PRELIMINARY DRAFT -- NOT FOR DISTRIBUTION

Measuring Physician Practice Competition Using Medicare Data

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1. Introduction

Questions about the market structure of physician practices have grown increasingly prominent in contemporary health policy discussions. Market forces over the last couple of decades appear to have favored the growth of larger multi-specialty groups, and more and more physicians seem to prefer the practice environment of larger groups to solo or smaller group practices, generating growth in the size of practices and horizontal merger activity (Liehaber and Grossman 2007). Growing vertical integration in health care delivery markets, such as through hospital purchase of physician practices (Kocher and Sahni 2011, O'Malley, Bond et al. 2011), may in some cases effectively increase horizontal integration of practices as well as change vertical market dynamics.

These changes could have a number of important effects (Gaynor and Town 2012). Larger practices could lead to improvements in health care quality and outcomes by improving coordination – patients of organizations with broader scope and more resources may benefit from things like better information systems, care organization activities, and investments in better infrastructure (Ketcham, Baker et al. 2007). At the same time, larger practices may be more difficult to effectively manage and more challenging for patients to navigate and, if inefficient, could drive higher costs of care. Larger practices may also increase the amount of concentration in health care markets. If practices gain market power through concentration, they may drive inefficient outcomes including inefficiently high prices and reduced quality (Schneider, Li et al. 2008, Berenson and Ginsburg 2010, Ginsburg 2010, Gaynor 2011, Berenson, Ginsburg et al. 2012, Dunn and Shapiro 2012). Hospital acquisition of practices may independently affect prices paid for care (Cuellar and Gertler 2006, Gaynor 2011).

Understanding the impact of changes in physician market structure would help interpret changes in utilization and prices for health care services over recent years. It may also be important for developing policies going forward, with efforts to promote the integration of care delivery at the center of prominent policy efforts to grapple with rising costs (Crosson 2009). Expected policy changes under

the Affordable Care Act seem likely to foster further consolidation and heighten the need for a clear understanding of appropriate reactions. Anti-trust authorities are increasingly faced with choices about the optimal response to changing practice structures, and recent policy positions promote use of the "rule of reason" in which potentially welfare-improving and welfare-decreasing effects of mergers must be assessed and weighed against each other (Federal Trade Commission/Department of Justice 1996, Federal Trade Commission 2011).

While concentration has been well studied in the case of hospitals, and to an important though lesser degree health insurers (Melnick, Zwanziger et al. 1992, Pennsylvania Health Care Cost Containment Council 2007, Antwi, GAynor et al. 2009, Dafny 2009, Wu 2009, Melnick, Shen et al. 2011). Howerver, there is little evidence about impacts of structural changes in physician markets. One of the primary causes is a lack of broadly based data on practice market structure that is (at least relatively) frequently collected.

Some emerging efforts have used data on large sample of physicians to create measures of practice size and organization. Dunn and Shapiro used data that characterized the location and group affiliations of a large number of physicians to construct Hirschman-Herfindahl Indices (HHIs) for cardiology and orthopedics practices for 2005-2008 (Dunn and Shapiro 2012). Their application creatively uses the physician data, but suffers from the drawback that it lacks information about the location of patients from which to identify the market areas of practices. McWilliams and colleagues have developed measures of physician practice structures that mimic ACOs based on AMA group practice data (McWilliams, Chernew et al. 2013). Welch and colleagues have tracked the size of practices using CMS data (Welch, Cuellar et al. 2013). We are also aware of ongoing efforts to use FairHealth data claims database to create measures of practice market areas for some specialties.

In this paper, we explore the creation of physician practice concentration measures using Medicare claims data. Medicare claims are available for large numbers of patients over time and can be

used to identify an important dimension of physician practices. We use claims data to construct measures of practice size and construct HHIs for physician practices over the period 1998-2010, and explore variations in measures of size and concentration. We explore a number of issues that arise in the construction of claims-based measures that may affect their validity and interpretation.

2. Some Conceptual Issues in Practice Definition

Physician practices can be organized and integrated at a number of different levels. An individual physician may be organized as a solo practice or may work as part of a medical group. Some groups may have a single site, and others may have multiple sites. Groups may be owned (or closely affiliated with) hospitals. Physicians may also work directly for hospitals. Finally, health systems may own hospitals, or groups, or directly hire physicians. These types of arrangements involve very different sizes of organizations, but they all tend toward a high degree of integration. Physicians in these arrangements are typically financially integrated, operating as a unified business. They may also be clinically integrated as well (though there is no guarantee that financial and clinical integration are closely correlated).

There are also looser organizations. In some cases physicians with practices organized as separate businesses may agree to jointly acquire office space or practice resources with other doctors, sometimes creating entities that link multiple doctors who each retain a separate underlying practice. Another example is independent practice associations (IPAs), which are typically looser organizations in which individual physicians or groups retain their independent status, but agree to work together for some business purposes.

The types of organizations of primary interest for tracking and concentration measurement may depend on the applications of interest. One important dimension is that physicians in the same medical group, physicians whose practices are owned by the same hospital, and physicians whose practices are

owned by the same system, are generally allowed by law to negotiate jointly over payment and other contract terms with health plans (Casalino 2006). However, physicians in separate practices with looser linkages (e.g. practices that are members of IPAs) are normally considered competitors and under antitrust law may not bargain together, with a couple of exceptions (Casalino 2006). The principal exception is that Federal Trade Commission allows physicians in IPAs to negotiate jointly for risk contracts involving capitation or other withholds that put the IPA at risk for aspects of performance (Federal Trade Commission/Department of Justice 1996). Anti-trust law, though, normally prohibits physicians in IPAs from negotiating jointly over fee-for-service payments, and the FTC has successfully challenged at least some situations in which IPAs have attempted to jointly negotiate non-risk contracts.

Some ambiguity in existing law does exist. Anti-trust law does allow physicians in IPAs to negotiate jointly for non-risk contracts if they can show that they are sufficiently clinically integrated across their member practices, though IPAs using the clinical integration enforcement safety zone to jointly negotiate non-risk contracts appear to be uncommon (Federal Trade Commission 2011). Another source of uncertainty comes from the legality of the so-called "messenger model" of physician organizations and negotiations (Casalino 2006). This model is intended to allow a non-interested third party to collect and convey information from multiple physician practices to payors for the purpose of facilitating contracting, though not to engage in joint negotiations. Some have argued that some messenger model arrangements in fact have facilitated unlawful joint contracting. The DOJ and FTC have challenged what they believe to have been abuses of the messenger model, which may limit the degree to which this is an issue in our data, but this remains a debated area and the extent of the practice is uncertain (Pelnar 2010).

We will develop measures that focus on more financially integrated organizations, that seem particularly relevant to studies of fee-for-service prices. Since these organizations constitute a large and

important subset of all physician organizations, they may also be more generally useful for studies of effects on quality of care and other outcomes.

3. Medicare Claims Data

We use data from 1998-2010 Medicare carrier claims files that include bills for services provided by physicians to a 20% sample of traditional (fee-for-service) Medicare enrollees, and corresponding denominator files that record information about enrolled beneficiaries. These contain, among other things, the reported ZIP code of the patient's residence, the reported ZIP code of the physician practice, the physician specialty, the CPT (HCPCS) code of the service provided, a physician identifier (UPIN and/or NPI), and the tax identification number (TIN) of the practice.

From these files, we select claims with positive Medicare allowed charges, apparently valid TIN and provider NPI or UPIN, and provider and patient ZIP codes that can be matched to databases containing valid ZIP codes. We restricted attention to claims where the recorded provider specialty code indicated a physician in a named specialty, and we grouped physicians according to specialty for many of the analyses. We exclude claims from pediatrics and obstetrics/gynecology, which may not be well represented in Medicare claims; pain management which was not defined as a separate specialty in all of the years we study; and preventive medicine, hand surgery, peripheral vascular disease, addiction medicine, and osteopathic manipulative therapy which have too few claims to effectively analyze. This left us with 34 specialty groupings. The Medicare claims allow the specialty designation "multispecialty group." In the early years of our sample, 4-6% of claims used this designation, but its use declines substantially over time. After 2003, 0.5% of claims or fewer used this code. In the most recent years of data it is found on less than 0.1% of claims. Because many of analyses are done on a specialty-by-specialty basis, we exclude claims with this specialty designation. In total, we analyze about 150 million

claims per year from the early years of the sample, rising to about 215 million claims per year in the later years.

Some of our analyses use Medicare allowed charges as the unit of output. This is the fee-schedule-based amount that Medicare rules allow the physician to be paid for the service, after application of Medicare rules. The doctor may receive some of this amount from the patient by way of applicable copayments. Other analyses use work relative value units (RVUs). We obtained these data from the annual Medicare Fee Schedule files, and attached them to the claims based on reported HCPCS and modifier codes.

Identifying Practices

We identify physician practices in the claims using the reported TIN. Solo practice physicians normally have their own unique TIN. Financially integrated entities commonly use a single TIN for the physicians in their organization. Physicians in medical group practices, perhaps the most common and most integrated form of practice organization nearly always use the same TIN. Physicians in hospitals or health systems that own practices or employ physicians, appear to commonly use the same TIN, though with some exceptions. Identifying practices using TINs thus seems to provide a useful means of obtaining useful information about physician organizations. Some previous studies have used tax IDs to identify physician practices as well (Pope, Trisolini et al. 2002, Pham, Schrag et al. 2007, Welch, Cuellar et al. 2013).

There is some ambiguity in the precise set of organizations that will be identified. For example, in cases where a physician group is purchased by a hospital but retains its structure as a medical group, it may continue to use a group TIN or it could switch to the hospital TIN. Some very large medical groups have also elected to organize themselves with subsidiaries that have their own TINs. With this uncertainty, TINs should be regarded as a measure of physician organizations with some noise. It

appears likely that to the extent there is bias, this approach would tend to lead to understatement of the size of organizations and thus to underestimation of the concentration of physician practices (McWilliams, Chernew et al. 2013, Welch, Cuellar et al. 2013). We present evidence below that suggests that this may have only a small effect on overall estimates of competition in physician markets. Looser forms of organizations with little financial integration across practices, such as IPAs, do not use unified TINs and will not be identified in claims data.

One source of information about the types of organizations identified by tax IDs in the claims data is publicly available data from IRS Form 990. A 990 must be filed annually by most tax-exempt organizations in the United States. For our purposes, the 990s report the name, business type, and TIN of reporting organizations. Among the entities filing 990s are many health care related organizations. Though this is only a small share of relevant health care organizations – most small and medium and even many large physician practices are structured as for-profit businesses – the 990 data do provide some useful insights. In the 2010 data, of 3,064 organizations that self-identify as hospitals, we find 1,824 (60%) in the claims data. Of 705 organizations in the group health practice category, we find 383 (54%) in the claims data. A number of organizations that place themselves in the community health systems (214), community clinics (573), ambulatory and primary health care (439), or health general and financing (14) categories also appear, as do 95 organizations from the 990 educational institution category (possibly representing faculty practice plans at medical schools). Among the large organizations in the form 990 data that we find in the claims data are many large and well known health care systems and physician groups in the country, including among many others the Cleveland Clinic (1,834 physicians in the claims data), Mayo Clinic (2,199 physicians), Partners (558), Henry Ford (1,056), and the Palo Alto Medical Foundation (880). Similar patterns are evident in other years. This suggests that in many cases, the claims data will identify the organizations at the large end of the spectrum, not just the individual physicians or smaller groups that may be owned by larger entities.

Identifying Physicians

In later years of the claims data, individual physicians can be identified on the basis of the National Provider Identifier (NPI), included on every claim. During 2007, CMS begin requiring the inclusion of the NPI of the physician performing the service on physician bills. NPI fields in the claims data appear reasonably complete beginning in 2008. Prior to this, claims contain the "Unique Physician Identification Number" (UPIN) of the physician performing the service. Though they should generally identify individual physicians, UPINs are often thought to be less precise than NPIs as a unique physician identifier. Even after the NPI phase-in, Medicare claims continued to report UPINs where they were available.

We identify physicians in two ways. Beginning in 2007, we can identify them using NPIs alone. To obtain a longer time series, we developed a UPIN-based measure as follows. We first used UPINs where available. Some claims in later years did not report a UPIN but did report an NPI. For these, we attempted to link a UPIN based on a patterns observed on previous claims and information reported on the National Plan and Provider Enumeration System (NPPES). When a match was found, we used the matched UPIN. If no matching UPIN was found, we counted on the basis of NPI.

The claims data will include information about practicing physicians who submit bills for patients in the 20% sample of fee-for-service Medicare beneficiaries. (This will not typically include residents and fellows, who do not file Medicare claims for their services.) We believe this will include the vast majority of physicians providing services to Medicare patients. We found 566,149 unique NPIs in the 2010 data. This is consistent with other calculations that, though done in a slightly different way, reported the number of physicians appearing in the 2010 100% sample of Medicare claims (Welch, Cuellar et al. 2013). As a further way of gaining information about the completeness of the 20% sample data, we computed the number of unique NPIs in the 2010 5% sample of Medicare claims. We found

532,375 unique NPIs, 94% of the 566,139 in the 20% sample. Because nearly all of the physicians identified in the 20% sample are also identified with only the 5% sample, we take it as unlikely that there would be a large number of additional physicians providing services to Medicare patients but not found in the 20% sample.

The set of physicians providing services to Medicare patients is likely to be a large subset of all physicians in the United States, though will not contain all physicians. Based on results from the National Ambulatory Medical Care Survey, MedPAC recently reported that more than 90% of U.S. physicians report that they accept new Medicare patients (Medicare Payment Advisory Commission 2012). Some physicians in pediatrics and obstetrics/gynecology may not frequently see Medicare patients. Physicians who primarily serve managed care patients would not be expected to frequently appear in fee-for-service claims data. Other physicians may also have practices focused on non-Medicare patients. To get a better sense for the share of physicians represented in the claims data, we used data from NPPES to identify physicians active in 2010, for non-student physicians in specialties that we include in the analysis. We found 667,265 total NPIs in the NPPES data, in the included specialties. Our 2010 data contain 566,139 NPIs, 85% of this number. This seems promising, given that the NPPES may overstate the number of active physicians by retaining NPIs for a time after physicians retire and including some physicians who are not actively practicing. The number of physicians we find also appears to be much lower than numbers reported from the AMA physician masterfile, though the masterfile may substantially overstate the number of active physicians (Staiger, Auerbach et al. 2009).

As described below, we also compare the claims data to data from SK&A which provides another source of information, consistent with the view that the claims data represent a large fraction of U.S. physicians.

4. Trends in the Number and Size of Practices

For each observed practice (TID), we counted the number of physicians billing within the practice each year. In these calculations an individual physician can appear more than once if he or she bills with more than one practice within a year. (Include stats on N TINs per physician.) The size of practices has been increasing over time. We first computed the mean number of physicians per practice using UPINs and using NPIs (Table 1). We observe 220,341 unique TINs in 1998, with a mean of 2.66 UPINs per practice. The number of practices declines over time, to 167,950 unique TINs in 2010, and average size increases to 3.96 physicians per practice. The decline in number of practices is particularly concentrated in the 2005-2010 period. Over 2008-2010, estimates of the number of practices and physicians using NPIs is quite similar to the number we obtain using our approach that relies on UPINs, from which we gain some confidence that trends based on UPINs are useful to examine.

The distribution of physicians across organizations of different sizes is presented in Table 2. The number of solo practices declines by more than 50,000 between 1998 and 2010, falling from 77% of practices to 70%. The number of practices of 10 or more physicians rises. In the lower panel of Table 2, the share of physicians in solo practice falls to 18% by 2010, and the share in practices of 100 or more doctors increases from 13 to 24%.

Much of this shift toward larger practices is driven by physicians entering and exiting practice. We classified physicians as new entrants if they were first observed in the claims data after 1998 and still observed in 2010. We classified physicians as exiting practice if they were first observed in 1998 and last observed before 2010. Among 275,750 physicians in the entrant group, in the year in which they are first observed, about 10% are in a solo practice, compared to nearly 40% in practices of 50 or more. Among 139,899 exiting physicians, 33% were in a solo practice in the last year they were observed, compared to 21% in a practice of 50 or more. There are some transitions toward larger practices among

physicians that neither enter nor leave during our study period. In this group, the share in solo practice falls from 27% to 23%, while the share in practices of over 50 rises from 20% to 27%.

Another way to characterize practices is on a specialty-by-specialty basis. This approach is of particular note for development of competition measures, where relevant product markets frequently would be specialty-specific. To compute specialty specific practice sizes, we separated the claims by specialty of the physician, and computed the number of practices (TINs) and physicians (UPINs or NPIs) separately within each specialty. In these calculations, the same practice will appear in more than one specialty if it contains physicians in multiple specialties. Physicians can also be included multiple times if they appear in multiple specialties or multiple practices. By specialty, the number of practices decreases over time, with the decrease concentrated in the later part of the 2000s (Table 3). The share of practices that are small practices and the share of physicians in small practices decline over time. Larger practices become more prominent. The overall shift from solo practice toward larger practice seen here is similar in magnitude but, as might be expected, the overall size of practices is smaller. Patterns vary somewhat across specialties. Table 4 shows changes in the number of practices by specialty between 2000, 2005, and 2010. A common pattern in medical subspecialties is an increase in the number of practices over the course of the early 2000s, and declines in the later part. A number of surgical specialties saw some declines in the number of practices in the early 2000s, and faster declines after 2005. Figure 1 plots the mean number of physicians per practice for a number of individual specialties (selected to represent a range of types of medicine and sizes of practices).

By other metrics, practices are also increasing in size. For specialty-specific practices, Table 5 reports the number of claims per practice, work RVUs per practice, and Medicare allowed charges per practice, all of which increase markedly over time. Some of this can be attributed to changes in the number of physicians, and to the amount of activity per physician, which are both increasing.

Interestingly, and consistent with reports of changing patterns of billing, the mean work RVUs per physician across practices increases markedly over the study period.

In addition to increases in practice size, the share of practices with multiple specialties has increased over time (Table 6). The number of practices with a single specialty falls by 50,000 while the number with 3 or more specialties increases. The share of physicians in multispecialty practices grows from less than half to more than 60%. (The number of physicians in this analysis differs from the number in Table 3 because physicians are counted one time per specialty per practice here.)

5. Concentration Measures

To study concentration more directly, we computed Hirschman-Herfindahl Indices (HHIs) for physician practices. By convention, HHIs have a maximum value of 10,000, reached in monopoly markets. As the amount of competition increases, the HHI falls and approaches 0 as the number of sellers increases and the size of each individual seller falls.

Computing HHIs requires defining product markets. Here we take product markets to include all services produced by physicians in one of the specialties studied in the paper. The extent to which relevant product markets would vary within specialty, either for subgroups of services or for subgroups of patients served, is of some interest. As a practical matter, we found it difficult to compute HHIs that distinguished subgroups of patients and services for the broad range of specialties included here. Questions about more finely defined HHIs will need to be addressed in more focused analyses. It may also be worth noting that in some cases the relevant product market may span specialties that are distinguished here. For example, physicians in internal medicine and family medicine may be competitors for many primary care services.

HHIs also require defining geographic markets. We derive geographic markets for each practice empirically, based on observed patient flows in the claims data. This approach seems superior to

approaches that would identify HHIs using fixed boundaries like Hospital Referral Region or Metropolitan Statistical Area as geographic markets.

We compute our HHIs using Medicare allowed charges as the unit of service, following the guidance issued by the DOJ and FTC for evaluation of market power when considering Accountable Care Organizations (Federal Trade Commission 2011). Other units of service, including individual claims and work RVUs, are possible. Varying the choice of service unit will tend to weight services in different ways, particularly in specialties that provide services across a wide range of magnitudes, and will vary the HHIs, though we show below that in many cases the choice of service unit has a small impact on the final results.

Our analytic approach adapts the approach of Kessler and McClellan (2000) to the case of hospitals (Kessler and McClellan 2000). We derive HHIs for (specialty-specific)practices in two steps. We begin by constructing a ZIP code HHI for each ZIP code, by specialty, by year. Denote by $service_{i,j}$ the number of service units provided by physicians in practice *i* to patients who reside in ZIP code *j* . Denoting the total number of service units provided to patients in ZIP *j* as $service_j$, the market share of practice *i* for ZIP *j* is $share_{i,j} = service_{i,j} / service_j$. The ZIP code HHI is then the sum of squared market shares:

$$ZIPHHI_j = \sum_{\substack{practices \\ i\ serving \\ ZIP\ j}} share_{i,j}^2$$

This construction allows flexibility in the market size, basing the HHI on the set of physicians actually observed to provide services to patients in the given ZIP code. We exclude from this calculation claims where the physician is more than 100 miles from the patient ZIP, to reduce the potential for bias from cases where a patient, perhaps while traveling, sees a distant physician who does not play a substantial role in competition for patients in the ZIP code. (Distances were determined based on the

centroid of the patient and provider ZIP codes, using the Haversine formula. Between 90 and 95% of claims meet the 100 mile criteria in any given year.)

In the second step, we identify the observed market area of each practice as the set of patient ZIP codes with non-zero service units (i.e. the set of *j* for which $service_{i,j} > 0$), excluding cases where the patient ZIP is more than 100 miles from the physician ZIP. We then average the ZIPHHI values for the ZIP codes in the market area, weighting by the number of services practice *i* provides in each of the patient ZIPs in its market area, to create a practice level HHI:

$$PRACHHI_i = \sum_{\substack{ZIPs\ j \\ in\ market \\ area\ of \\ practice\ i}} w_{i,j} ZIPHHI_j$$

where $w_{i,j}$ is a weight with sum 1 derived from the $service_{i,j}$ values (i.e. $service_{i,j} / service_i$ where $service_i$ is the sum of all services provided by practice *i*).

This approach diverges somewhat from approaches that would simply define the market area of the practice as the set of ZIP codes served and then compute the HHI from the market shares of all practices serving the area. Our approach allows us to increase the weight put on areas from which the practice draws most of its patients. Many practices draw patients from a large number of ZIP codes in total, but have a much smaller set of areas from which the bulk of their patients come. Weighting by the concentration of patients should make the HHIs more accurate in this sense.

Table 7 presents summary statistics for the resulting practice HHIs, pooling all specialty-specific practices. We compute an HHI for 269,013 practices in 1998, and for 226,332 practices in 2010. (These counts of practices are slightly lower than those reported earlier because we restrict analysis to claims where the patient are provider are within 100 miles of each other, and a few practices have some claims but no claims satisfying this criteria.) Mean HHIs are more than 2,350 in all years. Median HHIs are more than 1,802. The 90th percentile practices have HHIs of more than 5,000. Though the approach we use to calculate HHIs differs from the specific analyses that might be used in an anti-trust proceeding, it

follows somewhat similar contours. In that light it is interesting to note that the FTC and DOJ normally express concern about markets where HHIs are more than 1,500, considering markets between 1,500 and 2,500 to be moderately concentrated and markets above 2,500 to be highly concentrated. (Federal Trade Commission and Department of Justice 2010) Between the beginning of the study period and 2005, HHIs are generally declining, suggesting less concentration. In 2005 HHIs begin increasing. The mean rises by about 100 points, to 2,446 and HHIs rise at the 10th, 50th, and 90th percentiles. Changes of 100 points are large enough to be of interest in many anti-trust contexts.

There are marked differences in HHIs across specialties. Figure 2 reports the median HHI by specialty in 2010, and the 10th and 90th percentiles. Internal medicine and family practice, two of the largest specialties, have the lowest median HHIs at 760 and 1,211 respectively. Cardiac surgery and hematology have the highest, at 6,561 and 8,432. Twenty-three of the 34 specialties we studied have a median HHI of more than 2,500. Practice HHIs within each of the specialties vary considerably as well. Specialties differ somewhat in their patterns over time. Figure 3 tracks median HHIs in a number of specialties over the study period.

There are clear patterns of consolidation in the 2005-2010 period that vary across specialties. [need to put labels on the figure]. Thoracic surgery, emergency medicine, urology, hematology, radiation oncology, ophthalmology, and general surgery all lost significant shares of practices and had increases of more than 200 points in the mean practice HHI. Pathology, endocrinology, critical care, and geriatrics all added practices and had declines of more than 200 in the mean practice HHI.

Multi-specialty practice HHIs

In some settings, the potential for product tying in negotiations may be important [Gal-Or?]. Physicians in multi-specialty groups may in some instances be able to negotiate jointly across multiple specialties. One way of examining the extent to which this is likely to be an important issue is to

compute the share of practices by specialty that are part of a multi-specialty group. We do this in Figure 5. The share of practices that are part of a multi-specialty group varies considerably across specialties. We further break down multi-specialty practices according to the highest HHI among specialties in the multi-specialty practices, since multi-specialty practices may be more successful at product tying as the position of their component specialties becomes stronger.

Comparisons with alternate approaches

To examine robustness to alternate specifications, we computed HHIs for practices in a number of different ways. Table 8 summarizes results. We examined the effect of using the number of claims and the number of work RVUs as the measure of output, and found results very similar to those obtained using charges. In some applications, it is recommended that the market area be defined as the smallest number of ZIP codes from which a practice draws 75% of its patients. For example, this is the recommendation in the FTC/DOJ guidance for anti-trust related to Accountable Care Organizations. Computing HHIs using this approach has little effect on the results, as might be expected since our approach weights ZIP HHIs by the number of claims in the practice when computing the practice HHIs, so ZIPs less important to the practice will already have reduced impact in the baseline approach. Finally, we examined the effect of relaxing the restriction that the physician and patient must be within 100 miles for the claim to be included, which also had little effect on the overall pattern of results.

6. Area-Level Analyses

In many analyses, it is important to be able to summarize the degree of competition in a given geographic area. For example, one may wish to know the average HHI for providers in a given county or HRR. This can be easily computed from the PRACHHI values. Denoting areas by k, we take the average of PRACHHI values over the practices *i* with provider locations in area k, weighting by the services provided by the practice attributable to area k.

$$GEOHHI_k = \sum_{\substack{\text{practices } i \\ \text{with provider} \\ \text{ZIPs in} \\ \text{area } k}} b_{i,k} PRACHHI_i$$

where *b* is a weight that sums to one, capturing the distribution across practices of services attributable to area *k* (i.e. $b_{i,k} = service_{i,k} / service_k$). The principle of weighting here is to upweight practices that have a prominent presence in the area, and downweight practices that do not.

We have done this here for Hospital Referral Regions as defined in the Dartmouth Atlas. Paralleling the patterns seen at the practice level, there are wide variations in concentration across specialties and, within specialty, across geographic areas. Figure 6 shows variation across specialty, and within specialty across areas for 2010. Comparing by specialty, median HHIs at the HRR level are generally 30-60% higher than median practice HHIs (e.g. Figure 2). This may reflect the fact that larger, less competitive practices naturally play a bigger role their geographic areas, and thus drive up the measure of the average HHIs by area.

Note that in principle this calculation could also be made weighting by the location of patients, and would then give the average HHI of practices serving patients in a given geography. Results using this method are quite similar to those weighting by the location of doctors.

7. Comparisons to SK&A Data

Data from the consulting firm SK&A provide an alternate way of characterizing the practice affiliations of physicians. This data is obtained by contact with physicians, and includes information about group affiliation as well as hospital or system ownership of practice. SK&A reports that the data are updated twice per year, and contain information about nearly all physicians practicing in the United States. We used SK&A data from 2008-2010. We selected data for physicians in the specialties identified above. (SK&A specialty codes do not contain a code for cardiac surgery.)

Table 9 presents summary information. In 2010, the data contain information for 528,225 physician-specialty pairs (about 3,000 physicians appear with more than one specialty, and we allow physicians to count in each indicated specialty.) Of these, about 60% have a group, hospital, or system code indicating that the doctor is part of a larger entity. Curiously, the share of doctors with one of these codes declines slightly over time, despite popular reports of accelerating consolidation during this time period.

We match SK&A data to the Medicare claims data on the basis of NPI or UPIN physician identifiers. Between 83 and 88% of physicians in the SK&A data had either a UPIN or NPI with which to attempt a match (Table 9, column 6). Of all physician-specialty-practice (TID) combinations in the claims data, we match between 60 and 66% to information from the SK&A data. Match rates are particularly low (<50% in a year) for critical care, geriatrics, anesthesiology, emergency medicine, and psychiatry. Match rates are highest for surgical specialties, near or above 80% for orthopedics, otolaryngology, urology, and ophthalmology. (Going in the other direction, of all doctors in the SK&A data in specialties we analyze, we find about 80% in the Medicare claims data, consistent with the comparison to the NPPES data reported above.)

Using the matched data, we computed HHIs for practices to examine the effects of characterizing practices in different ways. The first two columns of Table 10 report the results using the method described above based on Medicare-reported TID for specialty-specific practices. We first compare to results that use the group code reported on the SK&A data as the indicator of practice (columns 3 and 4). This code is intended to identify medical groups of which a doctor is part, but not hospitals or systems that might own the practice. Using this code, we find more practices than using the TID approach, and the median HHI across practices is a bit lower – between 10 and 20% lower for most of the specialties reported. The correlation between the specialty median HHI based on TID and SK&A group code is 0.98.

We next consider the effect of incorporating hospital ownership information. We assign physicians to the hospital they indicate owning their practice first. If there is no hospital indicated, we assign them to their group. This reduces the number of practices by a modest amount, and increases the measured HHIs a small amount relative to measures using just the group code (columns 5 and 6). Finally, we considered the effects of assigning physicians to the indicated system owner first, followed by hospital, followed by group. This further reduces the number of practices and increases the measured HHIs. Overall, the effect of incorporating information about hospital and system ownership has some effect on measures of concentration, but does not substantially change the patterns observed. The patterns observed across specialties and over time are also similar in the SK&A data and the Medicare data, with somewhat higher reported HHIs based on the Medicare data.

8. Conclusions

We reach several conclusions based on the analyses reported. First, it appears that TIDs reported in Medicare claims can provide a useful tool for measuring the size and concentration of physician practices. Medicare data appear to contain a large sample of the physicians in the United States, across a broad range of specialties. Reported TIDs appear to frequently represent practice structures that are meaningful for market structure identification, generally consistent with results observed using another data source that has been used in the literature.

Second, there is a considerable degree of concentration in many physician markets. A large number of practices have HHIs of more than 2,500, in many cases well more than 2,500. In many specialties, the median HRR is served by practices with highly concentrated markets. This suggests that attention to concentration may be warranted, as the potential for inefficient market outcomes appears to be substantial.

Third, there has been some consolidation over time in some areas. Surgical specialties in particular have seen significant consolidation over the past decade or so. But, there are patterns across specialties that may be of interest. Not all specialties have seen consolidation. Some medical specialties in particular appear to have become more competitive over time. In addition, there are variations in trends at different points in time. The early part of the 2000s frequently saw declines in HHIs, while increases in HHIs are more apparent later in the sample period.

Fourth, the role of hospitals and systems is important in measuring concentration, but the overall impact is modest. When we used SK&A data to examine measures using different approaches, being able to account for hospital and system ownership raised HHIs by a non-negligible, but overall modest amount.

These results suggest some issues of importance for practice market structure measurement.

- Getting product markets right. Our current specialty groupings may be suboptimal. More generally, the particular set of doctors of interest could vary from context to context. Do IM and FP doctors compete with one another or not? In some cases general surgeons and more specialized surgeons may compete, and in other cases not. The optimal product market may in some cases be segmented by type of patient, or by particular service.

- A related issue is practice setting. For example, hospitalists may be in specialties similar to those of physicians working in outpatient settings. In some cases, they may be effectively competitors and in other cases they may not be.

These analyses do not address some issues of potential interest. The Medicare data, though generally useful, will not capture market dynamics for physicians that primarily serve managed care patients and do not bill Medicare on a fee-for-service basis. The SK&A data may better capture these physicians, though lacks data on the locations of managed care patients from which to track market

areas. The analyses reported here focus on financially-integrated practice arrangements, and will not capture market dynamics related to IPAs or other less integrated organizational forms.

Table 1: Physicians per practice

	Physician ID based on UPIN			Physician ID based on NPI		
	N practices	N physicians	Physicians per practice	N practices	N physicians	Physicians per practice
1998	220,341	587,165	2.66	---	---	---
1999	211,718	581,741	2.75	---	---	---
2000	205,488	570,625	2.78	---	---	---
2001	205,179	570,667	2.78	---	---	---
2002	200,879	593,588	2.95	---	---	---
2003	204,013	605,982	2.97	---	---	---
2004	203,744	618,440	3.04	---	---	---
2005	206,139	635,734	3.08	---	---	---
2006	189,895	624,244	3.29	---	---	---
2007	184,990	634,549	3.43	171,483	601,330	3.51
2008	180,865	645,311	3.57	180,338	641,777	3.56
2009	170,683	646,879	3.79	170,682	644,901	3.78
2010	167,950	665,025	3.96	167,948	662,740	3.95

Table 2: Distribution of practices and physicians by size, combining all specialties

	Number of physicians per practice									
	1		2-9		10-49		50-99		>=100	
	N	%	N	%	N	%	N	%	N	%
Practices										
1998	169,433	77%	42,059	19%	7,955	4%	571	0.3%	323	0.1%
1999	161,062	76%	41,753	20%	7,997	4%	584	0.3%	322	0.2%
2000	155,201	76%	41,597	20%	7,794	4%	565	0.3%	331	0.2%
2001	154,533	75%	41,937	20%	7,811	4%	565	0.3%	333	0.2%
2002	149,658	75%	42,115	21%	8,098	4%	631	0.3%	377	0.2%
2003	151,667	74%	43,062	21%	8,223	4%	675	0.3%	386	0.2%
2004	150,805	74%	43,388	21%	8,441	4%	714	0.4%	396	0.2%
2005	152,855	74%	43,450	21%	8,642	4%	744	0.4%	448	0.2%
2006	137,496	72%	42,430	22%	8,754	5%	756	0.4%	459	0.2%
2007	132,314	72%	42,450	23%	8,969	5%	776	0.4%	482	0.3%
2008	129,545	72%	40,981	23%	8,994	5%	823	0.5%	522	0.3%
2009	120,334	71%	39,893	23%	9,046	5%	852	0.5%	558	0.3%
2010	117,767	70%	39,475	24%	9,177	5%	922	0.5%	609	0.4%
Physicians										
1998	169,433	29%	153,231	26%	148,823	25%	38,139	6%	77,539	13%
1999	161,062	28%	151,882	26%	149,851	26%	39,051	7%	79,895	14%
2000	155,201	27%	151,251	27%	145,548	26%	37,516	7%	81,109	14%
2001	154,533	27%	151,917	27%	146,421	26%	37,977	7%	79,819	14%
2002	149,658	25%	153,366	26%	153,349	26%	42,330	7%	94,885	16%
2003	151,667	25%	155,917	26%	154,341	25%	45,220	7%	98,837	16%
2004	150,805	24%	157,392	25%	159,294	26%	48,137	8%	102,812	17%
2005	152,855	24%	158,267	25%	163,143	26%	50,115	8%	111,354	18%
2006	137,496	22%	154,409	25%	165,241	26%	50,990	8%	116,108	19%
2007	132,314	21%	153,855	24%	170,203	27%	53,030	8%	125,149	20%
2008	129,545	20%	149,990	23%	172,784	27%	55,697	9%	137,298	21%
2009	120,334	19%	146,278	23%	174,642	27%	58,081	9%	147,544	23%
2010	117,767	18%	145,226	22%	177,156	27%	62,730	9%	162,146	24%

Table 3: Practices by physician size category, practices defined by specialty

		Number of physicians per practice				
	N practices	1	2-9	10-49	50-99	>=100
			Practices			
1998	271,804	74%	22%	3%	0.1%	0.03%
1999	261,964	74%	23%	3%	0.1%	0.03%
2000	253,590	73%	23%	4%	0.2%	0.03%
2001	253,027	73%	23%	4%	0.2%	0.03%
2002	249,540	72%	24%	4%	0.2%	0.04%
2003	256,544	72%	24%	4%	0.2%	0.04%
2004	257,578	72%	24%	4%	0.2%	0.05%
2005	260,278	72%	24%	4%	0.2%	0.05%
2006	243,292	70%	25%	4%	0.2%	0.06%
2007	239,252	69%	26%	5%	0.2%	0.07%
2008	236,226	69%	26%	5%	0.3%	0.08%
2009	226,871	68%	26%	5%	0.3%	0.09%
2010	227,179	68%	27%	5%	0.3%	0.10%
			Physicians			
1998	614,710	33%	35%	26%	4.1%	1.96%
1999	605,023	32%	35%	26%	4.2%	2.21%
2000	592,873	31%	35%	27%	4.3%	2.14%
2001	592,605	31%	36%	27%	4.3%	2.04%
2002	608,661	30%	35%	28%	4.9%	2.49%
2003	625,209	30%	35%	28%	4.9%	2.57%
2004	638,354	29%	35%	28%	5.2%	2.74%
2005	653,215	29%	34%	29%	5.6%	2.85%
2006	639,751	27%	34%	30%	5.7%	3.19%
2007	650,532	26%	34%	31%	6.2%	3.58%
2008	662,245	25%	33%	32%	6.5%	4.29%
2009	662,161	23%	33%	32%	7.2%	4.60%
2010	684,301	22%	32%	33%	7.8%	5.08%

Table 4: Changes in number of practices, by specialty, 2000 - 2010

	2000	2005	2010	% change 2000-2005	% change 2005-2010
internal medicine	45,848	48,400	41,480	5.6%	-14.3%
family practice	44,789	46,529	40,341	3.9%	-13.3%
allergy/immunology	2,277	2,346	2,275	3.0%	-3.0%
cardiology	10,540	10,551	9,386	0.1%	-11.0%
critical care	549	920	1,174	67.6%	27.6%
dermatology	6,562	6,812	6,302	3.8%	-7.5%
endocrinology	1,992	2,420	2,691	21.5%	11.2%
gastroenterology	5,563	5,898	5,312	6.0%	-9.9%
geriatrics	728	1,003	1,245	37.8%	24.1%
hematology	395	518	511	31.1%	-1.4%
infectious disease	1,775	2,195	2,355	23.7%	7.3%
nephrology	2,440	3,034	3,094	24.3%	2.0%
neurology	6,376	6,959	6,556	9.1%	-5.8%
oncology	3,391	3,970	3,590	17.1%	-9.6%
pulmonary disease	4,568	5,070	4,690	11.0%	-7.5%
radiation oncology	2,052	2,261	2,187	10.2%	-3.3%
rheumatology	2,052	2,394	2,456	16.7%	2.6%
cardiac surgery	789	1,134	1,149	43.7%	1.3%
colorectal surgery	591	678	773	14.7%	14.0%
general surgery	15,420	13,914	11,134	-9.8%	-20.0%
neurosurgery	2,301	2,308	2,074	0.3%	-10.1%
ophthalmology	11,039	10,588	9,255	-4.1%	-12.6%
orthopedics	10,425	10,368	8,682	-0.5%	-16.3%
otolaryngology	5,666	5,394	4,630	-4.8%	-14.2%
plastic/maxilofacial surgery	4,891	4,815	4,601	-1.6%	-4.4%
thoracic surgery	1,862	1,640	1,463	-11.9%	-10.8%
urology	5,450	5,214	4,109	-4.3%	-21.2%
vascular surgery	1,443	1,683	1,819	16.6%	8.1%
anesthesiology	9,285	8,883	7,406	-4.3%	-16.6%
emergency med	10,448	10,433	7,092	-0.1%	-32.0%
pathology	3,264	3,070	2,760	-5.9%	-10.1%
physical medicine/rehab	4,142	4,827	5,139	16.5%	6.5%
psychiatry	16,747	16,180	13,680	-3.4%	-15.5%
radiology	7,930	7,869	5,768	-0.8%	-26.7%

Table 5: Measures of specialty-specific practice size

	N practices	claims/ practice	work RVUs / practice	allowed charges / practice	physicians per practice	claims/ physician	work rvus/ physician
1998	271,804	497	419	29,929	2.26	234	209
1999	261,964	527	444	32,717	2.31	244	218
2000	253,590	555	470	37,002	2.34	253	227
2001	253,027	581	494	41,007	2.34	262	237
2002	249,540	630	545	43,889	2.44	285	260
2003	256,544	693	599	50,190	2.44	302	276
2004	257,578	720	633	55,375	2.48	309	288
2005	260,278	749	649	57,522	2.51	318	289
2006	243,292	802	698	62,478	2.63	335	305
2007	239,252	803	798	63,313	2.72	328	343
2008	236,226	814	823	64,897	2.80	328	348
2009	226,871	840	868	69,889	2.92	334	361
2010	227,179	839	888	72,717	3.01	327	360

Table 6: Practices by number of specialties

		1 specialty		2 specialties		3+ specialties	
	N	N	%	N	%	N	%
Practices							
1998	220,341	195,726	88.8%	16,893	7.7%	7,722	3.5%
1999	211,718	187,672	88.6%	16,519	7.8%	7,527	3.6%
2000	205,488	182,159	88.6%	16,208	7.9%	7,121	3.5%
2001	205,179	182,079	88.7%	16,008	7.8%	7,092	3.5%
2002	200,879	179,011	89.1%	14,415	7.2%	7,453	3.7%
2003	204,013	179,267	87.9%	16,856	8.3%	7,890	3.9%
2004	203,744	178,498	87.6%	17,133	8.4%	8,113	4.0%
2005	206,139	181,316	88.0%	16,485	8.0%	8,338	4.0%
2006	189,895	165,935	87.4%	15,754	8.3%	8,206	4.3%
2007	184,991	161,112	87.1%	15,604	8.4%	8,275	4.5%
2008	180,865	157,099	86.9%	15,368	8.5%	8,398	4.6%
2009	170,683	147,093	86.2%	15,102	8.8%	8,488	5.0%
2010	167,950	143,325	85.3%	15,779	9.4%	8,846	5.3%
Physicians							
1998	587,165	307,117	52.3%	70,712	12.0%	209,336	35.7%
1999	581,741	299,986	51.6%	71,649	12.3%	210,106	36.1%
2000	570,625	295,891	51.9%	71,609	12.5%	203,125	35.6%
2001	570,667	295,008	51.7%	72,188	12.6%	203,471	35.7%
2002	593,588	289,868	48.8%	73,458	12.4%	230,262	38.8%
2003	605,982	288,513	47.6%	78,928	13.0%	238,541	39.4%
2004	618,440	289,963	46.9%	80,704	13.0%	247,773	40.1%
2005	635,734	294,132	46.3%	82,356	13.0%	259,246	40.8%
2006	624,244	277,511	44.5%	83,651	13.4%	263,082	42.1%
2007	634,551	275,010	43.3%	84,329	13.3%	275,212	43.4%
2008	645,314	269,994	41.8%	85,053	13.2%	290,267	45.0%
2009	646,879	259,156	40.1%	84,459	13.1%	303,264	46.9%
2010	665,025	254,991	38.3%	86,569	13.0%	323,465	48.6%

Table 7: HHIs by Practice, all specialties pooled

			HHI percentiles		
	N	Mean HHI	p10	p50	p90
1998	269,013	2,478	612	1,938	5,146
1999	259,543	2,477	610	1,932	5,157
2000	251,731	2,480	605	1,931	5,172
2001	250,930	2,479	599	1,919	5,197
2002	248,062	2,407	565	1,864	5,057
2003	254,826	2,377	563	1,835	5,008
2004	256,076	2,350	554	1,802	4,956
2005	258,775	2,369	556	1,836	4,983
2006	242,093	2,381	534	1,837	5,041
2007	238,253	2,405	543	1,866	5,069
2008	235,354	2,420	554	1,884	5,080
2009	226,035	2,448	561	1,904	5,130
2010	226,332	2,446	558	1,904	5,122

Table 8: Comparison of different measurement approaches, 2010 practice-level HHIs

	N (specialty-specific) practices	Mean HHI	p10	p50	p90	correlation with baseline approach
Baseline approach	226,332	2,446	558	1,904	5,122	---
Use claims as output measure	226,332	2,461	607	1,972	4,994	0.969
Use work RVUs as output measure	223,508	2,416	544	1,892	5,020	0.971
Impose 75% limit in practice market definition	226,332	2,395	517	1,819	5,106	0.995
Use all claims, not just those where physician-patient distance<=100 miles	227,179	2,284	551	1,808	4,714	0.979

Table 9: Number of observations and presence of affiliations codes and NPI or UPIN, SK&A data

	N	with group	with hospital	with system	with group, hospital, or system	with NPI or UPIN
All Specialties						
2008	496,339	43%	18%	17%	58%	83%
2009	508,575	46%	19%	17%	60%	87%
2010	528,225	46%	17%	18%	59%	88%
By specialty 2010						
internal medicine	62,915	42%	16%	19%	52%	90%
family practice	80,943	41%	17%	19%	55%	89%
allergy/immunology	4,138	42%	11%	12%	50%	85%
cardiology	21,294	61%	16%	18%	70%	89%
critical care	361	58%	30%	50%	79%	80%
dermatology	10,306	37%	10%	12%	43%	90%
endocrinology	4,300	42%	23%	26%	59%	90%
gastroenterology	11,368	53%	13%	14%	61%	91%
geriatrics	1,223	33%	36%	33%	61%	87%
hematology	364	36%	40%	44%	71%	74%
infectious disease	4,024	38%	32%	33%	66%	90%
nephrology	7,557	54%	16%	26%	70%	84%
neurology	10,137	40%	20%	23%	57%	90%
oncology	10,779	54%	24%	25%	71%	86%
pulmonary disease	4,344	46%	19%	18%	59%	85%
radiation oncology	4,186	48%	34%	28%	74%	84%
rheumatology	3,752	42%	20%	23%	56%	91%
colorectal surgery	1,064	47%	12%	15%	57%	91%
general surgery	15,602	43%	19%	17%	57%	90%
neurosurgery	3,904	42%	22%	24%	61%	90%
ophthalmology	17,322	51%	9%	10%	57%	89%
orthopedics	22,567	56%	13%	13%	65%	89%
otolaryngology	8,515	46%	15%	15%	57%	91%
plastic/maxilofacial surgery	9,500	23%	8%	8%	30%	86%
thoracic surgery	2,896	44%	24%	25%	63%	90%
urology	8,835	52%	14%	14%	62%	90%
vascular surgery	2,272	43%	22%	23%	60%	86%
anesthesiology	22,423	59%	14%	16%	70%	92%
emergency med	19,865	49%	22%	20%	67%	85%
pathology	8,422	50%	25%	25%	72%	86%

physical medicine/rehab	5,358	36%	15%	16%	49%	89%
psychiatry	22,377	22%	13%	18%	38%	86%
radiology	25,005	67%	12%	15%	75%	80%

Table 10: Median HHIs by practice, using alternate practice measures

	Tax ID (Medicare)		SK&A Group		SK&A Group or Hospital		SK&A Group or Hosp or System	
	N	Med. HHI	N	Med. HHI	N	Med. HHI	N	Med. HHI
internal medicine	32,996	853	40,509	750	36,942	755	34,889	786
family practice	31,993	1,431	42,079	1,215	37,446	1,237	34,983	1,273
allergy/immunology	2,022	5,106	2,202	4,853	2,188	4,866	2,138	4,885
cardiology	7,953	1,914	10,085	1,577	9,165	1,576	8,694	1,587
critical care	684	6,825	751	5,943	702	6,137	643	6,249
dermatology	5,522	1,983	6,423	1,699	6,234	1,715	6,094	1,729
endocrinology	2,159	3,571	2,555	3,175	2,339	3,239	2,174	3,358
gastroenterology	4,621	2,382	6,206	1,859	5,834	1,893	5,585	1,893
geriatrics	738	6,520	826	5,814	734	6,453	684	6,497
hematology	388	8,862	465	8,093	424	8,520	391	8,613
infectious disease	1,576	4,483	2,158	3,553	1,849	3,781	1,706	3,837
nephrology	2,536	3,808	3,604	2,904	3,338	2,941	3,027	3,024
neurology	5,204	2,473	6,295	2,162	5,602	2,224	5,231	2,280
oncology	2,961	5,092	4,858	4,212	4,263	4,283	3,917	4,263
pulmonary disease	3,805	3,047	4,426	2,563	4,069	2,626	3,871	2,638
radiation oncology	1,679	6,215	2,271	5,203	1,976	5,459	1,785	5,569
rheumatology	2,000	5,085	2,355	4,639	2,199	4,733	2,114	4,771
cardiac surgery	877	7,143	975	6,649	929	6,812	893	6,842
colorectal surgery	617	6,558	679	6,012	662	6,053	647	6,077
general surgery	8,579	2,516	10,376	2,216	9,555	2,291	8,938	2,310
neurosurgery	1,682	5,112	2,280	4,740	2,049	4,829	1,890	4,901
ophthalmology	8,280	1,703	9,692	1,554	9,331	1,564	9,109	1,567
orthopedics	7,266	2,298	9,884	1,929	9,257	1,962	8,888	1,972
otolaryngology	4,009	3,131	4,999	2,587	4,782	2,634	4,589	2,663
plastic/maxilofacial surgery	3,604	4,702	3,826	4,630	3,731	4,651	3,663	4,674
thoracic surgery	1,076	6,431	1,290	5,877	1,164	6,089	1,108	6,121
urology	3,496	3,580	4,711	2,745	4,473	2,755	4,335	2,757
vascular surgery	1,429	5,162	1,534	4,580	1,456	4,700	1,385	4,719
anesthesiology	4,340	2,674	9,184	1,828	8,153	1,880	7,638	1,883
emergency med	5,070	3,946	8,877	1,924	7,572	2,234	6,973	2,324
pathology	1,757	3,821	3,485	2,485	2,764	2,768	2,543	2,824
physical medicine/rehab	3,470	3,098	3,739	2,868	3,550	2,924	3,370	3,006
psychiatry	9,352	2,090	11,618	1,820	10,897	1,870	10,047	1,908
radiology	4,397	2,935	8,696	1,803	7,782	1,840	7,289	1,879

Appendix Table: Included specialties and measures of output, 2000 and 2010

	2000			2010		
	claims (000s)	work RVUs (000s)	allowed charges ($m)	claims (000s)	work RVUs (000s)	allowed charges ($m)
internal medicine	29,625	18,810	1,383	37,420	35,115	2,387
family practice	21,578	11,982	827	25,850	19,217	1,349
allergy/immunology	682	151	28	765	261	46
Cardiology	14,596	11,308	965	18,641	18,498	1,520
critical care	195	253	16	449	924	54
Dermatology	3,729	3,241	253	5,863	6,257	569
Endocrinology	1,118	569	45	1,783	1,230	96
Gastroenterology	2,564	4,188	264	2,946	6,286	374
Geriatrics	320	252	16	563	711	42
Hematology	226	87	20	397	196	56
infectious disease	851	839	57	1,549	2,168	133
Nephrology	2,147	2,923	196	3,665	6,487	432
Neurology	2,008	2,432	172	2,794	4,087	338
Oncology	6,949	2,057	606	10,839	4,531	