THE IMPACT OF MEDICARE PART D ON ELDERLY HEALTH

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Mathematical Economics

Abstract

Medicare provides the 65+ population with affordable health insurance. Medicare Part D was introduced in 2006 and provides the Medicare population with prescription drug coverage. We examine the impact of Medicare Part D on the health of the elderly by examining the trends in mortality rates before and after the Medicare Part D implementation. We find that Medicare Part D reduced elderly mortality rates by 2.2%.

KEYWORDS: Health Insurance, Medicare, Prescription Drug Coverage
JEL CODES: I180, I130, C100

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Susannah Frechter

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I. Introduction

It has been 50 years since Medicare was introduced, and currently the United States government spends more than half a trillion dollars annually on the program.[1] As health services become more expensive and the elderly population grows, the government is challenged with paying for this increasingly expensive benefit. And yet, despite the enormous cost, Medicare has not been proven to improve health outcomes for recipients. That health insurance ensures positive outcomes has become a widespread assumption. But is this true?

Numerous previous studies have examined the effect of Medicare on health outcomes with inconsistent and therefore inconclusive results. Most of those studies have made use of data from the initial components of Medicare: Part A (Hospital Insurance) and Part B (Medical Insurance). In this study we exploit a new source of data resulting from the introduction of Medicare Part D (Prescription Drug Benefits) in 2006. This change provides a new source of variation to study the effect of insurance on health outcomes. Although a few studies have examined the short-term effects of Medicare Part D, none have examined the long-term effects.

In this study, we use a difference-in-differences approach to compare the changes in mortality rates before and after the Medicare Part D implementation for the young elderly (ages 65-74) who were eligible for Medicare to the changes in mortality amongst the near elderly (ages 55-64) who were not eligible for Medicare before or after the Medicare Part D implementation. Our main finding is that the 2006 introduction of Medicare Part D decreased the annual number of deaths by 2.2% for the young elderly compared to the near elderly in its first nine years.

[1] "State Health Facts," The Henry J. Kaiser Family Foundation, December 02, 2016, accessed March 05, 2018, https://www.kff.org/statedata/.

Medicare Part A (Hospital Insurance) and Part B (Medical Insurance) were established in 1965 so that the price of medical care would no longer inhibit the elderly from getting necessary medical services.[2] Finkelstein and Mcknight (2007) studied the impact of Medicare in the first 10 years after the program's 1965 introduction and find that there was no impact on elderly mortality. In contrast, Lichtenberg (2002) finds evidence that Medicare increased the survival rate of the elderly by about 13%. Card, Dobkin, and Masetas (2009) infer that Medicare reduced the mortality rate of the 65-year-old population by 20 percent. From previous literature, the impacts of "Original Medicare" (Parts A and B) on the health of the elderly seem inconclusive.

Despite the lack of consistent evidence that the original Medicare (Parts A and B) improved heath outcomes, Medicare was expanded in the mid 2000s to include a prescription drug benefit. By 2003, growing prescription drug costs resulted in about one-third of Medicare beneficiaries without prescription drug coverage skipping their doses to make their prescriptions last longer. Additionally, many chronically ill seniors without drug coverage opted not to buy any prescribed medications at all due to the high costs.[3]

To address this crisis, in 2003, George W. Bush signed into law The Medicare Prescription Drug, Improvement and Modernization Act. The act created a new prescription drug benefit (Medicare Part D) available to any individual eligible for Medicare. The prescription drug benefit provided prescription drug coverage to Medicare beneficiaries beginning in 2006. Medicare Part D added significant cost to the Medicare program. In 2006, the year Medicare

[2] "History: CMS' program history," Centers for Medicare and Medicaid Services, September 14, 2007, accessed February 26, 2018. https://www.cms.gov/About-CMS/Agency-information/History/

[3] Medicare: Medicare and Prescription Drugs Fact Sheet," Kaiser Family Foundation, last modified April 2003. https://www.kff.org/medicare/fact-sheet/medicare-and-prescription-drugs-fact-sheet/

Part D was implemented, annual Medicare spending increased by $56 billion (from $326 billion in 2005 to $382 billion in 2006),[4] which we can assume is attributable to Part D. From the implementation of Part D in 2006 until 2014, annual Medicare spending increased from $382 billion to $580 billion, a $198 billion increase.[5] Figure 1 plots per capita Medicare, Medicaid and Private Health Insurance spending from 1999 to 2014. Per capita Medicaid and Private Health Insurance spending display a somewhat constant trend. However, Medicare spending shows a distinct jump around 2006, the year Medicare Part D was implemented. We assume this jump is due to the 2006 introduction of Medicare Part D.

The significant cost of Medicare Part D was justified by the expected decrease in out-of-pocket spending and increase in prescription drug utilization and access, resulting in the betterment of the health of the Medicare population. And many studies have proven that Medicare Part D did, in fact, do just this. Polinksi et al (2011) find that Medicare Part D was associated with a 6-13% increase in drug utilization and a 13-18% decrease in patients' costs from 2006 to 2009. Kaestner and Khan (2012) find that gaining prescription drug insurance through Medicare Part D increased the number of annual prescriptions filled by 70%. Lichtenberg and Sun (2007) estimate that Medicare Part D lowered out-of-pocket spending by 18.4% and increased the use of prescription drugs by 12.8%.

It is clear that Medicare Part D decreased out-of-pocket costs and increased prescription drug accessibility and usage. But what was the effect on mortality from these changes? Figure 2 plots the mortality rates for the near elderly (ages 55-64) and the young elderly (ages 65-74) from 1999 to 2014. The young elderly (with access to Medicare) mortality rate shows a constant

[4] State Health Facts," The Henry J. Kaiser Family Foundation, December 02, 2016, accessed March 05, 2018, https://www.kff.org/statedata/.
[5] Ibid

decline, while the near elderly (with no access to Medicare) mortality rate seems to actually trend upward in recent years. In this paper, we investigate whether the implementation of Part D and the substantial increase in Medicare spending is the cause for the decline in mortality rates for the young elderly.

There have been no published studies of the long-term effects of Part D on health outcomes, but there have been several studies of the short-term effects. In these studies, health outcomes are measured by mortality because this is an objective and well-measured variable.[6] Kaestner, Long, and Alexander (2014) find no significant impact of Medicare Part D on mortality from 2002 to 2009. Dunn and Shapiro (2015) study mortality rates immediately before and after the implementation of Medicare Part D and estimate that 26,000 more individuals were alive one year later in mid-2007 because of the 2006 Part D implementation. Huh and Reif (2017) conduct a study that compares the differences in mortality trends between the near elderly (age 64) and the young elderly (age 66) around the time of the Medicare Part D implementation from 2001 to 2008. They estimate that Medicare Part D reduced annual mortality by 2.2% in its initial years with this reduction driven primarily by a significant reduction in cardiovascular mortality.

It has now been 13 years since the implementation of Medicare Part D and there are still no published studies of the longer-term impacts on health outcomes. Our study focuses on this longer time period and uses different assumptions than previous studies.

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[6] Finkelstein, Amy and Robin McKnight, *What did Medicare do? The initial impact of Medicare on mortality and out of pocket medical spending* (Journal of Public Economics, 2008) https://economics.mit.edu/files/7886

First, we use treatment and control groups that include 65-74 year-olds (who had access to Medicare) and 55-64 year-olds (who did not have access to Medicare), respectively. In contrast, Huh and Reif construct their treatment and control groups with 66- and-64-year-olds, respectively, due to previous literature that claimed that 1-2 years of exposure to prescription drug coverage is enough time for drugs to have significant health impacts.

Secondly**,** our study spans 1999-2014: seven years before the implementation of Part D and nine years after. Past studies looked at only eight years of data, from 2001-2009. This is too short a time period to consider, especially since there was a two-year transitional period between the time the Medicare Modernization Act was passed in 2003 and enacted January 1, 2006. To further confuse the issue, in 2004 and 2005, Medicare beneficiaries received benefits from the Medicare Prescription Drug Discount Card and Transitional Assistance Program. This program provided immediate relief to Medicare enrollees to help reduce costs for their prescriptions before the new drug benefit was actually implemented in 2006. Any decline in mortality found in 2004 and 2005 is attributable to this transitional program, rather than to actual prescription drug coverage provided by Medicare Part D. In order to prevent the impact of the transitional program from interfering with measuring the impact of the Part D program, it is important to study a longer pre-Part D period and a longer post-Part D period.

Lastly, our study isolates the variable of Medicare spending (as a proxy for utilization) to determine whether outcomes are directly impacted by the level of utilization. Previous studies do not include the magnitude of drug utilization or drug spending in their models, but only considered the presence of the absence of Part D.

One premise of this study is that the increase in drug prescription availability and usage leads to a decrease in mortality. In a perfect world, a study would include drug utilization as a

variable. However, we could not obtain annual state-level and age-group-level data for drug utilization. Given previous literature on the relationship between drug utilization and drug spending, we use Medicare spending as a proxy for drug utilization. We include Medicare spending in our model in order to estimate a more precise measure of the effect of Medicare Part D on elderly mortality.

II. Theoretical Framework

Studies have found that the less healthcare beneficiaries pay, the more health care services they utilize. Levy and Meltzer (2004) investigate how health insurance affects health. Specifically, they explore whether the relationship between health insurance and health is causal. A causal relationship would mean that health insurance actually causes better health. They find that large quasi-experimental studies, like the RAND Health Insurance Experiment (HIE), provide consistent evidence that health insurance does in fact improve health. The RAND HIE was an experimental study between 1974 and 1981 that assigned health insurance plans with varying levels of cost sharing to participants. Health insurance coverage ranged from full coverage, free care, to essentially no coverage.[7] The Rand HIE found that the more people had to pay for health insurance, the fewer services they used. Levy and Meltzer conclude that the experimental studies they investigate lead them to the conclusion that health insurance expansion policies have the ability to promote health. In a similar study, Brook et al (1983) studied 3,958 people between the ages of 14 and 61 who were randomly assigned to health insurance plans that provided free care or required enrollees to pay a share of their medical bills. They found that

[7] Aron-Dine, Aviva, Liran Einav and Amy Finkelstein, *The RAND Health Insurance Experiment, Three Decades Later* (Journal of Economic Perspectives, 2013) https://economics.mit.edu/files/8400

utilization of medical care was lower the more people had to pay for it. In particular, the groups of people who had to pay a share of their medical bills made a third fewer ambulatory visits and were hospitalized a third less often. Previous literature studying the impact of health insurance on health provides the underlying theory that health insurance does have the ability to better the health of its beneficiaries. We use this fundamental theory to create the hypothesis that the introduction of Medicare Part D will increase the elderly's use of prescription drugs, therefore improving their health.

And in fact, in the case of Medicare, utilization of prescription drugs did increase as costs came down for beneficiaries. Prior to the implementation of Medicare Part D, about 38% of Medicare beneficiaries did not have prescription drug coverage.[8] By 2014, that number had decreased to 10%.[9] Since Medicare Part D significantly reduces the financial burden of prescription drug costs for the elderly, we assume that Medicare beneficiaries will be more inclined to take their prescribed medication. As previous literature establishes, Medicare Part D did increase drug utilization for the elderly. In this paper, we contribute to previous literature by exploring the effect of Medicare Part D on health outcomes. The increase in government spending on and elderly utilization of prescription drugs has little significance if the elderly experience no health impacts. We use mortality rates as our measure of health due to its objectivity and ability to be easily measured, even though we do recognize that mortality rates do not measure the other benefits of prescription drugs such as relieving pain or managing

[8] "Medicare: Medicare and Prescription Drugs Fact Sheet," Kaiser Family Foundation, last modified April 2003. https://kaiserfamilyfoundation.files.wordpress.com/2013/01/medicare-and-prescription-drugs-fact-sheet-fact-sheet.pdf

[9] Donohue, Julie M., "The Impact and Evolution of Medicare Part D," last modified August 21, 2014. http://www.nejm.org/doi/full/10.1056/NEJMp1402471

symptoms.[10] We compare the difference in mortality rates for the near elderly, our control group, and the young elderly, our treatment group. Because the near elderly group is not eligible for Medicare, we expect no significant change in mortality trends. In contrast, we expect the mortality trends for the young elderly to show a distinct change around 2006, the Part D implementation period. Theoretically, Part D should decrease mortality rates for the young elderly due to increased access to medications and the decreased cost for prescription drugs.

III. Data

The data for this study comes primarily from the Centers for Medicare and Medicaid Services (CMS) and the Centers for Disease Control and Prevention (CDC). CMS publishes National Health Expenditure Data annually and includes historical spending, projected spending, age and gender spending estimates, and state health expenditures. This study relies on CMS for per capita spending on Medicare, Medicaid, and Private Health Insurance. The CDC provides detailed mortality reports. Additional data sets are included in this study for obtaining data for control variables and will be discussed briefly later in this section. Variable descriptions and descriptive statistics for key variables are given in Table 1 and Table 2, respectively.

The data set for this study is at the state level and spans 1999 through 2014. Data is included for the near elderly age group, 55-64 years old, and for the young elderly, 65-74 years old. Table 3 shows the demographic breakdown for the two age groups. Table 4 lays out the five leading causes of death for the near elderly and the young elderly. Note that the two age groups share Malignant Neoplasms (Breast Cancer), Heart Disease, Chronic Lower Respiratory

[10] Wallace, Amy, "Study finds elderly mortality reduced with Medicare Part D," last modified March 9, 2017. https://www.upi.com/Health_News/2017/03/09/Study-finds-elderly-mortality-reduced-with-Medicare-Part-D/4571489076022/

Diseases, and Diabetes Mellitus as leading causes of death. This study will focus on the effects of the Medicare Part D implementation on the five leading causes of death for the young elderly. Additionally, it is important to notice that while the near elderly and the young elderly have similar breakdowns for causes of death, the average deaths per year for each cause is significantly higher for the young elderly. Both age groups share Malignant Neoplasms as their leading cause of death, accounting for about 35% of all deaths for each age group.

Health Expenditure information comes from CMS. CMS provides Private Health Insurance, Medicare, and Medicaid expenditures by state of residence and includes aggregate and per capita health spending by type of good or service. State of residence estimates are based on the state in which the individual resides rather than where the individual actually receives care. Medicare spending includes hospital care, physician services, nursing home care, and prescription drugs. This study uses Medicare per capita spending as a proxy for spending on prescription drugs. Any large increases in Medicare spending after the Medicare Part D implementation will be assumed to be attributable to Medicare Part D. This study uses the per capita spending of Medicare, Medicaid, and Private Health Insurance at a state level.

Table 5 shows the mean, minimum, and maximum per capita Medicare spending for 1999 through 2014. The large disparities in per capita spending illustrate why this study observes mortality rates at a state level. The higher the cost share of health expenditure for the government, and the lower this share is for the individual, the more likely the individual is to utilize health services such as prescription drugs. This assumption comes from Brook et al (1983) who find that the more people had to pay for medical care, the less of it they used. Table 6 shows the average per capita Health Care spending for the years 1999-2014. Medicaid and

Private Health Insurance spending show a steady increase across the time period, but not as large in magnitude as the increase in Medicare spending.

The CDC provides detailed mortality reports. The data is based on death certificates for U.S. residents that identify a single underlying cause of death and demographic data. They include age, sex, cause of death, and the state of death for each individual in the United States who died between 1999 and 2014. For this study we use Number of Deaths, Population, and Crude Rate (deaths per 1,000 people) at a state, year and age group level. The data from CDC allows us to look at the effects of Medicare Part D on all causes of death, as well as the five leading causes mentioned above. Later sections will explore the impact of Medicare Part D on the mortality rate associated with each leading cause of death.

Consistent with previous studies on the impact of Medicare and Medicare Part D, we use state-level control variables in our model. We get annual, state-level estimates of poverty rates from the United States Census Bureau, level of employment from the Bureau of Labor Statistics and personal income per capita from the Bureau of Economic Analysis. Table 7 shows yearly averages of our control variables. Poverty rate and per capita personal income show a somewhat steady increasing trend. Employment has a significant decrease starting in 2008 through 2010, which coincides with The Great Recession of 2008.

IV. Model

One of the primary objectives of this paper is to estimate the impact of gaining prescription drug insurance. Specifically, we attempt to estimate the relationship between gaining drug coverage through Medicare Part D and mortality. We use a difference-in-differences approach to compare the changes in mortality rates before and after the Medicare

Part D implementation for the young elderly to the changes in mortality amongst the near elderly before and after the Medicare Part D implementation. The difference-in-differences approach classifies individuals into control and treatment groups in the pre-and-post-periods. The control group consists of the near elderly, ages 55-64, who are not eligible for Medicare Part D coverage. The treatment group consists of the young elderly, ages 65-74, who are eligible for Medicare Part D. Although the Medicare Prescription Drug, Improvement and Modernization Act was passed in 2003, we consider the pre period to be prior to 2006 and the post period to be after 2006 because prescription drug coverage did not begin until January 2006. However, it is important to note that the government implemented The Medicare Prescription Drug Discount Card and Transitional Assistance Program that would provide immediate relief to people with Medicare to help reduce their costs for prescriptions before the new drug benefit was implemented on January 1, 2006.[11] Due to this program, we may identify declining mortality prior to our designated post period. Because this study includes a control and treatment group, we assume any differences in mortality rate trends between the two groups results from the Medicare Part D implementation.

The regression model to implement the DID approach is:

$$\ln(DEATHS_{ast}) = \beta_1 ELDERLY_a + \beta_2 \ln(POP_{ast}) + \beta_3 MEDICARE_{ast} + \beta_4 MEDICAID_{st} + \beta_5 PHI_{st} + \beta_6 X_{st} + \lambda_t (ELDERLY_a * POST_t) + \alpha_s + \delta_t + \epsilon_i \quad (1)$$

[11] "Medicare Prescription Drug Discount Card and Transitional Assistance Program," Centers for Medicare and Medicaid Services. Last modified March 26, 2004. https://www.cms.gov/Newsroom/MediaReleaseDatabase/Fact-sheets/2004-Fact-sheets-items/2004-03-26.html.

Our dependent variable is the natural log of the number of deaths in age group *a*, state *s*, and year *t*. As previously mentioned, there are two age groups: the 65-74 year-olds and the 55-64 year-olds. The variable $\ln(POP_{ast})$ is the natural log of the state-and age-group specific population in year t. This model includes state- and year-level per capita spending for Medicare ($MEDICARE_{ast}$), Medicaid ($MEDICAID_{st}$) and Private Health Insurance (PHI_{st}). However, it is important to note that only Medicare spending is at an age-group level, since individuals under 65-years-old do not receive Medicare coverage. Medicare per capita spending serves as our measure for prescription drug spending. This model includes a full set of state (α_s) and year (δ_t) fixed effects. The variable X_{st} represents our state-level control variables that include poverty rate, personal income per capita, and employment levels. The variable of interest is the interaction term $ELDERLY_a * POST_t$. The variable $ELDERLY_a$ is our indicator variable that is 1 if the population is in the 65-74 year-old age group and 0 otherwise. Likewise, $POST_t$ is an indicator value that is 1 if the time period is post-Medicare Part D implementation, 2006 or later, and 0 otherwise. The coefficient on $ELDERLY_a * POST_t$, λ_t, represents the estimated trend in $\ln(DEATHS_{ast})$ over time for the Medicare population relative to the non-Medicare population. We assume that λ_t signifies the impact of prescription drug coverage on mortality for the young elderly. We expect λ_t to be negative, indicating that the introduction of Medicare Part D has decreased mortality rates.

V. Results

We report results from equation (1) by Generalized Least Squares in order to control for serial correlation. Table 8 shows the results for the full sample broken down by cause of death. When looking at all causes of death as the dependent variable, the coefficient on $ELDERLY_a *$

$POST_t$ is -.022, meaning that the annual number of deaths decreased by 2.2% for the young elderly compared to the near elderly following the implementation of Medicare Part D. We also look at the estimated decline in mortality for the five leading causes of death. Malignant Neoplasms, Heart Disease, and Diabetes Mellitus are the only causes of death with significant estimates. Heart Disease mortality experiences a 6.5% decrease and Diabetes Mellitus mortality experiences a 4.5% decrease. Interestingly, Malignant Neoplasms, breast cancer, actually has a positive coefficient on the interaction term $ELDERLY_a * POST_t$ in which we interpret as Medicare Part D increasing mortality rates. Heart Disease and Diabetes Mellitus are both treatable with prescription drugs, so we would expect a decrease in their mortality rates due to Medicare Part D. In contrast, breast cancer is best treated with surgery, radiation therapy, chemotherapy, hormone therapy, and targeted therapy, none of which are covered through Medicare Part D. Thus, we would not expect the implementation of Medicare Part D to have a significant impact on breast cancer mortality rates.[12]

Table 9 reports the effect of Medicare Part D on mortality based on different demographic measures. Females and males both experience approximately a 1.9% decline in mortality rates. When looking at the effect of Medicare Part D on mortality rates based on race, non-whites experience a significant decline, about 10.7%, which is almost double the decline in mortality for the white population, 5.9%.

We examine the robustness of our results by estimating several alternative specifications. These include varying our dependent variable by using the number of deaths, crude rate, and the natural log of the crude rate as measures for mortality. Additionally, we alter our control and treatment age groups. Table 10 shows our estimates when we vary our dependent variable. Our

[12] "Treating Breast Cancer," American Cancer Society, accessed March 11, 2018, https://www.cancer.org/cancer/breast-cancer/treatment.html.

main results hold up across these different dependent variables. Table 11 shows our estimates when we vary our ages in our treatment and control groups. When increasing the treatment group to include 65-84 year-olds and the control group to include 45-64 year-olds, we estimate that the implementation of Medicare Part D decreased mortality by 3.3%. Our results did not hold up and were not statistically significant when raising the treatment group to 75-84 year-olds and lowering the control group to 45-54 year-olds.

VI. Discussion

Our main specification estimates that annual mortality for 65-74 year-olds decreased by 2.2% relative to 55-64 year-olds in the nine years following the implementation of Medicare Part D. Comparing our estimate to other studies of Medicare is useful in contextualizing our results. Huh and Reif (2017) studied the effect of Medicare Part D on the mortality rate for 66-year-olds and found that Medicare Part D reduced the mortality rate by 2.2% in its initial years. However, their post Medicare Part D time period is 2004-2008, so the decrease they found in mortality rates in 2004 and 2005 can be at least partially attributed to the Medicare Prescription Drug Discount Card and Transitional Assistance Program, but not specifically to the Medicare Part D prescription drug coverage, which began in 2006. Card, Dobkin, and Maestas (2009) estimate that Medicare reduces 7-day mortality by about 1 percentage point, with similar sized reductions at 14 days, 28 days, and 90 days. Cutler, McClellan, and Newhouse find a 30-percent decline in 30-day mortality due to heart attacks between 1975 and 1995, which they attribute to improved access to pharmaceuticals. Dunn and Shapiro (2015) estimate that up to 26,000 more individuals were alive in mid-2007 because of the Part D implementation in 2006.

Many studies have found that Medicare has had no significant impact on the health of the Medicare population. Finkelstein and Mcknight (2008) studied the impact of the introduction of Medicare in 1965 and find no distinct impact on elderly mortality within the first 10 years. Similarly, Kaestner, Cuiping, and Alexander (2014) find no significant change in mortality due to the implementation of Medicare Part D, although they do find a substantial decrease in hospital admissions.

Our study uses a difference-in-differences approach to compare the changes in mortality rates before and after the Medicare Part D implementation for the young elderly to the changes in mortality amongst the near elderly before and after the Medicare Part D implementation. Our underlying assumption is that any change in mortality trends between our two age groups is attributable to the implementation of Medicare Part D. However, due to the lack of prescription drug utilization data, our study excludes any sort of measure for how many drugs Medicare beneficiaries were actually using. With prescription drug utilization data, further research could investigate the impact of how taking prescribed medications affects health outcomes. Additionally, prescription drug utilization data could help figure out if Medicare spending, drug utilization, or the combination of the two had different effects on health outcomes.

Another place for further study is exploring why the non-white population experiences a 10.7% decline in mortality, while the white population only experiences a 5.9% decline. The answer could lie in how the current opioid crisis impacts each of these populations differently. From 2000 to 2016, more than 600,000 people died from opioid drug overdoses.[13] An average of 115 Americans die every day from an opioid overdose in the United States.[14] As a result of

[13] "Opioid Overdose," Centers for Disease Control and Prevention, August 30, 2017, accessed March 12, 2018, https://www.cdc.gov/drugoverdose/epidemic/index.html.
[14] Ibid

Medicare Part D, in 2014, prescription opioid overdoses had been involved in more 18,893 overdoses, more than quadrupling the number of opioid overdoses in 2000.[15] In particular, the opioid epidemic is much less prevalent in the African-American and Latino communities than in white communities.[16] Dr. Kolodny, co-director of the Opioid Policy Research Collaborative at Brandeis, theorizes that doctors prescribe opioids more cautiously to non-white patients. He believes that the racial stereotyping behavior that doctors display actually has a protective effect on non-white populations. Obtaining data on white versus non-white opioid utilization could allow further exploration into whether opioid availability and abuse is the explanation for why the white population experiences less of a decline in mortality than does the non-white population.

VII. Conclusion

This study concludes that the introduction of Medicare Part D did decrease mortality rates for the Medicare population. By using a difference-in-differences approach, we find that Medicare Part D decreased elderly mortality rates by 2.2 percent in its first nine years. Further analysis shows that Heart Disease mortality and Diabetes Mellitus mortality, two of the top five leading causes of death, experienced reductions of 6.5% and 4.5%, respectively. Additionally, the non-white population experienced a significant decline in mortality, 10.7%. We vary our dependent variable to ensure robustness of our results and find that our results hold up.

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[15] David Powell, Rosalie Liccardo Pacula, and Erin Taylor, "How Increasing Medical Access to Opioids Contributes to the Opioid Epidemic: Evidence from Medicare Part D," National Bureau Of Economic Research, April 2015, , doi:10.3386/w21072.

[16] "Why Is The Opioid Epidemic Overwhelmingly White?" NPR, November 04, 2017, , accessed March 12, 2018, https://www.npr.org/2017/11/04/562137082/why-is-the-opioid-epidemic-overwhelmingly-white.

We use mortality rates as our measure of health outcomes due to its objectivity and its availability. However, living longer is not the exclusive health outcome from increased utilization of prescription drugs. Both quality of life and morbidity are additional health measures that could be used to quantify the impact of Medicare Part D on health outcomes. Finding reliable measures of quality of life and morbidity would allow for further research on the impacts of the Medicare Part D implementation.

Tables

Table 1: Variable Description

Variable	Description
Medicare	Annual Medicare Spending Per Capita Per State
Medicaid	Annual Medicaid Spending Per Capita Per State
PHI	Annual Private Health Insurance Spending Per Capita Per State
Poverty	Annual Poverty Level Per State
Income	Annual Income Per Capita Per State
Employment	Annual Employment Level Per State
Population	Annual Population Per Age Group and State (natural log)
Deaths (55-64, 65-74)	Annual Number Deaths Per State For 55-64 and 65-74 Age Groups
Deaths (Malignant Neoplasms)	Annual Number Deaths From Malignant Neoplasms Per State For 55-64 and 65-74 Age Groups
Deaths (Heart Disease)	Annual Number Deaths From Heart Disease Per State For 55-64 and 65-74 Age Groups
Deaths (Chronic Lower Respiratory Disease)	Annual Number Deaths From Chronic Lower Respiratory Disease Per State For 55-64 and 65-74 Age Groups
Deaths (Cerebrovascular Disease)	Annual Number Deaths From Cerebrovascular Disease Per State For 55-64 and 65-74 Age Groups
Deaths (Diabetes Mellitus)	Annual Number Deaths From Diabetes Mellitus Per State For 55-64 and 65-74 Age Groups
Deaths (Female)	Annual Number Deaths For Females Per State For 55-64 and 65-74 Age Groups
Deaths (Male)	Annual Number Deaths For Males Per State For 55-64 and 65-74 Age Groups
Deaths (White)	Annual Number Deaths For Whites Per State For 55-64 and 65-74 Age Groups
Deaths (Non-White)	Annual Number Deaths For Non-Whites Per State For 55-64 and 65-74 Age Groups

Table 2: Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
Medicare	3,988	4,303	-	12,614
Medicaid	6,788	1,900	2,921	13,880
PHI	3,531	976	1,900	8,904
Poverty	13	3	5	23
Income	36,947	8,430	20,563	70,041
Employment	3,397,355	3,668,941	314,050	22,000,000
Population	517,781	584,372	21,731	4,503,163
Deaths (55-64, 65-74)	6,936	7,173	389	41,859
Deaths (Malignant Neoplasms)	2,489	3,534	130	103,171
Deaths (Heart Disease)	1,686	2,378	86	65,527
Deaths (Chronic Lower Respiratory Disease)	437	481	11	3,230
Deaths (Cerebrovascular Disease)	296	336	-	2,608
Deaths (Diabetes Mellitus)	269	294	10	1,845
Deaths (Female)	2,920	3,079	150	18,741
Deaths (Male)	4,017	4,108	225	23,656
Deaths (White)	5,753	5,947	96	35,204
Deaths (Non-White)	1,180	1,393	-	7,847

Note: Descriptive Statistics given for all independent variables and different dependent variables

Table 3: Descriptive Statistics for Sample Population

Demographic	Near Elderly	Young Elderly
Average Age	59.16	69.14
Gender Breakdown		
Female	0.52	0.54
Male	0.48	0.46
Race Breakdown		
White	0.84	0.86
Non-White	0.16	0.14

Table 4: Leading Causes of Death

Cause of Death	Average Deaths Per Year	Percent Of Total
Near Elderly		
Malignant Neoplasms	102,058	36%
Diseases of Heart	66,826	23%
Chronic Lower Respiratory Diseases	13,209	5%
Accidents (Unintentional Injuries)	10,444	4%
Diabetes Mellitus	11,217	4%
Young Elderly		
Malignant Neoplasms	145,565	35%
Diseases of Heart	101,184	24%
Chronic Lower Respiratory Diseases	31,360	7%
Cerebrovascular Diseases	19,710	5%
Diabetes Mellitus	16,233	4%

Source: Centers for Disease Control and Prevention

Table 5: Medicare Spending Per Capita (in dollars)

Year	Mean	Min	Max
1999	$5,383	$3,915	$7,406
2000	$5,583	$4,061	$7,578
2001	$6,110	$4,505	$7,652
2002	$6,481	$4,796	$8,027
2003	$6,823	$5,093	$8,327
2004	$7,358	$5,546	$8,946
2005	$7,855	$5,757	$9,546
2006	$9,026	$6,591	$10,451
2007	$9,448	$6,845	$10,984
2008	$9,959	$7,326	$11,509
2009	$10,344	$7,431	$11,909
2010	$10,487	$7,602	$12,011
2011	$10,756	$7,721	$12,334
2012	$10,771	$7,857	$12,302
2013	$10,827	$8,046	$12,327
2014	$10,986	$8,238	$12,614

Source: Centers for Medicare and Medicaid Services

Table 6: Health Care Spending Per Capita (in dollars)

Year	Medicare	Medicaid	Private Health Insurance
1999	$5,383	$5,327	-
2000	$5,583	$5,474	-
2001	$6,110	$5,668	$2,250
2002	$6,481	$5,697	$2,462
2003	$6,823	$5,806	$2,681
2004	$7,358	$6,079	$2,891
2005	$7,855	$6,276	$3,080
2006	$9,026	$6,219	$3,229
2007	$9,448	$6,602	$3,402
2008	$9,959	$6,728	$3,578
2009	$10,344	$6,800	$3,872
2010	$10,487	$6,778	$4,063
2011	$10,756	$6,649	$4,239
2012	$10,771	$6,681	$4,326
2013	$10,827	$6,892	$4,419
2014	$10,986	$6,815	$4,551

Source: Centers for Medicare and Medicaid Services

Table 7: Control Variables

Year	Poverty Rate	Per Capita Income	Employment
1999	11.45	$27,613	3,167,280
2000	10.87	$29,500	3,242,565
2001	11.37	$30,567	3,245,475
2002	11.79	$30,970	3,238,414
2003	11.85	$31,927	3,255,422
2004	12.11	$33,527	3,314,445
2005	12.27	$35,044	3,383,478
2006	11.85	$37,217	3,453,404
2007	11.8	$38,994	3,527,171
2008	12.5	$40,569	3,522,351
2009	13.59	$39,091	3,416,347
2010	14.26	$39,985	3,392,837
2011	14.31	$42,208	3,456,445
2012	14.3	$43,933	3,511,406
2013	14.01	$44,066	3,576,629
2014	14.06	$45,932	3,654,016

Source: Centers for Medicare and Medicaid Services

Table 8: Effect of Medicare Part D on Mortality, Ages 65-74

Dependent Variable	Coefficient on Post05*Elderly
Any Cause of Death	-0.0225244**
	(0.0071944)
Malignant Neoplasms	0.0274375*
	(0.0079293)
Heart Disease	-0.0655689*
	(0.011279)
Chronic Lower Respiratory Disease	0.0166244
	(0.019557)
Cerebrovascular Disease	0.0006247
	(0.021545)
Diabetes Mellitus	-0.0450127**
	-0.0229025

** and * indicate significance at 1% and 5%, respectively

Table 9: Effect of Medicare Part D on Mortality, Ages 65-74

Demographic Breakdown (Full Sample)

Demographic	Coefficient on Post05*Elderly
Gender	
Female	-0.0194353**
	(0.0083124)
Male	-0.0199996**
	(0.0078107)
Race	
White	-0.0590565*
	(0.0082451)
Non-White	-0.1074183*
	-0.0212281

** and * indicate significance at 1% and 5%, respectively

Table 10: Effect of Medicare Part D on Mortality, Ages 65-74

Robustness Checks - Varying Dependent Variable

Dependent Variable	Coefficient on Post05*Elderly
ln(deaths)	-0.0225244**
	(0.0071944)
ln(crude)	-0.0226355**
	(0.0072157)
Number of Deaths	-3014.917*
	(200.355)
Crude Rate	-206.2329*
	(14.64931)

** and * indicate significance at 1% and 5%, respectively

Table 11: Effect of Medicare Part D on Mortality

Robustness Checks - Treatment and Control Groups

Treatment Group	Control Group	Coefficient on Post05*Elderly
65-74	55-64	-0.0225244**
		(0.0071944)
75-84	45-54	0.0244008
		(0.014323)
65-84	45-64	-0.033252**
		(0.0112915)

** and * indicate significance at 1% and 5%, respectively

Figures

Figure 1: Health Care Spending Per Capita (1999-2014)

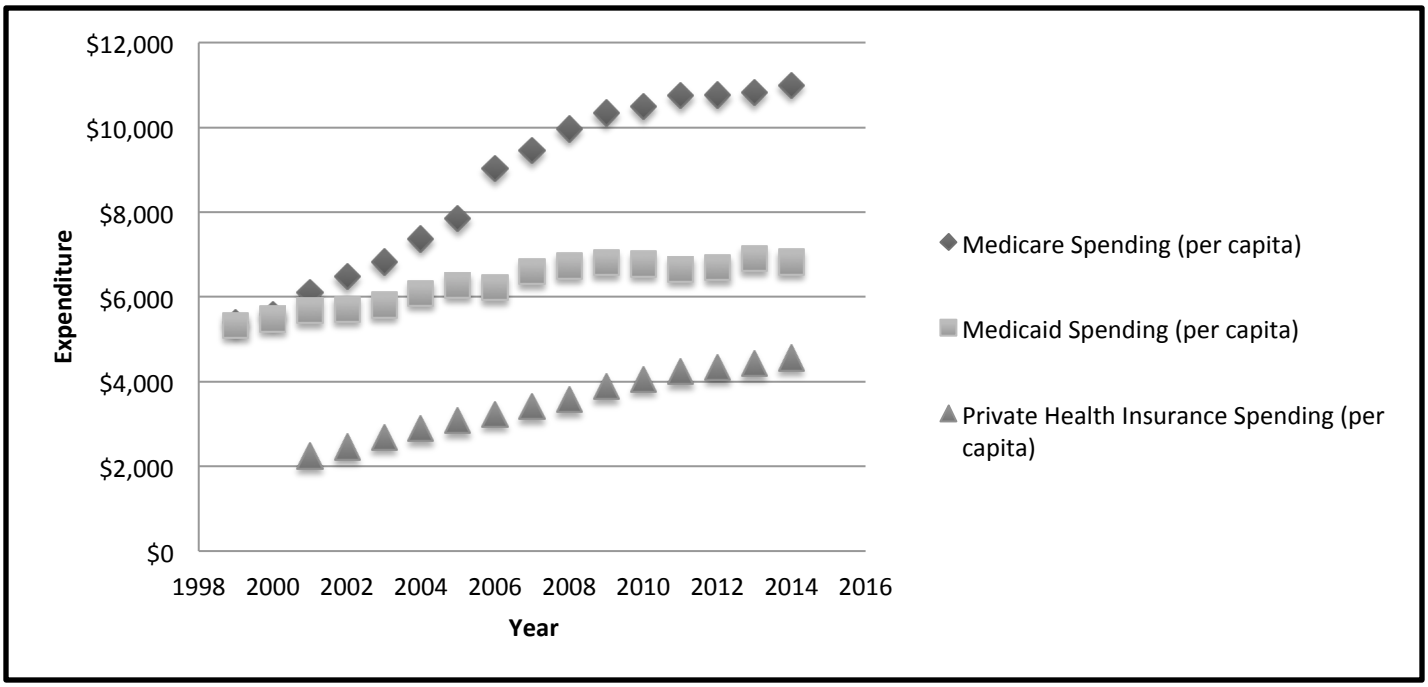
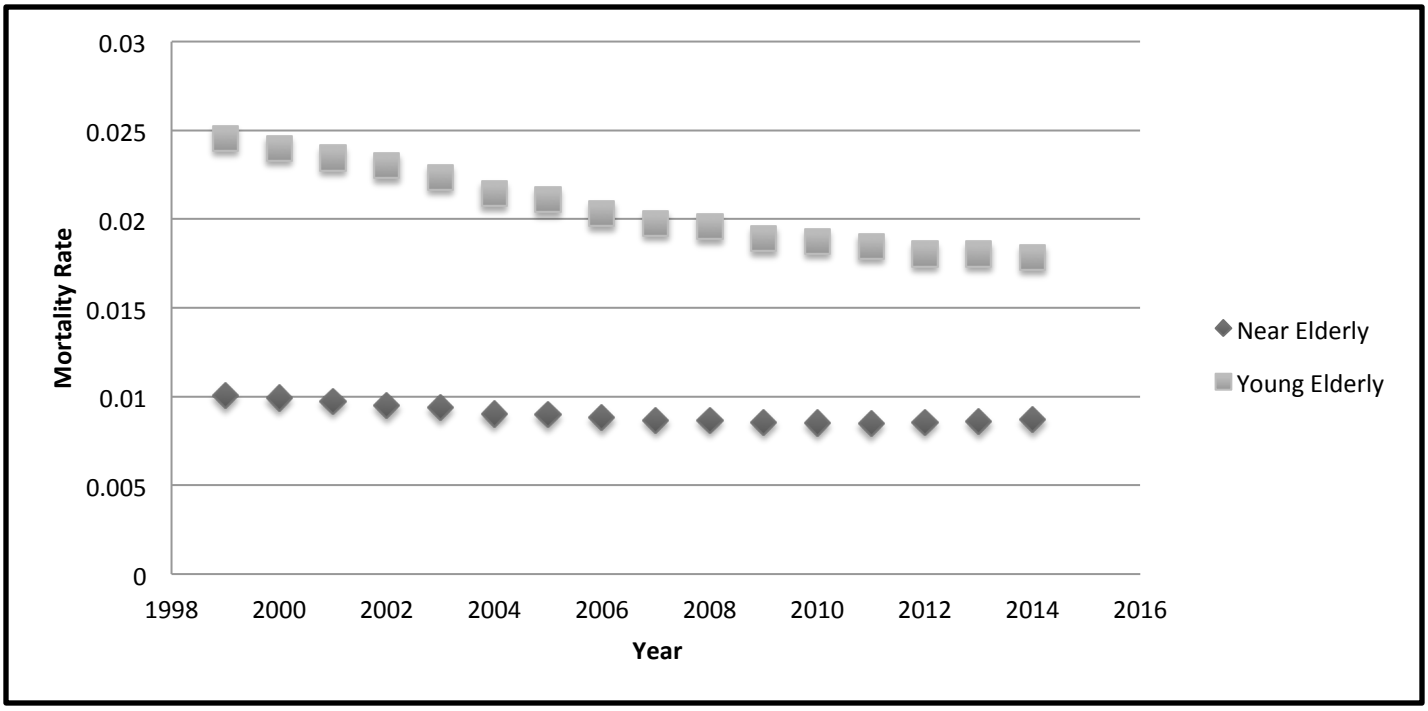


Figure 2: Mortality Rates (1999-2014)



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Appendix

Table 12.1: Impact of Medicare Part D on Mortality: All Causes of Death and Five Leading Causes

	Dependent Variable		
	All Deaths	**Malignant Neoplasm Deaths**	**Heart Disease Deaths**
Medicare	-0.0000292***	-0.0000245***	-0.0000235***
	(0.00000171)	(0.00000189)	(0.00000268)
Medicaid	0.00000876***	0.00000713***	0.0000112***
	(0.00000189)	(0.00000209)	(0.00000297)
PHI	-0.0000347***	-0.0000222***	-0.0000372***
	(0.00000559)	(0.00000616)	(0.00000876)
Poverty Rate	0.000912	0.000222	0.00200
	(0.000921)	(0.00102)	(0.00144)
Income	-0.00000240***	-0.00000367***	-4.88e-08
	(0.000000723)	(0.000000797)	(0.00000113)
Employment	1.69e-10	-3.39e-10	-7.05e-09
	(5.13e-09)	(5.66e-09)	(8.05e-09)
Elderly	0.939***	0.840***	0.942***
	(0.0142)	(0.0157)	(0.0223)
ln(Population)	0.681***	0.662***	0.694***
	(0.0191)	(0.0211)	(0.0300)
ELDERLY*POST	-0.0225**	0.0274***	-0.0656***
	(0.00719)	(0.00793)	(0.0113)
N	1428	1428	1428

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001
Note: Dependent Variables are regressed as its natural log

Table 12.2: Impact of Medicare Part D on Mortality: All Causes of Death and Five Leading Causes (continued)

	Dependent Variable		
	Chronic Lower Respiratory Disease Deaths	**Cerebrovascular Disease Deaths**	**Diabetes Mellitus Deaths**
Medicare	-0.0000334***	-0.0000597***	-0.0000279***
	(0.00000465)	(0.00000513)	(0.00000545)
Medicaid	0.0000201***	0.0000177**	0.0000139*
	(0.00000514)	(0.00000568)	(0.00000603)
PHI	-0.0000470**	-0.0000198	-0.0000667***
	(0.0000152)	(0.0000167)	(0.0000178)
Poverty Rate	0.00153	0.00527	-0.00357
	(0.00250)	(0.00276)	(0.00293)
Income	-0.00000855***	-0.00000274	-0.0000168***
	(0.00000196)	(0.00000216)	(0.00000230)
Employment	-1.67e-08	3.36e-08*	3.15e-09
	(1.39e-08)	(1.54e-08)	(1.63e-08)
Elderly	1.256***	1.375***	0.819***
	(0.0386)	(0.0425)	(0.0452)
ln(Population)	0.284***	0.508***	0.417***
	(0.0519)	(0.0575)	(0.0609)
ELDERLY*POST	0.0166	0.000625	-0.0450*
	(0.0196)	(0.0215)	(0.0229)
N	1427	1424	1428

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001
Note: Dependent Variables are regressed as its natural log

Table 13: Impact of Medicare Part D on Mortality: Demographic Breakdown

	Demographic			
	Female	**Male**	**White**	**Non-White**
Medicare	-0.0000259***	-0.0000325***	-0.0000131***	-0.0000136**
	(0.00000198)	(0.00000186)	(0.00000196)	(0.00000505)
Medicaid	0.0000105***	0.00000743***	0.0000107***	0.00000665
	(0.00000219)	(0.00000206)	(0.00000217)	(0.00000574)
PHI	-0.0000351***	-0.0000346***	-0.0000347***	-0.0000763***
	(0.00000645)	(0.00000607)	(0.00000640)	(0.0000166)
Poverty Rate	0.00145	0.000473	0.000266	0.00206
	(0.00106)	(0.00100)	(0.00106)	(0.00270)
Income	-0.00000350***	-0.00000179*	-0.00000159	-0.00000416*
	(0.000000836)	(0.000000785)	(0.000000829)	(0.00000212)
Employment	-7.01e-10	1.39e-09	-1.01e-08	5.38e-10
	(5.93e-09)	(5.57e-09)	(5.88e-09)	(1.49e-08)
Elderly	0.976***	0.916***	0.897***	0.480***
	(0.0164)	(0.0154)	(0.0163)	(0.0417)
Population	0.621***	0.720***	0.749***	0.397***
	(0.0221)	(0.0208)	(0.0219)	(0.0563)
ELDERLY*POST	-0.0194*	-0.0200*	-0.0591***	-0.107***
	(0.00831)	(0.00781)	(0.00825)	(0.0212)
N	1428	1428	1428	1364

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001
Note: Dependent Variable for each regression is the natural log of the number of deaths for each demographic group
Note: Population regressed as natural log

Table 14: Robustness Checks - Varying Treatment and Control Groups

Control Group	**55-64**	**45-54**	**45-64**
Treatment Group	**65-74**	**75-84**	**65-84**
Medicare	-0.0000292***	-0.0000419***	-0.0000409***
	(0.00000171)	(0.00000350)	(0.00000276)
Medicaid	0.00000876***	0.00000521	0.00000769*
	(0.00000189)	(0.00000387)	(0.00000304)
PHI	-0.0000347***	-0.0000378***	-0.0000375***
	(0.00000559)	(0.0000114)	(0.00000898)
Poverty Rate	0.000912	-0.00117	0.000180
	(0.000921)	(0.00188)	(0.00148)
Income	-0.00000240***	0.000000787	-0.00000105
	(0.000000723)	(0.00000148)	(0.00000117)
Employment	1.69e-10	-2.61e-08*	-8.49e-09
	(5.13e-09)	(1.05e-08)	(8.27e-09)
Elderly	0.939***	2.641***	1.766***
	(0.0142)	(0.0381)	(0.0286)
ln(Population)	0.681***	0.840***	0.709***
	(0.0191)	(0.0243)	(0.0256)
ELDERLY*POST	-0.0225**	0.0244	-0.0333**
	(0.00719)	(0.0143)	(0.0113)
N	1428	1428	1428

Standard errors in parentheses

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

Note: Dependent Variables are the number of deaths for each age group and are regressed as its natural log

Table 15: Robustness Checks - Varying Dependent Variables

	Dependent Variable			
	ln(deaths)	**ln(crude)**	**number of deaths**	**crude rate**
Medicare	-0.0000292***	-0.0000291***	0.803***	-0.0201***
	(0.00000171)	(0.00000172)	(0.0477)	(0.00349)
Medicaid	0.00000876***	0.00000865***	0.108*	0.00613
	(0.00000189)	(0.00000190)	(0.0528)	(0.00386)
PHI	-0.0000347***	-0.0000344***	-0.0718	-0.0496***
	(0.00000559)	(0.00000560)	(0.156)	(0.0114)
Poverty Rate	0.000912	0.000893	8.835	-0.278
	(0.000921)	(0.000924)	(25.66)	(1.876)
Income	-0.00000240***	-0.00000241***	-0.0673***	0.000321
	(0.000000723)	(0.000000725)	(0.0201)	(0.00147)
Employment	1.69e-10	-1.49e-10	0.00143***	-0.00000914
	(5.13e-09)	(5.15e-09)	(0.000143)	(0.0000105)
Elderly	0.939***	0.939***	15.21	1406.5***
	(0.0142)	(0.0143)	(395.8)	(28.94)
ln(Population)	0.681***	-0.318***	5245.8***	-79.65*
	(0.0191)	(0.0192)	(532.6)	(38.94)
ELDERLY*POST	-0.0225**	-0.0226**	-3014.9***	-206.2***
	(0.00719)	(0.00722)	(200.4)	(14.65)
N	1428	1428	1428	1428

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001