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Physician Behavior In Accountable Care Organizations

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Abstract
This dissertation studies how performance risk-based (i.e., value-based) reimbursement over total costs of care in health insurance contracting affects how providers, specifically physician groups and health systems, determine marginal treatment choice and set the level of care provided to patients. Utilizing the widespread adoption of Accountable Care Organization (ACO) contracts by both commercial payers and Medicare, presented research explores changes in care delivery and health system organization when risks for total costs of care and satisfactory attainment of specific quality metrics (i.e. an ACO contract) are offered to providers. This dissertation proceeds in five parts. First, I review the substantial literatures related to the specific characteristics of ACO contracts in addition to the institutional details of such contracts themselves. Next, leveraging optimal procurement and auction theory, I present a theoretical foundation for considering ACOs as a form of incentive contract auction by Medicare and other insurers. This theoretical foundation motivates three principal empirical analyses of ACO contracts, each briefly explained in the preface, focused on changes in physician behavior following ACO contract adoption.

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PHYSICIAN BEHAVIOR IN ACCOUNTABLE CARE ORGANIZATIONS

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ABSTRACT

PHYSICIAN BEHAVIOR IN ACCOUNTABLE CARE ORGANIZATIONS

William P. Pajerowski

Dan Polsky

This dissertation studies how performance risk-based (i.e., value-based) reimbursement over total costs of care in health insurance contracting affects how providers, specifically physician groups and health systems, determine marginal treatment choice and set the level of care provided to patients. Utilizing the widespread adoption of Accountable Care Organization (ACO) contracts by both commercial payers and Medicare, presented research explores changes in care delivery and health system organization when risks for total costs of care and satisfactory attainment of specific quality metrics (i.e. an ACO contract) are offered to providers. This dissertation proceeds in five parts. First, I review the substantial literatures related to the specific characteristics of ACO contracts in addition to the institutional details of such contracts themselves. Next, leveraging optimal procurement and auction theory, I present a theoretical foundation for considering ACOs as a form of incentive contract auction by Medicare and other insurers. This theoretical foundation motivates three principal empirical analyses of ACO contracts, each briefly explained in the preface, focused on changes in physician behavior following ACO contract adoption.

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PREFACE

This dissertation studies how performance risk-based (i.e., value-based) reimbursement over total costs of care in health insurance contracting affects how providers, specifically physician groups and health systems, determine marginal treatment choice and set the level of care provided to patients. Utilizing the widespread adoption of Accountable Care Organization (ACO) contracts by both commercial payers and Medicare, presented research explores changes in care delivery and health system organization when risks for total costs of care and satisfactory attainment of specific quality metrics (i.e. an ACO contract) are offered to providers. This dissertation proceeds in five parts. First, I review the substantial literatures related to the specific characteristics of ACO contracts in addition to the institutional details of such contracts themselves. Next, leveraging optimal procurement and auction theory, I present a theoretical foundation for considering ACOs as a form of incentive contract auction by Medicare and other insurers. This theoretical foundation motivates three principal empirical analyses of ACO contracts, each briefly explained in this summary, focused on changes in physician behavior following ACO contract adoption.

The first principal analysis of my dissertation considers the effects of physician participation in Medicare Accountable Care Organizations (ACOs), where unit prices are generally fixed. I utilize a number of publicly available panel data sources from CMS to review changes in physician administration of total services per beneficiary, specific procedures, and referral patterns to other physicians and health care providers more broadly.

I next leverage commercial claims data from the Healthcare Cost Institute (HCCI) in the second principal analysis of my dissertation to evaluate the effects of competition amongst providers under a regime of mixed market-based and administered prices (i.e., negotiated prices). HCCI claims data are analyzed at the provider level in combination with physician ACO participation

data from SK&A, details of commercial ACO contracts (such as payer affiliations), and other sources. I examine how participation in a commercial ACO contract affects physician treatment intensity and determine if effects are generalizable across both Medicare and commercial populations.

The impact of public payers like Medicare on negotiated commercial prices is well documented (Clemens and Gottlieb, 2013; Ketcham, Nicholson, et. al, 2013). However, the transition from "fee-for-service" to "value-based" payment models changes provider-insurer bargaining with the introduction, or modification, of a secondary objective in the form of quality. Gaining insights from earlier results, the final analysis of my dissertation considers positive and negative spillover mechanisms on payment and utilization of physician services across health care markets, as opposed to explicitly within a specific payer's ACO or enrolled population. I jointly examine whether providers participating in multiple ACOs are more effective and how physician participation in a Medicare or commercial ACO contract affects physician treatment intensity for commercial patient populations unaffiliated with those ACOs.

Key empirical results highlight both the promise and pitfalls of early ACO contracts in public and commercial markets for physician services. Consistent with policy goals and theoretical predictions, physicians participating in Medicare ACO programs are found to significantly decrease marginal, per patient utilization of services, particularly specialist services. This effect is less evident under negotiated prices, where specialist s participating in ACO contracts are found to increase total payment and provision of services (in aggregate) following contract adoption, with no significant effects on per patient spending or service provision. However, both Medicare and commercial ACOs are found to effectively shift physicians away from per patient provision of discretionary services and procedures following contract adoption. In HCCI claims specifically, commercial ACO contracts are estimated to reduce per patient utilization for potentially elective medical services such as hip and knee replacements, ambulatory and minor procedures, basic and advanced imaging, and radiation therapy for prostate cancer.

Demonstrating either selection effects in ACO adoption or potential cost-shifting, empirical analysis in Part V demonstrates unintended increases in spending and utilization for HCCI-insurers' enrollees by specialists following local market entry of a public or non-HCCI affiliated commercial ACO contract. Only stand-alone commercial ACOs, and not those jointly affiliated with a Medicare ACO agreement, are estimated to significantly reduce the per patient commercial utilization of services provided by specialist physicians.

CHAPTER 1: Introduction, Background, and Overview

Introduction

The Institute of Medicine estimates that $765 billion dollars were wasted on national health care expenditures related to excess administration of services, fraud, and low-value care in 2013; $340 billon dollars was wasted on low-value care alone (IOM, 2013). From 2000 to 2013, Medicare spending per beneficiary for physician services increased by 67 percent, far surpassing growth in Medicare spending due to increases in reimbursement prices or inflationary adjustments. With services reimbursed under the physician fee schedule representing 12 percent of total Medicare spending (MedPAC, 2015), a major policy goal of ACOs is containing such volume growth and provision of low-value services.

Policy reforms have in general taken two approaches to further incentivize quality and efficiency in health care markets: service-specific changes in reimbursement such as pay-for-performance schemes or readmission penalties and transition to capitated payments based around specific ACO type contracts for whole populations (Doyle, Graves, and Gruber, 2015). Initial evidence highlights the potential for ACOs to improve quality of care, patient satisfaction, and, in some cases, constrain costs (McWilliams et al., 2015, 2016; Song et al., 2014; Nyweide et al., 2015). However, it is not known what specific changes in behavior by physicians, if any, are driving these early results. In their most recent work on the subject, Pauly and Burns question the promise of accountable care, drawing direct comparisons to the promotion and ultimate limits of managed care in past decades (2012). They argue that the success of ACOs will depend similarly to managed care on such organizations' ability to target specific populations such as those with chronic disease for which care coordination will be cost-effective. Meanwhile, such organizations may also promote increased integration and decreased competition thus causing unintended consequences for health reform efforts. This dissertation seeks to understand the response of

physicians and their firms as payers shift to risk-based ACO contracts and corresponding effects on social welfare.

Institutional Details on ACOs

Accountable Care Organizations are one of many reforms initiated with the Affordable Care Act to help providers improve quality while maintaining or reducing cost levels. Such delivery system reforms seek to improve the health of local populations and slow inefficient and rising cost growth. Proposed regulations on Medicare ACOs were first issued on March 31, 2011 with the stated goal of better care coordination across providers. Multiple trends in population health and health services motivated the development of Accountable Care models (Cutler, 2012). Particularly, ACOs highlight the need for and benefits of coordinated care for patients with multiple comorbid and chronic conditions. More than half of all Medicare beneficiaries have greater than four chronic conditions such as diabetes, arthritis, hypertensions, and kidney disease, often receiving care for these conditions through treatment by multiple, unaffiliated physicians (Cutler, 2012). This can result in patients receiving duplicative or unnecessary treatments and a corresponding increase in the risk of suffering medical errors. One in seven Medicare patients admitted each year to the hospital is expected to endure a medical mistake during treatment. Furthermore, one in five Medicare beneficiaries discharged from a hospital will be readmitted within 30 days. Such incidents are presumed to be to some extent avoidable; if physicians and other providers were forced to internalize the cost of sub-optimal care then such errors and readmissions would be dramatically reduced. Thus, ACO proponents argue (Fisher, 2007), improving care coordination and communication across providers through the use of an ACO will help improve beneficiaries' care while also reducing costs. However, Chernew and McWilliams question this approach (2015). To what extent are quality and quantity of treatment substitutes or complements in practice?

Saliently, ACOs create previously non-existent incentives (at least outside of fully integrated settings) for providers to coordinate care for such patients across primary care, inpatient, and

post-acute settings (Fisher, 2007). The Medicare Shared Savings Program (MSSP) model specifically rewards ACOs that are able to provide health care to an attributed population at a lower rate than an expected cost benchmark while still meeting performance standards regarding quality of care. Both patient and provider participation in Medicare ACOs is voluntary. While most Medicare ACO contracts currently feature one-sided risk (e.g. no risk for cost overruns), the federal government has strongly communicated a coming shift to two-sided risk for participating provider groups.

Accountable Care Organization Basics

Under Medicare regulations, as well as in most commercial ACO settings, ACOs refer to a group of providers assigned an incentive contract by the payer to be held responsible for the health and resource use of an attributed population of patients. Such attribution may be done prospectively or retrospectively. With a stated goal of seamless, high quality care for their patient populations, ACOs are not dissimilar to the movement toward patient-centeredness in care delivery and trends toward the patient-centered medial home. Networks of ACO affiliated providers include provider types from across the health care continuum, including: physicians and hospitals in group practice arrangements, fully integrated health systems, small or independent practices incorporated for the sole purpose of sharing risk under the ACO contract, and the full spectrum of other health care providers (including post-acute providers, social work organizations, and pharmacies) at the discretion of the reimbursing principal (either Medicare or another payer) who ultimately approves the ACO composition and contract. Under current CMS regulations and the Affordable Care Act, ACOs must have a minimum total attributed population of 5,000 patients (15,000 for the Pioneer program). Medicare compares the realized costs of care for such a population against a cost benchmark. This benchmark weighs both previous annual expenditures for the ACO's attributed patient population as well as local market and/or national growth expenditure trends. In addition, Medicare has implemented minimum gain ratios (MGR) and minimum loss ratios (MSR) around the benchmark such that small fluctuations in expenditures

due to random annual variation are neither rewarded nor penalized (CMS, 2012, 2016). A representation of this ideal is shown in

Figure 1 (Xcenda, 2017). Additionally important features of ACO contracts in the Medicare context are then described in added detail below.

Figure 1: An Idealized Model of an ACO

Quality Improvement

While measure development is ongoing, ACOs in the larger Medicare Shared Savings Program (MSSP) are currently monitored across 33 quality measures regarding patient experience/satisfaction, management of at-risk populations, preventive care, and care coordination/patient safety. In early years of most contracts, many measures were satisfactorily met solely through reporting (similar to pay-for-reporting schemes used in pay-for-performance

contracts). A weighted scoring rule combining these measures is known by ACOs in advance and used to determine whether the ACO met quality goals. If quality goals are not met, ACOs are not eligible to receive their portion of shared savings should any realize (CMS, 2012, 2016). Commercial ACO contracts employ heterogeneous incentive schemes that often parallel Medicare quality measures but may include custom or tailored measures for commercial populations. The wide array of commercial quality measures are discussed in further detail with reference to analyses on commercial ACOs in Part 4 of this dissertation.

Public Reporting

A public reporting requirement requires Medicare-participating ACOs to publicly report salient features to the public on their own websites. Notably, this reporting includes characteristics of the ACO's internal distribution of share savings to individual physicians and other providers. Specifically, ACOs must report the percentage of shared savings respectively invested in infrastructure, invested in redesigned care processes, and distributed to primary care physicians, specialists, and hospitals. No regulation, with an exception for non-profit hospitals discussed below, dictates how ACOs distribute savings; substantial variation is expected in these internal incentives. While not centrally located, such information is very useful for subgroup analyses. (CMS, 2016)

Antitrust Guidance for ACOs and Non-Profit Hospital Participants

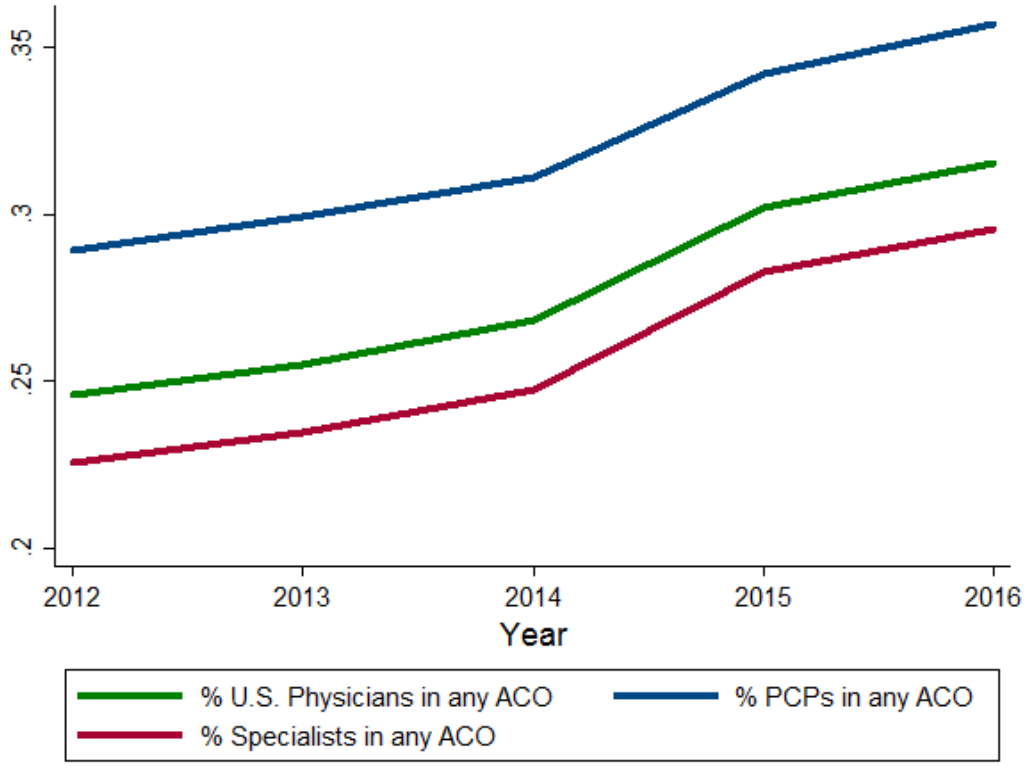
Providers in ACOs have been allowed wide breath to integrate under safe harbor notices provided the Federal Trade Commission (FTC) and the Department of Justice (DOJ). ACOs participants are encouraged to clinically and financially integrate, thus prompting substantial antitrust concerns. In the antitrust phrasing, regulatory bodies will apply a rule-of-reason to ACO behavior based primarily around consideration of ACO market shares. A description of the 'safety-zone' allowed for ACOs to consolidate market share in their local markets, even for commercially populations, without running afoul of regulatory authorities has been communicated by regulators (Department of Justice, 2014).

Non-profit hospitals have received additional guidance from the Internal Revenue Service regarding participation in hybrid-organizations such as ACOs. Primarily, the IRS has directed non-profit participants in ACOs to not engage in anti-competitive behavior (e.g. through the use of "fair-market" rates to coordinating firms) and to require that shared savings/losses are distributed proportionally such that they don't surpass the non-profit's proportional entitlement (Internal Revenue Service, 2016).

Growth of Commercial ACO Designs

Attaining higher quality care at lower cost is clearly a hope of Medicare's ACO contracts (Tu, Muhlestein, Kocot, and White, 2015). Though the efficacy of these public programs to meet these goals remains unknown, many commercial insurers have begun to mimic Medicare's programs (Eggbeer and Morris, 2013) either in locations where a Medicare ACO already exists or as a stand-alone contract. In doing so, commercial insurers expect that they can significantly lower consumer premiums while using quality monitoring to at minimum maintain existing quality (Williams, 2015). If possible, attainment of lower prices from providers would give such insurers an advantage in the new health insurance exchanges and other redesigned insurance markets reformed under the Affordable Care Act (Eggbeer and Morris, 2013). Some have also argued that provider-led ACOs are forming to compete with payer-led HMOs (Scheffler, 2015, Whaley, Frech, and Scheffler, 2015). A study in California found a positive correlation with HMO density and ACO entry, which supports this claim despite multiple, competing explanations for such a phenomenon noted by the authors (Whaley, Frech, and Scheffler, 2015). For example, this correlation could be the result of provider experience with managed care and population health, such that the ACO transition requires less organizational change for such providers. (Whaley, Frech, and Scheffler, 2015). Regardless, growing shares of both primary care and specialist physicians across the U.S. have continued to join some combination of public and commercial ACO contracts from 2012 to 2016 as shown in Figure 2.

Figure 2. Estimated PCP and Specialist Participation in any ACO Contract: 2012 - 2016



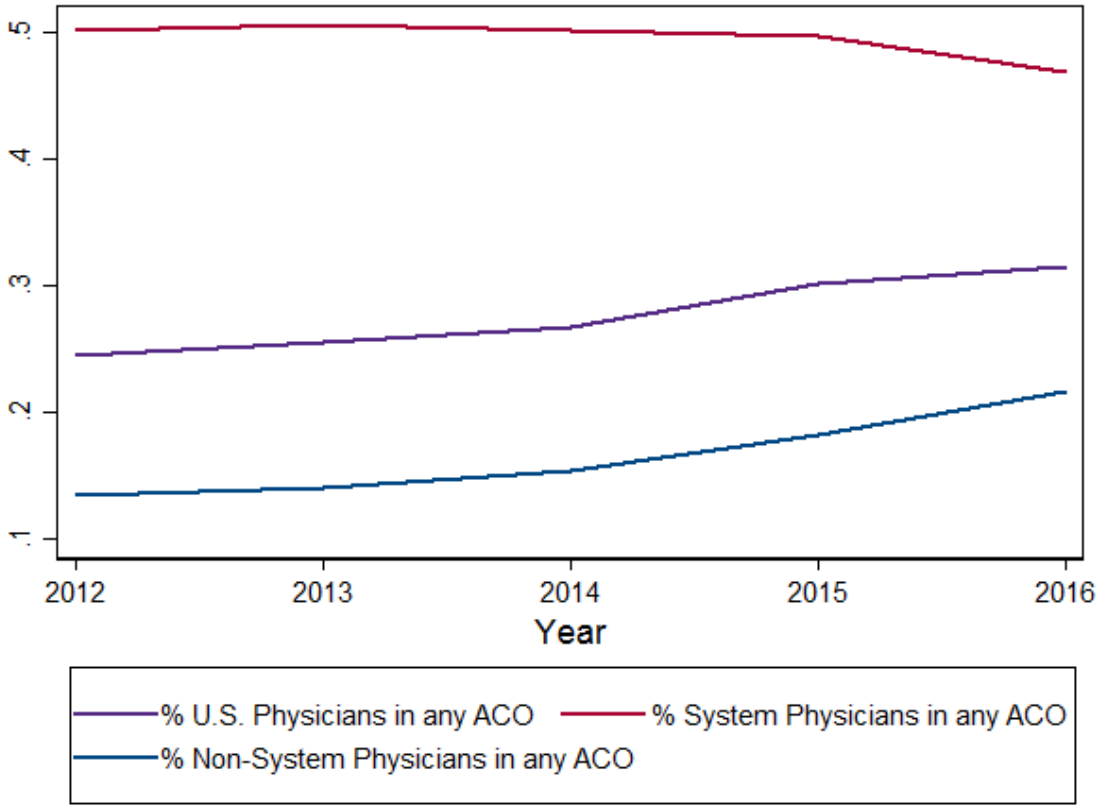
Source: Empirical analysis of 2012 – 2016 SK&A Office-Based Physician (OBP) files.

Concerns regarding Medicare ACOs are amplified for commercial ACOs, especially those concerning potentially diminishing quality and abuse of market control by a dominant provider group. To deal with quality concerns, Medicare takes a variety of quality measures and sets standards for the ACOs to meet (Scheffler, 2015). When mimicking the Medicare ACOs, the commercial providers also instituted quality measures, but insurers have tended to develop their own measures and standards, making the quality management process difficult for providers to navigate when multiple insurers are involved (Williams, 2015). Because of the requirements, providers seem to be very focused on the quality measures, which, if the measures accurately convey quality, should cause them to maintain their quality of service. However, quality measures

are not reported in real time, providing uncertainty and added pressure to providers, whom may receive little feedback on whether their attempts to improve are successful during a specific reporting period (Williams, 2015).

Expert concerns about market power from so-called integrated delivery networks (IDNs) stem from the vertical and horizontal integration that an ACO requires. Vertical integration may be necessary to obtain the efficiencies from economies of scope, for example by sharing medical information systems and reducing unnecessary testing and retesting, and allow for organizations to avoid antitrust laws when taking advantage of these economies of scope (Whaley, Frech, and Scheffler, 2015; Handel, 2015). Horizontal integration is also important to allow some flexibility and choice for consumers within the network. These efficiencies and options are beneficial for consumers, but the integration also gives the ACOs more of an ability to negotiate (Whaley, Frech, and Scheffler, 2015). If they use that power to negotiate for higher payments, then this could actually raise prices for consumers instead of lowering them (Feldman, 2015; Scheffler, 2015). As shown in Figure 3, ACO contract penetration among vertically-integrated physician is much higher than those unaffiliated with a hospital or health system. However, participation by system-affiliated physicians has slightly decreased in recent years while participation among non-system physicians continues to grow.

Figure 3. Physician Participation in any ACO Contract by System Status: 2012 - 2016



Source: Empirical analysis of 2012 – 2016 SK&A Office-Based Physician (OBP) files.

Narrow networks, typically with limited if any focus on quality compared to ACO networks, have also been increasing in popularity as a low-cost alternative, keeping costs low (in some cases, 25% lower than PPO and HMO plans) by excluding expensive providers. Such organizations could serve to compete with ACOs to keep commercial ACO prices low (Eggbeer and Morris, 2013). However, in other cases, such 'accountable care partnerships' will just be a rebranding of a narrow network (Eggbeer and Morris, 2013). Regardless, limited networks were found to be correlated with patients receiving more primary and preventative care with less use of emergency rooms (Optum Labs, 2015) However, in places where there are few providers and extensive

network restrictions, narrow networks have more trouble forming and providing competition with ACOs to challenge their market power (Handel, 2015). Some researchers are wary of the rise in narrow networks; a similar interest was shown in the 1990s for HMOs with narrow networks with limited success (Tu, Muhlestein, Kocot, and White, 2015). Similarly, others see the rise of commercial ACO networks as not dissimilar to the relatively unsuccessful spread of IDNs in decades past (Burns and Pauly, 2012).

Literature Review

Managed Care to Accountable Care

Over the last two decades the prevalence of managed care plans and capitated reimbursement has continually grown, with the current promotion of accountable care designs a direct evolution of this approach. In general, two main differences separate ACOs from managed care: a lack of restrictions on patient choice of provider and an increased use of financial incentives for quality reporting and improvement both within and across organizations. Under traditional managed care reimbursement, commercial insurers compete on the basis of price, administrative efficiency, and the attractiveness of their provider networks while hospitals and physician groups compete on the basis of price and quality attributes, both for inclusion into provider networks and for individual patients (Dranove and Satterthwaite, 2000). Dranove, Shanley, and White refer to such mechanisms as ‘payer-driven competition’ which may lead to lower prices but also potentially lower quality than that provided under a fee-for-service, ‘patient-driven competition’ reimbursement system (1993). Despite a backlash from consumers in the late 1990s, overwhelming evidence exists that managed care succeeded in lowering prices paid by both patients and plans (Dranove and Satterthwaite, 2000). Empirical work has found that managed care lowered premiums (Wholey, Feldman, and Christianson, 1995), decreased total health expenditures with no adverse effects on quality (Cutler, McClellan, and Newhouse, 2000), and decreased the diffusion of technology (Baker and Phibbs, 2002).

Cutler, McClellan, Newhouse (2000) reviewed the overall effects of HMOs in Massachusetts from 1993 to 1995 during which a large portion of the patient population shifted into managed care plans. They find treatments and health outcomes were not significantly affected by this change for HMO enrollees, although such patients had 30-40% lower expenditures compared to the control FFS plans. The authors determine this is due to lower unit prices, also noting potential increases in productivity for HMO plans. In a structural analysis of managed care markets in Medicare, Town and Liu documented overall welfare improvements due to increases in both producer and consumer surplus, although importantly consumers only benefited with surplus gains in competitive markets (2003).

Throughout this period, it was even speculated that a total market evolution was occurring from lightly integrated, low-managed care penetration physician and hospital markets to markets where managed care and capitated payments prevailed and made provider integration necessary. However, such stages did not necessarily occur across markets and the relationship between managed care penetration and integration remained ambiguous (Burns et al., 1997). Furthermore, Burns and Pauly highlight the many promises of managed care through integrated systems that have not yet been realized. The authors note their skepticism that the "California model" of capitated health care will be widely adopted, that hospitals can partner with physicians and thus control their referring habits, or that vertical integration of providers is usually beneficial due to economies of scale and natural complementarities across different providers (2002). So, while managed care has been successfully implemented with many estimated benefits, the extent of its impact remains to be seen.

Simultaneously with developments in managed care, the Triple Aim promoted by health reform advocates and motivating the Affordable Care Act has sought to improve the quality of care, increase access to health care for larger populations, and reduce per capita costs in care through efficiency gains (Berwick, 2008). Integrated health systems are one potential solution to each of these goals; federal and state promotion of ACOs, increased provider communication through

meaningful use of EHRs, and increased use of value-based reimbursement all encourage such integration. ACOs in particular have been lauded as a payment model of the future, with Emanuel and Liebman going so far as to predict the end of the American health insurance industry by 2020 following widespread adoption of ACOs able to provide higher quality and more efficient care (Emanuel and Liebman, 2012). The oft-credited creator of the ACO design, Elliot Fisher (Fisher et al., 2007), in an interview with the Wall Street Journal, noted important questions surrounding ACOs but noted his thinking that such models are "the best hope we have" (Avery, 2012).

Quality Improvement Incentives

Reimbursement of health care services is increasingly tied to "quality" measures like those used in ACO contracts. Efforts to improve quality have broadly used two approaches to incentivize quality improvement in health care markets: service-specific changes in reimbursement such as pay-for-performance schemes or readmission penalties and transition to capitated payments based around specific ACO type contracts (Doyle, Graves, and Gruber, 2015). In addition to affecting reimbursement, quality measures for most Medicare health care facilities are now publicly reported as indicators to beneficiaries and as market pressures for providers. Provider response to changes in reimbursement based on quality measures may be different than standard changes to the extent that providers maximize not only profits but quality, or intensity, itself. Hodgkin and McGuire (1994) note this tradeoff mathematically with the utility effect of the implicit derivative on demand inducement $\frac{U_I}{U_\pi}$. To the extent that hospitals do not solely maximize profits, changes in payment based on quality may also change the marginal benefit of quality.

However, it is commonly recognized that efforts to report or reimburse on quality may cause problems for sicker patient populations comparable to those of unprofitable populations under traditional prospective payment (Newhouse, 1996) as will be further discussed later. Pauly (2004) reviews the concept of quality of care in medical services, noting that hospital's choice of

optimal quality reflects the balance between marginal benefits and minimized marginal costs. In practice, actual quality may be suboptimal due to inefficiencies in its production by providers or the inability of consumers to make utility maximizing choices. Competition and informed consumers helps to alleviate these problems. However, in a system of administered, regulated prices, changes in prices will lead directly to changes in quality. Citing Rosen (2002), Pauly also notes that in equilibrium it is completely feasible that different health care providers will provide different levels of quality depending on their specific production functions.

Rosenthal and coauthors (2004) systematically reviewed all past pay for performance Medicare demonstrations, including nine aimed specifically at hospitals, concluding that such programs tended to reward not quality improvements as intended but rather historically high quality providers. A broader review of pay for performance systems utilized both in and outside of health care settings also failed to find significant empirical evidence for such systems' efficacy (Rosenthal and Frank, 2005). However, the authors note in both cases that such demonstrations have been relatively small and may not compare with the larger and systemic policies then being considered for implementation. Mullen and coauthors use data from physician group performance reports published by a large network HMO to consider the effects of a pay-for-performance system, and also find little evidence of improvements in quality (2010). Helmchen and Sasso (2010), motivated by a lack of empirical evidence potentially due to the use of negligible incentives in past demonstrations, consider a sample of primary care clinic physician who were transferred from salaried positions to those based substantially on provision of selected encounters and procedures. Physicians responded by increasing selected encounters from 11% to 61% and increased provision of selected procedures to profit-maximizing levels. Despite this finding, empirical evidence of provider response due to service-specific performance payments remains weak, highlighting a divergence in findings with the broader literature on general changes to reimbursement both in and outside of health care markets. Kaarbøe and Siciliani (2008) propose a model of reimbursement on quality where some aspects of quality are verifiable

while others are not. Their model predicts that the degree to which a quality incentive payment scheme succeeds usually depends on the degree to observable and unobservable aspects of quality are complements or substitutes.

Early Consensus on Medicare Accountable Care Organizations

Under an ACO model, groups of providers are assigned groups of patients and allowed capitated payments to provide care, with accompanying quality benchmarks to be met. Although arrangements vary, ACOs are typically eligible for incentive payments if they are able to reduce expenditures while maintaining or improving quality. However, skepticism over the success of ACO models is increasing. Frandsen and Rebitzer calibrate a model of physician free-riding in ACOs using private insurer claims and quality measures. Their model predicts free-riding by physician members of the ACO will be a significant problem with optimal incentive payments likely to outweigh cost reductions (2014). McWilliams and coauthors have also found evidence of weak incentives by estimating leakage of ACO-assigned beneficiaries to non-ACO physicians prior to program implementation (9% of primary care visits and 67% of specialty visits by assigned patients occurred outside their ACO). Likewise, the authors estimate that on average only 40% of total Medicare outpatient billing by a physician was for patients actually assigned to her ACO (McWilliams et al., 2014).

While findings are still forthcoming with much active research, some early consensus is developing in the evaluation of ACO payment models with regards to quality improvement and cost reduction. Empirical evaluations of the earliest Medicare ACOs results highlight the potential for such contracts to modestly lower spending (Toussaint et al., 2013; Epstein et al., 2014). As more data has become available, growing evidence highlights the potential for ACOs to improve quality of care, patient satisfaction, and, in some cases, constrain costs (McWilliams et al., 2015; Song et al., 2014; Nyweide et al., 2015). McWilliams and his team have further evaluated effects of the MSSP ACO program and found participating organizations were able to reduce post-acute

spending by 9% without negative effects on health quality (2017). However, it poorly understood what specific changes in behavior by physicians, if any, are driving these early results.

In their most recent work on the subject, Pauly and Burns question the promise of accountable care, drawing direct comparisons to the promotion and ultimate limits of managed care in past decades (2012). They argue that the success of ACOs will depend similarly to managed care on such organizations' ability to target specific populations such as those with chronic disease for which care coordination will be cost-effective. Meanwhile, such organizations may also promote increased integration and decreased competition thus causing unintended consequences for health reform efforts.

Horizontal Integration in Physician Markets

A final concern regarding ACOs is the impression that participants are encouraged to clinically and financially integrate, thus prompting antitrust concerns and the formation of special safe harbors for ACOs by federal regulators. Integrated health care systems are not new, with ongoing trends of both horizontal and vertical integration across the physician, hospital, and insurance markets (Gaynor and Haas-Wilson, 1999; Welch et al., 2013). Baker and coauthors highlight a growing trend of physician-hospital integration, classifying nearly 60% of physician-hospital relationships as vertically integrated with 35% of all physicians working in fully integrated systems (2012) [1]. There are several hypothetical economic benefits to integration of health care providers. Firms may integrate to increase productivity by developing economies of scale, to improve their market power and negotiate higher prices, or to lower transaction costs stemming from business with multiple external suppliers (Laugesen and France, 2014). However, welfare

[1] Other forms of physician-hospital integration categorized by Baker et al. (2012) include independent physician associations, open-physician hospital organizations, closed-physician hospital organizations.

costs of integration and mergers are also increasingly evident. Evidence of price effects and increasing bargaining ability due to horizontal integration have been documented in hospital markets (Town and Vistnes, 2001; Capps, and Dranove, 2004; Ho, 2009), health insurance markets (Dafny, 2010; Dafny, Duggan, et al., 2012) and physician markets (Dunn and Shapiro, 2012). In recent work, Baker and coauthors utilize tax IDs and Medicare claims to track physician consolidation and then match these estimates to Truven MarketScan data on county commercial insurance prices. Results indicate a change from one standard deviation below the mean concentration level to one standard deviation above increases prices for physician services by 2.9% (2013).

Vertical Integration in Health Care Markets

Potentially negative effects of vertical integration between different types of providers are also increasingly well documented. Baker, Bundorf, and Royalty (2014) find that hospital-cardiologist integration is associated with higher spending, with some evidence of increased outpatient procedures and inpatient services. This effect is unlikely to be due simply to selection of high spending physicians into integrated arrangements (2014). Due to the prevalence of insurer-provider bargaining, the interaction of up- and down-stream markets is also important to consider. Ho (2009) models a bilateral bargaining game between hospitals and managed care plans, finding five factors that affect hospitals' ability to negotiate higher prices: consumer demand for a particular hospital; hospital costs of care; "star" status; expected capacity constraints; and the existence of hospital systems. Dafny et al. (2012) and Dunn and Shapiro (2014) also show that decreased insurer market power increases physician income and payments.

CHAPTER 2: A Moral Hazard Theory of Procurement Under Incomplete Contracts

To date, the estimated performance of ACO contracts has been mixed. ACOs are highly reliant on the response of individual physicians within participating firms to receive contractual shared savings. However despite widespread and increasing adoption, the effects of ACO style contracts on physician and firm behavior are not well understood. Relying on neoclassical contract theory (McAfee and McMillan, 1986; Laffont and Tirole, 1987), I present a model of ACO incentive contracts reliant on optimal procurement and auction theory. Under a setting of ex ante adverse selection (due to uncertainty and risk aversion) and ex post moral hazard by health care providers, contract theory reveals a separation property whereby (latently) high-efficiency physician-firms necessarily select into the ACO incentive contract. If a single-crossing assumption (Mirrlees, 1971) on participation holds, ACO contracts are an efficiency gain and a social welfare benefit. This is because the ACO contract internalizes the inefficiencies of supply-side moral hazard by making otherwise efficient firms responsible for cost-overruns; further social welfare benefits are implied if partially-altruistic physicians respond to contract adoption with least-harm, most-productive changes in treatment choice consistent with Chandra and Skinner's model of medical productivity (2012).

Moral Hazard in Demand and Supply: A Brief Overview

"Moral hazard" has a long history in health economics and refers to a type of information asymmetry ("hidden action") in which individuals are more likely to take actions or risks because they do not bear resulting costs (Pauly,1968) . Broadly, three types of moral hazard have been considered in the health economics literature from a demand perspective: *ex ante* moral hazard such as skimping on preventive care services (Zweifel and Breyer, 1997), *static ex post* like consuming more medical care when insured (Manning et al, 1987), and *dynamic ex post* such as opting for newest medical technology and thus prioritizing product innovation over process

innovation (Goddeeris, 1984; Baumgardner, 1991). However, it is often difficult to distinguish between the three types empirically (Zweifel and Manning, 2000). More notably for this dissertation, insurance also affects the behavior of physicians and other providers thought to act on patients' behalf, regardless of whether they are perfect agents or not. This is so called "supply side moral hazard" and the magnitude of such marginal effects is expected to be increasing in the degree of delegation to the physician in any given encounter. Health economists cite three main reasons patients may delegate medical-decision to physicians:

- Informational Asymmetries: Costs of gathering relevant medical knowledge are excessive for patient. However, given a sufficiently high expected return patient may choose to bridge the information gap.
- Shifting of Responsibility: Even a well-informed patient may wish to delegate most of decision-making authority, possibly to shift the source of their treatment's negative externalities (e.g. missing work, reduced income) from themselves to the physician
- Insurance Coverage: As insurance coverage insulates the patient from financial risk of treatment choices may increase their willingness to delegate treatment choices to physicians . Without insurance, patient's willingness to delegate treatment decisions would presumably be reduced.

On both the demand and supply sides, moral hazard mechanisms work in similar ways to reduce efficiency while increasing economic rents of patients and/or providers. Such effects may be heterogeneous and are subject to behavioral biases; Baicker, Mullainathan, and Schwartzstein (2012) identify and estimate the magnitude of demand side “behavioral hazard" where the insured may under-use high value medical services due to various behavioral biases. Such effects may dominate any overutilization due to classical moral hazard and may imply zero or negative optimal cost sharing. In addressing this and related issues, Pauly and Blavin (2008) seek reconcile traditional views of optimal cost sharing under moral hazard with value-based insurance designs promoting decreased cost-sharing for high (marginal) value services. They show how introducing cost-sharing based on services' marginal benefit is a superior approach to providing information when patient demand falls short of full information. Value-based, capitated

payment models such as ACOs represent the contemporary analogue to this value-based insurance design just as supply-side cost sharing through prospective payment has been compared to optimal cost-sharing in insurance markets (Newhouse, 1996).

Regulation of Multiproduct Monopoly Firms

Consideration of classic procurement contract theory is a useful starting place for modeling the economics of ACOs, as problems of multidimensional (e.g. quality and costs) incentive contracting are far from new in this literature. However, the case of ACO contracts provides a prime example of the tension between incentives to cuts costs and raise product quality. Bolton and Dewatripont (2005) aptly describes the classical model of reimbursing a multiproduct, monopoly firm. All ACO provider groups exhibit some market power and may be consider local monopolies. Thus, such organizations face a complex, nonlinear pricing problem depending on the range of health services they deliver. Subsequently a risk-neutral, profit-maximizing firm will in theory respond to an offered incentive contract with some mix of both selection (into the program and in effort provision) and moral hazard type effects (i.e. on marginal treatment intensity, or the mix of treatment inputs allocated to a specific patients) margin to maximize profits (or conversely some multi-objective utility function) across service lines. In the absence of regulation, a monopolist firm has two incentives to provide quality: to encourage future sales from repeat customers and to increase market share via reputation effects.

Regulation of Quality and Costs in Procurement

ACOs are an attempt by Medicare and other payers to regulate quality and the marginal benefit of services while also introducing incentives for cost savings. Writing decades before the ACO model was conceived, Laffont and Tirole (1993) described a model of quality regulation that lends itself well to health care finance. Product quality may be considered either a search good or an experience good. In the former case, quality is thought to be identifiable ex ante while in the latter quality is only knowable ex post. While product quality is ultimately visible to the consumer, the

extent to which quality is merely observable rather than verifiable is of added importance for quality regulation. In cases where quality is verifiable, where its level may be described ex ante and determined ex post by a court, quality may be directly contracted on as an additional good for purchase. Pay-for-performance incentives and recently introduced readmissions penalties for hospitals are good examples of contracting on verifiable aspects of quality in health care settings. However, the efforts and effectiveness of groups of physicians to promote health across their patient populations and broader communities is not likely to ever be fully verifiable regardless of advances in quality monitoring and health IT.

Closer to the less tangible quality of regulated television programming or the threat of core meltdown at a regulated nuclear power plant, examples cited by Laffont and Tirole (1993), population health services possess many aspects that may be difficult to measure and subsequently contract on. In the presence of such informational asymmetries, theorists propose a low-powered incentive schemes not dissimilar to a typical ACO contract in cases where quality and quantity are net substitutes in production. Bolton and Dewatripont (2005) similarly document the theoretical implication that in the presence of moral hazard type effects but little or no ability for selection, a regulator's best choice is to simply eliminate its financial stake and transfer financial risk to firms. By providing ACOs and their participating providers a financial interest in lowering health care spending and improving quality, Medicare thus seeks to reduce these inherent managerial incentive problems and promote "efficiency at the top".

In recent work, Feldman (2015) notes that because ACO contracts are so far voluntary, the expected utility of participation in the program must meet or exceed the ACO's reservation utility. This is an important point, highlighting a separation property of ACO incentive contracts that only providers with a reasonable expectation of success in the program (relative to outside options) will join. Furthermore, conditional on incentive contract participation, managerial effort to reduce costs and improve quality will vary with the ACO's expectation of shared savings (in addition to other payoffs, such as developing firm ability to manage risk). I will argue below that the ACO entry decision and effort to promote high value care will depend on providers' expectations about

their payoffs and the ability of their physicians to affect marginal care delivery and quality provision through (costly) effort. I will analyze these relationships using a principal-agent model of a procurement auction.

While perhaps not immediately intuitive, consideration of ACO contracts as a specific form of procurement auction (an incentive contract auction) by an issuer such as Medicare is both realistic and theoretically appealing. Contract theorists have long considered such contracts with respect to a wide variety of government procurement in goods and services across industries; such contracts are distinctly "not auctioned off like a painting or a treasury bill" but typically see the regulator able and eager to audit realized costs of the procurement (Laffont and Tirole, 1993). This observability of realized costs ex post allows the regulator to interpret participation as a choice of contract by providers across a menu composed of expected prices and the share ratio for cost overruns. Such models are conceptually appealing and noticeably similar to the payment structure and incentives for an ACO contract.[2]

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[2] Given that ACO contracts financially reward providers conditionally depending on cost and quality measures, an even more realistic model ties the award of the incentive contract to a scoring rule (Laffont and Tirole, 1993) dependent on both cost and quality measures. Such models are theoretically ambiguous if cost and quality are substitutes, generally resulting in no tractable predictions. Asker and Cantillon (2010) characterize the optimal procurement mechanism under private information about total costs and quality when both are valued; comparing this optimal mechanism to an efficient scoring auction highlights the ability of such mechanisms to reduce rents and improve welfare. For these reasons, the theoretical model assumesACO contracts incentivize those aspects of quality that are complementary to cost-reductions, reducing the theoretical framework to a singular dimension. This may be a better assumption for ACO quality measures regarding management of at-risk populations, preventive care, and care coordination/patient safety than for those related to patient experience/satisfaction.

Although noted welfare benefits of incentive contracts for government procurement date to at least Scherer (1964) and Myerson (1981), McAfee and McMillan (1986) were among the first to introduce a theory of optimal procurement incorporating moral hazard, risk-sharing with firms, and the potential for risk aversion by firms unsure of their ability to generate shared savings under a given incentive contract. The principal-agent type model presented below explains physician response to ACO contracts using a similar framework for physician-firms bidding on the opportunity to share savings (or cost overruns). Specifically, I structure a theoretic model of an ACO contract as an implicit auction[3] by Medicare offering firms an incentive contract. This is achieved primarily through a transfer payment to higher efficiency firms to induce them to provide services more efficiently at lower marginal rents.

Chandra and Skinner (2012) construct a principal-agent model containing elements of moral hazard in an endeavor to explain cost and technology growth in U.S. health care expenditures. They propose a model whereby providers seek to maximize the health of their patients, but may

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[3] In the economics literature "auctions" may refer and be used to model any general trading mechanism (Manelli and Vincent, 1995). In particular, this setting may be viewed as an all pay auction, where both winners and losers pay their bid and zero bids (non-participation) is possible. While Medicare allows any organization or set of organizations to form an ACO, substantial fixed costs as well as opportunity costs of lost revenue make participation (regardless of ex post effort) costly. Recall by the Revenue Equivalence Theorem (Vickrey, 1961; Myerson, 1981; Reily and Samuelson,1981) that such an auction is expected to be equal in payoffs for the principal/regulator relative to a broad class of other auctions, including first price and Vickrey auctions. It is also possible to frame the problem from the perspective of a tax and transfer scheme (Chetty, 2008). I may pursue this later with respect to a sufficient statistics approach to ACO contract design. This approach would apply the "exact identification" approaches of this literature to estimate marginal effects on treatment choice, allowing welfare considerations without the additional assumptions of structural estimation of model primitives.

deviate due to financial objectives, capacity constraints, ethical judgement, or patient demand. I adapt aspects of their model to make theoretical predictions about the types of health services most affected by an ACO incentive contract. This begins with a review of the classical result that menus of contracts should be offered to firms by a principal in cases where firms have private information.

The Problem of Principal Procurement from a Natural Monopoly Agent

Consider a principal such as Medicare or another issuer seeking to procure total costs of health care services for a population from a natural monopoly firm. This firm, referred to as the agent, has private information about its efficiency given by continuous parameter $\beta_i \in [\underline{\beta}, \bar{\beta}]$. Due to this information asymmetry, the firm enjoys profitable rents. The principal wishes to increases the allocative and productive efficiency of the firm and does so through a direct revelation mechanism that induces "truth-telling" behavior. hich the agent, privately knowing its own type, chooses to maximize its own utility (or profit, given a profit-maximizing firm). As such, after assuring the incentive compatibility of its contracts and committing to transfer some social surplus to higher types upon revelation of type, social welfare gains are possible for the principal through productivity increases and an overall reduction in rent to the agent. This is a classical theoretical result relying only on a single-crossing condition (Mirlees, 1971, Laffont and Tirole, 1993).

The presence of asymmetric information and uncertainty about future costs (due to general cost shocks) implies remaining monopoly rents from the procurement. Contract theorists and health economists alike have noted these remaining inefficiencies may to some extent be alleviated by yardstick competition (Holmstrom, 1982; Shleifer, 1985; Newhouse, 1996) comparable to that used in the DRG system for inpatient hospital reimbursement. Newhouse's (1996) review of the literature to date noted that extensions have in general relaxed one or more of the Shleifer model's assumptions regarding competition on a homogeneous product, of firms (hospitals) maximizing only profit (i.e. agency within the firm), and of perfect regulatory pricing (i.e. first best pricing). To the extent that natural monopoly firms are not comparable due to idiosyncratic

features, objectives, and costs, such mechanisms will provide limited if any efficiency gains (Laffont and Tirole, 1993). In an early reference to ACO-style contracts, Newhouse (1996) further conjectures that welfare gains are hypothetically possible if HMO-type organizations were able to bid a price schedule featuring fixed amounts per enrollee and variable amounts dependent on utilization. I present a formal auction model below that shows that ACOs represent a new procurement mechanism in health care (an incentive contract auction) reminiscent of this suggestion.

Ellis and McGuire (1986, 1996) produced seminal work across several articles highlighting the agency of utility-maximizing physicians on the part of both hospitals and patients as a violation of yardstick competition. Building on earlier work, their 1996 article highlights the potential of prospective payment systems to encourage moral hazard effects in which hospitals provide more or less care to certain sets of patients, selection effects in with hospitals make a choice in the average severity of patients admitted, and practice style effects through which hospitals' shares of total discharges change relative to other providers based on their specific utility functions.

Newhouse (1991, 1996) further notes across several articles that yardstick competition under Medicare's PPS assumes that the regulator is able perfectly set prices equal to costs. However, errors are likely to arise regardless of whether prices are set on aggregate or very fine levels due to measurement error or asymmetric information (1991). Even if average prices are perfectly known, errors will still occur equal to the variance across observably identical firms. Prospective payments are thus not optimal to the extent that they vary from first-best pricing equal to cost. McClellan (1997) develops a novel method for calculating relative prospective versus cost-based reimbursement as well as the profitability of payments for specific diagnoses. He argues from his results that the PPS is not as prospective as popularly thought and that profit incentives vary significantly across DRGs, demographic groups, and types of intensive treatment. Efforts to reimburse or publicly rate health care providers based on quality will encounter analogous selection and measurement error inefficiencies (Newhouse, 1996). A model such as that

proposed next seeks to confront such selection issues directly through the use of voluntary bidding to participate in an incentive contract rather than status quo mixed payment system.[4]

A Linear Model of ACO Incentive Contract Auctions

Suppose rather than a yardstick competition, where all firms are compared to some average cost, the principal wishes to introduce a cost saving, quality improvement program for health expenditures and assumes that there are now multiple agents (hereafter providers[5]) capable of promoting "value" in the Medicare system through a total cost of care (TCOC) incentive contract (Feldman, 2015). Assume for the moment that government is indifferent as to how "savings" are generated or value promotion is achieved so long as cost reductions are welfare improving. That is, the government is not concerned about distributional effects of the program so long as the program improves economic welfare for patients and taxpayers. To further simplify the theory, assume that promotion of quality is cost saving; that marginal quality and marginal quantity are net substitutes. Asymmetric information, the principal observes neither the agent's type $\boldsymbol{\beta_i} \in [\, \underline{\boldsymbol{\beta}}, \overline{\boldsymbol{\beta}}]$ nor its costly effort $\boldsymbol{h_i(\xi)}$ to efficiently produce, allowing regulated providers to enjoy rents.

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[4] This may in practice be a supply-side analogue of "selection on moral hazard" effects demonstrated by Einav, Finkelstein and coauthors (2013). Similar to that work's finding that consumers more likely to respond to reduced cost-sharing with increased utilization will select into such health plans, I conjecture that providers best able to respond to an ACO contract (through reduced supply-side moral hazard) will select into such payment models.

[5] This work is presently ambivalent with respect to the true boundaries of firms (Coase, 1937) across health care markets. However, boundaries of the firm are potentially important and will be addressed by considering different types of organizations. A number of managerial critiques follows this theoretical contribution.

The Provider's Problem

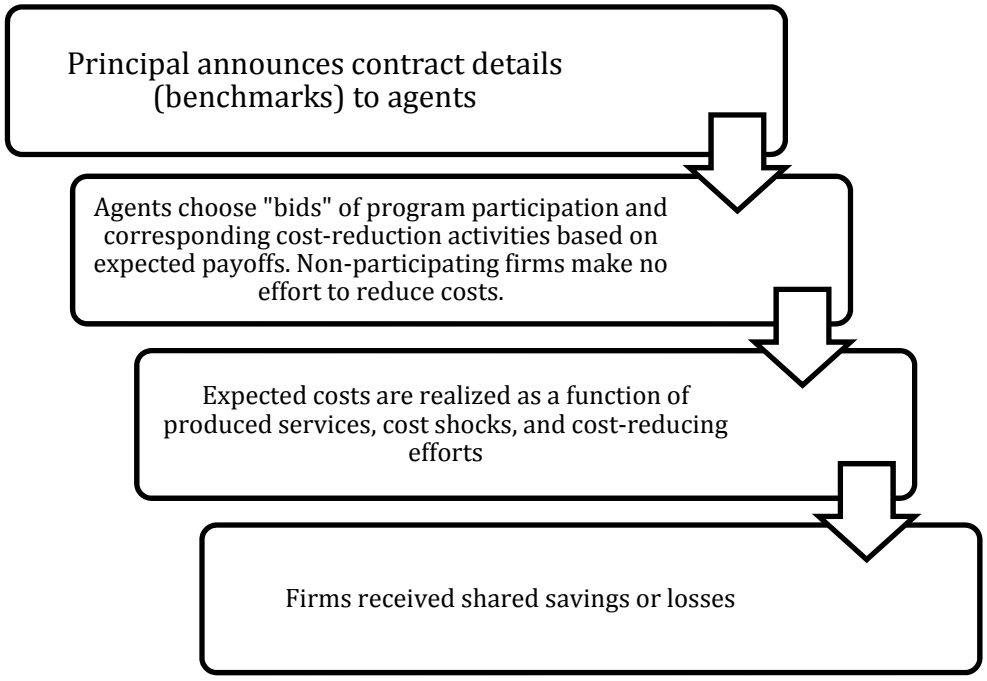
Given that a specific provider, *i,* participates in the incentive contract, the *ex post* cost $\boldsymbol{c_i(q)}$ of the program will have three parts:

$$\boldsymbol{c_i(q) = \beta_i + w - \xi_i}$$

where expected TCOC for a population as well as opportunity costs to the provider are given by the efficiency parameter β_i (this is private information, potentially over a distribution, known to the provider but not to the regulator), *w* is a random cost shock distributed over *F(w)* with expected value equaling zero that is only known ex post (following the contract participation decision), and $\boldsymbol{\xi}$ represents the realized cost savings due to effort by the provider. Let $\boldsymbol{h(\xi)}$ equal the cost of effort to participate in the incentive contract, which cannot be charged to the regulator as part of $\boldsymbol{c_i^*}$ and is assumed to have decreasing returns to scale (h'' > 0). Note this is without loss of generality as any costs that may be charged to the regulator will be encompassed in type parameter $\boldsymbol{\beta_i}$.

Note the regulator/principal observes neither the efficiency parameters nor the level of effort chosen by the provider, only an ex ante announcement of the firm's type $\widetilde{\boldsymbol{\beta_i}}$ and the realized costs $\boldsymbol{c_i(q)}$ of the winner (in reality, Medicare observes all realized costs).To select the provider(s) to undertake the ACO program, the regulator/principal organizes an "auction" to maximize social welfare and minimize monopoly rents. Figure 4 presents a basic conceptual model of this game.

Figure 4. Conceptual Model of ACO Incentive Contract Auction



Potential providers optimize their expected utility in their decision to participate in the incentive contract as well as their choice of effort to attain a bonus. Expected utility maximization is given by the profit function[6]:

$\boldsymbol{\pi_i = \alpha(\hat{\beta}_i) + (1 - \alpha) f_i(q) - \beta_i - h(\xi_i)}$, or

$$\boldsymbol{\pi_i = (1 - \alpha)\left(f_i(q) - c_i\ (q) - w_i\right) + (1 - \alpha)\xi_i - h(\xi_i)}$$

With a share rate α for cost overruns beyond the benchmark determined by the agent's announced type, $\boldsymbol{\hat{\beta}_i}$, and a fixed price per unit $\boldsymbol{f_i}$. If the expected utility given $\boldsymbol{\pi_i}$ from providing marginal efficiency under the contract is less than zero, the provider will not participate in an ACO. So, the principal's choice of the share ratio determines the agent's choice of effort to

[6] Ultimately, this dissertation seeks to present a dual objective function in which agents value both profits and health.

reduce cost-overruns relative to the initial bid. Maintaining an auction framework, let us for now note that the *ex ante* probability of "winning" shared savings under the ACO program is given by

$$\boldsymbol{EAU = EU\big((1-\alpha)(f_i(q) - c_i^*(q) - w_i) + (1-\alpha)\xi_i - h(\xi_i)\big) * (1 - F(b_i))}$$

For simplicity and to match actual program characteristics, presume a discrete choice of two bid options, $\boldsymbol{b_i}$, offered to each provider by Medicare. If the EU(π_i)<0 the physician firm does not bid (i.e. participate in the program or expend effort for cost-savings), while if EU(π_i)>0 the provider accepts the ACO benchmark contract and sets effort costs[7] h(ξ) to participate in the incentive contract. The benchmark[8] may (hopefully) be roughly equivalent to the competitive bidding mechanism of a competitive auction, with a symmetric Bayes-Nash equilibrium (BNE) given by $\boldsymbol{b_i = B(c_i^*(q))}$ when all other agents bid $\boldsymbol{b_j = B(c_j^*(q))}$. In other words, I assume that

$$\boldsymbol{b_i = B\big(c_{i,t-1}^*\big) \sim B\big(c_{i,t}^*\big)}$$

For truth telling to form a BNE it must be that $\boldsymbol{\widehat{\beta}_i = \beta_i}$ maximizes a provider's expected utility with respect to its true efficiency parameter. If this equilibrium exists, then conditional on participation in the ACO contract, effort provision $\boldsymbol{h_i(\xi)}$ will be selected to satisfy utility maximization. As such

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[7] Including opportunity costs. Recall that these costs cannot (at least in total) be charged to the regulator as part of $c_i\ (q))$ and is assumed to have decreasing returns to scale (h'' >0).

[8] While an ACO contract/program does not involve formal solicitation of bids from organizations, the cost benchmark is analogous to the competitive effects of other bidders via a slightly altered form of yardstick competition (Shleifer, 1985). From a bargaining perspective, models dating from Samuelson (1984) show that in the presence of private information and bilateral monopoly one party (typically a buyer) maximizes their own utility through the use of a first-and-final offer to the other (a seller). This is done administratively in the case of ACOs in the form of the benchmark; consistent with Samuelson (1984) the existence of a mutually profitable contract is necessary and sufficient for the economic exchange (and gains from trade) to occur.

the share ratio and methodology for setting bids (i.e. benchmarks) will be of clear importance. How to determine benchmarks in ACOs is a topic of active research (Chernew and McWilliams, 2015) with payment models heterogeneously mixing firm, market, and national cost estimates. Furthermore, newer ACO designs allow organizations to change their "bid" through changes to the minimum savings and loss ratios stipulated by the incentive contract.

The Principal's Problem

The procuring principal's goal given provider behavior is the creation of a direct revelation mechanism to induce high efficiency types to reveal themselves and produce health care more efficiently.[9] Such a mechanism is a set of functions $t_i(\beta)$,$C_i(\beta)$, $x_i(\beta)$ for all types β that induces truth-telling behavior for all types β_i with a net monterary transfer rule $t_i(.)$, cost $C_i(.)$ that the firm must realize if participating, and $x_i(.)$ a probability of receiving the transfer conditional on one's type (as well as effort choice, itself a function of the type and the transfer rule.) A general structure of reimbursement in procurement of health care services balances ex post, total costs of care (dependent on volume as prices are fixed) and fixed fee payment *f* reimbursed at a fixed rate plus the potential for some profit γ.

$$\boldsymbol{P_i = \alpha c_i(q) + (1-\alpha) f_i(q) + \gamma}$$

Reimbursement in health care is often structured in this way. The Physician Fee Schedule (PFS) has traditionally reimbursed physicians for all services on a roughly cost-plus basis for each marginal service (where α = 1, $(\boldsymbol{1-\alpha})$=0). Meanwhile, inpatient care is reimbursed through a menu of fixed prices contracts through a prospective payment system (PPS) on the basis of admitting diagnoses (where α=0, $(\boldsymbol{1-\alpha})$=1). Without consideration of incentive contracts, it has

[9] It is equivalent to frame these analyses as a general project (promotion of high value care in the U.S. health system). In that sense, welfare benefits exist regardless of the number of "winning" firms.

been shown that in the presence of physician agency a mixed payment system is optimal over either corner solution (Ellis and McGuire,1986, 1990; Newhouse, 1996).

Next consider the ACO incentive contract where 0 < α < 1. McAfee and McMillan[10] (1986) argue that under such a contract, only the share ratio α effects marginal behavior without regard for the other parameters (β and γ). Without loss of generality, reimbursement under the incentive contract will be announced by the regulator as:

$$\boldsymbol{P_i = f + \alpha(c_i(q) - f)}$$

With agents able to choose between the incentive contract and the status quo reimbursement and assuming truth-telling behavior, such a auction mechanism reveals a separation property. High efficiency types will choose the incentive contract (and more ex ante risk) while low-efficiency types will select status quo reimbursement. It may be shown that such a direct revelation mechanism is optimal and pareto improving. Each agent is incentivized to formulate a bidding strategy that is optimal regardless of other agents' bids, that is, such a mechanism is a direct strategy auction. Total costs of care provided by winning agents will be theoretically identical to those in the absence of the competitive mechanism, which simply reduces the agents' rents by reducing the principal's uncertainty about agents' true costs. Such a model also highlights the importance of ACO contract design, such as the share ratio and benchmark generosity, in determining agents' response.

Predicted Variations in Physician Response by Treatment Type

As individual physicians are often the ultimate agents of production within provider firms, the extent to which they value health promotion of their patient population (in addition to profit) is important to consider as it will be incorporated into their firm's decision to participate in the incentive contract. Regarding the range of services that physicians may choose to offer patients,

[10] A more realistic version of the model includes estimates of risk aversion. This will be explored further as the dissertation is developed.

including evaluation and management office visits, procedures, tests, and imaging, it is helpful to consider both the price and the productivity of a given treatment in predicting response due to the dual objectives of physicians. Chandra and Skinner (2012) model three types of medical technology productivity: highly cost-saving treatments with little chance of overuse, treatments which are highly effective for some but not for all, and treatments with uncertain clinical value. ACO contracts provide soft-powered incentives to increase cost-effective treatments (e.g. immunizations) while decreasing services with low or uncertain value. However, the extent to which ACOs are able to increase the appropriateness of providing treatments with mixed effectiveness to the marginal patient is a key question (Chandra, Skinner, Holmes, 2013). To be successful, ACOs need to limit investments in technology such as proton beam accelerators, steer patients away from cost-ineffective technologies, and slow the development of costly innovations (Finkelstein et al., 2007).

Predicted Variations in Physician Response by Payer Type

Theoretical and empirical analyses primarily assume that physicians are unable to significantly (or fully) distinguish between patients by payer type or ACO affiliation (Pauly and McGuire, 1991). However, conceptual questions exist related to the ability of providers to directly aim treatments and procedures at the patients of a single payer. Or, if as Pauly and McGuire (1991) model, the physician has a reasonable expectation of payer type over all patients. Empirical analyses in Part 5 will test these assumptions by estimating the extent of spillover effects from ACO contracts. Conceptual understanding of possible spillover effects will be further discussed jointly with empirical analysis.

Asset Control and Governance in ACOs: A Managerial Critique

Of course, a critique of the proposed auction theory may be made on the basis of incomplete contracts and unclear boundaries of the firm (e.g. Grossman and Hart, 1986, Williamson, 1985; Coase, 1937). Specifically, to what extent is the decision to participate in an ACO contract made by a rational decision maker with residual control of assets and profits? One important distinction from this literature notes differences across empirical settings in control over assets by in

managers/provider groups and human capital by agents/physicians (Holmstrom, 1999; Willamson, 2002). Williamson in particular has noted the importance of governance structure and/or residual ownership of assets (1986) when agents ultimately control production. Laffont and Tirole (1993) also note that such theoretical models (of incentive contract auctions) ignore transaction costs, capture costs, and dynamic costs of repeated games and renegotiation. Renegotiation may be of particular relevance in the Medicare program, where ACOs and their members have been able to exit or re-negotiate from two-sided to one-sided risk models retroactively. Theoretical predictions tempered by such critiques will be informed by empirical analysis.

One strand in the organizational economics literature focuses on moral hazard problems faced by organizations when agents within the firm control production, a useful setting relevant to the behavior of individual physicians within ACOs. In such cases, management can influence agents and production only indirectly. The key problem focused on by these alternative models are that actions are to some degree ex post non-contractible and as such behavior of physician agents will differ substantially in integrated (firm) vs. non-integrated (market) settings. Non-integration provides higher incentives for cost reduction while reducing those for efficiency improvements; integrated firms likewise diminish entrepreneurial incentives of employee-agents to reduce resource use but allow for increase coordination and economies of scope. This is consistent with the premise from early transaction cost economics (Coase, 1937) that firms, with their ability to coordinate production through bureaucratic decisions, show an advantage to market-based decision making. Within health care organizations, some physicians may deviate in the presence of weak internal incentives to respond or free rider problems in large groups (Gaynor and Gertler, 1995; Frandsen and Rebitzer, 2014). Such considerations will be further considered in empirical estimation when a number of ACO features, such as composition, integration with a health system, and internal financial incentives (how shared savings are distributed), will be tested in subgroup analysis.

Finally, Laffont and Tirole (1993) further note that incentive contracts auctions may not be practical due to two industrial policy considerations that are pertinent to health care services: the regulator may seek to keep capacity utilization, learning by doing, and firm efficiency approximately similar in order to preserve competition / bargaining ability in future auctions or to satisfy distributional constraints related to some "fair distribution" rule (such as a distribution of contracts across U.S. states). Given the relatively small portion of reimbursement tied to ACOs in the present day despite anticipated expansion, such concerns are not immediately relevant.

Regardless, the theoretical model of an incentive contract auction by a government purchaser matches fairly well to stylized facts surrounding ACOs. In reality, Medicare now offers a menu of contracts to providers ranging from the recently introduced Merit-Based Payment System (MIPS) system to advanced alternative payment models (APMs) such as Next Generation ACOs featuring substantial downside risk. In general response to such critiques, the preceding model emphasizes the information asymmetries faced in procurement rather than transaction cost issues. As noted by Burns and Pauly (2012), ACO contracts often have distinguishing features that many payer-provider partnership and integrated health systems in the past have lacked. These include a greatly expanded use of care management practices, significant investments in health IT, broad governance, and the holding of performance, rather than actuarial, risk. To the extent that ACOs respond to financial incentives and are able to improve care management for efficiency gains, welfare improvements are expected. The fact that some providers are willing to participate in ACO contracts and successfully attain shared savings seemingly reveals this to be true. However, it will be important to review subgroup results across two categories in empirical analysis in Part III: ACO governance (system-led, jointly-led, and physician-led) and the degree of distribution of shared savings to individual physicians.

CHAPTER 3: Effects of Medicare ACO Adoption on Physician Behavior

I test above theoretical predictions using a novel combination of physician, firm, and ACO data and an identification strategy that utilizes variation in ACO start dates. Consistent with ACO program goals and theoretical predictions, physicians participating in Medicare ACO programs are found to significantly decrease per patient utilization of services, particularly specialist services. Analyses on specific service categories find significant effects related to per patient reimbursements for imaging, testing and evaluation and management (E&M) services. Subgroup estimates highlight the important effects of ACO governance and profit-sharing with physician participants. Physicians in physician-led ACOs are found to respond significantly more to the contract change, as are those in system-led ACOs that distribute shared savings bonuses to physician members.

Introduction

Accountable Care Organizations (ACOs) are an evolving type of global capitation contract in health care which seek to reimburse health care providers conditionally on quality and total cost. ACOs are highly reliant on the response of individual physicians within participating firms to obtain contractual shared savings. However, despite widespread adoption by 26 percent of U.S. physicians, the effects of ACO style contracts on physician and firm behavior are not well understood.

This analysis seeks to investigate theoretical predictions reviewed in Part II regarding the changes in treatment choice by physicians following adoption of an ACO contract. This work seeks to answer related questions and test theoretical predictions utilizing physician-level indicators of participation in Medicare ACOs, rich firm organizational characteristics, and public use Medicare Part B claims data to analyze treatment and practice patterns following Medicare ACO adoption. Consistent with ACO program goals and previous theoretical predictions, physicians participating in Medicare ACO programs were found to significantly decrease marginal treatment intensity in terms of both total services and payments per Medicare beneficiary.

Presented analyses will first characterize the existing market for Medicare physician services with respect to health system and ACO participation. This research then seeks to answer several research questions of interest to both health policy makers and health economists. How does market structure and organizational features affect a firm's decision to form an ACO and the financial and quality performance of those who select to participate? What characteristics of ACO and their members predict success in meeting program goals and recouping shared savings? What are the effects of such clinical and financial integration on local market quality and costs?

I seek to answer these questions and test theoretical predictions utilizing physician-level indicators of participation in Medicare ACOs, rich firm organizational characteristics, and public use Medicare Part B claims data to analyze treatment and referral patterns following Medicare ACO adoption. Consistent with ACO program goals and theoretical predictions, physicians participating in Medicare ACO programs were found to significantly decrease marginal treatment intensity in terms of both total services and payments per beneficiary. Analyses on specific service categories find significant effects related to per beneficiary reimbursements for imaging, testing and evaluation and management (E&M) services. Applying the Shortell et al. (2015) categorization of ACO types, subgroup results suggest that smaller, physician-led ACOs are more effective in limiting the marginal administration of services and reducing referrals to specialists compared to hospital and system-led organizations. I further explore the roles of non-profit hospitals and for-profit population health services organizations (PHSOs), which are expected to offer different incentive schemes to providers due to regulation. Further analysis seeks to link estimated changes in marginal utilization across a number of service categories to a specific mechanism: changes in referrals by primary care physicians participating in ACOs to specialists, hospitals, and post-acute providers. This is completed utilizing Medicare referral data from 2010 – 2014 and the same generalized difference in differences approach to evaluate trends in referrals by primary care physicians out to other providers. Controlling for all static physician and geographic characteristics, primary care physicians participating in early Medicare ACOs significantly increased total referral rates to specialists. Furthermore, primary care physicians did significantly increase referrals to specialists within their own firms and health systems upon ACO

adoption (both in terms of share and total). Interestingly, only physician-led ACOs show significantly reduced total primary care referrals to specialists or an ability to reduce referrals to specialists in the same organization. In empirics, I also show significant increases in primary care physician referrals to hospitals and post-acute providers following ACO adoption by system-led and jointly-led organizations. Consistent with previous results, only physician-led ACOs significantly reduced referrals to inpatient and post-acute providers.

Findings highlight the promise of the ACO approach to limit health care utilization while underlining potential unintended consequences and ongoing antitrust concerns. Results are relevant not only to policy makers, but also the patients, providers, and insurers increasingly participating in such arrangements and will inform the ongoing development of both public and commercial ACOs through identification of estimated physician responses to changed incentive schemes.

Causal Identification of Physician Response

Research Questions

Empirical analysis seeks to investigate the above theoretical predictions regarding the changes in treatment choice by physicians following adoption of an ACO contract utilizing a unique dataset of physician and provider participation in ACOs as well as newly available data on Medicare ACO program results. Analyses first characterize the existing market for physician services with respect to ACO participation. This work then seeks to answer several research questions of interest to both health policy makers and health economists. How does the adoption of ACO incentive contracts in Medicare affect physician treatment choice? How do ACO organizational features such as governance and internal incentives affect the treatment choices of physicians who select to participate?

Empirical Specification

Analyses employ a modified form of generalized difference in differences (Bertrand, Duflo, and Mullainathan, 2004) type specifications across a range of dependent variables related to patient selection and marginal treatment intensity by physicians:

$$y_{ict} = \bar{\beta} ACO_c * Post_{ict} + \beta_t Year_t + \beta_c ACOCohort_c + \varepsilon_{ict}$$

In this specification, the mean causal effect of physician *i* in ACO cohort *c* adopting the ACO contract by year t $(ACO_c * Post_{ict})$ are estimated through $\bar{\beta}$ while controlling for differences in ACO treatment and control groups ($ACOCohort_c$) and time trends ($Year_t$).

Utilizing physician-level ACO affiliations and controlling for static, unobserved physician characteristics (through the use of physician-level fixed effects at the NPI level), the above specification ultimately reduces to:

$$y_{ict} = \bar{\beta} ACO_c * Post_{ict} + \beta_t Year_t + \beta_i Physician_i + \varepsilon_{ict}$$

The average treatment effect of Medicare ACO participation $\bar{\beta}$, for a given outcome y_{ict} is well identified with every untreated physician in a specific year (including those later joining an ACO) acting as controls for ACO adopting physicians in that year. So, physicians joining ACOs in 2014 act as controls for early adopters until the physician-year observation itself is treated. $\bar{\beta}$ will thus capture average treatment effect across the multiple start-dates and ACO cohorts. This second specification is identical to the first except for the addition of a physician fixed effect ($Physician_i$) to control for static differences across individual physicians. Multiple years of Medicare claims data across a large sample of physicians allow for such analyses while maintaining sufficient degrees of freedom; also note that neither the ACO cohort variables nor specific static physician characteristics (e.g. system integration) need be included in this regression due to perfect multicollinearity with the physician fixed effects (assigned at NPI level). Four sets of outcome measures, y_{ict}, are considered. The first are general measures of marginal reimbursement; these are constructed from the three aggregate outcomes to construct annual,

per beneficiary utilization estimates (results in Table 2). The second are aggregate measures on Part B utilization that test for effects of ACO adoption on total unique beneficiaries treated, total Part B reimbursement, and total services administered annually (in Appendix Table 23). Finally, remaining specifications each estimate specific measures of marginal treatment intensity for specific services; these are constructed similarly to the general marginal treatment measures by dividing total annual reimbursement for a specific service category by the physicians' total number of treated beneficiaries. So defined and estimated with physician fixed effects, such measures will estimate both the marginal propensity of a patient in the physician's panel to receive a service (e.g. an immunization) as well as the intensity of specific services (e.g. the time length and corresponding reimbursement of an office visit).

Two "triple difference" interaction specifications are included to highlight important differences in the effects of ACO adoption due to organizational differences. The first concerns differences in response between ACO governance types; the second how organizations choose to distribute shared savings to participants. With accumulating evidence (Shortell et al., 2015; McWilliams et al., 2016) on the importance of ACO composition, the triple difference specification estimates the varying effects of ACO adoption by organizational type:

$$y_{ict} = \bar{\beta}_J ACO_c * Post_{ict} * Type_J + \bar{\beta}_P ACO_c * Post_{ict} * Type_p + \bar{\beta}_S ACO_c * Post_{ict} * Type_S$$

$$+ \beta_t Year_t + \beta_i Physician_i + \varepsilon_{ict}$$

As such, the estimated effects of ACO adoption by physicians in ACOs operated primarily by physician groups ($Type_p$) will be estimated separately from effects for physicians in system-led ACOs ($Type_S$) and jointly-led ACOs ($Type_J$). For example, $\bar{\beta}_P$ may be interpreted as the effect of physician-led ACOs while the sum of $\bar{\beta}_S$ estimates the effect of ACO contract adoption on hospital or system-led organizations. Further detail on the underlying typology and the analytic definition of these two subgroups are provided in the earlier data section.

Robustness

Key findings are robust to multiple specifications and alternative modeling assumptions. Specifically, consistent results are estimated:

- Using an exposure variable (fraction of year), for ACO contracts beginning at different months of a year (January, April, July);
- Using a gap year to estimate effects in the second year of participation only;
- Using organization/firm level fixed effects rather than physician (NPI) level fixed effects; and
- Using a treatment group that excludes the Pioneer ACO participants.

Additionally, no significant effects are found for placebo contracts randomly assigned to physicians as well as assigned based on a non-random, arbitrary assignment rule (placebo assignment by physician last name). Standard errors are clustered at the primary care service area (PCSA) level to control for unobserved market-level characteristics such as ACO entry; the over six thousand PCSAs are compiled from zip codes and were designed to identify where populations of Medicare beneficiaries typically seek primary care. While clustering errors at this level is conceptually preferred, statistical significance holds using state-level clustering. Due to the volume of checks, robustness results are excluded but are available upon request.

Data

SK&A Physician and Organization Data

SK&A has collected a unique dataset of physicians' Medicare and commercial ACO affiliations typically unavailable to researchers. Until recently, complete national data on system ownership and provider integration was also not available across hospital, physician, and insurer markets. The SK&A data files are a increasingly used and continually updated commercial database of practicing office-based physicians organized at the physician-office level initially developed for marketing purposes. SK&A data is able to be used for research purposes and has been shown to include more than 90 percent of physician offices without selection in terms of safety-net providers (Rhodes et al., 2014). This data is maintained through a continuously updated phone survey of all U.S. office-based physicians. Data from 2014 show over 25 percent of all physicians

are participating in either a Medicare or commercial ACO contract. SK&A data files incorporated into final analysis file includes:

- Office-Based Physicians (OBP) files (2005 – 2014)
- ACO Contacts file (2014)
- Integrated Health System (HIS) Contacts file (2014)
- Hospital file (1816 Hospitals with links to physician file, ACO file, and IHS file, 2014)

Gresenz, Auerbach, and Duarte (HSR, 2013) compared SK&A with the AMA Masterfile and the American Community Survey, finding similar totals of office-based physicians and selection across broad specialties. The ACS listed 673,000 physicians (including non-office based and non-clinical), with AMA listing 553,000 and SK&A listing 552,000.

SK&A has since increased its total physician count, as of the 2013 OBP file uniquely counting 568,748 unique physicians across 737,183 sites. Exercises completed by the author comparing state-level counts of physicians from SK&A and data from the Kaiser Family Foundation produced similar distributions. Furthermore, SK&A data does appear upon review to underestimate certain hospital-based subspecialties.

Several categories of variables are available for use in analysis. “ACO contract design” metrics include total assigned beneficiaries, financial alignment of physicians across the ACO (within groups, health systems, or jointly operated ACOs), and ACO governance. Additional characteristics at the ACO level for Medicare ACOs, including ACO start date, were merged in from public use Medicare files to define ACO treatment cohorts. Ultimately, analyses include observations from 23 Pioneer ACOs (all completing second year, exiting Pioneers were excluded) and 335 Medicare Shared Savings Program (MSSP) ACOs with one of four start dates from April 2012 to January 2014.

Defining the Firm

Shortell and coauthors, in their book on American health systems, define an organized delivery networks as a group of “organizations that provides or arranges to provide a coordinated continuum of services to a defined population and is willing to be held clinically and fiscally

accountable for the outcomes and health status of the population served" (2000). However, defining a modern, integrated firm from multiple, partially overlapping organizational categories is a non-trivial empirical challenge. Recently, Baker and coauthors have utilized tax ids to classify firms at the smallest ownership level (2014); the same authors also previously classified nearly 60% of physician-hospital relationships into some vertically integrated form (2012). While such approaches in many cases will identify a residual claimant (i.e., the taxed physician group or the hospital-owner), this approach may underestimate the impact of system ownership if physicians integrated into systems work across non-system hospitals or in different markets. Instead, this project seeks to assign physicians to the broadest organizational form listed by SK&A under the assumption that physicians participating in larger groups or health systems will utilize their broader organizations' full market power.

A hierarchy of organizational forms exists in the SK&A data around physician offices:

- Integrated Health Systems (689 unique IHS)
- Health Systems (5,055 unique systems)
- Hospital Ownership (528 unique hospitals)
- Group Medical Practice (18,388 unique GMPs)
- Independent Physician Association (5,055 unique IPAs)
- Company (222,653 unique companies)
- Offices (294,989 unique offices)

To overcome this variety of overlapping forms, a unique firm identifier was assigned to each physician based on the largest organization they were a part of. While the variable does not completely overlap physicians participating in other organizations, it uses all identifiable connections to summarize physicians expected to have related financial interests. This approach is similar to that used by Dunn and Shapiro (2014) in their research utilizing the SK&A, although their data has fewer identified organizational categories. Table 1 indicates what percentage of physicians in the same organization will be defined as being in the same firm by the unique firm identifier.

Table 1. Overlap of Unique Firm Identifier with other Organizational Categories

Organization	Overlap
Office	91%
Company	95%
Group Medical Practice	95%
Health System	91%
Hospital Owner	96%
Independent Physician Association	66%
ACO	68%
Integrated Health System	100%

Consideration of the other organizational categories provided in the data is interesting despite the need to create a single, universal firm identifier. The company variable appears to be the nearest identifier of a unique, traditional firm in the SK&A. Members of the same company are more than 95% likely to be in the same health system, owned by the same hospital, be in the same IPA, be in the same ACO, and/or be in the same IHS. Conversely, not all offices reporting the same group practice report being in the same company (52%); though members of such organizations do choose to be in the same IHS and ACOs approximately 98% of the time. Accountable Care Organizations (578 unique ACOs) may also be considered as a type of organizational form, but are better thought of as payment arrangements entered into by multiple firms. 86% of physician offices in the same ACO are in the same IHS; likewise members of an IHS are 89% likely to be in the same ACO.

Medicare Provider Utilization and Payment Data

The Physician and Other Supplier public use file (PUF) available from CMS provides information on utilization and Medicare reimbursement and is organized by National Provider Identifier (NPI) and Healthcare Common Procedure Coding System (HCPCS) code. While some data is censored in cases where a physician provides fewer than 10 of a specific procedure a year, these annual summaries benefit from being drawn from 100% of all final claims for the population

enrolled in traditional Medicare. Files were additionally aggregated in several ways. First, HCPCS codes were aggregated to service category levels using the Berenson-Eggers Type of Service (BETOS) classification. Additionally, specific procedure codes were organized into categories of interest such as physician provision of evaluation and management (E&M) office visits and preventive services. Meaningful preventive services categories were primarily defined using Medicare's own list of preventive services, for which out of pocket payments are typically waived. Only specific procedure codes are eligible for reimbursement under these benefits, allowing for direct identification in the PUF data. A full list and definition of those services is provided in Appendix Table 17. In addition, a list of costly, high volume procedures recently developed by Austin and Baker (2015) are flagged to evaluate how physicians in ACOs are approaching administration of particularly salient procedures.

Medicare Physician Referrals Data

Additional public use data is available from CMS on physician referral patterns from 2010 – 2014[11]. The data is structured as a data dump from 100% traditional Medicare claims across all provider types, with a referral being defined as any pair of claims (i.e. patient encounters) from two different NPIs occurring within 30 days of each other. I aggregate this to the physician-year level so that it is possible to consider both referrals-out and referrals-in (i.e. referral capture). Empirical analysis presents trends in referrals related to one specific relationship: referrals from primary care physicians (i.e. generalists) to specialists. I identify a consistent panel of 92,247 primary care physicians (PCPs) found to refer Medicare beneficiaries to specialists from 2010 – 2014 in public use referral data as well matched to the SK&A physician file (for firm and ACO organizational affiliations). The combined analytic sample allows for creation of firm self-referral

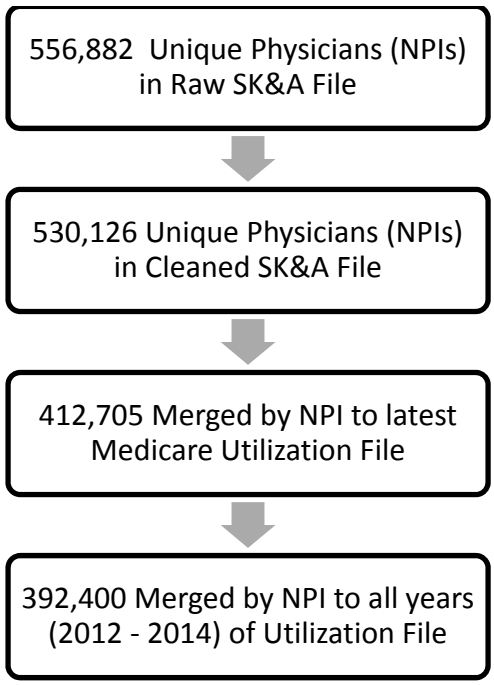
[11] Data years released by CMS actually ranged from 2009 – 2015, however both years at the ends of the data are incomplete annual summaries (half-years). While results are consistent with these years included, they were excluded over concerns of heterogeneous differences in the completeness of the summary data for ACO- and non-ACO providers.

measures in cases where primary care physicians refer to specialists in the same group or system.

Sample Selection and Summary Statistics

From the raw SK&A file, I exclude physicians identified as specializing in oral surgery/dentistry, holistic medicine, or acupuncture, as well as medical trainees, allied health professionals, and physician executives. This cleaned file of 530,126 unique physicians was then merged with the Medicare data also at the physician level by National Provider Identifier (NPI). A substantial amount of SK&A physicians, 22.2 percent, were not present in Medicare data. Such providers do not treat Medicare patients (e.g. most pediatricians) or treat less than ten unique beneficiaries a year (a requirement for inclusion in the public use Medicare data). Almost all physician observations in the 2014 Medicare file were matched to SK&A, only 23,941 observations (or 5.4 percent) were not found in SK&A; these physicians are likely hospitalists or other facility-based physicians not identified in SK&A's office-based data collection. This sample selection process is shown in Figure 5 below.

Figure 5. Sample Selection Flow Chart



Summary Statistics

Table 2 presents descriptive statistics on the final analysis sample of 392,400 unique U.S. physicians, including 118,982 primary care physicians, participating consistently in Medicare from 2012 – 2014. Physicians specializing in primary care, in larger offices (in terms of other physicians), in larger physician groups, and vertically integrated with health systems are all more likely to form and participate in ACO agreements by 2014. As of 2014, ACO physicians had lower billed utilization levels across a range of measures both in total and on the margin per beneficiary. The next section provides additional detail on how data on ACO governance and internal incentives were collected and defined.

Table 2. Physician Summary Statistics, 2014

	All Physicians		Non-ACO Physicians		ACO Physicians		Sig. Diff.?
	Mean	SD	Mean	SD	Mean	SD	
Total MDs in Office	11.3	28.6	10.9	27.0	14.0	36.1	***
Total MDs in Group/System	326.6	743.2	288.4	758.1	539.9	610.5	***
Primary Care	30%	46%	28%	45%	42%	49%	***
Surgeon	27%	45%	28%	45%	26%	44%	***
Internal Medicine Sub.	18%	39%	19%	39%	14%	35%	***
Hospital Specialties	24%	43%	25%	43%	19%	39%	***
System Integration	38%	49%	33%	47%	68%	47%	***
Total Services	3,960	18,008	4,151	19,009	2,890	10,759	***
Total Unique Bene.	449.6	678.6	459.5	697.4	394.1	558.8	***
Total Part B Payments (Thousands)	$140.9	$266.5	$146.3	$278.2	$110.9	$185.2	***
Service Per Bene.	8.3	34.4	8.6	36.2	6.8	21.7	***
Payment Per Bene.	$329.45	$534.87	$336.70	$559.91	$288.94	$361.63	***
Unique Physicians	392,400	392,400	332,897	332,897	59,503	59,503	

* p<0.05, ** p<0.01, *** p<0.001

Source: 2014 SK&A OBP file, 2014 Medicare Physician and other Supplier PUF.

Construction of ACO Characteristic Variables

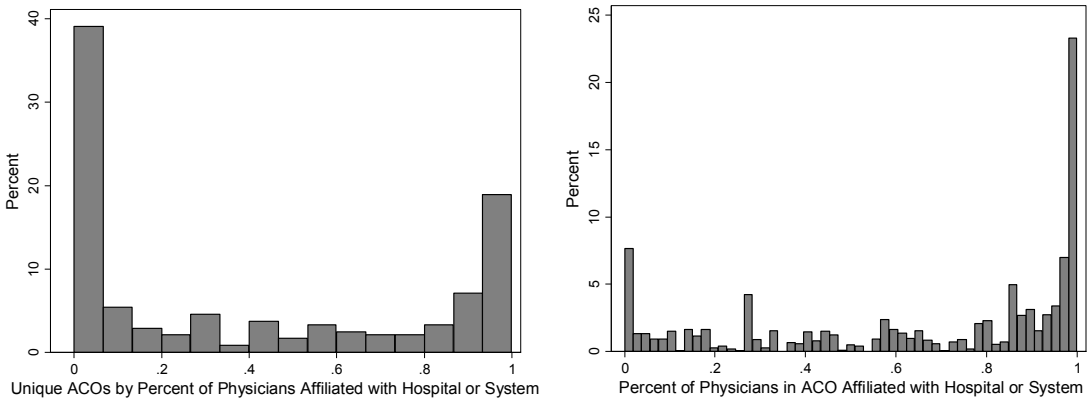
This section describes two typologies of ACO contracts to be used as separate treatment groups in analysis. First, I describe the creation of ACO governance variables based on the noted importance of such features in the literature (Shortell et al., 2015). Next I detail new data collection on the internal incentives provided to physicians participating across 193 ACO agreements, which is publicly reported and scraped from ACO websites.

Characterizing ACOs by Shortell et al. (2015) Typology

Shortell and coauthors distinguish between smaller, physician-led ACOs versus those jointly-operated with hospitals or overseen by an integrated health system. This categorization has been validated in the literature (McWilliams et al., 2015, 2016) as well as in self-reported composition MSSP program ACOs (CMS, 2015). A recent CMS brief on MSSPs notes that 56% of such ACOs include networks of individual practices, 37% include group practices, 34% include hospital/professional partnerships, and 25% include hospital-employed physicians (2015).

Figure 6 below shows two clusters of system participation in ACOs using this analysis' primary analytic sample of all physicians. I define two mutually exclusive categories based around the thresholds of 20% and 80% system affiliation (defined from SK&A) among physicians in the ACO. Some ACOs (and 42% of ACO participating physicians) have little to no system or hospital involvement. Others are nearly or exclusively operated by hospitals and health systems (26%). The remainder fall somewhere between, with joint participation in the ACO across multiple types of providers (32%). I find that physician-led ACOs tend to be smaller in term of beneficiary enrollment compared to the other forms, consistent with findings from Shortell (2015). Looking at a subset of data where enrollment information is available, early physician-led ACOs participating in the MSSP program had a median organizational enrollment of 9,814 beneficiaries compared with median enrollment of 13,314 for jointly led MSSP ACOs and 20,982 for system-led MSSP ACOs.

Figure 6. Distribution of ACOs and ACO-Affiliated Physicians by Health System Share



Source: 2014 SK&A OBP file and 2014 CMS Physician and Other Supplier Aggregate file.

Characterizing Shared Savings Distributions (Internal Incentives) by ACOs

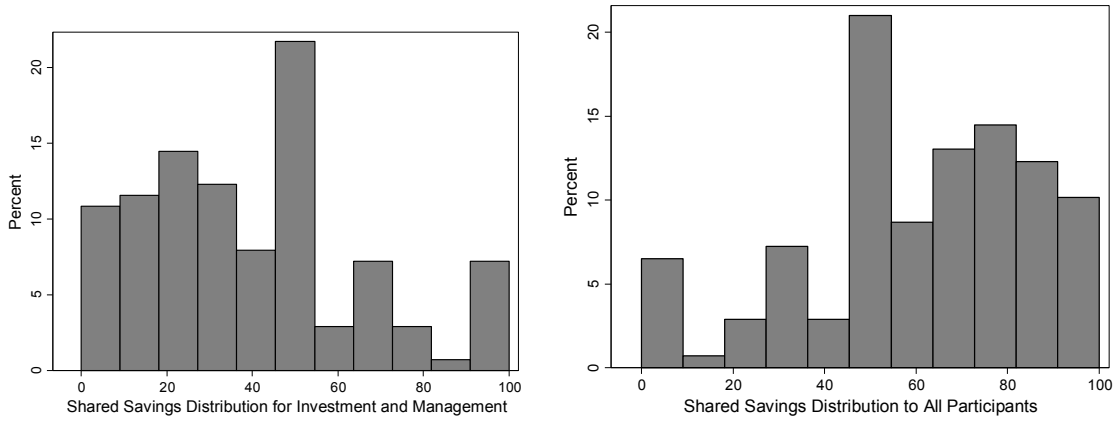
New data collection was completed by the author to scrape public websites for a sample of ACOs (primarily the first three cohorts of MSSP ACOs) to identify how each ACO distributes shared savings to provider participants. While non-profit hospitals participating in ACOs are required to receive proportional ratios of shared savings (discussed below), other ACOs are given full flexibility on how, and if, shared savings bonuses are distributed to ACO participants. While significant variation exists across actual compliance with reporting, ACOs are required to make a public disclosure available on their websites listing distribution of savings, typically across five categories:

- Proportion invested in infrastructure
- Proportion invested in redesigned care processes/resources
- Distribution to ACO primary care physicians
- Distribution to ACO specialists
- Distribution to ACO hospitals

Completed web scraping has identified the distribution of shared savings across 138 organizations participating in the MSSP program. An additional 55 ACOs were identified as not publicly reporting the distribution of shared savings, explicitly stating either that such decisions were to be decided or were not available. Of the sample 209 MSSPs for which such data was

sought, shared savings policies could not be found for 16 ACO contracts (representing a 7.6% error rate); an additional 13 cases were completed using a web archive from 2014 due to the ACOs listed website being no longer active. Ultimately, 7 of the identified ACOs were excluded from the final analysis, 2 of which were in fact identified to disclose shared savings distributions.

Figure 7. Distribution of ACO-Affiliated Physicians by Internal Incentives



Source: 2014 SK&A OBP file, 2014 CMS Physician and Other Supplier Aggregate file, author's self-collected data on ACO distributions.

Substantial variation exists across ACO composition with respect to the level of shared savings internally distributed to physicians, although this is generally positively correlated with ACO status as physician-led. Physician-led ACOs on average distributed 29.5 percent of shared savings to primary care physicians, while system-led ACOs on average distributed 26.1 percent. System-led ACOs were more likely on average to distribute a greater share of shared savings bonuses to participants, with physician-led ACOs more likely to reinvest or allocate the bonuses to reinvestment for infrastructure or payments for management.

Although results are robust to several categorical definitions, review of summary statistics led to creation of four categories of treatment: ACOs with low internal incentives (0 – 19% of distributed bonus payments) for physicians, those with moderate internal incentives (20 – 80%), those with

high internal incentives (81 – 100%), and those for which the information was not publicly reported. Approximately 25% of physicians participating in ACO contracts with scraped internal incentive data fell into the unreported category. A review of the ACOs in this category highlight that many are associated with for-profit management companies known as population health services organizations (PHSOs). Additional institutional detail on these organizations is reviewed in a later section of this chapter.

Results

This section presents results of empirical analyses on Medicare ACOs. First, I show how ACO contracts reduce per capita utilization and payment for physician services. This effect is heterogeneous, with ACO contracts increasing primary care while reducing specialty care. This difference is related to the next set of results, which detail how ACO contracts have heterogeneous effects on per capita aggregate utilization due to varying organizational designs. Furthermore, ACOs will heterogeneously affect types of services based on the value of the service with respect to total costs of care and the ACO's quality goals. Specifically, I show that ACO contracts reduce the provision and intensity of evaluation and management services while increasing per capita administration of specific cardiac tests and imaging. Finally, I present results showing the relevance of shared savings distributions for system-led ACOs; physician-led ACOs do not appear to require these specific incentives to generate significant cost savings.

Changes in Treatment Intensity and Patient Mix Following Medicare ACO Adoption

Analyses begin with a series of generalized difference in differences regressions on outcomes defined from data at the physician – year level related to changes in per capita treatment intensity and patient panel selection (e.g. patient mix). No significant changes were detected in physicians' Medicare panel size of unique beneficiaries. However, consistent with ACO program goals, negative and statistically significant average treatment effects on Part B Medicare payments and services are estimated in total (columns 2 and 3) and on a per beneficiary level (columns 4 and 5)

for participating doctors. While marginal decreases of approximately $7 on a per beneficiary level may seem small, estimated total annual reductions of -$1990 (stat. sig. at a 10% level) indicate meaningful changes by ACO-participating doctors.

Table 3. DID Results Across Aggregate Utilization and Marginal Treatment Measures

	Aggregate Utilization Measures			Marginal Treatment Measures	
	Total Unique Bene.	Total Part B Payments ($)	Total Services	Part B Payments Per Bene.	Total Services Per Bene.
ACO Treatment * Post	-0.03	-1990.07	-451.39**	-7.83***	-0.74***
2013	2.98***	-929.92***	21.09	-1.70**	0.11**
2014	-4.04***	-2,236.52***	273.04***	-0.44	0.62***
Constant	512.60***	143,469.14***	3,755.76***	331.09***	7.78***
Fixed Effects	NPI	NPI	NPI	NPI	NPI
R2	0.91	0.92	0.96	0.88	0.92
Unique Physicians	392,400	392,400	392,400	392,400	392,400
N	1,177,200	1,177,200	1,177,200	1,177,200	1,177,200

** p<0.05, ** p<0.01, *** p<0.001*

Source: 2014 SK&A OBP file, 2012-2014 Medicare Physician and other Supplier PUF. Standard errors clustered at the primary care service area (PCSA) level.

Changes in Treatment Intensity by Specialty Type

Consistent with ACO program goals, negative and statistically significant average treatment effects on Part B Medicare payments and counts of services are estimated on a per beneficiary level (columns 1 and 4 in Table 4) for participating doctors. Consistent with predictions that ACO contracts will increase provision of higher-value services, per capita primary care payments and services increase following ACO adoption while specialty care per capita is reduced, where over-use of services due to grey-area medicine (Chandra and Skinner, 2012) is more common.

Table 4. DID Results Across Aggregate Per Capita Utilization Measures

Dep. Variable	Part B Payments Per Bene.			Total Services Per Bene.		
	All Physicians	Primary Care Physicians	Specialists	All Physicians	Primary Care Physicians	Specialists
ACO Treatment * Post	-7.83***	2.48*	-14.56***	-0.74***	0.03	-1.12***
	(1.95)	(1.08)	(3.06)	(.13)	(.05)	(.20)
2013	-1.70**	-1	-1.99**	0.11**	0.01	0.15**
	(.53)	(.56)	(.72)	(.03)	(.02)	(.05)
2014	-0.44	-1.57*	0.04	0.62***	-0.08**	0.92***
	(.76)	(.74)	(1.03)	(.06)	(.03)	(.08)
Constant	331.09***	263.39***	360.47***	7.78***	6.53***	8.30***
	(.40)	(.37)	(.55)	(.03)	(.01)	(.04)
Fixed Effects	NPI	NPI	NPI	NPI	NPI	NPI
R2	0.92	0.87	0.92	0.88	0.88	0.88
Unique Physicians	392,400	118,977	273,423	392,400	118,977	273,423
N	1,177,200	356,931	820,269	1,177,200	356,931	820,269

** p<0.05, ** p<0.01, *** p<0.001*

Source: 2014 SK&A OBP file, 2012-2014 Medicare Physician and other Supplier PUF. Standard errors clustered at the primary care service area (PCSA) level.

Physician Response Varies by Organizational Characteristics

Table 5 replicates the regressions from the previous table, now separately specifying treatment effects by ACO organizational governance or internal incentives (distribution of shared savings bonuses), respectively. Specialists in physician-led ACOs are found to respond significantly more to the contract change, while primary care physicians in system-led organizations show the largest (and only statistically significant) increases in per capita payments.

Table 5. Triple Difference Results Across Aggregate Per Capita Utilization Measures by ACO Type

Dep. Variable	Part B Payments Per Bene.			Part B Payments Per Bene.		
Physician Type	All Physicians	Primary Care Physicians	Specialists	All Physicians	Primary Care Physicians	Specialists
ACO * Post * System-Led	-6.38***	3.07**	-11.02***			
	(2.33)	(1.32)	(3.29)			
ACO * Post * Jointly-Led	-8.38**	0.55	-15.31**			
	(3.83)	(1.96)	(6.54)			
ACO * Post * MD-Led	-12.27**	2.83	-33.60**			
	(5.62)	(2.22)	(13.25)			
ACO * Post * Low Internal Incentives				2.27	5.79**	0.21
				(2.90)	(2.78)	(4.00)
ACO * Post * Medium Internal Incentives				-4.57*	2.19	-9.09**
				(2.55)	(2.20)	(3.56)
ACO * Post * High Internal Incentives				-0.72	5.79**	-4.61
				(3.15)	(2.42)	(4.55)
ACO * Post * Unreported Internal Incentives				-26.06***	-4.3	-40.98***
				(6.69)	(3.22)	(11.33)
2013	-1.71***	-1.00*	-2.02***	-1.71***	-0.93*	-2.06***
	(.54)	(.56)	(.72)	(.53)	(.56)	(.72)
2014	-0.44	-1.57**	0.04	-0.68	-1.41*	-0.37
	(.76)	(.74)	(1.03)	(.75)	(.72)	(1.01)
Constant	331.11***	263.42***	360.53***	330.89***	263.51***	360.19***
	(.41)	(.37)	(.56)	(.39)	(.38)	(.54)
Fixed Effects	NPI	NPI	NPI	NPI	NPI	NPI
R2	0.92	0.87	0.92	0.88	0.88	0.88
Unique Physicians	392,400	118,977	273,423	392,400	118,977	273,423
N	1,177,200	356,931	820,269	1,177,200	356,931	820,269

** p<0.05, ** p<0.01, *** p<0.001*

Source: 2014 SK&A OBP file, 2012-2014 Medicare Physician and other Supplier PUF. Standard errors clustered at the primary care service area (PCSA) level.

Physicians in ACO contracts with medium level of performance incentives outperformed both those in both high and low incentive categories. Interestingly, ACO contracts which did not publicly report (and/or have not yet determined) internal incentives were the most effective in reducing per capita payments, particularly for specialists.

Physician Response Varies by Treatment Type

The next series of regressions use BETOS services categorization to aggregate data on annual reimbursement for specific service codes into clinically relevant measures. For narrative convenience, this may be presented chronologically to a patient encounter with a physician. First, physicians typically bill an evaluation and management code (E&M) once per beneficiary per day of treatment. Table 6 highlights that on this extensive margin, specialist physicians in ACOs are reducing office visits for established patients (column 2) while not limiting access for new patients (column 1). The next five columns present effects on per capita spending related to the visit intensity (typically based on the number of minutes spent with the patient) across established patient visits. Specialists reduce per capita provision of mid-level visits lasting app. 15 or 25 minutes rather than short (app. 5 or 10 min.) or long (app. 40 min.) patient encounters.

Appendix Table 19 presents similar findings for primary care physicians. Consistent with predictions that ACO contracts will incentivize higher-value care, primary care physicians reduce established patient visits and in particular longer visits (25 min.) while also increasing shorter office visits (10 minutes or less) as well as preventive care appointments known as annual wellness visits.

Table 6. DID Results Across E&M Service Categories for Specialists

	E&M Office Visits By Patient Type		E&M Office Visits By Visit Intensity (Visit Time) (for Est. Patients)				
	New	Established	5 Min.	10 Min.	15 Min.	25 Min.	40 Min.
BETOS/CPT Code	M1A	M1B	99211	99212	99213	99214	99215
ACO Treatment * Post	-0.17	-1.90***	0	0.15	-1.01***	-1.42***	0.25
	(.20)	(.36)	(.12)	(.15)	(.22)	(.35)	(.66)
2013	-0.55***	1.26***	-0.14***	-0.48***	0.05	0.98***	-0.89***
	(.04)	(.10)	(.04)	(.04)	(.07)	(.11)	(.25)
2014	-1.02***	4.46***	-0.50***	-0.61***	1.40***	3.99***	0.24
	(.05)	(.15)	(.06)	(.06)	(.10)	(.15)	(.31)
Constant	23.78***	69.44***	2.93***	8.40***	30.99***	42.52***	27.79***
	(.03)	(.08)	(.03)	(.03)	(.05)	(.08)	(.17)
Fixed Effects	NPI	NPI	NPI	NPI	NPI	NPI	NPI
R2	0.91	0.95	0.94	0.95	0.94	0.93	0.93
Unique Physicians	138,623	159,677	14,751	58,420	135,511	120,890	43,495
N	415,870	479,031	44,254	175,259	406,532	362,670	130,485

* p<0.05, ** p<0.01, *** p<0.001

Source: 2014 SK&A OBP file, 2012-2014 Medicare Physician and other Supplier PUF. Standard errors clustered at the primary care service area (PCSA) level.

In addition to billing Medicare for the E&M visit, physicians will further be reimbursed for all procedures and services completed during the appointment. Physicians participating in early ACO programs were found to significantly increase per beneficiary provision of treatments across advanced imaging, cardiac testing, and other advanced tests. Not presented are results, consistent with expectations, showing no significant effect on payment per beneficiary across the nine procedural categories defined in the BETOS typology. Appendix Table 20 highlights key

effects of ACO adoption on reimbursement across these affected services for specialists. Significant increases in cardiac testing are driven primarily by increases in “Cardiac Stress Tests” (T2B) and “Other Cardio. Tests” (T2D). Significant increases in advanced imaging are related to increased non-brain imaging scans of the body (I2B, I2D) for both CT and MRI.

While a second objective of Medicare ACO contracts is to monitor and improve quality, it is unclear to what extent ACO adoption affects quality promotion behavior among physicians. As a final use of the procedure code data, measures of marginal reimbursement per beneficiary for multiple preventive services were considered as possible ACO outcomes. These analyses find limited effects of ACO adoption on the marginal administration of most preventive treatments; notable exceptions include increased reimbursement to ACO-participating physicians for annual wellness visits, seasonal flu vaccines, and diagnostic colonoscopies (data not presented). Additional analyses not presented found no significant effect differences by type of ACO in changes related to marginal preventive care across the various other services defined in Appendix Table 17. This is accompanied by an increase in some, and no estimated decrease, across several high cost, high volume procedures developed following Austin and Baker (2015). Significant results may be related to the specific quality measures of ACO contracts. However, results suggest physicians do not respond to ACO contracts by significantly changing their practice styles toward preventive care as way to improve overall care quality.

Organizational characteristics affect physician responses in treatment choice as well. Appendix Table 21 presents results employing the triple difference interaction variables to separately estimate the effects of adopting either a physician group led or health system led ACO contract. Total annual payments for several categories of evaluation and management (E&M) visits occurring in office, inpatient, and post-acute settings are presented. While a general effect across ACO types is significantly estimated for decreased marginal office visits for established patients, distinct patterns between the organizational types emerge in other cases. Only system-led ACOs significantly decreased reimbursement per beneficiary for new office visits; conversely physicians in such organizations all received higher marginal reimbursement for initial hospital visits. Only

physician-led ACOs, those with little or no financial stake in hospital profitability, were effective in reducing inpatient E&M spending per beneficiary for subsequent and critical care visits.

For System-Led ACOs, Internal Incentive Payments to Physicians Appear Necessary

Finally, results highlighting that while the distribution of shared savings bonuses was only weakly significant in general, clear effects are more evident when stratifying by ACO governance. These results are shown in Appendix Table 22. Such payment schemes are a priori expected to be more impactful in systems and jointly-led ACOs; under a physician-led ACOs physicians are often owners of the organization and residual claimants regardless of performance due to ownership. For integrated health systems, distributing some but not all shared savings to physician participants appears optimal; while the point estimate for the high incentive category is also negative the effect is not statistically significant. Interestingly, estimated effects for those ACO contracts where internal incentives are not publicly disclosed continue to be high and strong across governance types; physician-led ACOs with unreported incentive schemes reduced spending by approximately $101 upon joining the ACO.

Changes in Referral Patterns Following Medicare ACO Adoption

To further explore mechanisms for unintended increases in volume and per capita reimbursement within ACOs following adoption of such payment models, I identify a consistent panel of 92,247 primary care physicians (PCPs) found to refer Medicare beneficiaries to specialists from 2010 – 2014 using both public use referral data and the SK&A physician file (for firm and ACO organizational affiliations). Approximately 20.5% of primary care physicians were found to enter an ACO that started during this period. Results from two referral-related outcome variables are presented in Table 7: total annual referrals to specialists and the share of self-referrals to all referrals. The latter variable was defined by dividing the number of specialist referrals to members of one's own group or health system (as defined by SK&A) by the total referrals to all providers. Two specifications analogous to those used previously are employed. The first estimates the average treatment effect (columns 1 and 2) and the second presenting results with triple

difference interactions (columns 3 and 4) included to separately estimate adoption effects on physicians in physician-led versus system-led ACOs.

Difference in differences regressions fail to find a robust, significant effect of general Medicare ACO participation on total specialist referrals by PCPs as shown in the first column of Table 7. However, as shown in the second column, physicians are significantly more likely to refer patients to specialists within their own organization upon ACO adoption. With the average ACO PCP referring 26.6% of specialist visits to members of their own organization, the estimated effect of a 1.1% annual increase is both plausible and nontrivial.

Repeatedly highlighting the importance of ACO financial alignment and governance, the last two columns of Table 7 show significantly different effects on referral behavior following adoption of a physician or system-led ACO contract. While participation in the former appears to prompt PCPs to reduce referrals both generally and within their firm, results indicate that hospital or health system-led ACOs significantly increase both total specialist referrals as well firm self-referral rates. With the opposing effects for physician-led ACOs separately estimated in the interaction term, the general effect of ACO adoption increases and becomes statistically significant. With an average of 3029.5 referrals by ACO PCPs to specialists in 2014, estimates of the change in marginal referrals for each of the ACO organizational types are all economically significant. Appendix Table 24 presents the triple difference specifications from Table 7 across a range of specialist types that primary care physicians to which may refer patients. While such subgroup analyses are individually interesting, the repetition of similar results is a useful robustness check for the analyses generally.

Table 7. DID Results for PCP to Specialist Referrals for Physician vs. System Led ACOs, 2010 - 2014

Specification	DID Estimates		Triple Difference Estimates	
Dependent Variable	Total Annual Referrals	Self-Referral Share	Total Annual Referrals	Self-Referral Share

ACO Treatment*Post	47.3	0.011***	84.5*	0.004
ACO * Post * System-Led			128.0*	0.024***
ACO* Post * Physician-Led			-311.8***	-0.009**
2011	-3.2	0.008***	-2.9	0.008***
2012	-143.0***	0.017***	-142.1***	0.017***
2013	-385.9***	0.026***	-386.3***	0.026***
2014	-699.6***	0.030***	-699.2***	0.030***
Constant	4087.2***	0.153***	4087.2***	0.153***
Fixed Effects	NPI	NPI	NPI	NPI
R2	0.894	0.928	0.894	0.929
Unique Physicians	92,247	92,247	92,247	92,247
N	461,235	461,235	461,235	461,235

** p<0.05, ** p<0.01, *** p<0.001*

Source: 2014 SK&A OBP file, 2010-2014 Medicare Physician Referral Data PUF. Standard errors clustered at the primary care service area (PCSA) level.

Referrals to Inpatient and Post-Acute Providers

In below results, I next show significant increases in primary care physician referrals out to hospitals and post-acute providers following ACO adoption by system-led and jointly-led organizations. This is consistent with recent findings from McWilliams, Grabowski, and coauthors (2017) on the effects of ACOs on post-acute care. Consistent with previous results, Table 8 shows only physicians in physician-led ACOs significantly reduced referrals to inpatient and post-acute providers following contract adoption. Estimated an average treatment effect across all ACO contracts, statistically significant results shown in Appendix Table 25 show that ACO-adopting physicians also increased referrals to outside lab providers upon adoption.

Table 8. Triple Difference Results for PCP to Organizational Provider Referrals for Physician vs. System Led ACOs, 2010 - 2014

Dependent Variable: PCP "Referrals Out" to Provider Type				
Provider Type	Acute Care Hospital	Home Health	Skilled Nursing Facility	Labs
ACO * Post * System-Led	130.767***	-3.162	20.892	6.287
ACO* Post * Physician-Led	-90.697***	-13.917**	-13.335	34.135
ACO* Post * Joint-Led	32.502	10.321**	15.359	23.332
2011	21.695***	-6.518***	-2.687	-28.543***
2012	23.857*	-11.715***	-22.997***	-67.268***
2013	-8.715	-19.986***	-56.191***	-93.184***
2014	-65.751***	-30.882***	-75.984***	-134.581***
Constant	1583.403***	220.021***	608.253***	987.642***
Fixed Effects	NPI	NPI	NPI	NPI
R2	0.803	0.836	0.914	0.873
Unique Physicians	116,493	58,222	41,662	101,231
N	582,465	291,110	208,310	506,155

** p<0.05, ** p<0.01, *** p<0.001*

Source: 2014 SK&A OBP file, 2010-2014 Medicare Physician Referral Data PUF. Standard errors clustered at the primary care service area (PCSA) level.

Policy Implications and Counterfactuals

Policy Implications

Criticisms of current ACO designs include an over-reliance on hospitals for generating savings, likely conflicts preventing hospital-physician collaboration, generally weak incentives, lack of patient involvement, and the possibility of cost-shifting to commercial payers due to increased integration. Due to these problems with the current ACO program designs, Goldsmith proposes a

payment model with separate payments and incentives provided for long-term, low-intensity primary care, and urgent/emergency care (2011). The latest Medicare alternative payment models, including the Next Generation ACO, Advance Payment ACO, and the Comprehensive Primary Care Plus (CPC+) models appear to address many of these concerns. Future work will be able to provide insights into the importance of ACOs' specific designs on physician and firm behavior, holding market and organizational characteristics fixed.

With respect to treatment choice and organizational subgroup findings, results provide added insight. Regarding the former, no evidence was found of physicians reducing high-value services such as major procedures or new evaluation and management visits. Rather reductions in per capita utilization were found for less beneficial services such as mid-intensity repeat office visits. Whether this is due to ACO quality objectives, physician altruistic tendencies, or other factors such as reputation or liability concerns, it is reassuring from a program evaluation perspective that physicians were found to reduce services in ways less potentially harmful to beneficiaries' health. Further research is necessary to monitor for unintended consequences, for example due to free-riding behavior, in future ACOs.

Regarding organizational subgroup findings, results highlight the importance of physician governance, preferably by physician groups if not a physician group-hospital joint venture, in managing physicians' behavior within an ACO contract. Integrated health systems, where decision-making is unlikely to be well-centralized, appear less likely to succeed. For systems primarily, the transfer of some performance risk from the organization to individual physicians through the use of internal distribution of shared savings bonus payments appears beneficial to encourage desired cost savings.

These findings also point toward an additional typology of ACOs worth further consideration in future work. Two new organizational categories for evaluating the internal design (or strength) of ACO contracts are shown by my results: non-profit affiliated ACOs and for-profit management companies known as population health services organizations (PHSOs). The former is bound by

IRS regulation to only obtain a “fair share” of shared savings and more likely to be jointly-led; the latter is assumed to maximize profits, is more likely to be physician-led, and comprise over half of participating ACOs which do not publicly disclose internal shared savings distributions. These evolving forms are briefly described below.

Anecdotal reports indicate that many ACO providers, particularly those in physician-led ACOs, are turning to for-profit management companies known as population health services organizations (PHSOs). A review of public use Medicare data notes that one Universal American Corp. VP, Richard Kory, was the listed public contact and ACO executive for no less than 34 MSSP ACOs nationally. Such activities appear highly profitable for the PHSO; as a publicly traded firm Universal American reported two thirds of total income ($8.2 million) in the first half of 2016 stemmed from ACO management (Universal American Corp., 2016). Furthermore, the company claims to require an ownership stake (51%) in the assets of any ACO it operates (Fierce Healthcare, 2012). 48 total PHSOs identified in the data include MSSP contracts operated by Imperium Health (5), American Health Network (3), ApolloMed (2), Akira (2), and Walgreens (2) and started across four start dates from April 2012 to January 2014. Strategies employed by such firms vary, Imperium Health appears to partner mainly with system-led groups of providers while Walgreens, which recently exited the ACO market, focused on pharmaceutical management. While a more comprehensive review of shared savings distributions to members and strategies employed by PHSOs is necessary, initial review indicates that such organizations are much less likely to distribute shared savings to provider participants while also taking a greater role in practice management.

Conversely, profit and loss sharing by non-profit hospitals operating ACOs appears much more highly regulated in the distribution of shared savings bonuses internally to participants. Non-profit hospitals have received additional guidance from the Internal Revenue Service regarding participation in hybrid-organizations such as ACOs. Primarily, the IRS has directed non-profit participants in ACOs to not engage in anti-competitive behavior (e.g. through the use of “fair-market” rates to coordinating firms) and to require that shared savings/losses are distributed

proportionally such that they don't surpass the non-profit's proportional entitlement (Internal Revenue Service, 2016). Colla and coauthors (2016) show that most (~80%) of hospitals participating in ACOs are in fact non-profit, although as previously noted approximately 42% of ACOs are unaffiliated with any hospital or health system. Consideration of ACO physicians affiliated (as well as those fully integrated) with non-profit hospitals will thus be important subpopulations to consider moving forward, with different predictions for salaried physicians and those physicians only affiliated but not financially integrated with a non-profit.

Estimation of Total Savings and Counterfactuals

Ultimately, this research is interested not in current but optimal design of value-based, incentive contract reimbursement. To this end, I utilize the reduced form estimates from Table 3 and a sufficient statistic (Chetty, 2008, Chetty, 2009) from presented theory to consider counterfactuals. Historically, reduced form estimates have been critiqued as local average treatment effects endogenous to a policy regime (Lucas, 1976; Heckman and Vytlacil 2005) with counterfactual analysis typically requiring structural estimation of underlying market and firm primitives, often by fairly strict assumptions. Work over the past decade in the public economics and labor literatures have introduced broadly applicable methods for welfare analysis that, unlike structural work, may utilize reduced form estimates with limited assumptions (Chetty, 2008, 2009). Specifically, the principal-agent model presented in the theory section highlights a basic sufficient statistics $\frac{\partial Costs}{\partial ACO}$ that I may use to make statements about welfare.

In terms of estimated total savings, topline results indicate an estimated reduction of $7.83 per year, across 59,503 physicians in ACO contracts, who have an average annual per capita spending of $361.63. Across mean patient panels of 394 beneficiaries, this represents total estimated aggregate savings of approximately $183.57 million dollars. This is a plausible result; Medicare itself estimated 2014 savings across all ACOs at $411 million (with $422 million in bonus transfers to just 97 ACOs) across all services, including Part A inpatient care on which this analysis lacks data. That figure is also estimated through benchmarks; so, $183 million in savings

from reductions in physician services is convincing given $411 million as a reasonable upper bound.

With physician services captured by my data representing 16.2 percent of the traditional Medicare payments of $441.78 billion (such that $71.56 billion is made toward physician services) (Kaiser Family Foundation, 2015), estimated savings represent only 0.26 percent of total annual expenditures in 2014 on physician services. To the extent that providers reveal an ability to generate savings through continued participation in ACO contracts, economic theory implies that cost savings and social welfare gains will accrue. As participation in Medicare ACOs continues to grow in adoption, additional savings are expected *because* participation is voluntary relative to a lower risk, fee-for-service baseline. Policy changes to strengthen the design and incentives of ACO contracts will also encourage larger responses. For example, currently only 42% of physicians in participating ACOs are in the more successful physician-led organizations. With estimated savings for this ACO governance type at a higher per capita effect of $12.27 in reduced spending per participating physician, this implies physician-led ACOs alone are responsible for $120.8 million in estimated reductions (app. two thirds of the total effect on physician services).[12] While more rigorous consideration of counterfactuals will be helpful, it is interesting to note that a population of only 25 thousand physicians in physician-led ACO contracts generated such significant savings. Medicare, should it choose, would have little problem doubling physician enrollment in such payment models. This is notably already being done through specific physician-focused ACO models, namely the previously noted CPC+ alternative payment model which seeks to enroll up to 5,000 practices into primary-care centered ACO-type contract featuring a combination of fee-for-service and capitation-based payments.

[12] Note that neither of these aggregate estimates reflect the economic value of any quality improvements brought on by organizations' pursuit of quality measures under an ACO contract.

Discussion

Presented analyses in Part III seek to demonstrate the role of physician decisions and organizational form in the success and failure of ACO contracts. I show heterogeneous, economically significant responses to ACO adoption by physicians in terms of marginal treatment intensity and, to a lesser extent, patient panel selection. Given the free choice of providers by beneficiaries under Medicare and documented increases in specialist referrals by ACO PCPs, the weaker evidence of selection is not surprising. Furthermore, data restrictions limit the work from identifying differences in treatment between ACO-affiliated patients and those unaffiliated. While anecdotal evidence suggests that early ACOs were unable to cleanly determine such a difference due to retrospective attribution, presented results may be lower-bound estimates of effects on attributed patients if this is not the case. Results reflect the importance of large physician groups and integrated health systems in development of ACOs, as well as the importance of market structure in terms of primary care physician integration with health systems and specialists. In the case of ACOs, discussion of clinical integration is often synonymous with financial integration. Whether the benefits of the former outweigh the negative effects of decreased competition in ACO markets is yet to be shown. However, ACO contracts that appear to do both are able to reduce both per capita spending and service utilization.

Future research is well positioned to evaluate the effects of value-based designs in physician markets. Further characterizing the various vertical relationships between primary care physicians, specialists, and inpatient providers will be an important aspect of this work. Within ACOs, Mostashari and coauthors have noted that physicians, and in particular primary care physicians, have stronger financial incentives than hospitals or health systems to reduce health care costs outside of their physician group (Mostashari, Sanghavi, and McClellan, 2014). Indeed, criticisms of current ACO designs include an over-reliance on hospitals for generating savings, likely conflicts preventing hospital-physician collaboration, generally weak incentives, lack of patient involvement, and the possibility of cost-shifting to commercial payers due to increased integration. Due to these problems with the current ACO program designs, Goldsmith proposes a

payment model with separate payments and incentives provided for long-term, low-intensity primary care, and urgent/emergency care (2011). The latest Medicare ACO models, including the Next Generation ACO, Advance Payment ACO, and the Comprehensive Primary Care Plus (CPC+) models appear to reflect many of these concerns. Presented research provides further insights into the importance of ACOs' specific designs on physician and firm behavior, holding market and organizational characteristics fixed. Understanding how health systems and ACOs manage the array of incentives and disincentives presented to them, sometimes referred to as polarity management (Burns, 1999), will likely be an important factor in explaining ACO program outcomes. Medicare spending per beneficiary for physician services increased by 67 percent from 2000 to 2013, far surpassing growth in Medicare spending due to increases in reimbursement prices or inflationary adjustments. Findings highlight the promise of the ACO approach to limit health care utilization while underlining potential unintended consequences for treatment choice and ongoing antitrust concerns. Results are relevant not only to policy makers, but also the patients, providers, and insurers increasingly participating in such arrangements and will inform the ongoing development of both public and commercial alternative payment models.

CHAPTER 4: Commercial ACO Designs: Evidence from Three National Payers

Does adoption of Accountable Care Organization (ACO) type contracts by commercial insurers, which reimburse providers conditionally on quality and cost benchmarks, affect physician treatment behavior and subsequent patient outcomes? By what mechanisms may physician behavior change and care quality improve? Presented research is positioned to answer such questions using a unique analysis file combining physician-level commercial ACO identifiers by zip code with commercial claims data from a consortium of three top U.S. insurers. Commercial claims data were accessed through the Health Care Cost Institute (HCCI), a non-profit organization partnering with Aetna, Humana, and United Healthcare to share claims data with researchers.

Introduction

Over the past fifteen years, industrial organization and health economists have made major contributions in understanding the role of health care provider competition and provider-insurer bargaining on price determination in health care. (Town and Vistnes, 2001; Capps, Dranove, and Satterwaite, 2003; Ho, 2009). Less clearly understood is how providers determine the quality of care provided to patients. Policy reforms have in general taken two approaches to further incentivize quality in health care markets: service-specific changes in reimbursement such as pay-for-performance schemes or readmission penalties and transition to capitated payments based around specific ACO type contracts (Doyle, Graves, and Gruber, 2015). Initial evidence highlights the potential for ACOs and other total cost of care (TCOC) contracts to improve quality of care, patient satisfaction, and, in some cases, constrain costs (McWilliams et al., 2015; Song et al., 2014; Nyweide et al., 2015). However, it is not known what specific changes in behavior by physicians, if any, are driving these early results. This work contributes to this literature by showing that while commercial ACOs are estimated to increase overall payments, payments per patient, and units of service per patient provided by specialists, such contracts are able to significantly shift important aspects of patient care away from elective and discretionary services

including specific specialist procedures, imaging, and testing. After broadly reviewing effects across various specialist services following commercial ACO entry, I focus on the estimated effects of ACO contracts in two categories: discretionary services and radiation oncology treatment.

While it is increasingly understood how providers and insurers negotiate prices, how provider organizations set the level of quality (i.e., the mix of services) provided is significantly less understood (Gaynor and Town, 2012). Such "quality" selection is likely endogenous to the competitive environment and thus to underlying prices and payment models. However, I propose that physician's recent exposure to newly implemented Medicare and commercial ACO arrangements are significant shocks to identify how physicians make marginal treatment decisions in response to changes in reimbursement incentives. Underlying the validity of such policy instruments are assumptions that providers do not cost-shift in response to financial shocks, that quality levels are endogenously set on average across payer types, and that reimbursement based on quality by one payer affects the aggregate returns to quality (i.e. that quality is at least partially set on average across patients). Results from this work estimate that while specialists participating in commercial ACO contracts increase both total reimbursement and units of service provided, no significant changes are evident in terms of per patient spending or service provision. Instead, commercial ACO contracts reduced utilization of discretionary, elective medical services such as hip and knee replacements, ambulatory and minor procedures, basic and advanced imaging, and radiation therapy for prostate cancer.

Background

Commercial ACO designs in their early development have introduced various, often idiosyncratic designs (Health Affairs Blog, 2014). A push is underway for payers to streamline quality measures and incentive contracts. However, to the extent that commercial ACO contracts are the result of provider group-insurer bargaining, contract designs will likely continue to maintain some distinctiveness across markets.

Aetna, Humana, and United Healthcare (the three HCCI data contributors) are each known to operate ACOs associated with specific quality measures that physicians must meet to be eligible for shared savings bonus payments. Often, contacts are linked to National Quality Forum (NQF) or National Committee for Quality Assurance (NCQA) Healthcare Effectiveness Data and Information Set (HEDIS) measures. An insurance industry movement toward measure standardization is under way, with HCCI data contributor Humana recently reporting a drop to "202 key quality measures instead of 1,100". So, meaningfully aggregating and summarizing quality measures across specialty types and ACO goals (e.g. increased quality, increased access, reduced utilization) is difficult and prone to measurement bias. Qualitatively, reviewed quality measures typically employed across the three insurer's 96 commercial contracts considered in claims analysis appear to parallel estimated significant responses from physicians. For example, most if not all ACO contracts across the three HCCI payers have quality measures related to reduced emergency room utilization; such a reduction is significantly shown in results. Among these HCCI data contributors, examples of commonly reported quality measures of associated ACOs include (Health Affairs Blog, 2014, Bates White, 2015):

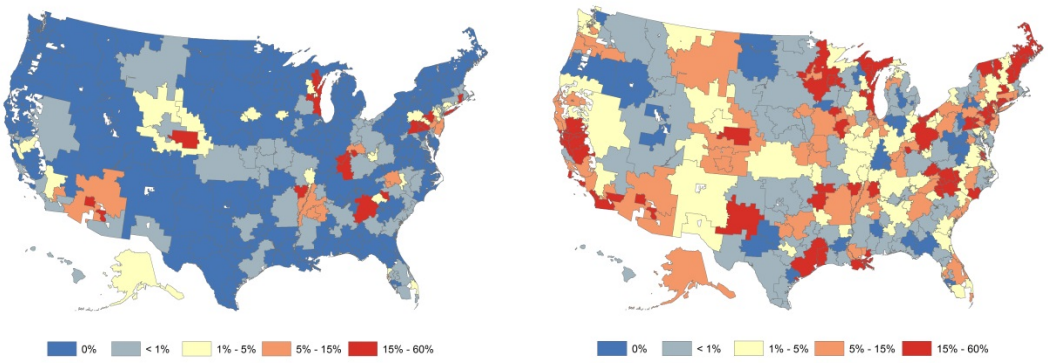
- Increased access to primary care physicians
- Better management of patients with chronic conditions like diabetes and heart failure
- Routine diabetes screenings and control of blood sugar
- Multiple metrics around care of patients with chronic asthma
- Decreased hospital readmission rates
- Reductions in "avoidable" hospital readmission rates
- Decreased emergency room visits
- Reductions in "avoidable" emergency room visits via expanded primary care access
- Increased patient satisfaction
- Percentage of beneficiaries receiving recommended screenings

Data

SK&A ACO Affiliations Data

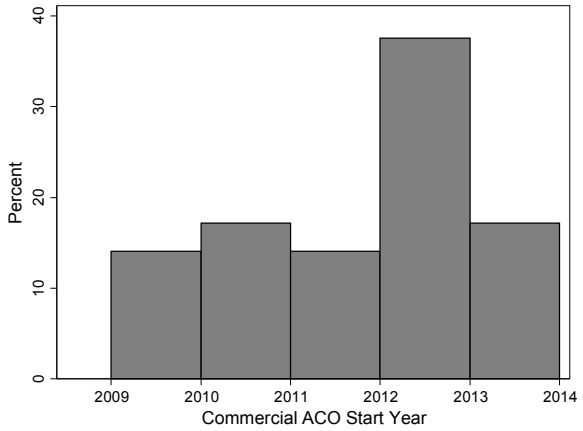
SK&A has collected a unique and valuable dataset of physician commercial ACO affiliations previously unavailable to researchers. 25 percent of all physicians are identified by SK&A as participating in either a Medicare or commercial ACO contract, with 9% of physicians affiliated with a commercial contract specifically. Approximately 25 thousand physicians are participating in one or more of the 96 ACO contracts affiliated with a HCCI data contributor (Aetna, Humana, UnitedHealthcare) present in the SK&A data. Figure 8 below provides detail on the geographic distribution of commercial ACO physician penetration rates at the HRR level for the primary treatment group of HCCI-contributor ACOs (left) as well as for all commercial ACOs (right).

Figure 8. HRR Penetration of HCCI-Contributor ACOs (left) and All Commercial ACOs (right)



This data set is supplemented by an additional custom data source collected for this research: start dates for each of the commercial ACOs featured in the empirical analyses of Part IV and Part V. These start dates are necessary for determining when commercial ACOs changed physician incentives and thus for identification of underlying causal effects; this is directly comparable to the identification strategy used with Medicare ACO start dates in Part III. While introduction of commercial ACOs has occurred fairly smoothly time, this distribution presented in Figure 9 shows that many commercial ACOs were started in 2012, simultaneously with the launch of the first Medicare ACO agreements in the Pioneer and MSSP programs.

Figure 9. Distribution of Sample Commercial ACO Contract Starting Years



HCCI Physician Services Claims Data

In primary analysis, HCCI claims were processed into physician-year level claims summaries for focus of the analysis and consistency with previous Medicare results. The raw claims file prior to aggregation to the physician-year level contains over 96 million observations representing 19.2 million physician-patient relationships (across any given year). From physician billing claims, treatment choice summary variables were constructed from HCPCS codes analogous to work presented previously in this dissertation using Medicare data. Outcome variables across multiple treatment categories were defined to generate measures of per treated enrollee (hereafter, per patient) per year spending on treatment categories such as specific procedures (using the BETOS and CPT categorizations), testing, and preventive services. All outcome variables are in the form of per patient per physician annual payment for the specific service. Paralleling previous analyses in Medicare populations, these variables are generate by dividing annual specialist reimbursement for services as specific as the procedure level by the total number of patients seen by the physician in that year. In this way and combined with physician fixed effects in regression, dependent variables measure physicians changing propensity to administer specific treatments on the margin.

A consistent data panel of physicians treating and being reimbursed for at least one adult member insured by an HCCI insurer in each available year (2010 – 2014) was assembled totaling 903,914 unique providers. Presented analyses focus on changes in behavior by specialists, with

restricting the sample to 601,050. Of this population, a consistent panel of 357,535 specialists billing to an HCCI insurer in each year from 2010 – 2014 was utilized in final analyses to reduce any biases from physicians churning in and out of commercial insurance networks. This large convenience sample of specialist physicians present in each year of HCCI claims were then mapped at the provider zip code level to ACO penetration rates to estimate treatment with an HCCI commercial ACO as described next.

Mapping SK&A ACO Affiliations to HCCI Physicians by Zip Code

To map 2014 ACO affiliations to the HCCI claims, a summary file at the zip code level was created. Commercial ACO contracts with physicians were identified using the nationally representative SK&A office-based physician file (fully described in Part 3). A zip code summary file was created from a final analysis file of 700,380 unique physician-zip pairs across 562,747 physicians.

Penetration rates for public, HCCI, and non-HCCI ACOs were each estimated by zip code using the shares of physicians (head counts) in the zip code participating in such a contract. In 61.2% of physician-zip pairs and for 78.9% of unique physicians in SK&A, the physician location was unique to a single zip code. Physicians practicing in multiple zip codes were counted toward the ACO penetration rate in each respective zip code; no full-time equivalent adjustments were made. Physician location-based (rather than merely physician-based) ACO affiliations were considered in the ACO penetration rates. In less than one percent of observations where physicians were listed at multiple locations in the same zip code, physicians were uniquely assigned to a single location within a zip code via a sorting rule based on location commercial ACO participation and larger office size. Partly to preserve claim anonymity and meet HCCI use requirements, this file listing commercial ACO penetration rates and respective entry dates for any Medicare and commercial ACOs (separating HCCI and non-HCCI affiliated) by zip code was then transferred to the HCCI server. Physicians present in the HCCI data were merged to ACO contract data by zip code; 97.7 percent of unique zip codes from SK&A matched to the HCCI data.

Defining Commercial ACO Treatment

Physician ACO assignment by zip code occurred when a given zip code had more than 50% of providers participating in such a contract. Due to anonymity of the three larger insurers in HCCI data, all patients of physicians participating in an HCCI-contributor ACO were assumed to be (or assumed to be treated by physicians) in that ACO. The inability to attribute patients to the ACO in this way may be a source of measurement error bias. However, such error generally biases against finding significant treatment effects of ACO participation. Significant results may thus be overly conservative. However, given that specific insurer's ACO entry within a zip code was mapped to physician services known to be reimbursed by the insurer in the same area, any such measurement error is expected to be relatively small. For example, if SK&A identify a United Healthcare ACO operating in a given zip code and this is confirmed in the merge to HCCI claims, the percentage of claims that are truly treated by the United Healthcare ACO is bounded at more than zero and up to one hundred percent.

The pre-aggregated SK&A analysis file use to make the zip code file was also used to consider the validity of defining ACO treatment for HCCI commercial ACOs and other types through zip code penetration rates based on SK&A physician counts. This check estimated that a zip-level assignment of ACO identification correctly assigned the true physician ACO affiliation for 87% of physicians in Medicare ACOs and 86% of those in all commercial ACOs. The smaller penetration of either HCCI-insurer affiliated ACOs and those associated with non-HCCI payers, respectively, led to higher accuracy rates of 96.5% and 92.7%.

For HCCI-insurer affiliated ACOs specifically, using a 50% share threshold resulted in 2.9% of physician-zip pairs being incorrectly not assigned to an HCCI zip (false negatives), while 0.6% of physicians-zip pairs were incorrectly assigned to an HCCI ACO (false positives). Empirical results in Part IV and Part IV are robust to alternative ACO treatment measures employing 10% and 25% thresholds. Utilizing "any ACO" penetration resulted in an overly high false positive rate; Medicare ACOs with any adoption by zip code in particular were found to have "treated" over 70% of observations using such a definition.

Summary Statistics

Summary statistics presented in Table 9 show appropriate analytic file construction and cleaning. I restrict presented analyses to specialist physicians only, excluding primary care physicians and general internists as defined by a specialty of family medicine or internal medicine. I define a consistent panel of specialists billing at least one service and receiving reimbursement from an HCCI insurer in each of the five years of the panel data. This results in a final analytic sample of 357,535 specialist physicians with 1.78 million physician-year observations.

While the majority of my results are robust to measures utilizing payments per patient for specific services, I mainly present results relating to service units rather than payments as an exogenous measure of marginal resource use not (or less) affected by endogenous market structure like negotiated commercial prices. To adjust for long distributional tails in unit counts and payments per patient, dependent variables in regression are the transformed natural log of claimed units per patient treated in a given year, in aggregate and for specific service categories. Specialists in my final sample were paid a mean total $71k annually by HCCI insurers, receiving an average payment per unique treated patient of $418 for 7.6 claimed service units. While such general measures of service utilization (total claimed units per patient) are often unhelpful, the use of NPI fixed effects in regression analysis allows for physician-adjusted unit counts allowing for unbiased comparisons.

Table 9. HCCI Commercial Payment and Claimed Units Summary Statistics

	Obs.	Mean	SD
Commercial Payments			
Total Commercial Payment	1,787,675	$71,006.5	$461,054.7
Natural Log of Total Payment	1,787,675	9.8	2.1
Total Payment Per Patient Treated	1,787,675	$418.0	$1,157.3
Natural Log of Per Patient Payment	1,787,675	5.4	1.3
Units			
Total Units Claimed	1,787,675	1519.8	34359.9
Natual Log of Total Units	1,787,675	5.7	1.7
Total Units Claimed Per Patient Treated	1,787,675	7.61	32.5
Natural Log of Per Patient Units	1,787,675	1.37	0.92

Source: 2014 SK&A OBP file, 2010-2014 HCCI Commercial Claims for physician services.

Methods

Methods employed in analysis of commercial ACOs are very similar to those used in the Medicare analyses (Part III) to ensure comparability of results. Utilizing physician-level commercial ACO assignment and controlling for observable physician characteristics (primarily through the use physician-level fixed effects), regression models employ the following generalized difference-in-differences (Bertrand, Duflo, and Mullainathan, 2004) specifications:

$$y_{it} = \bar{\beta} ACO * Post_{it} + \beta_t Year_t + \beta_i Physician_i + \varepsilon_{it}$$

Where the average treatment effect of commercial ACO participation $\bar{\beta}$, for a given outcome y_{ict} is well identified with every untreated physician in a specific year (including those later joining a commercial ACO) acting as controls for ACO adopting physicians participating in that year. So, physicians joining ACOs in 2014 act as controls for early adopters until the physician-year observation itself is treated. $\bar{\beta}$ will thus capture average annual treatment effect across the multiple start-dates and ACO cohorts. Such a specification is identical to a classical difference in differences approach except for the inclusion of a physician fixed effect ($Physician_i$) to control for static differences across individual physicians and related nonrandom selection into the ACO contract. Five years of commercial claims data across a national sample of physicians allow for such analyses while maintaining sufficient degrees of freedom; also note that neither the ACO cohort variables nor specific static physician characteristics (e.g. system integration) need be included in this regression due to perfect multicollinearity with the physician fixed effects (assigned at NPI level). Key outcome measures, y_{it}, similar to those used in Medicare analyses, include multiple metrics of treatment behavior and procedure utilization.

Recognizing that the potentially time-varying assignment of commercial ACO affiliation may introduce measurement error bias into results that is likely to vary across geographic markets, I cluster standard errors at the zip code level (with the number of zip code clusters utilized reported) in each regression sample presented in regression tables. Use of robust standard

errors without clustering does not change results but does improve the statistical confidence of many results.

Results

Results utilizing commercial HCCI claims are presented below after export from the HCCI server environment. Broadly, commercial ACOs appear to be successfully shifting specialist provision of services away from costly procedures and tests and toward increased evaluation and management both in outpatient and acute care settings.

Unlike work presented in chapter 3 on Medicare ACO contracts, physicians participating in the sampled commercial ACO contracts (representing entry of 96 different ACOs) did not significantly reduce per patient annual spending (measured by payments). These results are presented below in Table 10. Finding no significant effect on payments per members is not inconsistent with a conceptual framework where in a market with negotiated prices payers are not able to substantially alter equilibrium prices with the introduction of a new quality contract (unlike Medicare where prices are administratively set). Anecdotally, commercial ACOs often de-prioritize reductions in per capita payments to providers (or increase reimbursement rates) in order to promote physician participation in the contracts initially.

Table 10. Commercial ACO Effects Across Payments and Service Units

Dep. Variable	Natural Log of Total Commercial Payments		Natural Log of Claimed Units	
Transformation	Total	Per Patient	Total	Per Patient
ACO Treatment * Post	0.080***	0.006	0.068***	-0.005
	(0.02)	(0.011)	(0.019)	(0.007)
2011	0.121***	0.036***	0.087***	0.003***
	(0.004)	(0.002)	(0.003)	(0.001)
2012	0.189***	0.043***	0.152***	0.002*
	(0.005)	(0.003)	(0.004)	(0.001)
2013	0.220***	0.043***	0.181***	0.004***

	(0.006)	(0.003)	(0.005)	(0.001)
2014	0.139***	0.017***	0.113***	-0.009***
	(0.009)	(0.004)	(0.006)	(0.002)
Constant	9.64***	5.380***	5.636***	1.373***
	(0.004)	(0.002)	(0.003)	(0.001)
Fixed Effects	HNPI	HNPI	HNPI	HNPI
R2	0.89	0.89	0.87	0.88
Zip SE Clusters	12,940	12,940	12,940	12,940
Unique Physicians	357,535	357,535	357,535	357,535
N	1,787,675	1,787,675	1,787,675	1,787,675

** p<0.10, ** p<0.05, *** p<0.01*

Source: 2014 SK&A OBP file, 2010-2014 HCCI Commercial Claims for physician services.

Standard errors clustered at the zip code level.

ACO Contract Effects on Discretionary and Non-Discretionary Procedures

Despite a null effect with respect to total per patient provision of services, specialists in zip codes treated by commercial ACO contracts are estimated to broadly affect per patient treatment intensity in various care settings. This is most evident by a robust finding not presented that specialists are reimbursed less per patient for all procedures following entry of a commercial ACO contract. Table 11 and Table 12 seek to highlight a specific mechanism by which commercial ACOs reduce per patient provision of services. By reducing the provision of elective and/or discretionary services while increasing the provision of high-value services, commercial ACO contracts, specialists respond to commercial ACO contract adoption with least-harm, most-productive changes in treatment choice consistent with Chandra and Skinner's model of medical productivity (2012).

Table 11 confirms this hypothesis with respect to both orthopedic and ophthalmologic procedure sub-categories. Similar to an approach taken by Clemens and Gottlieb (2014), I focus on estimated effects of three elective procedures: hip replacements (3B), knee replacements (3C), and cataract removal/lens insertions (cataract surgery) (4B). These are contrasted with three

higher acuity, higher risk procedures by the same specialty categories that neither specialists nor patients are assumed to have as much discretion over: hip fracture repairs (3A), corneal transplants (4A), and retinal detachment surgery (4C).

Hip and knee replacements are well-studied examples of physician services where total volume of service provided is closely linked to the number of local-market specialists (Weinstein et al., 2004) and other supply factors rather than solely clinical need. Each is shown in Table 11 to significantly decrease (by 6.7% and 2.8%, resp.) in each year following commercial ACO adoption while no significant changes are estimated for the hip fracture repair control outcome. Conversely, cataract surgery (P4B) has been shown in the medical literature to provide potential survival benefits (Fong et al., 2013), reduce risks of falls and hip fractures, and improve patient-reported quality of life (as well as quality-adjusted life years) (Brown et. al, 2013). Following Chandra and Skinner's typology (2012), this service category may be considered a highly cost-effective innovation with little chance of overuse that theory predicts would increase under an ACO contract. For each of the ophthalmologic procedures, estimated treatment effects are consistent with theoretic predictions with commercial ACO contracts increasing cataract surgery by approximately 17%. Further, higher acuity ophthalmologic procedures related to corneal transplants (P4A) and retinal detachment (P4C) are not found to be significantly affected by commercial ACO entry; a similarly consistent null response is estimated for hip fracture repairs.

Table 11. Effects for Orthopedic and Ophthalmologic Procedures

Dep. Variables:	Natural Log of Claimed Units Per Patient for:					
BETOS Category	Major Procedure, Orthopedic - Hip Fracture Repair	Major Procedure, Orthopedic - Hip Replacement	Major Procedure, Orthopedic - Knee Replacement	Eye Procedure - Corneal Transplant	Eye Procedure - Cataract Removal/Lens Insertion	Eye Procedure - Retinal Detachment
BETOS Code	3A	3B	3C	4A	4B	4C
ACO Treatment * Post	0.03	-0.067*	-0.028*	-0.177	0.172***	0.024
	(0.056)	(0.040)	(0.031)	(0.15)	(0.061)	(0.066)
2011	-0.056***	0.002	-0.032***	-0.75**	-0.034***	-0.024
	(0.011)	(0.01)	(0.01)	(0.034)	(0.011)	(0.015)
2012	-0.099***	0.004	-0.015	-0.083**	-0.011**	-0.081***
	(.012)	(0.02)	(0.01)	(.036)	(.012)	(.017)
2013	-0.121***	0.05***	0.02**	-0.173***	0.020	-0.109***
	(.013)	(0.01)	(0.01)	(.04)	(.013)	(.017)
2014	-0.102***	0.08***	0.019*	-0.153***	-0.007	-0.177***
	(.01)	(0.01)	(0.01)	(.04)	(.02)	(.02)
Constant	-4.18***	-3.71***	-3.33***	-4.40***	-2.70***	-3.55***
	(0.008)	(0.008)	(0.007)	(0.025)	(0.008)	(0.012)
Fixed Effects	HNPI	HNPI	HNPI	HNPI	HNPI	HNPI
R2	0.796	0.98	0.82	0.86	0.77	0.92
Zip SE Clusters	4,200	4,119	4,365	1,260	6,760	2,366
Unique Physicians	14,937	12,987	14,249	1,698	22,331	4,621
N	45,770	42,635	52,513	4,816	79,801	14,601

** p<0.10, ** p<0.05, *** p<0.01*
Source: 2014 SK&A OBP file, 2010-2014 HCCI Commercial Claims for physician services.
Standard errors clustered at the zip code level.

Estimated Changes in Other Discretionary Service

Estimated effects of commercial ACO adoption related to specialist testing, imaging services, minor procedures, and ambulatory procedures where physicians again have greater discretion in utilization and choice of services are presented in Table 12. While the magnitude of effect sizes is not large, changes in the provision of services by specialists for several discretionary service

categories highlight how commercial ACO participants seek to reduce per patient resource utilization.

Table 12 considers multiple other service categories predicted as more likely to be affected by an ACO contract due to their discretionary or elective characteristics (Chandra and Skinner, 2012). Statistically significant annual percentage reductions are estimated each for standard imaging, advanced imaging, ambulatory procedures, and minor procedures in the range of 3.4% - 4.6% for patients treated by the specialists. However, no significant impact is estimated for provision of lab or other tests (primarily cardiac tests). Analyses not presented estimated no significant impacts of commercial ACO adoption on several subcategories of major procedures (BETOS category P1) that are in general more likely to be non-elective.

The last column of Table 12 presents large estimated reductions of approximately 16.6% per physician per year for service units related to radiation therapy services in oncology care (P7A). This economically significant result was robustly estimated in various alternative specifications, including specifications considering total payment and payments per patient treated for such services by radiologists. Additional results focused specifically on radiation therapy services are reviewed in focus next.

Table 12. Effects Across Imaging, Testing, and Select Other Service Categories

Dep. Variable	Natural Log of Claimed Units Per Patient for:						
BETOS Category	Standard Imaging	Advanced Imaging	Lab Tests	Other Tests	Ambulatory Procedures	Minor Procedures	Oncology - Radiation Therapy
BETOS Code	I1	I2	T1	T2	P5	P6	P7A
ACO Treatment * Post	-0.034*	-0.045*	-0.009	0.003	-0.036***	-0.046***	-0.166**
	(0.02)	(0.03)	0.028	(0.025)	(0.013)	(0.013)	(0.078)
2011	-0.077***	-0.372***	-0.056***	-0.035***	-0.021***	-0.027***	-0.024
	(0.003)	(0.010)	(0.004)	(0.004)	(0.002)	(0.002)	(0.016)
2012	-0.134***	-0.403***	-0.085***	-0.091***	-0.085***	-0.079***	-0.08***
	(0.004)	(0.010)	(0.005)	(0.005)	(0.003)	(0.002)	(0.016)
2013	-0.162***	-0.415***	-0.119***	-0.254***	-0.111***	-0.117***	-0.116***
	(0.005)	(0.010)	(0.006)	(0.006)	(0.003)	(0.003)	(0.018)
2014	-0.186***	-0.422***	-0.155***	-0.245***	-0.17***	-0.15***	-0.14***
	(0.005)	(0.011)	(0.005)	(0.007)	(0.003)	(0.001)	(0.02)
Constant	-1.47*** (0.002)	-1.91*** (0.007)	-1.25*** (0.004)	-1.72*** (0.004)	-2.34*** (0.002)	-1.49*** (0.001)	-0.69*** (0.012)
Fixed Effects	HNPI	HNPI	HNPI	HNPI	HNPI	HNPI	HNPI
R2	0.909	0.886	0.899	0.912	0.912	0.934	0.961
Zip SE Clusters	10,758	6,099	9,847	9,865	10,725	12,470	2,607
Unique Physicians	161,580	46,728	131,587	148,348	207,162	309,753	6,892
N	623,868	169,315	485,937	503,714	792,121	1,313,398	23,898

** p<0.10, ** p<0.05, *** p<0.01*

Source: 2014 SK&A OBP file, 2010-2014 HCCI Commercial Claims for physician services. Standard errors clustered at the zip code level.

Estimated Effects on Radiation Oncology and IMRT Provision

Significant reductions in radiation oncology treatments merited a focused analysis at the per member, per procedure annual reimbursement to see how oncology teams in commercial ACOs reduced per capita costs of care. One primary finding emerges from a review of effects by CPT/HCPCS procedure (rather than BETOS) codes related to oncology care: significant reductions in per capita spending are estimated for treatments related to intensity-modulated radiation therapy (IMRT). This oncology treatment is more complex than conventional radiotherapy methods and is most commonly used to treat cancers of the prostate, head and neck, and central nervous system, although such modalities are also used in treating other cancers in more complex cases. It has often been cited as an overused treatment modality in the health services research literature (Jacobs et al., 2012), with "watchful waiting" or "active surveillance" approaches typically providing higher value (depending on the patient) with lower resource use. Efforts of commercial ACO participants to reduce per capita utilization around this modality were evident in considering logged-transformed, per patient, annual units claimed across various procedure codes (CPT/HCPCS) related to IMRT. These included significant estimated decreases in per patient utilization of:

- Use of clinical treatment planning in IMRT (CPT/HCPCS 77263)
- Teletherapy, isodose plan, complex (77315)
- Radiation treatment delivery (77413)
- IMRT delivery-single or multiple fields/arcs (77418)

In addition, each of the average treatment effects shown in Table 13 is statistically significant in regressions utilizing non-logged (raw counts) of units per patient measures that are not presented. The changes in per patient provision of IMRT services that significantly decreased but were not robust to the log transformation include:

- IMRT Plan, including dose-volume histrograms (billed once during course of therapy) (*77301)*
- Use of clinical treatment planning in IMRT (simple) (*CPT 77261)*
- Multi-Lead Collimator (MLC) Devices for IMRT, design and construction (77338)

Table 13. Effects Across Select Radiation Oncology Services

Dependent Variable	Natural Log of Claimed Units Per Patient for:						
Service Description	Oncology - Radiation Therapy	IMRT Plan	Clinical Treatment Planning in IMRT		Teletherapy, Isodose Plan (complex)	MLC Devices for IMRT	IMRT delivery
Service Category / Code	P7A	77301	77261	77263	77315	77338	77413
ACO Treatment * Post	-0.166**	-0.094	-0.184	-0.110**	-0.155***	-0.05	-0.543*
	(0.078)	(0.071)	(0.184)	(0.056)	(0.061)	(0.069)	(0.306)
2011	-0.024	0.058***	-0.01	-0.005	-0.054***	0.087***	-0.064
	(0.016)	(0.016)	(0.042)	(0.012)	(0.019)	(0.017)	(0.040)
2012	-0.08***	0.015	-0.118***	-0.023*	-0.121***	0.047***	-0.119***
	(0.016)	(0.017)	(0.047)	(0.012)	(0.020)	(0.019)	(0.044)
2013	-0.116***	0.078***	-0.141***	-0.025*	-0.211***	0.107***	-0.101***
	(0.018)	(0.018)	(0.051)	(0.014)	(0.022)	(0.020)	(0.044)
2014	-0.14***	0.062***	-0.095*	-0.031**	-0.250*	0.111***	-0.131*
	(0.02)	(0.021)	(0.527)	(0.015)	(0.025)	(0.022)	(0.045)
Constant	-0.69***	-2.57***	-3.84***	-1.59***	-2.47***	-2.46***	-0.54***
	(0.012)	(0.013)	(0.032)	(0.009)	(0.014)	(0.014)	(0.029)
Fixed Effects	HNPI	HNPI	HNPI	HNPI	HNPI	HNPI	HNPI
R2	0.961	0.8436	0.875	0.925	0.813	0.829	0.862
Zip SE Clusters	2,607	2025	1,233	2,195	1,890	1,989	1,281
Unique Physicians	6,892	4,126	2182	4661	3,804	4,089	2,303
N	23,898	16,154	4,671	18,896	14,311	15,869	7,548

** p<0.10, ** p<0.05, *** p<0.01*
Source: 2014 SK&A OBP file, 2010-2014 HCCI Commercial Claims for physician services.
Standard errors clustered at the zip code level.

Discussion

Following review of empirical results, commercial ACO contracts appear to lower marginal provision of per-patient services utilization primarily in the service categories where they (in coordination with patients) have greater discretion in clinical decision-making. While I identify several service-category specific effects that are plausible, I do not estimate any changes in

major procedures or other high-acuity service categories where I should not expect them. This validates my theoretical approach while also suggesting potential welfare benefits from ACOs and reassurances against any concerns for patient safety like those historically made toward managed care.

To the extent that classifying Medicare ACOs was difficult in Part III, the mix of commercial ACO contracts and relationships are even more heterogeneous. However, subgroup effects estimated in the Medicare analysis note a few salient characteristics (organizational governance and physicians' internal financial incentives) that are likely to impact commercial ACO success or failure as well. The optimal design of health care organizations like those entering ACO contracts will continue to be an important avenue of research in the transition to value-based payment models.

Furthermore, the role of spillovers and the overlap between Medicare and various commercial payers' ACO contracts is a natural next analysis that will be the last empirical analysis of my dissertation. Scale economies and incentive alignment across payers in markets with multiple ACOs may generate larger responses; however such overlap could just as easily make the commercial ACO's design less salient and corresponding provider response smaller. Analyses presented next indicate that market entry of commercial ACOs from non-HCCI insurers may also result in negative spillovers in the form of cost and/or utilization shifting for the treatment of patients insured through an HCCI affiliated insurer. Such considerations are explored in Part V next.

CHAPTER 5: Spillover Effects of ACO Contracts on Payments and Utilization

Introduction

For the final empirical analysis of this dissertation, I approach the topic of overlapping ACO contracts and spillovers using four distinct categories of ACO contracts and again utilizing the Health Care Cost Institute (HCCI) commercial claims data considered in Part IV. Specifically, I will estimate the effects of ACO contracts by one or more payers (i.e. Medicare, HCCI Commercial, and non-HCCI Commercial ACOs) on the patients of three major commercial payers (the HCCI data partners). Analyses estimate potential spillover effects of physician participation in Medicare and non-HCCI insurer on HCCI commercial claims. In addition, I separately estimate effects of HCCI-commercial ACO contracts on physician behavior with and without the entry of a Medicare ACO.

Empirics seek to consider conceptual questions related to the ability of providers to directly aim treatments and procedures at the patients of a single payer. The Medicare ACO program expects 50% of total expenditures to be tied to risk-based contracts by 2018. Such large changes in the flows of expenditures will almost certainly affect commercial care and insurance markets to some extent. However, the directionality of spillover effects is theoretically ambiguous and may vary significantly to the extent that physicians are able to distinguish patients by their insurance contract. While beneficial positive spillovers due to redesigned care processes may arise, negative spillover effects due cost-shifting, utilization shifting, or selection are also possible based on my results.

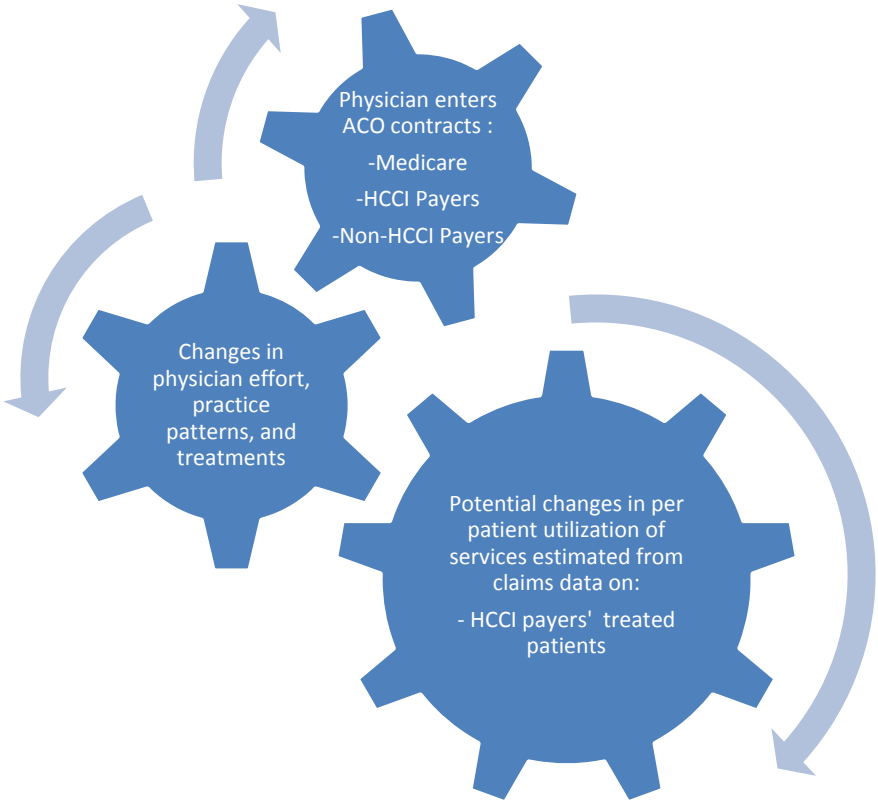
I present evidence of unintended and economically costly spillovers to HCCI payer's insured patients in terms of increased total payment, spending per patient, and total utilization in markets with both public and non-affiliated commercial ACOs as well as Medicare ACOs alone. This is accompanied by increases in unique patients treated annually for all physicians adopting ACOs. Completing similar analysis of specific service categories to those completed in Part IV, I show how stand-alone commercial ACOs as well as those holding contracts with both public and

commercial payers may effectively reduce per patient provision of discretionary services. These potentially beneficial effects do not in general spillover to non-ACO affiliated commercially insured patients.

A Conceptual Framework for Spillover Effects

Empirics below seek to address conceptual questions regarding the ability of providers to directly aim treatments and procedures at the patients of a single payer. Or, if as Pauly and McGuire (1991) model, the physician has a reasonable expectation of payer type over each treated patient. I will take a particular focus on effects of Medicare ACOs on commercial insurance populations. Spillover effects may be heterogeneous and are theoretically ambiguous to the extent that physicians and organizations are able to target different patient populations. For example, if physicians have decreased capacity constraints due to decreased low-value utilization for Medicare beneficiaries, commercial populations may experience increased marginal (and potentially low-value) treatment by physicians participating in Medicare ACOs. On the other hand, physicians who are incentivized to invest in improved care processes (e.g. EMR upgrades, disease registries, standards for imaging, etc.) through Medicare ACO programs may extend these efficiency gains to their whole patient panel regardless.

Figure 10. Conceptual Model of Spillovers



Review of Literature on Spillovers in Health Care

Motivating work on spillover effects of ACO contracts is recent reduced form work has highlighted the importance of public payers' impact on negotiated commercial prices (Clemens and Gottlieb, 2013; Ketcham, Nicholson, et. al, 2013). Presented analyses seek to highlight the role of public health care financing on provider group-insurer bargaining and the corresponding effects of such relationships on physician provision of services. Specifically, physician participation in Medicare ACO contracts may cause spillover effects on patient treatment and outcomes in the commercial insurance market as shown previously with other changes in Medicare reimbursement. Baker has shown previously how penetration of Medicare HMOs reduced fee-for-service expenditures in traditional Medicare (1997) as well as how commercial managed care impacted conventional insurance premiums (Baker and Corts, 1995). The direction of such spillovers is theoretically

ambiguous (Baicker, Chernew, and Robbins, 2013; Romley et al., 2015) and heterogeneous across populations of providers.

With regard to spillovers from ACO contracts specifically, much less evidence currently exists. The commercial BCBS Alternative Quality Contract was found to lower medical spending while improving quality of care (Song et al., 2012); this was accompanied by some potential but mixed spillovers to the Medicare population. Based on theoretical predictions and previous empirical results from Part IV, spillover effects may be expected to vary by treatment type.

Such spillover effects on quality and treatment choice may be partly related to the large literature around potential "cost-shifting" by health care providers from one payer to another following a reimbursement cut and/or general inflation of charges due to some financial shock. There is increasing evidence that though cost-shifting has occurred in some circumstances, it is rare and when occurring is of relatively small magnitude (Dranove, Garthwaite, and Ody, 2013; Frakt, 2011). To the degree that providers are profit-maximizing, any ability to increase charged prices following some shock would imply sub-optimally set prices previously. Why may ACO contracts be an exception to this literature? As noted by Gaynor and Town (2012), providers like physicians and hospitals may not directly choose quality but at minimum choose an aggregate level of effort based on the incentives they face. As patient and insurer demand (for network inclusion) is increasing in the quality of care provided, efforts to promote efficiency and quality competition through ACO contracts in one market (such as Medicare) are likely to affect both quality and price competition in commercial care markets.

Characterizing Public and Commercial ACO Penetration

Physicians were mapped at the provider zip code level to ACO penetration rates to estimate treatment with either an HCCI commercial ACO (treatment), Medicare ACO (spillover), and non-HCCI commercial ACO (spillover). As more fully reviewed in Part IV, respective ACO participation was defined at the zip code level in HCCI claims when more than 50% of physicians in that zip code participate in an affiliated ACO (either an HCCI insurer ACO, a Medicare ACO, or a non-

HCCI insurer commercial ACO). From physician billing claims, treatment choice summary variables were constructed from HCPCS codes analogous to previous work in Parts III and IV.

Overall, I estimate average treatment effects of the various ACO contract types on a substantial portion of the physician sample. First, I separate treatment effects for HCCI-affiliated ACOs into markets with and without Medicare ACO entry:

- Zip codes with a local HCCI-affiliated ACO but neither a Medicare nor non-HCCI affiliated commercial ACOs
- Zip codes with a local HCCI-affiliated ACO and a Medicare ACO, but no non-HCCI affiliated commercial ACOs[13]

Next, I also estimate average spillover effects on HCCI claims from unaffiliated local ACO contracts for two groups:

- Zip codes with no commercial ACO, but a Medicare ACO
- Zip codes with a local non-HCCI affiliated commercial ACO and a Medicare ACO, but no HCCI-affiliated ACOs

This provides four mutually exclusive cohorts that I may include in my final series of regressions. Table 14 shows the estimated coverage by 2014 of ACO contracts in each cohort across unique physicians, zip codes, and Core-Based Statistical Areas (CBSAs), a proxy for larger urban markets, present in the HCCI claims data.

[13] The category also includes a small number of physician observations in which the provider's zip code was found to include two types of commercial ACOs (67 unique physicians) or those in zip codes with all three ACO types (34 unique physicians). While these treatment cohorts were to small to be estimated separately, they are consistent with the empirical approach that considers the effects of other ACO adoption in addition to an HCCI-affiliated ACO.

Table 14. Distribution of Treatment Cohorts Across Specialists, Zip Codes, and CBSAs

	Unique Specialists	Percent Specialists	Unique Zip Codes	Unique Core-Based Statistical Areas (CBSAs)
Medicare and HCCI Commercial ACOs	4,145	1.2%	238	70
HCCI ACO Only	7,082	2.0%	148	41
Medicare and Non-HCCI Commercial ACOs	4,130	1.2%	246	67
Public ACO Only	30,669	8.6%	1,054	165
No ACO (Control)	311,509	87.1%	11,254	381
All Physicians	357,535	100.0%	12,940	396

Source: 2014 SK&A OBP file, 2014 HCCI Commercial Claims for physician services.

Empirical Approach to Estimating Spillovers

Familiar generalized difference-in-differences regressions will again be employed with treatment effects now being estimated separately for the four cohorts just described. Treatment effects for HCCI-affiliated ACOs are estimated in markets with and without parallel Medicare ACO entry. In addition, I estimate average spillover effects on HCCI claims from unaffiliated local ACO contracts for two groups: standalone Medicare ACO contracts and ACOs holding both Medicare contracts as well as a commercial ACO contract with an insurer unaffiliated with HCCI.

The datasets described in previous analyses will continue to be utilized. Analyses seek to estimate potential spillover effects of physician-level participation in Medicare and non-HCCI insurer on commercial claims. It is plausible that ACO contracts may result in externalities on non-attributed patients not specifically affected by the policy. Such spillovers could change the characteristics of physician treatment and referrals for commercial patients in the HCCI claims.

Review of trends in the dependent variables by treatment and control cohorts across the time series are important to consider for such reasons.

Methods employ regression specifications similar to those completed in other empirical sections of this dissertation to ensure comparability of results. Utilizing zip-code level commercial ACO assignment and controlling for observable physician characteristics (through the use physician-level fixed effects), regression models employ the following generalized difference-in-differences (Bertrand, Duflo, and Mullainathan, 2004) specifications:

$$y_{ict} = \overline{\beta_c} ACO_c * Post_{ict} + \beta_t Year_t + \beta_i Physician_i + \varepsilon_{ict}$$

Where the average treatment effect of ACO participation is now separately estimated($\overline{\beta_c}$) for each respective ACO cohort *c* for a given outcome y_{ict}. This regression model is well identified with every untreated physician in a specific year (including those later joining an ACO cohort) acting as controls for ACO adopting physicians participating in that year. So, physicians joining ACOs in 2014 act as controls for early adopters until the physician-year observation itself is treated. Note that in cohorts with both public and commercial ACO entry, I set the treatment year as the first year of ACO adoption regardless of whether that was via the commercial or public contract. $\overline{\beta_c}$ so captures an average annual treatment effect across the multiple start-dates separately for each of the ACO cohorts. Such a specification is identical to a classical difference in differences approach except for the inclusion of a physician fixed effect ($Physician_i$) to control for static differences across individual physicians and related nonrandom selection into the ACO contract. Five years of commercial claims data across a national sample of physicians allow for such analyses while maintaining sufficient degrees of freedom; also note that neither the ACO cohort variables nor specific static physician characteristics (e.g. system integration) need be included in this regression due to perfect multicollinearity with the physician fixed effects (assigned at NPI level). Key outcome measures, y_{ij}, similar to those used in Medicare analyses, will include multiple metrics of treatment behavior, procedure utilization, and observed quality measures over time.

Recognizing that the (potentially time-varying) assignment of ACO affiliation may introduce measurement error bias into results and is likely to vary across geographic markets, I cluster reported standard errors at the zip code level with the number of zip code clusters utilized in each specification presented by column in regression tables. Use of robust standard errors without clustering does not change coefficients or estimated effects but does improve the statistical confidence of many results.

Results

Table 15 presents regressions a broad set of dependent variables similar to that shown in the introductory Table 10 in Part IV. I estimate the effects of ACO adoption within specialists' local zip codes separately across the four mutually exclusive ACO cohorts.

Statistically significant, positive spillover effects are estimated on HCCI payer's insured patients in terms of increased total payment, spending per patient, and total utilization of services (units) in markets with both public and non-affiliated commercial ACOs (in row four) as well as Medicare ACOs alone (row three). This is accompanied by increases in unique patients treated annually for all physicians treated any of the ACO cohorts.

Only standalone, HCCI-affiliated commercial ACOs are found to significantly reduce per patient utilization of services (row one, column six), a primary measure of marginal resource use. While reductions in per patient payment are not found for any cohort, zip codes with HCCI-affiliated commercial ACOs were not estimated to significantly increased payments per patient (which occurs in areas where non-HCCI ACOs are adopted).

Table 15. Spillover Effects across Aggregate and Per Patient Payments and Services

Dep. Variable	Natural Log of Unique Patients	Natural Log of Total Commercial Payments		Natural Log of Claimed Units	
	Total	Total	Per Patient	Total	Per Patient
HCCI ACO Only * Post	0.07***	0.08***	0.006	0.057**	-0.01**
	(0.02)	(0.02)	(0.024)	(0.032)	(0.014)
HCCI and Medicare ACOs* Post	0.10***	0.12***	0.021	0.121***	0.019
	(0.03)	(0.04)	(0.010)	(0.022)	(0.007)
Medicare ACO Only * Post	0.03***	0.04***	0.011*	0.033***	0.003
	(0.01)	(0.01)	(0.003)	(0.09)	(0.002)
Non-HCCI and Medicare ACOs * Post	0.10***	0.15***	0.046***	0.108***	0.006
	(0.03)	(0.04)	(0.011)	(0.003)	(0.005)
Fixed Effects	HNPI	HNPI	HNPI	HNPI	HNPI
R2	0.88	0.79	0.89	0.88	0.90
Zip SE Clusters	12,940	12,940	12,940	12,940	12,940
Unique Physicians	357,535	357,535	357,535	357,535	357,535
N	1,787,675	1,787,675	1,787,675	1,787,675	1,787,675

** p<0.10, ** p<0.05, *** p<0.01*
Note: All specifications include year dummy variables and a constant not shown.
Source: 2014 SK&A OBP file, 2010-2014 HCCI Commercial Claims for physician services. Standard errors clustered at the zip code level.

Next, Table 16 below presents specifications modeling average treatment effects of the different ACO contract types on per patient discretionary service utilization similar to those shown previously in Table 11 and Table 12 in the preceding Part IV. Results show how stand-alone commercial ACOs as well as those holding contracts with both public and commercial payers may effectively reduce per patient provision of certain discretionary services (rows one and two). These potentially beneficial effects do not in general spillover to non-ACO affiliated commercially insured patients (rows three and four).

Per patient reimbursement for standard imaging services (Table 16, column 1) such as x-rays are estimated to decrease with ACO adoption in general; entry only by a Medicare ACO significantly

reduced commercial per patient spending on such imaging by around one percent annually. Despite this finding, overall estimated spillover effects were null in most cases, while also significantly increasing per patient spending on ambulatory procedures (column 3) and oncology services (column 5).

In the last three columns of Table 16, I review the three orthopedic and ophthalmologic services with estimated direction and effects matching theoretic predictions from Table 11. Consistent with the rest of the table, both stand-alone commercial ACO contracts and those supplemented with a Medicare ACO appear able to have some impact per patient spending for elective procedures like hip replacement, knee replacement, and cataract surgery. No beneficial spillovers were significantly estimated for non-HCCI ACO adoption, with the exception of orthopedist provision of hip and knee replacements in zip codes with a standalone Medicare ACO.

Table 16. Spillover Effects Across Imaging, Testing, and Select Other Service Categories

Dep. Variable	Natural Log of Claimed Units Per Patient for:							
BETOS Category	Standard Imaging	Advanced Imaging	Ambulatory Procedures	Minor Procedures	Oncology - Radiation Therapy	Major Procedure, Orthopedic - Hip Replace.	Major Procedure, Orthopedic - Knee Replace.	Eye Procedure - Cataract Removal/ Lens Insertion
BETOS Code	I1	I2	P5	P6	P7A	P3B	P3C	P4B
HCCI ACO Only * Post	-0.045**	-0.075***	-0.027**	-0.051***	-0.15*	-0.05	-0.016	0.223***
	(0.02)	(0.04)	(0.014)	(0.017)	(0.14)	(0.064)	(0.038)	(0.088)
HCCI and Medicare ACOs* Post	-0.001	0.075**	-0.034*	-0.026*	-0.118*	-0.159*	-0.034	0.132*
	(0.02)	(0.03)	(0.019)	(0.014)	(0.045)	(0.09)	(0.056)	(0.078)
Medicare ACO Only * Post	-0.004	0.013	0.007	-0.005	-0.001	-0.039*	-0.022	0.0001
	(0.001)	(0.01)	(0.007)	(0.003)	(0.021)	(0.013)	(0.022)	(0.016)
Non-HCCI and Medicare ACOs * Post	-0.029	0.004	0.014	0.001	-0.034	0.038	0.025	0.011
	(0.02)	(0.03)	(0.012)	(0.013)	(0.078)	(0.057)	(0.054)	(0.05)
Fixed Effects	HNPI	HNPI	HNPI	HNPI	HNPI	HNPI	HNPI	HNPI
R2	0.909	0.886	0.919	0.934	0.961	0.835	0.820	0.767
Zip SE Clusters	10,758	6,099	10,725	12,470	2,607	4,119	4,365	6,760
Unique Physicians	161,580	46,728	207,162	309,753	6,892	12,987	14,249	22,331
N	623,868	169,315	792,121	1,313,398	23,898	42,635	52,513	79,801

** p<0.10, ** p<0.05, *** p<0.01*

Note: All specifications include year dummy variables and a constant not shown.

Source: 2014 SK&A OBP file, 2010-2014 HCCI Commercial Claims for physician services. Standard errors clustered at the zip code level.

Discussion

In this final empirical analysis of my dissertation, I consider potential spillovers and volume-shifting in commercial care markets due to commercial and Medicare ACO contracts. This empirical section sought to answer two questions: Are there economies of scope from pursuing ACO contracts with both commercial and public payers? Are there spillover effects on the treatment of patients by ACO physicians even if they participate in a contract unaffiliated with that patients insurer?

First, it does not appear there is any substantial benefit, in terms of estimated effects on commercial claims, for providers to adopt multiple ACO contracts instead of solely a commercial contract. Both cohorts significantly affected per patient utilization of discretionary services; it may be argued that providers participating only in a commercial ACO contract had a greater response than those adopting both Medicare and commercial ACO designs as this cohort was the only type to significantly reduce aggregate per patient utilization of physician services.

Second, while it is clear from Table 15 that ACO contracts by all payers are affecting payments and service provision in commercial markets to some extent regardless of the affiliated-payer, non-affiliated (Medicare and non-HCCI commercial) ACOs are not found to have spillover effects on the provision of discretionary services shown in Table 16. Specialists participating in commercial insurance markets may in practice have a strong understanding of the reimbursement incentives they face on a patient-specific basis and make marginal treatment decisions accordingly. Results noting the impact of competitor commercial ACO entry, particularly significantly increased total and per patient spending, in areas with competing, non-HCCI ACOs suggest that it may be in the self-interest of commercial insurers to seek their own contracts with established ACO organizations. The specific mechanism by which this occurs (e.g. selection of specific physician or patient populations into non-ACO arrangements), is an important avenue of future research. Based on all empirical results, it is also plausible to conjecture that there are likely spillovers from commercial ACOs to Medicare spending and treatment behavior even in areas where no public ACO exists.

CHAPTER 6: LIMITATIONS

Presented analyses estimating the effects of ACO contracts in Medicare and commercial markets demonstrate the potential for such contracts to reduce per capita utilization of services and, to a lesser degree, corresponding per capita spending. However, several limitations to work presented in this thesis worth consideration . I review three primary concerns below, then briefly discuss some revised empirical results seeking to address market and patient selection.

Importantly, most presented results do not account for dynamic selection of markets, individual organizations and physicians, and patient populations into (or out of) ACO contracts. For example, ACOs may be more likely to form in markets experiencing slower Medicare spending growth. Physicians or health systems selecting into ACOs may also know before participating that they can advantageously select their patient population, skimping on services for or dumping high severity patients (Ellis, 1998). This endogenous selection effect may change from one time period to the next, potentially biasing my causal estimates of changes in physician treatment behavior. Such dynamic selection may violate the parallel trends assumption in my specification such that physician fixed effects will not sufficiently restore randomness to the quasi-experimental design. This differs from any static covariates remaining constant over time, where physician-level fixed effects control for such selection into ACO contracts. Similarly, the timing of ACO entry is also potentially non-random. This may weaken my central identification strategy if provider groups are able to time ACO contracts to achieve the best financial results in terms of shared savings. Anecdotally, adoption of an ACO contract is generally a slow process of indeterminate length; adopting physicians, groups, and larger organizations appear to have limited ability to affect the specific start date of the ACO. However, to the extent that this is the case, estimates will measure not only changes in marginal treatment intensity but also ACO participants' (physicians' and provider organizations') ability for strategic behavior through cherry-picking of patients, strategic provision of services before and after the ACO contract start, or other mechanisms.

Any additional static selection of markets, organizations, and physicians into ACO contracts, which are fully controlled for through the use of physician fixed effects, may limit broader interpretation of my results in terms of their generalizability. Most ACO contracts to date have been voluntary. The theoretical model presented in Part II and classical economic theory demonstrate why this may be the case: such mechanisms promote a second-best solution of "efficiency at the top" for those voluntary provider participants whom are willing to increase total social welfare in exchange for financial reward. Feldman (2015) notes that because ACO contracts are so far voluntary, the expected utility of participation in the program must meet or exceed the participants' reservation utility. He instead recommends policy-makers simply lower prices to directly reduce incentives for over-utilization. While likely more efficient health policy, physician fee cuts are historically difficult to achieve. The ACO contracts I evaluate have been widely adopted by nearly a quarter of all U.S. physicians. However, the national generalizability of my empirical results may be questioned. While the efficacy of ACO contracts may be continually expanded and designs refined to encourage greater physician adoption, estimated empirical results are local average treatment effects that may not be generalizable to all U.S. physicians. Further, I estimate the effects of Medicare ACO contracts against a status quo of fee-for-service reimbursement in Medicare Part B. Physicians may maximize their own utility differently as we transition into a two-track Medicare reimbursement system under new MACRA legislation.

Third, it is worth noting the respective data limitations of the SK&A data used for assigning Medicare and commercial ACO affiliations, the public-use Medicare claims used in Part III, and the commercial HCCI claims used in Part IV and Part V. SK&A data is a commonly used dataset in health services research, with Baker and coauthors finding SK&A well-suited to characterize physician market and organizational structure (2014). However, the public and commercial ACO contract fields used in this work have not been well validated externally outside of checks made by the author. Conversely to previously stated selection concerns, presented results may also suffer from attenuation bias, biasing empirical estimates toward estimation of no significant effect. This may occur due to measurement error in how SK&A assigns physician (and/or office) level

ACO affiliation. Additionally, ACO contract affiliations occur over time, with physician entry and exit occurring somewhat fluidly. Any changes during a given year not captured by the point-in-time affiliations collected by SK&A would be another source of measurement error. Medicare public-use claims data, while an excellent new resource, lacks the ability of research-identifiable claims files to finely control for patient characteristics for specific services as they are published at the physician-year-service type level. HCCI commercial claims are utilized at a similar unit of observation, introducing limits to the interpretation of those results. I pointedly took a physician- rather than patient-focus to my analytic approach. I do not consider patient populations specifically attributed to ACOs like most research on this topic. This was done purposefully; I seek to consider all-patient effects of ACO contracts and not specific behavior change for attributed patients. Additionally, anecdotal evidence suggests that physicians and to a lesser degree organizations may not fully know which patients are attributed under an ACO contract and which patient are not. However, this again limits the interpretation of my results; my estimated effects do not necessarily apply specifically to attributed patient populations under ACO contracts. These data sets are each more fully reviewed, including discussion of their strengths and limitations, in the Data Appendix included at the end of this dissertation.

To briefly explore robustness to selection concerns, Appendix Table 26 and Appendix Table 27 present refined specifications for the first tables of Part IV (Table 3 and Table 4, resp.) that control for changes in patient case mix and local market conditions from one year to the next. Such time-varying characteristics of physicians should help to control for the dynamic selection concerns cited above. Time-varying market conditions were included from the 2015- 2016 Area Health Resources File and include the county unemployment rate, the county median household income, county Medicare Part C penetration rate, county Medicare Part D penetration rate, and county percent of Medicare beneficiaries who are dual-eligible. Time-varying physician-level characteristics of patient panels were incorporated from a different Medicare public use file and include the percent of beneficiaries who are dual-eligible, the percent of beneficiaries who are non-white, the mean HCC risk score of beneficiaries (a measure of health severity), and 16

variables measuring the percent of beneficiaries with one of sixteen chronic, comorbid conditions reported by Medicare publicly. Inclusion of such covariates has no statistically significant impact on my results, alleviating some but not all concerns over the extent of selection bias on my results.

CHAPTER 7: CONCLUSION

This dissertation advances the theoretical mechanisms on which total cost of care contracts may be expected to affect physician behavior and presents empirical evidence in both Medicare and commercial physician services markets validating proposed mechanisms. Foremost, I find that physician participation in ACO contracts may work to reduce inefficiencies caused by supply-side moral hazard that lead to sub-optimal provision and mix of physician services.

Despite stated limits regarding results' robustness to selection effects and broader generalizability cited above, this thesis makes a substantial contribution to the policy evaluation literature in several ways. My foundation for understanding provider behavior under ACO contracts is based in an economic model of incentive contract auctions that is broadly applicable in vertically integrated health care markets. Physicians and other providers are increasingly given a choice to hold performance risk through ACO contracts. This separation of high efficiency types into incentive contracts (with more ex ante risk) while low-efficiency types remain in the strictly fee-for-service contract is Pareto-improving to status-quo physician reimbursement. Empirical results highlight ACOs' potential to lower per capita utilization of physician services, particularly for services in which physicians have more discretion and when organizations forming ACO contracts do so in ways that align financial incentives of individual physicians to those of the larger organization. My work considers this mechanism in several ways, notably first in public Medicare markets where both prices and ACO contract terms are fixed then in commercial markets where both prices and ACO contracts may be negotiated with insurers.

In their extensive review of the industrial organization of health care markets, Dranove and Satterwaite (2000) analyze the three historically dominant regimes in U.S. health care: independent physicians and cost-based hospital reimbursement; regulation and prospective payment; and finally managed care and contracted physicians. The U.S. health care system is evolving toward a new regime, one that will certainly be informed by the testing and evaluation of early Medicare and commercial ACO contracts like those I consider in this research. Managed care is transitioning to accountable care in a majority of local health care markets. This is broadly

evident in increasing use of strategic network formation, total cost of care contracting through ACO-style contracts, and increased quality monitoring and reporting. ACO success by systems owning physician groups also increasingly requires physician profit sharing and financial incentives for physician staff to actively promote higher value care delivery and meet ACO goals, as results from Part 3 highlight. In this transition to a new dominant health policy regime, physicians and other qualified clinical professionals should be identified as the ultimate medical decision-makers in many treatment settings.

As shown in previous regimes (Dranove and Satterwaite, 2000), this thesis presents evidence that health care providers are found to respond to ACO incentive contract arrangements in ways generally consistent with economic theory. This work contributes to the broader understanding in the health economics literature that has developed over the past decade showing both demand- and supply-side interventions which public and commercial payers may introduce to promote efficient health care delivery.

On the demand side, value-based insurance design (VBID) (Pauly and Blavin, 2008) may nudge patients toward higher value providers, services, and prescription drug choices. However, increasing evidence shows that many patients are not rational consumers of health care, for instance in their response to high-deductible health insurance designs (Brot-Goldberg et al., 2015), and often rely on physician input in treatment and referral choices. Physicians' treatment choice is driven by a heterogeneous interplay of financial incentives and behavioral biases not dissimilar to those faced by patients themselves (Baicker and Mullainathan, 2013). However, value-based purchasing by payers through contracts like ACOs internalize the inefficiencies of supply-side moral hazard by making rent-seeking, but otherwise efficient, firms responsible for cost-overruns and quality-shortfalls. Like VBID, value-based purchasing hold promises to correct for mis-utilization of services within local health care markets and across diverse patient populations, including both Medicare beneficiaries and the commercially insured. Health policy makers are only starting to center on such payment contracts' potential to promote efficiency and value in the health system, as suggested by this dissertation and numerous other researchers.

New MACRA legislation specifically introduces a wide range of alternative payment models (APMs) such as ACOs in Medicare. The voluntary nature of such APM programs are a key feature of ACOs to date and not necessarily a flaw as some policy makers argue. My theoretical model presented in Part II and classical economic theory demonstrate why this the case: such systems promote a second-best solution of "efficiency at the top" for those voluntary provider participants whom are willing to increase total social welfare in exchange for financial reward. Non-participants are either unable (e.g. due to cost structures) or unwilling (e.g. due to reservation utility, opportunity costs) to increase social welfare through more efficient care delivery. With incentive-compatible payment schemes designed to promote value and reduce incentives for gaming, a wide-variety of APMs is expected to effectively decrease per capita service utilization and spending while increasing the marginal productivity and innovation of health care organizations. Within local markets, such models may further encourage quality competition as providers compete for inclusion in commercial networks or against regionally-set Medicare payment benchmarks. However, estimated increases in spending and utilization per patient in commercial markets with unaffiliated ACOs presented in Part V raise important questions surrounding selection of physicians and the underlying patient panels they treat through APMs. Advantageous selection of more productive physicians or healthier patients by ACOs will likely be a legitimate concern moving forward to be balanced against any gains in economic welfare caused by ACO contracts. Despite selection effects, this dissertation provides a theoretical foundation and new empirical evidence that ACO contracts can effectively promote efficiency in the U.S. health care system via a second-best mechanism that reduces supply-side moral hazard.

APPENDIX

Data Appendix

This data appendix describes the three primary data sources used in this dissertation: the SK&A physician marketing database; public use Medicare claims, payment, and referral summary files; and commercial health insurance claims data from the Health Care Cost Institute (HCCI).

SK&A

The SK&A's continually updated marketing database of office based physicians and other providers is currently licensed from IMS Health (IMS) as a premier database for most relevant information regarding health care providers such as physicians, nurses, physician groups, health systems, and accountable care organizations. Researchers and analysts find it useful both as primary data to study health care providers as well as a supplement to enhance the information known about such providers in other data sources.

This overview of the SK&A reviews the structure of data sets provided to the author through his affiliation with the Leonard Davis Institute of Health Economics, focusing on coverage, data collection methods, and linking the respective SK&A datasets to each other and/or external data sources. This physician database is unique in that data is collected through an ongoing, continually updated phone survey of recognized medical offices. SK&A provides a rich panel of office, organization, and individual characteristics useful in a tackling a variety of analytic questions in health economics and outcomes research.

Coverage

The SK&A database is compiled from an ongoing survey now being operated by IMS to all office-based physicians in the United States. These files are an increasingly used and continually updated commercial database of practicing office-based physicians organized at the physician-office level initially developed for marketing purposes. This data is maintained through a continuously operated phone survey of all U.S. office-based physicians. In addition to the primary data set with key physician characteristics commonly used by researchers such as location and

specialty, this dissertation leverages premium access to over 140 variables ranging from physician practice use of EMR and practice management software, ACO and system affiliations, new patient acceptance, drug market rep access, hours of operation, and other practice characteristic variables.

SK&A data has good coverage geographically across the U.S. and is able to be used for various research purposes. It has been shown to include more than 90% of physician offices, including capture of safety-net providers such as rural and federally qualified health clinics (Rhodes et al., 2014). Gresenz, Auerbach, and Duarte (2013) compared the SK&A with the AMA Masterfile and the American Community Survey, finding similar totals of office-based physicians and selection across broad specialties. The ACS listed 673,000 physicians (including non-office based and non-clinical), with AMA listing 553,000 and SK&A listing 552,000. More recently Baker, Bundorf, and Royalty find SK&A well-suited to characterize physician market structure and competition potentially preferable to Medicare claims data (2014).

SK&A has since increased its total physician count, as of the 2016 OBP file uniquely counting 606,495 unique physicians across 294,666 sites. In total, over 1.1 million unique clinicians (including both physicians and non-physicians) are present in the dataset.

Data Collection Process

IMS seeks to contact each physician office in their database every six months (twice annually) to confirm the validity of each individual record. Some internal validation is also undertaken by the data collection team. Variables exist noting both when an observation was first contacted as well as when it was last updated (origdate and change, resp.). “Current” a and “historic” data are structured identically; for example the 2015 file is simply a historic snapshot not including any updated data collected in 2016 or later.

The SK&A database is maintained through a now nearly universal phone census of active United States medical offices. This survey has been improved and expanded upon by the SK&A team for

over thirty years since it was first introduced in 1984. More recently fields have been added to collect additional information regarding health information technology (IT) infrastructure and physician integration with larger health care organizations.

Variable Set

The primary SK&A database of nearly 1.1 million clinicians includes over 140 fields of information across a wide range of individual, location, and organizational characteristics. This rich data allows for policy evaluation, market analysis, integrated health system valuation, health services research, and broad potential for various other types of analysis. Regarding individual characteristics, the data set allows review of clinicians:

- Medical specialties
- Education
- Departmental title (e.g. Medical Director)
- Date of birth
- State and federal licensing
- Medicare/Medicaid identifiers (e.g. NPI, UPIN)

Mainly geographic information is consistent across observations for clinicians in the same office (or other setting such as a hospital). This geographic identification is denoted by the identifier variable *id*. This allows for easy aggregation to the office level if individual clinician variables listed above may be dropped or summarized. Such fields include each location's:

- Street Address
- Geographic categories (state, county, MSA, zip, etc.)
- Latitude/Longitude
- Specialty (incl. multi-specialty)
- Usage and name of EMR vendor
- Usage and name of practice management software vendor
- Drug market rep access
- Hours of operation
- Foreign languages spoken
- Medicare, Medicaid, and new patient acceptance

- Daily patient volume estimate
- Number of exam rooms

Different clinical office locations can be connected by organizational fields in the database in multiple, overlapping ways, paralleling the various ways health care delivery organizations can be structured in reality. Clinicians may participate in a wide variety of organizations, which may be for-profit, non-profit, or public; independent practices only affiliated with local hospitals, horizontally integrated physician groups, or vertically integrated combinations of physician groups and hospitals referred to as hospital systems and integrated health systems. A hierarchy of organizational forms exists in the SK&A data centered around individual clinicians within (potentially multiple different) offices:

- Integrated Health Systems (801 unique IHS)
- Accountable Care Organization Affiliations (656 unique ACO contracts)
- Health Systems (5,818 unique systems)
- Hospital Ownership (892 unique hospitals)
- Group Medical Practice (17,951 unique GMPs)
- Independent Physician Association (123 unique IPAs)
- Affiliated hospitals (6149 unique hospitals)
- Company (240,207 unique companies)
- Offices (294,666 unique offices)

In addition to this vast set of physician and nursing staff characteristics, additional data files are available from IMS that relate this database to others providing characteristics at the level of the organizational fields above (e.g. an IHS characteristics file, an ACO characteristics file).

Data Population Contents (Physician and Non-Physician Observations)

Each year of the SK&A file contains observations across a wide range of active clinicians, from physicians who are medical residents or hospital CEOs, to nursing staff who are nurse practitioners, office administrators, or social workers. Analysts often prefer to separate these two cohorts (physicians and non-physicians) in separate files depending on their focus.

Physicians may be identified in the data using the *md* variable or also by noting a title of "Dr.". Research in this dissertation restricts analyses to active, non-trainee physicians by dropping those physician observations with the departmental titles (variable *dept_expl*) of Allied Health Professionals, Chief Executive Officer, Chief Financial Officer, Chief Information Officer, Chief Operation Officer, Fellow, President, Research, or Resident.

SK&A is unique among health data sources in capturing a detailed depiction of nursing and other clinical staff labor within health care organizations. With over 500k unique individuals in the 2016 file, this workforce is a large contributor to the U.S. health care system despite often providing services in comparable anonymity under a physician, hospital, or other employer. As noted by the same dept_expl field for non-clinicians, the most common types of non-physician clinicians with records maintained by SK&A include those in the role of Office Manager (20.8% of non-clinician observations), Nurse Practitioner (17.4%), Physician Assistant (11.2%), Receptionist/Secretary (11.1%), Medical Assistant (9.8%), Registered Nurse (7.1%), Administrator (3.8%), Licensed Practical Nurse (2.2%), Director of Nursing (2.2%), Insurance/Billing Supervisor (2.2%), Social Worker (2.%), Registered Dietitian (.9%), Physical Therapist (.9%), and Nurse Midwife (.8%). Over 45 non-physician departmental roles are listed in total for the non-clinician population alone.

Dataset Organization

This data source is presented at clinician-location level. SK&A seeks to have a record for each practicing clinician (part. in the case of physicians) at a location and to have multiple records per physician if they practice at multiple locations. Researchers often reshape the file to create a unique record per office (by variable id) or per physician (by uid or npi). These and other key identifier variables are described below.

Identifiers Used

The primary, unique individual identifier in the SK&A data is aptly called "uid". Alternatively, the federal National Provider Identifier (npi) may be used as a unique identifier for all physicians and

other providers participating in public health insurance programs. Other identifiers exist depending. These include:

- Uid – Unique SK&A Person ID Number for all locations
- Personid – Unique SK&A Person ID Number across all locations (unique observation identifier in data)
- Id – Unique SK&A Site ID Number
- Npi –National Provider Identifier – Used by Medicare and other insurers to universally track individual providers (and in some case organizations).

Merging SK&A Datasets Together

All of IMS's data files are easily joined together as needed to attain the necessary subset of variables for analysis over two (or more) years of data. Files are simply appended together to create a panel with consistent variable names across files; flat files at the (raw) physician-location level may be created by merging at the unique identifier (uid) level (generally after renaming remaining variables in one file). If linking to other SK&A files, files are in general easily linked at the respective organizational level (e.g. at the integrated health system id or ACO id levels)

Linking to Other Data Sources

SK&A physician practice characteristics are an excellent secondary source of data for analyses primarily utilizing insurance claims, health records data, or other health or economic outcomes data. Among other uses the SK&A physician data serves as a useful denominator of practicing physicians or provider groups within local markets. It is frequently matched to other data sources at a variety of different organizational and market levels.

Several public use datasets from Medicare and a commercial claims database were merge to the SK&A files in various ways over the course of preparing this thesis. These include aggregated claims, payment, utilization, and outcomes data from the entire population of Medicare beneficiaries. Combining SK&A physician characteristics with details on their respective patient populations allows for research on a range of topics, from comparative effectiveness research to policy evaluations of the Affordable Care Act. More broadly, SK&A contains a wealth of data and string fields capable of being matched by a data scientist to an innumerable set of data sources.

Medicare Provider Utilization and Payment Data

Newly available data from the Centers for Medicare and Medicaid Services (CMS) released by the Obama administration publicly discloses payment and utilization data on nearly all U.S. physicians participating in the Medicare program for senior citizens and the disabled. This data was merged with the SK&A file in Part III of this thesis to estimate a range of aggregate and subgroup effects of Medicare ACOs. The Physician and Other Supplier public use file (PUF) available from CMS provides information on utilization and Medicare reimbursement and is organized by National Provider Identifier (NPI) and Healthcare Common Procedure Coding System (HCPCS) code. A summary file at the NPI level lists physician aggregate Medicare payment information and information on the disease case mix and socioeconomic characteristics (on average) of treated Medicare patients. Linking the SK&A file to either of these datasets is straightforward based on the NPI field present in each of the files. In the former case it may be necessary to aggregate SK&A to a unique NPI level to avoid a many-to-many merge. Raw observations in the SK&A file may be merged to the provider summary file by NPI using a many-to-one merge, combining SK&A's variable set with a file presenting a range of average patient characteristics and disease complexity measures.

Medicare Physician Referrals Data

Another public use data series newly available from CMS and used in Part III contains a variety of data on physician referral patterns to other Medicare providers from 2009 – 2015. This data file is structured as a data dump from 100% traditional Medicare claims across all provider types, with a referral being defined as any pair of claims (i.e. patient encounters) from two different NPIs occurring within 30 days of each other. Because these files are structured as pairs of NPIs with no associated physician or organizational characteristics, pairing the referral data with SK&A is of great benefit. Such a combination allows consideration of various and nuanced questions about patient flows and referrals as a treatment choice such as:

- Are patient referrals made differently in health systems, multi-specialty groups, accountable care organizations?

- How are primary care referrals to specialists based on peer effects between clinicians?
- How does use of varying EMR software vendors affect health care firms' ability to retain patients within the health system?

Two particular samples of the referral data are of particular interest for combination with SK&A: referrals out by primary care physicians to specialists and referrals captured by specialists from PCPs. By merging to both the referring and referred physician variables, researchers may create unique lists by NPI with SK&A fields identifying characteristics like specialty. Also considered in Part 3 were primary care physician referrals to non-physician provider organizations such acute care hospitals and post-acute care providers.

HCCI Commercial Claims Data

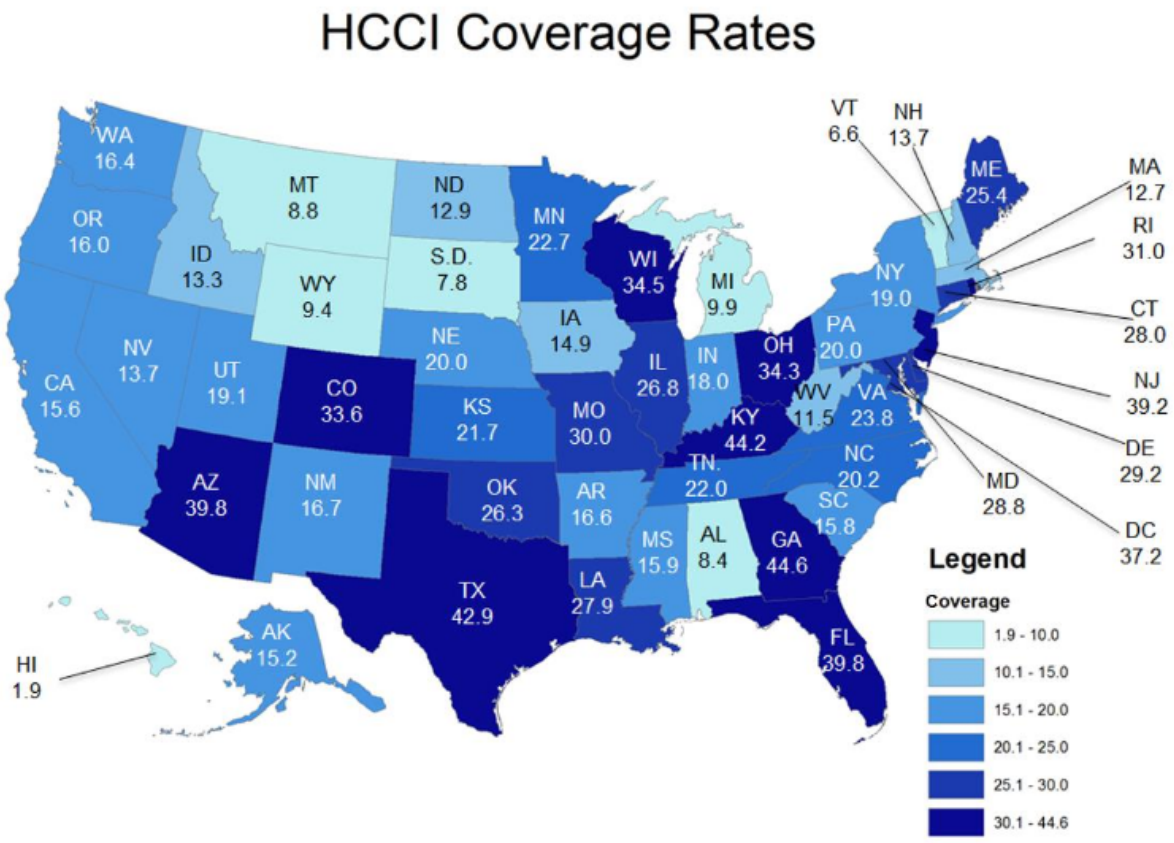
Commercial claims data were accessed through the Health Care Cost Institute (HCCI), a non-profit organization partnering with Aetna, Humana, and United Healthcare to share claims data with academic researchers. Commercial ACO contracts with physicians were identified using the nationally representative SK&A office-based physician file reviewed previously. Empirical analyses in Part 4 and Part 5 consider the effects on HCCI-insurer affiliated ACOs and the broader range of ACOs contracted by both Medicare as well as both HCCI- and non-HCCI affiliated insurers. Physician claims billing and aggregate member files were utilized to extract and create physician-year summary observations describing payment and unit billing counts, aggregating up from the HCPCS/CPT level. Presented analyses primarily utilize dependent variables aggregating these codes up to the BETOS typology of service definitions shown in

Appendix Table 18. Cooper and coauthors were among the first to utilize commercial claims from HCCI insurers; their appendix argues HCCI data is the most comprehensive data source of commercial claims data. HCCI is also a superior source of commercial claims data for its coverage across both fully- and self-insured insurance products in the national, large, small group, and exchange markets. In total, HCCI data is estimated to include over 40 million covered lives per year; providing coverage on average for 27.6 percent of all Americans with employer-

sponsored insurance. Coverage does vary substantially from one state to the next, as Figure 11 below reproduced from Cooper, Craig, Gaynor, and Van Reenen (2015).

Figure 11. Estimates of HCCI Commercial Insurance Coverage Rates by State, 2011

Figure A1: HCCI data Coverage Rates by State



Notes: Coverage rates were calculated using 2011 HCCI enrollment data. Statewide insurance coverage totals were derived from the American Community Survey for 2011.

Source: Reproduced from Cooper, Craig, Gaynor, and Van Reenen (2015).

Example Calculations

Measuring System Integration

Identifying the firm and corresponding market share can be difficult in health care provider markets due to varying levels of ownership, partnership agreements and joint ventures, and vertical integration across individuals, sites of care like hospitals, and larger health systems. One method used by researchers (e.g. Dunn and Shapiro, 2014) uses the SK&A file to assign observations to a distinct organization involving a step by step assignment rule. By starting at presumably larger organization levels (health systems) and moving to smaller categories (companies), an individual will be assigned by the Integrated Health Systems field when one is present, followed by the fields for Health Systems, Hospital Owner, Group Medical Practice, and Company in descending order. Of the organizational variables listed previously, note that Independent Physician Association, Accountable Care Organization, and Affiliated Hospital fields refer to much more limited affiliations than company ownership. While the company field (present for all observations) may be used to assign observations to unique firms, note this may underestimate corporate boundaries when systems hold full or partial stakes across multiple legal businesses.

Appendix Tables

Appendix Table 17. Preventive Service Category Definitions

Preventive Service Category	HCPCS Codes Used in Category Definition
Annual Wellness Visit (AWV)	G0438 G0439
Intensive behavioral therapy for obesity	G0447 G0473
Intensive behavioral therapy for CVD	G0446
Medical nutrition therapy	97802 97803 97804 G0270 G0271
Prostate Cancer Screening	G0102 G0103
Colorectal Cancer Screening	00810 82270 G0104 G0105 G0121 G0106 G0120 G0121 G0328 G0464
Diagnostic Colonoscopy	45378 45379 45380 45381 45382 45383 45384 45385 45386 45387 45391 45392
Hemoglobin screen (office and home)	83036 83037
Nepropathy Screening	82042 82043 82044 84156
Cardiovascular Disease Screening Tests / Lipid Panels	80061 82465 83718 84478
Pneumococcal Vaccine Administration	90669 90670 90732 G0009
Seasonal Influenza Virus Vaccine	90630 90653 90654 90655 90656 90657 90660 90661 90662 90672 90673 90685 90686 90687 90688 Q2035 Q2036 Q2037 Q2038 Q2039 G0008
Hepatitis B Vaccine Administration	90739 90740 90743 90744 90746 90747 G0010
Hepatitis C Screening	G0472
HIV Screening	G0432 G0433 G0435
Tobacco Cessation	G0436 G0437
Depression Screening	G0444
Diabetes Screening	82947 82950 82951
Diabetes Self-Management	G0108 G0109
Glaucoma Screening	G0117 G0118
Screening Mammography	77052 77057 77063 G0202
Diagnostic Mammography	77051 77055 77056 G0204 G0206
Screening Pap Test	G0123 G0124 G0141 G0143 G0144 G0145 G0147 G0148 P3000 P3001 Q0091
Screening Pelvic Examinations	G0101
Ultrasound Screening for Abdominal Aortic Aneurysm (AAA)	G0389
Alcohol Misuse Screening and Counseling	G0442 G0443
Bone Mass Measurements	76977 77078 77080 77081 G0130

Source: Centers for Medicare and Medicaid Services, 2015. "Preventive Services Chart -ICN 006559". Medicare Learning Network Brief.

Appendix Table 18. BETOS Typology of Service Categories

Evaluation And Management
M1A Office Visits - New
M1B Office Visits - Established
M2A Hospital Visit - Initial
M2B Hospital Visit - Subsequent
M2C Hospital Visit - Critical Care
M3 Emergency Room Visit
M4A Home Visit
M4B Nursing Home Visit
M5A Specialist - Pathology
M5B Specialist - Psychiatry
M5C Specialist - Ophthalmology
M5D Specialist - Other
M6 Consultations
Procedures
P0 Anesthesia
P1A Major Procedure - Breast
P1B Major Procedure - Colectomy
P1C Major Procedure - Cholecystectomy
P1D Major Procedure - Turp
P1E Major Procedure - Hysterectomy
P1F Major Procedure - Explor/Decompr/Excisdisc
P1G Major Procedure - Other
P2A Major Procedure, Cardiovascular - Cabg
P2B Major Procedure, Cardiovascular - Aneurysm Repair
P2C Major Procedure, Cardiovascular - Thromboendarterectomy
P2D Major Procedure, Cardiovascular - Coronary Angioplasty(Ptca)
P2E Major Procedure, Cardiovascular - Pacemaker Insertion
P2F Major Procedure, Cardiovascular - Other
P3A Major Procedure, Orthopedic - Hip Fracture Repair
P3B Major Procedure, Orthopedic - Hip Replacement
P3C Major Procedure, Orthopedic - Knee Replacement
P3D Major Procedure, Orthopedic - Other
P4A Eye Procedure - Corneal Transplant
P4B Eye Procedure - Cataract Removal/Lens Insertion
P4C Eye Procedure - Retinal Detachment
P4D Eye Procedure - Treatment Of Retinal Lesions
P4E Eye Procedure - Other
P5A Ambulatory Procedures - Skin
P5B Ambulatory Procedures - Musculoskeletal
P5C Ambulatory Procedures - Inguinal Hernia Repair
P5D Ambulatory Procedures - Lithotripsy
P5E Ambulatory Procedures - Other
P6A Minor Procedures - Skin
P6B Minor Procedures - Musculoskeletal
P6C Minor Procedures - Other (Medicare Fee Schedule)
P6D Minor Procedures - Other (Non-Medicare Fee Schedule)

P7A Oncology - Radiation Therapy
P7B Oncology - Other
P8A Endoscopy - Arthroscopy
P8B Endoscopy - Upper Gastrointestinal
P8C Endoscopy - Sigmoidoscopy
P8D Endoscopy - Colonoscopy
P8E Endoscopy - Cystoscopy
P8F Endoscopy - Bronchoscopy
P8G Endoscopy - Laparoscopic Cholecystectomy
P8H Endoscopy - Laryngoscopy
P8I Endoscopy - Other
P9A Dialysis Services (Medicare Fee Schedule)
P9B Dialysis Services (Non-Medicare Fee Schedule)
Imaging
I1A Standard Imaging - Chest
I1B Standard Imaging - Musculoskeletal
I1C Standard Imaging - Breast
I1D Standard Imaging - Contrast Gastrointestinal
I1E Standard Imaging - Nuclear Medicine
I1F Standard Imaging - Other
I2A Advanced Imaging - Cat: Head
I2B Advanced Imaging - Cat: Other
I2C Advanced Imaging - Mri: Brain
I2D Advanced Imaging - Mri: Other
I3A Echography - Eye
I3B Echography - Abdomen/Pelvis
I3C Echography - Heart
I3D Echography - Carotid Arteries
I3E Echography - Prostate, Transrectal
I3F Echography - Other
I4A Imaging/Procedure - Heart,Including Cardiac Catheterization
I4B Imaging/Procedure - Other Tests
Testing
T1A Lab Tests - Routine Venipuncture (Non Medicare Fee Schedule)
T1B Lab Tests - Automated General Profiles
T1C Lab Tests - Urinalysis
T1D Lab Tests - Blood Counts
T1E Lab Tests - Glucose
T1F Lab Tests - Bacterial Cultures
T1G Lab Tests - Other (Medicare Fee Schedule)
T1H Lab Tests - Other (Non-Medicare Fee Schedule)
T2A Other Tests - Electrocardiograms
T2B Other Tests - Cardiovascular Stress Tests
T2C Other Tests - EKG Monitoring
T2D Other Tests - Other

Appendix Table 19. DID Results Across E&M Service Categories for Primary Care Physicians

	E&M Office Visits By Patient Type		E&M Office Visits By Visit Intensity (Time) (for Est. Patients)					E&M Preventive Visits
	New	Established	5 Min.	10 Min.	15 Min.	25 Min.	40 Min.	-
BETOS/CPT Code	M1A	M1B	99211	99212	99213	99214	99215	G0438 / G0439
ACO Treatment * Post	0	-1.16**	0.25*	0.27*	-0.37	-0.97**	-0.54	1.67***
	(.18)	(.53)	(.13)	(.15)	(.30)	(.48)	(.66)	(.49)
2013	-0.94***	1.21***	-0.27***	-0.47***	-0.81***	2.51***	-1.14***	0.92***
	(.06)	(.17)	(.04)	(.06)	(.11)	(.16)	(.23)	(.18)
2014	-1.51***	0.25	-0.97***	-1.09***	-3.03***	4.38***	-0.80**	3.58***
	(.08)	(.25)	(.06)	(.09)	(.16)	(.23)	(.35)	(.22)
Constant	11.75***	146.34***	4.53***	7.08***	55.56***	83.93***	29.53***	28.50***
	(.05)	(.14)	(.03)	(.04)	(.09)	(.13)	(.17)	(.15)
Fixed Effects	NPI	NPI	NPI	NPI	NPI	NPI	NPI	NPI
R2	0.85	0.95	0.9	0.93	0.94	0.92	0.92	0.86
Unique Physicians	45,681	91,159	17,526	30,014	87,115	86,544	30,917	34,806
N	137,043	273,478	52,578	90,042	261,345	259,633	92,750	104,417

** p<0.05, ** p<0.01, *** p<0.001*

Source: 2014 SK&A OBP file, 2012-2014 Medicare Physician and other Supplier PUF. Standard errors clustered at the primary care service area (PCSA) level.

Appendix Table 20. DID Results Across Imaging and Testing Categories for Specialists

	Testing				Imaging			
	Lab	Adv.	Car. Stress Tests	Other Car. Tests	Stand.	Adv.	Non-Brain CT	Non-Brain MRI
BETOS/CPT Code	T1	T2	T2B	T2D	I1	I2	I2B	I2D
ACO Treatment * Post	-2.19**	2.20***	0.43**	3.20***	-0.13	5.16***	3.92***	2.11**
	(1.04)	(.70)	(.13)	(1.07)	(.64)	(1.34)	(1.38)	(.98)
2013	-1.27***	-5.32***	-1.65**	-7.56***	-0.93***	-4.62***	-1.89***	-3.66***
	(.28)	(.24)	(.05)	(.39)	(.11)	(.43)	(.46)	(.30)
2014	-2.68***	-6.06***	-2.0***	-8.48***	-2.07***	-7.46***	-2.12***	-5.65***
	(.48)	(.28)	(.07)	(.44)	(.18)	(.62)	(.62)	(.42)
Constant	32.32***	28.18***	7.01***	34.52***	25.22***	45.00***	23.18***	28.28***
	(.22)	(.16)	(.04)	(.26)	(.10)	(.31)	(.32)	(.22)
Fixed Effects	NPI	NPI	NPI	NPI	NPI	NPI	NPI	NPI
R2	0.9	0.91	0.92	0.91	0.94	0.94	0.93	0.95
Unique Physicians	45,832	51,330	13,201	33,250	62,621	23,923	17,765	16,519
N	137,495	153,989	39,603	99,749	187,862	71,768	53,295	49,555

** p<0.05, ** p<0.01, *** p<0.001*

Source: 2014 SK&A OBP file, 2012-2014 Medicare Physician and other Supplier PUF. Standard errors clustered at the primary care service area (PCSA) level.

Appendix Table 21. Triple Difference Results Across E&M Service Categories by ACO Governance Type

	E&M Office Visits by Site		E&M Office Visits By Patient Type		E&M Office Visits By Visit Intensity (Visit Time) (for Est. Patients)				
	Office	Facility	New	Established	5 Min.	10 Min.	15 Min.	25 Min.	40 Min.
BETOS/CPT Code	M1	M2	M1A	M1B	99211	99212	99213	99214	99215
ACO * Post * System-Led	-1.21**	1	-0.34	-1.64***	0.08	0.14	-0.42	-1.39***	-0.08
	(.49)	(.86)	(.23)	(.36)	(.23)	(.14)	(.28)	(.51)	(.72)
ACO * Post * Jointly-Led	-0.83	0.02	0.32	-1.59**	0.24	-0.06	-1.00***	-0.09	1.01
	(.63)	(.96)	(.25)	(.72)	(.26)	(.18)	(.34)	(.58)	(.80)
ACO * Post * MD-Led	-2.75***	-4.97***	-0.01	-2.81***	-0.08	0.14	-1.05**	-1.01	-1.79
	(.77)	(1.28)	(.24)	(.74)	(.13)	(.23)	(.45)	(.73)	(1.20)
2013	0.90***	-3.64***	-0.64***	1.22***	-0.21***	-0.48***	-0.33***	1.65***	-1.01***
	(.10)	(.17)	(.03)	(.09)	(.03)	(.03)	(.06)	(.10)	(.18)
2014	2.10***	-4.20***	-1.13***	2.91***	-0.76***	-0.76***	-0.40***	4.16***	-0.21
	(.14)	(.24)	(.05)	(.13)	(.04)	(.05)	(.09)	(.14)	(.23)
Constant	110.44***	83.17***	20.79***	97.45***	3.81***	7.96***	40.66***	59.75***	28.51***
	(.07)	(.12)	(.03)	(.07)	(.02)	(.02)	(.05)	(.07)	(.12)
Fixed Effects	NPI	NPI	NPI	NPI	NPI	NPI	NPI	NPI	NPI
R2	0.95	0.95	0.91	0.96	0.92	0.94	0.94	0.94	0.92
Unique Physicians	255,747	142,411	184,304	250,836	32,277	88,434	222,626	207,434	74,412
N	767,240	427,234	552,913	752,509	96,832	265,301	667,877	622,303	223,235

** p<0.05, ** p<0.01, *** p<0.001*

Source: 2014 SK&A OBP file, 2012-2014 Medicare Physician and other Supplier PUF. Note that the Public ACO dummy is omitted due to multicollinearity with physician-level fixed effects. Standard errors clustered at the primary care service area (PCSA) level.

Appendix Table 22. Triple Difference Results Across Aggregate Per Capita Utilization Measures by ACO Type and Internal Incentives

	Part B Payments Per Bene.	Total Services Per Bene.
ACO * Post * Low Internal Incentives* System-Led	1.85	-0.06
	(2.92)	(.18)
ACO * Post * Medium Internal Incentives* System-Led	-7.38***	-0.66***
	(2.67)	(.16)
ACO * Post * High Internal Incentives* System-Led	-0.38	-0.53**
	(3.93)	(.24)
ACO * Post * Unreported Internal Incentives* System-Led	-8.03*	-0.49**
	(4.23)	(.20)
ACO * Post * Unreported Internal Incentives* Jointly-Led	-13.37**	-0.73**
	(5.91)	(.30)
ACO * Post * Unreported Internal Incentives* Physician-Led	-101.97***	-8.74***
	(31.38)	(2.83)
2013	-1.71***	0.10***
	(.53)	(.03)
2014	-0.68	0.60***
	(.75)	(.06)
Constant	331.14***	7.77***
	(21.78)	(.44)
Fixed Effects	NPI	NPI
R2	0.92	0.88
Unique Physicians	392,400	392,400
N	1,177,200	1,177,200

** p<0.05, ** p<0.01, *** p<0.001*

Source: 2014 SK&A OBP file, 2012-2014 Medicare Physician and other Supplier PUF. Standard errors clustered at the primary care service area (PCSA) level Treatment effects for non-system ACOs were included in the regression, but insignificant results for the low, medium, and high incentive groups were all insignificant and are not reported.

Appendix Table 23 presents results from specifications investigating effects of ACO adoption on patient panel characteristics. Consistent with a hypothesis of advantageous selection of healthier, potentially more profitable patients by ACO physicians, adopting physicians are found on average to significantly increase the white and non-dual eligible share of patients within their beneficiary panels. The effect size of these increases, each approximately half a percentage point, is plausibly low given the relative freedom of physician choice provided to beneficiaries. However, no corresponding reductions are significantly estimated for the share of beneficiaries treated by the physician whom are black or dual-eligible. The last two columns introduce the triple difference interaction terms for ACO organizational types. While the interaction terms were insignificant for the racial patient share measures (not presented), the dual eligibility measures are suggestive of some selection by both physician and system led ACOs.

Appendix Table 23. DID Results Across Patient Selection Measures

	DID Estimates				Triple Difference Estimates	
	% White Bene.	% Black Bene.	% Non-Dual Eligible Bene.	% Dual Eligible Bene.	% Non-Dual Eligible Bene.	% Dual Eligible Bene.
ACO Treatment * Post	0.007**	0	0.004**	0	0	0.07**
ACO * Post * System-Led	-	-	-	-	0.011*	-0.005
ACO * Post * Physician-Led	-	-	-	-	0	-0.010***
2013	0.01***	0.00***	0.01***	-0.00***	0.01***	-0.00***
2014	0.01***	0.00***	0.00***	-0.01***	0.00***	-0.01***
Constant	0.62***	0.07***	0.64***	0.25***	0.64***	0.25***
Fixed Effects	NPI	NPI	NPI	NPI	NPI	NPI
R2	0.88	0.83	0.9	0.84	0.84	0.91
Unique Physicians	392,400	392,400	392,400	392,400	392,400	392,400
N	1,177,200	1,177,200	1,177,200	1,177,200	1,177,200	1,177,200

** p<0.05, ** p<0.01, *** p<0.001*

Source: 2014 SK&A OBP file, 2012-2014 Medicare Physician and other Supplier PUF. Standard errors clustered at the primary care service area (PCSA) level.

Appendix Table 24. Triple Differences Results for PCP to Specialist Self-Referral Shares by Specialty

	Cardiology	Surgery	Emergency	Gastroenterology	Pulmonology	Orthopedics	Psychiatry
ACO Treatment*Post	0.008	0.002	0.002	0.003	0.001	0	0.006
ACO * Post * System-Led	0.040***	0.016*	0.028**	0.039***	0.025*	0.040***	-0.001
ACO* Post * Physician-Led	-0.018***	-0.008	-0.012	-0.009	-0.008	-0.009	-0.015*
2011	0.011***	0.005***	0.006***	0.007***	0.009***	0.007***	-0.001
2012	0.022***	0.014***	0.014***	0.014***	0.017***	0.014***	0.005**
2013	0.033***	0.020***	0.020***	0.019***	0.025***	0.018***	0.011***
2014	0.039***	0.023***	0.020***	0.022***	0.029***	0.021***	0.013***
Constant	0.196***	0.135***	0.175***	0.132***	0.142***	0.189***	0.092***
Fixed Effects	NPI	NPI	NPI	NPI	NPI	NPI	NPI
R2	0.95	0.90	0.94	0.94	0.93	0.96	0.93
Unique Physicians	75,938	57,453	32,093	33,968	29,094	25,027	12,016
N	379,690	287,265	160,465	169,840	145,470	125,135	60,080

** p<0.05, ** p<0.01, *** p<0.001*

Source: 2014 SK&A OBP file, 2010-2014 Medicare Physician Referral Data PUF. Standard errors clustered at the primary care service area (PCSA) level.

Appendix Table 25. DID Results for PCP to Organizational Provider Referrals 2010 - 2014

	Acute Care Hospital	Home Health	Skilled Nursing Facility	Labs
ACO Treatment*Post	9.112	3.583	6.408	30.00***
2011	21.630***	-6.528***	-2.709	-28.53***
2012	24.427*	-12.136***	-23.042***	-68.48***
2013	-5.618	-20.664***	-55.921***	-94.84***
2014	-61.522***	-31.743***	-75.687***	-136.39**
Constant	1583.49***	220.03***	608.31***	987.61***
Fixed Effects	NPI	NPI	NPI	NPI
R2	0.803	0.836	0.914	0.873
Unique Physicians	116,493	58,222	41,662	101,231
N	582,465	291,110	208,310	506,155

** p<0.05, ** p<0.01, *** p<0.001*

Source: 2014 SK&A OBP file, 2010-2014 Medicare Physician Referral Data PUF. Standard errors clustered at the primary care service area (PCSA) level.

Appendix Table 26. DID Results Across Aggregate Utilization and Marginal Treatment Measures w/ Selection Controls

	Aggregate Utilization Measures			Marginal Treatment Measures	
	Total Unique Bene.	Total Part B Payments ($)	Total Services	Part B Payments Per Bene.	Total Services Per Bene.
ACO Treatment * Post	-0.25	-1675.35	-492.26***	-6.96***	-0.76***
	(7.87)	(1,083.39)	(126.34)	(1.98)	(0.13)
2013	10.74***	1075.60**	90.21*	-1.88	0.22*
	(1.67)	(459.39)	(40.29)	(1.01)	(0.10)
2014	16.31***	3043.64***	421.11***	0.03	0.79***
	(1.83)	(749.93)	(59.71)	(1.98)	(0.13)
2015	14.73***	4731.44***	799.18***	0.71	1.62***
	(2.50)	(967.60)	(85.69)	(2.55)	(0.18)
Market-Year Controls					
County Unemp. Rate By Year	0.07	80.23**	1.15	0.08	0
	(0.07)	(28.16)	(2.80)	(0.05)	(0.00)
County Median HH Income by Year	0	0.08	-0.02**	0	0
	(0.00)	(0.08)	(0.01)	(0.00)	(0.00)
County Part C Penetration Rate by Year	-0.06***	-15.82***	-0.33***	0	0
	(0.00)	(0.99)	(0.10)	(0.00)	(0.00)
County Part D Penetration Rate by Year	0	2.17***	0.13*	0.00***	0
	(0.00)	(0.64)	(0.06)	(0.00)	(0.00)
County Percent Bene. that are Dual-Eligible by Year	-0.02***	-4.08**	-0.26**	0	0
	(0.00)	(1.32)	(0.09)	(0.00)	(0.00)
Physician-Panel-Year Controls					
Physician Panel % Dual Eligible by Year	-3.53	-7007.8***	-488.03***	-14.17**	-0.70***
	(2.86)	(1,258.20)	(167.95)	(4.59)	(0.26)
Physician Panel % Non-White by Year	144.49***	37673.3***	1361.90***	-1.82	0.62*
	(6.89)	(2,001.72)	(220.85)	(6.70)	(0.31)
Physician Panel % w/ Afib. by Year	155.60***	36278.7***	559.84*	-0.97	-1.40*
	(7.08)	(2,202.6	(250.86)	(7.91)	(0.64)

		1)			
Physician Panel % w/ Alzheimer's Disease by Year	88.65***	19645.59***	-182.98	-1	-1.87***
	(5.36)	(1,946.40)	(199.27)	(7.37)	(0.44)
Physician Panel % w/ Asthma by Year	94.94***	20015.88***	-250.73	5.11	-2.05**
	(5.34)	(2,078.33)	(280.64)	(7.06)	(0.70)
Physician Panel % w/Cancer by Year	160.08***	40863.38***	1400.63***	40.71	3.37***
	(11.80)	(5,743.24)	(368.07)	(23.83)	(0.99)
Physician Panel % w/ CHF by Year	-37.46***	-14306.47***	-2400.41***	-0.91	-3.29***
	(4.29)	(2,290.65)	(224.46)	(8.50)	(0.40)
Physician Panel % w/ CKD by Year	-5.09	-2841.87	-195.07	5.82	-0.34
	(3.54)	(1,551.60)	(251.20)	(6.00)	(0.39)
Physician Panel % w/ COPD by Year	-14.88***	-17175.52***	1031.98***	-68.78***	1.26***
	(4.21)	(1,482.43)	(144.76)	(8.10)	(0.31)
Physician Panel % w/ Depression by Year	23.00***	6315.46***	277.16**	25.27***	0.29
	(2.59)	(1,307.16)	(83.02)	(7.51)	(0.25)
Physician Panel % w/ Diabets by Year	11.42**	2504.27	60.88	-9.91	0.25
	(3.82)	(1,445.05)	(152.37)	(7.52)	(0.49)
Physician Panel % w/ Hyperl. by Year	21.83**	6059.84***	562.73**	0.89	0
	(8.99)	(1,477.97)	(211.81)	(14.40)	(0.54)
Physician Panel % w/ Hypert. by Year	3.76	-4652.37***	120.63	3.55	-0.12
	(10.29)	(1,311.28)	(165.73)	(13.55)	(0.40)
Physician Panel % w/ IHD by Year	-3.11	8669.29***	125.42	47.97	1.06
	(8.44)	(1,991.48)	(233.72)	(26.06)	(0.77)
Physician Panel % w/ OST by Year	261.37***	88575.14***	3602.94***	85.10***	5.25***
	(7.53)	(4,267.81)	(557.65)	(20.03)	(0.91)
Physician Panel % w/ RAOA by Year	42.47***	8484.06***	176.45	25.29	0.6
	(8.93)	(1,460.90)	(157.90)	(18.88)	(0.41)

Physician Panel % w/ Sciot. by Year	264.57***	57731.45***	1419.89***	-37.79	-0.51
	(7.49)	(3,496.42)	(197.74)	(20.94)	(0.68)
Physician Panel % w/ Stroke by Year	292.87***	72305.06***	1670.26***	-35.41**	-0.85
	(9.94)	(3,784.65)	(423.63)	(11.14)	(0.83)
Physician Panel - Beneficiary Average HCC Risk Score by Year	-37.81***	-3517.87***	3.6	11.36***	0.23
	(2.49)	(1,003.37)	(63.39)	(3.05)	(0.15)
Constant	611.62***	152197.79***	4726.93***	255.72***	8.00***
	(26.29)	(7,456.65)	(654.35)	(16.41)	(1.04)
Fixed Effects	NPI	NPI	NPI	NPI	NPI
R2	0.92	0.94	0.84	0.88	0.82
Unique Physicians	392,400	392,400	392,400	392,400	392,400
N	1,177,200	1,177,200	1,177,200	1,177,200	1,177,200

** p<0.05, ** p<0.01, *** p<0.001*

Source: 2014 SK&A OBP file, 2012-2014 Medicare Physician and other Supplier PUF. Standard errors clustered at the primary care service area (PCSA) level.

Appendix Table 27. DID Results Across Aggregate Per Capita Utilization Measures w/ Selection Controls

Dep. Variable	Part B Payments Per Bene.			Total Services Per Bene.		
	All Physicians	Primary Care Physicians	Specialists	All Physicians	Primary Care Physicians	Specialists
ACO Treatment * Post	-6.96***	4.42***	-15.84***	-0.76***	-0.01	-1.21***
	(1.98)	(1.22)	(3.04)	(0.13)	(0.09)	(0.21)
2013	-1.88	-1	-2.34	0.22*	0.25***	0.19
	(1.01)	(0.96)	(1.41)	(0.10)	(0.06)	(0.13)
2014	0.03	5.88***	-1.07	0.79***	0.52***	0.91***
	(1.98)	(1.35)	(2.72)	(0.13)	(0.13)	(0.18)

2015	0.71	17.26**	-5.32	1.62***	2.28***	1.32***
	(2.55)	(1.76)	(3.55)	(0.18)	(0.21)	(0.24)
Market-Year Controls						
County Unemp. Rate By Year	0.12**	0.06	0	0.01	0	0.12**
	(0.04)	(0.08)	(0.00)	(0.00)	(0.01)	(0.04)
County Median HH Income by Year	0.00*	0	0	-0.00*	0	0.00*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
County Part C Penetration Rate by Year	-0.00**	0	0	0	0	-0.00**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
County Part D Penetration Rate by Year	0.00**	0.00**	0	-0.00**	0	0.00**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
County Percent Bene. that are Dual-Eligible by Year	0	0	0	0	0	0
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Physician Panel-Year Controls						
Physician Panel % Dual Eligible by Year	-14.17**	-9.11	-16.43**	-0.70***	0.03	-1.08***
	(4.59)	(4.99)	(6.32)	(0.26)	(0.27)	(0.37)
Physician Panel % Non-White by Year	-1.82	4.58	-5.44	0.62*	0.14	0.85
	(6.70)	(6.51)	(10.32)	(0.31)	(0.20)	(0.48)
Physician Panel % w/ Afib. by Year	-0.97	25.24**	-9.12	-1.40*	-0.87	-1.75*
	(7.91)	(9.56)	(10.64)	(0.64)	(0.73)	(0.89)
Physician Panel % w/ Alzheimer's Disease by Year	-1	-11.49	-0.56	-1.87***	-2.82***	-1.04
	(7.37)	(9.14)	(9.70)	(0.44)	(0.66)	(0.59)
Physician Panel % w/ Asthma by Year	5.11	-38.85***	24.45**	-2.05***	-3.10***	-1.52
	(7.06)	(9.63)	(8.95)	(0.70)	(0.76)	(0.96)
Physician Panel % w/Cancer by Year	40.71	66.36*	30.38	3.37***	2.38	3.75***
	(23.83)	(26.00)	(30.25)	(0.99)	(2.64)	(1.04)
Physician Panel % w/ CHF by Year	-0.91	-12.46	3.81	-3.29***	-0.26	-4.39***
	(8.50)	(8.63)	(11.75)	(0.40)	(0.41)	(0.56)
Physician Panel % w/ CKD by Year	5.82	-0.46	12.41	-0.34	-1.39***	-0.35
	(6.00)	(7.92)	(8.58)	(0.39)	(0.32)	(0.53)

Physician Panel % w/ COPD by Year	-68.78***	-5.34	-91.44***	1.26***	0.05	1.44**
	(8.10)	(5.88)	(11.14)	(0.31)	(0.39)	(0.41)
Physician Panel % w/ Depression by Year	25.27***	49.46***	12.31	0.29	2.06***	-0.31
	(7.51)	(6.64)	(10.39)	(0.25)	(0.37)	(0.33)
Physician Panel % w/ Diabets by Year	-9.91	-14.14**	-33.21**	0.25	0.85**	0.24
	(7.52)	(5.41)	(11.18)	(0.49)	(0.30)	(0.71)
Physician Panel % w/ Hyperl. by Year	0.89	19.97***	-6.48	0	0.45	-0.27
	(14.40)	(5.90)	(21.15)	(0.54)	(0.37)	(0.77)
Physician Panel % w/ Hypert. by Year	3.55	-18.07*	12.49	-0.12	-0.26	-0.09
	(13.55)	(7.10)	(18.56)	(0.40)	(0.43)	(0.52)
Physician Panel % w/ IHD by Year	47.97	4.6	65.88	1.06	-0.05	1.53
	(26.06)	(7.10)	(38.18)	(0.77)	(0.40)	(1.11)
Physician Panel % w/ OST by Year	85.10***	77.97***	85.36**	5.25***	3.71***	5.99***
	(20.03)	(9.74)	(29.22)	(0.91)	(0.66)	(1.31)
Physician Panel % w/ RAOA by Year	25.29	30.73***	23.36	0.6	0.66	0.59
	(18.88)	(6.98)	(27.06)	(0.41)	(0.45)	(0.57)
Physician Panel % w/ Sciot. by Year	-37.79	-39.74	-42.25***	-0.51	-1.27	-0.16
	(20.94)	(70.23)	(10.21)	(0.68)	(1.76)	(0.64)
Physician Panel % w/ Stroke by Year	-35.41**	27.54	-56.10***	-0.85	-0.74	-0.68
	(11.14)	(17.63)	(13.56)	(0.83)	(0.94)	(1.12)
Physician Panel - Beneficiary Average HCC Risk Score by Year	11.36***	14.04**	10.78**	0.23	-0.3	0.44*
	(3.05)	(4.55)	(3.70)	(0.15)	(0.27)	(0.18)
Constant	331.09***	263.39***	360.47***	7.78***	6.53***	8.30***
	(.40)	(.37)	(.55)	(.03)	(.01)	(.04)
Fixed Effects	NPI	NPI	NPI	NPI	NPI	NPI
R2	0.92	0.87	0.92	0.88	0.88	0.88

Unique Physicians	392,400	118,977	273,423	392,400	118,977	273,423
N	1,177,200	356,931	820,269	1,177,200	356,931	820,269

** p<0.05, ** p<0.01, *** p<0.001*

Source: 2014 SK&A OBP file, 2012-2014 Medicare Physician and other Supplier PUF. Standard errors clustered at the primary care service area (PCSA) level.

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