

Stocking Under the Influence: Spillovers from Commercial Drug Coverage to Medicare Utilization^{*}

Emma B. Dean, Josh Feng, Luca Maini[†]

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Abstract

We document a novel channel through which prescription drug coverage in commercial insurance can affect utilization in Medicare Part B – which covers almost all outpatient drugs. Using biosimilars as a setting and exploiting plausibly exogenous differences in their state-level commercial coverage, we show that increasing exclusion rates of biosimilars in commercial formularies by 10pp leads to 3pp lower utilization among Part B beneficiaries. We provide evidence that facilities, rather than doctors, are driving variation in biosimilar utilization, likely through preferred stocking of brands with better private insurance coverage. Our results have potential implications for government spending, market regulation, and antitrust.

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[†]Emma B. Dean: University of Miami, edean@bus.miami.edu. Josh Feng: University of Utah Eccles School of Business, josh.feng@eccles.utah.edu. Luca Maini, Harvard Medical School, maini@hcp.med.harvard.edu.

In the U.S., government-regulated insurance markets like Medicaid and Medicare coexist alongside a large and mostly unregulated commercial market. While health plans across these two markets rarely serve the same patients, the economic literature has highlighted several instances when outcomes in one market affect the other through regulation (Scott Morton, 1997; Duggan and Scott Morton, 2006, 2010; Feng et al., 2023), the introduction of new payment models (Baker, 2003; Baicker et al., 2013; Richards and Tello-Trillo, 2019), or capacity constraints (Garthwaite, 2012). The focus of this literature has almost entirely been on the spillover effects of government-regulated insurance on outcomes in commercial insurance markets.¹ However, the sheer size and profitability of the commercial market leaves open the possibility of reverse spillover effects.

In this paper, we provide causal evidence that equilibrium outcomes in the commercial health insurance market can affect the care that beneficiaries of government-funded insurance receive. In particular, we show that prescription drug coverage in the commercial insurance market affects drug utilization of Medicare Part B patients. Our analysis focuses on the adoption of biosimilar drugs—bioequivalent copies of complex biologic drugs such as monoclonal antibodies (US Department of Health and Human Services et al., 2015). We find that a 10 percentage point increase in biosimilar coverage by commercial plans leads to a 3 percentage point increase in biosimilar utilization among Part B beneficiaries.

The spillover effect we identify arises because patients covered by public and private insurance alike receive care from the same providers. Because providers tend to standardize care, their decisions to align with incentives generated by the commercial market can spill over to beneficiaries of government-funded programs (and vice versa). A recent, but growing literature has documented spillover effects of this nature that arise from reform-induced changes in physician behavior (see, e.g., Glied and Zivin, 2002; Barnett et al., 2022). We provide evidence that the main mechanism driving our spillover effect is not physician behavior, but rather the stocking decisions of healthcare facilities, which tend to prioritize drug brands with broad coverage among commercial health insurance plans.

Our paper focuses on the use of drug formularies to manage outpatient utilization

¹We note two exceptions: Richards and Tello-Trillo (2019) show that introduction of Managed Care in Florida by Blue Cross Blue Shield lead to higher utilization by Medicare and Medicaid patients, while Glied and Hong (2018) show that an expansion of dental care in the private market lead to a contraction in public provision of the same kind of care. Both papers test a theory of capacity constraints that is conceptually distinct from the channel we analyze and predicts diametrically opposite effects to the ones found here.

of physician-administered drugs.² Formularies are the main tool that health plans and healthcare facilities use to determine what drugs are available to patients. There are two types of formularies that are relevant for our study. Health plan *prescription drug formularies* are tiered menus of drugs that determine what is covered by the insurance company, and at what cost to the patient. *Facility formularies* are lists that determine what drugs are stocked and available to physicians at a given healthcare facility.

Traditional Medicare (TM) beneficiaries receive coverage for physician-administered drugs under Medicare Part B, which, crucially, covers virtually all drugs approved by the Food and Drug Administration. Conversely, commercial insurance health plans often employ prescription drug formularies that exclude certain drugs or impose additional restrictions on physicians, such as requiring prior authorization from the insurer before dispensing a given medication (see, e.g., [Brot-Goldberg et al., 2023](#)).

While not restricted by prescription drug formularies, TM beneficiaries may still face limited access because of facility formularies, which may impose restrictions on which drugs are stocked for two reasons. First, limiting the number of drugs simplifies logistics such as inventory management, storage space, and updating of electronic health records ([Dean et al., 2023](#)). Second, favoring a specific drug over its therapeutic substitutes can unlock higher discounts from the manufacturer.

When deciding which products to include on the formulary, the facility may have an incentive to favor drugs that are broadly covered by commercial insurance formularies in order to maximize the chance that patients will be able to receive the drug. This incentive creates a spillover effect from commercial formularies to facility formularies. In turn, because facility formularies determine what is administered to patients of both commercial and government health insurance, it introduces a channel through which equilibrium outcomes in the commercial market can influence patients covered by publicly-sponsored insurance plans.

To test the relevance of this channel empirically, we study the adoption of biosimilar drugs—highly similar alternatives to complex biologic drugs that enter the market after a reference biologic loses patent protection. We choose this setting for four reasons. First, many biologic drugs are infusions administered by physicians in hospital outpatient departments or physician offices, making facility formularies relevant. Second, originator biologics and biosimilars are close therapeutic substitutes. This means that, in most cases, patients can switch between one product and the other without suf-

²Examples of drugs that are administered by physicians include injections for macular degeneration, and chemo and immunotherapy agents to treat cancer.

ferring negative consequences (Barbier et al., 2020). This makes it more appealing for the hospital to favor a single product over the rest. Third, biosimilars are relatively new products, with widely varying adoption rates across the US, providing the necessary variation to identify our channel of interest. Fourth, and finally, biologic drugs are economically important, representing a large and growing component of pharmaceutical spending—46% of pharmaceutical spending in 2021, and growing at a 12.5% yearly rate (IQVIA Institute, 2023). Biosimilar competition represents one of the most important efforts in reining in biologic spending, but biosimilar uptake has been uneven across products and settings (Socal et al., 2020; Stern et al., 2021; Dean et al., 2021; Bond et al., 2023). In the public Medicare Part B program, low uptake of biosimilars has prompted substantial debate and a number of policy proposals to increase utilization.³

To establish the existence of a link between Part B drug utilization and commercial formulary exclusion rates, we employ a research design based on variation across states in exposure to “off-the-shelf” national commercial insurance formularies. The vast majority of plans contract with intermediaries known as Pharmacy Benefit Managers (PBMs) to design their formulary and negotiate rebates. Many plans use off-the-shelf formularies offered by the PBM, known as national formularies, whereas other plans may design their own formulary.⁴ We use data from MMIT Network Solutions that tracks coverage of reference biologic and biosimilar drugs across all commercial insurance plans to calculate variation in state-level exposure to different national formularies and translate national formulary changes into state-level changes in exclusion rates.

Our instrumental strategy relies on two assumptions. First, exclusions in national formularies cannot be motivated by patient or physician preferences at the state level. This assumption is likely to hold, because PBMs offer the same national formularies to payers across all states. Second, a large enough fraction of payers must keep the same national formulary year-after-year even if that formulary undergoes small changes (such as the inclusion or exclusion of a biosimilar or reference biologic drug). We validate this assumption by looking at yearly turnover rates at the health plan level in the MMIT data. Intuitively, our empirical approach identifies the effect of commercial exclusions by comparing changes in utilization among Part B beneficiaries in states where na-

³One recent policy proposal by the Medicare Payment Advisory Commission has been to assign biosimilars and their reference product to a single billing code, or, alternatively, a single reference price for reimbursement to encourage increased utilization of the lowest-cost alternative (Medicare Payment Advisory Commission, 2022).

⁴33% of individuals covered by commercial insurance are on a plan that uses a national formulary.

tional formularies that include (or exclude) a given reference biologic or biosimilar brand have higher penetration rates.⁵

Our results show that a 10pp higher exclusion rate from commercial formularies for a given brand results in a 3pp lower utilization rate among Part B beneficiaries. Beyond documenting a causal link between commercial formularies and Part B utilization that likely extends beyond reference biologics and biosimilars, this spillover effect has economically meaningful implications on government spending and biosimilar adoption. Biosimilars tend to be significantly cheaper than originator biologics but are often covered at lower rates in commercial formularies. Using a simple back-of-the-envelope calculation, we estimate that full nationwide biosimilar coverage could result in annual savings of approximately \$61 million for TM beneficiaries and for the government.⁶ However, we stress that any government intervention aiming to achieve this lower level of spending would likely require formulary coverage mandates, which would lead to significantly higher prices for affected drugs ([Hwang et al., 2019](#)).

Having documented the existence of a spillover effect between commercial formularies and Medicare Part B utilization, we provide further evidence that facility stocking decisions (rather than physician behavior) are the main transmission mechanism. First, we show that prescribing choices are strongly correlated within facility, with an overwhelming majority of facilities concentrating over 80 percent of prescriptions for a given molecule on a single brand. Moreover, we document many instances when a facility's preferred brand switches from one year to the next. Because physician practice style is likely to evolve slowly over time, these abrupt shifts provide an initial indication that prescription patterns are driven by facility-level factors. To confirm this intuition, we study variation in the prescription patterns of physicians who operate in different facilities. Using the same design as in [Finkelstein et al. \(2021\)](#), we decompose changes in prescribing behavior between physicians and facilities to estimate that 80% of variation in biosimilar adoption is explained by facility-level factors, thus confirming facility formularies as the most likely driver of the spillovers.

Our finding that the facility plays an important role in steering physician behavior is relevant for policy. Physicians are not isolated in their practice; rather, they are influenced by the incentives of the facilities in which they work. Our research highlights the significant role facilities play in guiding physician prescribing, finding that

⁵We use the term brand to refer to a version of the same molecule manufactured by a specific company—either the reference biologic or one of its biosimilar counterparts.

⁶TM patients face a 20% coinsurance rate for Part B services, though many beneficiaries also use Medigap to cover part of their out-of-pocket costs.

changes in physician prescribing behavior should be more appropriately attributed to facilities in our setting. Recognizing this distinction is crucial, because policies aimed at altering physician behavior may prove ineffective when facilities are putting restrictions on physicians.

Our paper makes three main contributions. First, we add to the literature documenting the complex interplay between the various segments of the U.S. healthcare market by highlighting the effect that equilibrium outcomes in commercial markets can have on the care experience of patients enrolled in government-sponsored plans. Whereas a large body of work has focused on the effect of government programs on the private market (see, e.g., [Scott Morton, 1997](#); [Glied and Zivin, 2002](#); [Duggan and Scott Morton, 2006, 2010](#); [Baicker et al., 2013](#); [Clemens and Gottlieb, 2017](#); [Einav et al., 2020](#); [Wilcock et al., 2020](#); [Barnett et al., 2022](#); [Feng et al., 2023](#)), relatively little attention has been paid to the impact of commercial market outcomes on government insurance. The existing work on the topic generally focuses on the rival nature of these two markets by highlighting how expansions (or contractions) in commercial coverage affect publicly insured patients through capacity constraints ([Glied and Hong, 2018](#); [Richards and Tello-Trillo, 2019](#)).⁷ Conversely, our paper identifies a channel that is fundamentally different, and depends on the standardization of care at the provider level.⁸

Second, our work contributes to the literature on manufacturer-PBM negotiations and insurance coverage incentives in drug markets. The topic of manufacturer-PBM negotiations has received increased attention in recent years, with researchers identifying a number of factors that affect negotiations such as demand inertia ([Feng and Maini, 2023](#)) and the presence of most-favored nation clauses ([Conti et al., 2021](#); [Feng et al., 2023](#)). A parallel line of work has studied the incentives facing insurance plans when choosing which drugs to cover, which include rebates ([Olssen and Demirer, 2023](#)), screening ([Geruso et al., 2019](#)), and spillovers to medical spending ([Lavetti and Simon, 2018](#); [Starc and Town, 2020](#)). Our work uncovers a mechanism that would encourage manufacturers of drugs administered in an outpatient setting to attain better formulary coverage when negotiating with PBMs.

Third, we contribute to the literature on biosimilar adoption by uncovering another potential barrier that could slow down the diffusion of biosimilar brands. Past work

⁷[Garthwaite \(2012\)](#) is another relevant work on the effect of capacity constraints on the healthcare system.

⁸A conceptually related, but fundamentally distinct paper is [Grabowski et al. \(2008\)](#), which shows how patients receive the same type of care at nursing homes regardless of their insurance provider.

on biosimilar uptake has highlighted the aggressive response of incumbent biologics (Maini et al., 2021), the role of patent uncertainty (Van de Wiele et al., 2021; Hemphill and Sampat, 2022), the relative safety and efficacy of biosimilar drugs (Cohen et al., 2017; Zhai et al., 2019), and the financial incentives faced by physicians and facilities (Scott Morton, 2021; Bond et al., 2023). In this paper, we show that the stocking behavior of outpatient facilities is an important barrier to adoption, and that most of the variation in U.S. physician-administered biosimilar adoption is at the facility level rather than the physician level.

1 Institutional Background and Data

1.1 Commercial Insurance and Facility Drug Formularies

When prescribing medication, physicians consider clinical concerns such as efficacy, safety, side effects, and drug interactions. In the case of drugs administered in an outpatient setting (e.g., hospital outpatient departments and physician offices) in the U.S., physicians also need to account for further restrictions created by two types of formularies: the prescription drug formulary of the patient's health plan and the formulary of the facility where the doctor is prescribing.⁹

1. *Prescription drug formularies* are tiered menus listing all drugs covered by the health plan. Tiers determine the out-of-pocket cost to the patient, and whether the plan imposes any non-monetary restrictions on the drug's utilization, such as step therapy or requiring prior authorization before administering the drug.

Drugs are assigned to tiers based on negotiations between drug manufacturers and intermediaries called Pharmacy Benefit Managers (PBMs). The role of PBMs is to negotiate higher rebates in exchange for better tier placement. Oftentimes, rebates are also contingent on the tier of direct competitors, with manufacturers granting additional concessions when direct competitors are placed in less generous tiers or excluded altogether (US Senate Finance Committee, 2021). As a result, it is not uncommon for drug formularies to exclude drugs that have close substitutes.

⁹Due to differences in reimbursement structure, hospitals may have separate inpatient and outpatient formularies. Our analysis focuses on drugs prescribed primarily in outpatient settings and therefore on hospital outpatient formularies.

After negotiating tiers and rebates, PBMs offer formularies to payers such as insurance companies and self-insured employers. Payers can create a custom formulary from the grids of contingent rebates negotiated by the PBM. Alternatively, most PBMs, including all largest ones, also offer a few ready-made formularies, called “national formularies.” Because they require less expertise and effort to adopt, national formularies are usually preferred by self-insured employers. As a result, they have a dominant position in the commercial insurance segment, which we exploit for our identification strategy.

2. *Facilityformularies* determine what drugs are stocked and made available to physicians in the facility. While it may seem optimal for a facility to stock all drugs, there are at least two reasons why a facility would choose to restrict its formulary. First, limiting the number of drugs in stock has practical advantages, such as easier inventory management, reduced storage space, less complex updating of electronic health records, and decreased potential for medical errors ([Dean et al., 2023](#)). Second, facilities can unlock additional discounts from manufacturers through volume or percentage-based guarantees, which often imply that competing products have to be either excluded or their use strongly discouraged.

Exclusive contracts for facility formularies are particularly prominent in cases where close therapeutic substitutes are available, like in the case of biologic drugs with biosimilar competitors. According to several interviews we conducted with hospital pharmacy representatives, exclusions are common, although products will occasionally be specially ordered for patients facing specific limitations. Exclusion is not costless, however, because it restricts the available options for patients and physicians, which can be particularly problematic for patients whose insurance company also uses a restricted prescription drug formulary. In the most extreme scenario, a patient whose insurance does not cover any of the drugs in stock at a facility would be responsible for the entire list price of the treatment received. To avoid such scenarios and ensure reimbursement from insurers, facilities strive to include in their formularies drugs that are broadly covered across insurance companies—especially commercial health plans, which tend to reimburse at higher rates than public insurers ([Levy and Ippolito, 2021](#)).

Figure 1 summarizes the key agents involved in physician-administered drugs and their incentives, with blue arrows highlighting the channels that directly influence Medicare Part B utilization and green arrows highlighting the channels that directly influ-

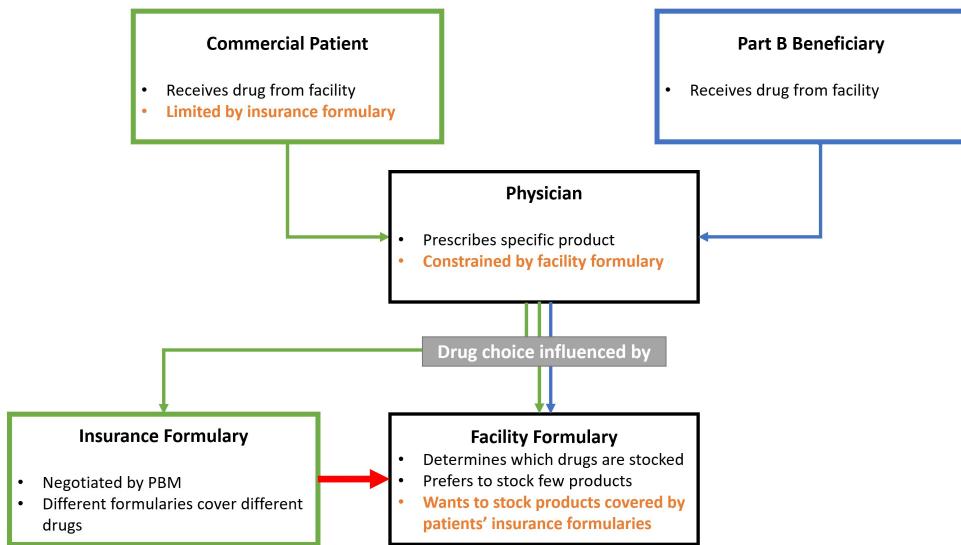


Figure 1: Diagram for impact of hospital formularies

ence commercial utilization. Commercial insurance formularies are separate from the blue part of the system, but may affect Medicare Part B utilization if the hypothesized spillover channel, represented by the red arrow, is present and significant.

1.2 Biosimilars

Biologic drugs (“biologics”) are complex molecules derived from organic material, such as insulin or monoclonal antibodies. Due to their complex nature, biologics cannot be exactly reproduced like traditional, small-molecule drugs. Instead, potential competitors can create “biosimilars”: highly similar versions of an existing reference biologic without clinically meaningful differences concerning safety and efficacy ([U.S. Food and Drug Administration, 2021](#)).

Biosimilars present a useful setting for studying potential spillovers of commercial formularies on facility formularies and drug utilization in Medicare Part B for a number of reasons. First, they are often physician-administered infusions, meaning they are covered by Medicare Part B. Second, the FDA standard for biosimilar approval requires that there are no clinically meaningful differences between biosimilar medications and their reference brand, meaning that—while not identical—these products are close substitutes. This makes them ideal candidates for the types of exclusive contracts that facilities might want to sign. Third, partly because biosimilars are relatively new, there is significant variation in how well they are covered in the commercial seg-

ment, both across plans and over time. Fourth, even though only a limited number of biosimilars have been approved, biologic drugs as a whole represent almost half of pharmaceutical spending, and many policymakers and researchers see adoption of biosimilars as a crucial step towards moderating drug spending.¹⁰

Specifically, our empirical analysis focuses on a set of four physician-administered biologic molecules with biosimilar competitors that launched prior to 2019: filgrastim (a bone-marrow stimulant, brand name Neupogen), infliximab (an imunosuppressant, brand name Remicade), pegfilgrastim (a bone marrow stimulant, brand name Neulasta), and epoetin alpha (a treatment for anemia, brand names Epogen and Procrit).¹¹ Appendix Table 2 shows the number and launch dates of the biosimilar competitors for each of these drugs.

1.3 Data Sources and Summary Statistics

We use two main data sources for our study. First, to measure physician administration behavior and brand-level utilization in the Medicare Part B program, we use a 20 percent random sample of all Medicare Part B fee-for-service claims data from 2015 to 2019. For our regression analyses, we aggregate this data to the state-brand-year level to calculate within-molecule brand market-share for each state over time.

Figure 2 provides an overview of biosimilar uptake in Medicare Part B, calculated as the annual state-level penetration rate of biosimilar brands for each of our four molecules of interest. We find that uptake is highly heterogeneous across states—ranging from 12% to 93% for filgrastim, 5% to 100% for infliximab, 0% to 65% for epoetin alfa and 7% to 47% for pegfilgrastim in 2019. Moreover, there is no apparent spatial correlation between the uptake of different molecules, which we would expect if physician or patients in a given state had strong preferences for low-cost biosimilar medications (or for reference brands). The lack of a reliable pattern is particularly striking in the case of filgrastim and pegfilgrastim, which are both prescribed and administered primarily by hematology-oncologists and oncologists. However, as shown in Appendix Table 4, there is no significant pairwise correlation in state-level biosimilar uptake be-

¹⁰See for example, Marta Wosińska's interview on Tradeoff on January 26, 2023 (<https://tradeoffs.org/2023/01/26/humira-biosimilar-drug-prices/>, retrieved June 8, 2023).

¹¹We chose 2019 as a cutoff because our Medicare data ends in 2019. Epoetin alfa's reference brands, Epogen and Procrit, are marketed by different manufacturers and used for different indications (Epogen is marketed to treat patients with end-stage renal disease (ESRD), whereas Procrit is marketed for all other indications). As usage for ESRD is limited and sample size is insufficient, we focus only on non-ESRD usage and the reference brand Procrit.

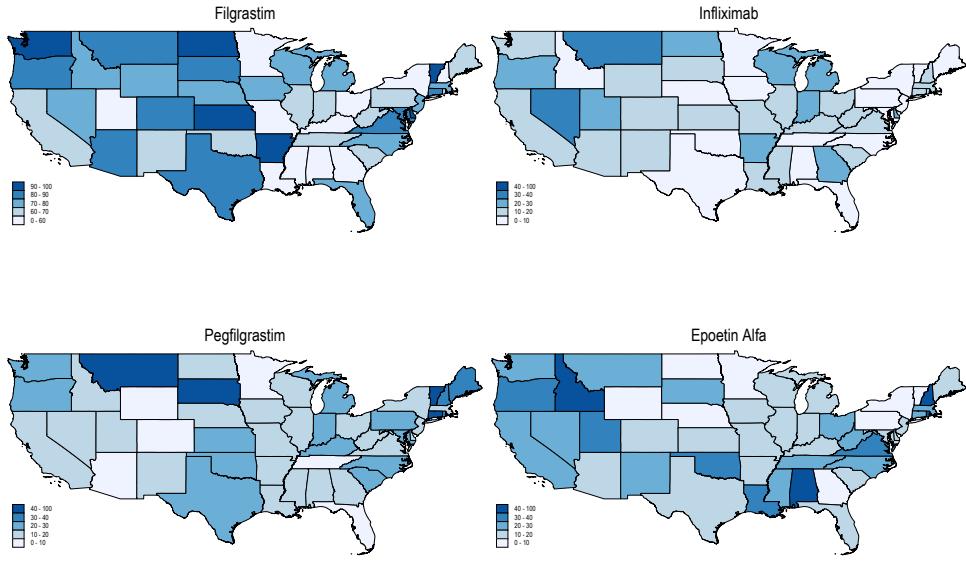


Figure 2: Uptake of biosimilar Filgrastim, Infliximab, Epoetin Alfa, and Pegfilgrastim across U.S. states in 2019

Notes: Data comes from the Medicare Part B 20% claims sample. Biosimilar uptake is measured as the sum of market shares across all biosimilar brands. Data for epoetin alfa includes only non-ESRD usage.

tween any molecules in our sample.

Second, to measure commercial insurance coverage we use plan-level insurance coverage information from MMIT Network solutions. The data contain plan-year-brand level coverage information for both reference biologic and biosimilar brands, including whether a brand is covered by the plan (our main variable of interest), and also whether its use has restrictions such as prior authorization requirements (which we use in robustness checks). In addition, MMIT also tracks enrollment numbers for each plan (which we use as weights in calculating state-level coverage statistics), and whether the plan adopted a specific national formulary or use a custom formulary. Table 3 in Appendix B reports some additional summary statistics on commercial formulary coverage, broken down by brand.

Finally, we also collect data on detailing payments to physicians from OpenPayments data, which we use as a control in one of our regressions.

2 Impact of Insurance Formulary Coverage on Biosimilar Uptake in Part B

In this section, we show that formulary coverage in commercial and Medicare Advantage plans causally affects biosimilar uptake among Medicare Part B patients.

Our strategy compares the within-molecule market share of a given biologic or biosimilar brand among Medicare Part B patients to the fraction of commercial and MA patient lives for whom the brand is not covered by the formulary. Our analysis is at the state-year level.¹² We estimate the following regression equation:

$$\text{Brand Market Share}_{jkt} = \lambda_t + \gamma_{jk} + \beta \text{ Fraction of uncovered lives}_{jkt} + \varepsilon_{jt} \quad (1)$$

where j denotes brand, k denotes state, and t denotes year. As controls, we include fixed effects for biosimilar age to account for national biosimilar uptake curves, λ_t , and the interaction of brand and state, γ_{jk} . Our coefficient of interest, β , represents the association of the fraction of uncovered lives amongst commercially insured patients with the brand market share amongst Medicare Part B patients. In this specification, our variation comes from changes in commercial insurance coverage over time within a given state.

A primary challenge in estimating Equation 1 is that correlations could reflect the unobserved evolution over time in state-level preferences for reference or biosimilar brands driving both insurance coverage and utilization. Evolving preferences may cause both changes in physician prescribing patterns and in commercial formularies, many of which are hand-picked by the health plan to match the preferences of enrollees. Insurers—even those contracting with the same PBM—have multiple options for prescription drug formularies; while they can select standard national plans offered by PBMs, many insurers instead create custom formularies for their enrollees which are based on the rebates negotiated by PBMs but independently determined. The alignment between changes in local preferences and insurance coverage decisions are most likely to arise among insurers adopting these custom formularies.

To establish a causal link, we therefore rely on an instrumental variable approach

¹²With more granular data, a better way to conduct this analysis would be at the level of a hospital referral region (HRR). However, this would also require exact data on the geographic location of patients (matched to formulary data), which is hard to come by at the scale required for this project.

based on changes in national formularies. National formularies are set by PBMs, offered to payers across the entire U.S. commercial segment, and are widely adopted by self-insured employers (which make up a significant fraction of the commercial insurance market). They provide a strong instrumental variable as they isolate a component of commercial insurance coverage that (1) has a strong effect on overall state-level commercial insurance coverage, (2) is independent of state-level preferences for a given brand, and (3) only impacts Medicare's brand market share through its impact on state-level commercial insurance coverage. As national formularies often maintain the same identity for many years (e.g., Express Scripts has been offering their "National Preferred Formulary" for the last ten years), and there is significant inertia in commercial plans partnerships with PBMs,¹³, any change in a national PBM formulary will mechanically affect exclusion rates at the state level in a way that is plausibly unrelated to changes in state-level preferences.

Formally, our instrument is the sum across all national formularies of the fraction of commercially insured lives in state k covered by national formulary f in year $t - 1$, multiplied by an indicator $\mathbb{I}^{\text{excluded}}_{jft}$ for whether brand j is excluded from coverage by formulary f in year t :

$$Z_{jkt} = \sum_{f=1}^N \left(\frac{\text{lives}_{kft-1}}{\text{lives}_{kt-1}} \times \mathbb{I}^{\text{excluded}}_{jft} \right)$$

Variation in our instrument Z_{jkt} arises from two sources. The first source of variation is the time-varying market share of specific national formularies across states. Appendix Figure 5 plots the distribution of state-level market shares in 2019 for the four most popular national formularies in the U.S. commercial insurance segment. It shows market shares for the four largest national formularies vary across states, ranging from 0.4% to 20.2%. The second source of variation is from changes in the exclusion of reference biologic and biosimilar brands across national formularies.¹⁴ Overall, we identify 29

¹³See Express Scripts' formulary page where they describe their National Preferred Formulary: <https://www.express-scripts.com/corporate/about/formularies>, retrieved July 27, 2023. Appendix Table 5 shows annual data on commercial plan partnerships with PBMs and national formularies over time and displays significant inertia in these partnerships. For instance, between 2017 and 2018, national formularies have an 79.3% retention rate among commercial plans.

¹⁴These coverage decisions are linked to the PBMs associated with the commercial insurers operating within a state. For instance, Connecticut's commercial insurance market is dominated by two large national PBMs, each of which covers between 30-40% of the commercial market in our timeframe. Between 2018 and 2019, commercial coverage for the pegfilgrastim biosimilar brand Udenyca in Connecticut increases from 41 to 91%, corresponding with both of these PBMs adding it to their standard covered brands. Similarly, coverage for the infliximab biosimilar Renflexis increases from 63% to 90% between

exclusion events and 206 coverage events (e.g., when a previously excluded brand is included in coverage), detailed in Appendix Table 6 .

We report our results in Table 1. Our first stage results in Panel C show a strong association between our instrument and coverage rates, confirming that this instrument has sufficient power. The reduced-form regression suggest that a 10pp increase in the exclusion rate of a given brand is associated to a 3.1pp decline in utilization among Medicare Part B beneficiaries (Column 1). When we instead rely solely on variation generated by national formularies through our IV approach, we find a similar effect (2.9pp). Additional specifications that control for marketing payments to physicians (Column 2) and weight results by state population (Column 3) return almost identical coefficients. Across all these regressions, the effect is consistent and ranges between 2.9 and 3.0pp. In Appendix E we conduct three sets of robustness checks, all of which confirm our results. First, we follow Papke and Wooldridge (2008) in calculating average partial effects using pooled quasi-maximum likelihood estimation (QMLE) to account for our fractional response variable and endogenous regressor. Second, we measure coverage using the fraction of commercial lives with unrestricted access to a given brand (e.g. coverage with no prior authorization or other restrictions). Third, we exclude the four largest states and re-run our analysis, to account for the possibility that PBMs cater to patients in these states. We recover similar estimates using these alternate approaches.

Our results suggest that the spillover effect of commercial formularies is economically significant. The reference biologic brand generally has broad coverage in commercial formularies, which translates to higher market share among TM beneficiaries. As reference brands are generally more expensive than biosimilar competitors, this likely increases Medicare spending.

While calculating the full impact of the spillover effect would require more detailed data and several additional assumptions, we can obtain an approximate value of the money potentially at stake using a simple back of the envelope calculation.¹⁵

To perform the calculation we take the difference in the average cost of a claim be-

2017 to 2018, corresponding to one of the two major PBMs including it as part of their standard covered brands.

¹⁵A full accounting of the impact of this spillover effect needs to consider two aspects. First, one would need to describe the counterfactual scenario in question. For example, a potential alternative policy could require biosimilar brands to be covered by all formularies. Alternatively, facilities may be required to stock all possible versions of a given molecule. In either case, firms would react by altering their pricing strategy in ways that are hard to assess (but that would almost surely lead to higher prices). Second, one would need to incorporate patients' behavioral responses, which requires estimating a demand model for each individual brand.

Table 1: IV Regression of Impact of Private Insurance Formulary Coverage on Biosimilar Uptake

	(1)	(2)	(3)
PANEL A. REDUCED-FORM ESTIMATES			
Fraction Excluded	-0.309 (0.036)	-0.306 (0.036)	-0.309 (0.058)
Specification	OLS	OLS	OLS
PANEL B. IV RESULTS			
Fraction Excluded	-0.290 (0.046)	-0.288 (0.046)	-0.297 (0.094)
Specification	2SLS	2SLS	2SLS
First-Stage <i>F</i> -stat.	941.0	823.3	941.6
PANEL C. IV FIRST STAGE			
Uncovered on National Formulary	0.522 (0.010)	0.522 (0.010)	0.511 (0.009)
Specification	OLS	OLS	OLS
R ²	0.921	0.921	0.928
Observations	1,836	1,836	1,836
Open Payments Control	No	Yes	Yes
Population Weights	No	No	Yes

Notes: Estimates of Equation 1, using OLS and IV approaches. The data is at the state-year-brand level and include data from 2015 to 2019. The dependent variable is the brand-level market share for each brand in a given state-year. Standard errors are clustered at the state-brand level. Molecules are only included after their first biosimilar launch.

tween each reference biologic and biosimilar brand. Then, for each biosimilar brand j , we assume that commercial formulary coverage covers all available biosimilar brands. Using our estimated coefficient in our preferred specification in Column (2) of Table 1, we can then estimate the change in utilization as $\Delta Q_{jk} = \hat{\beta} \times \Delta \text{Coverage}_{jk} \times Q_{jk}$, where Q_{jk} is the number of Part B claims for biosimilar j in state k . We also assume that the additional claims for biosimilar j come from the market shares of other brands proportionally to their observed market share.¹⁶

Using this method, we find potential excess Medicare Part B spending of up to \$61 million dollars in 2019, which is approximately 10 percent of the total potential savings from switching all patients to the cheapest available biosimilar. We stress that this number does not represent an accurate accounting of what would happen if regulation were to force broader adoption of biosimilars through expanded coverage in commercial formularies. Rather, this is an estimate of the amount of spending at stake through this spillover effect.

3 Mechanisms

Having established a link between commercial formularies and Part B utilization, we now investigate the mechanisms that generate this link. We start by presenting some summary statistics on facility-level prescribing patterns in Part B, and then decompose variation in these patterns into doctor-level and facility-level effects.

3.1 Facility Prescribing Patterns

From qualitative interviews, we know that facilities set internal formularies and earn financial considerations from manufacturers if they prefer one brand within a given molecule. We provide descriptive evidence consistent with this behavior by looking at facility-level prescribing patterns using the 20% random sample of fee-for-service Medicare beneficiaries.

Facilities overwhelmingly prescribe a single brand over all possible alternatives. In 2019, about 80 percent of facilities have a dominant brand (either a biosimilar or the reference biologic) with at least an 80 percent prescription share within a molecule.¹⁷ As

¹⁶We present a specific example with numbers in Appendix F.

¹⁷We use 80 percent as a threshold for dominance because discussions with hospital pharmacists and administrators responsible for facility purchasing indicated this threshold as a common requirement for percentage-of-sales contracts. We exclude facilities with fewer than 5 claims.

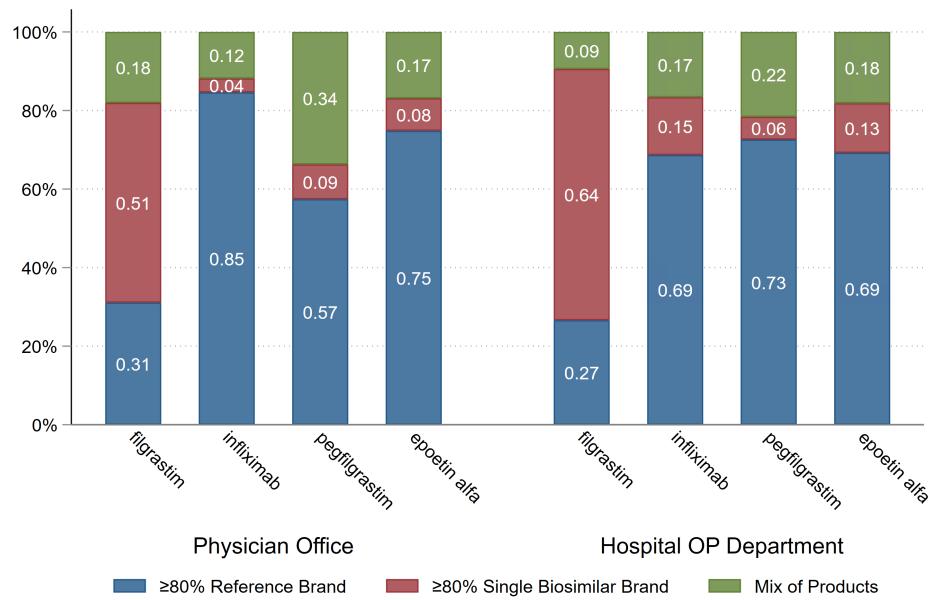


Figure 3: Fraction of Facilities with over 80% Utilization of a Single Brand, by Molecule and Facility Type

Notes: Figure is calculated using the 20% Medicare Part B data from 2019. Facilities with less than 5 administrations of a given molecule are excluded.

Figure 3 shows, the result holds for physician offices and hospital outpatient facilities alike. Across all molecules and settings, at least two thirds of facilities have a dominant brand for each molecule.

This result strongly suggests that prescribing choices are highly correlated within facilities. This correlation could arise either because of facility-imposed restrictions, or because of the preferences of physicians operating in that facility. A data pattern that provides suggestive support for facility restrictions is that a small, but non-negligible fraction of facilities (4.8 percent of facilities for filgrastim and 1.5 percent of facilities for infliximab) with a dominant brand in a given year switch to a different dominant brand in the following year.¹⁸ These abrupt switches are unlikely to be generated by changes in physician preferences or beliefs, which—while correlated with organizations and networks—tend to change in more varied ways (Epstein and Nicholson, 2009; Cutler et al., 2019).¹⁹ We provide more rigorous evidence in support of facility restric-

¹⁸We do not report numbers for pegfilgrastim and epoetin alfa because their first biosimilar entered during the year 2018, and so we can only observe switches that happened in the year immediately after biosimilar launch.

¹⁹An alternative explanation for prescribing choices being correlated within facilities could lie in patients with similar preferences clustering to certain facilities. The abrupt switches in facilities' preferred

tions in the next section.

3.2 Physicians versus Facilities

While existing research documents that physician practice style can generate spillovers across insurance markets (Glied and Zivin, 2002; Barnett et al., 2022), studies of biosimilar uptake have provided descriptive evidence that doctor characteristics do not explain much of the variation in utilization (Dean et al., 2021; Socal et al., 2020). Therefore, our hypothesis is that the primary mechanism behind the link between commercial formularies and Part B utilization is the effect of commercial formularies on facility formularies.

To test this hypothesis, we follow the methodology from Finkelstein et al. (2021). We construct aggregate utilization rates at the physician-facility-brand level using the 20% Medicare Part B sample. For each physician-facility pair we calculate the physician's average biosimilar utilization within the facility (Y_{if} , where i indexes physicians, and f indexes facility) as well as the biosimilar market share amongst all other physicians prescribing within the facility (γ_f).²⁰ This second measure is an indicator of facility-level prescribing that is not directly influenced by physician i . Then, limiting our sample to physicians who prescribe in two facilities f_1 and f_2 , we plot $Y_{if_1} - Y_{if_2}$ against $\gamma_{f_1} - \gamma_{f_2}$. Intuitively, this plots the change in facility-level biosimilar utilization from one facility to another on the x-axis against the change in a physician's prescribing when moving from that facility to the other facility on the y-axis. If variation in biosimilar prescribing was entirely due to physician choices, the slope of this line would be zero. However, if factors related to the facility influence the decision of which brand to prescribe, the slope will be positive. A slope of one would imply, for example, that when a physician moves from a facility where biosimilar share is 0% to a facility where biosimilar prescribing is 100%, that their prescribing of biosimilars should also change from 0% to 100%. This would be the case if facility formularies committed to stocking a single brand and did not allow for any exceptions in prescribing behavior.²¹

Figure 4 plots our results separately by molecule. Across all brands, the facility

brands we document would not be consistent with this explanation.

²⁰We aggregate across biosimilar brands because specific biosimilar brands often have very low market shares at the facility level.

²¹Notice that this is an indirect test because we cannot measure physician and facility responses to a change in formulary coverage using our data. If we had more granular data, we could measure doctor-facility level responses to insurance changes and decompose variation in that quantity. Instead, we decompose variation in the observational data.

appears to dominate the decision of whether to use a biosimilar or a reference brand, with line slopes of 0.897 (95% confidence interval: 0.844–0.951) for filgrastim, 0.788 (95% confidence interval: 0.737–0.843) for infliximab, 0.779 (95% confidence interval: 0.721–0.838) for pegfilgrastim, and 0.788 (95% confidence interval: 0.739–0.837) for epoetin alpha. Hence, across all molecules, physicians adapt their prescription patterns to adhere very closely to the choices of other physicians at the same facility.²²

The results help refine our understanding of our estimates in the previous section. The evidence suggests that doctors generally defer to the facility when choosing which brand to prescribe within a set of similar drugs. Therefore, facilities are more likely to be driving the responses to commercial insurance changes.

4 Conclusion

This article provides causal evidence of a quantitatively significant spillover from commercial insurance coverage restrictions to utilization in Medicare Part B, a program that does not limit drug coverage. We provide further evidence that this effect is likely driven by facility stocking decisions.

We demonstrate the existence of this channel empirically by analyzing coverage of reference biologics and their biosimilar competitors. In doing so, we also uncover a potential obstacle to biosimilar adoption, which in turn has the potential to affect Medicare spending. Extrapolating from our results, a back-of-the-envelope calculations suggest this spillover effect may generate as much as \$61 million excess spending in Medicare Part B. We note, however, that this effect would be difficult to eliminate through regulation. For example, requiring facilities to stock more brands or commercial formularies to exclude fewer would almost certainly result in higher costs for facilities and health plans.

More importantly, the channel we identify is unlikely to be limited to our empirical setting. The presence of this spillover channel unlocks a strategic opportunity for manufacturers of any outpatient-administered drugs with close therapeutic substitutes. Manufacturers that achieve broad commercial coverage for their brands enhance their ability to secure preferred status on facility formularies and, in turn, affect

²²Ideally, we would run a similar analysis for patients switching between two facilities. However, this switch is often associated with a corresponding change in prescribing physician, thus any change in prescribing behavior could not be directly attributed to the switch in facility. Previous literature shows that few patient characteristics are correlated with biosimilar utilization (Socal et al., 2020; Dean et al., 2021).

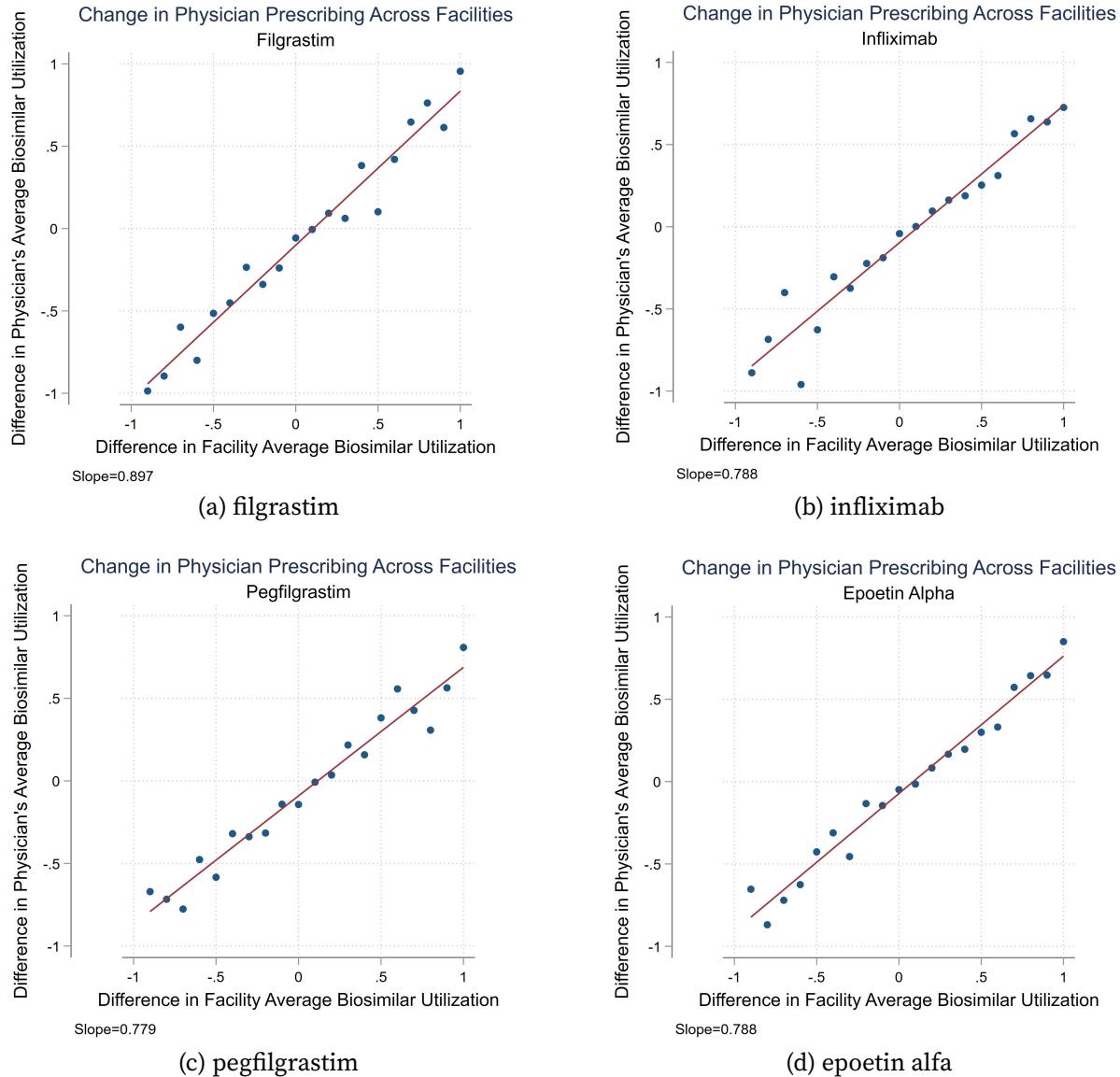


Figure 4: Change in Physician Biosimilar Prescribing Across Facilities

Notes: Figure reports estimates based on the [Finkelstein et al. \(2021\)](#) design. The sample includes all physicians prescribing a given drug in two facilities, using data from the 20% Medicare Part B data between 2015 and 2019.

drug utilization of any patients that receives care at those facilities. This includes Medicare Part B beneficiaries as well as those covered by other government programs that do not impose formulary restrictions, including state Medicaid programs. Our findings may even generalize to settings where different agents are in charge of making insurance coverage and distribution decisions.²³ For example, this channel could affect how pharmacies choose which generic brand to stock when insurance plans favor certain generics over near-identical counterparts.

Finally, our results raise two crucial policy questions. First, because the spillover effect we identify implies that equilibrium outcomes in commercial markets affect government spending, our results raise the possibility that the government may be justified in introducing limited regulation in private markets to protect public insurance programs from these spillover effects. Second, because it allows the linking of two otherwise separate markets, this channel can—in theory—allow firms to exploit a dominant position in one market to gain a competitive advantage in a separate market, a behavior that has traditionally been considered anticompetitive. Future research should investigate whether drug manufacturers engage in this type of behavior.

²³Interestingly, the health system with one of the highest rates of biosimilar penetration in the country is Kaiser Permanente, which is fully vertically integrated and therefore makes both coverage and stocking decisions ([Bhardwaja et al., 2022](#)).

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Appendix to “Stocking Under the Influence: Spillovers from Commercial Drug Coverage to Medicare Utilization”

Emma B. Dean, *University of Miami*
Josh Feng, *University of Utah – David Eccles School of Business*
Luca Maini, *Harvard Medical School*
July 2023

A Molecules and Brands Included in Analysis

Table 2: Reference biologic and biosimilar brand names and US launch dates

Generic Name	Brand Name	Biosimilar Brand Names & Launch Dates
filgrastim	Neupogen	Granix - 11/2013 Zarxio - 09/2015 Nivestym - 10/2018
infliximab	Remicade	Inflectra - 11/2016 Renflexis - 07/2017
pegfilgrastim	Neulasta	Fulphila - 06/2018 Udenyca - 11/2018
epoetin alfa	Epogen and Procrit	Retacrit - 11/2018

Notes: Information on doctor-administered biosimilars that launched before 2019 (our analysis sample). Granix's manufacturer submitted its regulatory application to the FDA prior to the availability of the Biologics Price Competition and Innovation Act, thus is approved under the traditional biologic pathway. Inflectra launched in November 2016, but was not given a Medicare billing code until January 2017, thus our analysis considers it to have launched in 2017. For epoetin alfa, the reference brands are marketed by two separate manufacturers based on patient indication. We only include Procrit and non-ESRD usage of Retacrit in our analysis. Two additional biosimilar launches – Avsola (infliximab) – 12/2019 and Ziextenzo (pegfilgrastim) – 11/2019 are not included in our sample as they launched at the end of our sample timeframe.

B Summary Statistics

Table 3: Summary Statistics of MMIT Commercial Insurance Coverage Data

Brand	All commercial plans (level: state-year)			National Formularies (level: formulary-year)		
	Fraction covered Mean, [IQR]	Fraction Unrestricted Mean, [IQR]	Covered Mean, [IQR]	Covered Mean, [IQR]	Unrestricted Mean, [IQR]	
Neupogen	0.872 [0.765, 0.988]	0.449 [0.269, 0.613]	0.897 [1,1]	0.897 [1,1]	0.384 [0,1]	0.384 [0,1]
Granix	0.954 [0.946, 0.982]	0.504 [0.386, 0.617]	0.813 [1,1]	0.813 [1,1]	0.432 [0,1]	0.432 [0,1]
Nivestym	0.811 [0.746, 0.912]	0.368 [0.276, 0.451]	0.459 [0,1]	0.459 [0,1]	0.233 [0,0]	0.233 [0,0]
Zarxio	0.953 [0.943, 0.984]	0.560 [0.426, 0.711]	0.720 [0,1]	0.720 [0,1]	0.441 [0,1]	0.441 [0,1]
Remicade	0.945 [0.929, 0.976]	0.165 [0.109, 0.188]	0.856 [1,1]	0.856 [1,1]	0.182 [0,0]	0.182 [0,0]
Inflectra	0.767 [0.732, 0.828]	0.328 [0.233, 0.411]	0.503 [0,1]	0.503 [0,1]	0.187 [0,0]	0.187 [0,0]
Renflexis	0.742 [0.620, 0.881]	0.250 [0.177, 0.309]	0.505 [0,1]	0.505 [0,1]	0.153 [0,0]	0.153 [0,0]
Neulasta	0.984 [0.986, 0.997]	0.308 [0.182, 0.406]	0.888 [1,1]	0.888 [1,1]	0.407 [0,1]	0.407 [0,1]
Fulphila	0.742 [0.571, 0.929]	0.357 [0.260, 0.446]	0.488 [0,1]	0.488 [0,1]	0.255 [0,1]	0.255 [0,1]
Udenyca	0.651 [0.368, 0.934]	0.337 [0.174, 0.489]	0.427 [0,1]	0.427 [0,1]	0.240 [0,0]	0.240 [0,0]
Procrit	0.964 [0.951, 0.994]	0.330 [0.246, 0.379]	0.964 [1,1]	0.964 [1,1]	0.272 [0,1]	0.272 [0,1]
Retacrit	0.871 [0.785, 0.977]	0.367 [0.283, 0.437]	0.593 [0,1]	0.593 [0,1]	0.215 [0,0]	0.215 [0,0]

Notes: Summary statistics on the coverage levels of different brands. Statistics shown are means and the interquartile range for each brand. The “All commercial plans” columns compute summary statistics at the state-year level using coverage data from 2015 to 2019. The “National Formularies” columns use data at the formulary-year level for national formularies (and the outcomes are binary variables for each formulary). Statistics are not weighted by enrollment.

C Within-State Correlation of Biosimilar Uptake Across Molecules

Table 4: Correlation Matrix of State-Level Biosimilar Uptake Across Molecules in 2019

	filgrastim	infliximab	pegfilgrastim	epoetin alfa
filgrastim	1			
infliximab	0.166 (0.244)	1		
pegfilgrastim	0.231 (0.103)	0.076 (0.598)	1	
epoetin alfa	-0.164 (0.250)	0.011 (0.937)	0.183 (0.198)	1

Notes: Correlations across brands in terms of biosimilar uptake at the state level, focusing on 2019. Biosimilar uptake is measured as the combined market share of all launched biosimilar brands. Epoetin alfa only includes non-ESRD usage.

D Breakdown of Variation in Instrumental Variable

D.1 Inertia in Commercial Insurance Partnerships with PBMs and National Formularies

Table 5: Percentage of Commercial Insurers that Contract with the Same PBM and National Formulary as the Previous Year

Year Transition	Plan Remains	Same PBM	Same National Formulary
2015 to 2016	66.47%	65.04%	34.87%
2016 to 2017	90.96%	84.87%	89.09%
2017 to 2018	88.14%	87.70%	79.33%
2018 to 2019	94.91%	93.85%	72.36%
2019 to 2020	89.70%	88.39%	86.54%

Notes: For a given year, we keep all plans that use a national formulary. We then calculate the probability that the same plan remains in the MMIT data for the next year (“Plan Remains”). We then calculate the probability that the plan remains AND uses the same PBM in the next year (“Same PBM”). Finally, we calculate the probability that the plan remains AND uses the same formulary (“Same National Formulary”). All probabilities are weighted by plan enrollment. The probability of using the same PBM is generally higher than using the same national formulary, but there are cases in which PBMs merge, so the identity of the PBM changes but not the national formulary.

D.2 Variation in Market Share of National Formularies Across States

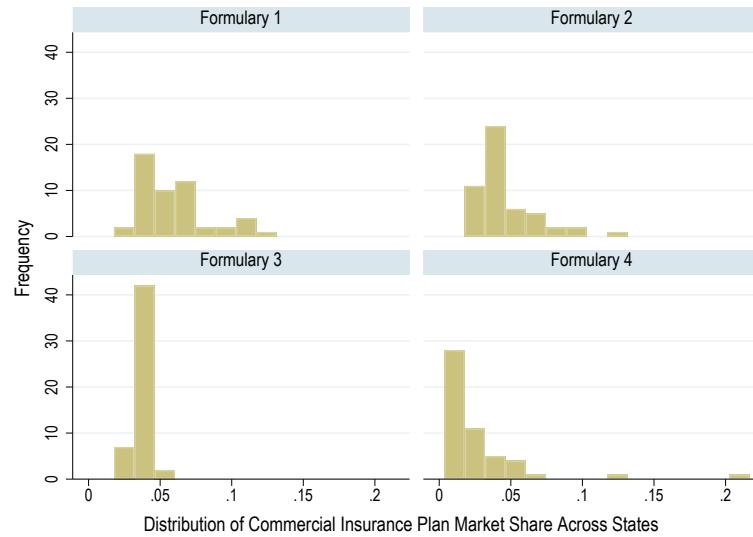


Figure 5: Distribution of Market Share of Four Largest National Formularies Across States in 2019

Notes: Distribution of market shares of national formularies across all fifty states. Market share is defined as the fraction of patients covered by a given national formulary in the given state.

D.3 Variation from Changes in the Exclusion of Reference Biologic and Biosimilars from National Formularies

Table 6: Coverage and Exclusion Events for Molecules of Interest

	Coverage Events	Exclusion Events
<i>Filgrastim Brands</i>		
Neupogen	2	9
Granix	4	0
Zarxio	8	2
Nivestym	16	0
<i>Infliximab Brands</i>		
Remicade	4	6
Inflectra	7	5
Renflexis	21	4
<i>Pegfilgrastim Brands</i>		
Neulasta	0	3
Fulphila	30	0
Udenyca	39	0
<i>Epoetin alfa Brands</i>		
Procrit	0	0
Retacrit	15	0
Total Reference Brand	6	18
Total Biosimilar	140	11
Total Events	146	29

Notes: Coverage events denote a change in a national formulary where a previously excluded brand is included in coverage. Exclusion events denote a change in a national formulary where a previously covered brand is excluded from coverage.

E Robustness Tests

E.1 Pooled Quasi-Maximum Likelihood Estimation

Table 7: IV Regression of Impact of Private Insurance Formulary Coverage on Biosimilar Uptake

	(1)
PANEL A. REDUCED-FORM ESTIMATES	
Fraction Excluded	-0.898 (0.060)
Specification	APEs using Pooled QMLE
PANEL B. IV RESULTS	
Fraction Excluded	-0.483 (0.100)
Specification	APEs using Pooled QMLE with endogenous regressor
First-Stage <i>F</i> -stat.	823.3
PANEL C. IV FIRST-STAGE	
Coverage on National Formulary	0.522 (0.010)
Specification	OLS
R ²	0.921
Observations	1,836
Open Payments Control	Yes
Population Weights	No

Notes: Robustness check related to Table 1 of the main text. We use the same sample (state-year-brand level aggregate data from 2015 to 2019). The dependent variable in all regressions is the brand-level market share for each state-year. Molecules are only included for years after their first biosimilar launch. Results shown are average partial effects calculated using a pooled quasi-maximum likelihood estimator, with bootstrapped robust standard errors.

E.2 Link between Preferred Coverage in Commercial Formularies and Part B Utilization

Table 8: Association of Private Insurance Formulary Unrestricted Coverage with Biosimilar Uptake

	(1)	(2)	(3)
PANEL A. REDUCED-FORM ESTIMATES			
Fraction Unrestricted	0.364 (0.030)	0.365 (0.029)	0.364 (0.060)
Specification	OLS	OLS	OLS
PANEL B. IV RESULTS			
Fraction Unrestricted	0.544 (0.045)	0.532 (0.044)	0.534 (0.114)
Specification	2SLS	2SLS	2SLS
First-Stage F-stat.	250.8	222.8	234.8
PANEL C. IV FIRST-STAGE			
Unrestricted Coverage on National Formulary	0.413 (0.013)	0.417 (0.013)	0.415 (0.12)
Specification	OLS	OLS	OLS
R ²	0.844	0.846	0.843
Observations	1,836	1,836	1,836
Open Payments Control	No	Yes	Yes
Population Weights	No	No	Yes

Notes: Robustness check related to Table 1 of the main text, using a fraction of lives with unrestricted coverage as the independent variable. We use the same sample (state-year-brand level aggregate data from 2015 to 2019). The dependent variable in all regressions is the brand-level market share for each state-year. Standard errors are clustered at the state-brand level. Molecules are only included for years after their first biosimilar launch.

E.3 Removing Large States

Table 9: IV Regression of Impact of Private Insurance Formulary Coverage on Biosimilar Uptake Excluding Large States

	(1)	(2)	(3)
PANEL A. REDUCED-FORM ESTIMATES			
Fraction Excluded	-0.304 (0.039)	-0.302 (0.038)	-0.298 (0.051)
Specification	OLS	OLS	OLS
PANEL B. IV RESULTS			
Fraction Excluded	-0.286 (0.049)	-0.284 (0.049)	-0.278 (0.080)
Specification	2SLS	2SLS	2SLS
First-Stage F-stat.	845.4	739.3	839.0
PANEL C. IV FIRST-STAGE			
Coverage on National Formulary	0.522 (0.010)	0.522 (0.010)	0.514 (0.010)
Specification	OLS	OLS	OLS
R ²	0.919	0.920	0.928
Observations	1,692	1,692	1,692
Open Payments Control	No	Yes	Yes
Population Weights	No	No	Yes

Notes: Robustness check related to Table 1 of the main text. We use the same sample (state-year-brand level aggregate data from 2015 to 2019) but exclude the four largest states by population (California, Texas, Florida, and New York). The dependent variable in all regressions is the brand-level market share for each state-year. Standard errors are clustered at the state-brand level. Molecules are only included for years after their first biosimilar launch.

F Calculation of savings from unrestricted formularies

In the main paper, we estimate potential Medicare Part B savings if all commercial formularies covered all biosimilar brands. We perform this calculation in three steps.

1. First, we use the estimated coefficient in our preferred specification, $\hat{\beta} = 0.301$ (Table 1, column 3) and calculate the predicted change in utilization rate (e.g. market share) for each biosimilar brand j and state k as $\hat{\beta} \times \text{Frac. Uncovered}_{jk}$ (note that all data refers to the year 2019)
2. Because all biosimilar brands increase in market share, we need to also adjust the number from step 1 downward to account for the fact that some of the increased utilization of a given biosimilar brand j may come from other biosimilar brands. To make this adjustment, we assume that substitution patterns are proportional to observed market shares (this is what would happen with logit demand). The Table below illustrates the adjustment with a numerical example

	Reference Biologic	Biosimilar 1	Biosimilar 2
Initial market share	70%	20%	10%
Fraction uncovered in commercial formularies	0%	40%	30%
Raw change in market share	0%	12%	9%
Adjustment	-17.5%	-2%	-1.5%
New adjusted market share	52.5%	30%	17.5%

In the example, Biosimilar 1 would experience a potential increase in market share of about 12% ($0.301 \times 40\%$), while Biosimilar 2 would experience a potential increase by 9%. Most of those increases would come at the expense of the reference biologic, but some of it would be from patients who were already using the other biosimilar brand. To calculate that proportion we use the leave-one-out market shares: Biosimilar 1 absorbs 2% of the potential market share increase of Biosimilar 2 because its market share relative to the reference biologic is $2/9$; Biosimilar 2 absorbs 1.5% of the potential market share increase of Biosimilar 1 because its market share relative to the reference biologic is $1/8$. The reference biologic absorbs what remains.

1. Finally, we multiply the difference between the initial and new adjusted market share by the total number of claims for a given molecule (inclusive of both

biosimilars and biologics) and by the difference in average spending between claims for the reference biologic and for each biosimilar.²⁴

Note that this procedure does not take into account two potential effects:

1. Changes in demand, which could arise because patient cost-sharing for biosimilars is lower than for reference biologics; and
2. Changes in equilibrium price for biosimilars (or reference biologics), which could arise if commercial insurers were forced to include all biosimilars on their formulary

²⁴An alternative way to compute this number would have been to use the publicly available Average Sales Price (ASP) series. However, ASP for some biologics and biosimilars refer to a different number of administered units, which would have required additional adjustments.