22] According to personal correspondence with Dr. David Leach, Executive Director of the ACGME, in April 2001.

[23] Most RRCs do not report the volume thresholds to the public.

the maximum number of residents that can be trained given the existing quantity of non-primary care patients at teaching hospitals.

One benefit of licensing is that when there is asymmetric information about the product or service, such as exists between a patient and a physician, licensing helps assure the patient that the physician has been adequately trained and will provide services exceeding some minimum acceptable (to the licensing organization) quality (Leland, 1979). It is possible, of course, that the minimum volume thresholds are a way of camouflaging cartel behavior. However, a RRC could conceivably enhance rather than decrease social welfare if the marginal benefit of an additional case on a physician's skill is large, and physicians would under invest in these skills without regulation because consumers cannot detect quality differences between physicians. However, if non-primary care RRCs are restricting residency positions to ensure a competent labor force, why don't teaching hospitals increase the number of patients available to residents? This could be achieved by either rotating residents through multiple hospitals in the course of their training, which already occurs to some extent, or by centralizing scarce types of patients at a single facility.

A third possible explanation for why the market for residents does not clear is that the ACGME has established a minimum wage for residents and used to require teaching hospitals to pay all residents the same wage, regardless of specialty. Until recently, the ACGME had established the following policy related to residents' salaries: "Financial support of residents is necessary to ensure that residents are able to fulfill the responsibilities of their educational programs. All residents at similar levels of experience and training in all of an institution's programs should receive a comparable level of financial support. Exceptions must be justified to the institution's Graduate Medical Education Committee" (Accreditation Council of Graduate Medical Education, 1996). Teaching hospitals have adhered to the ACGME's policy. The mean residents' salary nationally was almost constant across specialties in 1992, ranging from $28,200 in family practice to $29,300 in radiology. Anecdotal data and an analysis of a small sample of New England teaching hospitals indicates that almost all teaching hospitals paid residents the same salary, regardless of their specialty.

The Federal Trade Commission interpreted the ACGME's policy on residents' wages as a restraint of trade, so the ACGME recently added "adequate" to the beginning of the policy statement quoted above, and dropped the second and third sentences: "Adequate financial support of residents is necessary to ensure that residents are able to fulfill the responsibilities of their educational programs."[24] The principal objective of the current ACGME policy is to ensure that residents are paid enough so they will not feel compelled to take a second job, such as working a 24-hour shift in a hospital emergency room.[25] Moonlighting when a resident is already working 60 to 80 hours a week is perceived to endanger patients' lives and/or reduce the quality of the residency training.

The ACGME has not specified what the minimum wage is. However, one could imagine that a teaching hospital seeking permission to open or expand a program would risk rejection by the RRC if it proposed to pay its residents substantially less than the prevailing mean wage. The imposition of a minimum wage for residents could create abnormally high rates of return to specialization. In Figure 3, say the minimum wage is set at $\underline{W}$. Q^r_{NPC} residents would be hired, the same number as under the cartel model and the situation with limited clinical "teaching material." Therefore, each of the three potential explanations for why the market for residents does not clear could result in the same number of realized, observed non-primary care residents, and thus the same number of non-primary care physicians. Since it is difficult to distinguish empirically which of these three explanations is the principal cause of market failure, I focus in the next section on simulating the impact of allowing the market for residents to clear, without specifying the specific policy that would achieve this objective.

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[24] http://www.acgme.org

[25] According to personal correspondence with the Executive Director of the ACGME in April 2001.

IV. Simulating the Clearing of the Market for Residents

In this section I estimate the set of specialty-specific residents' wages that would equate the supply and demand of residents, and examine the implications of market clearing on the quantity of residents in each specialty, the rates of return to specialization, and teaching hospitals' labor expenses. Designing the policy that would allow the market to clear requires knowing what is preventing the market failure. If RRCs purposeful restrict residency positions to gain rents, the relevant policy would be the establishment of an objective, unbiased organization to approve residency programs. If there is insufficient teaching material in certain specialties, then the implicit action behind the simulation is a centralization of scarce patient types at teaching hospitals or rotating residents through multiple teaching hospitals. If market failure is due primarily to the minimum residents' wage, the relevant policy is the elimination of this rule.

Panel A of Figure 3 depicts a specialty with an excess supply of residents. Q^{r}_{NPC} residents are hired at wage $\underline{W}$. Q^{M}_{NPC}, the number of applicants who rank the specialty as their first choice in the Match, is also observed. Let W^{*}_{NPC} be the wage that equates the supply of and demand for residents, and Q^{r*}_{NPC} the quantity of residents employed under such circumstances. My goal is to estimate, for specialties that are currently experiencing an excess supply of residents, the market clearing wage and quantity (W^{*}_{NPC} and Q^{*r}_{NPC}). That is, I am trying to identify where the unrestricted supply and demand curves for residents intersect (Point K in Panel A of Figure 3). I simulate a partial rather than a general equilibrium model, because I do not allow medical students' income expectations to be affected by changes in the flow of residents, or medical students' subjective expectation of entering a specialty to depend on the number of residency positions offered.

If one knows the percentage change in the quantity of residents demanded associated with a one percent increase in the residents' wage (0^{d}), and the percentage change in the quantity of medical students who wish to enter a specialty associated with a one percent increase in the residents salary in that specialty (0^s), then one can solve the following two equations for W* and Q* -- the wage and quantity of residents that would clear the market at Point K:

$$(3) \qquad Q^* = Q^s \left(1 + \eta^s \frac{(W^* - W)}{W}\right) \quad ; \quad Q^* = Q^d \left(1 + \eta^d \frac{(W^* - W)}{W}\right),$$

where Q^s is the observed number of students who currently rank a specialty first in the Match (supply), Q^d is the observed number of residency positions offered in the Match (demand), and W is the prevailing residents' salary, which is the same in both specialties.

I use an estimate of 0^d (-0.08) from Nicholson and Song (2001). This parameter is identified by cross-sectional variation (across hospitals) in the change in the price of residents caused by a revision in 1986 of the government subsidization of residents.[26] The dependent variable in this analysis was the change in the number of residents hired by a teaching hospital between 1986 and 1991. One reason teaching hospitals may be unresponsive to changes in the price of residents is that they are constrained, either by residency review committees or by the lack of patients, in how many positions they can offer. If there were constraints on the demand for residents during this time period, the –0.08 demand elasticity would be biased toward zero; if teaching hospitals had been unconstrained when the policy altered the financial incentives to hire residents, they would have responded more aggressively to the change. Based on aggregate data, the barriers to entry were weaker between 1986 and 1991 than they are now. In the 1986-1991 period, for example, there was an average of 110 fewer residency positions available in the Match per year than there were applicants, whereas in the 1997-2002 period, there was an average of 4,800 fewer positions available per year than applicants. Nevertheless, in the simulation I also examine a scenario where the demand elasticity is twice as large in absolute value (-0.16) as that estimated in Nicholson and Song (2001).

[26] In 1986 Medicare made indirect medical education payments less generous and allowed teaching hospitals in Massachusetts and New York to receive these payments.

Since I am simulating the residents' wage that will clear the market for residents, ideally I would like 0^s to be an estimate of how responsive medical students' specialty choices are to the residents' wage. There is, as mentioned above, little cross-sectional variation in the residents' wage between specialties, so it is difficult empirically to measure such an elasticity. Therefore, I estimate 0^s as the responsiveness of medical students to the mean income of a practicing physician in a specialty, and then convert this estimate into a comparable measure in terms of the residents' wage.[27] Specifically, I estimate the following regression equation using ordinary least squares:

$$\text{(4)} \qquad \log(Q^s_{j,t}) = \beta_0 + \beta_1 \text{Specialty}_j + \beta_2 \log(Y_{j,t-1}) + \varepsilon_{j,t} \, ,$$

where Q^s is the number of Match applicants who rank specialty j as their first choice in year t. Q^s is the number of students who *desire* to enter a specialty rather than the number who successfully enter a specialty, and should therefore be a reasonably good measure of the supply of residents if there were no constraints on the number of positions available. The above equation is estimated using aggregated data on all Match applicants from 1986 and 1991-1999 for 12 specialties.[28] Mean physician income in specialty j ($Y_{j,t-1}$) is lagged one year because most surveys of physician income, including the AMA survey data that are used here, are published and available to medical students one year after the survey is conducted.[29]

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[27] I use the mean income of a specialty rather than the cross-section net present value of lifetime income because age-specific income data are not available in dermatology and emergency medicine. β_2 (in equation 4) measures the percentage change in the number of medical students who rank a specialty first in the Match in response to a one percent increase in the mean income of physicians in that specialty. In order to simulate residents' wages that will clear the market for residents, I want to know how medical students' specialty choices respond to changes in the residents' wage rather than the change in the mean income of practicing physicians. A general surgeon will practice for about 30 years but serve as a resident for only five years. Using general surgery as a representative non-primary care specialty, a one percent increase in the annual income of a practicing physician has the same cumulative impact on a surgeon's present value of lifetime earnings as a 27 percent increase in the annual salary of a resident. In the simulation, therefore, I divide β_2 by 27 when analyzing how a change in the residents' wage affects specialty choices.

[28] Data on the number of Match applicants who rank a specialty first were not available for 1987-1990.

[29] Income is adjusted for differences in hours worked between specialties using a Laspareyes-type adjustment based on hours worked by family practitioners.

Specialty indicator variables are included in equation (4), so the coefficient β_2 is identified by variation over time within a specialty in the mean income of practicing physicians. It is evident from Figure 4 that during the 1990s there was substantial variation between specialties in the growth rate of physician income. When the contemporaneous mean income rises in a specialty that already has an excess supply of residents, the rents associated with the specialty will increase, but the probability of entering the specialty will remain less than one. Since there are costs associated with failing to receive an assignment in the Match (Nicholson, 2002), the increased rents may convince fewer students to rank the specialty first in the Match than if there were no barriers to entry. In a specialty that is not demand-constrained, on the other hand, an increase in contemporaneous income may overstate the change in students' expected lifetime income if students forecast that the supply of physicians in that specialty will increase, which will eventually drive down the price of physician services.[30] Since β_2 may be biased downward, in the simulation I include a scenario where the supply elasticity is 50 percent larger than the elasticity derived with β_2.

I estimate equation (4) separately for U.S. and international medical school graduates (IMGs) because these groups may respond differently to income variation between specialties. I use the β_2 coefficient estimate from the U.S. medical school regression in the simulation below. I include year indicator variables in the IMG regression because immigration policy may affect the total number of non-U.S. citizens allowed to enter the Match.

Results for the supply regression are presented in Table 3. The coefficient on income in the U.S. medical school graduate regression (column 1) is positive and significant. A one percent increase in a specialty's contemporaneous income is associated with a 1.35 percent increase in the number of U.S.

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[30] Siow (1984) presents a model where only a single cohort of lawyers expect to receive rents following a shock to expected income because future cohorts will arbitrage away the rents.

medical school graduates who rank that specialty as their first choice in the Match.[31] The coefficient on income is also positive in the international medical graduate (IMG) specification but is not significantly different from zero at the 10-percent level. The monotonically increasing coefficients on the year dummies in the IMG regression indicate that the total number of foreign-trained physicians entering the U.S. for residency training increased throughout the 1990s.

In Table 4 I present the simulation results for the wage that would clear the market for residents in four specialties where there is currently an excess supply of residents. In most specialties in the 2001 Match there were more U.S. and international students who ranked a specialty as their first choice than there were positions available in that specialty. For purposes of the simulation, I adopt a more conservative definition of a specialty that has an excess supply of residents: a specialty where the number of U.S. medical school graduates (international medical graduates are omitted) who rank that specialty first in the Match exceeds the number of available positions. U.S. medical students are generally perceived by residency programs to be better qualified than students trained internationally, as evidenced by the much higher acceptance rate of U.S. students relative to IMGs in the Match.[32] If teaching hospitals have a minimum quality threshold for residents, the effective supply of residents will be less than the observed supply. Four specialties were experiencing excess supply in the 2001 Match according to this stricter definition: dermatology, general surgery, radiology, and orthopedic surgery.

The first column of Table 4 reports the number of residency positions offered in the 2001 Match (Q^d). The excess supply of residents is reported in the second column, where "excess supply" is defined as the number of U.S. medical students who ranked a specialty first in the Match but did not receive a position in that specialty in the Match. This is an underestimate of the true excess supply because some

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[31] This supply elasticity is similar to the 1.42 estimated by Nicholson (2002). Using a cross-sectional data set of medical students who graduated in 1992, he accounts for entry barriers by allowing a student's expected lifetime earnings in a specialty to depend on his likelihood of entering the specialty.

international students who did not receive a position in the Match would be hired by teaching hospitals at some wage, and the figure is an overestimate because some of the U.S. students who rank the specialty first would not be hired by teaching hospitals regardless of the wage.

The top panel of Table 4 presents results of the simulation using the -0.08 elasticity of demand from Nicholson (2002) and the elasticity of supply estimated above (1.35), converted into an elasticity with respect to the residents' wage rather than the mean income of a practicing physician. As mentioned previously, in a market with no or fewer barriers to entry, teaching hospitals might be more price-responsive than they have been in the past. Therefore, in the bottom panel of Table 4 I report simulation results with an elasticity of demand for residents, which is twice as large in absolute value as in the top panel (-0.16) and an elasticity of supply that is about 50 percent larger than that of Table 3 (2.0).

Using the relatively inelastic elasticity parameters (Scenario I), teaching hospitals are predicted to receive an annual payment of $95,000 from dermatology residents rather than paying them $34,000 per year, as is currently the case. The quantity of first-year dermatology residents is predicted to increase from 252 to 328, or by 30 percent. The new residents' wage is predicted to reduce the rate of return to the incremental year of dermatology training (relative to family practice) from 47 percent to 12 percent, a figure that is much closer to empirical estimates of the discount rate. If the increased supply of dermatologists eventually lowers the price of dermatology services, the new rate of return to dermatology would fall even further.

The equilibrium residents' wage in general surgery, radiology, and orthopedics are likewise predicted to be negative, but not as large in absolute value as for dermatology. The number of first-year residents hired in these three specialties is predicted to increase by 8 percent, 16 percent, and 10 percent, respectively, and the rates of return to training fall below 24 percent in all three specialties. One

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[32] In the 2001 Match, for example, 79 percent of U.S. medical school graduates who ranked orthopedic surgery as their first choice received a position in that specialty in the Match, versus 25 percent of the IMGs who ranked orthopedic surgery as their first choice (*NRMP Data*, *2001*).

implication of removing the barriers to entering residency programs is that teaching hospitals are predicted to reduce their net wage payments to residents by $1.0 billion per year if the lower wages were fully phased-in to residents of all experience levels (not just first-year residents) in the affected specialties.

In the bottom panel of Table 4 I simulate the residents' wage that clears the market when teaching hospitals and prospective residents are more responsive to price changes. In Scenario II, the equilibrium quantity of residents in each of the four specialties is larger and the equilibrium residents' wage is smaller than in the first simulation. Dermatology residents, for example, are predicted to pay hospitals $40,000 per year, and the quantity of dermatology residents is predicted to increase by 35 percent. Teaching hospitals would be predicted to spend $572 million less on resident salaries, and rates of return in all four specialties would be below 32 percent.

Conclusion

Medical students have experienced persistently large rates of return to specialization. These relatively high rates of return could be due, in part, to equalizing differences, variation in returns to ability by specialty, and liquidity constraints. However, these factors cannot fully explain the high rates of return to specialization because throughout the 1990s there have consistently been more medical students seeking entry into specialties with high rates of return than there are positions available. This implies that barriers to entry in the market for residents may affect the realized supply and price of physicians services and help create rents to non-primary care specialists.

I examine a number of explanations for persistent high rates of return to medical specialization and conclude that barriers to entry may be creating an economic shortage of non-primary care physicians. I estimate that medical students would be willing to pay teaching hospitals for residency training in dermatology, general surgery, orthopedic surgery, and radiology rather than receiving the average residents' salary of $34,000. When I simulate the residents' wage that clears the market, the quantity of residents in these four specialties is predicted to increase by an estimated six to 30 percent, rates of return would fall substantially, and teaching hospitals would save an estimated $0.6 to $1.0 billion per year.

References

Accreditation Council of Graduate Medical Education, 1996. *Graduate Medical Education Directory, 1996-1997*. Chicago, IL.

Barnes, Robert W., 1993, "The Residency Review Committee for Surgery and the Training of Vascular Surgeons," *Journal of Vascular Surgery* 17: 971-974.

Bhattacharya, Jayanta, 2000, "What Are the Returns to Specialization in Medicine?," mimeo.

Burstein, Phillip L., and Jerry Cromwell, 1985, "Relative Incomes and Rates of Return for U.S. Physicians," *Journal of Health Economics*, 4: 63-78.

Gramlich, Edward M., 1990. *A Guide to Benefit-Cost Analysis, 2nd edition*. Englewood Cliffs, NJ: Prentice Hall.

Jung versus Association of American Medical Colleges. Filed May 7, 2002, in the U.S. District Court for the District of Washington, D.C. Available at www.aamc.newsroom/jungcomplaint/jung~mrmp.pdf. Accessed March 11, 2003.

Kleiner, Morris, 2000, "Occupational Licensing," *Journal of Economic Perspectives* 14(4): 189-202.

Lindsay, Cotton M., 1973, "Real Returns to Medical Education," *Journal of Human Resources*, 3(3): 331-348.

Leland, Hayne E., 1979, "Quacks, Lemons, and Licensing: A Theory of Minimum Quality Standards," *Journal of Political Economy* 87(6): 1328-1346.

MaCurdy, Thomas E., and John H. Pencavel, 1986, "Testing Between Competing Models of Wage and Employment Determination in Unionized Markets," *Journal of Political Economy* 94(3): S3-S39.

Marder, William D., and Richard J. Willke, 1991, "Comparisons of the Value of Physician Time by Specialty," in Frech, H.E. (ed). *Regulating Doctor's Fees*. Washington, D.C.: American Enterprise Institute Press.

McGuire, Thomas, 2000, "Physician Agency," in *Handbook of Health Economics*, edited by Anthony J. Cuyler and Joseph P. Newhouse. Amsterdam: Elsevier Science B.V.

Miller, Frances H., and Thomas L. Greaney, 2003, "The National Resident Matching Program and Antitrust Law," *Journal of the American Medical Association* 289(7): 913-918.

Nicholson, Sean, and David Song, 2001, "The Incentive Effects of the Medicare Indirect Medical Education Subsidy," *Journal of Health Economics* 20(6): 909-934.

Nicholson, Sean, 2002, "Physician Specialty Choice Under Uncertainty," *Journal of Labor Economics*, forthcoming.

Nicholson, Sean, and Nicholas S. Souleles, 2002, "Physician Income Expectations and Specialty Choice," mimeo.

Pencavel, John, 1984, "The Tradeoff Between Wages and Employment in Trade Union Objectives," *Quarterly Journal of Economics* 99(2): 215-231.

Physician Payment Review Commission, 1995. *Annual Report to Congress*. Washington, D.C..

Siow, Aloysius, 1984, "Occupational Choice Under Uncertainty," *Econometrica,* 52(3): 631-645.

Weeks, William B., Amy E. Wallace, Myron M. Wallace, and Gilbert Welch, 1994, "A Comparison of the Educational Costs and Incomes of Physicians and Other Professionals," *The New England Journal of Medicine* 330(18): 1280-1286.

Willis, Robert J., 1986, "Wage Determinants: A Survey and Reinterpretation of Human Capital Earnings Functions," in O. Ashenfelter and R. Layard, eds., *Handbook of Labor Economics*. The Netherlands: Elsevier Science Publishers.

Table 1

Cross-Section Net Present Value of Lifetime Practice Earnings, 1986-1998
($ millions, 1998 dollars)[33]

Specialty	1986	1990	1992	1994	1996	1998	Percentage Change 1986–1992	Percentage Change 1992-1998
Radiology	5.23	5.78	6.30	5.30	6.42	5.84	20.5%	-7.3%
Orthopedic surgery	5.73	6.76	6.18	5.95	6.35	5.60	7.9%	-9.4%
General surgery	4.24	4.73	4.94	4.63	4.55	4.46	16.5%	-9.7%
Anesthesiology	4.57	5.02	5.29	4.91	N/A	4.34	15.8%	-18.0%
OB/GYN	3.69	4.86	4.63	3.99	4.70	3.82	25.5%	-17.5%
Psychiatry	3.24	3.49	3.70	3.20	3.21	3.32	14.2%	-10.3%
Family Practice	2.57	2.76	2.78	2.77	2.99	3.07	8.2%	10.4%
General internal med	2.69	3.11	3.10	2.89	3.23	2.99	15.2%	-3.5%
Pediatrics	2.56	2.92	3.08	2.81	3.11	2.89	9.8%	-6.2%

Notes: the net present values are adjusted for differences in hours worked per year, and a three percent real discount rate is used. In 1996 the American Medical Association did not report income data for anesthesiologists with several experience levels in, so the net present value was not available (N/A).

Source: *Physician Socioeconomic Characteristics*, American Medical Association; author's analysis.

[33] Adjusted using the urban consumer price index.

Table 2

Cross-Section Rates of Return to Specialization, 1986-1998
(relative to family practice)

Specialty	Years of Training	1986	1990	1992	1994	1996	1998
Radiology	4	107	89.2	N/A	119	173	83.3
Anesthesiology	4	105	N/A	235	216	N/A	46.5
OB/GYN	4	45.4	132	82.3	70.9	119	49.8
Psychiatry	4	41.0	61.6	123	49.8	12.8	17.2
Orthopedic surgery	5	71.7	74.2	59.9	60.8	48.8	38.9
General surgery	5	43.5	43.3	41.7	40.0	26.2	25.1

Notes: adjusted for differences in hours worked per year. N/A: income data are not available for certain experience levels from the American Medical Association survey.

Source: *Physician Socioeconomic Characteristics*, American Medical Association; author's analysis.

Table 3

Coefficient Estimates of the Supply of Medical Students to Specialties

Variable	US Medical Students	International Medical Graduates
Log(mean physician income $_{t-1}$)	1.35**	0.960
($000)	(0.309)	(0.700)
Year indicator variables (1991 omitted)		
- 1992		0.141
		(0.124)
- 1993		0.317**
		(0.127)
- 1994		0.460**
		(0.127)
- 1995		0.531**
		(0.126)
- 1996		0.633**
		(0.125)
- 1997		0.752**
		(0.122)
- 1998		0.780**
		(0.122)
- 1999		0.878**
		(0.124)
Constant	0.916	1.45
	(1.52)	(3.44)
Observations	113	102
Adjusted R^2	0.92	0.90

Notes: Dependent variable is the log(number of applicants to the Match who rank a specialty first) for 1986 and 1991-1999. Data on international medical graduates are not available for 1986. Indicator variables are included for each of the 12 specialties.

Table 4

Simulating Specialty-Specific Resident Wages That Would Clear the Market

Scenario I: Demand elasticity = -0.08; supply elasticity = 1.35

Specialty	First-Year Positions Offered, 2001	Excess Supply	Estimated Equilibrium Residents' Salary ($000)	Estimated Equilibrium Positions	Rate of Return 1998	Rate of Return w/ New Wage	Annual Hospital Labor Savings ($ million)
Dermatology	252	153	-$94.6	328	46.9	12.4	$110
General surgery	1,041	297	-$33.2	1,125	25.1	11.6	$508
Radiology	875	219	-$25.7	924	83.3	23.4	$218
Orthopedic surgery	566	139	-$24.6	625	38.9	18.5	$171
							$1,007

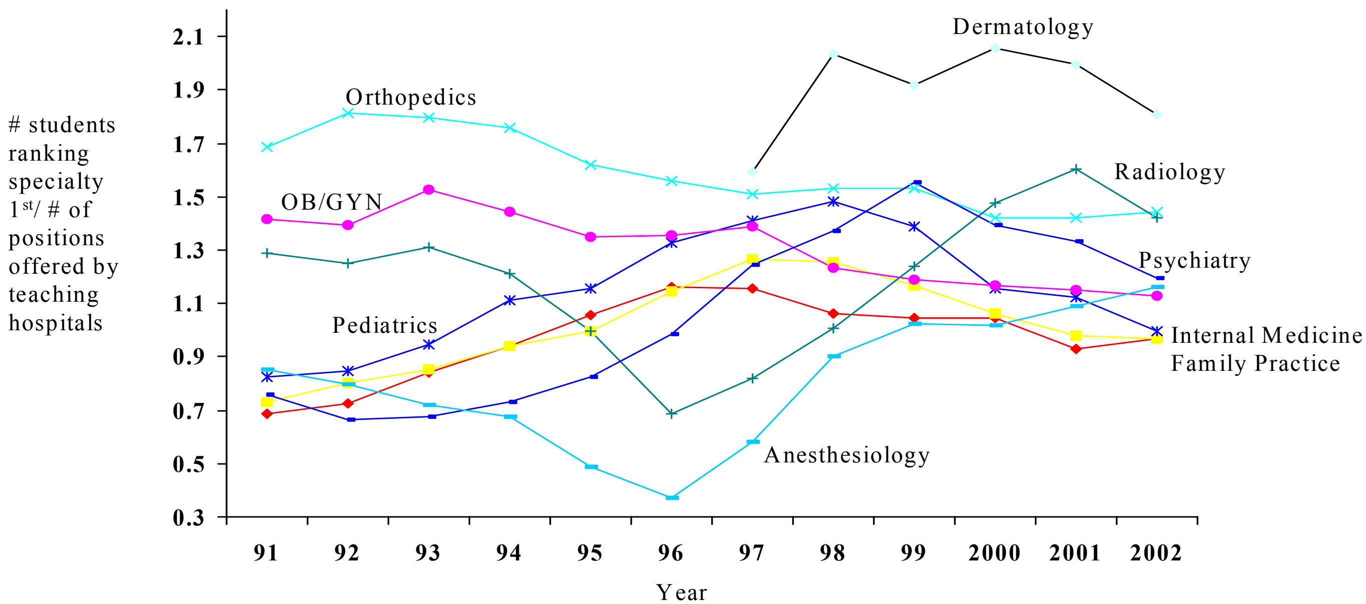
Scenario II: Demand elasticity = -0.16; supply elasticity = 2.00

Specialty	First-Year Positions Offered, 2001	Excess Supply	Estimated Equilibrium Residents' Salary	Estimated Equilibrium Positions	Rate of Return 1998	Rate of Return w/ New Wage	Annual Hospital Labor Savings
Dermatology	252	153	-$40.0	340	46.9	16.8	$64
General surgery	1,041	297	-$4.0	1,227	25.1	14.8	$288
Radiology	875	219	$0.3	1,014	83.3	31.8	$123
Orthopedic surgery	566	139	$0.9	654	38.9	23.0	$97
							$572

Notes: Baseline residents' wage is $34,000, the national mean in 1998. The excess supply of residents is the number of U.S. medical school students who ranked a specialty first in the Match in 2001 and did not receive a position in that specialty in the Match. Given estimates of the labor demand and labor supply elasticity parameters, I calculate the equilibrium residents' wage (or payment to the teaching hospital if the wage is negative) and number of residency positions that equates supply and demand. The rate of return is based on cross-section data from 1998 and the benchmark specialty is family practice. Teaching hospital labor savings are based on the number of residents employed in these four specialties and the estimated change in the residents' wage.

Figure 1

Ratio of Supply:Demand of Residents by Specialty (1991-2002)



Notes: Data from *Results and Data*, National Resident Matching Program. Desired supply is defined as the number of Match applicants who rank a specialty first, and demand is defined as the number of positions made available by teaching hospitals in the Match.

Figure 2

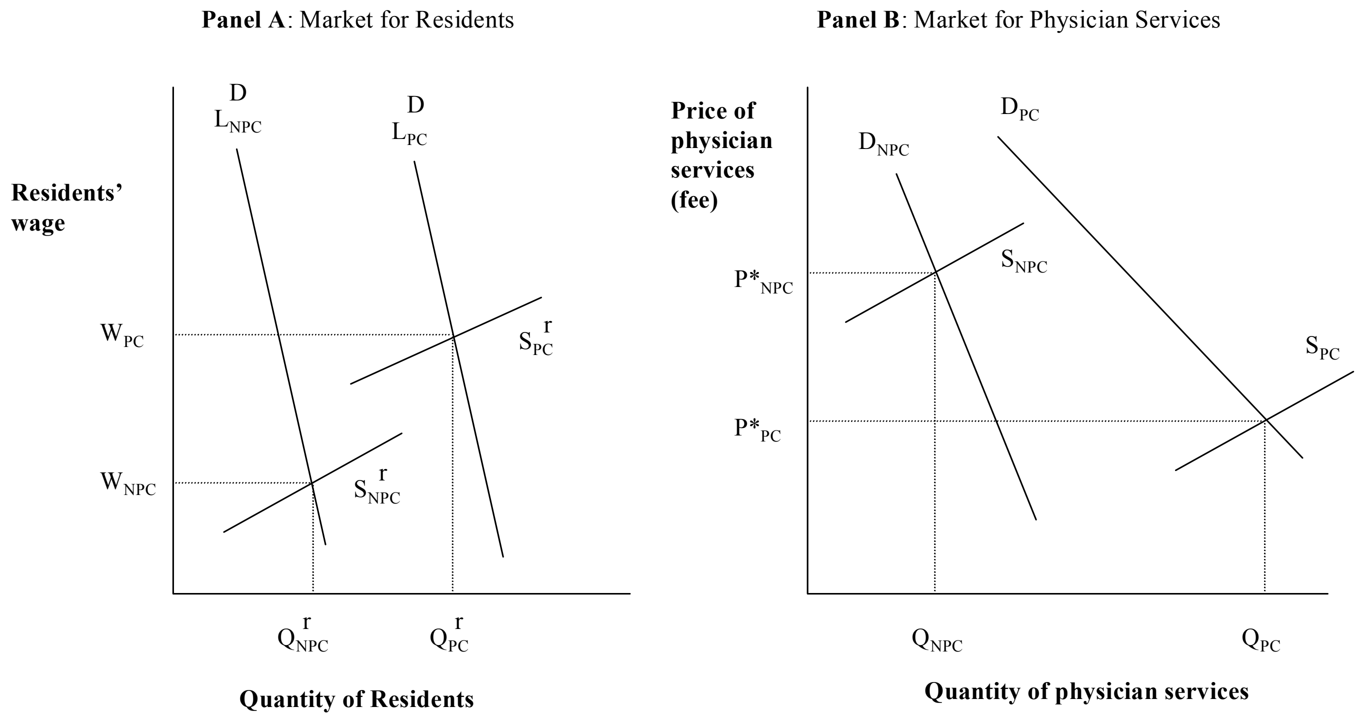
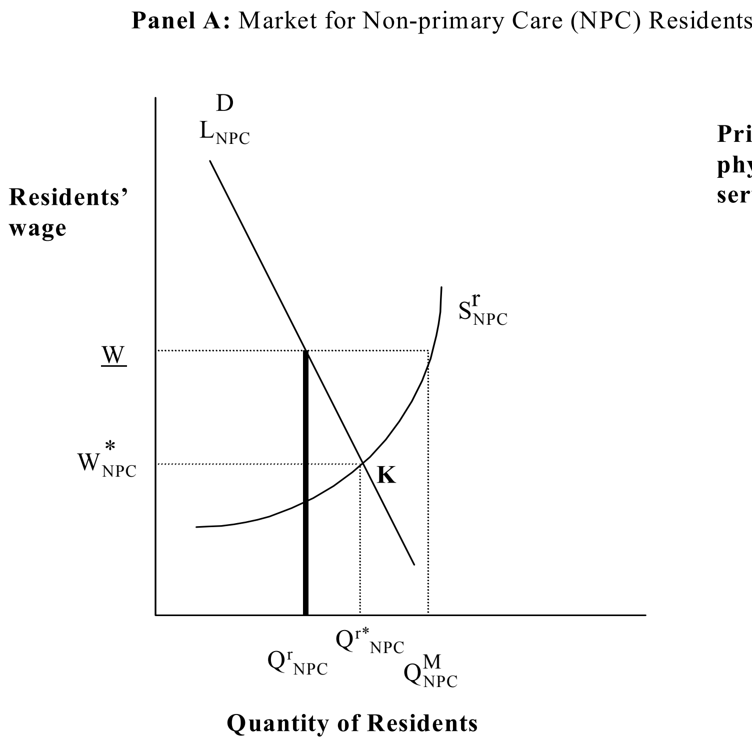

Panel A: Market for Residents
Residents' wage
L^{D}_{NPC}
L^{D}_{PC}
W_{PC}
W_{NPC}
S^{r}_{PC}
S^{r}_{NPC}
Q^{r}_{NPC}
Q^{r}_{PC}
Quantity of Residents
Panel B: Market for Physician Services
Price of physician services (fee)
D_{PC}
D_{NPC}
S_{NPC}
S_{PC}
P^*_{NPC}
P^*_{PC}
Q_{NPC}
Q_{PC}
Quantity of physician services

Figure 3


Panel A: Market for Non-primary Care (NPC) Residents
D
L NPC
Residents' wage
S r NPC
W
W* NPC
K
Q r NPC
Q r* NPC
Q M NPC
Quantity of Residents

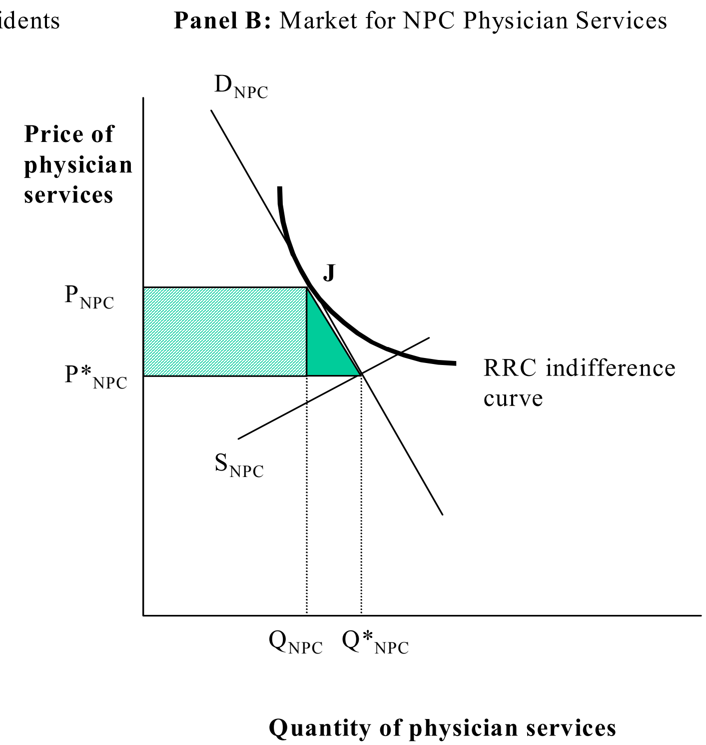
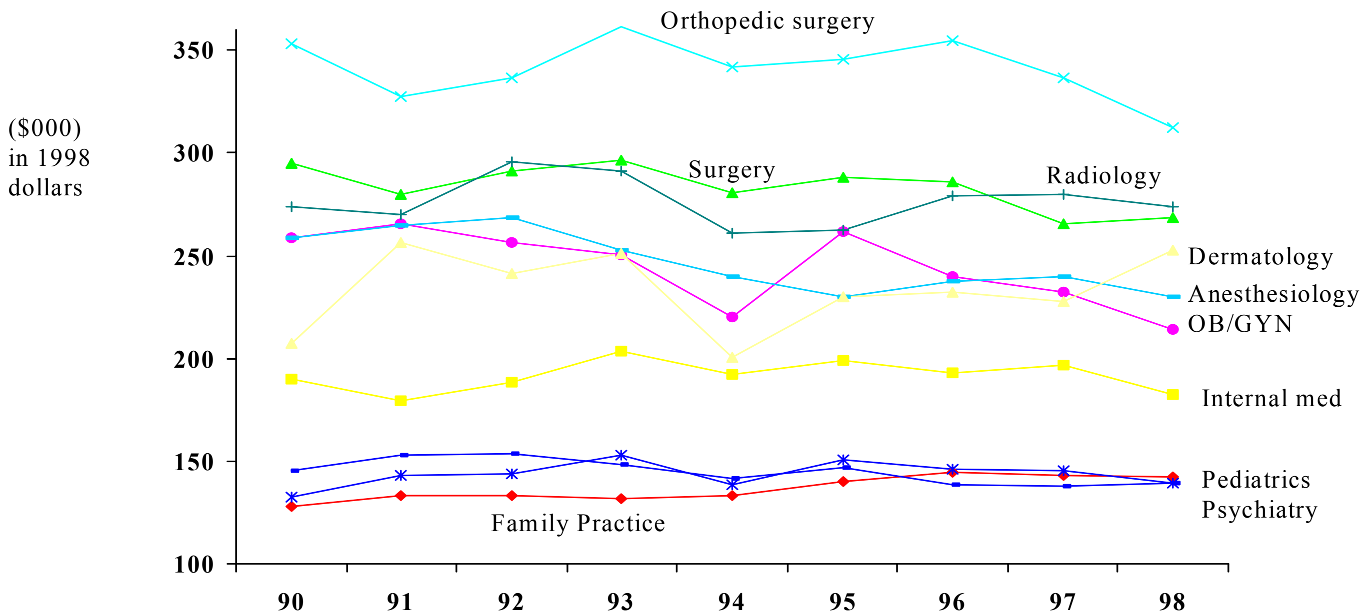

Panel B: Market for NPC Physician Services
D NPC
Price of physician services
J
P NPC
P* NPC
RRC indifference curve
S NPC
Q NPC
Q* NPC
Quantity of physician services

Figure 4

Mean Physician Income by Specialty, 1990-1998



Notes: Data from *Physician Socioeconomic Characteristics*, AMA. Income data are converted to 1998 using the urban consumer price index.