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**Size Matters: The Diversity of Physician Practice Production Functions**

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4 **Size Matters: The Diversity of Physician Practice Production Functions**  
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6 **Abstract**  
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9 Physician practices in the US are largely small-scale, independently-run enterprises,  
10 despite their potential critical role in creating a more integrated health care system. Using a  
11 more robust data set and a more appropriate estimation technique than previous studies, we  
12 estimate physician practice production functions for different types of practices (multispecialty,  
13 single-specialty, and six subspecialties within single-specialty practices). We find that these  
14 practices have distinct production functions, which suggests that each kind of practice has a  
15 different “theory of the business.” In addition, we find few technical advantages to size or  
16 growth for most practice types. As a result, analyses of physician practices that do not recognize  
17 the diversity of physician practices may reach erroneous conclusions and make inappropriate  
18 policy recommendations.  
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4 A contradiction exists at the core of the efforts to improve the US health care system.  
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6 Almost all health care reform proposals have envisioned that physicians and their practices will  
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8 be integral parts of a more efficient and effective health care delivery system. (American  
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10 Academy of Family Physicians, American Academy of Pediatrics, American College of  
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12 Physicians, & American Osteopathic Association, March 2007; Christensen, Grossman, &  
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14 Hwang, 2009; Daschle, 2008; Robinson, 1999; Tollen, April 2008) Yet, physicians seem  
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16 reluctant to practice in the large organizations needed to effect the integration envisioned in these  
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18 proposals.  
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25 We suspect that the answer to this contradiction may lie in the inherent economics of  
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27 physician practices. That is, are small practices more productive – and therefore more profitable  
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29 – than large practices? Or, are large practices more productive? If the latter is true, physicians  
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31 must be willing to sacrifice other goals more readily attainable in small practices (such as  
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33 professional autonomy and control) in order to achieve these efficiencies and profits. To test  
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35 these ideas, in this paper we begin the search for the “optimal” size of physician practices, by  
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37 examining the structure and performance of physician practices. We will demonstrate that the  
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39 production functions of physician practices differ by practice type and specialty. As a result,  
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41 multiple optimal sizes of physician practices may exist.  
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48 Several problems have plagued research on physician production functions: data sets that  
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50 focus on the individual physician, rather than the practice, as the unit of observation; sample  
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52 sizes that limit the disaggregation of practices; and the inherent endogeneity of inputs into the  
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54 production process. We believe that we have solved these problems, so that the operations of  
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56 physician practices can be examined more accurately.  
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4 In Section 1 we describe the environment of physician practices in the US and provide a  
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6 brief history of recent attempts to integrate physicians into larger health care organizations.  
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9 Section 2 reviews the major research to date on physician practice size and places our analytical  
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11 framework in the context of this research. Section 3 presents our analytical framework. Section  
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13 4 describes our data and estimation strategy. In Section 5 we present descriptive statistics and  
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15 the empirical estimates from our model. In Section 6 we discuss our findings and conclusions.  
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## 19 20 **1. The Environment of Physician Practices**

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22 Physician services currently constitute 21% of national health expenditures in the United  
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24 States (Hartman, Martin, McDonnell, & Catlin, 2009), and many have asserted that – through the  
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26 power of their referrals, hospital admissions, orders, and prescriptions – physicians have  
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28 effective control over the bulk of health care spending (Sirovich, Gallagher, Wennberg, &  
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30 Fisher, 2008). Paradoxically, physicians wield this influence despite the fact that, in most  
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32 instances, they practice largely in small-scale, independently-run enterprises. The demise of solo  
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34 practice has been heralded for decades, but nevertheless a large percentage of physicians remain  
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36 in solo or two-physician practices. According to the American Medical Association (Smart,  
37  
38 2004), only 10% of physicians were in group practice in 1965; by 1986 that percentage had  
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40 increased to 31.9%.<sup>1</sup> It appeared then that group practice was becoming the predominant mode  
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42 of practice. However, this trend appeared to stall out after 1986, with only 30.2% of physicians  
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44 in group practices in 2003. Data from this report also revealed that group practices are still  
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46 relatively small, with 69% of group practices in 1994-95 and 65% of group practices in 2003  
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48 having between 3 and 6 FTE physicians. A more recent AMA study (Kane, 2009) reported that  
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50 24.6% of physicians in clinical practice (and 32.5% of physicians in office-based practices) were  
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59 <sup>1</sup> The AMA defines a group practice as 3 or more physicians formally organized as a legal entity in which business,  
60 clinical, and administrative facilities are shared.  
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4 in solo practice in 2007-08, and that 21.4% (28.3%) were in practices of 2 to 4 physicians,  
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6 suggesting a decline in solo practice over the decade. Liebhaber and Grossman (August 2007),  
7  
8 using the Community Tracking Study, found a statistically significant decline in the percentage  
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10 of physicians in solo or 2-physician practices, from 40.7% in 1996-97 to 32.5% in 2004-05.<sup>2</sup>  
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12 They found the decline to be most prominent for specialists (both surgical and medical) rather  
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14 than for primary care physicians.  
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20 It has been argued that physicians need to agglomerate into larger and more integrated  
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22 practices. Many consider multispecialty group practices such as Kaiser Permanente and the  
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24 Geisinger Health System to be the ideal structure for the physician practice of the future, with a  
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26 balance of primary care and specialty physicians, supported by a full range of clinical and  
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28 ancillary services and administrative infrastructure. (Shih et al., 2008) Others argue that single-  
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30 specialty groups can match the quality and efficiency of multispecialty groups. (Casalino, Pham,  
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32 & Bazzoli, 2004) One recent analysis has found that small practices will be disadvantaged in  
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34 increasingly popular pay-for-performance programs because they lack sufficient patient  
35  
36 caseloads to demonstrate statistically reliable measures of superior performance. (Nyweide,  
37  
38 Weeks, Gottlieb, Casalino, & Fisher, 2009) Health policy advisors to President Obama are  
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40 telling physicians that, “The economic forces put in motion by the [Affordable Care] Act are  
41  
42 likely to lead to vertical organization of providers and accelerate physician employment by  
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44 hospitals and aggregation into larger physician groups.” (Kocher, Emanuel, & DeParle, August  
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51 23, 2010)  
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58 <sup>2</sup> The discrepancy in data on physician practice size is concerning, and suggests underreporting of group practices to  
59 the AMA’s surveys. However, we are unable to reconcile the different estimates by the available studies.  
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4 In the past two decades, at least two major attempts have been made to consolidate  
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6 physicians into large groups. The first was the rapid rise (and fall) of for-profit physician  
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8 practice management companies (PPMCs). The 1990s saw the launch of dozens of PPMCs  
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10 dedicated to the acquisition and management of physician practices. The PPMC business model  
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12 was based on the premise that these companies could exploit cost savings through economies of  
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14 scale and centralization, expanded access to capital, and bargaining clout with managed care  
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16 companies. Almost all of the PPMCs foundered within a few years as the purported benefits of  
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18 their business models failed to materialize, and either ceased operations or transformed their  
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20 business models. (Burns, 1997; Reinhardt, 2000; Robinson, 1999)  
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27 The second major attempt at physician aggregation was the acquisition of physician  
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29 practices by hospitals and health systems. With the growth of managed care in the 1990s, many  
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31 hospitals and health systems were concerned that they might be excluded from payer contracts.  
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33 As a result, they felt the need to migrate many of their medical staff (especially primary care  
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35 physicians) from the informal relationships represented by traditional hospital privileges and  
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37 credentialing to more formal relationships including practice acquisition. (Robinson, 1999)  
38  
39 Even after the restrictive managed care environment receded in the early 2000s, many hospitals  
40  
41 continued to see wholly-owned primary care physician practices as key components of their  
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43 retail supply chain. (Halley, 2007) Unfortunately, many hospitals found that they were  
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45 sustaining operating losses on these practices in excess of \$80,000 per physician, and responded  
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47 by divesting the practices. (Healthcare Advisory Board, 1999)  
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54 That both of these efforts – one well-funded and predicated on expected profit  
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56 opportunities, and the other formulated by insiders and created for supposed strategic advantages  
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58 –largely failed, combined with the limited organic growth of group practices, suggests that the  
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4 economics of physician practices may be more complicated than expected. Perhaps the  
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6 presumed economies of scale and scope of larger physician practices are illusory. That is, the  
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8 small physician practice may in fact be an economically robust enterprise; if so, this sector will  
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10 remain fragmented for the foreseeable future.  
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## 14 **2. The Analytical Context**

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18 The structure of physician practices has generated episodic interest of economists and  
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20 health service researchers over the past three decades. The research of relevance to the current  
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22 study has focused on three areas: optimality as determined by survivor analysis; practices as  
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24 organizations; and production function estimation. Frech and Ginsburg (1974) and Marder and  
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26 Zuckerman (1985) applied survivor analysis to physician practices, under the hypothesis that the  
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28 least (most) efficient size practices will disappear (thrive); they found that, in general, only large  
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30 multispecialty group practices may be of optimal size (although solo practices may still be  
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32 efficient, at least in certain parts of the U.S.).  
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39 Other researchers have analyzed the physician practice as a firm. Madison and Konrad  
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41 (1988) analyzed the growth and evolving organizational structure of large medical group  
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43 practices. Using a typology based on “organizational tradition” and “market-response strategy,”  
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45 they identified the expected internal conflicts within large physician practices as the practices  
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47 respond to changing market demands. Pauly (1996) argued that the primary competitive  
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49 advantage of multispecialty group practices is likely to be in coordinating the process of care  
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51 (especially in a managed care environment), rather than any inherent economies of scale or  
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53 scope. Getzen (1984) posited a “brand-name” theory of the firm applied to physician practices.  
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58 Town et al. (2004) examined in considerable detail the role of incentives in physician groups,  
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4 concluding that a single comprehensive theory of incentives within practices may not be possible  
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6 because of the complexity of physician utility functions and practice production functions.  
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10 A considerable – and varied – body of research has focused on the estimation of  
11 physician production functions. Some have focused on input mix and interdependency, others  
12 on economies of scale or scope. The seminal work was conducted by Reinhardt (1972), who  
13 estimated a transcendental production function for physicians, specifically for general  
14 practitioners in private practice. He used the individual physician – rather than the practice – as  
15 the unit of observation, and measured output by total patient visits, physician office visits, and  
16 patient billings – rather than impact on the patient’s health (arguing that physician services are  
17 intermediate goods, rather than final goods). In addition, he assumed that inputs – practice  
18 hours, office hours, capital, and non-physician labor (registered nurses, technicians, and office  
19 aides) – were exogenously determined.  
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35 Gaynor and Pauly (1990) used stochastic production frontier analysis to estimate both  
36 “traditional” and “behavioral” productions for primary care physicians, and confirmed the impact  
37 of incentives on productivity. Pope and Burge (1996) used the Reinhardt production function to  
38 estimate significant increasing returns to scale for single-specialty practices. Using stochastic  
39 production frontier analysis, DeFelice and Bradford (1997) found that primary care physicians in  
40 both solo and group practices produced less than the optimal number of patient visits per week,  
41 and that the differences between the two practice modalities were statistically – but not  
42 economically – significant.  
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56 Two studies deserve particular attention because of their relevance to our work. The first,  
57 Thurston and Libby (2002), applied a generalized linear production function to the Reinhardt  
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4 construct. This functional form allows for zero values for inputs, which is helpful in estimating  
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6 production functions for physician services given the large number of small practices that do not  
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8 employ all types of non-physician clinical providers.<sup>3</sup> This function also facilitates estimation  
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10 of the marginal productivity of inputs, as well as of Hicks elasticities of complementarity.  
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14 Thurston and Libby used the physician as the unit of observation, and implicitly assumed that the  
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16 physician services production function was homogeneous across practice types (i.e.,  
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18 multispecialty vs. single-specialty practices, and subspecialties within single-specialty practices).  
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20 They used office visits and total patient visits as the measures of output, and – as with Reinhardt  
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22 – assumed that the inputs were exogenously determined. The model found that all of the  
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24 estimated marginal productivities were positive, and that the three kinds of non-physician labor  
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26 included (administrative and clerical, nurses, and technicians and aides) were complements with  
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28 physician labor.  
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34 The second study of note – Rosenman and Friesner (2004) – applied data envelopment  
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36 analysis to explore the efficiency of physician practices. Unlike most previous studies, they used  
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38 the physician practice, rather than the individual physician within a practice, as the unit of  
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40 observation. They divided their analysis into two overlapping samples: the “primary care  
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42 sample” (which included single-specialty primary care practices, multispecialty practices with  
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44 primary care physicians only, and multispecialty practices with both primary and specialty care),  
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46 and the “specialty care sample” (which included single-specialty specialty care practices,  
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48 multispecialty practices with specialty care only, and multispecialty practices with both primary  
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50 and specialty care). Using data from the 1998 Medical Group Management Association Annual  
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52 Cost Survey, Rosenman and Friesner used three measures of output: “surgical and nonsurgical  
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59 <sup>3</sup> The generalized linear production function does have the limitation of imposing constant returns to scale to the  
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61 model.  
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4 procedures and services done inside the practice’s facility;” “surgical and nonsurgical procedures  
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6 and services done outside the practice’s facility;” and “total ancillary (diagnostic, radiological  
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8 and laboratory) procedures and services performed by the practice.” The data envelopment  
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10 analysis showed that single-specialty practices were more efficient than multispecialty practices,  
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12 with the inefficiency due primarily to technical (rather than allocative) inefficiency. In addition,  
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14 single-specialty practices had higher average scale efficiencies than multispecialty practices.  
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### 19 **3. Our Analytical Framework**

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23 We build on – and extend – this line of research in several ways in the present paper.  
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25 First, we follow Rosenman and Friesner by treating the physician practice – rather than the  
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27 individual physician – as the unit of observation. Most of the previous research recognized that  
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29 individual physicians worked with other clinicians, but assumed (at least implicitly) that  
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31 production was driven by the individual physician. Research cited above note the critical role of  
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33 organizational behavior in the production process; even though practices may be small and even  
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35 atomistic, it is clear that the nature and structure of the production of medical care is determined  
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40 by the firm.  
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44 Second, as has been recognized in the literature, physician practices are not  
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46 homogeneous, and we account explicitly for this diversity. For instance, single-specialty  
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48 practices may have significantly different production functions from multispecialty physician  
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50 practices. It can be argued that multispecialty practices seek scale in order to create an  
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52 “ecosystem” of physicians, so that primary care physicians can refer their patients mostly to  
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54 specialists within the practice, and in turn specialists in the practice can rely on their primary  
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56 care colleagues for a full practice of referred patients. In addition, different kinds of single-  
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4 specialty practices (primary care, medical subspecialty, surgical subspecialty) may themselves  
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6 have different production functions. Primary care practices (i.e., family practice, internal  
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8 medicine, and pediatrics) are usually office-based, in which they provide mostly cognitive  
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10 services (also known as evaluation and management services); some (but not many) primary care  
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12 practices offer revenue-generating diagnostic and treatment procedures in their own facilities.  
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14 Many medical specialties (such as cardiology and gastroenterology) and almost all surgical  
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16 practices (e.g., orthopaedic surgery, neurosurgery, and urology) concentrate on major  
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18 procedures; in fact, many practices own and operate their own diagnostic or surgical facilities,  
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20 which provide potential for both practice efficiencies (e.g., optimizing the use of physician time)  
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22 and profit (e.g., billing for technical as well as professional services). Other facility-based  
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24 single-specialty practices (e.g., anesthesiology, pathology, and radiology) typically provide  
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26 services in facilities owned and operated by others (e.g., hospitals) often on an exclusive  
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28 contractual basis, and often have office space only for billing and collection functions.<sup>4</sup> These  
29  
30 substantial structural differences among physician practices suggest that both the “nature of the  
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32 firm” (as elucidated by Coase (1937) ) and the “theory of the business” (as proposed by Drucker  
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34 (1994)) in physician practices are not uniform.  
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44 Third, we estimate physician practice production functions using a Cobb-Douglas model.  
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46 We recognize that this functional form limits our sample to practices with non-zero inputs. We  
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48 compensate for this problem by judicious aggregation of non-physician labor inputs. The Cobb-  
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50 Douglas form has two principal advantages for our work. First, it allows explicit estimation of  
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52 returns to scale (a primary goal of this research). Second, it enables us to address the inherent  
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57 <sup>4</sup> These descriptions are admittedly general and do not capture the diversity of each kind of physician practices.  
58 Readers who desire a more comprehensive description of physician practices are directed to (Freidson, 1988; 1970)  
59 and (Wagner, 2005).  
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4 issue of input endogeneity. At least as early as Marschak and Andrews (1944), economists  
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7 estimating production functions have been concerned about the endogeneity of inputs.

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9 Endogeneity can occur in two related forms. First, a firm will select inputs for time  $t$  based on  
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11 expectations that the inputs will be able to produce – and the firm will be able to sell – a given  
12  
13 amount of output; and second, input levels will be correlated with unobserved firm-specific  
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15 productivity shocks. As a result, ordinary least squares estimation of production functions will  
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18 yield biased parameter estimates.  
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22 As Akerberg et al. (2007) describe in an excellent review of the issue, traditional  
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24 approaches to accounting for endogeneity of production functions – instrumental variables and  
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26 fixed effects – have been insufficient both methodologically and in practice. Two related  
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28 approaches – Olley and Pakes (1996) and Levinsohn and Petrin (2003) – have shown significant  
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30 promise in addressing the fundamental problem. Both Olley and Pakes (1996) and Levinsohn  
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32 and Petrin (2003) employ a Cobb-Douglas production function in their approaches:  
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$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \varepsilon_t, \quad (1)$$

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41 where  $y_{it}$  is the log of output from firm  $i$  at time  $t$ ,  $k_{it}$  the log of capital input,  $l_{it}$  the log of labor  
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43 input, and  $\varepsilon_t$  the error term. Because the firm has some knowledge regarding the unobserved  
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45 sources of variances when it chooses its inputs,  $\varepsilon_t$  is not normally distributed. Olley and Pakes  
46  
47 argue that  $\varepsilon_t$  can be decomposed into two additively separable components:  $\omega_t$  and  $\eta_t$ .  $\omega_t$  is a  
48  
49 state variable, which Akerberg et al. call “unobserved productivity,” meaning that it is observed  
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51 (or predictable) by the firm but not by the econometrician.  $\eta_t$  are true unobservables that are not  
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4 observed (or predictable ) by the firm. In essence, estimating a production function for physician  
5 services without taking  $\omega_t$  into account will yield biased estimates of  $\beta_{ij}$ .  
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10 Olley and Pakes and Levinsohn and Petrin offer complementary econometric solutions to  
11 this problem. Olley and Pakes assume that one of the inputs (say, capital, or  $k_{it}$  in (1)) is fixed  
12 rather than variable at time  $t$ . They demonstrate that the investment demand function for the firm  
13 can be written as:  
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$$20 \quad i_t = i_t(\omega_t, k_{it}) \quad (2)$$

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25 Olley and Pakes make the reasonable assumption that (2) is strictly monotonic in  $\omega_t$ . As a result,  
26 (2) can be inverted to generate:  
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$$30 \quad \omega_t = h_t(i_t, k_{it}) \quad (3)$$

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35 As Akerberg et al. note (p. 4214), the intuitive interpretation of (3) is that, conditional on a  
36 firm's levels of  $k_{it}$ , its choice of investment ( $i_t$ ) tells us what its  $\omega_t$  must be. (1) can then be  
37 rewritten as:  
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$$42 \quad y_{it} = \beta_1 l_{it} + \varphi_t + \eta_t, \quad (4)$$

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47 where  $\varphi_t = \beta_0 + \beta_k k_{it} + \omega_t$ .  
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51 Olley and Pakes describe a two-stage estimation process, for which, as Levinsohn and Petrin  
52 explain, "a first-stage estimator that is linear in  $[l_{it}]$  and non-parametric in  $\varphi_t$  can be used to  
53 obtain a consistent estimate of  $\beta_1$ ." That is, a production function can be estimated that yields  
54 unbiased estimates of the input coefficients.  
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4 Levinsohn and Petrin note that the Olley and Pakes approach suffers from the fact that  
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6 many firms will have zero investments at any time  $t$ , and so will be excluded from the  
7  
8 estimation. They overcome this potentially severe reduction in sample size by using a different  
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10 input than capital ( $k_{it}$ ) as the proxy. In particular, they use what they call an “intermediate input”  
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12 ( $x_{it}$ , such as materials or energy), for which most – if not all – firms use in every time  $t$ .  
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15  
16 Levinsohn and Petrin then substitute  $x_{it}$  in all of the Olley and Pakes equations, and proceed  
17  
18 accordingly. We use the Levinsohn and Petrin approach, and selected medical and surgical  
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20 supplies as our intermediate input because of its ubiquity in physician practices.  
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25  
26 Finally, we present an alternative measure and/or interpretation of output than other  
27  
28 research on physician production functions. Many of the studies cited above use total physician  
29  
30 visits or office visits as their measure of output. These have the disadvantage of omitting major  
31  
32 services (e.g., surgical procedures for surgical practices and interventional procedures from  
33  
34 medical specialists). Unfortunately, there exists no single measure of total output of physician  
35  
36 practices, or a recognized index of practice services. However, we do have total revenue from a  
37  
38 practice, and most research on production functions for other industries uses total revenue as the  
39  
40 output measure. Given the nature of the physician services market, we can assume that  
41  
42 physician practices are price-takers.<sup>5</sup> After all, the primary payer for most practices (Medicare)  
43  
44 reimburses physicians uniformly through the Resource-Based Relative Value Scale (RBRVS)  
45  
46 system, and many other payers use that payment methodology as well. We can also assume that  
47  
48 practices of the same structure (i.e., all multispecialty groups or all single-specialty groups of a  
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58 <sup>5</sup> If this assumption is not valid and physicians have some ability to negotiate prices, then, as Klette and Griliches  
59 (Klette & Griliches, 1996) demonstrate, our estimates of returns to scale will be biased downwards. We shall  
60 recognize this potential for error in our discussion of results.  
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4 particular specialty) will have the same distribution of payer.<sup>6</sup> Under these assumptions, we can  
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6 use total revenue as a proxy for total output.  
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## 9 10 **4. Data and Methods**

### 11 12 **4.1. Data**

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15 Like Rosenman and Friesner (2004), we use data from the annual Medical Group  
16 Management Association (MGMA) Cost Surveys. Since its founding in 1926, MGMA has  
17  
18 collected and reported practice revenue and expense information on an ongoing basis. Since  
19  
20 1979, the annual MGMA Cost Survey has used a similar questionnaire and definitions to  
21  
22 facilitate year-to-year comparisons. Questionnaires are distributed to medical practices that have  
23  
24 an MGMA member, as well as to physician practices that register with MGMA to participate in  
25  
26 the survey. The survey contains over 130 questions that summarize a practice's financial  
27  
28 statements in a standardized manner to provide a comprehensive description of the  
29  
30 organization's activities, revenue, and expenses. The survey response is similar on a year-to-  
31  
32 year basis and, considering the complexity and length of the questionnaire, the rate of response is  
33  
34 considered reasonable. In 2008 10,535 questionnaires were distributed (by postal and e-mail),  
35  
36 and 1,679 responses were received for a 15.9% overall response rate. The overlapping survey  
37  
38 respondent population and stability in the survey questionnaire contribute to consistency in the  
39  
40 data report. MGMA Cost Surveys are widely accepted by federal agencies and academic  
41  
42 researchers as an accurate and comprehensive source of data on the financial performance of  
43  
44 medical group practices. (Pope, Olmsted, Healy, Zuckerman, & McFeeters, 2006)  
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58 <sup>6</sup> For example, we can assume that all single-specialty pediatric groups will have the same payer distribution (mostly  
59 private insurance and Medicaid, with little or no Medicare), and that all single-specialty cardiology practices will  
60 have the same payer distribution (primarily, Medicare and private insurance).  
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4 (Subcommittee on Health of the Committee on Energy and Commerce, 2002) These surveys  
5  
6 are described in more detail at (Medical Group Management Association, 2009).  
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10 We use Total Gross Charges as our measure of production output. MGMA defines Total  
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12 Gross Charges as the sum of gross fee-for-service charges (defined as “the full value, at the  
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14 practice’s undiscounted rates, of all services provided to fee-for-service, discounted fee-for-  
15  
16 service and non-capitated patients for all payers”<sup>7</sup>) and gross charges for patients covered by  
17  
18 capitation contracts (defined as “the full value, at a practice’s undiscounted rates, of all covered  
19  
20 services provided to patients covered by all capitation contracts, regardless of payer”<sup>8</sup>). Total  
21  
22 Gross Charges is superior to collections or revenue from a theoretical perspective because  
23  
24 charges are more indicative of practitioner performance whereas collections are influenced by  
25  
26 the ability of the practice to collect from payers. Total Gross Charges is superior to Relative  
27  
28 Value Units (which are used to generate the RBRVS system) from a practical perspective,  
29  
30 because only about 1/3 of respondents to the MGMA Cost Survey report RVUs for their practice.  
31  
32 Because we use four years of data, we deflate Total Gross Charges (scaled in millions USD) by  
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34 the Medical Care Services price index.  
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46 <sup>7</sup> Gross fee-for-service charges includes: professional services provided by physicians, non-physician providers, and  
47 other physician extenders such as nurses and medical assistants; both the professional and technical components of  
48 laboratory, radiology, medical diagnostic and surgical procedures; contractual adjustments (such as Medicare charge  
49 restrictions, third-party payer contractual adjustments, charitable adjustments, and professional courtesy  
50 adjustments); drug charges; charges for supplies consumed during a patient encounter inside the practice’s facilities;  
51 facility fees; charges for fee-for-service services allowed under the terms of capitation contracts; charges for  
52 professional services provided on a case-rate reimbursement basis; and charges for purchased services for fee-for-  
53 service patients.  
54

55 <sup>8</sup> Gross charges for patients covered by capitation contracts includes: fee-for-service equivalent gross charges for all  
56 services covered under the terms of the practice’s capitation contracts, including: professional services provided by  
57 physicians, non-physician providers, and other physician extenders such as nurses and medical assistants; both the  
58 professional and technical components of laboratory, radiology, medical diagnostic and surgical procedures; drug  
59 charges; charges for supplies consumed during a patient encounter inside the practice’s facilities; and facility fees.  
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4 We use five measures of inputs: the full-time-equivalent (FTE) number of physicians  
5 involved in clinical care; the FTE number of mid-level providers<sup>9</sup> involved in clinical care; the  
6 FTE number of clinical staff<sup>10</sup>; the FTE number of ancillary staff<sup>11</sup>; and annual capital  
7 expenditures.<sup>12</sup> In addition, we examine differences in production functions if physicians were  
8 the majority owners of the practice.  
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17 We construct an unbalanced panel using 2005-2008 MGMA data, which cover the  
18 calendar years 2004 through 2006. The MGMA Cost Surveys are repeated cross sectional data,  
19 but we are able to exploit the panel feature of it for the recent three years for two reasons. First,  
20 around 35% of the physician practices in the dataset appear at least twice in these three years;  
21 second, with improved data collecting procedures, MGMA has been able to use the Group  
22 Identification Number as a consistent identifier to match practices across years. This application  
23 is one novel use of the data.  
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35 The combined 2005-2008 MGMA data set included 5,851 observations for the years  
36 2004-2007. We eliminated 136 practices because of missing values of input and output  
37 variables, and 583 because of missing group identification numbers and therefore were unable to  
38 be matched. Lastly, we assumed that physician practices require non-zero FTE physicians and  
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48 <sup>9</sup> Mid-level providers include: non-physician providers who are specially trained and licensed providers who can  
49 provide medical care and billable services, such as Certified Registered Nurse Anesthetists, dietitians/nutritionists,  
50 midwives, nurse practitioners, occupational therapists, optometrists, physical therapists, physician assistants,  
51 psychologists, social workers, speech therapists, and surgeon's assistants.  
52

53 <sup>10</sup> Clinical staff include: registered nurses, licensed practical nurses, medical assistants, and nurse's aides.  
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55 <sup>11</sup> Ancillary staff include: clinical laboratory, radiology and imaging, and other medical support services.  
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57 <sup>12</sup> Capital expenditures are defined as annual costs for information technology (practice-wide data processing,  
58 computer, telephone and telecommunications services), building and occupancy (i.e., general operation of buildings  
59 and grounds), and furniture and equipment. Because we use four years of data, we deflate capital expenditures  
60 (scaled in millions USD) by the U.S. City Consumer Price Index.  
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4 capital expenditures to create output, which eliminated 597 observations. This process left us  
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6 with a total of 4,535 observations, of which 2,703 are unique physician practices.  
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## 10 **4.2 Estimation Strategy**

11  
12 We estimate a Cobb-Douglas production function for physician services, using the  
13  
14 Levinsohn-Petrin procedure to correct for endogeneity between the inputs and output. Because  
15  
16 of the significant number of zero values for specific non-physician clinical staff, we aggregated  
17  
18 mid-level providers, clinical staff, and ancillary staff. We estimate a production function for all  
19  
20 physician practices in the MGMA sample. We also estimate separate production functions for  
21  
22 multispecialty and single-specialty groups. Within the single-specialty category we estimate  
23  
24 separate production functions for the four major groupings (primary care, medical, surgical, and  
25  
26 indirect patient care) and six specific specialties for which we had sufficient sample size (family  
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28 practice, pediatrics, cardiology, orthopaedic surgery, obstetrics/gynecology, and urology).  
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## 35 **5. Results**

### 36 **5.1. Summary Statistics**

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38 We begin the empirical analysis by examining the characteristics of the 4,535  
39  
40 observations in our sample. Table 1 presents summary data on the size of these practices, as  
41  
42 measured by the number of FTE physicians. For the entire sample, the mean size was 22.4 FTE  
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44 physicians, with a median of 8.5; the smallest was 0.2 FTE physicians and the largest was 991.3.  
45  
46 Data not presented in the table show that 10% of the sample had 2 or fewer FTE physicians per  
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48 practice, which is notable because the source of the data (the Medical Group Management  
49  
50 Association) is a trade association that represents group practices.  
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59 TABLE 1 GOES ABOUT HERE  
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4 Table 1 also illustrates the dramatic size differences between multispecialty and single-  
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6 specialty group practices. The mean/median size of multispecialty practices in this sample was  
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8 52.9/28.0 FTE physicians, almost five times the mean/median size of single-specialty practices  
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10 (11.3/6.5 FTE physicians). Note, however, that the size distribution of these practice types  
11  
12 overlaps to a considerable degree. The largest single-specialty practice (235.0 FTE physicians)  
13  
14 exceeds the size of 75% of multispecialty practices, and the size of the 75<sup>th</sup> percentile of single-  
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16 specialty practices in the sample exceeds the size of the 25<sup>th</sup> percentile of multispecialty  
17  
18 practices. These differences suggest that the fundamental characteristics of multispecialty and  
19  
20 single-specialty physician practices (such as business models and production functions) may be  
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22 different as well; as a result, separate model estimation may be merited.  
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29 Table 1 reveals that size differences exist among single-specialty practices, as well.  
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31 Primary care practices (family practice, pediatrics, general internal medicine) are smaller than  
32  
33 medical or surgical practices, and much smaller than indirect patient care practices  
34  
35 (anesthesiology, pathology, radiology). This pattern holds for specific single-specialty practices  
36  
37 as well. The median size of family practice groups in the sample (3.3 FTE physicians) is the  
38  
39 smallest in the sample, followed by urology (5.0), obstetrics/gynecology (5.4), pediatrics (5.8),  
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41 orthopaedic surgery (8.0), and cardiology (11.5).  
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47 As noted above, primary care practices are usually office-based, and the bulk of their  
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49 services are office visits by patients, rather than extensive procedures; as a result, scale may not  
50  
51 be of economic or strategic advantage. Medical (cardiology) and surgical (orthopaedic surgery,  
52  
53 urology, and obstetrics/gynecology) practices are larger; these practices are focused on major  
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55 procedures, and often involve ownership of diagnostic or surgical facilities. The largest single-  
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57 specialty practices (indirect patient care) are facility-based, often provide services on an  
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4 exclusive contractual basis, and require office space only for billing and collection functions.  
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6 These differences in size and practice characteristics among single-specialty physician practices  
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8 suggest that it may be worthwhile to estimate separate production functions for each kind of  
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10 practice.  
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15 Table 2 reveals even more differences among physician practices, in terms of the  
16  
17 variables used in the production function model estimation. The mean physician practice among  
18  
19 the 4,535 in the sample had \$9.6 million in total gross charges per year from its 22.4 physicians  
20  
21 (for an average of \$427,800 per physician), and spent \$740,000 on capital expenditures. This  
22  
23 practice employed 49.1 non-physician clinical staff. 70% of the responding practices were  
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25 owned by physicians.  
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31 TABLE 2 GOES ABOUT HERE  
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33  
34 This mean practice masks the significant diversity among practices. The differences  
35  
36 between multispecialty and single-specialty practices are even more dramatic than simply size,  
37  
38 as indicated in Table 1. The mean multispecialty practice generated over three times the total  
39  
40 gross charges as the mean single-specialty practice, but with almost five times the number of  
41  
42 FTE physicians; as a result, the mean multispecialty practice produced 29% less charges per FTE  
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44 physician (\$372,000 versus \$517,000). Controlling for practice size, the mean multispecialty  
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46 practice employed more non-physician clinicians and office staff than did the mean single-  
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48 specialty practice. If one can assume that multispecialty and single-specialty practices have the  
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50 same maximand and same level of efficiency, then it is likely that their production functions are  
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52 different.  
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4 As with practice size, the subspecialties within single-specialty practices differ dramatically  
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6 in terms of practice characteristics. Primary care practices by far had the lowest mean total gross  
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8 charges per FTE physician, less than half of that for medical and surgical specialty practices;  
9  
10 they employed fewer office staff and non-physician providers. In addition, they were the least  
11  
12 likely to be physician-owned. Indirect patient care practices (that is, anesthesiology, radiology,  
13  
14 and pathology) were the largest single-specialty practices, with \$11.3 million in annual gross  
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16 charges and 27.2 physicians per practice.  
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22 These findings hold for the specific single-specialty practices, as well. Family practices had  
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24 the lowest mean total gross charges and charges per FTE physician, and the fewest number of  
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26 non-physician clinical staff; in addition, they were the least likely (by far) to be physician-owned  
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28 (33%, compared to the single-specialty practice average of 79%). Cardiology practices had the  
29  
30 highest mean total gross charges, the second-highest mean charges per FTE physician, and the  
31  
32 highest mean level of capital expenditures; in addition, they employed the highest mean number  
33  
34 of FTE non-physician clinical and office staff. Family practices had the lowest capital  
35  
36 expenditures, and employed the fewest FTE non-physician clinicians). Orthopaedic surgery  
37  
38 practices generated the highest mean level of charges per FTE physician, and urology practices  
39  
40 were the most likely (at 97%) to be owned by physicians. As with the other summary data, these  
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42 differences support the conjecture that the structure and production functions of physician  
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44 practices are likely to differ by specialty.  
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4 **5.2 Empirical Estimates**  
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8 Given these summary results, we turn to the results of the model estimation using the  
9  
10 Levinsohn and Petrin procedure.<sup>13</sup> Table 3 presents the results of the model estimation for all  
11  
12 practices, all multispecialty practices, and the four major single-specialty practice groupings.  
13  
14 Some of the results are similar. In each model, the FTE physician and other clinician variables  
15  
16 are statistically significant in every model, with physicians consistently the input with the highest  
17  
18 output elasticity. In other words, to no surprise the physician is identified in these models as the  
19  
20 most important resource in the medical practice production function.  
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26 TABLE 3 GOES ABOUT HERE  
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29 However, it is the differences among the models that yield the most substantive insights.  
30  
31 First, the differences among the models confirm the strategy of estimating separate production  
32  
33 functions for different kinds of physician practices: multispecialty vs. single-specialty, and  
34  
35 different single-specialty groupings. Second, it is clear that non-physician clinicians are more  
36  
37 important in some practices (primary care, medical) than in others. Third, it is curious that  
38  
39 despite the “obvious” differences between multispecialty and single-specialty practices the  
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41 physician and other clinician output elasticities are economically the same, but that capital is  
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43 more important in single-specialty than multispecialty practices. (In fact, capital is not  
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45 statistically significant in multispecialty practices.)  
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52 Finally, the sum of the coefficients of the input variables yields an estimate of the returns  
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54 to scale for each modeled type of practice. Table 3 shows that this estimate is dependent on the  
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56 type of practice. The all practices model suggests that physician practices have increasing  
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<sup>13</sup> The model was estimated using Stata/SE 9.2.  
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4 returns to scale, whereas the first disaggregated models estimate that multispecialty practices  
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6 have constant returns to scale and single-specialty practices have increasing returns to scale. The  
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8 latter finding largely disappears when single-specialty practices are disaggregated into major  
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10 single-specialty groupings; three of the four show constant returns to scale.  
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15 The results presented in Table 3 confirm that physician practices are not homogeneous in  
16  
17 terms of production functions, and that multispecialty and single-specialty practices should be  
18  
19 analyzed separately. Table 4 displays the estimated production functions for six specific single-  
20  
21 specialty practices.<sup>14</sup> In general, these more granular models reveal even more diversity among  
22  
23 the production functions for single-specialty practices. First, although all the physician input  
24  
25 variables are statistically significant, the coefficients (and thus the output elasticities) are smaller  
26  
27 than in the aggregated models. Second, all the coefficients for non-physician clinicians are  
28  
29 statistically significant, and in one case (family practice) exceeds the coefficient for physician  
30  
31 input. Third, capital is statistically significant for three specialties -- orthopaedic surgery (which  
32  
33 is expected given that specialty's potential for growth through development of ambulatory  
34  
35 surgery centers) and, surprisingly, family practice and pediatrics (which are less reliant on  
36  
37 equipment for provision of services). Finally, the estimated returns to scale are dramatically  
38  
39 different from the estimates in the aggregated specialty categories. None of the disaggregated  
40  
41 single-specialty practices demonstrates increasing returns to scale. Five show constant returns to  
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43 scale, and one (surprisingly, cardiology) indicates decreasing returns to scale.  
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52 TABLE 4 GOES ABOUT HERE  
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58 <sup>14</sup> As Table 1 shows, these six subspecialties represent 1,869 (56.5%) of all single-specialty practices in the sample.  
59 The sample sizes of the remaining subspecialties were too small to permit estimation of their production functions  
60 using the Levinsohn-Petrin procedure.  
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4 We tested the impact of physician ownership on the practice production function by  
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6 disaggregating the all practices model by ownership. The results are shown in Table 5. The  
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8 production function for practices not owned by physicians shows higher output elasticities for  
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10 physician and other clinician inputs, but a statistically insignificant impact of capital, compared  
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12 to physician-owned practices. In addition, these practices reveal increasing returns to scale,  
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14 whereas physician-owned practices have constant returns to scale.<sup>15</sup>  
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20 TABLE 5 GOES ABOUT HERE  
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23 We tested the robustness of our estimated production functions by using two alternative  
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25 estimators that are common in the literature: ordinary least squares and fixed effect estimators.  
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27 Thurston and Libby (2002), for example, applied ordinary least squares to estimate a physician  
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29 production function. Table 6 displays the results of using OLS on our data set, for the all  
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31 practices, multispecialty practices, and single-specialty practices models, without and with  
32  
33 controlling for area variables. The OLS model without area variables confirms the Levinsohn  
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35 and Petrin finding that OLS tends to bias upward the coefficients for variable inputs (in this case,  
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37 physicians and non-physician clinicians). Levinsohn and Petrin also demonstrated that the  
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39 direction of bias for the OLS estimate of capital is determined by the correlation between capital  
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41 and the productivity shock. If capital is less weakly correlated with the productivity shock than  
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43 are the variable labor inputs, the capital coefficient estimated by OLS could be biased downward.  
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45 In our case, the OLS coefficient on capital is smaller than the Levinsohn-Petrin estimation for all  
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47 practices and single-specialty practices, but not for multispecialty practices. That is, the OLS  
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56 <sup>15</sup> These results raise interesting causality issues, which are beyond the scope of this paper. The physician-owned  
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58 practices had an average of 20.1 FTE physicians, whereas the non-physician-owned practices had 29.1 FTE  
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60 physicians. Did hospitals, health systems, and other organizations acquire physician-owned practices that were  
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62 already organized for scale, or did the non-physician owners create production processes that generated increasing  
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64 returns to scale?  
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4 model incorrectly estimates that physician practices – both multispecialty and single-specialty –  
5 exhibit increasing returns to scale.  
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10 Interestingly, controlling for area characteristics in the OLS regression yields few  
11 significant area variables and has no impact on the practice input coefficients. That is, the  
12 inclusion of area variables does not improve the OLS regression by controlling for unobserved  
13 productivity shocks. The coefficients of the input variables are still biased upwards.  
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21 TABLE 6 GOES ABOUT HERE  
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24 Finally, in Table 7 we estimate the physician practice production functions using a fixed  
25 effects estimator. The coefficients for the input variables differ substantially from the Levinsohn-  
26 Petrin estimates, potentially because the productivity shocks are firm-specific and stochastic  
27 which cannot be fully captured by a constant fixed effect. Again, the Levinsohn-Petrin  
28 procedure demonstrates its superiority to other estimators because it uses intermediate inputs to  
29 control for firm-specific and any time-varying productivity shocks with minimal assumptions.  
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40 TABLE 7 GOES ABOUT HERE  
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## 42 **6. Discussion and Conclusions**

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46 The results presented above demonstrate that the production functions of physician  
47 practices differ substantially by type of practice. We have shown that multispecialty practices  
48 are different than single-specialty practices in terms of resource utilization (as measured by the  
49 output elasticities of physician and other clinician inputs), and the subspecialties within single-  
50 specialty practices have significantly different production functions. We also found that the  
51 estimated returns to scale differed based on the level of practice aggregation; in general, the more  
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4 aggregation, the more that the model estimated increasing returns to scale. These findings  
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6 suggest that analyses of physician practices at a highly aggregated level will yield inaccurate  
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8 conclusions about the true nature of physician practice.  
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12 More importantly from an analytical and policy perspective, these findings suggest that  
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14 each kind of physician practice has a different “theory of the business” (Drucker, 1994), and that  
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16 size and resource mix have different implications for different practices. For instance, it has  
17  
18 been argued that multispecialty practices may gain by size through the creation of an internal  
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20 referral network among their physicians, and through the capture of ancillary services and  
21  
22 control over equipment and facilities. On the other hand, primary care single-specialty practices  
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24 such as family practice have few opportunities to generate production (and revenue) beyond  
25  
26 direct patient care and cognitive services, and thus have little to gain from size in terms of care or  
27  
28 revenue. For other single-specialty practices, size may be an advantage. For example, in  
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30 orthopaedics, an increase in the number of physicians can enable subspecialization within the  
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32 practice (such as hand surgery, spine surgery, and sports medicine), as well as the acquisition of  
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34 ancillary services (e.g., advanced imaging [CT, MRI], physical therapy and rehabilitation) and  
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36 ambulatory surgery facilities. These services can improve the productivity of individual  
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38 practitioners, and represent significant sources of revenue to the practice.  
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48 While our analysis described differences among practice types, we found few instances  
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50 of advantages to practice size, even for multispecialty practices. In fact, the more disaggregated  
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52 (and thus more homogeneous) practice types showed decreasing or constant returns to scale.  
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54 That is, there seems to be no technical advantage to size or growth for most practice types.<sup>16</sup>  
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59 <sup>16</sup> Recall our assumption that physician practices are price-takers. If this assumption is not valid, as Klette and  
60 Griliches (1996) show the results reported here may underestimate the true returns to scale.  
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4           The absence of compelling production efficiency rewards to size suggests that owners of  
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6 medical practices will use other factors in choosing size. For example, physicians may have  
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8 personal preferences for smaller practices. This possibility combines the classic target income  
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10 hypothesis (as exemplified by McGuire and Pauly [1991] and Rizzo and Blumenthal [1994])  
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12 with the hypothesis that physicians may seek to maximize non-profit-related goals such as  
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14 professional autonomy, quality, and service to patients (May, 1983; Starr, 1983). If this  
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16 hypothesis is true, those who advocate for size and integration of physician practices will find  
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18 their task more difficult.  
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24           Another possibility is that the market may not reward physician practice size. A firm,  
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26 after all, is assumed to be interested in maximizing profit, not production. The results shown in  
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28 this paper demonstrate that a physical motivation for growth exists for few types of physician  
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30 practices. If this finding holds, health care reform proposals that expect that physician practices  
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32 must become larger and more integrated will need to identify or create financial or other  
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34 incentives for practices to expand (through internal growth or merger). Fortunately for these  
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36 proposals, while the analysis in this paper did not find a benefit for larger practices, it also did  
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38 not find that physician practice production functions favor small practices (the solo and 2-  
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40 physician practices that still represent the plurality of practices in the US). The current increase  
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42 in the frequency of practice mergers and the integration of hospitals and physicians are occurring  
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44 for reasons other than economic efficiency. Our research indicates that there is not an economic  
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46 penalty for these initiatives.  
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54           To conclude, this paper has attempted to extend the analysis of the structure of physician  
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56 practices in four ways. The first advance is that we analyzed the practice – rather than the  
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58 individual physician – as the unit of observation. Although physicians often render their services  
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4 on a one-to-one basis with their patients, increasingly the care itself is produced by a team of  
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6 health professionals. In addition, with physicians practicing in increasingly formal  
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8 organizations, the practice is a firm as defined by Coase (1937) and Drucker (1994) and should  
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10 be analyzed as such. The second advance is that – unlike previous research on the production of  
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12 physician services – we estimated total production by the firm, not individual services (such as  
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14 office visits). Third, we were able to take advantage of an econometric technique, the  
15  
16 Levinsohn-Petrin estimator, to control for the inherent endogeneity of inputs in production  
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18 function estimation. Fourth, by using the annual surveys conducted by the Medical Group  
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20 Management Association, we had the advantage of a large enough sample to allow analysis at a  
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22 finer level of granularity than previous studies. That is, we were able to analyze multispecialty  
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24 and single-specialty practices separately. In addition, we were able to model six subspecialty  
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26 practice types within single-specialty practices: family practice, pediatrics, cardiology,  
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28 orthopaedic surgery, obstetrics/gynecology, and urology.  
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37 This paper does have a number of limitations. First, because the MGMA survey is  
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39 conducted of its membership of organized physician practices, it contains relatively few solo and  
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41 two-physician practices. As a result, our analysis may not be as robust for these smaller  
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43 practices. Second, even with access to four years of data, our sample size was still small enough  
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45 that some single-specialty practices of interest (i.e., general internal medicine, gastroenterology,  
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47 general surgery, anesthesiology, and radiology) could not be included in the analysis. Lastly, as  
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49 noted earlier, identifying the structure of the physician practice production function is just the  
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51 first step in determining whether or not there are optimal sizes of physician practices.  
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55 Nevertheless, the analysis presented here provides the foundation for the next phase of the  
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57 research – the analysis of “contribution margin” (i.e., total gross charges for the practice minus  
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4 all costs except physician compensation) – which, after all, is the real focus of a profit-  
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6 maximizing practice.  
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4 **References**  
5

6  
7 Akerberg, D., Benkard, C. L., Berry, S., & Pakes, A. (2007). Econometric tools for analyzing  
8  
9 market outcomes. In J. J. Heckman, & E. E. Leamer (Eds.), *Handbook of econometrics* (pp.  
10  
11 4171-4276). Amsterdam, The Netherlands: Elsevier/North-Holland.  
12

13  
14  
15 American Academy of Family Physicians, American Academy of Pediatrics, American College  
16  
17 of Physicians, & American Osteopathic Association. (March 2007). *Joint principles of the*  
18  
19 *patient-centered medical home* Retrieved from  
20  
21 <http://www.medicalhomeinfo.org/joint%20Statement.pdf>  
22  
23  
24

25  
26 Burns, L. R. (1997). Physician practice management companies. *Health Care Management*  
27  
28 *Review*, 22(4), 32-46.  
29

30  
31  
32 Casalino, L. P., Pham, H., & Bazzoli, G. (2004). Growth of single-specialty medical groups.  
33  
34 *Health Affairs*, 23(2), 82-90.  
35  
36

37  
38 Christensen, C. M., Grossman, J. H., & Hwang, J. (2009). *The innovator's prescription: A*  
39  
40 *disruptive solution for health care*. New York, NY: McGraw-Hill.  
41  
42

43  
44 Coase, R. H. (1937). The nature of the firm. *Economica*, 4(16), 386-405.  
45  
46

47  
48 Daschle, T. (2008). *Critical: What we can do about the health-care crisis*. New York, NY: St.  
49  
50 Martin's Press.  
51  
52

53  
54 DeFelice, L. C., & Bradford, W. D. (1997). Relative inefficiencies in production between solo  
55  
56 and group practice physicians. *Health Economics*, 6, 455-465.  
57  
58  
59  
60  
61  
62  
63  
64  
65

- 1  
2  
3  
4 Drucker, P. F. (1994). The theory of the business. (cover story). *Harvard Business Review*, 72(5),  
5  
6 95-104.  
7  
8  
9
- 10 Frech III, H. E., & Ginsburg, P. B. (1974). Optimal scale in medical practice: A survivor  
11  
12 analysis. *The Journal of Business*, 47(1), 23-36.  
13  
14
- 15  
16 Freidson, E. (1988; 1970). *Profession of medicine: A study of the sociology of applied*  
17  
18 *knowledge: With a new afterword*. Chicago: University of Chicago Press.  
19  
20
- 21  
22  
23 Gaynor, M., & Pauly, M. V. (1990). Compensation and productive efficiency in partnerships:  
24  
25 Evidence from medical group practice. *Journal of Political Economy*, 98(3), 544-573.  
26  
27
- 28  
29 Getzen, T. E. (1984). A 'brand name firm' theory of medical group practice. *The Journal of*  
30  
31 *Industrial Economics*, 33(2), 199-215.  
32  
33
- 34  
35 Halley, M. D. (2007). *The primary care -- market share connection: How hospitals achieve*  
36  
37 *competitive advantage*. Chicago, IL: Health Administration Press.  
38  
39
- 40  
41 Hartman, M., Martin, A., McDonnell, P., & Catlin, A. (2009). National health spending in 2007:  
42  
43 Slower drug spending contributes to lowest rate of overall growth since 1998. *Health Affairs*,  
44  
45 28(1), 246-261.  
46  
47
- 48  
49 Healthcare Advisory Board. (1999). *Stopping the bleed: Reversing losses in owned practices*.  
50  
51 Washington, D.C.: The Advisory Board.  
52  
53
- 54  
55 Kane, C. K. (2009). *The practice arrangements of patient care physicians, 2007-2008: An*  
56  
57 *analysis by age cohort and gender*. Chicago: American Medical Association.  
58  
59  
60  
61  
62  
63  
64  
65

- 1  
2  
3  
4 Klette, T. J., & Griliches, Z. (1996). The inconsistency of common scale estimators when output  
5 prices are unobserved and endogenous. *Journal of Applied Econometrics*, 11(4), 343-361.  
6  
7  
8  
9  
10 Kocher, R., Emanuel, E. J., & DeParle, N. (August 23, 2010). The affordable care act and the  
11 future of clinical medicine: The opportunities and challenges. *Annals of Internal Medicine*,  
12  
13  
14  
15  
16 Levinsohn, J., & Petrin, A. (2003). Estimating production functions using inputs to control for  
17 unobservables. *Review of Economic Studies*, 70(243), 317-341.  
18  
19  
20  
21  
22 Liebhaber, A., & Grossman, J. M. (August 2007). *Physicians moving to mid-sized, single-*  
23 *specialty practices* (Tracking Report No. 18). Washington, D.C.: Center for Studying Health  
24 System Change.  
25  
26  
27  
28  
29  
30  
31 Madison, D. L., & Konrad, T. R. (1988). Large medical group-practice organizations and  
32 employed physicians: A relationship in transition. *The Milbank Quarterly*, 66(2), 240-282.  
33  
34  
35  
36  
37 Marder, W. D., & Zuckerman, S. (1985). Competition and medical groups. *Journal of Health*  
38 *Economics*, 4, 167-176.  
39  
40  
41  
42  
43 Marschak, J., & Andrews, W. H., Jr. (1944). Random simultaneous equations and the theory of  
44 production. *Econometrica*, 12(3/4), 143-205.  
45  
46  
47  
48  
49 May, W. F. (1983). *The physician's covenant :Images of the healer in medical ethics* (1st ed.).  
50 Philadelphia: Westminster Press.  
51  
52  
53  
54  
55  
56 McGuire, T. G., & Pauly, M. V. (1991). Physician response to fee changes with multiple payers.  
57 *Journal of Health Economics*, 10(4), 385-410.  
58  
59  
60  
61  
62  
63  
64  
65

1  
2  
3  
4 Medical Group Management Association. (2009). *Cost survey: 2009 report based on 2008 data*.  
5  
6 Englewood, CO: Medical Group Management Association.  
7  
8  
9

10 Nyweide, D. J., Weeks, W. B., Gottlieb, D. J., Casalino, L. P., & Fisher, E. S. (2009).  
11  
12 Relationship of primary care physicians' patient caseload with measurement of quality and  
13 cost performance. *JAMA: The Journal of the American Medical Association*, 302(22), 2444-  
14  
15 2450.  
16  
17  
18  
19  
20

21 Olley, G. S., & Pakes, A. (1996). The dynamics of productivity in the telecommunications  
22 equipment industry. *Econometrica*, 64(6), 1263-1297.  
23  
24  
25  
26

27 Pauly, M. V. (1996). Economics of multispecialty group practice. *Journal of Ambulatory Care*  
28 *Management*, 19(3), 26-33.  
29  
30  
31  
32

33 Pope, G. C., & Burge, R. T. (1996). Economies of scale in physician practice. *Medical Care*  
34 *Research and Review*, 53(4), 417-440.  
35  
36  
37  
38

39 Pope, G. C., Olmsted, E., Healy, D., Zuckerman, S., & McFeeters, J. (2006). *Review of physician*  
40 *practice expense geographic adjustment data, report to centers for medicare & medicaid*  
41 *services by RTI international*. No. CMS Contract No. 500-00-0024 T.O. #16)  
42  
43  
44  
45  
46  
47

48 Reinhardt, U. E. (2000). The rise and fall of the physician practice management industry. *Health*  
49 *Aff*, 19(1), 42-55.  
50  
51  
52  
53

54 Reinhardt, U. (1972). A production function for physician services. *The Review of Economics*  
55 *and Statistics*, 54(1), 55-66.  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

1  
2  
3  
4 Rizzo, J. A., & Blumenthal, D. (1994). Physician income targets: New evidence on an old  
5  
6 controversy. *Inquiry*, 31, 394-404.  
7  
8  
9

10 Robinson, J. C. (1999). *The corporate practice of medicine*. Berkeley, CA: University of  
11  
12 California Press.  
13  
14

15  
16 Rosenman, R., & Friesner, D. (2004). Scope and scale inefficiencies in physician practices.  
17  
18 *Health Economics*, 13(11), 1091-1116.  
19  
20

21  
22 Shih, A., Davis, K., Schoenbaum, S. C., Gauthier, A., Nuzum, R., & McCarthy, D. (2008).  
23  
24 *Organizing the U.S. health care delivery system for high performance* No. Publication No.  
25  
26 1155). New York, NY: The Commonwealth Fund.  
27  
28  
29

30  
31 Sirovich, B., Gallagher, P. M., Wennberg, D. E., & Fisher, E. S. (2008). Discretionary decision  
32  
33 making by primary care physicians and the cost of U.S. health care. *Health Aff*, 27(3), 813-  
34  
35 823.  
36  
37  
38

39 Smart, D. R. (2004). *Medical group practices in the US, 2004 edition*. Chicago: American  
40  
41 Medical Association.  
42  
43  
44

45 Starr, P. (1983). *The social transformation of american medicine*. New York: Basic Books.  
46  
47  
48

49 Medicare payment policy: Ensuring stability and access through physician payments:  
50  
51 Subcommittee on Health of the Committee on Energy and Commerce, U.S. House of  
52  
53 Representatives, 107th Congress, 2nd Session (2002).  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

1  
2  
3  
4 Thurston, N. K., & Libby, A. M. (2002). A production function for physician services revisited.  
5  
6 *The Review of Economics and Statistics*, 84(1), 184-191.  
7  
8

9  
10 Tollen, L. (April 2008). *Physician organization in relation to quality and efficiency of care: A*  
11  
12 *synthesis of recent literature*. New York, NY: The Commonwealth Fund.  
13  
14

15  
16 Town, R., Wholey, D. R., Kralewski, J., & Dowd, B. (2004). Assessing the influence of  
17  
18 incentives on physicians and medical groups. *Medical Care Research and Review*, 61(3),  
19  
20 80S-118S.  
21  
22

23  
24  
25 Wagner, S. L. (2005). Organization and operations of medical group practice . In L. F. Wolper  
26  
27 (Ed.), *Physician practice management, essential operational and financial knowledge* (pp.  
28  
29 29 – 62). Sudbury, MA: Jones and Bartlett Publishers.  
30  
31

Table 1: Number of FTE Physicians by Type of Practice

	Entire Dataset <sup>a</sup>	All Practices <sup>b</sup>	4 major single-specialty groupings						6 Single Specialty Groups					
			Multi Specialty Practices	Single-Specialty Practices	Primary Care	Medical	Surgical	Indirect Patient Care	Family Practice	Pediatrics	Cardiology	Orthopaedic Surgery	Obstetrics/Gynecology	Urology
<b>N</b>	5,851	4,535	1,194	3,307	907	789	1087	524	490	289	301	390	216	183
<b>Mean</b>	19.09	22.43	52.90	11.34	6.77	10.14	8.52	27.17	5.19	8.57	15.20	10.38	7.33	8.32
<b>Std. Deviation</b>	42.86	47.39	80.84	15.70	10.66	10.86	8.17	27.22	6.84	15.37	14.86	8.19	8.80	8.96
<b>Minimum</b>	0.00	0.20	0.40	0.20	0.20	0.50	0.40	1.00	0.20	0.86	1.00	1.00	0.50	1.00
<b>Maximum</b>	991.27	991.27	991.27	235.00	235.00	119.12	87.00	222.00	61.93	235.00	119.12	48.98	87.00	54.00
<b>25%ile</b>	3.00	4.00	11.25	3.77	2.00	4.00	4.00	10.10	2.00	3.94	7.00	4.50	4.00	3.00
<b>Median</b>	7.00	8.50	28.01	6.50	4.50	7.50	6.00	19.95	3.32	5.80	11.50	8.00	5.36	5.00
<b>75%ile</b>	18.00	21.00	62.23	13.00	7.25	13.00	10.00	34.64	5.25	9.00	18.75	13.50	8.00	9.00

<sup>a</sup>Observations with no missing values for any variable

<sup>b</sup>Excludes those responses with missing Group Identification Number or zero values for FTE physicians or capital expenditures

Source: Medical Group Management Association, Cost Surveys, 2005-2008

Table 2: Mean Values of Model Variables

	All Practices	Multi-Specialty Practices	Single-Specialty Practices	4 major single-specialty groupings				6 Single Specialty Groups					
				Primary Care	Medical	Surgical	Indirect Patient Care	Family Practice	Pediatrics	Cardiology	Orthopaedic Surgery	Obstetrics/Gynecology	Urology
N	4,535	1,194	3,307	907	789	1087	524	490	289	301	390	216	183
Total gross charges (\$ Million)	\$9.59	\$19.69	\$5.86	\$1.70	\$7.24	\$5.79	\$11.33	\$1.15	\$2.34	\$11.33	\$8.61	\$2.84	\$5.44
FTE physicians	22.43	52.90	11.34	6.77	10.14	8.52	27.17	5.19	8.57	15.20	10.38	7.33	8.32
Gross charges/MD (\$)	\$427,826	\$372,097	\$517,060	\$251,157	\$714,397	\$679,320	\$417,094	\$220,760	\$273,127	\$745,346	\$828,790	\$387,726	\$369,580
Non-physician clinicians	49.10	128.15	20.54	14.08	26.72	22.58	19.36	11.07	17.55	45.94	31.69	18.46	17.47
Capital expenditures (\$ Million)	\$0.74	\$1.75	\$0.31	\$0.19	\$0.43	\$0.40	\$0.19	\$0.14	\$0.26	\$0.68	\$0.54	\$0.25	\$0.40
% Physician owned	69.7	60.6	78.6	47.2	87.2	91.6	92.4	33.1	73.7	96.0	96.4	84.7	96.7
Medical and surgical supply (\$ Thousands)	\$75.9	\$166.8	\$38.0	\$18.8	\$45.4	\$48.5	\$40.0	\$13.1	\$28.9	\$73.6	\$58.1	\$36.3	\$70.0

Source: Medical Group Management Association, Cost Surveys, 2005-2008

Table 3: Levinsohn-Petrin Estimation: Major Practice Groupings

	4 major single-specialty groupings													
	All Practices		Multispecialty Practices		Single-Specialty Practices		Primary Care		Medical		Surgical		Indirect Patient Care	
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Inputs:														
In (physicians)	0.559***	0.0230	0.569***	0.0355	0.676***	0.0286	0.404***	0.0428	0.420***	0.0334	0.608***	0.0548	0.751***	0.0339
In (other clinicians)	0.097***	0.0174	0.163***	0.0248	0.124***	0.0229	0.335***	0.0410	0.269***	0.0304	0.099***	0.0338	0.098***	0.0339
In (capital)	0.370***	0.0499	0.090	0.0797	0.350***	0.0589	0.240***	0.0758	0.400***	0.113	0.320***	0.0955	0.130	0.300
Intermediate Input:														
In (medical supplies)	0.0100	0.0431	0.220***	0.0585	0.02	0.0469	0.110+	0.0747	0.02	0.111	0.03	0.0653	0.06	0.378
<b>N</b>	3,800		1,116		2,652		809		701		1,012		136	
<b>Estimated returns to scale</b>	1.036		1.042		1.170		1.089		1.109		1.057		1.039	
<b>Wald value</b>	6.460		2.470		32.970		3.930		1.860		1.160		0.000	
<b>p-value</b>	0.011		0.116		0.000		0.047		0.173		0.282		0.949	

Robust s.e. \*\*\* p&lt;0.01, \*\*p&lt;0.05, \*p&lt;0.10

Table 4: Levinsohn-Petrin Estimation: Specific Single-Specialty Practices

	Family Practice		Pediatrics		Cardiology		Orthopaedic Surgery		Obstetrics/ Gynecology		Urology	
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Inputs:												
ln (physicians)	0.348***	0.0523	0.414***	0.0596	0.437***	0.0613	0.498***	0.0573	0.469***	0.0550	0.435***	0.114
ln (other clinicians)	0.392***	0.0680	0.207***	0.0466	0.265***	0.0642	0.283***	0.0389	0.301***	0.0552	0.309**	0.130
ln (capital)	0.210**	0.0817	0.360**	0.153	0.03	0.0700	0.200**	0.0982	0.09	0.0815	0.180+	0.120
Intermediate Input: ln (medical supplies)	0.130**	0.0509	0.02	0.158	0.130***	0.0462	0.06	0.0647	0.160**	0.0687	0.08	0.0803
<b>N</b>	434		264		287		368		207		178	
<b>Estimated returns to scale</b>	1.080		1.001		0.862		1.041		1.020		1.004	
<b>Wald value</b>	1.610		0.000		8.270		0.100		0.040		0.000	
<b>p-value</b>	0.204		0.993		0.004		0.747		0.839		0.965	

Robust s.e \*\*\* p&lt;0.01, \*\*p&lt;0.05, \*p&lt;0.10

Table 5: Levinsohn-Petrin Estimation By Practice Ownership

	All Practices		Non-physician Owned		Physician Owned	
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Inputs:						
ln (physicians)	0.559***	0.0230	0.690***	0.0427	0.538***	0.0270
ln (other clinicians)	0.097***	0.0174	0.197***	0.0367	0.084***	0.0219
ln (capital)	0.370***	0.0499	0.090+	0.0551	0.360***	0.0432
Intermediate Input:						
ln (medical supplies)	0.010	0.0431	0.090**	0.0408	0.010	0.0338
<b>N</b>	3,800		974		2,826	
<b>Estimated returns to scale</b>	1.036		1.067		0.992	
<b>Wald value</b>	6.460		7.07		0.08	
<b>p-value</b>	0.011		0.008		0.784	

Robust s.e \*\*\* p<0.01, \*\*p<0.05, \*p<0.10

Table 6: Robustness test: OLS without and with Area Variables

	All Practices		Multispecialty Practices		Single-Specialty Practices		All Practices		Multispecialty Practices		Single-Specialty Practices	
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Inputs:												
ln (physicians)	0.758***	0.0127	0.668***	0.0239	0.866***	0.0142	0.771***	0.0147	0.757***	0.0294	0.822***	0.0173
ln (other clinicians)	0.158***	0.0127	0.197***	0.0199	0.205***	0.0140	0.173***	0.0145	0.160***	0.0247	0.214***	0.0165
ln (capital)	0.144***	0.0104	0.237***	0.0199	0.157***	0.0111	0.085***	0.0115	0.169***	0.0229	0.096***	0.0129
Physician Ownership							0.611***	0.0228	0.270***	0.0299	0.609***	0.0314
Census Population (million)							0.0206	0.0147	-0.03	0.0209	0.0489***	0.0183
% of Population 65+							-0.324	0.320	0.841**	0.421	-0.880**	0.390
Population per Square Mile (million)							1.468	4.587	-5.603	21.65	0.299	4.808
Per Capita Income							-2.679	1.927	4.228+	2.658	-4.196*	2.336
% of Persons in Poverty							-0.289	0.312	0.331	0.438	-0.424	0.371
MD Per capita							15.42*	9.088	-20.05+	13.43	19.54*	10.63
Hospital Admission Per capita							-0.042	0.166	0.297	0.227	-0.124	0.199
Constant	11.17***	0.104	9.717***	0.197	10.81***	0.113	11.50***	0.146	10.09***	0.251	11.38***	0.170
<b>N</b>		4,270		1,176		3,062		2,594		787		1,794
<b>Estimated returns to scale</b>		1.060		1.102		1.228		1.029		1.086		1.132
<b>Wald value</b>		68.54		116.25		439.96		12.6		60.3		90.31
<b>p-value</b>		0.00		0.00		0.00		0.00		0.00		0.00
<b>Overall R-square</b>		0.833		0.925		0.806		0.881		0.931		0.856

Robust s.e \*\*\* p&lt;0.01, \*\*p&lt;0.05, \*p&lt;0.10

Table 7: Robustness test: Fixed Effects

	All Practice		Multispecialty		Single-Specialty	
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Inputs:						
ln (physicians)	0.784***	0.0189	0.701***	0.0459	0.892***	0.0233
ln (other clinicians)	0.147***	0.0188	0.102***	0.0362	0.177***	0.0224
ln (capital)	0.140***	0.0156	0.281***	0.0360	0.165***	0.0184
Constant	11.18***	0.156	9.397***	0.362	10.74***	0.189
<b>N</b>	4,270		1,176		3,062	
<b>Estimated returns to scale</b>	1.071		1.084		1.234	
<b>Wald value</b>	41.03		22.19		157.55	
<b>p-value</b>	0.00		0.00		0.00	
<b>R-square</b>	0.837		0.927		0.808	

Robust s.e \*\*\* p<0.01, \*\*p<0.05, \*p<0.10