

APPENDIX

TABLE OF CONTENTS

BACKGROUND.....	1
TWO-PART METHODOLOGY.....	2
RECONCILING DIFFERENCES IN THE LITERATURE.....	4
APPENDIX REFERENCES.....	7
APPENDIX TABLES.....	9

BACKGROUND

Aggregate national health expenditure (NHE) growth rates slowed to 4.8 percent per year from 2006-2010, in contrast to growth rates of 7.9 percent per year from 2000-2006. NHE growth slowed even more in the years following the recession, averaging only 3.5 percent per year from 2010 to 2013. NHE grew by 5.2 percent in 2014 and 5.8 percent in 2015, a spike which coincided with approximately 20 million people gaining coverage under the ACA. However, spending growth once again fell below 5 percent in 2016 and to 3.9 percent in 2017, suggesting that growth returned to a rate similar to that which immediately preceded full implementation of the ACA (Holahan & McMorrow, 2019; Martin, Hartman, Washington, & Catlin, 2019).

Several studies have also assessed the relative importance of rising disease prevalence versus the cost of treatment in explaining spending growth. For example, Blavin et al. (2012) found that while compositional changes in demographic characteristics and insurance coverage were not driving forces in per capita spending growth, the prevalence of chronic conditions did appear to be an important factor. However, most growth in expenditures was due to other factors not measured (e.g., changes in price or quality), leaving 78 percent of the increase in per capita spending unexplained. An analysis by Thorpe (2013) identified increased treated prevalence of disease as the most significant driver of health expenditure growth from 1987 to 2009, accounting for over 50 percent of growth among all adults 18 and over, 77 percent of growth for Medicare beneficiaries, and 33 percent of growth among privately insured nonelderly adults. A later analysis by Thorpe, Allen, & Joski, (2015) estimated that over 77 percent of healthcare spending growth was attributable to patients with four or more chronic conditions. Dunn et al. (2018) found that health care spending growth from 2000 to 2014 was mostly driven by use of new technologies, increases in preventative services, aging of the population and increases in obesity. Bundorf, Royalty, & Baker (2009) analyzed spending growth solely among the privately insured and found that outpatient

services and pharmaceuticals were the main drivers of spending growth among this population. Growth in outpatient procedures represented 64 percent of spending growth and was driven almost entirely by increased quantities of services per patient, while growth in drug spending was driven both by rising prices and increasing quantities.

Other analyses found more limited effects of disease prevalence. Dieleman et al. (2017) found that 50 percent of the growth in total health expenditures from 1996 to 2013 was associated with increased service price and intensity and that demographic shifts (such as population growth and aging) had a significant but limited effect on growth. They also found that changes in overall disease prevalence were associated with spending reductions, though associations vary by individual conditions. Starr, Dominiak, & Aizcorbe (2014) concluded from an analysis of national survey data from 1980 to 2006 that growth in service prices and intensity and rising cost per disease case – particularly growth in costs of routine care – were dominant sources of growth in per capita spending, while changes in treated disease prevalence only accounted for one third of growth. Roehrig and Rousseau (2011) also found that growth in cost per disease case was responsible for most growth in real per capita health spending from 1996 to 2006.

TWO-PART METHODOLOGY

We use a two-part model to predict individual-level expenditures and decompose the variation in per-capita expenditures between 2007-2009 and 2014-2015. The two-part model avoids estimation bias due to a large frequency of zero-value outcomes and the skewed nature of health care costs data. The first part relies on parametric binary models to estimate the predicted probability of nonzero expenditures conditional on a set of individual and household characteristics $[\Pr(Y > 0 \mid \mathbf{X})]$. The second part has the expenditure level as the dependent variable and is conditional on the individual

having nonzero expenditures. The model also assumes that the level of expenditures is a linear function of exogenous covariates i.e., $E(\ln(Y)|Y>0, \mathbf{X}) = \mathbf{X}\beta$ (Mullahy, 1998). The final unconditional level of predicted expenditures is the product of the probabilities of any expenditure from the first part and the expected levels from the second part of the model i.e., $E(Y_i|\mathbf{X}_i) = \Pr(Y_i > 0 | \mathbf{X}_i) * E(Y_i|Y_i > 0, \mathbf{X}_i)$. We use a probit model for the first part of the model (but found similar results with logit models) and a generalized linear model (GLM) with a log-link function to estimate the level of expenditures.¹ As suggested by Manning and Mullahy (2001), we use the Park test to choose the variance distribution for our models. The Park tests we performed overwhelmingly support the use of the Gamma distribution as the variance function for all of the GLM models ($\lambda_1 \approx 2$ for all GLMs). We estimate two restricted models and one unrestricted model for each service type. The first restricted model use socioeconomic characteristics only (as described in the main text) and and second restricted model uses socioeconomic characteristics and health insurance status as explanatory factors. The unrestricted model, in addition to socioeconomic characteristics and health insurance status, includes controls for the number of major health conditions. For both restricted and unrestricted models, we use the 2014-2015 sample and coefficients to predict the probabilities of any expenditure (first part) and level of expenditure (second part), using 2007-2009 covariate values. The products of the probabilities and expected level of expenditures on 2007-2009 explanatory factors are the unconditional expected level of expenditures in 2014-2015, had each set of explanatory covariates remained at 2007-2009 levels. Assuming a simplified model with one restricted and one unrestricted model, the variation in the per-capita expenditure between 2007-2009 and 2014-2015 can be decomposed as:

$$(1) \quad y_{14-15A} - y_{07-09A} = y_{14-15A} - y_{14-15r} + y_{14-15r} - y_{14-15u} + \text{Unexplained}$$

¹ See Buntin and Zaslavsky (2004) for more on differences between comparison of GLM and OLS models.

Where y_{14-15A} and y_{07-09A} are actual 2014-2015 and 2007-2009 per-capita expenditures and y_{14-15r} and y_{14-15u} are the counterfactual predicted 2014-2015 per-capita expenditures from the restricted and unrestricted models, respectively. The first part of the right-hand side of (1), $y_{14-15A} - y_{14-15r}$, is the variation explained by the restricted model i.e., changes in the socio-economic characteristics and the health insurance status of the nonelderly population between the years. The second part of the equation, $y_{14-15r} - y_{14-15u}$, is the variation explained by the change in prevalence of chronic conditions among the nonelderly over the period.

RECONCILING DIFFERENCES IN THE LITERATURE

There are several important methodological differences between this study and others to note. First, this study decomposes spending growth over a unique period dominated by the Great Recession and unprecedented coverage expansions under the ACA, whereas the others assess earlier time periods (e.g., 1996 to 2006, 1987 to 2009, and 2001 to 2009) that did not include major coverage expansions for adults. Second, this study focuses on the population targeted by the ACA—nonelderly population 18-64—whereas the other studies include the elderly or the full population.

Third, some studies decompose total spending (e.g., Thorpe, 2013; Thorpe, Allen, & Joski, 2015), while others decompose per capita spending (Roehrig & Rousseu 2011). Both Thorpe studies examine total spending and do not account for the effect of population growth. The authors measure change in disease prevalence as the change in the number of people with a certain condition, rather than the change in the rate of disease in the population. This approach does not distinguish between the effects of increasing prevalence rates and increasing population size, which likely results in overestimating the effect of increased disease prevalence. In contrast, Roehrig and Rousseau (2011) decompose per capita spending rather than total spending. Holding population growth constant, they find that treated disease prevalence accounted for only one fourth of observed growth in per capita health expenditures, which is more consistent with the findings from our study.

Fourth, some studies examine data on clinical disease prevalence whereas others focus on treated prevalence. For example, Roehrig and Rousseau (2011) examine data on clinical disease prevalence, and report that their evidence suggests that most of the spending growth attributable to treated prevalence is due to the increase in the share of people being treated, not in the underlying clinical prevalence of diseases. Starr, Dominiak, & Aizcorbe (2014) use a similar approach and find that rising costs of treatment accounted for a much greater portion of per capita spending growth than treated prevalence. In contrast, Thorpe, Allen, & Joski, 2015 do not use clinical prevalence data and their analysis does not make this distinction. This study captures both clinical and treated prevalence—most of the conditions are identified through medical events, but conditions may also be identified as reasons for one or more episodes of disability days or as conditions that bothered the person during the reference period.

Finally, the studies discussed here use different data sources. Thorpe, Allen, & Joski, 2015 and Roehrig and Rousseau (2011) use the MEPS, Dunn et al. (2018) use claims data from the commercial insurance sector only from the MarketScan® Research Databases from Truven Health, Starr, Dominiak, & Aizcorbe (2014) use the National Medical Care Utilization and Expenditure Survey and MEPS, and Dieleman et al. (2017) use data extracted from the 2015 Global Burden of Disease Study and the US Disease Expenditure 2013 project.

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APPENDIX TABLES

**Appendix Table 1. Health insurance coverage distribution by Age Group
2007-2016 MEPS-HC**

	Ages 18-25			Ages 26-64		
	Great Recession 2007-2009	Economic Recovery & Early ACA Implementation 2010-2013	Main ACA Coverage Expansion 2014-2016	Great Recession 2007-2009	Economic Recovery & Early ACA Implementation 2010-2013	Main ACA Coverage Expansion 2014-2016
Sample size	10,381	15,248	10,650	46,655	67,350	49,315
Non-mutually exclusive						
Any group insurance (ESI, other group)	57.9%	60.5% **	63.3% ***	71.9%	68.8% ***	68.2%
Any private nongroup or marketplace	3.3%	3.0%	5.3% ***	3.3%	3.9% ***	7.5% ***
Any public coverage	17.9%	19.9% **	25.2% ***	10.7%	12.8% ***	17.5% ***
Uninsured whole year	25.4%	21.6% ***	13.3% ***	17.1%	17.8%	12.2% ***
TOTAL	104.6%	105.0%	107.2%	103.1%	103.3%	105.4%
Mutually exclusive hierarchy (sums to 100%)						
Any group insurance (ESI, other group)	57.9%	60.5% **	63.3% ***	71.9%	68.8% ***	68.2%
Any private nongroup or marketplace	2.1%	2.0%	4.2% ***	2.4%	3.0% ***	5.9% ***
Any public coverage	14.6%	15.9% *	19.1% ***	8.6%	10.4% ***	13.7% ***
Uninsured whole year	25.4%	21.6% ***	13.3% ***	17.1%	17.8%	12.2% ***
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Notes:

Source: Agency for Healthcare Research and Quality, Medical Expenditure Panel Survey—Household Component, 2007-2016.

Group insurance includes coverage for retired military personnel and military dependents through TRICARE or CHAMPVA

Private nongroup includes both Marketplace and non-Marketplace nongroup coverage. Marketplace coverage becomes available in 2014.

Public coverage includes Medicaid, Medicare, the Children's Health Insurance Program, and other government programs providing comprehensive insurance

* p<0.1; **p<0.05; ***p<0.01 (compared to the previous period)

**Appendix Table 2. Health insurance coverage distribution, nonelderly adults
2007-2016 MEPS-HC**

	2007	2008	2009	2010	2011	2012	2013	2014	
Sample size	17,323	18,727	20,986	18,797	20,181	22,441	21,179	19,884	
Non-mutually exclusive									
Any group insurance (ESI, other group)	70.4%	69.5%	68.5% *	68.0%	67.9%	67.2%	66.4%	66.8%	
Any private nongroup or marketplace	3.2%	3.2%	3.5%	3.8%	3.6%	3.8%	3.8%	6.2%	***
Any public coverage	11.8%	12.0%	12.1%	13.0% **	14.0% **	14.4%	14.8%	17.9%	***
Uninsured whole year	18.1%	18.5%	19.2%	18.6%	17.9%	18.5%	18.9%	14.4%	***
TOTAL	103.4%	103.2%	103.3%	103.4%	103.3%	103.9%	103.9%	105.3%	
Mutually exclusive hierarchy									
Any group insurance (ESI, other group)	70.4%	69.5%	68.5% *	68.0%	67.9%	67.2%	66.4%	66.8%	
Any private nongroup or marketplace	2.3%	2.3%	2.4%	2.7%	2.8%	2.8%	2.8%	4.7%	***
Any public coverage	9.2%	9.7%	9.9%	10.7% **	11.4% **	11.5%	11.9%	14.1%	***
Uninsured whole year	18.1%	18.5%	19.2%	18.6%	17.9%	18.5%	18.9%	14.4%	***
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	
Mutually exclusive hierarchy (sums to 100%)									
Uninsured for full year	18.0%	18.4%	19.1%	18.5%	17.8%	18.5%	18.8%	14.4%	***
Uninsured for part year	11.7%	12.7% **	11.7% **	11.4%	11.2%	11.1%	11.9% *	13.4%	***
Majority ESI	61.2%	59.9% *	59.5%	59.6%	60.0%	59.1%	57.4% **	58.2%	
Majority private nongroup or marketplace	2.1%	1.9%	2.2% *	2.4%	2.4%	2.5%	2.8%	3.4%	**
Majority public	7.0%	7.1%	7.4%	8.1% **	8.6%	8.8%	9.0%	10.5%	***
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	

Notes

Source: Agency for Healthcare Research and Quality, Medical Expenditure Panel Survey–Household Component, 2007-2016.

Sample includes adults 18-64

Employer-sponsored insurance includes coverage for retired military personnel and military dependents through TRICARE or CHAMPVA

Private nongroup includes both Marketplace and non-Marketplace nongroup coverage. Marketplace coverage becomes available in 2014.

Public coverage includes Medicaid, Medicare, the Children's Health Insurance Program, and other government programs providing comprehensive insurance

* p<0.1; **p<0.05; ***p<0.01 (compared to the previous year)

Appendix Table 3. Decomposition of Changes in Per Capita Expenditure, 2007-2013, Pooled, by Service Type, Nonelderly Adults

Services	Actual Per Capita Spending				2010-2013: Predicted Per Capita Spending if characteristics remain at 2007-2009 level					
	2007-2009	2010-2013	Difference		Socioeconomic characteristics ^c		Socioeconomic characteristics + Health Insurance ^d		Socioeconomic characteristics + Health Insurance + Chronic Conditions ^e	
					Mean	% Difference [^]	Mean	% Difference [^]	Mean	% Difference [^]
Total	5,353	5,654	301	**	5,595	-1.0%	5,491	-2.9%	5,420	-4.1%
Hospital Outpatient + Physician	1,991	1,881	-110		1,885	0.2%	1,877	-0.2%	1,848	-1.8%
Hospital Inpatient ^a	1,561	1,767	207	**	1,722	-2.5%	1,655	-6.4%	1,622	-8.2%
Prescription Drugs	931	1,057	126	***	1,035	-2.1%	1,022	-3.3%	1,005	-4.9%
Emergency Room										
Hospital	254	279	25	**	277	-0.8%	275	-1.6%	271	-3.0%
All Other Services ^b	617	594	-22		612	2.9%	603	1.4%	598	0.7%

Notes:

Source: Agency for Healthcare Research and Quality, Medical Expenditure Panel Survey–Household Component, 2007 to 2013.

[^]Compared to actual 2010-2013 spending

^aIncludes zero-night hospital stays.

^bOther services = other providers + dentist + home health + medical equipment expenditures.

^cThe model controls for age, age², sex, race, health status, family type, family income, and region at the 2007-2009 level.

^dModel controls for insurance coverage categories at the 2007-2009 level. Individuals are assigned to a single type of coverage based on the following hierarchy: Any group insurance, any private nongroup or marketplace insurance, any public coverage, uninsured the whole year.

^eModel controls for numbers of reported chronic conditions (0, 1, 2, 3 or more) at the 2007-2009 level.

* $p < .10$; ** $p < .05$; *** $p < .01$

12

Appendix Table 4. Decomposition of Changes in Per Capita Expenditure, 2010-2015, Pooled, by Service Type, Nonelderly

Services	Actual Per Capita Spending				2014-2015: Predicted Per Capita Expenditures if characteristics remain at 2010-2013 levels					
					Socioeconomic characteristics ^c		Socioeconomic characteristics + Health Insurance ^d		Socioeconomic characteristics + Health Insurance + Chronic Conditions ^e	
	2010-2013	2014-2015	Difference		Mean	% Difference [^]	Mean	% Difference [^]	Mean	% Difference [^]
Total	5,654	5,927	163	*	5,984	1.0%	5,676	-4.2%	5,719	-3.5%
Hospital										
Outpatient +										
Physician	1,881	2,179	166	***	2,061	-5.4%	1,973	-9.5%	1,993	-8.6%
Hospital										
Inpatient ^a	1,767	1,603	-342		1,616	0.8%	1,516	-5.4%	1,510	-5.8%
Prescription Drugs	1,057	1,195	294	**	1,211	1.3%	1,127	-5.7%	1,131	-5.4%
Emergency Room										
Hospital	279	320	6	**	333	3.9%	317	-0.9%	322	0.5%
All Other Services ^b	594	629	114		667	6.1%	641	1.9%	643	2.1%

Notes:

Source: Agency for Healthcare Research and Quality, Medical Expenditure Panel Survey–Household Component, 2010-2015.

[^]Compared to actual 2014-2015 spending

^aIncludes zero-night hospital stays.

^bOther services = other providers + dentist + home health + medical equipment expenditures.

^cThe model controls for age, age², sex, race, health status, family type, family income, and region at 2010-2013 levels.

^dModel controls for insurance coverage categories at 2010-2013 levels. Individuals are assigned to a single type of coverage based on the following hierarchy: Any group insurance, any private nongroup or marketplace insurance, any public coverage, uninsured the whole year.

^eModel controls for numbers of reported chronic conditions (0, 1, 2, 3 or more) at 2010-2013 levels.

* $p < .10$; ** $p < .05$; *** $p < .01$

13

Appendix Table 5. Decomposition of Changes in Per Capita Expenditure, 2007-2013, Pooled, by Service Type, Nonelderly Adults

Spending Means										
Services	Actual Per Capita Spending				2014-2015: Predicted Per Capita Spending if characteristics remain at 2007-2009 level					
	Great Recession 2007-2009	Main ACA Coverage Expansion 2014-2015	Difference		Socioeconomic characteristics ^c		Socioeconomic characteristics + Chronic Conditions ^e		Socioeconomic characteristics + Chronic Conditions ^e + Health Insurance ^d	
					Mean	% Difference ^a	Mean	% Difference ^a	Mean	% Difference ^a
Total	5,353	5,927	574	***	5,892	-0.6%	5,745	-3.1%	5,523	-6.8%
Hospital Outpatient + Physician	1,991	2,179	188	**	2,056	-5.7%	1,998	-8.3%	1,943	-10.8%
Hospital Inpatient ^a	1,561	1,603	42		1,588	-0.9%	1,544	-3.7%	1,459	-9.0%
Prescription Drugs	931	1,195	265	***	1,186	-0.8%	1,135	-5.1%	1,077	-9.9%
Emergency Room Hospital	254	320	66	***	331	3.4%	326	1.7%	314	-2.1%
All Other Services ^b	617	629	13		660	5.0%	648	2.9%	630	0.1%

Notes:

Source: Agency for Healthcare Research and Quality, Medical Expenditure Panel Survey–Household Component, 2007 to 2015.

^aCompared to actual 2014-2015 spending

^aIncludes zero-night hospital stays.

^bOther services = other providers + dentist + home health + medical equipment expenditures.

^cThe model controls for age, age², sex, race, health status, family type, family income, and region at the 2007-2009 level.

^dModel controls for insurance coverage categories at the 2007-2009 level. Individuals are assigned to a single type of coverage based on the following hierarchy: Any group insurance, any private nongroup or marketplace insurance, any public coverage, uninsured the whole year.

^eModel controls for numbers of reported chronic conditions (0, 1, 2, 3 or more) at the 2007-2009 level.

* $p < .10$; ** $p < .05$; *** $p < .01$