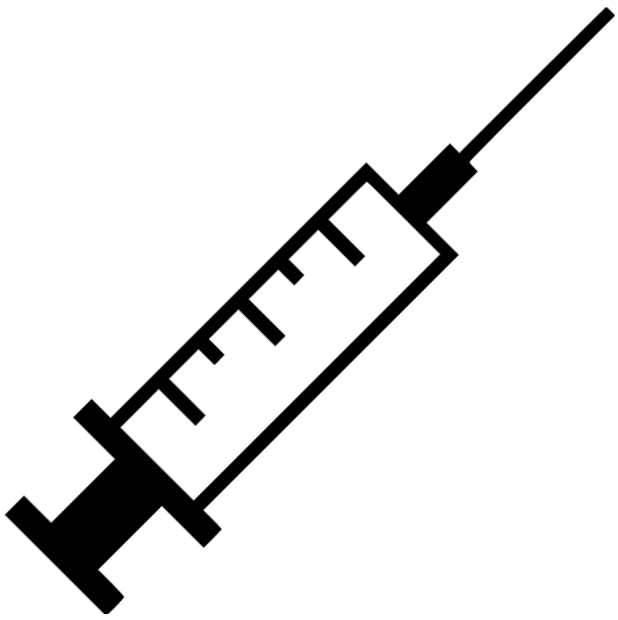
Own and Cross Price Elasticities of Demand of Diabetic Expenditures



ECON 8099
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Spring 2019

Introduction of diabetes and the insulin market today

The estimation of cross elasticities of demand for healthcare products and services typically examines the effect of changes to values such as coinsurance rates, for example Phelps and Newhouse, who investigated the relationship between the price elasticity of demand for medical services and prescriptions. (Gemmil, 2008) Typically, most pharmaceuticals, specifically prescription medications, are relatively price inelastic with numerous studies indicating this value lies in between -0.18 to -0.60. (Cox, 2010) These studies will be discussed in detail later.

This investigation will focus on the price elasticity of demand for healthcare services for diabetes, and how governments, in an effort to control the propensity to consume sugar, are manipulating the price elasticity of demand for sugar containing foods and beverages to promote healthy eating and lifestyle choices. Price elasticity of demand measures the percentage change in quantity demanded resulting from a 1% change in price, all else being equal. (Rittenburg, 2014)

Diabetes[1] is an incurable disease and is typically treated with insulin, a pharmaceutical biologic. A biologic is a bioengineered treatment that is grown in genetically modified tissue to produce human hormones or proteins. (Center for Drug Evaluation and Research, 2018) Insulin is a textbook example of a perfectly inelastic good, but as Rittenberg and Tregarthen note, perfectly inelastic goods are a theoretically extreme case, and no good that has been previously study is able to empirically fit this mold exactly. In many cases, prescription insulin acts as a singular solution to managing a diabetic's

[1] Footnotes refer to expanded scientific definitions at the conclusion of the investigation, after works cited.

insulin levels, meaning that each patient *likely* consumes the same amount of insulin as prescribed, regardless of price. (Rittenburg, 2014)

Insulin is naturally produced by beta cells in the pancreas and is vital for the digestion of sugar. With the onset of diabetes mellitus type 1 (T1D) insulin therapy is obligatory for the rest of the patient's life because the pancreas completely stops producing natural insulin hormone due to an autoimmune response on beta cells in the pancreas. Other types of treatment for different types of diabetes like diabetes mellitus type 2 (T2D), or other types of diabetes such as those caused by infections or gestation, are typically able to be treated with lifestyle changes or with medications such as Metformin[2], because in these types of diabetes, the pancreas continues to produce insulin, unlike in T1D, but the diseases' pathophysiologies are fundamentally different. (Nelson, 2017) It is important to note however, that around 30% of people with T2D use insulin to control their symptoms, and of that 30%, some 13% use a combination of insulin and oral medication. (American Diabetes Association, 2015) Insulin was introduced to the market in 1923 by Eli Lilly (which obtained the patent for insulin from the University of Toronto for $1.00 for humanitarian reasons) under the trade name Iletin ®. (Eli Lilly and Company, 2016)

More than 6 million people in the United States use insulin daily, and diabetes is the direct the cause of death for 69,071 Americans annually. Complications from diabetes contributes to over 200,000 deaths annually. The United States spent $245 billion dollars in 2012 in diabetes treatments, and 1 in 10 U.S. health care dollars spent is for treating diabetes and its complications. The most common form of diabetes is T2D, which is caused by obesity and an increased intake of sugar. T1D is unable to be prevented, however, T2D can be prevented by living a healthy lifestyle with being active and choosing healthy foods. (American Diabetes Association, 2015)

Own and cross price elasticity of healthcare and insulin

Understanding the mechanisms acting behind the specific cross price elasticity of demands for healthcare requires a more complicated description due to the multiple actors in the medicinal and pharmaceutical supply chain payment pathways. This designation is important because it shows that when serious health problems present themselves, people likely to seek out help regardless of the cost. In regard to payment for health services, interactions between providers and patients are deeply integrated with negotiations happening in the background between insurance and medical providers. In the case of pharmaceuticals, the interactions are between the drug manufacturer, pharmacy benefit managers (PBMs), pharmaceutical whole sellers, and individual pharmacies, all before the consumer pays their out of pocket cost for the medication. This relationship is typically referred to as cost-sharing. (Ringel, et al., 2002) (World Health Organization, 1997)

Literature in this topic has shown measurable change in cross price elasticities of demand for healthcare services, such as doctor visits, hospitalization and inpatient procedure rates, and prescription medication usage rates with changes in coinsurance and copayment rates. As noted previously, literature highly devotes its focus into the own and cross price elasticities of demand for healthcare systematically, because these systems are simply too comprehensive to provide accurate results without controlling for specific subsets of the population. The relevance of this topic is due to the fact that people with diabetes are prone to higher medical costs and significantly higher incidence rates of hospitalization. (American Diabetes Association, 2015)

In 1974, Phelps and Newhouse found a direct relationship between own and cross price elasticity of demand for ambulatory services, hospital admissions, length of stay of hospitalization, and physician office visits to coinsurance rates. The authors concluded that

coinsurance rates at the margin are the own-price variables and that these values are endogenous. Dummy variables for demographics of the insurance enrollees and their occupations were also included to control for mutual exclusion. Cross price elasticity was specified as the net price paid for length of stay and visit for a marginal unit, measured in dollars. Their estimations were regressed using OLS and TSLS estimations but note that these methods are not ideal for calculating elasticities due to OLS reporting inconsistent values away from zero, and TSLS estimates have relatively large standard errors. The authors used hospitalization data, physician visits, and ambulatory services as dependent variables to examine the effects of coinsurance, wage, and demographics on the price elasticities of demand for these separate groups. (Gemmil, 2008)

A complexity in this study was estimating an equation to predict the probability of admission to a hospital, and further the reasonable amount of uncertainty that patients face when anticipating the average out-of-pocket cost that their stay will incur. They overcame this by constructing a probability estimator over a function of health stock lost (costs incurred by the provider) and the insurance policy of said patient. They note the complexities in estimate the health stock lost to providers and note that this measure is "imperfect." Their final results showed that as coinsurance obligations fall, the price elasticity of demand for healthcare services overall becomes significantly more inelastic, with elasticities for coinsurance rates between 20 and 25% valuing some -0.12 and falling to -0.04 for coinsurance rates between 10 to 15%, respectively. (Gemmil, 2008)

Another study conducted in Denmark in 2011 commissioned by the University of Aarhus investigated the effect of reimbursement reforms and stockpiling of insulin. In response to a 30% rise in drug expenditures from 1995-2003, the government enacted a series of copayment increases to fund a new drug subsidy scheme. The author, Niels

Skipper, investigated the change in consumer behavior following these reforms for Danish diabetics. After the change in policy, Danish citizens would be responsible for up to 50%, a two-fold increase from the previous amount, of the copayment for their medications. (Skipper, 2012)

Skipper used a fixed effects regression to estimate the changes to the average individual out-of-pocket price per prescription, utilization rates, and number of total prescriptions in response to the legislation reform. His data showed that prior to this legislation, Danes were stockpiling insulin vials before the change took effect in anticipation of higher out-of-pocket costs. Further in the long run (90 days after the legislation took effect, in this case), the reforms caused a large increase in copayments, and caused a decline in both utilization rates and total prescriptions, meaning there was an indication that insulin rates in this case responded somewhat elastic in nature. His research was solely focused on insulin stockpiling and commented how possibly Danes could have stockpiled other drugs (such as Metformin), prior to the end of the old payment scheme. (Skipper, 2012)

He notes that changes to own price elasticity of demand for drugs due to changes in copayments can be difficult to identify if the change to their copayment commitment is announced beforehand, and that this sudden surge in demand can cause results to be biased. Further, it is noted that literature fails to classify demand response rates to changes in price are nonspecific between drugs that are used to treat chronic disease, such as insulin. The results conclude that the higher prices cause a negative spillover effect on consumption of other drugs used to treat diabetes, and that increasing copayments might result in poorer health status for the chronically ill, ceteris paribus. (Skipper, 2012)

Own and cross price elasticities of demand affected by T2D

As insulin prices and diabetes rates continue to rise uncontrollably, governments are scrambling promote healthy lifestyle changes that will effectively lower incidence rates of T2D, which as noted previously, is primarily caused by a combination of genetic factors and obesity rates. The intersection of diabetes and drinks that are high in sugar has been investigated by researchers in Mexico, which struggles with an obesity epidemic and undernutrition. (Colchero, et al., 2015)

A report commissioned by the Nation Institute of Public Health in Mexico during 2013 investigated the effect on the price elasticity of sugar-sweetened beverages (SSBs) and high sugar foods and snacks, such as candy, in the event that policy makers were to enact a tax to systematically curtail sugar consumption. Policy decisions like these are difficult to enact, as they disproportionally affect the poorest income quintile ranges and are often accompanied by public backlash. The benefits of decreasing consumption of processed sugars are numerous, as they can lower obesity rates and promote alternatives, such as water. They organized SSBs, and other SSB alternatives such as milk and water, into several categories to estimate their own price elasticities of demand across quintile ranges. This analysis used an LA/AIDS model, which is a common regression used in health economics which performs well with the complexities of health-related investigations, and typically offers lower standard errors than other methods such as three staged least square. (Colchero, et al., 2015)

The results indicated that own price elasticity of demand soft drinks to a value of -1.16, meaning that a 10% increase in price would decrease consumption by 10.6%, and this value for other SSBs such as juices and energy drinks to have a price elasticity of -1.17. Their results further indicated that a 1% increase in the price of soft drinks would affect a

cross price elasticity of demand of -0.21 in other SSBs, and a value of 0.07 for bottled natural and mineral waters. In their conclusion, the public health investigators conclude that even though this tax would hit the poor at a higher expense than that of the wealthy in Mexico, that if SSB consumption decreased due to enacted fiscal policy, that they should expect to see an effect on obesity and diabetes which should cause a reduction in health expenditures among the poor. (Colchero, et al., 2015)

There is an important policy decision that legislatures must consider in enacting new taxes to guide behavior. This is especially evident in Guatemala where in 2014, nearly 60% of the population was below the poverty line, and the fact that the country like many others is being hit by the devastating obesity epidemic. (CIA, 2018) In 2018, a study conducted investigate the effects of implementing a tax on SSBs to control obesity and non-communicable diseases like diabetes. There studies introduce the reality that between 2011 and 2016, SSBs have become increasingly more affordable due to an increase in per capita GDP. These investigations utilized a similar model to that of the National Institute of Public Health in Mexico by using an AIDS model for demand elasticities by controlling for differences in goods' qualities. This investigation also controlled for income differences, which is even more critical than in Mexico for estimating the effects of policy implementation and how this would affect Guatemala, which is significantly more impoverished. They also discovered that in rural regions, sodas account for the largest portion of beverage purchases. (Chacon, Violeta, et. al, 2018)

Their results indicated that the own-price elasticities for sodas to a value of -1.39, meaning that a 10% increase in price would decrease consumption by 13.9%, with high statistical significance. Milk, juices, and water also indicated a consumption decrease would result from higher prices. They note the differences between the own-price

elasticities between rural regions (-2.09) and urban ones (-0.80) to be significantly different. There data was inconclusive as to the substitution rates that which people would replace SSBs with bottled water, and they note this to the lack of data to justify their results. (Chacon, Violeta, et al, 2018)

Taxes on SSBs have been enacted already in several countries, such as the United States and France, and several economists have estimated the effects of own and cross price elasticities of demand in response to these taxes. In March 2015 Berkeley, California became the first US municipality to introduce an SSB tax which effected a 1 cent tax per once on SSBs, but not diet drinks. The tax (Measure D) specifically targeted sodas, sports drinks, energy drinks, and sweetened teas. Early last year, two investigators from Texas A&M University used random-coefficient/BLP RC-Logit demand model to see how household with high SSB consumption levels respond to product characteristics after the change in policy was adapted. In this model, they measured beverage substitution patterns by examining cross price elasticity of beverages with different caloric content. (Zhang, Yinjunjie, and Marco A. Palma, 2018)

Their time series model measured utility differences from the pre-tax years 2006 to 2014, then compared them to post-tax years of 2015 to 2016 to calculate price own and cross price elasticities. This study cites the investigation from the Mexican National Institute of Public Health and reports that their findings are similar to those proposed in 2015, with post-tax own price elasticity values averaging around -0.022, and compared their results to locales around Berkeley, but excluding these values in the second set of regressions to serve as instrumental variables. The effect was also seen to decrease consumption around the city limits of Berkeley as well. This model differed from the previous in that it classified SSBs by product, with examples including the likes of A&W

Root Bear, Coca-Cola, Fresca, Pepsi, and Sprite. Cross price elasticities were calculated for all products in the investigation, and the results showed positive elastic responses from regular SSBs to those of diet sodas, indicating that a decrease in consumption of regular SSBs was accompanied by an increase in consumption of diet sodas in response to Measure D. (Zhang, Yinjunjie, and Marco A. Palma, 2018)

Conclusions and necessary governmental intervention

As society begins to feel the deep-rooted cavities of unprecedented rises in sugar consumption, steps must be taken to ensure that heathy, affordable food and drink options are available to consumers. DT2 is controllable to an extent, and public health officials in places like California and France are leaders in taking the first steps in curbing sugar consumption in places like SSBs which general serve no nutritional value and are empty calories. Diabetes is a natural born killer, and in many cases, completely mitigatable.

However, in contrast taxes aren't the only solution to the diabetes epidemic. Insulin prices, and pharmaceuticals in general, are deregulated in the U.S., unlike that of most other developed nations. The U.S. has an obligation to force insulin producers to systematically lower out-of-pocket costs for those dependent on insulin in the interests of those who are completely and permanently dependent on insulin, such as those with T1D. As seen with the stockpiling effect in Denmark, patients are overall worse off when prices are high, and because their treatment for diabetes cannot be complimented with any other type of pharmaceutical.[3] Skipper's investigation also presented viable evidence that consumers do act in response in changes to prices in insulin, and therefore calls into question the general assumption by several economic textbooks that insulin is a *perfectly* inelastic good.

Congress has taken initial steps to prioritize the advancement of biosimilars (generics of biologics) into the U.S. market with the passage of the Biologics Price Competition and Innovation Act (BPCI) of 2009. Legislation was vital for the accelerated introduction of generic biologics into the marketplace because the prior legislation, the Hatch-Waxman Act of 1984 specifically only covered oral and topical patents for pharmaceuticals. (Center for Drug Evaluation and Research, 2018) Even though the passage of BCPI was passed nearly a decade ago, today there is no generic alternative to insulin analogs in use today. The federal government, whether it be through legislation, executive action, or departmental intervention must act immediately to prevent further harm to those who already suffer so greatly.

Action on insulin reform is an enormous public health priority that must be taken seriously in order to tackle immediate harm to insulin consumers. However, in order to address long term costs and actually taking a systemic approach to treating all type of diabetes, policy makers must consider in their arsenal things like taxes on sugar and lower costs for health foods in order to completely address the harms that obesity related non-communicable diseases can cause to society.

Expanded Scientific Definitions

1. Diabetes mellitus is a group of several diseases that arises for several reasons, whether it be genetic, pathogenic, gestational, or lifestyle caused. As the disease progresses, which can happen over a process of years or manifest in a matter of weeks, the patient's

body, specially the pancreas, loses its ability to naturally respond to rises in blood sugar caused by the intake of sugars (glucose) or other macromolecules in food such as carbohydrates or starches, which are both chemically composed of large chained sugars called polysaccharides, and represent a major portion of balanced nutrition. (Nelson, 2017)

2. Metformin is an antihyperglycemic medication that decreases hepatic glucose production, decreases intestinal absorption of glucose, and improves insulin sensitivity by increasing peripheral glucose uptake and utilization. (Food and Drug Administration, 2006) Metformin is a generic drug that lost patent exclusivity in 1999, and today is available free or below $5.00 from most pharmacies, with or without insurance. (GoodRX, 2019) Metformin is highly elastic to the US pharmaceutical market.
3. Without a steady access to viable treatment, a diabetic can quickly enter a state of metabolic decline. Two major concerns for diabetics are insulin shock, or severe hypoglycemia, and hyperglycemia, which are both reactions resultant from blood glucose imbalances. These conditions can cause symptoms such as blurred vision, coma, crying out in sleep, excruciating headaches, fainting, gastrointestinal distress, neuropathies, nightmares, renal failure, seizures, and unconsciousness. If left untreated, these symptoms can even cause death. (American Diabetes Association, 2015)

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