Who benefits from health signals? The case of diabetes

Toshiaki Iizuka (The University of Tokyo)
Junya Kawamura (The University of Tokyo)
Hitoshi Shigeoka (The University of Tokyo, Simon Fraser University, IZA and NBER)

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Extended abstract:

The decision to receive healthcare service is often left up to the individual. Receiving treatment is often voluntary and individuals self-select into treatment based on its observable and unobservable costs and benefits. For example, a person experiencing chest pain must decide whether to visit a physician to check the condition of the heart. One must also decide whether to undergo a cancer screening when they reach a recommended age. An important understudied issue, in our view, arising from self-selection into treatment is that those who self-select into treatment may or may not be those who benefit most from receiving the treatment. If there is a discrepancy between the two, one may improve efficiency by, for example, targeting treatment to the latter.

We investigate these issues of marginal returns to health care in the context of diabetes care, using the data from annual health checkups. We exploit the fact that individuals just below and just above a clinical threshold of fasting blood glucose (FBS) are similar, but only those just above receive a warning about diabetes mellitus (DM) to see a doctor. Such health signal discontinuously increases the probability of receiving treatment, and we use the above-threshold status as an excluded instrument to identify the impact of DM treatment on health outcomes.

DM is a costly, incurable chronic disease with increasing incidence and prevalence. In fact, DM is also a major health problem in Japan. It is the third largest disease category in 2019, with a prevalence rate of 19.7% (men) and 10.8% (women), increasing with age. Individuals are initially asymptomatic, but in the long run suffer from serious complications (e.g. eye, heart, kidney, nerve, and foot). However, it is preventable through early intervention to reduce risk factors such as smoking, unhealthy diet, sedentary lifestyle and obesity. Importantly, DM and prediabetes can be detected by elevated fasting blood sugar (FBS). Thus, it is common to establish some clinical thresholds of FBS, as in our case of 126.

We use administrative data on mandatory health examinations and health care utilization in Japan. By law, employers are required to provide an annual health examination for their employees between the ages of 35 and 75. Starting in 2015, the largest insurer in Japan decided to use a follow-up document to

encourage its members to visit a doctor. To increase efficiency, the insurer sends the document to those whose FBS is above 126 mg/dl and those who are not currently being treated for diabetes. This insurer covers up to 40 million people, or about one-third of all Japanese (about 120 million), giving us enough power to not only run the RDD on average, but also to examine treatment heterogeneity at a granular level.

We have five main findings. First, we find strong evidence that exceeding the threshold (FBS of 126 mg/dl) increases health care utilization, as measured by DM-related physician visits and outpatient expenditures. The magnitude is relatively large; for example, the probability of visiting a physician at least once in the first year after the health screening increased by 8.7 percentage points (from 33.3 to 42.0 percent) at the cutoff, indicating an increase of as much as 26.1 percent (=8.7/33.3). Thus, the provision of health warnings induces relatively large increases in utilization.

Second, we find that the additional care improves almost all biomarkers at next year's checkup, including FBS, BMI, total cholesterol, and blood pressure. Our reduced-form estimates show that exceeding the threshold leads to a reduction of 0.92 mg/dl in FBS (from a mean of 124.4 mg/dl), 0.097 in BMI (from a mean of 25.5), and 0.90 in total cholesterol (from a mean of 216.3). Although the magnitude seems small at first glance, the average treatment effect for compliers is much larger, as the magnitude of the first stage is about 9 percentage points. In fact, the local average treatment effect (LATE) on FBS, for example, is as large as 11.06 mg/dl, compared to the mean of 124.4 mg/dl, just below the cutoff.

Third, we show that those who "respond" the most to health signals and visit doctors are not those who "benefit" the most, suggesting *reverse* selection on gains based on observables. To account for the high dimensionality of our observable characteristics, we apply causal forest (Wager and Athey 2018) and estimate the conditional average treatment effect (CATE) of receiving health signals, separately for the probability of visiting a doctor and health outcomes. We find that those who are more likely to visit a doctor are observably healthy, and those who are least likely to visit a doctor are observably sick. However, we find the opposite pattern in health outcomes: those who benefit most from visiting a doctor are observably sicker, and those who benefit least from visiting a doctor are observably healthier.

Fourth, we find that such negative selection on gains applies not only to compliers but also to all patients near the cutoff. So far, our discussion is limited to selection and treatment heterogeneity of compliers based on observable characteristics. Here, we go beyond LATE and incorporate unobserved heterogeneity by estimating the marginal treatment effect (MTE) (Björklund and Moffitt 1987; Heckman and Vytlacil 1999, 2005, 2007). Since our instrument is binary (a dummy that takes one if FBS is above 126), we apply the method proposed by Brinch et al. (2017). We show that the MTE of health outcomes

decreases with unobserved resistance to treatment. This result is consistent with the result of CATE for compliers based on observables. Thus, selection into treatment is negative based on both observables and unobservables in this setting, suggesting that there may be room for targeting.

Finally, we conduct the policy simulation to see if we can improve the current status quo. To do this, we calculate a policy-relevant treatment effect (PRTE), which is a weighted difference between the average treatment effect on the treated (ATT) under the alternative policy and the ATT under the baseline policy (Heckman and Vytlacil 2001,2005; Carneiro et al. 2011; Cornelissen et al. 2016, 2018). In particular, we consider a scenario in which we identify patients with more severe health status and provide stronger nudges to visit a physician to treat DM . More practically, we select individuals whose systolic blood pressure (SBP) exceeds 160 mmHg, an often-used threshold, in addition to the FBS threshold of 126, and strengthen the health warning nudges by adding 0.2 to the propensity score of these sicker patients. However, the PRTE of such targeting is only marginally higher than the average treatment effect and substantially lower than the average treatment effect on untreated. Thus, targeting by observables does not successfully induce patients who are reluctant to visit a doctor, but could benefit greatly from doing so, to visit a doctor. Our results suggest that when individuals self-select into treatment, targeting individuals based on observable characteristics may have a limited effect on improving health outcomes, at least in this setting. A different approach, such as sending such health information to primary care physicians (rather than patients), may be more effective.