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POLICY OPTIONS FOR THE DRUG PRICING CONUNDRUM

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ABSTRACT

Current proposals aimed at reducing U.S. pharmaceutical prices would have immediate benefits (particularly for low-income and elderly populations), but are likely to dramatically reduce firms' investment in highly welfare-improving R&D. The U.S. subsidizes the worldwide pharmaceutical market: U.S. drug prices are more than 250% of those in other OECD countries. If each drug had a single international price across the highest-income OECD countries and total pharmaceutical firm profits were held fixed: U.S. prices would fall by half; every other country's prices would increase (by 28 to over 300%); and R&D incentives would be maintained. We propose a potential lever for the U.S. government to influence worldwide drug pricing: access to the Medicare market.

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Introduction

Pharmaceutical prices in the U.S. are high. If we consider data for all prescription drugs, average U.S. prices are more than 250% of those in 32 comparison OECD countries combined(Mulcahy, Schwam and Lovejoy, 2024) [1]. Accordingly, policy options have been proposed and partially implemented to reduce the burden of pharmaceutical prices on the U.S. population, particularly on seniors and low-income consumers (Seshamani, 2024; Freed, Neuman and Cubanski, 2024).

Though these policies will help U.S. consumers in the short run, they are likely to have harmful long-run effects. There is general agreement that much of the decrease in morbidity and mortality in the U.S. population over the last decade is the result of new pharmaceuticals. In this paper we quantify these benefits and compare them to the social costs of producing the drugs (over 80% of which are funded by private firms, according to OECD data[2]). The results suggest that it would be socially beneficial to increase pharmaceutical research, and as long as the vast majority of the funds for research are supplied by firms, an increase in pharmaceutical research likely requires increased private incentives to do that research.

We then consider the likely implications of recent U.S. pricing policies, if expanded to cover all drugs, for firm profits. Using data from sixteen of the largest pharmaceutical companies worldwide by market capitalization, we calculate that if fully implemented these policies would lead to about a 20% reduction in worldwide pharmaceutical profit margins. Assuming firms expect the policies to continue, their expected future profits will also fall and, with them, their incentives to invest in R&D.

If one has the contractarian view that certain basic goods, including a minimal amount of health care that requires less costly access to pharmaceuticals, are a right of consumers who abide by society's rules[3], and also wants to keep pharmaceutical R&D incentives at current levels, then there needs to be a change in the institutions governing the pharmaceutical market. The margins of Pharmaceutical Benefit Managers (PBMs), for-profit firms that act as middlemen negotiating formularies and discounts for commercial plans (including in Medicare Part D), are under investigation by the Federal Trade Commission (FTC, 2024). A change in their structure is one source of possible savings. Others have noted that changes in the length of drugs' effective patent life would provide additional incentives for R&D[4] but they would also prolong the period without generic competition and the higher prices this induces.

We want to draw attention to another issue that, though often mentioned, is seldom quantified with this tradeoff in mind: the international dimension of the pharmaceutical

[1](Mulcahy, Schwam and Lovejoy, 2024) conduct a bilateral comparison between the U.S. and each comparison OECD country. For each one, they calculate an other-country volume-weighted price equal to the sum of the product of the U.S. volume weights and the other country's prices, and divide it by the U.S. volume-weighted U.S. price. They also calculate an all-other-countries volume weighted price using US volumes and all other countries' prices, and use it with the same denominator to find a price index for all countries combined.

[2]Source: the OECD Business Enterprise R&D Expenditure by Industry data at `https://stats.oecd.org/Index.aspx?DataSetCode=BERD_INDU`.

[3]For more detail on the contractarian argument see Rawls (1971).

[4]See, for example, a Bloomberg Opinion Editorial from July 19 2024, available at `https://news.bloomberglaw.com/health-law-and-business/want-cheaper-prescriptions-let-the-bargaining-begin-editorial`. The European Parliament's Pharmaceutical Proposal of 2024, discussed below, is also relevant.

market. Pharmaceuticals, like climate change, are "international products": once a new drug is developed all countries can benefit from it. Yet unlike the attempts to mitigate the impacts of climate change, there are no international agreements on either pharmaceutical pricing, or publicly funded pharmaceutical research. We argue that the burden of pharmaceutical R&D should be shared more equally across high-income countries.

As a simple benchmark, we explore how different countries' prices would change if pharmaceutical firms charged a single international price for each drug to high-income countries, and total pharmaceutical revenues were held fixed. The results illustrate just how high US drug prices are relative to prices in other high income countries. Moreover the pharmaceutical package adopted by the European Parliament in April 2024, if it is adopted by the European Council, is likely to accentuate the already large differences between the U.S. and European prices reported below.

Finally, we propose a (partial) solution to the problem. The U.S. government has a lever to affect international drug company pricing policy: access to the Medicare and Medicaid markets. The Centers for Medicare and Medicaid (CMS) already stipulates that, if a manufacturer chooses to opt out of the Medicare Drug Price Negotiation Program set out in the Inflation Reduction Act (2022), CMS can choose to remove its drugs from the Medicare and Medicaid programs (or alternatively, pay a high excise tax on its Medicare sales) (Seshamani, 2024). Access to one or both of these markets could also be tied to increases in other-country prices.

We investigate this further in the final section of the paper, by comparing Medicare revenues to rest-of-the-world or European revenues for the fifteen firms producing most of the fifty largest drugs by expenditure in the Medicare program. The revenues from Medicare are large, often exceeding the entirety of non-U.S. revenues for these firms, and almost always exceeding the revenue from European countries. So the threat to bar a firm from Medicare if its European prices do not increase would provide the firms with significant leverage in their negotiations with European institutions.

Benefits and Costs of R&D

Benefits. Buxbaum et al. (2020) report that between 1990 and 2015 life expectancy increased by 1.32 years per decade. They attribute about 35% of this, or .46 years, to pharmaceuticals. There were 48.9 million live births in the U.S. between 2005 and 2015. If we value a life year at $100,000 (which may be an underestimate, see Neumann, Cohen and Weinstein (2014)), this generates 2.25 trillion dollars in value.

This ignores the improvement in life expectancy of immigrants. Net migration over this period averaged 1.03 million immigrants per annum. If we value the contribution to their welfare at one tenth of the decadal savings for every year they were in the U.S., this adds another .57 trillion dollars of welfare benefits. Harder to quantify, but also important, is the contribution of pharmaceuticals to decreased morbidity over time. If we consider only the over-65 population (about 16% of the U.S. population), Chernew et al. (2016) calculate that their disability-free life expectancy increased by 1.8 years between 1992-2008 or by 1.125 per decade. They find that roughly half of this was due to health improvements and most of that was due to pharmaceuticals[5]. Valuing a healthy life year at $50,000 (half the value of a life year overall) this adds another .25 trillion dollars per decade.

[5]Chernew et al. (2016) write: "Our results show that use of effective treatments ... would have led to roughly half the health improvements that we observe. Most of the treatment improvements are pharmaceutical ". The 2010 U.S. over-65 population was 40.6 million.

It seems clear, then, that the welfare benefits to the U.S. population from pharmaceutical research exceed three trillion dollars per decade.

Expenditures. U.S. companies spent 747 billion dollars on pharmaceutical research between 2011-2021[6]. US pharmaceutical firms funded about 87% of these expenditures, 7% were funded by companies whose parents were foreign, 3% were funded by other U.S. companies, and the rest were funded by a mix of governments hospitals and universities.

The federal government is also involved in funding pharmaceutical research both directly, through National Institute of Health (NIH), and indirectly through tax and subsidy policies. Here we consider only the NIH expenditures, and we come back to the implications of tax/subsidy policies below. Funding from the NIH "*contributed to* 354 of 356 drugs approved from 2010 to 2019 with expenditure totaling $187 billion ..." (Cleary et al. (2023))[7]. So government institutions (principally the NIH) are involved in some way in the development of most new pharmaceuticals, but they spend much less than pharmaceutical firms on drug development.

Benefit to Expenditure Ratios. Even if we allocate all the government research that "contributed to" new drugs to the R&D of drug development, the U.S. population's welfare benefit-to-expenditure ratio from pharmaceutical company research has recently been extremely high, 4 or more. These simple calculations are subject to a number of caveats, some of which we return to below. Still, the numbers suggest that it would be socially beneficial to increase pharmaceutical research, not decrease it.

Pricing Policies, Incentives, and Profits.

Two policy changes that aim to reduce U.S. drug prices have been initiated at a small scale, and are being considered for broader application.

The Inflation Reduction Act of 2022 is allowing bargaining between the Centers for Medicare and Medicaid services (CMS) and drug companies to determine the price Medicare pays for some prescription drugs[8]. Currently the new rules apply to only ten products with about $48 billion in sales. However President Biden's state of the union address (Biden, 2024) included the following statement

"Now it's time to go further and give Medicare the power to negotiate lower prices for 500 drugs over the next decade".

[6]Source: the OECD Business Enterprise R&D Expenditure by Industry data at `https://stats.oecd.org/Index.aspx?DataSetCode=BERD_INDU`. We focus on the industry defined as "Manufacture of basic pharmaceutical products and pharmaceutical preparations" and the currency measure "2015 constant prices and PPP" so that expenditure in other countries' local currencies (see later in this paper) are converted to US dollars under PPP and years other than 2015 are adjusted for inflation.

[7]The following quote describes how this study was performed (Cleary et al. (2023)). "This study extended these methods by developing an accounting for NIH spending that was comparable with reported investments by the industry. Using a data set of drugs approved from 2010 to 2019 (before the COVID-19 pandemic), this analysis estimated the NIH investment in these drugs, including the cost of published basic and applied research associated with these products, cost of phased clinical trials of failed product candidates, and opportunity cost, using discount rates recommended for government spending"

[8]The new pricing process has a price ceiling for the new negotiated price which is not higher than 40-75% of the drug's non-federal average manufacturer price (non-FAMP). The percentage is 75% for small-molecule drugs and vaccines 9-12 years beyond approval, and lower for older drugs. Details of the process are provided in a CMS Memorandum from March 2023 (Seshamani (2023)).

Medicare's share of U.S. sales of pharmaceutical products grew to 30% by 2017. (Source: Kaiser Family Foundation, "10 Essential Facts about Medicare and Prescription Drug Spending", January 29 2019.)

The Congressional Budget Office has estimated a detailed model of the drug research and approval process (Adams, 2021). They predict, and we agree, that the pricing changes inherent in the Inflation Reduction Act of 2022 are unlikely to lead to a substantial reduction in research spending[9]. However the consequences of extending these changes to what is essentially all pharmaceuticals are another matter.

The second change involves allowing importation of pharmaceuticals from Canada. Florida has been approved by the FDA to do so (initially only for 14 drugs and only for people serviced by state agencies (Freed, Neuman and Cubanski, 2024)). Seven other states have applied for similar permissions. Together these states account for about 20% of U.S. pharmaceutical sales, and U.S. sales are over fifty percent of global pharmaceutical sales. More precisely U.S. sales are on average 55% of sales for the sixteen large pharmaceutical companies listed in Table 1 and used in our calculations below, and 62.5% of the sales in the thirty three OECD countries listed in the RAND (2024) study we come back to below (Mulcahy, Schwam and Lovejoy, 2024).

To get some idea of what the impact of the broader changes would be on company profitability we need a guess at what "bargained prices" would be. If bargaining with Medicare was instituted at a larger scale, the final result would have to be endorsed by a government sanctioned institution (probably CMS), as is true in most other countries including Canada. The proximity of Canada to the U.S. facilitates importation, and cultural similarities make Canada a natural reference point for bargained outcomes. So we use Canadian prices to evaluate the implications of both CMS bargaining with the pharmaceutical companies and pharmaceutical product importation from Canada. Canadian prices are the second highest prices among developed countries (the U.S. is highest, see below). So moving to Canadian prices would generate a smaller loss in profits than moving to the prices of any other developed country.

Our calculations indicate that, assuming demand was totally inelastic and there were no other mitigating developments, applying the bargained prices to all Medicare demand and allowing for importing drugs from Canada for the eight states currently negotiating with the FDA would cause about a 16% fall in pharmaceutical revenue[10].

Before turning to the implications of the 16% fall in revenues on pharmaceutical company profits, two caveats are in order. First, demand does respond to price, although the elasticities reported in empirical work on pharmaceutical demand are small[11]. More importantly, related studies emphasize that any lowering of prices is likely to have beneficial health effects. For

[9]This is due to the small number of drugs included in the new pricing policy; the fact that the new pricing scheme kicks in only after the drug has been on the market for almost a decade; and the fact that price changes apply only to Medicare.

[10]We use the data in Mulcahy, Schwam and Lovejoy (2024), Figure 3.6 which specifies that US prescription drug prices, accounting for rebates, were 276% of Canadian prices for retail-dispensed brand-name drugs in 2022. Given this, extending CMS bargaining to all Medicare drugs might reduce total pharmaceutical revenues by 30% (the share of pharma revenues from Medicare) x (1/2.76) = 10.9%. Importing drugs from Canada, if these drugs could be used by the relevant states' entire non-Medicare population, might further reduce pharma revenues by ((100% - 30%) x 20%) x (1/2.76) = 5.1%.

[11]For example, Gatwood et al. (2014) use MarketScan data in a panel data analysis with individual fixed effects to estimate the response to cost sharing incentives for eight categories of medication. They obtain elasticities between -.015 to -.157 for seven of the eight categories and no elasticity at all for anti-platelet agents. The -.157 was for smoking deterrents, and the next highest was -.087 for Proton Pump Inhibitors. This paper also contains an extensive review of the literature on price effects .

example, in a large scale study of diabetes, cardiovascular, and hypertension patients, Van Alsten and Harris (2020) find that cost is the most common reason for medication non-adherence, with more than two-thirds of patients skipping or delaying medication. Further, cost related non-compliance was associated with 8% to 18% higher disease-specific mortality rates. So were we to adjust our estimates of the revenue reduction to account for the price-induced increase in demand, we should adjust the welfare benefits for the gains from increased compliance, and the result may well increase the benefit-to-cost ratio. That is, because reducing prices increases consumer surplus, it raises the welfare gains from pharmaceutical innovation. This increases the social benefit to social cost ratio which underlies our argument for more, not less, pharmaceutical research.

Perhaps a bigger caveat is that the reduced prices of pharmaceutical products in the U.S. might induce a change in pharmaceutical prices in other countries, and this could change the impact of the proposed policies on pharmaceutical firm revenues overall. The market for pharmaceutical products is international and other countries, particularly other developed countries, might be induced to change their prices once they realized how the proposed policies would affect the health of their populations in the future. We come back to the issue of the structure of the international pharmaceutical market below, but currently we do not know of any institution in another country that ties their pharmaceutical pricing policies to the incentives to perform pharmaceutical research. Moreover, as we discuss below, there are good reasons to expect pharmaceutical prices in other high income countries to fall relative to U.S.prices in the near future, not rise.

Company Profits. We have gathered data from the SEC reports on 16 of the largest pharmaceutical firms (by capitalization)[12]. The reports provide net profits and net margins. Net profit is computed as pharmaceutical global revenue after rebates minus operating expenses, taxes, interests, and other expenses. Net margins are defined as net profits divided by global revenue after rebates. The data are reported in Table 1.

The weighted average of the global net margins of these firms, weighted by shares of net profit, is 32%. We calculate that a 16% reduction in U.S. revenues would lead to about a 9% reduction in global revenues. If there was no change in costs, net margins would fall from 32% to 25%. That is, the proposed policies could cause an almost 20% decrease in net profits[13].

Of course there is a difference between the average and the marginal welfare benefits of pharmaceutical research, and we have not directly measured the relationship between company funded pharmaceutical research and the development of new drugs. There are several reasons for this. In addition to the standard difficulties in production function estimation (De Loecker and Syverson, 2021), there are at least two additional issues that make it difficult to empirically establish the relationship between research expenditures and the production of new pharmaceuticals. First, the outcomes of different research programs designed to mitigate a particular disease are correlated due to the common element of the underlying scientific

[12]We use 10K reports from the SEC for 2022. For example, the report for Pfizer is at `https://s28.q4cdn.com/781576035/files/doc_financials/2022/ar/PFE-2022-Form-10K-FINAL-(without-Exhibits).pdf`. Our analysis includes the top 18 firms by global market capitalization except CVS Health, which is integrated with a pharmacy chain, a health insurer and a pharmacy benefits manager, and Zoena which is an animal health firm.

[13]If net margin is 32% on average, and is defined as net profit divided by global revenue, then cost is currently 68% of revenue. U.S. revenues make up an average of 55% of global revenues for these firms. So the proposed policies would reduce global revenues to approximately (0.55*0.85 + 0.45)=0.92 of their previous value. Hence new margins would be approximately (0.92-0.68)/0.92 = 0.26, a reduction of (0.32-0.26)/0.32, i.e. 19%.

knowledge in the area. So the disturbances in this R&D-to-new-drug relationship do not average out in the cross section, and are commonly impacted by the increments in scientific knowledge in the time dimension. Second, the relationship between the inputs and the outputs in the pharmaceutical production function involves two distributed lags, one which reflects the production process itself and the other which is a result of the requirements to get FDA approval for the drug. Both of these vary from outcome to outcome[14].

The international dimension of the market

Our calculations indicate that currently the U.S. provides a substantial subsidy to the worldwide pharmaceutical market. Some of this is due to the size of the U.S. market. We will focus on quantifying the impact of international differences in prices conditional on differences in market size. Before going to those calculations, we briefly consider public funds.

Public funds for pharmaceutical research. A recent OECD report on publicly funded health related research in OECD countries (OECD, 2021) finds that government expenditures were .21% of GDP in the U.S.; .07% of GDP in Europe (that is, in the 21 EU member states that are part of the OECD); and .04% of GDP in the other OECD member countries.

We provide these numbers only to show that if we included differences in direct government support of pharmaceutical research, the inequities in the international distribution of the costs of pharmaceuticals would likely only grow. The numbers on "health related" research relate to a broader category than pharmaceutical research, and were we to do a careful study of this issue we would also need to include the role of tax and subsidy differences across countries. This would include both the subsidies given to privately funded R&D and the impact of tax avoidance policies favoring U.S. companies that offshore profits and production. As discussed in Setser (2023), the implications of the tax avoidance policies would likely dominate, reinforcing the international inequities seen in the differences in pricing regimes across countries.

Prices. Much of the international inequity in funding private incentives to do pharmaceutical research is due to international differences in pharmaceutical prices. A recent RAND report (Mulcahy, Schwam and Lovejoy (2024)) calculates that, using U.S. revenue shares of pharmaceutical products as weights, the indices of U.S. prices for retail-dispensed branded drugs in 2022 were 276% of Canadian prices; 434% of United Kingdom prices, and 381% of a share weighted average of 33 developed countries[15]. These differences have been growing over the last two decades (see Danzon (2018) and the literature she cites on international price differences).

[14]We could also ask whether, if firms did change pharmaceutical R&D spending, this would necessarily affect projects with high social value. A number of studies consider this issue using the introduction of Medicare Part D as change that increased firms' market size. Dranove, Garthwaite and Hermosilla (2014) and Dranove, Garthwaite and Hermosilla (2020), for example, provide evidence that while the new program increased development of new medical products and pharmaceuticals for the elderly, they were concentrated among diseases for which treatments already existed rather than more novel innovations. These findings are not directly relevant to our argument, however, because the revenue loss from the policies we consider would impact research for all age groups, and we know that much of the benefit of new medical products is due to an improvement in infant health, with long expected lifespan benefits (Cutler and Meara, 2000).

[15]These indices understate the gap between US prices and other countries' prices because they adjust US prices to account for manufacturer rebates but do not adjust prices in other countries for any rebates or other discounts there.

The Impact of Internationalizing Pharma Prices

We consider the impact of internationalizing the branded drug prices for only those 21 countries with at least $50,000 in per capita GDP. That is, we ask if (i) there is an international price for each branded drug that each of these countries abide by, and (ii) we assume total branded drug revenue is the same as current total branded revenue (so incentives to perform R&D would be unchanged),

What would be the weighted average markup or markdown in each country's prices, where the weights are country specific revenue shares?

Details of our data and analysis, and a table of results, are provided in the Appendix.

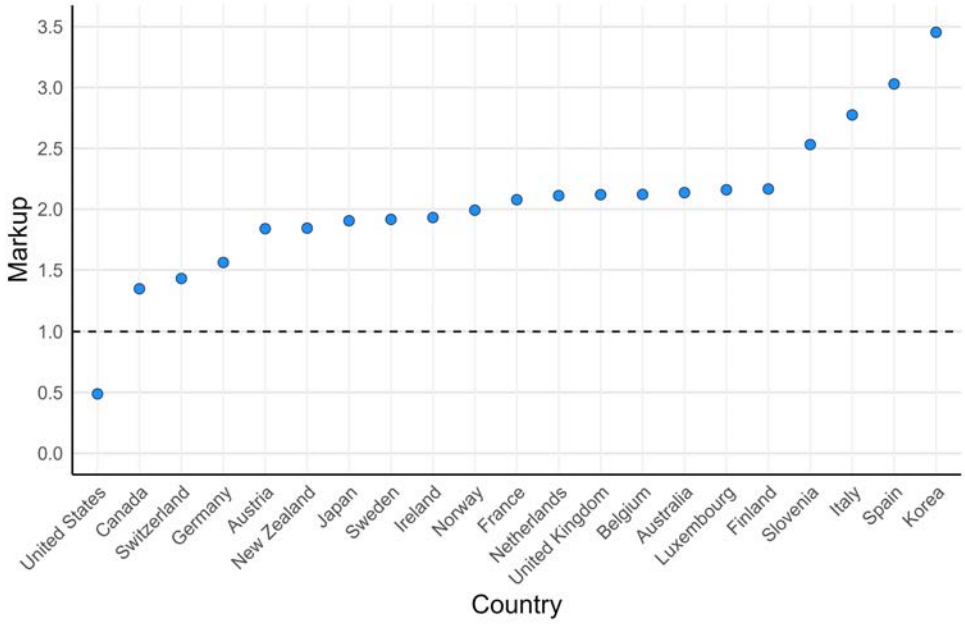

Figure 1: Markups Required for Internationalized Pricing

Figure 1 provides the results in terms of markup (or markdown) over current prices for the twenty other countries included in this analysis. As expected, every country except the U.S. has a price increase. The U.S. would pay only 46 cents for every dollar we now spend, whereas the lowest price increase among the other countries would be Canada, with a branded index of 1.28, indicating that its prices would be 128% of its current prices. The indices for the larger European economies include; 1.48 for Germany, 1.97 for France, 2.00 for the United Kingdom, 2.63 for Italy, and 2.87 for Spain; while the Korean index is over 325%. We conclude that the use of international pharmaceutical prices would cut U.S. prices in half, but would cause sharp increases in other countries' prices (of 28% to over 300%).

There would be both obstacles and benefits to proceeding with a single international price for each drug. Benefits would include not having to worry about either the costs of quasi-governmental committees setting and monitoring prices in different countries, or "parallel trade" in pharmaceuticals among the countries that agreed to the single price policy. There are numerous obstacles, including the fact that many countries might have to find alternative ways of providing their citizens the minimal level of health care that they require. We would also need to formulate international prices, hopefully in a way that led to optimal R&D

incentives. Still, any movement in the direction of equating prices would likely lead to less political pressure for the current U.S. policy options and mitigate their negative impacts on pharmaceutical R&D.

The European Parliament's Pharmaceutical Proposal. Are high income countries likely to increase their pharmaceutical prices? An indication of likely trends is given by the European Parliament's Pharmaceutical Proposal. The package, adopted by the European Parliament in April 2024, needs to be approved by the Council before it is enforced. The two parts of the package that are particularly relevant for the current discussion (Amand-Eeckhout, 2024*a*) are: (i) creation of a single market for medicines for all countries across the EU, and (ii) exclusivity policies which are designed to increase R&D incentives.

The creation of a single market is intended to include concentrating pharmaceutical purchases for all of Europe in a single purchasing agent[16]. This would have administrative, pricing, and R&D incentive effects. Administratively, it would eliminate both free riding in setting prices (see Dubois, Gandhi and Vasserman (2022), for a discussion) and parallel trade among members of the European Union. It may also decrease the cost of negotiating prices with manufacturers because this would only have to be done once for all member states. The impact on R&D incentives depends on how it would affect pharmaceutical prices.

The single purchaser would likely have higher bargaining leverage in negotiations with the pharmaceutical companies than any single member state. As a result a bargaining model would predict that the change would further lower European prices, accentuating current international inequities. Of course it could also facilitate a negotiation of prices between the U.S. and European nations (since there would be a single European agency to deal with). However this would require the European pricing agent to agree to increase prices in order to foster R&D activity, and as noted above we do not know of a quasi-governmental pricing institution who has done this in the past.

The European Parliament's proposal also extends exclusivity on pharmaceutical products (Amand-Eeckhout, 2024*b*). They i) set a minimum period of 7.5 years of protection after approval (designed for drugs for which there is a long interval between approval and use), ii) guarantee two years of market exclusivity (even if a bio-similar drug appears), and iii) grant other extensions in specific cases[17].

Notice, however, that there is no reference to pharmaceutical prices. Without a lessening of the international price disparities the political pressure on the U.S. government to decrease pharmaceutical prices is unlikely to abate, with potentially serious consequences for pharmaceutical innovation.

Can we induce higher pharmaceutical prices in other high income countries? Pharmaceutical prices in other high income countries are set in agreements between governmental (or quasi governmental) institutions and the pharmaceutical firms, in a manner

[16]The new purchasing authority is defined in the legislation as follows. "The Health Emergency Preparedness and Response Authority (hereafter 'HERA' or 'the Authority') is hereby established as a separate structure under the legal personality of the European Centre for Disease Prevention and Control (ECDC). The Authority shall be responsible for creating, coordinating and implementing of the long-term European portfolio of biomedical research and development agenda for medical countermeasures against current and emerging public health threats as well as the, production, procurement, stockpiling and distribution capacity of medical countermeasures and other priority medical products in the EU. (...) (Article 175a new)" (Popp, 2024).

[17]These include: if the drug meets an "unmet" medical need, if much of the R&D is done in Europe, and if approval is granted for a second indication.

similar to how the U.S. prices for the drugs specified in the IRA are to be determined. Economic theory argues that the outcome of the negotiations leading to these prices depends on the outside option (or threat value) of each participant: that is on how each participant would fare were no agreement reached and no trade to occur. The more a participant has to lose, the smaller the share of the gains from trade they capture. Recognizing this fact, the IRA threatens firms who do not abide by the prices that are approved by the government with discontinuing Medicare purchases from the firm.

How would use of a similar threat in Europe impact the bargaining position of the pharmaceutical firms in their dealings with the European authorities? To get some idea of the leverage that would be gained by threatening to withhold Medicare sales to pharmaceutical firms if they did not obtain higher prices from their European customers, we compared Medicare revenues to European revenues for those of our fifteen firms for which the requisite data was available.

Figure 2 summarizes our results looking only at the drugs that are among the top fifty in Medicare Part D purchases[18]. The left half of the figure provides the 2022 net revenue (revenue minus rebates) from each of these firms from sales of these drugs to Medicare enrollees in billions of dollars. The right hand side provides the ratio of Medicare sales to sales to all members of the European Union. The ratios in light blue are for the companies that report European sales of the fifty drugs in their SEC reports. The dark blue figures are for firms that only report the fraction of their total sales that are to European Union members, in which case we take that fraction and multiply it by total sales of the firm to E.U. members. AbbVie and Amgen do not report the numbers needed to do either calculation.

Only three of the thirteen firms for which we can make a calculation have European sales more than Medicare sales (Roche, Regeneron, and Glaxco Smith Kline) and, perhaps not surprisingly, they are the three firms with the smallest shares of Medicare sales. Merck also has higher European sales but that is because it has one high-selling drug, Gardasil (an HPV vaccine) which is only meant for those age 9-45, and if we drop it, that is if we apply the threat only to those drugs sold to Medicare, its ratio becomes 1.89. We then asked the following questions.

If we were to increase European prices for the ten companies in which Medicare revenue is higher than European revenue to a level which equates Medicare and European revenues from the drugs they sell to Medicare: (i) how much would the European price of those drugs rise? and (ii) were we to use the increase in revenue that the price rise generates to decrease the price on those drugs to the total (public plus private) U.S. expenditure on those drugs but hold the worldwide revenue of each firm (and hence its R&D incentives) constant, what would be the impact on U.S. prices for those drugs?

The price changes ranged from 10% for Novartis to 240% for Eli Lily, with an average increase across firms of just over 100%. The fall in U.S. prices for those drugs would vary between 3% for drugs sold by Novartis to 30% for drugs sold by Merck, with an average across firms of 18%. Details are provided in Appendix 2.

These are very rough calculations of the likely impact of the threat of withholding Medicare sales on the negotiations between the firms and the European authorities. On the one hand they assume that the European governments could push prices down to their "threat value", and so capture 100% of the surplus that trade would generate with 0% going to the

[18] Appendix 2 provides the details on how we constructed these data as well as a similar figure for the drugs procured by either Part D or Part B

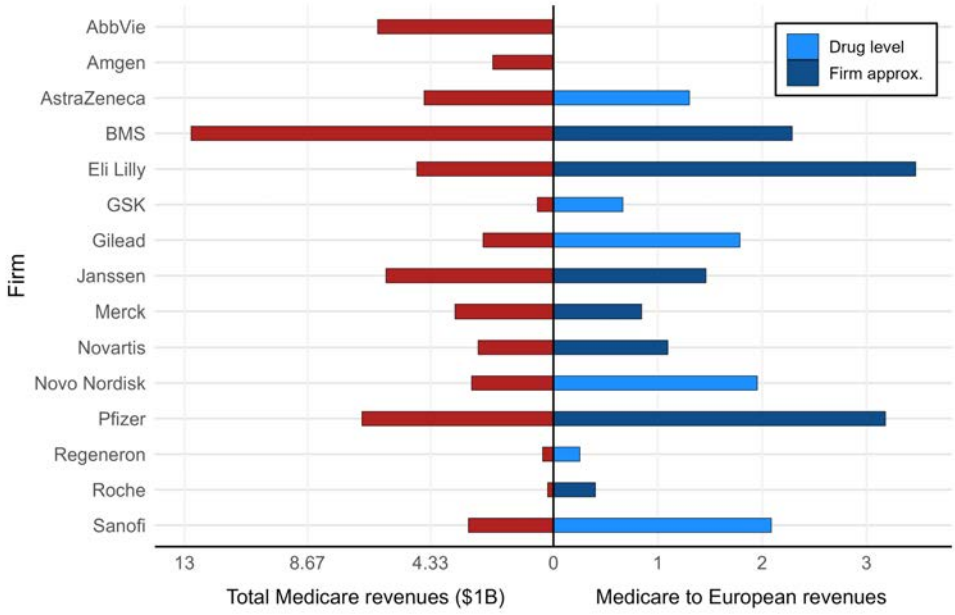

Figure 2: Ratio of Medicare Part D to E.U. Revenues for Firms Producing Top 50 Medicare Part D Drugs

firms. An alternative which might be viewed as more equitable, though perhaps is equally unlikely, would be to assume that pharmaceutical prices were equalized across countries. As shown above this would lead to much higher European, and much lower U.S., prices. On the other hand our calculated threat value may be a poor approximation to the true threat value generated by withholding access to Medicare sales. If the threat were to stop firm A from supplying drugs to Europe, over time firms not among our fifteen large firms might step in with substitute drugs, or new firms might appear to produce them. What is clear, however, is that Medicare sales are a large enough proportion of the total sales of these firms that withholding access to Medicare would have a large impact on these firms' profits. Our bargaining models predict that this would have a significant impact on the prices the firms negotiate with European governments.

Conclusion

There is a worry that the policies directed at the pharmaceutical industry that are currently being discussed would decrease the profits from firms' R&D activities dramatically. These policies are directed at reducing the costs of pharmaceuticals to the American population, particularly to the low income and elderly population. The evidence indicates that the long term welfare benefits to pharmaceutical research greatly exceeds the costs. A change to more equitably share the costs and benefits of pharmaceutical research across developed countries might enable us to mitigate the costs to American consumers while also maintaining current incentives for pharmaceutical R&D, and there is policy that would likely move the market in that direction.

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Table 1: Large Pharmaceutical Firm Profits, Revenues and R&D Spending

Firm	Country	Global rank in market cap in 2023	Total net-of-discounts global revenue on pharmaceuticals ($ million)	Total net-of-discounts US revenue on pharmaceuticals ($ million)	Share of global revenue that comes from US	R&D spend on pharmaceuticals ($ million)	Net profit ($ million)	Net margin
Eli Lilly	US	1	$28,541	$18,190	63.7%	$7,191	$6,245	21.9%
Novo Nordisk	Denmark	2	$25,057	$11,987	47.8%	$3,405	$7,862	31.4%
Janssen	US	3	$52,563	$28,604	54.4%	$11,622	$17,941	34.1%
Merck	US	4	$52,005	$24,989	48.1%	$7,700	$14,519	27.9%
AbbVie	US	5	$58,054	$45,713	78.7%	$6,510	$11,836	20.4%
Roche	Switzerland	6	$47,742	$21,078	44.2%	$14,736	$14,182	29.7%
AstraZeneca	United Kingdom	7	$44,351	$17,920	40.4%	$9,762	$3,293	7.4%
Novartis	Switzerland	8	$50,545	$17,653	34.9%	$9,996	$6,955	13.8%
Pfizer	US	9	$100,300	$42,126	42.0%	$11,428	$31,372	31.3%
Amgen	US	10	$24,801	$17,743	71.5%	$4,434	$6,552	26.4%
Sanofi	France	11	$32,222	$14,379	44.6%	$5,320	$16,372	50.8%
BMS	US	12	$46,159	$31,850	69.0%	$9,509	$6,327	13.7%
Gilead	US	13	$27,281	$18,884	69.2%	$4,977	$4,592	16.8%
Vertex	US	14	$8,931	$5,699	63.8%	$2,540	$3,322	37.2%
Regeneron	US	16	$12,173	$6,825	56.1%	$3,593	$4,338	35.6%
GSK	United Kingdom	18	$36,271	$17,987	49.6%	$6,788	$19,322	53.3%

Notes: We include the top 18 firms by global rank in market capitalization in 2023 other than CVS Health (which is integrated with a large pharmacy chain, a health insurer and a Pharmacy Benefit Manager) and Zoetis (an animal health company).
Source of all data is firm annual reports 2022. For Janssen we include only pharmaceuticals. For Merck we consider only the human health segment (animal health is excluded). Net margin is net profit / total net-of-discounts global revenue.

Appendix 1: Price Comparisons

We use 2022 data from Mulcahy, Schwam and Lovejoy (2024). We include countries whose GDP per capita is over $\$50,000$, and we add Japan and Spain whose GDP per capita are in the $(\$45,000, \$50,000)$ range but which have total pharmaceutical revenues in the top 15 countries worldwide.

The RAND report provides data on each non-U.S. country k's branded drug price index relative to the U.S., weighted by U.S. drug market shares. It also includes data on total pharmaceutical drug revenues, and the percent of sales to branded drugs, for each country. Our method, which uses all these data, is as follows.

Define

- $v_d^k \equiv$ volume of branded drug d in country k,
- $p_d^k \equiv$ price of branded drug d in country k,
- $R^k = \sum_d v_d^k p_d^k$, i.e. revenue of branded drug sales in country k,
- $R^* \equiv \sum_k R^k$, i.e. total branded sales revenue.

We make the simplifying assumption that the ratio of U.S. to country k prices is constant across branded drugs and equal to P^k. Then the U.S. share-weighted index of prices reported in RAND (2024), i.e., the ratio of U.S. prices to country k's prices share-weighted with U.S. revenue shares is $(P^k)^{-1}$.

Let $p^* = \{p_d^*\}_d$ be a vector of international prices that generate total revenues across drugs (d) and countries (k) equal to R^* as defined above. We find a uniform markup (or markdown) on each country's prices that makes

$$\sum_k \sum_d p_d^* v_d^k = R^*.$$

Under our assumptions this can be rewritten as

$$\sum_d p_d^* v_d^k = \sum_d (p_d^u / p_d^k)(p_d^* / p_d^u) p_d^k v_d^k = \sum_d P^k P^{*,u} p_d^k v_d^k = P^k P^{*,u} R^k,$$

where P^u is the constant ratio of international to U.S. prices. This will ensure we maintain global sales if

$$P^{*,u} \sum_k P^k R^k = R^* \;\Rightarrow\; P^{*,u} = (R^* / (\sum_k P^k R^k)$$

which defines the ratio of international to branded U.S. prices. The markup for country k is then $P^k P^{*,u}$.

Results are given in Appendix Table 1.

Appendix 2: Computing Medicare and European Revenues

We analyze the top 50 pharmaceutical drugs by global net revenues in 2022 as reported in firms' annual financial filings. Of these 50 drugs, we drop four Covid-19 related products and one product manufactured by Vertex, which we omit because no regional information on product-level sales is provided in their annual reports. 34 of the remaining 45 products

are outpatient prescription drugs covered by Medicare Part D plans, while the remaining 11 products are physician-administered drugs covered by Medicare Part B.

We estimate 2022 revenues in the Medicare market for each drug in our sample as follows. First, we begin with the 2022 drug-level gross expenditures data reported by CMS. We assume revenues are equal to gross expenditures for Part B drugs, while we estimate revenues as gross expenditures net of rebates for Part D drugs. Because drug-level rebates in the Medicare Part D program are not publicly reported, we approximate them as the average of two estimates: (i) a flat rate of 23.07% on gross expenditures, corresponding to the overall Medicare Part D rebate rate reported by the GAO[19]; (ii) a measure generated by assuming that the ratio of Medicare Part D rebate rates between any two firms in our sample is equal to the ratio of their overall rebate rates, which are known from their annual reports.

When European revenues are reported at the drug level in firms' annual reports, we use these figures before aggregating up to the firm level. Otherwise, we first compute firm-level rest of world (non-U.S.) revenues from the drugs in our sample before approximating European revenues as total rest of world revenues multiplied by the firm-level European share of rest of world revenues from their annual reports. Two firms in our sample, AbbVie and Amgen, do not report either drug-level or aggregated European revenues in their annual filings.

To compute the overall reduction in U.S. prices r such that each firms' total revenues from the drugs in our sample are unchanged when European revenues are brought up to Medicare revenues, define

- $rev^G \equiv$ global revenue
- $rev^{US} \equiv$ U.S. revenue
- $rev^{EU} \equiv$ total E.U. revenue
- $rev^{Mcare} \equiv$ Medicare revenue
- $rev^{resid} \equiv$ residual revenue.

Then we note that

$$rev^G = \left(rev^{US} + rev^{EU}\right) + rev^{resid},$$

where r^{resid} is equal to firms' global revenues minus U.S. and European revenues (and held fixed), and solve for r such that

$$rev^G = r\left(rev^{US} + rev^{Mcare}\right) + rev^{resid}.$$

so that $(1-r)rev^{US} = r(rev^{Mcare} - rev^{EU})$.

Results for Part D drugs are shown in Appendix Table 2.1 and Figure 2 in the main text. Results for Parts B and D drugs combined are in Appendix Table 2.2 and Figure 3, below.

[19] https://www.gao.gov/products/gao-23-105270

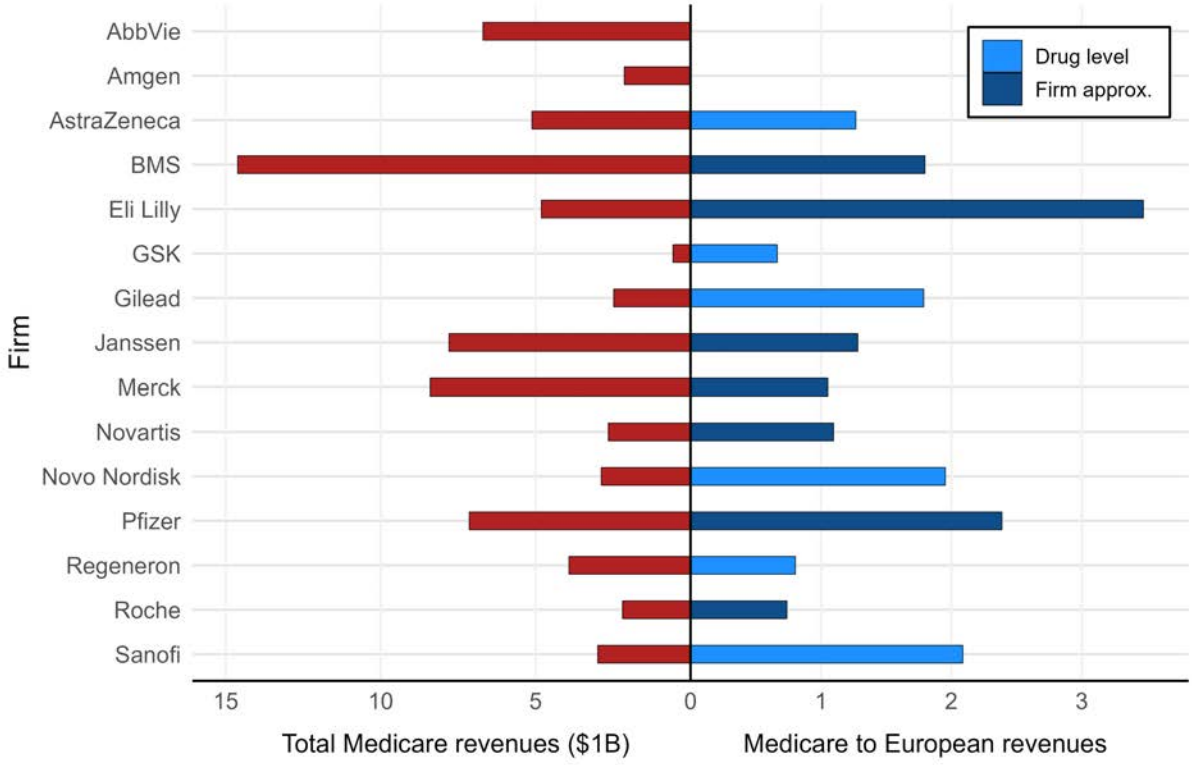

Figure 3: Ratio of Medicare Parts B and D to E.U. Revenues for Firms Producing Top 50 Medicare Drugs

Appendix Table 1: Price Comparisons Across Countries

	Sales (bn USD)	Volume (bn)	GDP (PPP) per capita 2022	Price index (retail dispensed brand-name)	Price index (all drugs)	Revenue weighted by price (brand-name)	Revenue weighted by price (all drugs)	Markup (retail-dispensed brand-name)	Markup (all drugs)	Markup by country (brand-name)	Markup by country (all drugs)
Total								0.46	0.58		
United States	617.2	261.6	$76,399	100.00	100.00	617.20	617.20			0.46	0.58
Japan	64.9	219.8	$45,573	390.57	347.07	253.48	225.25			1.80	2.02
Germany	46.5	63.9	$63,150	320.30	294.18	148.94	136.79			1.48	1.72
France	37.5	51.1	$55,493	426.01	326.41	159.75	122.40			1.97	1.90
Italy	33.0	44.3	$51,865	568.77	268.03	187.69	88.45			2.63	1.56
United Kingdom	31.6	66.8	$54,603	434.47	270.04	137.29	85.33			2.01	1.58
Spain	27.4	48.6	$45,825	620.93	284.22	170.13	77.88			2.87	1.66
Canada	26.6	30.6	$58,400	276.03	228.92	73.42	60.89			1.28	1.34
Korea	15.3	54.9	$50,070	707.92	391.29	108.31	59.87			3.27	2.28
Australia	10.9	15.6	$62,625	437.95	369.89	47.74	40.32			2.02	2.16
Belgium	7.3	8.8	$65,027	434.95	320.61	31.75	23.40			2.01	1.87
Switzerland	6.5	5.8	$83,598	293.30	218.87	19.06	14.23			1.35	1.28
Austria	5.7	6.5	$67,936	377.21	276.24	21.50	15.75			1.74	1.61
Sweden	4.7	9.1	$64,578	392.85	333.19	18.46	15.66			1.81	1.94
Netherlands	3.6	13.5	$69,577	432.88	333.17	15.58	11.99			2.00	1.94
Norway	3.2	4.7	$114,899	408.35	248.17	13.07	7.94			1.89	1.45
Finland	2.7	5.4	$59,027	444.07	322.81	11.99	8.72			2.05	1.88
Ireland	2.6	4.5	$126,905	396.00	291.64	10.30	7.58			1.83	1.70
New Zealand	1.2	5.0	$51,967	378.05	288.07	4.54	3.46			1.75	1.68
Slovenia	0.8	1.6	$50,032	518.86	423.92	4.15	3.39			2.40	2.47
Luxembourg	0.2	0.4	$142,214	442.69	413.56	0.89	0.83			2.04	2.41

Notes: GDP (PPP) per capita is from worldometer. All other data are from the RAND 2024 study cited in the text. Method is explained in Appendix 1.

Appendix Table 2.1: Medicare Part D Drugs Only

Firm	Medicare (bn USD)		Europe (bn USD)		Share of All Drugs		
	Gross	Est. net	By drug	Firm approx.	Top 50 share	Medicare/EU	U.S. markdown
AbbVie	8.897	6.158			0.599		
Amgen	3.202	2.113			0.312		
AstraZeneca	5.861	4.555	3.496	3.069	0.313	1.303	0.884
BMS	17.385	12.751		5.579	0.604	2.285	0.784
Eli Lilly	7.174	4.762		1.387	0.435	3.434	0.756
GSK	0.768	0.566	0.851	0.528	0.101		
Gilead	3.371	2.477	1.387	1.225	0.469	1.786	0.916
Janssen	8.267	5.882		4.036	0.458	1.457	0.918
Merck	4.330	3.465		4.100	0.248		
Merck (adj.)		3.463		1.826		1.896	0.707
Novartis	3.519	2.652		2.419	0.187	1.096	0.970
Novo Nordisk	4.628	2.800	1.475	1.425	0.338	1.898	0.840
Pfizer	8.881	6.744		2.120	0.148	3.181	0.711
Regeneron	0.539	0.378	1.500		0.359		
Roche	0.254	0.203		0.505	0.054		
Sanofi	4.246	2.981	1.434	1.507	0.209	2.079	0.748

Notes: Data for Medicare and European revenues are from CMS and firms' annual filings in 2022. Top 50 share is each firm's share of total revenues from the drugs in our sample. For firms where Medicare revenues are estimated to exceed EU revenues, Medicare/EU is the ratio of Medicare to EU revenues while U.S. markdown is the reduction in overall U.S. prices such that firms' worldwide revenues are unchanged when European revenues are equal to Medicare revenues. Merck (adj.) corresponds to Merck figures with Gardasil omitted.

Appendix Table 2.2: Medicare Parts B and D, Combined

Firm	Medicare (bn USD)		Europe (bn USD)		Share of All Drugs		
	Gross	Est. net	By drug	Firm approx.	Top 50 share	Medicare/EU	U.S. markdown
AbbVie	9.403	6.666			0.691		
Amgen	3.202	2.113			0.312		
AstraZeneca	6.424	5.118	4.040	3.477	0.375	1.267	0.904
BMS	19.235	14.603		8.134	0.783	1.795	0.837
Eli Lilly	7.174	4.762		1.387	0.435	3.434	0.756
GSK	0.768	0.566	0.851	0.528	0.101		
Gilead	3.371	2.477	1.387	1.225	0.469	1.786	0.916
Janssen	10.162	7.781		6.077	0.610	1.280	0.941
Merck	9.266	8.402		7.983	0.651	1.052	0.983
Merck (adj.)		8.401		5.709		1.471	0.884
Novartis	3.519	2.652		2.419	0.187	1.096	0.970
Novo Nordisk	4.628	2.800	1.475	1.425	0.338	1.898	0.840
Pfizer	9.277	7.140		2.991	0.211	2.387	0.797
Regeneron	4.081	3.922	4.878		1.404		
Roche	2.247	2.196		2.971	0.407		
Roche (adj.)		1.992		1.104		1.804	0.887
Sanofi	4.246	2.981	1.434	1.507	0.209	2.079	0.748

Notes: Data for Medicare and European revenues are from CMS and firms' annual filings in 2022. Top 50 share is each firm's share of total revenues from the drugs in our sample. For firms where Medicare revenues are estimated to exceed EU revenues, Medicare/EU is the ratio of Medicare to EU revenues while U.S. markdown is the reduction in overall U.S. prices such that firms' worldwide revenues are unchanged when European revenues are equal to Medicare revenues. Merck (adj.) corresponds to Merck figures with Gardasil omitted. Roche (adj.) corresponds to Roche figures with Acemtra, Perjeta, and Hemlibra removed.