The Impact of a National Formulary Expansion on Diabetics

Cici McNamara[a] Natalia Serna[b]

Abstract

This paper estimates the causal impact of Colombia's national prescription drug formulary expansion on the healthcare utilization and costs of type I diabetics, and identifies the channels through which outpatient cost reductions are realized. We find that insulin consumption rises for almost all insulin types, while outpatient care utilization falls by 3.2 claims. We devise tests to explore the relative importance of two channels by which the expansion may have lowered non-drug costs: spillovers from drug to non-drug spending and rationing of care. We find no evidence that the formulary expansion reduces the rate of complications from diabetes, and find substantial declines in non-drug costs even among the subset of diabetics with no scope for spillovers. We find large reductions in the utilization of discretionary care including diagnostic tests, but no such declines for the use of essential drugs, suggesting that 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.

[a]University of Wisconsin-Madison, 1180 Observatory Drive, Office 8410, cmcnamara6@wisc.edu

[b]Corresponding author. University of Wisconsin-Madison, 1180 Observatory Drive, Office 7316, nserna@wisc.edu. We are deeply grateful to the Colombian Ministry of Health for providing the data. We want to thank Alan Sorensen, all participants to the UW-Madison Student Research Group, the attendants to the Midwest Economics Association Conference, and the attendants of the American Society of Health Economists Conference for their useful comments. Findings in this paper do not represent the views of any of the related institutions. All possible errors and omissions are our own.

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 such changes are endogenous choices 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 additions might decrease healthcare costs overall. For instance, Tamblyn et al. (2001) show that the rate of adverse health outcomes and emergency room visits increase among poor and elderly persons following an increase in cost sharing for essential prescription drugs. 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 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. The government also regulates drug prices by setting price ceilings according to the level of competition each drug class. 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 plans. 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 approach to identify the causal effect of the formulary expansion. The treatment group is comprised of individuals with type I 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 2 claims 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. While diabetics' prescription drug spending increases by 56% as a result of the expansion, non-drug spending on outpatient and inpatient care declines by 4% and 27%, respectively. 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.

[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.

The spillovers hypothesis posits that increased drug spending can result in lower non-drug costs as patients are matched to their optimal prescription and their health status is improved. Lavetti and Simon (2018) find that Medicare Advantage 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 unlikely to be the source of cost savings, and provide evidence that these cost reductions stem from the targeted rationing of discretionary healthcare, specifically of laboratory tests.

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 healthcare utilization 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,

[2]If rationing care is a well-known phenomenon, we might worry about rationing generating disenrollment 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 analysis period.

2000; Fabbri and Monfardini, 2009). While this paper provides anecdotal evidence of the mechanisms by 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. All individuals are divided into one of the two regimes - the Contributory Regime (CR) and the Subsidized Regime (SR) - that make up the health insurance system. The CR covers individuals above a monthly income threshold. The 51% of the population eligible to join the CR contribute 12% of their monthly income to the system. The remaining 49% of the population below the income threshold are 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. At the beginning of that year the plans' benefits were equalized. 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 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. 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 be chosen by the insurer allows us to isolate the impact of the

[3]Established in decree 029 of 2011.

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. Note that the average institutional price of newly added insulins is anywhere from 5 to 12 times the price of NPH or regular insulin in 2013. This means that even modest amounts of substitution towards the newly added insulins can generate large increases in costs.

Table 1: Types of insulin

Insulin type (brand name)	Onset	Peak	Duration	Avg. price 2011	Avg. price 2013
Bolus (preprandial or mealtime) insulins					
Rapid-acting insulin analogues					
• Insulin aspart (NovoRapid®)	9-20 min	1-1.5 hr	3-5 hr		
• Faster-acting insulin aspart (Fiasp®)	4 min	0.5-1.5 hr	3-5 hr	—	79.2
• Insulin glulisine (Apidra®)	10-15 min	1-1.5 hr	3.5-5 hr	—	86.2
• Insulin lispro (Humalog®)	10-15 min	1-2 hr	3-4.75 hr	—	81.6
Short-acting insulins					
• Insulin regular (Humulin®-R, Novolin®ge)	30 min	2-3 hr	6.5 hr	33.4	15.6
• 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	14.5	15.5
Long-lasting insulin					
• Insulin detemir (Lemevir®)			16-24 hr	—	146.3
• Insulin glargine U-100 (Lantus®)	90 min	N/A	24 hr	—	182.1
• Insulin glargine U-300 (Toujeo®)			> 30 hr		

Note: Adapted from Canadian Journal of Diabetes, 2018-04-01, Volume 42, Pages S314-S314. Continuously covered insulins are regular and NPH. The rest of insulins in the table were added to the formulary by the end of 2011. Prices are in thousands of Colombian pesos.

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 the subsample of enrollees who made at

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

least one health claim. For every enrollee, we observe basic demographic characteristics including sex, 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 must remain enrolled with their choice of insurer for at least a year, we do not observe patients switching insurers 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 do not observe each enrollee's monthly income, but rather an aggregate income measure that is collinear with combinations of sex, age group, and municipality, so we cannot separately identify the impact of differences in cost sharing across income groups on healthcare utilization. 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 similar to the treatment group of type I diabetics in terms of comorbidities (with the exception of diabetes), sex, age, insurer, and municipality. This choice of control group 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. Using exact matching to create the comparison group has three advantages. First, the comparison group will resemble the treatment group,

and will therefore be expected to respond to shocks in a similar way. This is important, since both the treatment and control groups were subject to universal elements of the healthcare reform in the post-policy period, including the plan 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.

We perform one-to-many matching of diabetics to 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. 43% of our sample is male, and the average individual is 63 years old. The most common comorbidities are cardiovascular disease which is present in 73% of patients and renal disease which is present in 15% of patients. More than 12% of individuals are enrolled to each of insurers H and I. 73% of diabetics live in urban or metropolitan municipalities. The matched sample consists of 97,210 type I diabetics and 2,333,213 exactly matched controls.

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. 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 7.3 insulin claims in the pre-policy and 9.3 in the post-policy period, non-diabetics have virtually no insulin claims before or after the formulary expansion. 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.

Table 2: Balance table of treated and control units

	Control	Treated
Demographics		
Male (%)	43.08	43.18
Age, mean (sd)	62.99 (12.81)	63.02 (12.81)
Diagnoses (%)		
Arthrosis	2.28	2.32
Cardiovascular disease	73.61	73.43
Long term pulmonary disease	4.52	4.66
Renal disease	14.83	15.24
Insurer (%)		
A	1.78	1.79
B	7.75	7.74
C	1.81	1.81
D	4.18	4.18
E	5.66	5.61
F	9.78	9.75
G	1.73	1.74
H	12.60	12.62
I	12.69	12.73
J	7.08	7.05
K	0.04	0.04
L	0.00	0.00
M	0.31	0.31
Type of municipality (%)		
Metropolitan	73.47	73.05
Normal	26.35	26.75
Special	0.19	0.20
N	2,333,213	97,210

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.

Table 3: Utilization and cost outcomes for type I diabetics and exact match counterparts

	Control		Treated	
	2011	2013	2011	2013
Claims				
All claims	48.5	50.8	100.6	101.3
	(46.9)	(50.1)	(71.3)	(75.6)
Outpatient claims	23.1	22.7	41.9	38.2
	(27.9)	(27.0)	(42.1)	(39.2)
Inpatient claims	2.0	1.3	5.8	4.1
	(9.9)	(7.6)	(19.4)	(14.3)
Prescription claims	23.4	26.8	52.9	59.0
	(24.7)	(29.9)	(35.7)	(44.6)
Insulin claims	0.0	0.0	7.3	9.3
	(0.4)	(0.4)	(4.9)	(5.9)
Lab claims	10.0	10.0	23.5	21.7
	(16.1)	(15.6)	(28.7)	(26.5)
Imaging claims	1.4	1.5	1.9	1.9
	(2.4)	(2.5)	(3.2)	(3.2)
Office consultation claims	9.3	9.0	13.9	13.4
	(8.8)	(8.7)	(11.2)	(10.6)
Costs (Million COP)				
All costs	1.80	1.68	3.44	3.84
	(6.44)	(6.12)	(8.50)	(8.22)
Outpatient costs	1.06	0.90	1.73	1.58
	(3.65)	(2.84)	(4.43)	(3.73)
Inpatient costs	0.53	0.46	1.13	1.06
	(3.84)	(3.44)	(5.02)	(4.76)
Prescription costs	0.21	0.31	0.57	1.21
	(1.80)	(2.68)	(1.96)	(2.72)
Insulin costs	0.00	0.00	0.14	0.64
	(0.01)	(0.03)	(0.30)	(0.99)
Lab costs	0.12	0.13	0.30	0.30
	(0.29)	(0.31)	(0.48)	(0.52)
Imaging costs	0.12	0.12	0.18	0.19
	(0.34)	(0.36)	(0.43)	(0.55)
Officecosts	0.26	0.28	0.44	0.57
	(0.86)	(1.09)	(1.28)	(1.59)
Observations	1,065,674	1,267,539	41,911	55,299

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 for control units are weighted by the inverse number of controls matched to each diabetic.

4 Methodology

Here 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 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 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). We provide evidence of parallel trends in appendix C.

5 Results

In table 4, we present the results of equation 1 using as dependent variable the number of claims filed by individual i in year t for various types of drug and non-drug healthcare utilization. References to baseline levels of utilization and costs refer to those of control units in the pre-policy period. 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, 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 2 more insulin claims relative to baseline as a result of the expansion. Columns 2 and 3 show that diabetics filed an average of 1 more claim for regular insulin and an average of 3 fewer claims for insulin NPH after the policy. The formulary's positive impact on insulin consumption and the substitution it generated away from insulin NPH toward the newly covered insulins suggests that it was potentially welfare enhancing for diabetics who were newly able to consume a more optimal insulin regimen. These results are also consistent with the story of spillovers from drug to non-drug spending, which we explore further in section 6.

In column 4, we see that the formulary expansion decreased the total number of claims in a year by 1.5. This effect can be decomposed into an increase in the utilization of prescription drugs and a decline in non-drug healthcare utilization. Utilization of outpatient and inpatient care declined by 3.2 claims (14%) and 1.1 claims (55%), respectively, while annual prescription drug claims increased by 2.8 (12%).

Table 4: Effect of the formulary expansion on number of healthcare claims

	(1) All insulin	(2) Regular insulin	(3) NPH insulin	(4) All	(5) Outpatient	(6) Inpatient	(7) Prescriptions
Diabetic × policy	2.007***	1.101***	-2.894***	-1.499***	-3.257***	-1.076***	2.834***
	(0.0347)	(0.0232)	(0.0235)	(0.453)	(0.268)	(0.111)	(0.240)
Diabetic	7.313***	1.978***	5.335***	51.85***	18.64***	3.824***	29.38***
	(0.0239)	(0.0152)	(0.0168)	(0.334)	(0.209)	(0.0940)	(0.162)
Policy	-0.0162***	0.00198**	-0.0193***	1.697***	-0.757***	-0.639***	3.094***
	(0.00141)	(0.000612)	(0.000972)	(0.134)	(0.0886)	(0.0261)	(0.0642)
Constant	0.0251***	-0.00308	-0.0227***	18.94***	10.31***	-0.525***	9.161***
	(0.00743)	(0.00428)	(0.00443)	(0.401)	(0.232)	(0.0612)	(0.239)
Observations	2430423	2430423	2430423	2430423	2430423	2430423	2430423
R^2	0.6694	0.3188	0.4933	0.2122	0.0942	0.0688	0.2673

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

Note that the effect of the policy on non-drug healthcare is not limited to type I diabetics; control units also experience a reduction in outpatient care utilization of 0.8 claims and in inpatient care of 0.6 claims. These declines are consistent with both spillovers and rationing of care. Drugs other than insulin that were

included in the formulary expansion had the potential to generate spillovers and reduce non-drug spending among the full population with chronic conditions. It is also the case that if rationing of care were targeted toward types of non-drug healthcare that are primarily but not exclusively used by diabetics, then this could generate an overall reduction in non-drug healthcare utilization.

Table 5 presents the results of equation 1 using as outcomes the logarithm of total cost (plus 1) for the same healthcare categories considered in table 4. Column 1 shows that the total cost of insulin consumption among type I diabetics increased 105% after the formulary expansion. The increase in insulin cots contributes to an increase of 56% in total prescription drug costs as seen in column 7. This increase in drug costs for diabetics is accompanied by a decline in non-drug spending. Columns 5 and 6 show that total outpatient and inpatient costs fall by 4% and 27% respectively among type I diabetics after the policy relative to control units. Together these estimates imply that total healthcare costs in column 4 increase far less than do prescription drug costs. Because the government's risk adjustment formula controls for only sex, age category, and type of municipality, all of which are covariates in our regressions, the estimated effect on total healthcare costs directly translates into changes in insurers' profits from coverage of type I diabetics.

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	1.054***	0.937***	-5.966***	0.277***	-0.0410***	-0.269***	0.555***
	(0.00917)	(0.0348)	(0.0264)	(0.00853)	(0.0100)	(0.0397)	(0.0135)
Diabetic	11.11***	4.927***	10.20***	0.997***	0.716***	1.943***	3.101***
	(0.00575)	(0.0263)	(0.0136)	(0.00647)	(0.00659)	(0.0303)	(0.00991)
Policy	-0.0307***	-0.00801***	-0.0457***	-0.0513***	-0.142***	-0.422***	0.185***
	(0.00251)	(0.00177)	(0.00204)	(0.00364)	(0.00392)	(0.0122)	(0.00860)
Constant	0.0725***	0.0702***	0.0234**	12.45***	11.61***	0.648***	7.625***
	(0.00820)	(0.00801)	(0.00877)	(0.0168)	(0.0283)	(0.0452)	(0.0443)
Observations	2430423	2430423	2430423	2430423	2430423	2430423	2430423
R^2	0.8900	0.4473	0.6624	0.1226	0.0667	0.0788	0.1708

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, municipality, and insurance carrier. Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Our results so far are consistent with spillovers from drug to non-drug healthcare spending, whereby diabetics' 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 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 change in insulin costs from 2011 to 2013 alone represents 0.8% of total costs to insurers in 2011.

6 Mechanisms

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. Our tests will examine how proxies for the health status of diabetics and utilization of both discretionary and non-discretionary types of healthcare change with the increased availability of insulin. A theoretical framework of how drug availability impacts the relative effects of spillovers and rationing in the insurers' profit function can be found in appendix B.

6.1 Testing for spillovers

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. Our first test uses the subsample of diabetics to estimate

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

where P_t is a post-policy indicator and $\mathbf{x}_i$ is a vector of demographic characteristics and diagnoses. We use as outcome variables indicators for being diagnosed with a complication associated with type I diabetes. We use only the subsample of treated units in these specifications as these diagnoses only apply to type

I diabetics by definition. In particular, we estimate the effect of the formulary expansion on the rates of kidney complications; neurological complications; circulatory complications; other specified complications including diabetic arthropathy, skin complications, oral complications, hypoglycemia, and hyperglycemia; and unspecified complications due to diabetes.[6] The results of these specifications are presented in table 6. The rates of all complications from diabetes rise as a result of the formulary expansion. Note that this rise is not a mechanical result of disease progression as we do not employ a balanced panel. Assuming that the rate of complications from diabetes is reflective of the patient's underlying health status, these results in general suggest that health status does not improve with the formulary expansion and constitute evidence against spillovers being the primary mechanism generating the reduction in non-drug care and costs observed in section 5.

Table 6: Effect of the formulary expansion on rate of complications from diabetes

	(1) Kidney complications	(2) Neurological complications	(3) Circulatory complications	(4) Other specified complications	(5) Unspecified complications
Policy	0.0155***	0.0123***	0.00642***	0.00701**	0.0185***
	(0.00172)	(0.00115)	(0.00124)	(0.00219)	(0.00237)
Constant	-0.0779***	0.00656	-0.00115	0.0914***	-0.00445
	(0.00691)	(0.00416)	(0.00406)	(0.0104)	(0.00976)
Observations	97210	97210	97210	97210	97210
R^2	0.0539	0.0170	0.0194	0.0257	0.0321

Note: OLS estimation of equation 2 with binary indicator for diagnosis as dependent variable, on the sample of type I diabetics. All models control for sex, age, comorbidities, municipality, and insurance carrier. Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

We perform another test for spillover effects which leverages the fact that diabetics who only ever consume continuously covered insulins have no scope for more optimal matching to a newly covered insulin and thus no scope for a subsequently improved health status. We construct a subsample of our data which includes only diabetics whose choice of insulin does not change as a result of the policy. If this subsample experiences declines in healthcare utilization and costs similar in magnitude to those estimated for the full sample, then we will interpret this as evidence against the spillovers hypothesis. We create a sample of type I diabetics that have zero consumption of newly added insulins and for whom the amount of regular and NPH insulin

[6] ICD10 codes used to create these indicators are E10.2, E10.4, E10.5, E10.6, and E10.8 respectively. Rates of ketoacidosis and ophthalmic complications are not sufficient for estimation.

consumed did not change. We use coarsened exact matching as in Iacus et al. (2011) to match diabetics in 2011 and diabetics in 2013 based on demographics, diagnoses, and their level of regular and NPH insulin claims, and estimate equation 2 using the resulting subsample. We also weight our regressions according to the weighting schedule outlined in Iacus et al. (2011). 24% of all type I diabetics satisfied the sample selection criteria of having no change in insulin consumption and having an exact match counterpart.

The results for our second spillovers test are presented in tables 7 and 8. As a sanity check, we note that there are no statistically or economically significant change in insulin consumption as seen in columns 1 through 3 of table 7. When compared to our results in tables 4 and 5, the estimates for the outpatient and inpatient specifications show that diabetics with no scope for spillovers experience declines in non-drug healthcare utilization and costs greater in magnitude than those experienced by diabetics who consume the newly covered insulins. Given that changing one's insulin prescription requires an appointment with a primary care physician, it is likely that diabetics who do not alter their insulin consumption in response to the formulary expansion have less contact with the healthcare system overall compared to their counterparts who consume the newly covered insulins. While we might expect a lower baseline level of non-drug utilization for this subsample, its limited scope for spillovers indicates that we would also expect a decline in non-drug utilization smaller in magnitude than the one estimated for the full sample. Instead, we find that the reduction in non-drug healthcare utilization for this subsample is larger than that estimated for the full analysis sample. We now turn to exploring a second mechanism - namely, rationing of care - that might explain the change in drug and non-drug consumption patterns that we observe as result of the formulary expansion.

Table 7: Effect of the formulary expansion on number of healthcare claims by diabetics with no change in insulin consumption

	(1) All insulin	(2) Regular insulin	(3) NPH insulin	(4) All	(5) Outpatient	(6) Inpatient	(7) Prescriptions
Policy	0.0453	0.0662	-0.0209	-12.84***	-10.05***	-4.110***	1.323*
	(0.0699)	(0.0423)	(0.0622)	(1.144)	(0.585)	(0.377)	(0.603)
Constant	2.977***	1.567***	1.410***	21.07***	11.60***	-2.871**	12.34***
	(0.271)	(0.160)	(0.225)	(3.733)	(1.896)	(1.109)	(2.179)
Observations	23531	23531	23531	23531	23531	23531	23531
R^2	0.2578	0.4471	0.3165	0.2206	0.1144	0.1538	0.2698

Note: OLS estimation of equation 2 with number of claims 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. All models control for sex, age, comorbidities, municipality, and insurance carrier. Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8: Effect of the formulary expansion on $\log(cost+1)$ by diabetics with no change in insulin consumption

	(1) All insulin	(2) Regular insulin	(3) NPH insulin	(4) All	(5) Outpatient	(6) Inpatient	(7) Prescriptions
Policy	-0.148***	0.270***	-1.047***	-0.362***	-0.351***	-1.520***	-0.196***
	(0.0193)	(0.0782)	(0.0664)	(0.0235)	(0.0292)	(0.122)	(0.0218)
Constant	11.13***	8.956***	5.977***	12.62***	11.40***	1.035*	11.50***
	(0.0901)	(0.363)	(0.410)	(0.0942)	(0.151)	(0.459)	(0.0969)
Observations	23531	23531	23531	23531	23531	23531	23531
R^2	0.1705	0.3084	0.4239	0.1768	0.1141	0.1424	0.1883

Note: OLS estimation of equation 2 with logarithm of cost per healthcare type 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. All models control for sex, age, comorbidities, municipality, and insurance carrier. Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

6.2 Evidence of rationing

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 a specialist or provide 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."

Our test for rationing of care is premised on the assumption that insurers will ration discretionary diagnostic services rather than essential healthcare. We construct three measures of discretionary healthcare services - claims for imaging, lab tests, and office visits - as well as a measure of utilization of essential drugs as defined in Tamblyn et al. (2001). The authors define essential drugs as those that "prevent deterioration in health or prolong life and would not likely be prescribed in the absence of a definitive diagnosis." Examples of essential drugs include insulin, inhaled steroids, and beta blockers. We do not include in our measure of essential drug utilization drug classes that were expanded as part of the policy. The full list of essential drugs as well as those that are included in our measure can be found in table A3 in the appendix. We employ the same differences-in-differences empirical specification as in equation 1 to estimate the impact of the formulary on diagnostic outpatient care and essential drug use.

The results of estimating these specifications are presented in 9. Lab tests see the largest decline in utilization, falling by nearly 2 claims; followed by imaging, which sees a small but significant decline; and office visits that do not change as a result of the formulary expansion. The utilization of essential drugs, which by definition are not discretionary, experiences a small (12% relative to baseline) increase following

the formulary expansion. These findings are consistent with a story of rationing of care in which insurers ration healthcare that is diagnostic and preventive in nature, but do not ration drugs which are necessary to avoid adverse health outcomes.

Table 9: Effect of the formulary expansion on number of discretionary outpatient & essential drug claims

	(1) Imaging	(2) Labs	(3) Office vists/ consultations	(4) Essential drugs
Diabetic × policy	-0.0908***	-1.834***	0.0718	0.312***
	(0.0210)	(0.181)	0.0480)	(0.0480)
Diabetic	0.496***	13.42***	3.233***	2.803***
	(0.0158)	(0.141)	(0.0344)	(0.0344)
Policy	0.0841***	-0.168**	-0.170***	-0.0209
	(0.00708)	(0.0519)	(0.0136)	(0.0136)
Constant	0.382***	2.154***	4.227***	2.166***
	(0.0214)	(0.154)	(0.0607)	(0.0607)
Observations	2430423	2430423	2430423	2430423
R^2	0.0687	0.1005	0.1077	0.1664

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, municipality, and insurance carrier. Robust 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 and in particular from lab tests, we now zoom in and examine which types lab tests 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 testss. The DiD coefficients displayed in table 10 show significant reductions in all types of laboratory tests with the exception of A1C, which experiences an economically insignificant increase of 0.03 as a result of the formulary expansion. The largest effect is observed for blood sugar lab tests, which fall 0.75 claims for type I diabetics relative to baseline. We confirm that our findings from tables 9 and 10 that insurers are rationing discretionary diagnostic services holds for the subsample of diabetics who exhibit no change in insulin consumption used in our second test for spillovers. The results of estimating equation 2 on this subsample of diabetics are presented in tables A1 and A2 in the appendix. The estimates show declines in utilization across all specific types of lab tests.

Table 10: Effect of the formulary expansion on number of claims for lab tests and office visits

	(1) Cholesterol labs	(2) Tryglicerides labs	(3) Blood sugar labs	(4) Creatinine labs	(5) A1C test
Diabetic × policy	-0.163***	-0.0877***	-0.748***	-0.196***	0.0371***
	(0.0189)	(0.0203)	(0.0623)	(0.0171)	(0.00877)
Diabetic	1.183***	1.059***	3.452***	1.173***	1.666***
	(0.0151)	(0.0158)	(0.0457)	(0.0137)	(0.00670)
Policy	-0.0812***	-0.0260***	0.0497***	-0.0407***	0.0277***
	(0.00558)	(0.00676)	(0.0112)	(0.00526)	(0.000893)
Constant	0.465***	0.222***	0.0650**	0.0596**	0.00955*
	(0.0210)	(0.0220)	(0.0209)	(0.0225)	(0.00430)
Observations	2430423	2430423	2430423	2430423	2430423
R^2	0.1245	0.0648	0.0433	0.1273	0.3864

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, municipality, and insurance carrier. Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The rationing of routine lab tests like those included in table 10 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 over twice as many lab tests as their exactly matched counterparts, a greater differential than any other type of outpatient care. In table 11, we present the predicted number of lab tests received annually by diabetics using the estimates from table 10. These predictions show that prior to the expansion, average utilization of cholesterol, creatinine, and blood sugar labs was in keeping with the guidelines for diabetes management. But after the expansion, blood sugar labs fall to below the recommended amount. 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.

Table 11: Pre- and post-formulary expansion predicted number of claims for lab tests by diabetics

	(1) Cholesterol labs	(2) Trygliceride labs	(3) Blood sugar labs	(4) Creatinine labs	(5) A1C test
Pre-policy period	2.90 (2.87, 2.93)	2.26 (2.23, 2.29)	4.44 (4.35, 4.53)	2.34 (2.31, 2.36)	1.72 (1.71, 1.74)
Post-policy period	2.66 (2.63, 2.68)	2.15 (2.12, 2.17)	3.74 (3.66, 3.82)	2.10 (2.08, 2.12)	1.79 (1.78, 1.80)

Note: Predicted values of lab test utilization for diabetics in the pre- and post-policy periods. 95% confidence intervals in parentheses.

7 Conclusion

In this paper, we measure the impact of the expansion of Colombia's national drug formulary on type I diabetics. We find that the expansion raises the relative cost of providing health insurance to diabetics by increasing the utilization of relatively more expensive types of insulin. Insurers respond to this decreased profitability of type I diabetics mostly by rationing discretionary outpatient care, including lab tests. This targeted rationing in part offsets the 56% increase in prescription drug costs. The ability to ration care to an identifiable subset of enrollees allows insurers in this market to respond to changes in 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.

References

Alfonso, E., Riascos, A., and Romero, M. (2013). The performance of risk adjustment models in Colombia competitive health insurance market. *Documentos CEDE 012062, Universidad de los Andes - CEDE*.

Américo, P. and Rocha, R. (2020). Subsidizing access to prescription drugs and health outcomes: The case of diabetes. *Journal of Health Economics*, 72:1–19.

Andersen, M. (2017). Constraints on Formulary Design under the Affordable Care Act. *Health Economics*, 26(12):160–178.

CDC (2019). Your diabetes care schedule. https://www.cdc.gov/diabetes/managing/care-schedule.html.

CDC (2020). National diabetes report 2020: Estimates of diabetes and its burden in the United States. https://www.cdc.gov/diabetes/pdfs/data/statistics/national-diabetes-statistics-report.pdf.

Cullis, J. and Propper, P. (2000). *Handbook of Health Economics*, chapter Waiting lists and medical treatment, pages 1201–1249. North-Holland, Amsterdam.

Fabbri, D. and Monfardini, C. (2009). Rationing the public provision of healthcare in the presense of private supplements: Evidence from the italian nhs. *Journal of Health Economics*, 28(2):290–304.

FDA (2020). Insulin. https://www.fda.gov/consumers/free-publications-women/insulin.

Giedion, U. and Uribe, M. V. (2009). Colombia's Universal Health Insurance System. *Health Affairs*, 28(3):853–863.

Iacus, S., King, G., and Porro, G. (2011). Causal inference without balance checking: Coarsened exact matching. *Political Analysis*, 20(1):1–24.

Lamprea, E. and Garcia, J. (2016). Closing the gap between formal and material health care coverage in colombia. *Health and Human Rights*, 18(2):49–65.

Lavetti, K. and Simon, K. (2018). Strategic Formulary Design in Medicare Part D Plans. *American Economic Journal: Economic Policy*, 10(3):154–192.

National Institute of Diabetes and Digestive and Kidney Diseases (2016). 4 steps to manage your diabetes for life. https://www.niddk.nih.gov/health-information/diabetes/overview/managing-diabetes/4-steps.

NIH (2020). Preventing diabetes problems. https://www.niddk.nih.gov/health-information/diabetes/overview/preventing-problems.

OECD (2015). *OECD Reviews of Health Systems: Colombia 2016*. OECD Publishing, Paris.

OECD (Accessed September 26 2020). Health resources - pharmaceutical spending. https://data.oecd.org/healthres/pharmaceutical-spending.htm.

Regan, T. (2008). Generic entry, price competition, and market segmentation in the prescription drug market. *International Journal of Industrial Organization*, 26(4):930–948.

Reiffen, D. and Ward, M. (2005). Generic drug industry dynamics. *The Review of Economics and Statistics*, 87(1):37–49.

Riascos, A. and Camelo, S. (2014). Una estimación del costo y cambios en el bienestar de los colombianos con el nuevo plan de beneficios en salud. *Revista de Economía del Rosario*, 17(2):299–314.

Scott Morton, F. (2005). Entry Decisions in the Generic Pharmaceutical Industry. *NBER Working Paper 6190*.

Tamblyn, R., Laprise, R., Hanley, J., Abrahamowicz, M., Scott, S., Mayo, N., Hurley, J., Grad, R., Latimer, E., Perreault, R., McLeod, P., Huang, A., Larochelle, P., and Mallet, L. (2001). Adverse Events Associated with Prescription Drug Cost-Sharing Among Poor and Elderly Persons. *JAMA*, 285(4).

Tenn, S. and Wendling, B. (2014). Entry Threats and Pricing in the Generic Drug Industry. *The Review of Economics and Statistics*, 96(2):214–228.

Appendix A Rationing of discretionary healthcare in no-spillovers subsample

Table A1: Effect of the formulary expansion on number of outpatient care & essential drug claims by diabetics with no spillovers

	(1) Imaging	(2) Labs	(3) Office vists/ consultations	(4) Essential drugs
Policy	-0.677***	-7.220***	-1.070***	-0.0569
	(0.0717)	(0.450)	(0.144)	(0.144)
Constant	-0.665**	5.050**	3.986***	4.428***
	(0.213)	(1.568)	(0.567)	(0.567)
Observations	23531	23531	23531	23531
R^2	0.1221	0.1204	0.1260	0.1846

Note: OLS estimation of equation 1 with utilization of different types 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. All models control for sex, age, comorbidities, municipality, and insurance carrier. Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A2: Effect of the formulary expansion on number of claims for of lab tests and office visits by diabetics without spillovers

	(1) Cholesterol labs	(2) Tryglicerides labs	(3) Blood sugar labs	(4) Creatinine labs	(5) A1C
Policy	-0.705***	-0.732***	-1.539***	-0.662***	-0.300***
	(0.0602)	(0.0573)	(0.0937)	(0.0460)	(0.0290)
Constant	1.395***	0.0883	1.622***	0.177	1.379***
	(0.234)	(0.195)	(0.313)	(0.154)	(0.134)
Observations	23531	23531	23531	23531	23531
R^2	0.1077	0.0971	0.0610	0.1558	0.0993

Note: OLS estimation of equation 1 with utilization of laboratory tests and office 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. All models control for sex, age, comorbidities, municipality, and insurance carrier. Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A3: Essential drugs and inclusion status for analyses presented in table 9

Essential drug	Included in measure?
Insulin	No
Anticoagulants	No
Angiotensin-converting enzyme inhibitors	Yes
Lipid-reducing medication	No
Antihypertensives	Yes
Furosemide	Yes
β-blockers	No
Antiarrhythmics	Yes
Asprin	Yes
Antiviral medication	Yes
Thyroid medication	Yes
Neuroleptics	Yes
Antidepressants	No
Anticonvulsants	No
Antiparkinsonian drugs	No
Prednisone	Yes
β-agonists	Yes
Inhaled steroids	Yes
Chloroquines	Yes
Primaquines	Yes
Cyclosporine	Yes

Note: Essential drugs as defined in Tamblyn et al. (2001). We exclude drugs on the basis of being part of a drug class that was expanded as part of the formulary expansion.

Appendix B 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.

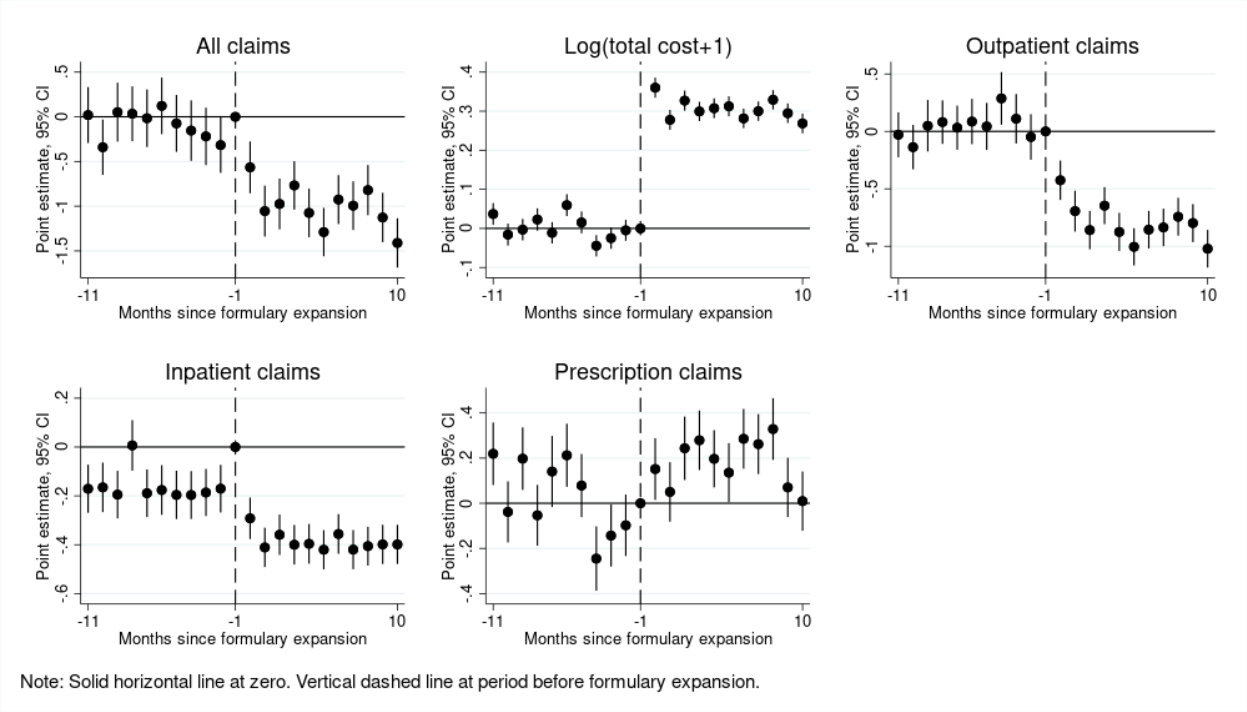
Appendix C Parallel trends

We test the parallel trends assumption of the differences-in-differences methodology presented in section 4 by conducting an event study for our primary outcomes: total claims, total cost, outpatient claims, inpatient claims, and prescription claims. Let τ_{it} be the number of months since enrollee i was treated by the expanded coverage insulins, and let τ_{it} be normalized to -1 for control units. We estimate

$$y_{it} = \alpha + \beta_{\tau_{it}} + \delta D_i + \eta_t + \mathbf{x}_i'\beta + \varepsilon_{it}. \tag{6}$$

Here, 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; η_t are month-year fixed effects; and $\mathbf{x}_i$ is a vector of demographic characteristics including sex, age group, comorbidity dummies, insurer dummies, and type of municipality dummies. We plot the $\hat{\beta}_\tau$s in figure 1 below.

Figure 1: Plot of months-since-expansion fixed effects from event study regressions



Note: Solid horizontal line at zero. Vertical dashed line at period before formulary expansion.