Decomposing Medical-Care Expenditure Growth*

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Abstract

Medical-care expenditures have been rising rapidly, accounting for almost one-fifth of GDP in 2009. In this study, we assess the sources of the rising medical-care expenditures in the commercial sector. We employ a novel framework for decomposing expenditure growth into four components at the disease level: service price growth, service utilization growth, treated disease prevalence growth, and demographic shift. The decomposition shows that growth in prices and treated prevalence are the primary drivers of medical-care expenditure growth over the 2003 to 2007 period. There was no growth in service utilization at the aggregate level over this period. Price and utilization growth were especially large for the treatment of malignant neoplasms. For many conditions, treated prevalence has shifted towards preventive treatment and away from treatment for late-stage illnesses.

*The views expressed in this paper are solely those of the authors and do not necessarily reflect the views of the Bureau of Economic Analysis, the Federal Reserve Bank of San Francisco, or the Board of Governors of the Federal Reserve System.

1 Introduction

Medical-care expenditure per capita in the United States is larger and rising faster relative to other developed countries (see Chernew and Newhouse (2012) and Chandra and Skinner (2012)). In 2009 health care accounted for more than 17 percent of U.S. GDP, which was more than double the average of other OECD countries. Despite the substantial expenditures on medical care in the United States, many gaps remain in our understanding of the sources of expenditure growth. Current national statistics that track spending by service category (for example, physicians, hospitals and prescription drugs) do not convey information about spending for specific disease categories. To fill this void, academics and policy makers have advocated for more detailed statistics on health-care expenditures centered around the ultimate goal: disease treatment (see Berndt et al. (2000) and Accounting for Health and Health Care (2010)). Additional information on disease spending may provide greater insight into how to contain and efficiently manage health-care expenditure growth.

We analyze health-care expenditures in the commercial sector over the period 2003 to 2007. The commercial health-care market is economically important, accounting for 60 percent more expenditures than Medicare in 2009. Over this period of study, commercial medical-care expenditures per commercially insured person grew by 26 percent, surpassing the 20 percent growth in nominal GDP per capita.[1] Prior research studies have examined several factors driving the growth in medical-care expenditures, however, each of these studies leaves out pieces of the puzzle. For instance, Roehrig and Rousseau (2011) and Thorpe, Florence, and Joski (2004) look at the cost of disease and the prevalence of disease, but do not analyze changes in service prices or service utilization (that is, the quantity of services per episode of care); Aizcorbe and Nestoriak (2011) and Dunn et al. (2012a) look at cost of disease treatment used as a measure of disease price growth, but do not assess disease prevalence. Statistical agencies such as the Bureau of Labor Statistics (BLS) and Bureau of Economic Analysis (BEA), as well as research by

[1] Commercial medical-care expenditure growth is calculated from the National Health Expenditure Accounts. Overall inflation as reported by the BEA PCE deflator grew by 11.5 percent over the period of study. Commercial premiums also grew faster than inflation with a growth rate of around 32 percent according to estimates from the Kaiser Employee Health Benefit Survey.

Bundorf, Royalty, and Baker (2009) report changes in service prices for precisely defined services, but do not focus on the cost of disease treatment or disease prevalence.

The aim of this study is to more comprehensively assess the sources of medical-care expenditure growth. We do so by decomposing expenditure growth into four distinct components: service-price growth, service-utilization growth, prevalence-of-treated-disease growth, and demographic shift. We track and dissect these key components of medical-care expenditure growth for the years 2003 to 2007 for the commercial sector using a rich claims database from MarketScan. The framework presented in this paper breaks expenditures into various components applying a similar methodology to that developed in Dunn, Shapiro and Liebman (2012a). First, using demographic population weights assessed in Dunn, Liebman, and Shapiro (2012b), we extract expenditure growth attributable to demographic shifts—primarily, an aging population. Second, as advocated by most health experts, we allocate expenditures into disease level categories. This allows protocols, technologies, and prices relevant for treating specific diseases to vary uniquely over time. Third, we break expenditures down into expenditure per treatment and treated prevalence of a disease. For example, in the case of hypertension, we track the number of episodes of treatment for hypertension per capita as well as the expenditure per episode of treating hypertension. Finally, expenditure per episode of treatment is split into service price and service utilization. Service price represents the payment for a specific service, for example, a 15-minute office visit. Service utilization represents the quantity of services performed during an episode of treatment. For example, in our methodology, a 30-minute doctor office visit will be a higher quantity of services than a 15-minute office visit.

Analyzing each of these factors within a single framework allows for a simple and tractable way of comparing the various contributors to medical-care expenditure growth. Foremost, determining whether expenditures are rising from disease prevalence, service utilization, service prices, or demographic reasons is informative to policy makers attempting to hold back the rising cost of health care. The methodology also provides a more precise mapping between BLS methods (which track price per service) and the types of price indexes that health economists have advocated (expenditure per episode for a specific disease, often referred to as a disease price).

We find that, between 2003 and 2007, rising medical-care expenditures per capita (that is, per commercially enrolled person) came from two primary sources: an increase in the prevalence of treated diseases (accounting for around one-third of the increase in expenditure growth) and an increase in service prices (accounting for around half of the increase in expenditure growth). The remaining increase is attributable to demographic shifts, in particular, a slightly aging commercially insured population. Interestingly, there is no aggregate growth in expenditures due to service utilization per episode. In fact, service utilization may be falling slightly for some conditions. While service price growth is a large contributor to expenditure growth, it is important to highlight that price growth does not greatly exceed inflation. After deflating price growth measures by the national personal consumption expenditure (PCE) deflator, we find that growth in prevalence accounts for two-thirds of expenditure growth in our sample.[2]

The three largest contributors to expenditure growth are the medical practice categories of orthopedics, gastroenterology, and endocrinology. These practice categories represented 33 percent of expenditures in 2003 but made up 40 percent of expenditure growth between 2003 and 2007. Each of these practice categories had large growth in service prices and the prevalence of treated disease. The major practice category with the largest expenditure growth was preventive and administrative services, which grew 64 percent over the sample period. On the flip side, cardiology made up 12 percent of 2003 expenditures but accounted for less than 8 percent of the share in expenditure growth. This relatively slow rise in expenditure per capita for cardiology services is attributable to a decline in the prevalence of heart disease but also to a decrease in service utilization. Our decomposition shows that the decline in service utilization was driven by a shift from inpatient to outpatient services and from brand to generic drugs. These shifts may be indicative of greater efficiency, since fewer resources are necessary to treat each episode. The shifts are reflected in lower disease price growth relative to the service price index, which holds utilization constant. This finding is consistent with the work of Cutler et al. (1998), who find that a price index that allows for greater substitution

[2] The remaining 10 percent is attributable to real service price growth and 20 percent to demographic shift. This result is somewhat consistent with the finding of Bundorf, Royalty, and Baker (2009) that, after accounting for overall inflation, shows that the growth in the health sector is mostly driven by nonprice factors.

across services leads to lower price growth for the case of heart attack treatments.

Digging deeper into the specific disease categories reveals some interesting patterns. Within cardiology and endocrinology services, there has been a large increase in the prevalence of early-stage contributors to heart disease such as hypertension, diabetes, obesity, and hyperlipidemia. However, there has been a decline in the prevalence of ischemic heart disease. This pattern may indicate that people are simply seeking treatment for heart disease at an earlier stage of illness. Indeed, there has been a large increase in spending on preventive services across the entire sample. For example, two of the largest contributors to growth in spending for gastroenterology were attributable to preventive services. Specifically, there was a 41 percent increase in expenditure per capita on "gastroenterology signs and symptoms" (a large portion of which includes colonoscopy) and a 34 percent increase in expenditure per capita for patients with "non-malignant neoplasm of intestines" (e.g., benign polyps). Our decomposition shows that the majority of this growth is attributable to an increase in the prevalence of treatment and demographic shifts.

Our decomposition also sheds light on productivity in the treatment of cancer. Over the four-year sample period, expenditure per capita rose twice as fast for malignant neoplasms (48 percent growth in expenditure per capita) than non-malignant neoplasms (24 percent growth in expenditure per capita). A large reason for the discrepancy is the difference between growth in the cost of treatment (that is, expenditure per episode of care). Service prices for malignant neoplasms grew over twice as fast as service prices for non-malignant neoplasms. This may indicate that more expensive and innovative services are playing a role in cancer spending growth.

This paper focuses on the economic analysis of the components of medical care expenditure growth and trends. However, there are several methodological issues that arise when studying the components of expenditure growth that are not covered in this paper. Some of these topics are explored in companion pieces to this work: (1) Dunn et al. (2012b) examine different approaches for assigning medical services to disease categories and the effect of these assignments on the components of spending growth; (2) Dunn, Liebman, and Shapiro (2012a) examine alternative strategies for separating utilization and price, which offer some implications for medical-care price indexes; (3) Dunn, Lieb-

man, and Shapiro (2012b) examine the representativeness of the data used in our study and the effects of analyzing different samples and applying alternative weights; and (4) Dunn, Shapiro, and Liebman (2012) study the geographic differences in expenditure levels across MSAs.

2 Methodology of Index Construction

The methodology of this paper borrows heavily from the Dunn, Shapiro, and Liebman (2012) study of geographic variation in disease expenditures. However, instead of focusing on differences across regions, we examine differences over time. To begin, we measure expenditure per capita for disease d for time period t, $C^*_{d,t}$ which is simply total expenditures for disease d in period t divided by the total commercial-insured population in period t. To create a measure of medical-care expenditure growth, we form the following expenditure-per-capita index (ECI):

$$ECI_{d,t} = \frac{C^*_{d,t}}{C^*_{d,0}}, \tag{1}$$

where $C^*_{d,0}$ is expenditure per capita for disease d in the base period, 0. Next, we create a demographically fixed ECI, or $DECI$, by applying age, geographic location, and gender weights to our selected commercially insured population, so that the age and sex distribution is identical across regions and time periods.[3] A measure of demographically fixed medical care expenditure growth from period 0 (the base period) to t is then:

$$DECI_{d,t} = \frac{C_{d,t}}{C_{d,0}} \tag{2}$$

where $C_{d,t}$ is expenditure per capita after fixing the demographic distribution to the base period. Note that any difference between the ECI and $DECI$ will be attributable to demographic shifts in the commercially insured population. We label this the "demographic residual" (Dem):

[3] A detailed discussion regarding the use of demographic weights is presented in Dunn, Liebman, and Shapiro (2012b).

$$Dem_{d,t} = ECI_{d,t} - DECI_{d,t} + 1. \tag{3}$$

Since the denominator of the $C_{d,t}$ term is the full population, this measure of expenditure growth does not take into account the health of the population. For instance, if expenditures per capita are higher in the second period because more individuals develop ischemic heart disease (i.e., a rise in the prevalence of ischemic heart disease), the expenditure measure $C_{d,t}$ will grow, even if the expenditure per episode of heart disease does not change. Alternatively, $C_{d,t}$ may grow if the expenditure per heart disease episode increases, even if prevalence remains unchanged. In the following section we will decompose the growth in population expenditures into the prevalence of the condition and the expenditure per episode of the condition.

2.1 Decomposing Expenditure per Capita into Expenditure Per Episode and Prevalence of Treated Disease

We divide demographically fixed expenditure per capita, $C_{d,t}$, into two components. One component is the prevalence of treated disease index, $PREV_{d,t}$, which we define as growth in the demographically fixed prevalence of treated disease, $prev_{d,t}$:

$$PREV_{d,t} = \frac{prev_{d,t}}{prev_{d,0}}, \tag{4}$$

where $prev_{d,t}$ is the number of episodes treated in the population divided by the commercially insured population, holding fixed the demographic distribution. Note that $prev_{d,t}$ includes only those who are aware of their condition and seek some medical attention, and excludes those individuals who are unaware of their condition or are aware of their condition and choose not to be treated.[4]

The second component of $C_{d,t}$ is the expenditure per episode d, $c_{d,t}$. The value $c_{d,t}$ may be calculated by dividing total expenditures of disease d by the number of episodes of disease d in period t, holding fixed the demographic distribution to the base period.

[4]Those individuals who have a condition but are unaware that they have a condition or do not seek medical attention for their condition would be considered in measuring the population's prevalence, but are not included in the treated prevalence figure.

It follows that the medical-care expenditure index, or MCE index, is a measure of the medical-care expenditures for the treatment of an episode of care for a certain disease, and is defined as the dollar amount of medical care used until treatment is completed.[5] Denoting $c_{d,0}$ as the average expenditure per episode in the base period, $t = 0$, the MCE index for disease d is the ratio of the two measures:

$$MCE_{d,t} = \frac{c_{d,t}}{c_{d,0}} \tag{5}$$

Since this index controls for the health of the individual, it may be viewed as measuring the cost of treatment. Thus, if the $MCE_{d,t}$ is larger than one, it signifies that the expenditure for treating disease d is larger than the base period and if the index is less than one it signifies that the expenditure is less than the base.

Using these equations it follows that $C_{d,t} = c_{d,t} \cdot prev_{d,t}$. From this we can see that the $DECI_{d,t}$ may be decomposed into its two components, which include the episode-based index, $MCE_{d,t}$ and the prevalence of treated disease index, $PREV_{d,t}$:[6]

$$DECI_{d,t} = MCE_{d,t} + PREV_{d,t} + \frac{(prev_{d,t} - prev_{d,0})(c_{d,t} - c_{d,0})}{prev_{d,0} c_{d,0}} - 1. \tag{6}$$

This equation makes it clear that the $DECI$ will rise if there is either an increase in the $PREV_{d,t}$ or an increase in the $MCE_{d,t}$. These two components of expenditure capture distinct elements of cost growth. Changes in the prevalence of a condition capture the changing health of the population, such as the growth in diabetes due to obesity. It may also reflect a growing awareness of a condition, such as the increase in awareness and diagnosis of high cholesterol. The second component of care may be viewed as the price for treating the disease, which includes the prices of those services and also the mix of those services provided. Assuming that the quality of the underlying treatment mix remains constant, this treatment price reflects the productivity in the health sector for the treatment of disease d.

[5] For example, for an individual with a broken foot, the episode of treatment will be defined by the dollar of medical services used to treat that condition from the first visit to a provider until the foot is healed. For medical conditions that are chronic, we interpret an episode as expenditure for services used to treat the chronic condition over a one-year period.

[6] A decomposition using logs is: $\log(DECI_{d,t}) = \log(MCE_{d,t}) + \log(PREV_{d,t})$.

The indexes presented here are directly related to a simple and often reported figure, total medical-care expenditures per capita. To see this, we can create aggregate disease-specific indexes from the population-based measure, $DECI_{d,t}$. When $DECI_{d,t}$ is weighted by the national expenditure share for each disease in the base period, this becomes a measure of medical-care expenditures per capita relative to the base period's medical-care expenditures per capita:

$$\begin{aligned} DECI_t &= \sum_D DECI_{d,t} \cdot (\text{Expenditure Share}_0) \\ &= \sum_D \frac{C_{d,t}}{C_{d,0}} \cdot \left(\frac{C_{d,0}}{\sum_D C_{d,0}} \right) = \frac{\sum_D C_{d,t}}{\sum_D C_{d,0}} \\ &= \frac{\text{Medical-Care Expenditures Per Person}_t}{\text{Medical-Care Expenditures Per Person}_0}. \end{aligned}$$

2.2 Expenditure Per Episode Decomposition: Service Price and Service Utilization

Next, we decompose the MCE index into two distinct components: a service price and service utilization component. This can be seen more easily by showing that the average expenditure is calculated by totaling dollars spent on all services to treat the condition and dividing those dollars by the number of episodes: $c_{d,t} = \sum_s p_{d,t,s} Q_{d,t,s} / N_{d,t}$, where $Q_{d,t,s}$ is the quantity of services for service type, s; $p_{d,t,s}$, is the service price for service type s; and $N_{d,t}$ is the number of episodes treated.

Measuring service utilization is not a straightforward task since the definition of a "quantity of service" is a bit ambiguous and there are a variety of ways that one could define it across various service types.[7] The approach taken here to define service utilization closely follows the methodology of Dunn, Shapiro, and Liebman (2012). Ideally, we would like the definition of a specific service to depend on how the price of that service is typically set and paid. For example, for physician services, individuals pay a unique price for each procedure done to them (that is, the insurer and the patient together pay this

[7] The key service types are inpatient hospital, outpatient hospital, physician office, and prescription drugs.

amount). Therefore, we would like service utilization to reflect the amount of procedures done. Since not all procedures are equivalent, we weight each procedure by the average dollar amount paid for that procedure. This is a similar concept to a relative value unit or RVU, which measures the approximate cost of each procedure and is used by Medicare to reimburse physicians for each procedure that is performed.[8] For prescription drugs, we define the unit of service as a prescription filled, although this is a misnomer since a prescription is really a good, not a service. Since prescriptions vary depending on the active ingredient, the manufacturer, and strength, we weight each unique drug purchase by the average dollar amount we observe for that particular prescription across time periods. For hospital facility charges for inpatient stays, the prices paid to facilities are often set based on a visit for a particular disease. Therefore, for inpatient stays we define the unit of service as the visit. For outpatient facility services we also define the service as the visit. The exact construction of these measures is explained in more detail later in this paper.

Given the definitions of service and expenditure, the price for a particular service type and disease can be calculated by dividing its expenditure by the quantity of services provided: $p_{d,t,s} = \frac{c_{d,t,s}}{(Q_{d,t,s}/N_{d,t})}$ where $c_{d,t,s}$ is the average expenditure on disease d for service type s at time t. For example, the price of an inpatient stay for treating heart disease is the total expenditure of inpatient treatment for heart disease in an area, divided by the quantity of inpatient services for heart disease in that area.

This decomposition allows us to create a service price and service utilization index. To simplify, let $q_{d,t}$ be a vector of services utilized for the typical treatment of diseases in an area, $q_{d,t} = Q_{d,t}/N_{d,t}$, where the component of the utilization vector for service type s is , $Q_{d,t,s}/N_{d,t}$. Also, let $p_{d,t}$ be a vector of service prices, where the component of the vector for service type s is, $p_{d,t,s}$. The service price index (SPI) is then calculated as

$$SPI_{d,t} = \frac{p_{d,t} \cdot q_{d,0}}{c_{d,0}},$$

[8]This framework has also been adopted by the commercial market. In a survey of 20 health plans conducted by Dyckman & Associates, all 20 health plan fee schedules were influenced by a resource-based relative value scale. There are deviations from the basic resource-based relative value scale methodology, so taking the average of observed prices in the market for each procedure is one measure used for capturing the typical resources used for a procedure.

which holds the utilization of services fixed at a base period level. Similarly, the service utilization index (SUI) may be defined as

$$SUI_{d,t} = \frac{p_{d,0} \cdot q_{d,t}}{c_{d,0}},$$

which holds the price of services fixed while allowing the utilization of services to vary. Note that there is a precise relationship between these three indexes that is described by the following decomposition:

$$MCE_{d,t} = SPI_{d,t} + SUI_{d,t} + \frac{(q_{d,t} - q_{d,0})(p_{d,t} - p_{d,0})}{c_{d,0}} - \frac{p_{d,0} \cdot q_{d,0}}{c_{d,0}}$$

Here the MCE index is equal to the service price index, $SPI_{d,t}$, plus the service utilization index, $SUI_{d,t}$, plus a cross term, $\frac{(q_{d,t}-q_{d,0})(p_{d,t}-p_{d,0})}{c_{d,0}}$, and subtracting $\frac{p_{d,0} \cdot q_{d,0}}{c_{d,0}}$ (which is close to 1). The cross term accounts for joint changes in both price vectors and utilization vectors and, in practice, the term is near zero. In the case where there are very few changes in utilization over time, $SUI_{d,t}$ is fixed near 1, then the $MCE_{d,t}$ will entirely be determined by service prices. Similarly, if there are very few changes in service prices over time, $SPI_{d,t}$, is near 1, and the $MCE_{d,t}$ will entirely be determined by utilization.

3 Data

We use retrospective claims data for a sample of commercially insured patients from the MarketScan® Research Database from Thomson Reuters. The specific claims data used is the Commercial Claims and Encounters Database which contains data from the employer and health plan sources containing medical and drug data for several million commercially insured individuals, including employees, their spouses, and dependents. Each observation in the data corresponds to a line item in an "explanation of benefits" form in a medical claim. Each claim can consist of many records, and each encounter can consist of many claims.

We use a sample of enrollees that are not in capitated plans from the MarketScan database for the years 2003 to 2007. We also limit our sample to enrollees with drug benefits because drug purchases will not be observed for individuals without drug cov-

erage. The MarketScan database tracks claims from all providers using a nationwide convenience sample of enrollees. Each enrollee has a unique identifier and includes age, sex, and region information that may be used when calculating patient weights. All claims have been paid and adjudicated.[9]

The claims data were processed using the Symmetry grouper from Ingenix. The grouper assigns each claim to a particular episode treatment group (ETG) disease and severity category. Thus each disease category d represents a type of disease (e.g., hypertension), as well as the severity of the disease classified into up to four severity bins. A higher severity number indicates a more serious medical condition. In this manner, "hypertension 3" is a distinct disease with a higher severity relative to "hypertension 1." The grouper uses a proprietary algorithm, based on clinical knowledge, that is applied to the claims data to assign each record to a clinically homogeneous episode. The episode grouper allocates all spending from individual claim records to a distinct condition; the grouper also uses other information on the claim (e.g., procedures) and information from the patient's history to allocate the spending. An advantage of using the grouper is that it can use patients' medical history to assign diseases to drug claims, which typically do not provide a diagnosis. However, these algorithms are also considered a "black box" in the sense that they rely entirely on the grouper software developer's expertise. The ETG symmetry grouper is applied to one calendar year of data at a time. Although this limits the amount of information used for each person (since we often observe multiple years), it also avoids potential biases that may occur if the grouper is not applied symmetrically across all years.[10]

For all measures but the ECI, demographic weights are applied to each individual to adjust for differences in age, sex, and region across populations, so the expenditure estimates may be comparable across years. Specifically, enrollees in each year are assigned weights so the weighted population has an age and sex distribution that is identical to that of the U.S. commercially insured population in 2007.[11] To look at the growth

[9] Additional details about the data and the grouper used in this paper are in Dunn et al. (2012a).

[10] The ETG grouper allocates each record into one of over 500 disease groups. To symmetrically process the data, we apply the ETG episode grouper on the claims data one year at a time. We explore the robustness of the estimates to various grouping methodologies in Dunn et al. (2012b).

[11] We use 2007 as the base to look at a population of individuals and their diseases that is more similar

in expenditure due to population growth and shifts, we also calculate total weighted spending over this period in a way that allows populations to vary.

3.1 Service Price, Utilization, and Episodes

The number of episodes is a simple count of the total number of episodes of a medical disease for that calendar year. Total episode expenditures are measured as the total dollar amount received by all providers for the services used to treat an episode of a specific disease (including both out-of-pocket payments and amounts paid by insurance carriers).

We created utilization measures, which indicate the quantity of services per episode, based on the specific definitions of services. The service type categories are physician, inpatient hospital, outpatient hospital, prescription drug, and other. Using the definitions of the unit of service for each service type, the price of the service is calculated as the total expenditures for a particular disease and service category, divided by the quantity of services performed for that disease and service category. Furthermore, service utilization for a particular category is defined as the quantity of services divided by the total number of episodes for a particular disease. Below is a listing of the service types and how the quantity of services is measured.

Physician office - Expenditures from physician office visits are from procedures performed in a physician's office. We assign a measure comparable to an RVU for each procedure performed by the physician for that office visit. Specifically, for each Current Procedure Terminology (CPT) code and modifier code, we calculate a relative value unit by computing the average fee for that procedure performed in an office setting. The total amount of services performed in an office is calculated by summing over these calculated RVUs. Note that there is a simple interpretation of these amounts. For example, if the fees are the same as the average computed in our sample, then the total cost of office visit divided by the amount of the visit will be equal to 1.[12]

to our current population distribution. Similar results are found if we use the 2003 population as the base.

[12] Although procedure codes are observed for 98 percent of physician office claim lines, in those cases for which we don't observe a procedure code we calculate the average price for a missing procedure code

Hospital inpatient - Inpatient hospital stays consist of both facility fees paid to the hospital and fees paid to the physician. For the portion of fees paid to the hospital, the amount of services is measured as the average dollar amount for an inpatient stay for the observed disease. For the portion of fees paid to the physician, we assign an RVU in the same way that we calculate an RVU in an office setting. The total amount of services performed in an inpatient setting is calculated by adding the physician and facility amounts.[13]

Hospital outpatient - Outpatient hospital visits are calculated in an identical fashion to the inpatient hospital visits. That is, the facility amount is calculated based on the average outpatient visit for that disease, and the doctor's portion of the total amount is calculated based on the average payment for the procedure codes.

Prescription drugs - The amount of the prescription drug varies based on the molecule, the number of pills in the bottle, the strength of the drug, and the manufacturer. To capture these differences, we calculate the average price for each National Drug Code (NDC), since each prescription is given a unique NDC. The average price for each NDC represents the amount of the service used. If the expenditure on a prescription is greater than this amount, it suggests that prices are above average in the given time period.[14]

All other - The other category primarily includes ambulatory care, independent labs, and emergency room visits. For these services, the amount of each category is measured as the average cost for a visit to that particular place of service, for example, the average cost of an ambulatory care visit to treat ischemic heart disease. For cases where procedure codes are available, we use the average cost of that procedure code for that place of service.

There are a few additional points to note. A small fraction of the procedures (less than 5 percent of the claims observations for nonfacility claim lines) are missing procedure

for patients with a particular disease. The results of the paper do not change substantially if those claim lines missing procedure codes are dropped from the analysis.

[13] As an alternative, we have also examined changing this definition to consider the facility price per inpatient day. The results do not change significantly based on these two alternative measures of utilization.

[14] An 11-digit NDC uniquely identifies the manufacturer, strength, dosage, formulation, package size, and type of package.

codes. For these procedures we use the average price of the missing procedure codes for that service and disease type.

3.2 Summary Statistics

Table 1 provides some basic descriptive statistics for the selected commercially insured population of the MarketScan data. Each enrollee is assigned a population weight based on age, gender, and location so that the number of enrollees represents the actual number of commercially insured enrollees measured by the Current Population Survey (CPS). Note that this table reports figures where weights are applied, so that the population changes and grows with the actual commercially insured population. As described above, when calculating the $DECI$ and subsequent decomposition indexes, we hold fixed the age, gender, and location. There are 455 ETG disease categories in the sample,[15] representing \$454.4 billion for 180.5 million enrollees in 2003, growing to \$589.4 billion and 182.5 million enrollees in 2007. This growth is accompanied by a growth in the number of episodes from 2.7 per enrollee in 2003 to 3.0 per enrollee in 2007. The average age grew slightly from 32.3 to 32.9 over the sample period. The table shows that this growth is primarily from an increased percentage of enrollees over the age of 55.

[15] Severity adjustment increases the number of disease categories to 682. About 19 percent of expenditures are not assigned to any ETG disease category. Ungrouped claims include screening for diseases and other records that cannot be assigned a category. The ungrouped claims are removed from our analysis. If we do not adjust for severity, then the ungrouped share falls to 13 percent, but the results stay the same.

Table 1. Summary Statistics

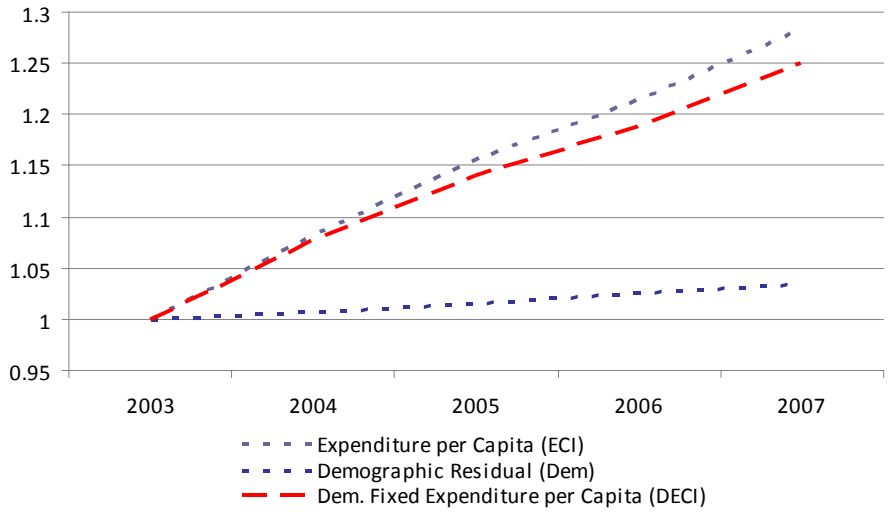
	2003	2007
Expenditure (Billions)	$454.39	$589.35
Enrollees (Millions)	180.58	182.53
Expenditure per Capita (Enrollee)	$2,516	$3,229
Episodes per Capita (Enrollee)	2.71	2.96
Expenditure per Episode	$929	$1,092
Percent Male	49.5%	49.6%
Average Age	32.3	32.9
< Age 18	27.3%	26.3%
Age 18 - Age 24	9.6%	9.6%
Age 25 - Age 34	14.5%	14.7%
Age 35 - Age 54	36.3%	35.6%
> Age 55	12.2%	13.8%

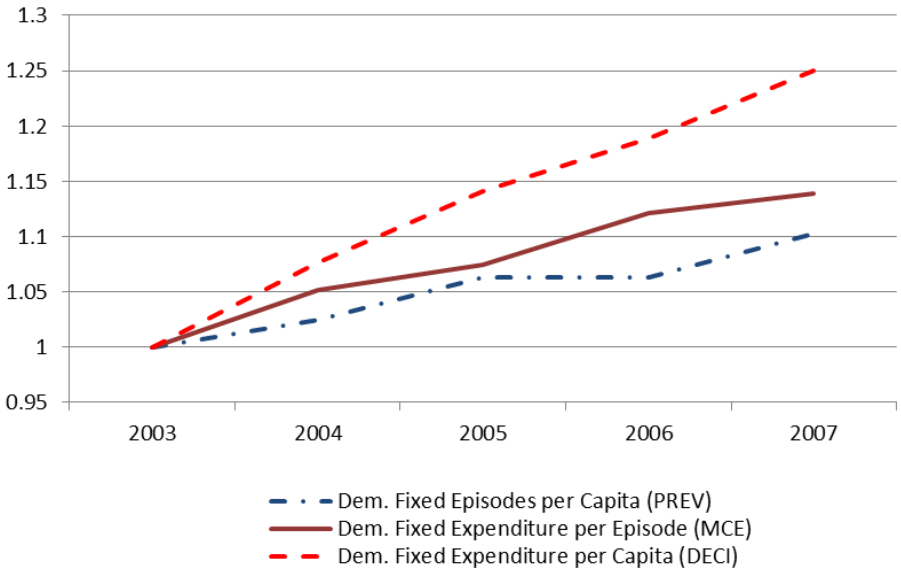
4 Results

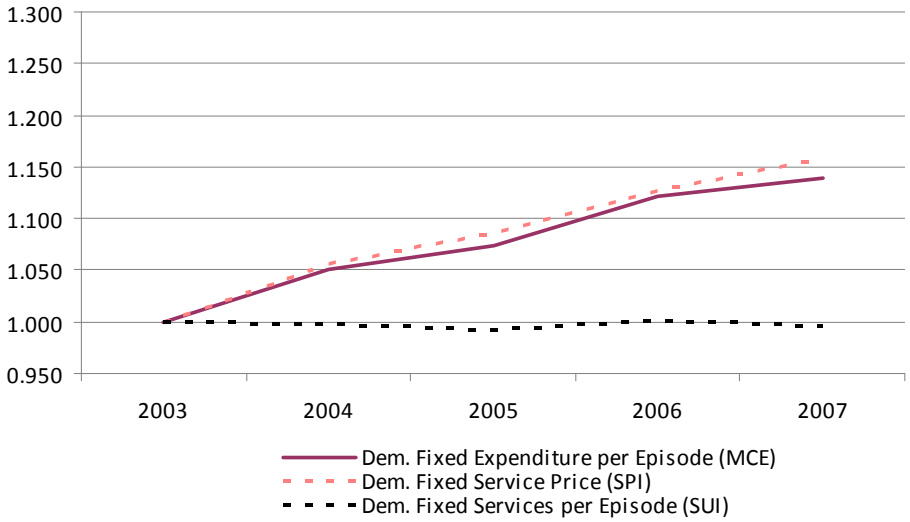
4.1 Aggregated Indexes

We begin our analysis by examining aggregated time-specific indexes, which provide information about the entire commercial health-care market for a given year. Specifically, we create ECI_t, $DECI_t$, $PREV_t$, MCE_t, SPI_t, SUI_t, and Dem_t by weighting each disease-specific index by the expenditure share of that disease in the base period. The top panel of Figure 1 displays the aggregated expenditure per capita index (ECI_t) along with its decomposition between the demographic residual (Dem_t) and the demographically fixed expenditure per capita index ($DECI_t$). The ECI grew 6.4 percent per year from 2003 to 2007— a total of 28 percent over the four years. Demographic factors accounted for about a tenth of this growth, as the demographic residual grew by only 3 percent over the four years and the $DECI$ grew by 25 percent.

Figure 1. Aggregated Indexes


1.3
1.25
1.2
1.15
1.1
1.05
1
0.95
2003
2004
2005
2006
2007
Expenditure per Capita (ECI)
Demographic Residual (Dem)
Dem. Fixed Expenditure per Capita (DECI)


1.3
1.25
1.2
1.15
1.1
1.05
1
0.95
2003
2004
2005
2006
2007
Dem. Fixed Episodes per Capita (PREV)
Dem. Fixed Expenditure per Episode (MCE)
Dem. Fixed Expenditure per Capita (DECI)



The second panel displays the $DECI_t$ along with its decomposition between the MCE_t and $PREV_t$. Growth in MCE_t represents about 56 percent of the total growth in the $DECI$ while growth in the prevalence index accounted for about 41 percent. Specifically, the MCE_t grew by 3.3 percent per year while the $PREV_t$ grew by 2.5 percent. Finally, the third panel decomposes the MCE_t between service prices (SPI_t) and service utilization (SUI_t). These aggregate indexes show that the cost of treatment growth is entirely due to changes in the underlying prices of the services and not the quantity of services being provided per episode. To be more precise, the SPI_t grew by 3.8 percent per year (15.9 percent over the sample period) while the SUI_t fell just 0.4 percent over the sample period.

All spending is calculated in nominal terms, but because health care has taken up an increasing share of GDP, it is interesting to investigate the contributing factors to growth after accounting for national inflation figures. Previous researchers also accounted for inflation, including Roehrig and Rouseeau (2011) and Bundorf et al. (2009), two papers that have looked at decomposing expenditure growth into components of price and utilization. After accounting for inflation by the PCE deflator (which grew by 11.5 percentage points between 2003 and 2007), we find that real service prices grew by 1 percent per year—about 4 percent from 2003 to 2007. This is consistent with the finding

in Bundorf et al. (2009) who also look at commercial markets and find very little service price growth relative to inflation over the 2001-2006 time period for the commercial sector. Another way of stating this is that, of the 28 percent expenditure per capita (ECI_t) growth from 2003 to 2007, 15.1 percentage points were attributable to things other than PCE inflation. Two-thirds of those 15.1 percentage points are attributable to increasing prevalence of treated diseases[16] and one-fifth was attributable to demographic shifts.[17]

4.2 Major Diagnostic Categories

The aggregated indexes discussed above suggest that expenditure growth is occurring for two primary reasons: (1) growth in service prices and (2) growth in the prevalence of treated diseases. As treatments and changes in treatments are unique to each disease,[18] we next show indexes specific to 22 Major Practice Categories (MPC). Each category is calculated as a weighted average of the many underlying disease-severity specific indexes in that category, where the weights are the proportions of expenditure shares in 2003.[19] These broader categories give some sense of where expenditure growth is occurring.

We report MPCs ordered according to the size of their expenditure share in Table 2.

[16] This was calculated as $\frac{1-PREV_{2007}}{1-\frac{ECI_{2007}}{PCE_{2007}}}$, where PCE_{2007} is one plus the percentage growth in the PCE deflator between 2003 and 2007.

[17] The results presented here are quite distinct from the results of Roehrig and Rouseeau (2011), who use the Medical Expenditure Panel Survey data and find that, even after accounting for inflation, expenditure per capita growth is primarily driven by expenditures per episode (i.e., MCE) and not prevalence, with the growth in the expenditure per episode accounting for 75 percent of expenditure growth. We find that expenditure per episode accounts for only about 20 percent of inflation-adjusted growth in the commercial sector. The vast differences in our results warrant future investigation. We suspect that the reliance of the MEPS data on the survey responses from individuals is one potential limitation of the Roehrig and Rouseeau study.

[18] This has been demonstrated in prior work by Thorpe, Florence, and Joski (2009), Roehrig and Rousseu (2011), Aizcorbe and Nestoriak (2011), Dunn et al. (2012a), and Dunn, Shapiro, and Liebman (2012).

[19] For instance, the aggregated ECI for Cardiology was calculated as $ECI_{Card,t} = \sum_{d \in Card} \omega_d \cdot ECI_{d,t}$ where $\omega_d = \frac{C_{d,0}}{\sum_{d \in Card} C_{d,0}}$ and $Card$ is the set of diseases in the Major Practice Category: Cardiology.

The largest category is orthopedics and rheumatology, which accounted for 16.6 percent of spending in 2003. Spending in this category grew from $418 per capita in 2003 to $558 per capita in 2007—an increase of 33 percent as indicated by the 2007 ECI of 1.33. Orthopedics' share of expenditure growth (19.6 percent) exceeded its share of 2003 expenditure (16.6 percent), which is attributable to the fact that this diagnostic category grew faster than average. We can assess the sources of this growth by examining the 2007 indexes. For instance, demographic shift accounted for 3 points of the 33-percentage-point increase in expenditure per capita, treated prevalence accounted for another 12 percentage points, service prices accounted for 15 percentage points, service utilization 3 percentage points, and the cross-term is zero.

Table 2. Major Practice Category

	2003 Expenditure per Capita	2007 Expenditure per Capita	2003 Share of Total Expenditure	Share of Expenditure Growth	2007 Indexes						
					ECI	Dem	DECI	PREV	MCE	SPI	SUI
Orthopedics & rheumatology	$418	$558	16.6%	19.6%	1.33	1.03	1.30	1.12	1.17	1.15	1.03
Cardiology	$296	$348	11.8%	7.3%	1.18	1.07	1.11	1.04	1.06	1.16	0.93
Gastroenterology	$228	$304	9.1%	10.6%	1.33	1.04	1.29	1.11	1.17	1.17	1.01
Gynecology	$181	$222	7.2%	5.9%	1.23	1.02	1.22	1.01	1.20	1.19	1.01
Endocrinology	$169	$236	6.7%	9.4%	1.40	1.05	1.34	1.27	1.07	1.17	0.93
Otolaryngology	$163	$186	6.5%	3.2%	1.14	1.00	1.14	1.03	1.11	1.13	1.00
Neurology	$147	$195	5.8%	6.7%	1.33	1.03	1.30	1.10	1.19	1.21	0.99
Pulmonology	$119	$143	4.7%	3.4%	1.20	1.04	1.16	1.01	1.16	1.20	0.97
Psychiatry	$119	$150	4.7%	4.3%	1.26	1.00	1.26	1.13	1.12	1.15	1.01
Dermatology	$115	$149	4.6%	4.7%	1.29	1.02	1.28	1.08	1.18	1.16	1.03
Obstetrics	$112	$139	4.4%	3.9%	1.25	0.99	1.26	1.08	1.17	1.15	1.02
Urology	$91	$116	3.6%	3.5%	1.27	1.05	1.22	1.12	1.11	1.14	0.98
Hematology	$62	$82	2.5%	2.8%	1.32	1.04	1.28	1.11	1.15	1.22	0.96
Preventive & administrative	$59	$97	2.4%	5.3%	1.64	1.02	1.62	1.29	1.26	1.14	1.11
Hepatology	$59	$68	2.3%	1.2%	1.15	1.03	1.12	0.99	1.12	1.17	0.96
Ophthalmology	$40	$50	1.6%	1.4%	1.25	1.06	1.19	1.13	1.05	1.09	0.98
Infectious diseases	$34	$48	1.3%	1.9%	1.41	1.03	1.38	1.15	1.18	1.12	1.06
Nephrology	$34	$47	1.3%	1.9%	1.39	1.06	1.33	1.49	0.90	0.91	1.00
Neonatology	$25	$36	1.0%	1.5%	1.43	1.12	1.32	1.14	1.17	1.13	1.03
Isolated signs & symptoms	$19	$21	0.7%	0.3%	1.12	1.01	1.11	1.00	1.11	1.10	1.02
Late effects, environmental trauma	$14	$18	0.6%	0.6%	1.30	1.02	1.27	0.96	1.34	1.29	1.04
Chemical dependency	$12	$18	0.5%	0.7%	1.42	1.00	1.41	1.38	1.06	1.10	0.99
Total	$2,516	$3,229	100.0%	100.0%	1.28	1.03	1.25	1.10	1.14	1.16	1.00

One striking feature of Table 2 is the substantial growth in preventive health services. This category represented only 2.4 percent of 2003 expenditures but 5.3 percent of expenditure growth between 2003 and 2007. This category appears to be growing out

of proportion for two reasons, increased prevalence of treatment (29 percent growth) as well as a large increase in service utilization (11 percent growth). One question raised is whether the greater prevalence and utilization of preventive services ultimately leads to lower overall health expenditures and better health outcomes. This is especially important given that the passage of recent health care reform passed in the Patient Protection and Affordable Care Act encourages the use of preventive care services. Although more preventive care services are likely to lead to expenditures increasing in the short term, it is unclear what the long-term effects may be on both future health and expenditures.

It is especially interesting to note that many of the other diagnostic categories do not grow in proportion to their expenditure share. For example, cardiology diseases accounted for around 12 percent of spending in 2003, but only 7.3 percent of the expenditure growth between 2003 and 2007. Although service prices in this area are growing at a similar pace with other disease categories (around 16 percent) expenditure growth is kept in check by slower-than-average growth in prevalence as well as *declining* service utilization. Endocrinological diseases, many of which are major contributors to cardiovascular diseases, also show a decline in service utilization, however they show much faster growth in treated disease prevalence. For this reason, expenditure per capita rose twice as fast for endocrinological diseases than for cardiology diseases.

For many disease conditions, we see important differences between the disease price (MCE) and the prices of the underlying services (SPI). These differences may be of significant economic importance. For instance, if the SPI growth exceeds the MCE, this indicates that the price of disease treatment is growing slower than the rate implied by traditional inflation measures. To better understand the difference between SPI and MCE indexes, we apply an additional decomposition that reports the difference between the SPI and MCE indexes by service type, s.[20] The decomposition equation is

$$MCE_{d,t} = SPI_{d,t} + (MCE_{d,t} - SPI_{d,t}) = SPI_{d,t} + \sum_{s} (MCE_{d,t,s} - SPI_{d,t,s}) \left(\text{Exp. Share}_{d,0,s}\right) \tag{7}$$

[20] This same decomposition is applied in Dunn, Liebman, and Shapiro (2012a). The only difference is that here we apply the full sample of diseases, while in Dunn, Liebman, and Shapiro (2012a), looked only at disease conditions with more than 10,000 episodes.

$$= SPI_{d,t} + \sum_s (MCE_{d,t,s} - SPI_{d,t,s}) \left(\frac{q_{d,0,s} \cdot p_{d,0,s}}{\sum_s q_{d,0,s} \cdot p_{d,0,s}} \right).$$

The term $(MCE_{d,t,s} - SPI_{d,t,s})$ $\left(\text{Exp. Share}_{d,0,s}\right)$ represents service category s's contribution to the difference between the MCE and SPI indexes. To gain some additional intuition for this equation, we take the decomposition from equation (7), but remove the cross term, which gives the approximate relationship $MCE_{d,t} \approx SPI_{d,t} + SUI_{d,t} - 1$. Applying this approximation, we substitute $SUI - 1$ for $MCE - SPI$ into equation (7); then the decomposition by service category is $MCE_{d,t} \approx SPI_{d,t} + \sum_s (SUI_{d,t,s} - 1)$ $\left(\text{Exp. Share}_{d,0,s}\right)$. From this approximate decomposition, one can see that the difference between the two indexes will primarily depend on the change in utilization of the different services and the corresponding expenditure share of the service category.

Table 3 shows the contribution of each service type, s, to the difference between the MCE and SPI (applying the exact decomposition 7). Table 3 shows several clear patterns across services for the top five spending diseases.[21] First, nearly every disease category shifts away from spending on inpatient services, which is especially large for cardiology and endocrinology conditions. This savings from reduced utilization on inpatient services is partly offset by an increase in the utilization of physician services for most disease categories. For drug services, we observe a shifting away from branded drugs, leading to a relative decline in the MCE, and we see an increase in generic drugs, contributing to an increase in the MCE. Combined, the shifting away from branded drugs toward generics causes a net decline in the MCE relative to the SPI for these top five diseases.

4.3 Disease-Specific Indexes

Our methodology for decomposing expenditure growth may be used to drill down even further to the specific disease-severity level. Due to the large number of diseases,

[21] See Dunn, Shapiro, and Liebman (2012) for a more complete discussion of this topic.

Table 3. Comparison of MCE and SPI and sources of differences, 2003 - 2007

		Contribution to MCE-SPI difference					
	MCE - SPI	Inpatient Hospital	Outpatient Hospital	Physician Office	Other	Brand Drugs	Generic Drugs
Orthopedics & rheumatology	0.017	-0.026	0.001	0.038	0.021	-0.036	0.019
Cardiology	-0.097	-0.101	-0.005	0.017	-0.001	-0.028	0.021
Gastroenterology	-0.003	-0.035	-0.008	0.014	0.041	-0.029	0.015
Gynecology	0.010	-0.044	0.029	0.030	0.002	-0.016	0.009
Endocrinology	-0.092	-0.090	0.000	-0.001	0.008	-0.055	0.047

there are numerous dimensions in which we could look at the growth in expenditures. In the following section, we demonstrate how the methodology may be applied to a few areas of spending. Specifically, we focus on those diseases that are included in some of the larger MPCs and on the treatment of neoplasms (that is, benign and malignant tumors).

4.3.1 Cardiology and Endocrinology

Table 4. Cardiology and Endocrinology

	2003 Expenditure per Capita	2007 Expenditure per Capita	2007 Indexes						
			ECI	DEM	DECI	PREV	MCE	SPI	SUI
Ischemic heart disease 1	$55	$54	0.98	1.07	0.91	0.95	0.96	1.14	0.86
Hypertension 1	$48	$64	1.33	1.06	1.27	1.14	1.11	1.13	1.01
Diabetes 1	$43	$68	1.58	1.09	1.48	1.28	1.16	1.17	1.01
Ischemic heart disease 2	$30	$32	1.07	1.08	0.99	1.09	0.91	1.09	0.84
Hyperlipidemia, other 1	$26	$37	1.43	1.08	1.35	1.29	1.05	1.16	0.95
Ischemic heart disease 3	$24	$24	1.01	1.07	0.94	0.88	1.07	1.20	0.90
Ischemic heart disease 4	$22	$23	1.05	1.07	0.98	0.91	1.08	1.20	0.90
Obesity 2	$17	$15	0.89	1.00	0.88	1.55	0.57	1.04	0.54
Cardiovascular diseases signs & symp. 1	$16	$18	1.13	1.02	1.11	1.02	1.09	1.11	1.00
Diabetes 4	$13	$17	1.27	1.03	1.23	1.04	1.19	1.20	1.00

Table 4 reports the expenditure decomposition for the ten largest diseases by spending in the major diagnostic categories of cardiology and endocrinology. The table shows

there have been large increases in the prevalence of treated hypertension, hyperlipidemia, diabetes, and obesity. This may correspond to changing lifestyles or eating habits of the commercially insured population. However, these four diseases are also major contributors to ischemic heart disease, which has strikingly shown a decline in treated prevalence.[22] This may indicate that people are seeking treatment earlier, $before$ ischemic heart disease arises, perhaps reflecting a growing awareness of this medical condition. Indeed, evidence from the National Health and Nutrition Examination Survey shows very rapid growth in treated prevalence for diabetes, hyperlipidemia, and hypertension, even though the underlying clinical prevalence has remained relatively flat for these conditions.[23]

Also of note is that spending for low-severity ischemic heart disease has been declining over the sample period. In fact, were it not for an aging commercial population, spending per capita would have fallen by almost 10 percent between 2003 and 2007. This decline in spending is mostly attributable to the large decline in service utilization. This finding is also consistent with the work of Cutler et al. (1998), who find the quality-adjusted prices for treating heart attacks to be declining. As discussed in the previous section, this shift in utilization is attributable to the shift from inpatient to outpatient services in the treatment of heart disease.

[22]The decline in treated prevalence may be seen by averaging over the different severities of ischemic heart disease based on expenditures per capita. A study by the Centers for Disease Control and Prevention has also reported a decline in the prevalence of ischemic heart disease for the 2006 to 2010 period based on the Behavioral Risk Factor Surveillance System surveys (http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6040a1.htm).

[23]Specific values of these trends from the National Health and Nutrition Examination Survey are reported in Roehrig and Rousseau (2011).

4.3.2 Gastroenterology

Table 5. Gastroenterology

	2003 Expenditure per Capita	2007 Expenditure per Capita	2007 Indexes						
			ECI	DEM	DECI	PREV	MCE	SPI	SUI
Inflammation of esophagus 1	$27	$29	1.09	1.02	1.07	1.06	1.01	1.12	0.92
Gastroenterology diseases signs & symptoms 1	$23	$33	1.41	1.03	1.39	1.16	1.20	1.15	1.05
Non-malignant neoplasm of intestines & abdomen 1	$20	$27	1.34	1.08	1.26	1.16	1.08	1.08	1.02
Hernias, except hiatal 1	$10	$12	1.19	1.03	1.16	1.02	1.14	1.19	0.96
Appendicitis 1	$9	$12	1.41	0.99	1.42	1.15	1.24	1.20	1.02
Inflammatory bowel disease 3	$7	$11	1.51	0.99	1.52	1.28	1.19	1.18	1.03
Malignant neoplasm of rectum or anus 2	$6	$9	1.45	1.08	1.37	0.93	1.47	1.41	1.05
Inflammation of esophagus 2	$5	$6	1.12	1.06	1.06	1.12	0.95	1.12	0.86
Bowel obstruction 1	$5	$7	1.26	1.05	1.22	1.04	1.16	1.13	1.03
Malignant neoplasm of rectum or anus 3	$5	$8	1.55	1.10	1.45	0.95	1.54	1.49	1.04

Similar to cardiological and endocrinological diseases, gastroenterological diseases saw a shift in prevalence to earlier stage-of-illness treatment. Table 5 shows that prevalence in "gastroenterology signs and symptoms 1" and "non-malignant neoplasm of intestines and abdomen 1" (e.g., benign polyps) both saw 16 percent growth in prevalence over the sample period. These two diseases represented one-fifth of gastroenterological expenditures in 2003 and grew by 41 and 34 percent, respectively, over the sample period. Endoscopic procedures (mainly colonoscopy) represented the largest share of spending (16.4 percent of spending) for "gastroenterology signs and symptoms 1," indicating that this disease category likely represents a large amount of preventive treatment. By contrast, "malignant neoplasm of the rectum or anus" saw a decline in prevalence. Similar to cardiology services, there seems to be shift in prevalence from later-stage severe illnesses to preventive care. This growth in prevalence of preventive treatment may be attributable to the new screening guidelines instituted by the Committee of the American College of Gastroenterology (ACG) in 2000.[24] Note that, although prevalence declined for rectal cancer, expenditures per capita rose significantly over the sample period. Our decompo-

[24]The ACG recommends colonoscopy every 10 years, beginning at age 50, as the preferred strategy. This is in contrast to a menu of options strategy endorsed by the American Cancer Society.

sition shows that this was mainly attributable to the large growth in the cost of treatment (the MCE index grew by approximately 50 percent). As we discuss in Section 4.3.4, many other types of cancer also reported large growth in treatment costs over the sample period.

4.3.3 Gynecology

Table 6. Gynecology

	2003 Expenditure per Capita	2007 Expenditure per Capita	2007 Indexes						
			ECI	DEM	DECI	PREV	MCE	SPI	SUI
Malignant neoplasm of breast 1	$26	$41	1.60	1.10	1.50	1.07	1.40	1.27	1.10
Non-malignant neoplasm of female genital tract 3	$19	$21	1.09	0.99	1.09	1.02	1.07	1.16	0.92
Malignant neoplasm of breast 2	$17	$25	1.52	1.03	1.49	1.10	1.36	1.28	1.06
Conditions associated with menstruation 1	$15	$14	0.99	1.01	0.99	0.87	1.14	1.13	1.03
Non-malignant neoplasm of female genital tract 1	$12	$15	1.18	0.99	1.19	0.94	1.26	1.19	1.06
Non-malignant neoplasm of breast 1	$11	$11	1.03	1.01	1.02	0.85	1.20	1.18	1.02
Endometriosis 1	$9	$8	0.89	0.98	0.90	0.82	1.10	1.14	0.97
Conditions associated with menstruation 2	$9	$13	1.43	0.99	1.43	1.11	1.29	1.21	1.07
Other diseases of female genital tract 1	$9	$9	1.08	1.03	1.05	1.04	1.01	1.17	0.86
Malignant neoplasm of breast 3	$8	$10	1.33	1.02	1.31	1.07	1.23	1.26	0.98

As shown in Table 2, gynecology was the fourth largest diagnostic category in 2003 but the fifth largest in 2007, falling behind endocrinology. This was attributable to the slightly lower-than-average growth in ECI (23 percent) for this diagnostic category. Table 6 reports the ten largest gynecological diseases in terms of expenditure per capita. These ten diseases made up about three-quarters of 2003 gynecological spending. The results show that the lower-than-average spending was mainly attributable to "non-malignant neoplasm of the genital tract 3 and 1," "non-malignant neoplasm of the breast 1," and "conditions associated with menstruation 1." Expenditures for these diseases all grew less than 10 percent over the 2003 to 2007 sample period. Our decomposition shows that cost of treatment (MCE) growth was about average for these diseases, however, they had low growth in prevalence and had negligible growth due to demographic factors. By contrast, the highest spending gynecological disease, breast cancer, had large growth

in the cost of treatment—40 percent growth in MCE for severity 1 and 36 percent growth in MCE for severity 2.

4.3.4 Neoplasms

Table 7. Neoplasms

		2003 Expenditure per Capita	2007 Expenditure per Capita	2007 Indexes						
				ECI	DEM	DECI	PREV	MCE	SPI	SUI
Neoplasm of breast	Malignant	$50	$77	1.53	1.06	1.47	1.07	1.37	1.27	1.33
	Non-Malignant	$11	$12	1.04	1.01	1.03	0.85	1.21	1.18	1.03
Neoplasm of pulmonary system	Malignant	$16	$21	1.27	1.09	1.17	0.95	1.23	1.28	1.40
	Non-Malignant	$1	$1	1.12	1.03	1.09	1.04	1.05	0.97	1.08
Neoplasm of rectum or anus	Malignant	$13	$21	1.55	1.09	1.46	0.97	1.51	1.45	0.99
	Non-Malignant	$2	$3	1.73	1.09	1.64	1.52	1.08	1.06	1.04
Neoplasm of prostate	Malignant	$13	$20	1.55	1.15	1.40	1.09	1.29	1.17	1.07
	Non-Malignant	$4	$6	1.56	1.13	1.43	1.06	1.35	1.15	1.19
Neoplasm of skin, major	Malignant	$10	$14	1.35	1.08	1.28	1.08	1.18	1.11	1.04
	Non-Malignant	$15	$19	1.27	1.03	1.25	1.13	1.10	1.11	1.00
All neoplasms	Malignant	$162	$240	1.48	1.08	1.40	1.08	1.30	1.25	1.05
	Non-Malignant	$107	$133	1.24	1.03	1.21	1.11	1.11	1.15	0.98
	All other diseases	$2,247	$2,856	1.27	1.03	1.24	1.10	1.13	1.15	0.99

To more comprehensively assess expenditure growth for cancer treatment, we group neoplasm conditions in Table 7. Specifically, we display the five most expensive neoplasm conditions (in terms of expenditure per capita), both malignant neoplasms and non-malignant neoplasms separately. For ease of display, we aggregated severity types into one disease category (e.g., neoplasm of breast 1, 2, and 3 were aggregated into "neoplasm of breast"). At the bottom of the table we also report aggregated indexes of all malignant and non-malignant neoplasms, along with aggregated indexes of all conditions but neoplasms.[25]

The first result to note is that "non-malignant neoplasms" look very similar to "all other diseases." Specifically, the MCE for non-malignant neoplasm treatment grew by 11

[25] For instance, the aggregated ECI for non-malignant neoplasms was calculated as $ECI_{Non,t} = \sum_{d \in Non} \omega_d \cdot ECI_{d,t}$ where $\omega_d = \frac{C_{d,0}}{\sum_{d \in Non} C_{d,0}}$ and Non are the set of non-malignant diseases.

percent over the sample period, slightly below the 13 percent growth in all other diseases. By contrast, the cost of treatment for malignant neoplasms grew much more rapidly, with an MCE growth of 30 percent. Faster growth for malignant neoplasms is attributable to both service prices, which grew by 25 percent, and service utilization, which grew by 5 percent. A plausible reason for this discrepancy between malignant neoplasms and the rest of the sample are the distinct and likely innovative technologies that are used to treat malignant neoplasms. Note that in our framework, when a procedure is first introduced into the market (i.e., an innovation), it will show up as an increase in utilization if this new procedure is measured to have a large quantity of RVUs. Furthermore, its price may subsequently increase as the new procedure diffuses and demand rises.

5 Conclusion

This paper presents a descriptive picture of the various sources of health-care expenditure growth. Our decomposition shows that growth in both service prices and prevalence of treated disease are responsible for the large increase in nominal medical-care expenditure growth. Other factors, such as changes in the demographics of the population or changes in service utilization, have a limited impact on expenditures.

Perhaps equally important to the descriptive findings of this study are the avenues for future research that it reveals. For instance, our analysis shows that there has been tremendous growth in preventive service expenditures. Future research may decipher whether these preventive services ultimately lead to lower expenditures in the future, better health outcomes, or both. Second, although utilization has been declining for diseases due to a shift from inpatient to outpatient services, some areas such as the treatment for malignant neoplasms have seen a growth in both service utilization and service prices. We hypothesize that this growth in the cost of treatment is attributable to the large degree of innovation for cancer treatment. However, a more comprehensive study specific to cancer treatment will likely lead to a better understanding of this cost of treatment growth. Third, future research may uncover if the shift in treated prevalence toward diseases that lead to ischemic heart failure (e.g., hypertension and hyperlipidemia) and away from ischemic failure is due to a worsening health status of the population or

if it is attributable to better awareness of these types of conditions or more individuals with a condition seeking treatment. If the growth is attributable to an earlier awareness of a health condition, this may translate into lower expenditure growth or better health outcomes in the future.

References

[1] Aizcorbe, Ana and Nicole Nestoriak, (2011), "Changing Mix of Medical Care Services: Stylized Facts and Implications for Price Indexes", *Journal of Health Economics*, 30(3) pgs 568-574

[2] Berndt, Ernst, David Cutler, Richard Frank, Zvi Griliches, Joseph Newhouse, and Jack Triplett, (2000), "Medical Care Prices and Output", Handbook of Health Economics, Chapter 3.

[3] Bundorf, Kate, Anne Royalty, and Laurence Baker, (2009), "Health Care Cost Growth Among the Privately Insured", *Health Affairs*, September/October.

[4] Chandra, Amitabh and Jonathan Skinner, (2012), "Technology Growth and Expenditure Growth in Health Care", *Journal of Economic Literature*, 50(3) pgs 645-680.

[5] Chernew, Michael and Joseph Newhouse, (2012), "Health Care Spending Growth", Handbook of Health Economics, Chapter 1 pgs 1-43.

[6] Cutler, David M., Mark McClellan, Joseph P. Newhouse, and Dahlia Remler. "Are Medical Prices Declining? Evidence from Heart Attack Treatments." *Quarterly Journal of Economics* 113 (1998) pgs 991-1024.

[7] Dunn, Abe, Eli Liebman, Sarah Pack, and Adam Shapiro, (2012a), "Medical Care Price Indexes for Patients with Employer-Provided Insurance: Nationally-Representative Estimates from MarketScan Data", *Health Services Research*, Forthcoming.

[8] Dunn, Abe, Eli Liebman, Adam Shapiro, and Lindsey Rittmueller, (2012b), "Defining Disease Episodes and the Effects on the Components of Expenditure Growth", Bureau of Economic Analysis, *Working Paper.*

[9] Dunn, Abe, Eli Liebman, and Adam Shapiro, (2012a), "Implications of Utilization Shifts on Medical-Care Price Measurement", Bureau of Economic Analysis, *Working Paper.*

[10] Dunn, Abe, Eli Liebman, and Adam Shapiro, (2012b), "Developing a Framework for Decomposing Medical-Care Expenditure Growth: Exploring Issues of Representativeness", Chapter 17 in Dale Jorgenson, Steven Landefeld, and Paul Schreyer, eds., *Measuring Economic Sustainability and Progress*, NBER Book Series Studies in Income and Wealth, Forthcoming

[11] Dunn, Abe, Adam Shapiro, and Eli Liebman, (2012), "Geographic Variation in Commercial Medical-Care Expenditures: A Framework for Decomposing Price and Utilization", Bureau of Economic Analysis, *Working Paper.*

[12] Roehrig, Charles and David Rousseau, (2011), "The Growth in Cost Per Case Explains Far More of US Health Spending Increases Than Rising Disease Prevalence", *Health Affairs*, 30(9) pgs 1657-1663.

[13] Thorpe, Kenneth, Curtis Florence, and Peter Joski, (2004), "Which Medical Conditions Account for the Rise in Health Care Spending?", *Health Affairs*, August - Web Exclusive.