The Impact of a National Formulary Expansion on Diabetics

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Abstract

This paper estimates the causal impact of Colombia's national prescription drug formulary expansion at the end of 2011 on healthcare utilization and costs by type I diabetics, and identifies the channels through which cost reductions are realized. We find that insulin consumption shifts toward newly covered, more expensive insulin types, increasing insulin costs by 67%. This increase is almost entirely offset by decreases in the utilization of outpatient care, which falls by 3 claims on average. We devise tests to explore the relative importance of two channels by which the expansion may have lowered costs: spillovers from drug to non-drug spending and rationing of care. Controlling for the presence of spillover effects, we still find substantial cost reductions. We find large reductions in the utilization of discretionary care including diagnostic tests and visits to specialty providers that suggest rationing of care is the primary driver of observed cost savings.

Keywords: Healthcare rationing, prescription drug formulary, diabetes, insulin, health insurance.

JEL Codes: I100, I110, I130, I180.

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1 Introduction

Prescription drug formularies are an element of health insurance plan design that determine coverage and coinsurance rates for medications. Formularies are an important mechanism for healthcare cost containment that can increase the bargaining power of insurance companies in their negotiations with pharmaceutical manufacturers over the price of prescription drugs. The complexity of insurance plan design in settings such as the U.S. healthcare market and insurers' control over the elements of that design make it difficult to assess how changes in prescription drug coverage impact consumers, especially with respect to the extensive margin of whether a drug is covered at all. Evaluating changes in formulary design when it is an endogenous choice of the insurer usually requires a structural approach, as well as information on all other elements of plan design. While formulary additions might be expected to weakly increase prescription drug costs, spillovers from drug to non-drug spending raise the possibility that those additions might decrease healthcare costs overall. For instance, Lavetti and Simon (2018) show that Medicare Part D insurers risk select on spillovers by lowering coinsurance rates for drugs that are associated with lower non-drug spending. Understanding how formulary design impacts healthcare costs and utilization is of great concern to countries like Canada, Mexico, Japan, Colombia, and the U.S. where prescription drug spending comprises more than 10% of total healthcare costs (OECD, 2020). Also of keen interest is how insurers' ability to respond to exogenous changes in formulary design along other dimensions of plan design impacts outcomes for enrollees.

In this paper, we examine the impact of an exogenous expansion of Colombia's national prescription drug formulary at the end of 2011. The national formulary in Colombia is designed by the government and determines the set of covered medications and their level of cost sharing for all insurers. The formulary is part of a wider benefits package that covers inpatient and outpatient care and which private health insurers are obliged to offer to all of their enrollees. An estimated 96.6% of Colombians are covered by the nation's universal healthcare system (OECD, 2015). The government regulates premiums and cost sharing, but service and drug prices are determined through bilateral bargaining between insurers and pharmaceutical companies. Before 2012, the formulary covered 673 medications. At the end of 2011, it was expanded to include 736 medications as part of a broader healthcare reform which unified the income-based insurance regimes. We describe the Colombian healthcare system and this reform in more detail in section 2.

Regulation of cost sharing and coverage schedules in Colombia alleviates the endogeneity of formulary design and allows us to isolate the impact of the formulary's expansion. We are able to separate the effect of the formulary expansion from the effect of plans' unification by focusing on a particular type of drug and its users, namely, insulin and diabetics. The formulary expansion affected all enrollees to the healthcare system, but focusing on insulin - which is taken exclusively by diabetics - allows us to build a control group from the non-diabetic population. Since there is no generic insulin,[1] our focus also allows us to examine the impact of an increase in branded competition on healthcare utilization and costs. This is in contrast to the bulk of literature examining drug pricing and entry, which has focused on the effects of generic drug entry (Tenn and Wendling, 2014; Regan, 2008; Reiffen and Ward, 2005; Scott Morton, 2005). Diabetes is an increasingly prevalent chronic condition in many countries, especially the United States, where over 1 in 10 individuals had diabetes in 2018 and the total direct estimated costs of diagnosed diabetes increased from $188 billion in 2012 to $237 billion in 2017 (CDC, 2020). Research on how formulary design affects the costs associated with diabetes is therefore of particular interest to policymakers.

We use a difference-in-differences (DiD) approach to identify the causal effect of the formulary expansion. The treatment group is comprised of individuals with diabetes, and the control group is constructed by exactly matching diabetics to non-diabetics based on demographics, comorbidity profiles, and insurance carrier. Using granular claims data, we are able to analyze the impact of the formulary expansion on the utilization and cost of several types of healthcare. We find that consumption of insulin increased by 13% among type I diabetics as a result of the formulary expansion. Because we do not observe out-of-pocket insulin purchases, we cannot quantify how much of the observed increase in insulin consumption is attributable to moral hazard, and how much is the mechanical result of out-of-pocket payments becoming covered claims. We also find that diabetics' total healthcare costs decline by 67% as a result of the policy despite a 53% increase in prescription drug costs. We look for evidence of two channels which might generate this increase in drug and decline in non-drug spending: spillovers, and rationing of care. The spillovers hypothesis posits that increased drug spending can result in lower non-drug costs as patients are matched to their optimal prescription, thereby improving health status. Lavetti and Simon (2018) find that Medicare Advantage

[1] Because insulins are biologically based rather than molecularly based, they are too complicated to replicate exactly. Insulins that are relatively close substitutes for one another are called biosimilars.

plans capitalize on spillovers once open enrollment has closed by lowering coinsurance rates for drugs that are associated with lower non-drug spending.

The rationing of care hypothesis posits that in the short run, insurers respond to increases in prescription coverage and costs by limiting the amount of discretionary care that newly more costly patients receive. In the long run, this rationing can result in lower enrollment from these more costly individuals, acting as a mechanism for selection.[2] There is an impressive literature examining how insurers respond to regulations and regulatory changes in government coordinated health insurance markets. Andersen (2017) finds that in the United States insurers respond to drug coverage requirements under the Affordable Care Act by placing both marginal and inframarginal drugs on higher formulary tiers, or subjecting them to utilization management. Whether insurers in Colombia's tightly regulated health insurance market are able to respond to variations in selection incentives is still an outstanding empirical question. We devise tests to show that spillovers from drug to non-drug spending are not the source of cost savings, and provide evidence that these cost reductions stem from the targeted rationing of discretionary healthcare, specifically of laboratory tests and office visits.

Our paper is related to the literature studying the effects of prescription drug coverage and insulin consumption on diabetics' healthcare utilization and costs. In recent work, Américo and Rocha (2020) evaluate the impact of a policy implemented in Brazil that made subsidized pharmaceutical drugs available at retail pharmacies, focusing on the spillover effects of the policy. They find that the increase in cost sharing for and availability of prescription drugs reduced the hospitalization rate of diabetics by 3.6 percent. This paper complements Américo and Rocha (2020) by examining how a different element of formulary design – the extensive margin decision of whether a drug is covered at all – impacts insulin consumption by type I diabetics. In testing for rationing of care as a response to changing selection incentives, this paper is also related to the literature on rationing of healthcare, the vast majority of which is both theoretical and specific to the use of waiting time as a tool for engaging in general rather than targeted rationing (Cullis and Propper, 2000; Fabbri and Monfardini, 2009). While this paper provides anecdotal evidence of the mechanisms by

[2]From the consumer's perspective if rationing care is an issue documented in newspapers and magazines, we would worry about rationing of care being correlated with disenrollment due to risk selection in the short run as well. The best way to account for that correlation would be to focus on the subsample of patients that are continuously enrolled, unfortunately we have no data on enrollment spell lengths for our period of analysis.

which rationing is achieved, its main contribution is to quantify insurers' success at achieving rationing targeted at a newly unprofitable set of enrollees, a strategy of insurers that to our knowledge has not yet been examined. Quantifying the degree to which the formulary expansion increased access to essential drugs and reduced access to discretionary care among the population of type I diabetics provides valuable insights into the efficacy of health insurance market regulations and the welfare impacts of expanding prescription drug coverage.

2 Background

2.1 Colombia's universal health insurance system & formulary expansion

Colombia's universal health insurance system was established in 1993 with Law 100. Before 2012, all individuals were divided into one of the two regimes - the Contributory Regime (CR) and the Subsidized Regime (SR) - that made up the health insurance system. The CR covered individuals above a monthly income threshold. The 51% of the population eligible to join the CR contributed 12% of their monthly income to the system. The remaining 49% of the population below the income threshold were part of the SR. Before 2012, the national plan offered by the CR covered different services, procedures and medications than that offered by the SR, but at the beginning of that year the plans were unified. Individuals choose from amongst a set of private insurers with which to enroll and access the national plan. To deliver the services covered under the national plan, insurers contract with healthcare providers to create a network. Out-of-network claims are not covered. The sample of enrollees used in our analysis belong only to the CR.

The cost sharing rules for the national insurance plan in the CR are determined by the government and indexed to the enrollee's monthly income. For individuals earning less than two times the monthly minimum wage (MMW), the coinsurance rate is 11.5% of the price of the health claim, the copay is 11.7% of the daily minimum wage, and the maximum out-of-pocket expenditure in a year equals 57.5% of the MMW. For those whose monthly income is between 2 and 5 times the MMW, the coinsurance rate is 17.3% of the health claim price, the copay is 46.1% of the daily minimum wage, and the maximum out-of-pocket expenditure in a year equals 230% of the MMW. Finally, for enrollees whose income exceeds 5 times the MMW, the

coinsurance rate equals 23%, the copay is 121.5% of the daily minimum wage, and the maximum out-of-pocket expenditure in a year is 460% of the MMW. There are no deductibles in the Colombian system, so copays and coinsurance rates always apply. These cost sharing percentages have remained fixed since the establishment of Colombia's healthcare system and their absolute levels only vary with changes in the minimum wage. Individuals are required to report their income monthly so that their plan can apply the appropriate cost sharing rules to them.

Insurers are not allowed to charge premiums through the national plan. Instead, they are reimbursed by the government every year with capitated payments that are risk adjusted for age, sex, and location. Transfers for year t are approximately calculated as the present value of the average healthcare cost of a given risk pool using the data of all claims reimbursed by insurers during year $t-2$. The capitated payments replace premiums, so that other than the monthly contribution to the CR, enrollment in the national insurance plan is free. The strict regulation of cost sharing and benefits means that insurers compete in terms of quality and provider networks (Giedion and Uribe, 2009). As in the US, insurers and providers bargain freely over the price of health services, devices, and medications. Private insurers are also allowed to offer complementary insurance plans, for which they can determine cost sharing rules and premiums. However, consumers can only access these complementary packages once they are enrolled in the national plan. The data used in this paper are the cross sections of health claims made by all enrollees to the CR through the national insurance plan in 2011 and 2013.

At the end of 2011, the Colombian Ministry of Health implemented a reform that unified the contributory and subsidized systems' insurance plans and expanded the national prescription drug formulary by 63 drugs.[3] Most drug inclusions were for treatment of mental health conditions (all of which were previously uncovered), insulin, antibiotics, and chemotherapy. The wider benefits package was also expanded to cover complex procedures like open breast biopsy, laparoscopy ovary cystectomy, and colored doppler echocardiogram, but the most significant changes were with respect to the drug formulary. Although there have been studies that measure the overall impact of the unification of the CR and SR (Riascos and Camelo, 2014), there is less work on the impact of the formulary expansion. The exogeneity of variables that in other countries would

[3]Established in decree 029 of 2011.

be chosen by the insurer allows us to isolate the impact of the fomulary expansion on healthcare costs and utilization. This is relevant not only for Colombia, where the formulary continues to be modified, but also for countries where the scope and role of national health insurance continues to be debated.

While many of the tools that insurers in other settings use to engage in risk selection are not available to insurers in the CR, there is still scope for insurers to target healthier enrollees through "illicit formularies," whereby insurers deny the provision of or payment for certain medical services or medicines. It is perhaps in part because of these illicit formularies that, since the establishment of its universal health system, Colombia has become the most litigious country in Latin America with respect to lawsuits concerning the refusal of treatments, exams, and pharmaceuticals by insurers. In 2013, 115,147 of such lawsuits were filed in Colombia (Lamprea and Garcia, 2016). We provide anecdotal and empirical evidence of the use of illicit formularies in section 6.

2.2 Diabetes & insulin

Insulin is a hormone produced by the pancreas that allows glucose from food to enter a person's cells and controls their blood sugar. A person has diabetes if they do not produce enough insulin or their body does not use insulin well. Type I diabetics produce no insulin, and must take insulin every day in order to stay alive. Type II diabetics produce some insulin, but less as the disease progresses. Type II diabetics can control their blood sugar with diet and exercise or oral medications such as metformin, but others will require insulin (FDA, 2020). In the short run, failure to control blood sugar can result in hypoglycemia. In the long run, uncontrolled blood sugar can result in kidney disease, heart disease, nerve damage, and several other adverse health outcomes (NIH, 2020).

Prior to its expansion in 2012, two types of insulin were covered by the Colombian formulary: regular and NPH.[4] Regular insulin is a type of bolus insulin. Bolus insulins are fast-acting, taking effect and wearing off more quickly. Bolus insulin is usually taken shortly before mealtimes to provide immediate blood sugar control. NPH belongs to the class of basal insulins, which are longer-lasting and provide blood sugar control throughout the day. These two types of insulin can be consumed together to better manage the disease. With the expansion of the formulary in 2012, the number of insulins covered increased from two to seven, providing

[4] ATC codes A10AB01 and A10AC01, respectively.

more options for patients to exploit the complementarities between types of insulin. The five newly added insulins included three additional bolus insulins and two additional basal insulins.[5] The characteristics of these insulin types are summarized in table 1 below. Differentiation in the characteristics of insulin including onset time, peak time, and duration generate the potential for increased insulin coverage to allow diabetics to be better matched to an insulin regimen and generate spillovers. Also note that average institutional price of the newly added insulins is anywhere from 4 to 15 times higher those of NPH or regular insulin. These price differentials imply that even modest amounts of substitution from the continuously covered insulins to the newly covered ones will generate large increases in insulin costs.

Table 1: Types of insulin

Insulin type (brand name)	Onset	Peak	Duration	Avg. price (thous. pesos)	Part of expansion?
Bolus (preprandial or mealtime) insulins					
Rapid-acting insulin analogues					
• Insulin aspart (NovoRapid®)	9-20 min	1-1.5 hr	3-5 hr	87.5	Yes
• Faster-acting insulin aspart (Fiasp®)	4 min	0.5-1.5 hr	3-5 hr		
• Insulin glulisine (Apidra®)	10-15 min	1-1.5 hr	3.5-5 hr	85.9	
• Insulin lispro (Humalog®)	10-15 min	1-2 hr	3-4.75 hr	90.9	
Short-acting insulins					
• Insulin regular (Humulin®-R, Novolin®ge)	30 min	2-3 hr	6.5 hr	20.3	No
• Insulin regular (Entuzity®(U-500))	15 min	4-8 hr	17-24 hr		
Basal Insulins					
Intermediate-acting					
• Insulin NPH (Humulin®-N, Novolin®ge NPH)	1-3 hr	5-8 hr	Up to 18 hr	11.71	No
Long-lasting insulin					
• Insulin detemir (Lemevir®)	90 min	N/A	16-24 hr	145.8	Yes
• Insulin glargine U-100 (Lantus®)			24 hr	172.1	
• Insulin glargine U-300 (Toujeo®)			> 30 hr		

Note: Adapted from Canadian Journal of Diabetes, 2018-04-01, Volume 42, Pages S314-S314.

3 Data

We use two samples of cross sectional health claims data from the CR from 2011 and 2013, which are one year pre- and post-policy respectively. These data includes all diabetics and the subsample of enrollees who made at least one health claim. For every enrollee, we observe basic demographic characteristics including sex,

[5] ATC codes A10AB05, A10AB06, A10AB04, A10AE05, and A10AE04.

age, and municipality of residence. For every claim, we observe date of provision, service provided, service price, contract under which the claim is reimbursed, insurer, provider, and associated ICD-10 diagnosis code. Since patients have to be enrolled with their choice of insurer for at least a year, we do not observe patients switching their insurer during either cross-section of our data.

We obtain each enrollee's set of comorbidities by grouping ICD-10 codes according to Alfonso et al. (2013) into the following conditions: genetic anomalies, arthritis, arthrosis, asthma, autoimmune disease, cancer, cardiovascular disease, diabetes, long-term pulmonary disease, renal disease, HIV-AIDS, transplant, tuberculosis, and epilepsy. Age is categorized into the following groups used by the government for the risk adjustment formula: 19-44, 45-54, 55-59, 60-64, 65-69, 70-74, 75+. We collapse the claims level data to the patient-year level and build measures of utilization and cost by summing across each patient's claims within a year.

We define treatment in a year as having been diagnosed with type I diabetes at any moment during that year and being at least 19 years old. We exclude type II diabetics from our analyses, as their extensive margin decision to use medication to manage their diabetes determines whether they have a diabetes diagnosis. This implies that treatment for type II diabetics is not exogenous conditional on observables, which is a requirement of the DiD approach we employ. We determine which patients are diabetic using the ICD-10 diagnoses that accompany their claims, so treated units who did not make a health claim are unobserved. We expect the number of unobserved treated individuals to be close to zero since type I diabetics can be expected to make at least one claim associated with diabetes management.

We use exact matching to create a control group that is identical to the treatment group of type I diabetics in terms of comorbidities (with the exception of diabetes), sex, age, insurer, and municipality category. Municipalities are categorized as urban, normal, or special, following the definitions of Colombia's National Department of Statistics. We do not match on income in our main specifications as we do not observe each enrollee's monthly income, but rather a group average of income. However, as a robustness check, we present all of our results for a sample that is matched on income as well as all of the covariates included in the matching for our main specification sample in appendix B. Using exact matching to create the comparison group has three advantages. First, the comparison group will be identical to the treatment

group, and will therefore be expected to respond to shocks in a similar way. This is important, since both the treatment and comparison groups were subject to universal elements of the healthcare reform in the post-policy period, including the regime unification. Second, by matching treated units in the pre-policy to those in the post-policy period and then matching treated units to control ones separately for each year, we achieve common support on the distribution of the covariates across all four cells. This will keep us from making inferences about outcomes for treated individuals we don't observe in the data. Third, common support also allows us to relax the assumption that the effect of the policy is homogeneous across individuals. This choice of control group also implies that the effect being estimated is that of the element of the formulary expansion that is relevant only to type I diabetics, namely expanded coverage of insulins.

Table 2: Balance table of treated and controls

	Control	Treated
Demographics		
Male, (%)	53.58	53.61
Age, Mean (SD)	61.98 (14.22)	61.99 (14.26)
Diagnoses, (%)		
Arthrosis	0.27	0.29
Cardiovascular disease	58.15	57.98
Long term pulmonary disease	0.60	0.62
Renal disease	11.80	11.85
Insurer, (%)		
A	0.22	0.23
B	0.02	0.02
C	0.04	0.07
D	0.03	0.03
E	1.97	1.96
F	0.34	0.37
G	31.67	31.68
H	0.45	0.47
I	2.12	2.17
J	61.68	61.50
K	1.43	1.51
UPC Zone (%)		
Metropolitan	53.03	53.02
Normal	46.74	46.70
Special	0.23	0.27
N	141,115	9,231

Note: This table shows some descriptive summary statistics of treated and control units after $1 - to - n$ exact matching on age, sex, comorbidities, type of municipality, and insurer. Summary statistics for control units are weighted by the inverse number of controls matched to each diabetic.

We perform one-to-many matching of diabetics to identical non-diabetics. Table 2 presents summary

statistics of the demographic characteristics and diagnoses of the treatment and control groups. Statistics for control units are weighted by the inverse number of controls matched to each diabetic in each year. 54% of our sample are males and the average age equals 62 years with a standard deviation of 14 years. The most common comorbidities are cardiovascular diseases which is present in 58% of patients and renal disease which is present in 12% of patients. More than 61% of individuals are enrolled to insurer J, followed by 32% to insurer G. 53% of diabetics live in urban or metropolitan municipalities and 47% in normal areas. The matched sample consists of 9,231 type I diabetics and 141,115 exactly matched controls.

Table 3: Summary of outcome measures for treated and controls

	Control		Treated	
	2011	2013	2011	2013
Claims				
Total	20.40	19.22	48.45	42.36
	(23.89)	(25.10)	(36.15)	(37.57)
Outpatient	8.11	7.20	17.53	13.60
	(8.35)	(8.16)	(12.44)	(11.22)
Inpatient	0.55	0.33	1.25	0.42
	(4.66)	(3.40)	(6.91)	(3.50)
Prescription	11.74	11.80	29.66	28.35
	(17.95)	(19.91)	(28.19)	(31.62)
Insulin	0.02	0.01	4.385	4.918
	(0.401)	(0.257)	(5.257)	(6.111)
Procedure	0.24	0.13	0.089	0.11
	(1.37)	(0.87)	(0.67)	(0.98)
Lab	4.48	4.10	11.12	8.71
	(6.37)	(6.18)	(9.628)	(8.477)
Imaging	0.32	0.30	0.34	0.27
	(0.88)	(0.82)	(1.04)	(0.77)
Office\consultation	3.10	2.75	5.48	4.64
	(2.82)	(2.61)	(3.74)	(3.90)
Costs (COP)				
Total	258,229	402,955	587,013	1,026,842
	(440,408)	(4,507,050)	(482,105)	(3,002,923)
Outpatient	125,519	383,587	262,753	469,587
	(201,230)	(2,645,282)	(213,635)	(2,275,585)
Inpatient	11,654	113,508	24,027	108,432
	(121,753)	(1,382,401)	(140,206)	(1,086,230)
Prescription	121,053	269,483	300,233	448,823
	(238,985)	(2,930,823)	(328,346)	(1,083,757)
Insulin	207	235	48,781	328,613
	(5,259)	(15,696)	(74,260)	(721,939)
Procedure	5,167	175,480	1,374	190,663
	(70,783)	(2,220,927)	(10,037)	(2,110,973)
Lab	89,601	47,514	199,782	98,672
	(171,179)	(150,319)	(182,289)	(157,428)
Imaging	5,692	31,184	5,425	27,113
	(20,623)	(159,259)	(19,093)	(132,919)
Office\consultation	26,500	75,517	49,403	141,125
	(39,034)	(204,191)	(59,689)	(310,071)
Observations	65,640	75,475	3,578	5,653

Note: This table presents summary statistics of outcomes measures after $1-to-n$ exact matching on age, sex, comorbidites, type of municipality, and insurer. Summary statistics of controls are weighted by the inverse number of controls matched to each diabetic.

Table 3 summarizes healthcare utilization and costs for each group in the pre- and post-policy periods. Outcomes for control units are weighted as they were in table 2. We define outpatient claims as those associated with a hospital length-of-stay (LOS) of at most 1 day and inpatient claims as being associated with a LOS of at least 2 days. First-time visits correspond to doctor appointments related to a new diagnosis, while follow-up visits are doctor visits related to existing diagnoses relative to past appointments with the

same doctor. Our measure of insulin consumption is the number of insulin claims. Almost all of these claims are for a concentration of 100 UL/ml. As a sanity check, in table 3 we note that while the average diabetic has 4.4 insulin claims in the pre-policy and 4.9 insulin claims in the post-policy period, non-diabetics have virtually no insulin claims before or after the formulary expansion. Conditional on having the same comorbidities, we see that diabetics have a significantly higher number of claims for outpatient care, lab tests, and office visits than non-diabetics. Diabetics are also costlier than their matched counterparts both before and after the expansion as seen in the second panel of table 3.

4 Methodology

In this section we present an empirical strategy that will allow us to estimate the impact of the national prescription drug formulary expansion on various outcomes of interest for the population of patients with diabetes. We employ a DiD estimation strategy, summarized by the estimating equation

$$y_{it} = \alpha + \tau D_i * P_t + \delta D_i + \gamma P_t + \mathbf{x}_i'\beta + \varepsilon_{it} \tag{1}$$

where y_{it} is the outcome for patient i in year t; D_i is an indicator variable for patient i being a type I diabetic; P_t is an indicator variable for year t following the formulary expansion; and $\mathbf{x}_i$ is a vector of demographic characteristics including sex, age group, comorbidity dummies, insurer dummies, and type of municipality dummies. The coefficient of interest is τ, which provides an estimate of the average treatment effect on the treated. Our identifying assumptions are that the formulary expansion affected all insurance companies and enrollees to the CR, so there is no selection into the policy, and that our definition of treatment as being type I diabetic is exogenous, conditional on all other comorbidities and demographics. Because we use one-to-many matching, we weight our regressions using the weighting scheme described in Iacus et al. (2011).

5 Results

In table 4, we present the results of equation 1 using as the dependent variable the number of claims filed by individual i in year t for various types of drug and non-drug healthcare utilization. We turn first to the effect of the formulary expansion on insulin consumption by type I diabetics, the relevant outcomes for which are given in columns 1 through 3. Note that because our measure of insulin utilization is constructed using claims, our outcome does not capture out-of-pocket purchases of insulins not covered by the national formulary. If type I diabetics consumed uncovered insulins in the pre-policy period, then after the formulary expansion in 2012, these out-of-pocket purchases would become claims and generate an increase in insulin utilization as a result of the policy even though insulin consumption patterns would not have changed. Column 1 shows that type I diabetics made 0.55 (13%) more insulin claims as a result of the expansion. Columns 2 and 3, show that the consumption of regular and NPH insulin, both of which were covered by the formulary in the pre-policy period, have a decrease in utilization of 0.12 and 1.37 claims, respectively. This suggests that diabetics switched to a preferred bolus or basal insulin once it was covered, implying that the formulary expansion was welfare enhancing for consumers who are now able to switch to their optimal insulin regimen. This switching creates the potential for spillovers; we explore this possibility further in section 6. In column 4 of table 4, we see that across all types of healthcare, the policy generated a significant reduction in utilization: the total number of claims for type I diabetics fell by 4.6 (19%) as a result of the expansion. This effect can be decomposed into a reduction of 3 outpatient claims as seen in column 5 and of 0.61 inpatient claims in column 6, reductions which constitute a 34% decrease in outpatient claims and a 125% decrease for inpatient claims relative to baseline utilization. Column 7 shows no significant effect of the formulary expansion on overall consumption of prescription medications by type I diabetics.

Table 4: Effect of the formulary expansion on healthcare utilization

	(1) All insulin	(2) Regular insulin	(3) NPH insulin	(4) All	(5) Outpatient	(6) Inpatient	(7) Prescriptions
Diabetic × policy	0.547***	-0.120*	-1.365***	-4.623***	-3.077***	-0.608***	-0.938
	(0.119)	(0.0509)	(0.0875)	(0.712)	(0.250)	(0.132)	(0.571)
Diabetic	4.365***	0.916***	3.450***	28.13***	9.455***	0.695***	17.98***
	(0.0873)	(0.0416)	(0.0721)	(0.542)	(0.202)	(0.120)	(0.420)
Policy	-0.0174***	-0.000325	-0.00751**	-0.322	-0.821***	-0.140**	0.639***
	(0.00308)	(0.000993)	(0.00246)	(0.173)	(0.0764)	(0.0475)	(0.117)
Constant	0.0496	0.0751	-0.0799	-0.609	-0.900	-0.304**	0.595
	(0.0789)	(0.0646)	(0.0411)	(0.981)	(0.558)	(0.0926)	(0.674)
Observations	150346	150346	150346	150346	150346	150346	150346
R^2	0.3758	0.1101	0.2927	0.3183	0.2251	0.0157	0.2928

Note: OLS estimation of equation 1 with utilization outcomes as dependent variable, on the sample of type-I diabetics and their exactly matched controls. All models control for sex, age, comorbidities, type of municipality, and insurance carrier. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5 presents the results of equation 1 using as outcomes the logarithm of total cost for the same healthcare categories considered in table 4. Column 1 shows that the total cost of insulins among type I diabetics increased 67% after the expansion. Columns 2 and 3 show that the increase in costs comes from the newly covered insulins, since the total cost per regular and NPH insulin claims decreased by 27% and 214%, respectively. These coefficients are consistent with the price differentials highlighted in table 1, as well as with the reductions in utilization presented in table 4. The increase in total costs for newly covered insulins is part of an overall increase in total prescription drug costs as seen in column 7. This increase in drug costs for diabetics is accompanied by a significant decline in non-drug spending. Column 4 shows that total costs across all healthcare types falls 39% among type I diabetics after the policy relative to control units. This decline in total costs stems from declines in outpatient and inpatient costs equal to 110% and 27% respectively. Because the government's risk adjustment formula controls for sex, age category, and type of municipality, all of which are included in our cost regressions, the estimated effect on total healthcare costs can also be interpreted in terms of profits to the insurer. Column 4 shows that the formulary expansion increased total healthcare costs for all individuals by 4%, consistent with a decrease in profits of 340 thousand pesos per enrollee.

Table 5: Effect of the formulary expansion on $\log(cost + 1)$

	(1) All insulin	(2) Regular insulin	(3) NPH insulin	(4) All	(5) Outpatient	(6) Inpatient	(7) Prescriptions
Diabetic × policy	0.674***	-0.270**	-2.143***	-0.389***	-1.098***	-0.270***	0.531***
	(0.120)	(0.0899)	(0.112)	(0.0415)	(0.0694)	(0.0624)	(0.112)
Diabetic	6.395***	2.211***	5.709***	1.418***	1.134***	0.352***	3.935***
	(0.0893)	(0.0716)	(0.0889)	(0.0220)	(0.0406)	(0.0501)	(0.0844)
Policy	-0.0270***	0.00105	-0.0264***	0.0397*	0.109***	0.0421	-0.821***
	(0.00483)	(0.00317)	(0.00410)	(0.0202)	(0.0272)	(0.0240)	(0.0518)
Constant	0.0984	0.108	-0.0148	9.610***	8.574***	0.0367	2.552***
	(0.0996)	(0.0837)	(0.0662)	(0.180)	(0.285)	(0.194)	(0.448)
Observations	150346	150346	150346	150346	150346	150346	150346
R^2	0.5322	0.1717	0.3906	0.1433	0.0582	0.0162	0.2861

Note: OLS estimation of equation 1 with the logarithm of cost per healthcare type as dependent variable, on the sample of type-I diabetics and their exactly matched controls. All models control for sex, age, comorbidities, type of municipality, and insurance carrier. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Our results so far are consistent with a story of spillovers from drug to non-drug healthcare spending, whereby individuals' improved health status as a result of their newfound ability to take their preferred insulin makes them less likely to seek care in an outpatient or inpatient setting. We have also seen that as a result of the formulary expansion, the cost of insulin coverage and by extension the cost of covering type I diabetics rises. This change in selection incentives could motivate insurers to ration care to type I diabetics, which would lower their non-drug costs and potentially disincentivize enrollment in the long run. There are sufficient financial incentives for insurers to attempt targeted rationing, as the increase in insulin costs alone constitutes 1.72% of total costs to insurers in 2011.

As discussed in section 3, variation across individuals with respect to their level of cost sharing is a function of income. It is of interest whether our findings hold when controlling for income, as changes in the income distribution might generate changes in enrollees' price elasticity of demand for healthcare. In appendix B, we construct an analysis sample via exact matching using the same patient-level covariates as before as well as income and estimate our main specifications controlling for income. Our findings are similar to those presented here.

6 Spillovers and rationing of care

In this section, we test for spillovers from drug to non-drug spending and provide evidence of insurers' rationing of discretionary healthcare provided to type I diabetics. Spillovers from drug to non-drug spending are generated when patients with specific diagnoses take up a drug that has the potential to prevent serious adverse health events. Because some of the diabetics in our sample change their choice of insulin as a result of the policy, as seen in table 4, there is potential for spillovers in this setting. We test for whether spillovers generate the non-drug utilization and cost reductions by comparing the results of the previous section against those generated using a subsample of our data which includes only diabetics whose choice of insulin does not change as a result of the policy, and for whom there is therefore no scope for spillovers.

We create a sample of type I diabetics that have zero consumption of newly added insulins after the policy and for whom the consumption of regular and NPH insulin did not change with the formulary expansion. To do so, we implemented coarsened exact matching as in Iacus et al. (2011) to match diabetics in 2011 and diabetics in 2013 based on their level of regular and NPH insulin claims. We use this sample to estimate the equation

$$y_{it} = \alpha + \tau P_t + \mathbf{x}_i'\beta + \varepsilon_{it} \tag{2}$$

where P_t is the post-policy indicator and $\mathbf{x}_i$ is a vector of demographic characteristics and diagnoses. The results of equation 2 are given in tables 6 and 7. As a sanity check, we note that there are no changes in insulin consumption as seen in columns 1 through 3 of table 6. We also observe that the utilization and cost reductions in non-drug healthcare are of similar magnitude and statistical significance in this sample without spillovers as they were for the full sample of type I diabetics (see column 4 in tables 4 and 5). Although with this empirical exercise we look at the presence of spillovers coming from insulin consumption alone, we note that there are no economically significant differences in the consumption of other types of drugs subject to expanded coverage after the policy (like antibiotics, antidepressants, antianxiety, antischizophrenics, etc.) between treated and controls. Another way to test for spillovers in the full sample of patients is to directly estimate the effect of drug spending on non-drug spending. The results of this exercise are provided in table

C1 in appendix C. The coefficient on drug spending is small and positive, opposite to what we would expect under spillovers. This evidence rules out spillover effects as potential explanation for the observed utilization and cost patterns.

Table 6: Effect of the formulary expansion on healthcare utilization by diabetics without spillovers

	(1) All insulin	(2) Regular insulin	(3) NPH insulin	(4) All	(5) Outpatient	(6) Inpatient	(7) Prescriptions
Policy	0.0704	-0.00540	0.0758	-3.379*	-4.770***	-1.015***	2.406
	(0.214)	(0.128)	(0.151)	(1.451)	(0.383)	(0.265)	(1.255)
Constant	8.143**	6.011	2.132*	27.72**	12.50	-0.0861	15.30***
	(2.854)	(3.521)	(0.845)	(9.364)	(6.947)	(0.731)	(3.870)
Observations	3858	3858	3858	3858	3858	3858	3858
R^2	0.1058	0.0586	0.1591	0.2370	0.1908	0.0395	0.2462

Note: OLS estimation of equation 2 with utilization outcomes as dependent variable, on the sample of type-I diabetics who have zero consumption of newly added insulins and similar consumption of regular and NPH insulins before and after the formulary expansion. Treated units in 2011 are coarsened exactly matched to treated units in 2013 based on the number of regular and NPH insulin claims. All models control for sex, age, comorbidities, type of municipality, and insurance carrier. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7: Effect of the formulary expansion on $\log(cost + 1)$ by diabetics without spillovers

	(1) All insulin	(2) Regular insulin	(3) NPH insulin	(4) All	(5) Outpatient	(6) Inpatient	(7) Prescriptions
Policy	0.185***	0.0720	-0.306*	-0.501***	-0.697***	-0.352***	-0.791***
	(0.0417)	(0.195)	(0.130)	(0.0331)	(0.0832)	(0.0982)	(0.0388)
Constant	11.72***	8.953***	10.52***	12.41***	10.89***	1.013	11.81***
	(0.244)	(1.717)	(0.356)	(0.346)	(0.799)	(1.089)	(0.162)
Observations	3858	3858	3858	3858	3858	3858	3858
R^2	0.1198	0.0789	0.2164	0.2496	0.1141	0.0508	0.3047

Note: OLS estimation of equation 2 with the logarithm of healthcare cost as dependent variable, on the sample of type-I diabetics who have zero consumption of newly added insulins and similar consumption of regular and NPH insulins before and after the formulary expansion. Treated units in 2011 are coarsened exactly matched to treated units in 2013 based on the number of regular and NPH insulin claims. All models control for sex, age, comorbidities, type of municipality, and insurance carrier. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

By making type I diabetics relatively more expensive than other enrollees with similar comorbidity profiles, the formulary expansion incentivized insurers to try to selectively disenroll type I diabetics by decreasing the quality of care offered to them. One way to do this is through rationing. Insurers in Colombia can ration care by limiting the provider network or provider choices made available to their enrollees, by requiring

authorization for provision of certain services or procedures, or by steering physicians away from recommending certain treatments. Anecdotal evidence in local newspapers and magazines shows that healthcare rationing is a prevailing strategy used by insurers to contain costs. In 2014, *Semana* magazine conducted an investigation that revealed some of the most popular cost containment mechanisms used by insurers: notifying doctors periodically about the expenditures they generate, putting caps on per-patient spending, and denying requests by primary care physicians to refer patients to the specialist or get expensive diagnostic services. Their investigation noted,

> "Although primary care physicians already have limited access to expensive diagnostic services like CT scans or MRIs, insurers also restrict the use of basic clinical services. In this email, the insurance company states that physicians need to start filing a formulary every time they request a Thyroid Stimulating Hormone (TSH) test for their patients. After evaluating every request, the insurer will notify physicians they believe are overprescribing this lab test."

In 2009, *El Colombiano* magazine published,

> "In a study conducted by the National University of Colombia, findings show that out of 458 people who visited their healthcare provider, 17% were denied a medical evaluation. Of those who were evaluated by the doctor, 24.9% were denied laboratory tests and 45% were denied other types of treatment including medications, surgeries, and medical equipment."

We test for rationing of care as the channel for the observed utilization and costs reductions using the same DiD empirical specification as in equation 1, but we now use as outcomes utilization of four broad types of outpatient care: procedures, lab tests, imaging, and office visits/consultations. The latter three types of outpatient care deal with diagnosis rather than treatment, and therefore relatively more discretionary and therefore easier to ration. Table 8 shows that the decrease in total utilization is driven by a sizable reduction in the number of lab tests and office visits. The number of lab tests falls by 2 (40%) for type I diabetics after the expansion, and the number of office visits decreases 0.5 (9%). We see no effect of the formulary expansion on the number of imaging services, and observe a small increase in the number of outpatient procedures which would be used to treat acute conditions.

Table 8: Effect of the formulary expansion outpatient care utilization

	(1) Procedures	(2) Labs	(3) Imaging	(4) Office vists/ consultations
Diabetic × policy	0.135***	-2.059***	-0.0417	-0.506***
	(0.0233)	(0.195)	(0.0224)	(0.0778)
Diabetic	-0.154***	6.666***	0.0201	2.383***
	(0.0181)	(0.158)	(0.0189)	(0.0601)
Policy	-0.113***	-0.259***	-0.0249**	-0.316***
	(0.0159)	(0.0588)	(0.00955)	(0.0244)
Constant	0.105*	-2.049***	0.177**	0.396*
	(0.0515)	(0.416)	(0.0589)	(0.166)
Observations	150346	150346	150346	150346
R^2	0.0655	0.1931	0.0258	0.2414

Note: OLS estimation of equation 1 with utilization of different types of outpatient care as dependent variable, on the sample of type-I diabetics and their exactly matched controls. All models control for sex, age, comorbidities, type of municipality, and insurance carrier. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Having presented evidence that reductions in non-drug spending stem primarily from reductions in discretionary services including lab tests and office visits, we now zoom in and examine which types of discretionary services are subject to rationing. We decompose lab tests into cholesterol, triglycerides, blood sugar, and creatinine lab tests, which together comprise more than two-thirds of all lab tests, and decompose office visits into first-time and follow-up visits. Note that all of these categories of care were covered by the formulary before the expansion. The DiD coefficients displayed in table 9 show significant reductions in all types of laboratory tests. The number of cholesterol tests by type I diabetics decreases 0.21 (15%) after the policy relative to matched counterparts in the pre-policy period. Triglyceride tests decrease 0.15 (21%) as a result of the policy, and creatinine lab tests fall by 0.21 claims. The largest effect is observed for blood sugar lab tests, which decrease 0.69 (95%) for type I diabetics as a result of the expansion. The reduction in office visits from table 8 comes mainly from a significant decrease in the number of first-time visits as seen in column 5, which outweighs the increase in follow-up visits seen in column 6. The direction of these effects are as expected given that first-time visits are defined as consultations associated with a new diagnosis while follow-up visits are defined as consultations due to existing health conditions.

Table 9: Effect of the formulary expansion on utilization of lab tests and office visits

	(1) Cholesterol labs	(2) Tryglicerides labs	(3) Blood sugar labs	(4) Creatinine labs	(5) First time office visits	(6) Follow up office visits
Diabetic × policy	-0.207***	-0.152***	-0.693***	-0.209***	-0.807***	0.362***
	(0.0395)	(0.0282)	(0.0444)	(0.0272)	(0.0548)	(0.0534)
Diabetic	0.885***	0.558***	1.767***	0.655***	1.673***	0.605***
	(0.0317)	(0.0225)	(0.0377)	(0.0220)	(0.0464)	(0.0370)
Policy	-0.0980***	-0.0442***	-0.0588***	-0.0646***	-0.447***	0.0403*
	(0.00938)	(0.0108)	(0.00576)	(0.00931)	(0.0135)	(0.0174)
Constant	-0.506***	-0.293***	-0.238*	-0.300***	0.392***	-0.523***
	(0.0600)	(0.0461)	(0.115)	(0.0468)	(0.105)	(0.136)
Observations	150346	150346	150346	150346	150346	150346
R^2	0.2388	0.1223	0.2652	0.1910	0.2946	0.1476

Note: OLS estimation of equation 1 with utilization of laboratory tests and office visits as dependent variables, on the sample of type-I diabetics and their exactly matched controls. All models control for sex, age, comorbidities, type of municipality, and insurance carrier. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Finally, we confirm that our findings from tables 8 and 9 that insurers are rationing discretionary diagnostic services holds for the subsample of diabetics who exhibit no change in insulin consumption used in estimating equation 2. The results for these specifications displayed in tables 10 and 11 show declines in utilization across all specific types of office visits and lab tests.

Table 10: Effect of the formulary expansion on outpatient care utilization by diabetics without spillovers

	(1) Procedures	(2) Labs	(3) Imaging	(4) Office vists/ consultations
Policy	0.00812	-2.887***	-0.116**	-1.293***
	(0.0307)	(0.318)	(0.0377)	(0.130)
Constant	-0.0852	4.828	-0.128	4.198*
	(0.0699)	(4.696)	(0.134)	(1.699)
Observations	3858	3858	3858	3858
R^2	0.0396	0.1403	0.0537	0.1903

Note: OLS estimation of equation 2 with utilization of outpatient care as dependent variable, on the sample of type-I diabetics who have zero consumption of newly added insulins and similar consumption of regular and NPH insulins before and after the formulary expansion. Treated units in 2011 are coarsened exactly matched to treated units in 2013 based on the number of regular and NPH insulin claims. All models control for sex, age, comorbidities, type of municipality, and insurance carrier. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 11: Effect of the formulary expansion on utilization of lab tests and office visits by diabetics without spillovers

	(1) Cholesterol labs	(2) Tryglicerides labs	(3) Blood sugar labs	(4) Creatinine labs	(5) First time office visits	(6) Follow up office visits
Policy	-0.370***	-0.313***	-0.940***	-0.298***	-1.016***	-0.308***
	(0.0623)	(0.0464)	(0.0732)	(0.0442)	(0.0921)	(0.0875)
Constant	1.175	0.794	-0.111	-0.108	0.997	2.275*
	(0.819)	(0.839)	(0.724)	(0.349)	(0.583)	(0.909)
Observations	3858	3858	3858	3858	3858	3858
R^2	0.0991	0.0972	0.1821	0.1492	0.3211	0.3143

Note: OLS estimation of equation 2 with utilization of laboratory tests and ofdice visits as dependent variables, on the sample of type-I diabetics who have zero consumption of newly added insulins and similar consumption of regular and NPH insulins before and after the formulary expansion. Treated units in 2011 are coarsened exactly matched to treated units in 2013 based on the number of regular and NPH insulin claims. All models control for sex, age, comorbidities, type of municipality, and insurance carrier. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The rationing of routine lab tests like those included in table 9 is consistent with weakened adherence to guidelines for diabetes management, which recommend lab testing at regular intervals. For example, the U.S. Department of Health and Human Services and the Centers for Disease Control both recommend annual cholesterol testing for diabetics, blood glucose testing every 3 months, and annual screening for kidney disease (CDC, 2019; National Institute of Diabetes and Digestive and Kidney Diseases, 2016). That these types of lab tests are a routine part of diabetes management is reflected in the fact that type I diabetics in 2011 received 2.5 times more lab tests than their exactly matched counterparts, a greater differential than any other type of outpatient care. Rationing of these lab tests reduces costs in the short run. In the long run, it may disincentivize the enrollment of diabetics and delay the diagnosis and treatment of comorbidities.

7 Conclusion

In this paper, we find that the expansion of Colombia's national formulary raises the cost to insurers of covering diabetics as covered insulin consumption increases, particularly of newly covered, more expensive insulins. Insurers respond to the decreased profitability of diabetics by rationing discretionary outpatient care, including lab tests and visits to specialists. This targeted rationing more than offsets the increase in insulin costs, so that total costs for diabetics decline by nearly 40% as a result of the formulary expansion.

The ability to ration care to an identifiable subset of enrollees allows the insurers in this market to respond to changing selection incentives despite having no control over premiums, coinsurance rates, or co-pays. While our granular claims data allows us to identify the narrow types of discretionary care that insurers ration, our short time frame does not allow us to observe any effects of the policy that may take longer to manifest, such as changes in enrollment patterns and health status. The results presented here suggest that insurers respond to changes in selection incentives with the tools available to them, no matter how unrefined they may be, and that careful consideration must be given to policy changes altering the profitability of identifiable groups of enrollees.

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Appendix A Theoretical framework

Let a denote a measure of availability of prescription drugs, d the probability of rationing, TC^D drug-related costs, TC^M non-drug costs, R per patient reimbursement, and Q total demand. An insurer's profits are given by:

$$\pi(a,d) = (R - TC^D(a,d) - TC^M(a,d))Q(a,d) \tag{3}$$

Assume $\frac{\partial Q}{\partial a} > 0$, $\frac{\partial Q}{\partial d} < 0$, $\frac{\partial TC^D}{\partial a} > 0$, $\frac{\partial TC^D}{\partial d} < 0$, $\frac{\partial TC^M}{\partial d} < 0$, so that demand for an insurance carrier is increasing in the availability of drugs and decreasing in the probability of rationing. Both types of costs are also decreasing in the probability of rationing. If there are spillovers from drug to non-drug spending then $\frac{\partial TC^M}{\partial a} < 0$, otherwise the partial derivative is non-negative. For simplicity assume $\frac{\partial^2 TC^D}{\partial a \partial d} = \frac{\partial^2 TC^M}{\partial a \partial d} = 0$. The availability of drugs is exogenous and determined by the government, while the probability of rationing is a choice variable to the insurer. The insurer's problem is to maximize profits choosing d, the FOC given by:

$$\partial\pi/\partial d = (R - TC^D(a,d) - TC^M(a,d))\partial Q/\partial d - (\partial TC^D/\partial d + \partial TC^M/\partial d)Q = 0 \tag{4}$$

We check whether the profit function is supermodular in (a,d) by taking the derivative of the FOC with respect to a as seen in the equation below:

$$\begin{aligned}\partial^2\pi/\partial a\partial d = (R - TC^D(a,d) - TC^M(a,d))\partial^2 Q/\partial a\partial d - (\partial TC^D/\partial a + \partial TC^M/\partial a)\partial Q/\partial d \\ - (\partial TC^D/\partial d + \partial TC^M/\partial d)\partial Q/\partial a\end{aligned} \tag{5}$$

If there are no spillovers from drug to non-drug spending, $\partial TC^M/\partial a \geq 0$ and π is supermodular in (a,d). In this case, exogenous increases in the availability of drugs, as the one generated by the formulary expansion, increases the probability of rationing. In the polar case where spillovers are present and large in magnitude, π is submodular in (a,d). Intuitively, if spillovers are large then insurers need not engage in rationing to achieve cost savings following an increase in the availability of drugs. For moderate levels of spillovers from drug to non-drug spending, there is scope for a positive relation between a and d.

Appendix B Robustness tests for matching on average income

In this appendix, we provide results of our main regressions using exact matching of treated and controls based on sex, age, insurer, municipality category, comorbidites, and average monthly income at the sex-age-municipality-year level. For the matching procedure, we categorize the average monthly income relative to the monthly minimum wage (MMW) into the following groups: $<= 1.5 \times MMW$, $(1.5, 2] \times MMW$, $> 2 \times MMW$. The monthly minimum wage during 2011 equals 535,600 COP and during 2013 equals 589,500 COP. The regression specifications for these exercises are the same as in the main text, except we include the income group as an additional control. Table B1 shows the effect of the formulary expansion on the number of claims and table B2 on the logarithm of total costs for different healthcare categories. This set of results are qualitatively the same as in the main text, though their magnitudes slightly smaller in absolute value.

Table B1: Effect of the formulary expansion on healthcare utilization

	(1) All insulin	(2) Regular insulin	(3) NPH insulin	(4) All	(5) Outpatient	(6) Inpatient	(7) Prescriptions
Diabetic × policy	0.551***	-0.114*	-1.357***	-4.312***	-3.001***	-0.626***	-0.684
	(0.128)	(0.0541)	(0.0936)	(0.769)	(0.270)	(0.148)	(0.618)
Diabetic	4.311***	0.895***	3.417***	28.06***	9.547***	0.731***	17.79***
	(0.0913)	(0.0438)	(0.0758)	(0.578)	(0.219)	(0.134)	(0.443)
Policy	-0.0166***	-0.000909	-0.00723*	-0.623**	-0.947***	-0.147*	0.471***
	(0.00352)	(0.00110)	(0.00287)	(0.202)	(0.0898)	(0.0595)	(0.137)
Constant	0.0470	0.0739	-0.0865	-1.453	-0.773	-0.623***	-0.0561
	(0.109)	(0.0930)	(0.0577)	(1.370)	(0.731)	(0.156)	(0.912)
Observations	124018	124018	124018	124018	124018	124018	124018
R^2	0.3689	0.1075	0.2902	0.3173	0.2327	0.0152	0.2893

Note: OLS estimation of equation 1 with utilization outcomes as dependent variable, on the sample of type-I diabetics and their exactly matched controls. All models control for sex, age, comorbidities, type of municipality, insurance carrier, and income. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table B2: Effect of the formulary expansion on the logarithm of healthcare costs

	(1) All insulin	(2) Regular insulin	(3) NPH insulin	(4) All	(5) Outpatient	(6) Inpatient	(7) Prescriptions
Diabetic × policy	0.621***	-0.213*	-2.159***	-0.341***	-1.012***	-0.254***	0.557***
	(0.129)	(0.0955)	(0.120)	(0.0449)	(0.0748)	(0.0674)	(0.121)
Diabetic	6.328***	2.148***	5.659***	1.404***	1.134***	0.364***	3.846***
	(0.0941)	(0.0746)	(0.0936)	(0.0236)	(0.0427)	(0.0536)	(0.0900)
Policy	-0.0243***	0.0000861	-0.0238***	-0.000232	0.0606	0.0428	-0.916***
	(0.00516)	(0.00336)	(0.00433)	(0.0234)	(0.0319)	(0.0266)	(0.0586)
Constant	0.115	0.0805	-0.0378	9.564***	8.684***	-0.272**	2.404***
	(0.140)	(0.116)	(0.0900)	(0.217)	(0.330)	(0.0994)	(0.705)
Observations	124018	124018	124018	124018	124018	124018	124018
R^2	0.5251	0.1703	0.3911	0.1470	0.0622	0.0158	0.2843

Note: OLS estimation of equation 1 with the logarithm of cost per healthcare type as dependent variable, on the sample of type-I diabetics and their exactly matched controls. All models control for sex, age, comorbidities, type of municipality, insurance carrier, and income. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table B3 provides the results of estimating equation 2 on the new sample generated from matching on income. Most of the results are also qualitatively equal to our main specification. Note that the coefficient on the policy indicator in column 7, the specification for prescription drug utilization, is significant unlike results in the main text. One might initially worry that this result suggests that increased consumption of a drug other than insulin generates spillovers that explain cost savings. However, because the increase in prescription drug utilization in the subsample without spillovers - which we find to be driven by increased consumption of continuously covered antithrombotic agents - is not observed in the sample as a whole (see column 7 of B1), it cannot be the driver of the reductions in outpatient care utilization of similar magnitudes that we observe in the sample as a whole as well as in the subsamples with and without the potential for spillovers.

Table B3: Effect of the formulary expansion on healthcare utilization of diabetics without spillovers

	(1) All insulin	(2) Regular insulin	(3) NPH insulin	(4) All	(5) Outpatient	(6) Inpatient	(7) Prescriptions
Policy	0.139	-0.0279	0.167	-2.345	-4.812***	-1.067***	3.534**
	(0.214)	(0.124)	(0.162)	(1.378)	(0.423)	(0.320)	(1.107)
Constant	9.686**	7.498	2.188	34.77***	14.83	1.111	18.82***
	(3.697)	(4.702)	(1.252)	(10.51)	(8.428)	(1.273)	(4.070)
Observations	3287	3287	3287	3287	3287	3287	3287
R^2	0.1053	0.0665	0.1584	0.2435	0.2003	0.0402	0.2562

Note: OLS estimation of equation 2 with utilization outcomes as dependent variable, on the sample of type-I diabetics who have zero consumption of newly added insulins and similar consumption of regular and NPH insulins before and after the formulary expansion. Treated units in 2011 are coarsened exactly matched to treated units in 2013 based on the number of regular and NPH insulin claims. All models control for sex, age, comorbidities, type of municipality, insurance carrier, and income. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table B4: Effect of the formulary expansion on the logarithm of healthcare costs of diabetics without spillovers

	(1) All insulin	(2) Regular insulin	(3) NPH insulin	(4) All	(5) Outpatient	(6) Inpatient	(7) Prescriptions
Policy	0.202***	0.0784	-0.274	-0.495***	-0.718***	-0.340**	-0.767***
	(0.0436)	(0.205)	(0.147)	(0.0354)	(0.0949)	(0.112)	(0.0405)
Constant	12.00***	8.151***	11.07***	12.59***	10.89***	1.962	11.99***
	(0.280)	(2.217)	(0.567)	(0.301)	(0.845)	(1.481)	(0.174)
Observations	3287	3287	3287	3287	3287	3287	3287
R^2	0.1175	0.0845	0.2037	0.2495	0.1197	0.0500	0.3037

Note: OLS estimation of equation 2 with the logarithm of healthcare cost as dependent variable, on the sample of type-I diabetics who have zero consumption of newly added insulins and similar consumption of regular and NPH insulins before and after the formulary expansion. Treated units in 2011 are coarsened exactly matched to treated units in 2013 based on the number of regular and NPH insulin claims. All models control for sex, age, comorbidities, type of municipality, insurance carrier, and income. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Finally, tables B5 to B8 present our analysis of rationing of outpatient care and laboratory tests. After controlling for income, the magnitude of the coefficients decrease slightly relative to our main results, but they are all of the expected sign and significance and consistent with targeted rationing of discretionary care.

Table B5: Effect of the formulary expansion outpatient care utilization

	(1) Procedures	(2) Labs	(3) Imaging	(4) Office vists/ consultations
Diabetic × policy	0.115***	-1.992***	-0.0188	-0.487***
	(0.0245)	(0.210)	(0.0250)	(0.0850)
Diabetic	-0.135***	6.703***	0.0130	2.408***
	(0.0190)	(0.171)	(0.0210)	(0.0651)
Policy	-0.0851***	-0.363***	-0.0379**	-0.344***
	(0.0173)	(0.0671)	(0.0115)	(0.0298)
Constant	0.0993	-2.819***	0.318***	0.896*
	(0.0837)	(0.481)	(0.0738)	(0.383)
Observations	124018	124018	124018	124018
R^2	0.0630	0.1987	0.0279	0.2439

Note: OLS estimation of equation 1 with utilization of different types of outpatient care as dependent variable, on the sample of type-I diabetics and their exactly matched controls. All models control for sex, age, comorbidities, type of municipality, insurance carrier, and income. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table B6: Effect of the formulary expansion on utilization of laboratory test and office visits

	(1) Cholesterol labs	(2) Tryglicerides labs	(3) Blood sugar labs	(4) Creatinine labs	(5) First time office visits	(6) Follow up office visits
Diabetic × policy	-0.191***	-0.132***	-0.716***	-0.188***	-0.792***	0.372***
	(0.0425)	(0.0306)	(0.0471)	(0.0292)	(0.0592)	(0.0591)
Diabetic	0.879***	0.556***	1.790***	0.655***	1.696***	0.591***
	(0.0336)	(0.0249)	(0.0394)	(0.0238)	(0.0494)	(0.0409)
Policy	-0.111***	-0.0645***	-0.0713***	-0.0839***	-0.457***	0.0121
	(0.0108)	(0.0124)	(0.00638)	(0.0104)	(0.0146)	(0.0227)
Constant	-0.646***	-0.344***	-0.313*	-0.430***	0.555**	-0.482
	(0.0783)	(0.0622)	(0.123)	(0.0514)	(0.172)	(0.254)
Observations	124018	124018	124018	124018	124018	124018
R^2	0.2372	0.1286	0.2743	0.2035	0.3015	0.1444

Note: OLS estimation of equation 1 with utilization of laboratory tests and office visits as dependent variables, on the sample of type-I diabetics and their exactly matched controls. All models control for sex, age, comorbidities, type of municipality, insurance carrier, and income. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table B7: Evidence of rationing on outpatient care utilization of diabetics without spillovers

	(1) Procedures	(2) Labs	(3) Imaging	(4) Office vists/ consultations
Policy	0.0152	-2.912***	-0.103*	-1.316***
	(0.0302)	(0.356)	(0.0434)	(0.144)
Constant	-0.0695	5.399	0.0693	5.022*
	(0.126)	(5.682)	(0.206)	(2.190)
Observations	3287	3287	3287	3287
R^2	0.0401	0.1502	0.0521	0.1940

Note: OLS estimation of equation 2 with utilization of outpatient care as dependent variable, on the sample of type-I diabetics who have zero consumption of newly added insulins and similar consumption of regular and NPH insulins before and after the formulary expansion. Treated units in 2011 are coarsened exactly matched to treated units in 2013 based on the number of regular and NPH insulin claims. All models control for sex, age, comorbidities, type of municipality, insurance carrier, and income. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table B8: Effect of the formulary expansion on utilization of laboratory test and office visits of diabetics without spillovers

	(1) Cholesterol labs	(2) Tryglicerides labs	(3) Blood sugar labs	(4) Creatinine labs	(5) First time office visits	(6) Follow up office visits
Policy	-0.370***	-0.313***	-0.977***	-0.296***	-1.041***	-0.291**
	(0.0684)	(0.0511)	(0.0811)	(0.0489)	(0.102)	(0.0977)
Constant	1.053	0.930	-0.338	-0.333	0.848	2.560*
	(0.959)	(1.121)	(0.868)	(0.301)	(0.681)	(1.155)
Observations	3287	3287	3287	3287	3287	3287
R^2	0.1181	0.1077	0.1926	0.1588	0.3064	0.3204

Note: OLS estimation of equation 2 with utilization of laboratory tests and ofdice visits as dependent variables, on the sample of type-I diabetics who have zero consumption of newly added insulins and similar consumption of regular and NPH insulins before and after the formulary expansion. Treated units in 2011 are coarsened exactly matched to treated units in 2013 based on the number of regular and NPH insulin claims. All models control for sex, age, comorbidities, type of municipality, insurance carrier, and income. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix C Additional test for spillovers

In this appendix, we present an additional regression to test for the presence of spillovers from drug to non-drug spending. We regress the logarithm of total outpatient and inpatient spending on the logarithm of total drug spending by patient, controlling for demographics, comorbidities, and insurance carrier. Table C1 shows the results. Higher drug expenditures are associated to relatively higher outpatient and inpatient spending, although the magnitudes of the coefficients are not economically relevant. This rules out spillovers as a possible explanation for the observed reduction in utilization and costs for type I diabetics.

Table C1: Regressions of drug spending on non-drug spending

	Log outpatient spending			Log inpatient spending		
	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample	Spillovers subsample	No spillovers subsample	Full sample	Spillovers subsample	No spillovers subsample
Log drug spending× policy	0.0554***	0.0909***	0.184	0.00677	0.0128	0.0561
	(0.0126)	(0.0159)	(0.0983)	(0.00978)	(0.0123)	(0.101)
Log drug spending	0.0101	-0.0475***	0.325***	0.0545***	0.0441***	0.262***
	(0.00675)	(0.0106)	(0.0523)	(0.00802)	(0.0111)	(0.0565)
Policy	-1.412***	-1.574***	-2.586*	-0.204*	-0.191*	-0.727
	(0.135)	(0.141)	(1.195)	(0.0852)	(0.0853)	(1.159)
Constant	7.149***	6.394***	5.260**	-0.247	-0.499*	-1.996
	(1.062)	(1.359)	(1.794)	(0.451)	(0.229)	(1.387)
Observations	9231	5262	3969	9231	5262	3969
R^2	0.1559	0.1822	0.1408	0.0341	0.0340	0.0596

Note: This table presents the results of an OLS regression of the logarithm of non-drug spending on the logarithm of drug costs, controlling for sex, age, type of municipality, comorbidities, and insurance carrier. Standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$