ISSUE BRIEF:

THE IMPACT OF BIOPHARMACEUTICAL INNOVATION ON HEALTH CARE SPENDING

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Abstract

This paper reviews the evidence covering the impact of biopharmaceuticals on the level and growth of total health care costs. The primary source of spending in health care is on labor, such as doctors, nurses or assistants, which makes up over 70% of overall spending, similar to other US industries. Nevertheless, many lawmakers often stress that capital spending on medical products such as drugs, diagnostics, and devices is the cause of the level and growth in overall health care spending. We find that during the last 20 years, profits and sales by research-based pharmaceutical companies made up 1.0% and 7.5% of total health care spending, respectively. In addition, annual sales growth contributed -4.5% to the annual growth in total health care spending, partly due to real declines in drug spending in some years when there were increases in real health care spending. We thereafter summarize the evidence base on the impact of biopharmaceutical innovation on overall health care spending, which has been addressed by a large literature on so called cost offsets of new drugs. We find that these studies report an average cost offset from medical innovation, or total cost decrease, of $151.94 per new drug. We estimate how much recently proposed US price controls on drugs in the US would raise health care spending and find that total health care spending would increase by $50.8 billion over a 20-year period.

Section 1: Introduction

The primary source of spending in health care is on labor rather than capital factors such as drugs and medical devices. Labor for short-and long-term hospital spending – doctors, nurses, and assistants – makes up more than 70% of health care spending. In this way, the health care sector is representative of the overall economy, as we spend about 70% of our overall GDP on labor, while the rest is spent on capital and land.

Over time, the increased use of capital in health care through drugs, devices, and diagnostics has impacted labor spending by raising its productivity. Labor and capital may be complements in producing better health, but a great deal of evidence also exists that they are sometimes substitutes whereby labor spending falls as new capital is deployed. Examples include antidepressants cutting spending on psychologists, statins cutting heart attack surgeries, and hepatitis C drugs reducing liver transplants.

Despite the role of labor costs driving health care spending and labor productivity rising with new medical products, many lawmakers are very concerned with the role of medical products in driving spending growth, which has resulted in misguided policies. Specifically, many lawmakers mistakenly associate the growth in overall health care costs with growth in biopharmaceutical profits and spending, even though they represent a small share of total health care spending.

The misguided focus of lawmakers on biopharmaceuticals as a key source of spending growth leads to harmful attempts to control overall health care spending by biopharmaceutical legislation and regulation. This hurts patients by limiting future treatments that benefit their health and often lower overall costs. Indeed, innovation often lowers the cost of better health even if it involves high prices, as before innovation the better health was equivalent to being prohibitively expensive.

In this paper, we review the evidence base on how much biopharmaceuticals have contributed to overall health care spending. Using data from the CMS and PhRMA, we find that during the period 2001 – 2021, profits and sales by research-based pharmaceutical companies made up 1.0% and 7.5% of overall health care spending, respectively. Moreover, annual sales growth contributed -4.5% to the annual growth in overall health care spending.

We thereafter examine a large literature on the cost offsets of medical innovation. Ultimately, we find that these studies report an average cost offset from medical innovation, or total cost decrease, of $151.94 per new drug. We find that recently proposed price controls on drugs in the US would raise health care spending by $50.8 billion over a 20-year period due to such cost offsets.

Section 2: The Role of Biopharmaceuticals in the Level and Growth of Overall Health Care Spending

This section discusses the role of domestic sales by US pharmaceutical innovators in both the level of overall health care spending and the growth of health care spending over time.

Table 1 presents aggregate data on national health expenditures from the Centers for Medicare & Medicaid Services (CMS) and domestic sales by US pharmaceutical innovators from PhRMA's Annual Membership Survey. The nominal total health care spending in the 3rd column is sourced from CMS

(2022), while the nominal domestic sales by pharmaceutical innovators in the 5th column is sourced from PhRMA (2022). To be eligible for membership in PhRMA, companies must have a three-year average global R&D to global sales ratio of at least 10% and have a three-year average global R&D spending of at least $200 million per year.
Results are collected from the 20-year period that spans 2001 – 2021. The expenditure data from the CMS only extends to 2020, so we utilize an estimate from Poisal et al. (2022) that total US health care spending was projected to be $4,297.1 billion in 2021. All calculations and conversions (including averages) were performed using the original numbers from CMS (2022) and PhRMA (2022) and then rounded to the nearest tenth for reporting purposes in Table 1.

The leftmost column in Table 1 presents the year in which the information is sourced from. The 2nd column is the cumulative rate of inflation from the given year to 2022 and is provided by the US Inflation Calculator (2022). This column is used to convert the nominal total health care spending in the 3rd column into the real total health care spending in the 4th column (in 2022 dollars). The cumulative inflation rate is also used to convert the nominal domestic sales by US pharmaceutical innovators in the 5th column into the real domestic sales of US pharmaceutical innovators in the 6th column (in 2022 dollars). The inflation conversions between the 3rd and 4th columns and the 5th and 6th columns are critical to our analysis of the level and growth of health care spending. These calculations are performed using the US Inflation Calculator (2022). Our methodology is to input the expenditure or sales statistic from the given year and compare to the base year of 2022 dollars. From this, the calculator reports the real value of the inputted number in 2022 dollars. For example, in 2020, the nominal total health care spending from the CMS of $4,124.0 billion is converted into $4,721.5 billion, the real total health care spending in 2020. In the same year, the nominal domestic sales by US pharmaceutical innovators reported by PhRMA of $307.2 billion is converted into its real value of $351.8 billion in the 6th column. We repeat this method of calculation for every year in the 20-year period from 2001 – 2021.

The 7th column displays real domestic sales by US pharmaceutical innovators as a fraction of total health care spending. This column is obtained by dividing the 6th column by the 4th column, i.e. dividing the real domestic sales by US pharmaceutical innovators by the real total health care spending. For example, when we divide the real 2019 domestic sales of US innovators, $350.9 billion, by the real total health care spending of $4,356.9 billion, our result is that real sales represent 8.1% of total health care spending. We repeat this calculation for every year in the period from 2001 – 2021. Ultimately, Table 1 shows that from 2001 – 2021, real domestic sales by US innovators made up 7.5% of real total health care spending, on average. Moreover, real domestic sales by US innovators made up no more than 8.8% of real total spending over the 20-year period.

We also present the profits of US pharmaceutical innovators in 2022 dollars in the 8th column of Table 1. We utilize a key result from Ledley et al. (2020), which studied the profits of 35 large pharmaceutical companies from 2000 to 2018 and found that their median net income margin was 13.8%. When we multiply this 13.8% net income margin by the real domestic sales figures reported in the 6th column, we find the profits of the US pharmaceutical industry from 2001 – 2021. For example, when we multiply the net income margin of 13.8% by the amount of domestic sales in 2019 of $350.9 billion, we find a profit of $48.4 billion. We repeat this method of calculation for every year in the 20-year period. From the table, we observe that profit has increased over time at a relatively constant rate and is $35.1 billion, on average, among US pharmaceutical innovators.

Lastly, the rightmost column of Table 1 reports the profit of pharmaceutical innovators as a share of real total health care spending. The values in this column are obtained by dividing the 8th column by the 4th column, i.e. dividing pharmaceutical innovators' profit by real total health care spending. For example, we divide 2019's profit of $48.4 billion by the real total health care spending of $4,356.9 billion to find that innovators' profits represent only 1.1% of total health care spending. We repeat this calculation for

every year between 2001 – 2021 and find that the share remains constant over time around an average of 1.0%.

Table 1: National Health Care Expenditures and Sales & Estimated Profits of US Pharmaceutical Innovators (in billions of dollars)

Year	Cumulative Rate of Inflation from Given Year to 2022	Nominal Total Health Care Spending (dollars of given year)	Real Total Health Care Spending (2022 dollars)	Nominal Domestic Sales by US Pharma Innovators (dollars of given year)	Real Domestic Sales by US Pharma Innovators (2022 dollars)	Real Domestic Sales as Share of Real Total Spending	Pharma Innovators' Profit (2022 dollars)	Pharma Innovators' Profit as Share of Real Spending
2021	9.4%	$4,297.1[1]	$4,699.0	$334.0	$365.2	7.8%	$50.4	1.1%
2020	14.5%	$4,124.0	$4,721.5	$307.2	$351.8	7.4%	$48.5	1.0%
2019	15.9%	$3,759.1	$4,356.9	$302.8	$350.9	8.1%	$48.4	1.1%
2018	18.0%	$3,604.5	$4,253.4	$280.8	$331.3	7.8%	$45.7	1.1%
2017	20.9%	$3,446.5	$4,166.3	$224.9	$271.9	6.5%	$37.5	0.9%
2016	23.5%	$3,305.6	$4,081.1	$218.4	$269.6	6.6%	$37.2	0.9%
2015	25.0%	$3,163.6	$3,955.0	$202.4	$253.0	6.4%	$34.9	0.9%
2014	25.2%	$3,001.4	$3,756.7	$178.6	$223.6	6.0%	$30.9	0.8%
2013	27.2%	$2,855.8	$3,632.5	$175.8	$223.6	6.2%	$30.9	0.8%
2012	29.1%	$2,782.8	$3,591.5	$178.4	$230.3	6.4%	$31.8	0.9%
2011	31.7%	$2,676.2	$3,525.3	$187.9	$247.5	7.0%	$34.2	1.0%
2010	35.9%	$2,589.4	$3,518.7	$184.7	$250.9	7.1%	$34.6	1.0%
2009	38.1%	$2,492.5	$3,442.6	$181.1	$250.2	7.3%	$34.5	1.0%
2008	37.6%	$2,402.0	$3,305.8	$183.2	$252.1	7.6%	$34.8	1.1%
2007	42.9%	$2,305.0	$3,294.1	$185.2	$264.7	8.0%	$36.5	1.1%
2006	47.0%	$2,164.4	$3,181.2	$177.7	$261.2	8.2%	$36.1	1.1%
2005	51.7%	$2,025.9	$3,073.7	$166.2	$252.1	8.2%	$34.8	1.1%
2004	56.9%	$1,894.1	$2,971.1	$160.8	$252.2	8.5%	$34.8	1.2%
2003	61.0%	$1,769.9	$2,850.2	$148.0	$238.4	8.4%	$32.9	1.2%
2002	64.7%	$1,630.6	$2,685.7	$139.1	$229.2	8.5%	$31.6	1.2%
2001	67.4%	$1,483.0	$2,482.7	$130.7	$218.8	8.8%	$30.2	1.2%
Average	35.4%	$2,751.1	$3,597.4	$202.3	$266.1	7.5%	$35.1	1.0%

Table 1 also presents key information about the growth in drug and health care spending over time. As such, we use Table 1 to find the increases and decreases in real total health care expenditures and real domestic sales by US pharmaceutical innovators from 2001 – 2021. We do so by subtracting one year's real total expenditures by the previous year's real total expenditures, and one year's real domestic sales by the previous year's real domestic sales. For example, the real increase in total health care spending in 2019 of $103.5 billion is the difference between the real total health expenditures in 2019 and 2018 of $4,356.9 billion and $4,253.4. Similarly, the real increase in domestic sales by US innovators in 2019 of $19.6 billion is the difference between the real sales in 2019 and 2018 of $350.9 billion and $331.3

[1] Estimate from Poisal et al. (2022).

billion. We calculate these real increases and decreases for both real total health spending and real domestic sales for every year between 2001 – 2021.

Our calculations demonstrate that from 2001 – 2021, there are both real increases and decreases in innovators' domestic sales. For example, in 2013, domestic sales by US innovators decreased by $6.7 billion to $223.6 billion from $230.3 billion in 2012. By averaging these increases and decreases over the period from 2001 – 2021, we find that on average, real total health care spending increased by $111.9 billion and real domestic sales by US innovators increased by $7.9 billion annually.

After dividing the real change in sales by the respective real change in overall spending for every year between 2001 – 2021, we find that the annual growth in domestic sales by US innovators contributed negatively to the annual growth in real health care spending. On average, real domestic sales by US pharmaceutical innovators made up -4.5% of the real increase in total health care spending from 2001 – 2021. In other words, real domestic sales by US pharmaceutical innovators may have contributed to reducing total health care spending, as opposed to raising it.

The overall finding is that increased pharmaceutical sales over the last 20 years seem to have played a very small role in the increase in total health care spending.

Section 3: The Evidence Base on the Impact of Drug Innovation on Overall Health Care Spending

This section summarizes the existing evidence base on the academic literature analyzing biomedical innovation's impact on overall health care costs. The evidence base often finds that drug innovation not only improves health outcomes but also lowers overall health care spending by estimating so called cost offsets of new drugs. Such offsets are defined as the difference between an increase in spending on new drugs minus the reduction in total non-drug spending.

There is a large body of research which discusses the impact of pharmaceutical innovation on health care spending. The Tufts Medical Center Cost-Effectiveness Analysis (CEA) Registry is a comprehensive database of over 10,000 cost-utility analyses published from 1976 to the present day which span a range of diseases and treatments. A large portion of the cost effectiveness studies analyze pharmaceutical drugs as a medical intervention, as opposed to medical devices or surgery. In the dataset, the unit of observation is a cost effectiveness analysis, but there are often multiple cost effectiveness analyses per study. Using the CEA Registry, we find what fraction of studies that look at overall health costs say that overall health costs decline with new drugs. In total, there are 3,402 cost-effectiveness studies (i.e. published papers) which measure how much drugs improve overall health care costs. 824 of these studies find that health costs decline with new drugs (for at least one analysis in the study). Thus, 24.2% of analyses that measure how much drugs improve overall health costs find that overall health costs decline with new drugs (CEA Registry 2022).

Much of the literature studying the association between drug and non-drug expenditures focuses on specific drugs that treat specific health conditions. Neumann et al (2000) analyze cost-effectiveness studies which present their results in cost-per-quality-adjusted life years (QALYs). Their findings serve to distinguish between drugs that are cost saving (reduce overall cost of treatment), cost effective (increase overall costs, but produce outcomes that are worth the cost), and neither cost saving nor cost effective. This underscores the mixed results on the association between drug and non-drug expenditures – some drugs reduce total health costs, while others increase them, but any drug's effectiveness depends on its use context and the intervention it is compared to.

In Table 2, we present data from various cost offset studies. The 4th column reports the size of the cost offset in 2022 dollars using the US Inflation Calculator (2022). Our methodology is to input the year of

the study and the cost offset from that year into the calculator, which has a base year of 2022 dollars. From this, the calculator tells us the value of the cost offset in 2022 dollars. For example, Lichtenberg (2002) studies the 1996 – 1998 Medical Expenditure Panel Surveys (MEPS). Thus, we convert the reported cost offset of $111 from 1996 dollars, 1997 dollars, and 1998 dollars into 2022 dollars ($209.63, $204.93, $201.78, respectively). Taking the average of these conversions over the three years, our final cost offset for Lichtenberg (2002) is $205.45 per new drug. We repeat this process for Lichtenberg (2001), Miller et al. (2005), and Zhang and Soumerai (2007). For example, Zhang and Soumerai (2007) also study the 1996 – 1998 Medical Expenditure Panel Surveys (MEPS). Thus, we convert the reported cost offset of $23 from 1996 dollars, 1997 dollars, and 1998 dollars into 2022 dollars ($43.44, $42.46, $41.81, respectively). When we take the average of these conversions over the three years, our final cost offset for Zhang and Soumerai (2007) is $42.57 per new drug.

To interpret these cost offsets, we note that the literature uses a particular estimation method that involves drug age. In Lichtenberg (2001), the author defined "drug age" as the number of years since a drug's active ingredient was first approved by the FDA. He claimed that reducing the mean age of drugs used to treat a condition by one log unit, i.e. switching from a 15-year-old drug to a 5.5-year-old drug, results in a cost offset effect. Thus, we interpret the size of all the reported cost offsets as a cost offset per new drug because an older drug is replaced with a newer drug. Since each of the papers in Table 2 uses this basic methodology to estimate cost offsets, we apply the same units to each paper.

Table 2: Summary of the Literature Analyzing Cost Offsets from Medical Innovation

Author (s)	Population and Years Studied	Size of Cost Offset (dollars of given year per new drug)	Size of Cost Offset (2022 dollars per new drug)	Result
Lichtenberg (2001)	1996 Medical Expenditure Panel Survey (MEPS)	-$54.00	-$101.98	Reducing drug age by one log unit decreases total health care spending per new drug.
Lichtenberg (2002)	1996 – 1998 Medical Expenditure Panel Surveys (MEPS)	-$111.00	-$205.45	Reducing drug age by one log unit decreases total health care spending per new drug.
Miller et al. (2005)	1996 – 1999 Medical Expenditure Panel Surveys Household Component (MEPS-HC)	-$140.64	-$257.76	Reducing cardiovascular drug age by one log unit decreases total health care spending per new drug, not controlling for the number or mix of drugs used.
		$293.37	$537.69	Reducing cardiovascular drug age by one log unit increases total health care spending per new drug, controlling for drug quantity.
Zhang and Soumerai (2007)	1996 – 1998 Medical Expenditure Panel Surveys (MEPS)	-$23.00	-$42.57	Reducing drug age by one log unit decreases total health care spending per new drug.

3.1 Lichtenberg's Analyses on Medical Innovation and Relevant Criticisms

Lichtenberg (2001) showed that replacing older drugs with newer drugs reduced mortality, morbidity, and total medical expenditure. Analyzing the 1996 Medical Expenditure Panel Survey (MEPS) with his unit of analysis as a prescription, he estimated that reducing a drug's age by one log unit had a drug-offset effect of $54 per new drug (saves $72 in non-drug health care spending and costs $18 more in drug spending). Focusing on medical expenditures, Lichtenberg found that though the reductions in drug age tend to reduce all types of non-drug medical expenditure, the reduction in inpatient expenditure was the largest.

Lichtenberg (2002) demonstrated that in the entire population, reducing the age of drugs utilized reduced non-drug expenditure 7.2 times as much as it increased drug expenditure. In this study, Lichtenberg expanded his sample to the 1996 – 1998 MEPS and the unit of analysis was a medical condition, rather than a prescription. Lichtenberg showed that reducing the mean age of drugs used to treat a condition by one log unit increased prescription drug spending by $18 but reduced other medical spending by $129 for a reduction in total health spending of $111. Of this $111 reduction in the total medical cost of a condition, most of the savings were reductions in hospital expenditure ($80) and in physician office-visit expenditures ($24). Furthermore, Lichtenberg showed that in the Medicare population, reducing the age of drugs utilized reduced non-drug expenditure for all payers (e.g. Medicare, private supplemental insurance, Medicaid for dually eligible individuals and out of pocket) 8.3 times as much as it increased drug expenditure. Particularly, it reduced Medicare non-drug expenditure 6.0 times as much as it increased drug expenditure. Lichtenberg estimated that 2/3 of the non-drug Medicare cost reduction was in reduced hospital costs, while 1/3 was (roughly) evenly divided between reduced costs of Medicare home health care and Medicare office-visits.

However, in Miller et al. (2005), the researchers focused specifically on new cardiovascular drugs and contradicted Lichtenberg's findings. Two important confounding variables in the study were the number of drugs used and the mix of drugs of different ages. The researchers found that controlling for the number or mix of drugs used reduced the cost offset effects of new cardiovascular drugs. Particularly, a reduction in drug age led to a $135.88 *increase* in total non-drug expenditures, a $157.49 increase in drug expenditures, and an increase in total expenditures of $293.37. When the researchers did not control for the number or mix of drugs used, the use of newer drugs was associated with a $208.88 decrease in total non-drug expenditures, an increase in drug expenditures of $68.23, and a cost offset of $140.64.

Similarly, Zhang and Soumerai (2007) challenged Lichtenberg's findings by replicating his analysis and coming to different conclusions. The authors updated data on the ages of prescription drugs, calculated drug spending associated with medical conditions, controlled for the severity of illnesses, and tested alternative model specifications. While their analyses found cost offsets that were relatively lower than Lichtenberg's estimates, their main analysis found a drug offset effect that was only $23 per new drug, 20% of what Lichtenberg originally reported.

In Lichtenberg (2007), the author reanalyzed Zhang and Soumerai (2007). He claimed that the researchers inappropriately controlled for the total number of prescriptions during the year and were unclear on how they updated the data on drug age. Moreover, he claimed that the authors failed to adjust for overestimation of the relative cost of drugs in the Medical Expenditure Panel Survey (MEPS) data. After adjusting the estimates, Lichtenberg showed that if we assume all of Zhang and Soumerai's modifications were appropriate, the reduction in non-drug spending from using newer drugs is 122 % larger than the increase in drug spending. Overall, Lichtenberg emphasized that even when his model was modified by

the previous researchers, it still implied that using newer drugs reduced non-drug costs more than it increased drug costs. Specifically, he detailed that in general, the reduction in non-drug spending from using newer drugs is 32% larger than the increase in drug spending. An implication of this fact is that the results in Miller et al. (2005) for cardiovascular drugs do not generalize to other drugs.

These analyses therefore tend to support the overall qualitative claim that new drugs lower total health care costs, although there is some debate to the degree it does.

3.2 Substitution Effects in Health Care Spending

Other studies analyzing the impact of biomedical innovation on health care spending focus on the substitution effects from changes in cost sharing.

Deb et al. (2009) found that the magnitudes of cost offsets depended on the amount of drug spending in the present period. For an elderly sample consisting of individuals 65 and older, previous quarter drug spending at the 25th percentile (approximately $40) was associated with a current quarter decrease in non-drug spending of about $50. Moreover, previous quarter drug spending at the 75th percentile (approximately $200) was associated with a current quarter reduction in non-drug spending of approximately $10. Estimates using an average partial effect (APE) within the 25th to 75th percentile range for other samples were – continuously insured: -$35 to -$5, diabetes: -$90 to -$30, arthritis: -$60 to -$10, heart condition: -$70 to -$10. For the mental illness sample, non-drug spending was about -$20 at the 25th percentile and $10 at the 75th percentile. For the most part, estimates of APE decreased as previous quarter drug spending increased because these estimates were positive and increasing between the 25th and 75th percentiles of drug spending.

Gaynor et al. (2007) used data on individual health insurance claims and benefits from 1997 – 2003 to analyze how changes in consumers' co-payments for prescription drugs affected their expenditures on drugs, inpatient care, and outpatient care. They found that a $1 increase in a drug price reduced drug spending by $23.62 in the first year after the price change, and total spending fell by $20.88. In the second year after the price change, a $1 increase in a drug price reduced drug spending by $32.57, and total spending fell by $21.23. Over the full period, total spending fell by about 65% as much as drug spending, so 35% of the savings due to reductions in drug spending were offset by increases in other medical spending.

These types of analyses therefore also tend to support the overall qualitative claim that new drugs lower total health care costs.

3.3 The Roles of Medicaid and Medicare in Health Care Spending

Another large portion of existing research studies the roles of Medicaid and Medicare in overall health care spending. The most important work in this section is a Congressional Budget Office (CBO) report that summarizes and reanalyzes previous literature to find that increased drug use leads to decreased spending on medical services. In this section, we discuss the CBO report at length, as well as the various studies mentioned in the paper.

Specifically, Congressional Budget Office (2012) analyzed the results of three different types of studies estimating the impact of pharmaceutical policies on medical expenditures of (i) the population outside of Medicare, (ii) Medicare beneficiaries before Medicare Part D was implemented, and (iii) Medicare beneficiaries before and after the implementation of Medicare Part D. To synthetize the evidence, they

scaled all changes in medical spending to a 1% change in prescription drug use, measured in terms of the number of prescriptions filled: this allowed them to isolate changes in the use of prescription drugs from shifts between different types of drugs with different prices that do not affect overall use, like, for example, a shift from a brand-name drug to its generic equivalent would do.

Ultimately, the CBO found that in response to a 1% increase in the number of prescriptions filled, the change in spending for medical services ranged from a decrease of two-thirds of a percent to an increase of one-third of a percent, so that the middle of the distribution of results shows that a 1% increase in prescription drug use would cause spending for medical services like emergency department visits and hospitalizations to fall by one-fifth of 1% (or 0.20%) (Congressional Budget Office 2012).

According to the CBO's scenario, a policy that increases prescription drug copayments for Medicare beneficiaries might save $4 billion in federal drug costs in a given year but would reduce the number of prescriptions filled that year by 1%. Said reduction in use would result in a 0.20% increase in the affected population's total spending for medical services, so that if the total spending would otherwise be $250 billion in that year, then those costs would increase by $0.5 billion (Congressional Budget Office 2012). Thus, the net effect of the policy, combining both the federal savings on drug costs and the increased costs in medical services for the affected population, would be a savings for the federal government of $3.5 billion in that year. Yet, this report is inconclusive whether there are costs offsets or not, because it measures the changes in the number of prescriptions, instead of the spending in said drugs, which does not consider the pricing and innovation effects on the total health spending, which is our measure for cost offsets.

In response to the CBO, Roebuck (2014) studied prescription drug use among Medicare beneficiaries and found that among seniors with chronic vascular diseases, a 1% increase in condition-specific prescription drug use was associated with significant decreases in the consumers' gross nonpharmacy medical costs by 0.63% for dyslipidemia, 0.77% for congestive heart failure, 0.83% for diabetes, and 1.17% for hypertension.

Duggan (2005) used a 20% sample of Medicaid recipients from California from 1993 – 2001 to analyze antipsychotic drugs. He found that the 610% increase in Medicaid spending on antipsychotic drugs during the study period did not reduce spending on other types of medical care.

In Hsu et al. (2006), the researchers studied how caps on Medicare benefits impacted drug use and medical outcomes. They analyzed Medicare and Choice beneficiaries at the Kaiser Permanente from 2002 – 2003 and found that individuals whose benefits were capped consumed drugs at a lower rate and had worse health outcomes, which included higher death rates. The money saved from the drug costs was offset by increased costs for hospitalization and emergency department care.

Shang and Goldman (2007) used the Medicare Current Beneficiary Surveys (MCBS) from 1992 – 2000 to study how prescription drug benefits effect Medicare spending. Specifically, they analyzed Medicare beneficiaries who had Medicare coverage and a Medigap supplemental plan with/without a drug benefit. Ultimately, the researchers found that a $1 increase in drug spending is associated with a $2.06 decrease in Medicare spending. Thus, as income increases, the substitution effect increases, which shows how impactful Medicare Part D is as a government program that helps low-income individuals.

Chandra et al. (2010) studied the effect of increases in cost sharing for prescription drugs on Medicare beneficiaries from the California Public Employees Retirement System (CalPERS) between 2000 and 2003. They analyzed these beneficiaries before and after they were impacted by a new policy that raised cost sharing. Ultimately, they found that a decrease in the use of prescription drugs increased the utilization of medical services. They also found that increased cost sharing caused savings that accrued

mostly to CalPERS, while the costs associated with increased hospitalization accrued mostly to Medicare.

Stuart et al. (2009) examined how outpatient prescription drug utilization effected hospitalization for Medicare beneficiaries. To determine this, they studied a sample of Medicare beneficiaries from the 1999 and 2000 Medicare Current Beneficiary Surveys. Ultimately, the researchers found that each additional prescription fill decreased hospital spending by $104.

Afendulis et al. (2011) analyzed whether the change in Medicare Part D's prescription drug insurance coverage decreased hospitalization rates for specific conditions. Linking hospital discharge data from 2005 – 2007 for 23 states with state-level drug coverage data, the researchers compared hospitalizations before and after Medicare Part D's implementation. Ultimately, they found that Medicare Part D reduced the hospitalization rate by 4.1%, or 42,000 admissions, which was around half of the reduction in admissions over the study period. Thus, the implementation of Medicare Part D reduced elderly Americans' non-drug health care spending.

Zhang et al. (2009) studied the effect of increased prescription drug use on spending for other medical care. They compared spending for prescription drugs and other medical care 2 years before Medicare Part D was implemented in January 2006 with the expenditures 2 years after the program was implemented for the following elderly groups: Medicare Advantage enrollees with stable, uncapped, employer-based drug coverage (no-cap group), those with no previous drug coverage, and those with previous limited benefits (with either a $150 or a $350 quarterly cap) before they were covered by Part D in 2006. Comparing with the expenditures in the no-cap group between December 2005 and December 2007, monthly medical expenditures (excluding drugs) were $33 lower in the no previous coverage group and $46 lower in the previous $150 quarterly cap group, while medical spending was $30 higher in the previous $350 cap group. Overall, the researchers concluded that though enrollment in Medicare Part D was associated with greater spending on prescription drugs, other medical spending decreased for groups that had no or minimal coverage before the implementation of Medicare Part D. The decrease in expenditures ultimately offset the increased drug spending for these groups, but there was no cost offset for the group with more generous previous coverage.

McWilliams et al. (2011) studied the same phenomenon as Zhang et al. (2009), i.e. how the implementation of Medicare Part D effected non-drug medical spending. The researchers found that among Medicare beneficiaries with limited prior drug coverage, the implementation of Part D was associated with significant decreases in non-drug medical spending. Specifically, after the implementation of Medicare Part D on January 1, 2006, total non-drug medical spending decreased for Medicare beneficiaries with limited prior drug coverage by $306 per quarter, as compared to beneficiaries with generous prior drug coverage.

Table 3: Summary of the Literature Analyzing the Roles of Medicaid and Medicare in Health Care Spending

Author (s)	Population and Years Studied	Result
Duggan (2005)	20% sample of California Medicaid recipients from 1993 – 2001	610% increase in Medicaid spending on antipsychotic drugs during the study period did not reduce spending on other types of medical care.
Hsu et al. (2006)	Medicare and Choice beneficiaries at the Kaiser Permanente from 2002 – 2003	Individuals whose benefits were capped consumed drugs at a lower rate and had worse health outcomes, which included higher death rates. The money saved from the drug costs was offset by increased costs for hospitalization and emergency department care.
Shang and Goldman (2007)	Medicare beneficiaries who have Medicare coverage and a Medigap supplemental plan with/without a drug benefit from the 1992 – 2000 Medicare Current Beneficiary Surveys	A $1 increase in drug spending is associated with a $2.06 decrease in Medicare spending.
Stuart et al. (2009)	Sample of Medicare beneficiaries from 1999 and 2000 Medicare Current Beneficiary Surveys	Each additional prescription fill decreased hospital spending by $104.
Zhang et al. (2009)	Compared spending for prescription drugs and other medical care between December 2005 and December 2007 (before and after Medicare Part D was implemented in January 2006)	Though enrollment in Medicare Part D was associated with greater spending on prescription drugs, other medical spending decreased for groups that had no or minimal coverage before the implementation of Medicare Part D.
Chandra et al. (2010)	Medicare beneficiaries from the California Public Employees Retirement System (CalPERS) between 2000 and 2003	A decrease in the use of prescription drugs increased the utilization of medical services. Increased cost sharing caused savings that accrued mostly to CalPERS, while the costs associated with increased hospitalization accrued mostly to Medicare.
McWilliams et al. (2011)	Used nationally representative longitudinal survey data of 6,001 elderly Medicare beneficiaries and Medicare claims from 2004-2007 to compare nondrug medical spending before and after Medicare Part D's implementation	After the implementation of Medicare Part D on January 1, 2006, total non-drug medical spending decreased for Medicare beneficiaries with limited prior drug coverage by $306 per quarter, as compared to beneficiaries with generous prior drug coverage.
Afendulis et al. (2011)	Linked hospital discharge data from 2005 – 2007 for 23 states with state-level drug coverage data	Medicare Part D reduced the hospitalization rate by 4.1%, or 42,000 admissions, which was around half of the reduction in admissions over the study period.
Congressional Budget Office (2012)	Review of previous research	A 1% increase in prescription drug utilization among Medicare beneficiaries led to a 0.20% decrease in spending on other medical services, like emergency department visits and hospitalizations.
Roebuck (2014)	Sample of seniors with chronic vascular disease enrolled in employer-sponsored insurance from 2005 – 2008	A 1% increase in condition-specific prescription drug use was associated with significant decreases in the consumers' gross nonpharmacy medical costs by 0.63% for dyslipidemia, 0.77% for congestive heart failure, 0.83% for diabetes, and 1.17% for hypertension.

3.4 Costs Offsets for Specific Indications: Statins, Substance Abuse Drugs, and Hepatitis C Drugs

Other studies in the field focus on the cost offsets of drugs with specific indications, such as substance abuse drugs, statins, and Hepatitis C drugs.

In their study of the cost offsets of statins, Grabowski, Goldman, Philipson, et al. (2012) used combined population and clinical data from 1987 – 2008 to calculate statins' social value to consumers (the value of survival benefits above actual payments for the drug) and to producers (drug revenues). They found that statin therapy reduced low-density lipoprotein levels by 18.8%, which led to 40,000 less deaths, 60,000 less hospitalizations for heart attacks, and 22,000 less hospitalizations for strokes in 2008. Moreover, the use of statins avoided heart attack hospitalization costs of $4.4 billion and stroke hospitalization costs of $440 million. Importantly, for people who started statin therapy between 1987 – 2008, consumers captured 76%, or $947.4 billion, of the total social value of the survival gains. At the individual level, the average social value of the survival gains was $46,157 per statin user, and the weighted average cost was $11,231 per person. Thus, the consumer surplus for the period between 1987 – 2008 was $34,926. Overall, statin treatment generated a benefit-to-cost ratio of about 4.1:1.

In Parthasarathy et al. (2003), the researchers studied substance abuse drugs by analyzing adult patients entering the outpatient Kaiser Sacramento Chemical Dependency Recovery Program from 1997 – 1998. They randomly assigned patients to either an Integrated Care model that provided primary health care along with substance abuse treatment, or an Independent Care model where primary medical care was provided independently from substance abuse treatment. Based on a 12-month pre-period and post-period, total medical costs per member-month fell from $431.12 to $200.03.

Chhatwal et al. (2015) studied Hepatitis C treatments, specifically how sofosbuvir and ledipasvir are safer and more effective than older drugs, but also more expensive. They found that sofosbuvir-based therapies added 0.56 QALY relative to older standard of care drugs. The researchers predicted that, as compared to the old standard of care drugs, the use of the combination therapy of sofosbuvir and ledipasvir would cost an additional $65 billion over the next 5 years to treat people with Hepatitis C virus (HCV) in the United States. Ultimately, the cost offsets of its use would be $16 billion.

Similarly, Moreno et al. (2016) simulated how expanded HCV treatment coverage would impact private payers' medical expenditures. The researchers found that as a result of expanded HCV treatment coverage, private payers would experience lower medical expenditures, but higher treatment costs, over a time horizon of 3-to-5 years. Nevertheless, over the span of 20 years, private payers would have $10 billion to $14 billion in savings after treatment costs.

Section 4: The Impact of Proposed Price Controls on Health Care Spending

This section discusses the quantitative implications of the evidence base reviewed for the impact of proposed US price controls on raising health care spending. To find how much total health care spending would increase with the drugs lost due to price controls, we use the cost offsets in 2022 dollars discussed in Table 2. Under the implementation of price controls and the implied reductions in new drugs, these cost offsets now become lost offsets, or how much total health care spending would increase given fewer drugs are created.

Philipson and Durie (2021) found that 135 fewer new drugs would be produced from the implementation of price controls in the US between 2019 and 2039. We multiply the result from this 20-year period by the lost offsets for the studies listed in Table 2 to find how much total spending would increase as a result of

losing 135 new drugs to price controls. Lastly, we multiply this product by the average number of patients in the US taking the average drug, which we estimate from ClinCalc (2019).

To find the average number of patients taking the average drug, we use ClinCalc's Drug Stats Database that lists the number of patients for the top 300 prescription drugs in the US in 2019. We take the average of the total number of patients that use each of the top 300 drugs listed. This calculation yields that about 2.47 million individuals represent the average number of patients that use each of these drugs.

When we combine each of these elements, we find how much proposed price controls on medical innovation would increase total health care spending over a 20-year period. Our methodology is summarized below:

$$135 \text{ drugs lost to price controls} \times \text{Cost Offset Lost} \times 2.47 \text{ million users}$$

An example of how this calculation works is as follows. For Lichtenberg (2002), we multiply the size of the lost offset in 2022 dollars of $205.45 by the 135 new drugs lost to price controls. We then multiply this product by our estimated number of average users for the average drug, 2.47 million people. The result is $68.6 billion, which measures how much price controls would increase total health care spending over a 20-year period.

Table 4: Increase in Health Care Spending Due to Lost Offsets of Drugs

Author (s)	Years Studied	Size of Lost Offset (dollars of given year per new drug)	Size of Lost Offset (2022 dollars per new drug)	Estimate for Increase in Total Health Care Spending (billions)
Lichtenberg (2001)	1996	$54.00	$101.98	$34.1
Lichtenberg (2002)	1996 – 1998	$111.00	$205.45	$68.6
Miller et al. (2005)[2]	1996 – 1999	$140.64	$257.76	$86.1
Zhang and Soumerai (2007)	1996 – 1998	$23.00	$42.57	$14.2
Average	**1997**	**$82.16**	**$151.94**	**$50.8**

From Table 4, we see that halting investment in medical innovation is harmful to consumers. Indeed, if proposed price controls on medical innovation were implemented, the results from the summarized literature show that the average increase in total health care spending would be about $50.8 billion over a 20-year period. This value shows the dramatic effect that recently proposed legislation could have on consumers' pockets and health outcomes.

Ultimately, our results demonstrate that more medical innovation is cost effective to consumers because new drugs create cost offsets, or reductions in total health care spending. With the current political rhetoric around pharmaceutical drug prices and their impact on consumers, these results may seem counterintuitive. Nevertheless, our findings show that investments in more innovative medicine are well worth their cost.

[2] Miller ran various models for when drug age decreased – here we only present the cost offset result.

Section 5: Concluding Remarks

In this paper, we analyzed how biopharmaceutical innovation affects total health care costs. Using CMS data on national medical expenditures and PhRMA statistics on domestic sales by pharmaceutical innovators, we found that during the last 20 years, profits and sales by research-based pharmaceutical companies made up 1.0% and 7.5% of total health care spending, respectively. In addition, their annual sales growth contributed negatively, -4.5%, to the annual total health care spending growth, partly because some years saw real declines in drug spending while real health care spending rose. Summarizing the evidence base on drug offsets on other forms of health care spending, we found that the literature almost uniformly confirmed the validity of such offsets, to a varying degree. Lastly, we discussed how price controls, by limiting the flow of new drugs, would increase total health care spending by about $50.8 billion over a 20-year period.

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