Decomposing the Behavioral Responses to the Flu Vaccine Shortage‡

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This paper uses a randomized encouragement design to decompose the behavioral responses to shortage announcements in a non-market setting. Given an unexpected shortage of flu-vaccines, we observed the responses of the members of a campus community to two distinct experimental treatments: a deadline reminder (treatment one), and the same deadline reminder plus an appeal for cooperative restraint to favor priority groups in the general population (treatment two). This experiment and two subsequent follow-up surveys allowed us to distinguish between different types of behavioral responses: cooperation, cheating, hoarding (increase in demand induced by scarcity), and mobilization of procrastinators. Results suggest a strong “net” cooperative response, leading to the desired decline in demand. This occurred in spite of the fact that the announcement of scarcity mobilized an unusually large number of first-timers for vaccination (hoarders) and induced many procrastinators to seek vaccination. Results also reveal that screening was effective in rejecting many who attempted to cheat to qualify for vaccination, although quite a few did remain undetected.

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“Flu shots, often a test of bravery, became a test of character ..., and not everyone was passing”,

1. INTRODUCTION

While history is replete with situations where individuals have been confronted with unexpected commodity shortages, the way shortages have been handled has been quite varied. When a market exists, rising prices serve as a rationing device. When the price is fixed, allocation of the scarce commodity across wanting individuals is done by introduction of rules, presumably to distribute the scarce commodity to those most in need. Rules are implemented by screening or by appeals to cooperative restraints. Appeals to voluntary cooperation in response to a shortage cannot, however, be expected to produce the same outcome as appeals to cooperation in a steady state situation. In the context of a shortage, cooperative response is met not only by defaults on cooperation (cheating), but also by hoarding and by a decline in procrastination that diminish the impact of cooperative response.

Hoarding occurs when new demand is induced by the shortage announcement itself. The announcement of shortage and accompanying deadlines for obtaining the commodity may also result in increased demand due to less procrastination. Finally, rationing may induce individuals to behave in a non cooperative way by self-declaring themselves to satisfy the distribution criteria when in fact they do not (hence by cheating). Cheating may neither increase nor decrease demand, since many cheaters are likely former legitimate consumers of the now scarce commodity who have to cheat to continue to access the good. Cheating and getting away with it, though, decreases efficiency in targeting access to the scarce commodity to those who need it the most.
Given these contradictory behavioral responses at play, the net effect may be in favor of cooperation, with an aggregate decline in demand, or of non-cooperation, resulting in an increase in demand. While, in the longer run, initiatives can be taken to respond to the shortage by increasing supply, understanding the forces at play in the short-run demand response to the shortage is an important instrument to efficiently distribute the scarce commodity.

In this research, a field experiment was designed to observe and analyze behavioral responses to an unexpected shortage of flu-vaccines in the fall of 2004. The analysis took place during two flu-clinics at one California university campus medical center. For the flu-clinics, the center was open not only to the campus community (faculty, staff, and students), but also to the non-campus community. Prior to the first clinic, we subjected the campus community randomly to two experimental treatments. Departments were assigned at random into three groups: a control group, that received no email from us (C); a treatment one group (T1) that received an email reminder about deadlines for the next two clinics without mentioning the shortage; and a treatment two group (T2) that received an email like the previous one, but additionally describing the shortage situation and appealing (as the Center for Disease Control was recommending at the time) for voluntary cooperation from non-members of the defined priority groups in refraining from seeking vaccination. Prior to the second clinic, the medical center sent an email to all campus members announcing that this last clinic was open to priority groups only.

This randomized encouragement design, and the follow up surveys at two campus clinics, allows us to decompose empirically the different behavioral responses at play: cooperation helping to reduce demand; and cheating, hoarding, and reduced procrastination contributing to increase demand. The net effect of these two sets of responses can be measured, and the relative contribution of each social group to each effect can also be identified.

The paper is organized as follows. Section 2 reviews the literature, while section 3 describes the experimental design and the surveys at the two clinics. Section 4 presents the data analysis and implications of the results are discussed in section 5.
2. BEHAVIORAL RESPONSES TO THE SHORTAGE

Cooperative responses

While non-cooperative responses to scarcity can be expected, there is also abundant evidence of voluntary cooperative responses to scarcity. Individuals not in priority groups may voluntarily incur a loss to allow the scarce resource to reach the people most in need, even under conditions of anonymity and lack of enforcement.\(^1\) A number of recent behavioral experiments (e.g., Fehr and Gachter, 2000; Gintis et al., 2003; Heinrich et al., 2001; Ostrom et al., 1992) have found that groups behave more cooperatively than the “self-interest individual model” would predict. Cooperative behavior can be further strengthened when individuals are given the option of incurring a cost to themselves in order to limit other people’s cheating and free-riding (Fehr and Fischbacher, 2004; Ostrom et al, 1992; Ostrom, 1990).

As shown by Hollander (1990), voluntary cooperation is possible even in large social groups and is motivated by contagion games (the fear that social norms will collapse) or by self-satisfaction in cooperating (Trivers, 1971). Cooperation is more likely to occur in smaller social groups, such as families or in a closed campus community such as the one in the present experiment, where individuals can monitor (purposefully or haphazardly) each other’s cooperative responses and ostracize those who fail to cooperate.

Hoarding as a response to scarcity

Hoarding, even in the context of non-durable goods (i.e., services), is a common behavioral response to scarcity. Examples are the stockpiling of Strategic Petroleum Reserves given a potential outbreak of war; the oil “buyer panic” of late 1973 that

\(^1\) Many individuals give blood, donate to charities, and show general consideration for their fellow citizens. During the 2001 California Electricity crisis, Californians were asked to reduce demand via voluntary conservation (“Flex Your Power” campaign). The most successful demand reducing campaign, known as “20/20”, though, was associated with a promise of a 20% rate reduction if they reduced electricity demand by 20%.
resulted in long lines at the gas pumps (Adelman, 2004); and the “Great Toilet Paper Shortage” caused by Johnny Carson in 1973. In fact, at the time of the flu-shortage announcement, hoarding was expected to happen as a response to the flu-shortage. In a market setting, given a contraction in supply, if demand expands, then the price increase is greater than the one caused solely by the upward supply shift.

Procrastination, even on one’s own health

As previously mentioned, another force that may increase demand due to shortage is that the deadlines associated with the distribution of a scarce resource (that shall eventually run out) may reduce the occurrence of procrastination. Procrastinators are individuals who delay tasks until a later period, and who, when the later period arrives, delay those tasks again and again (Akerlof, 1991; Silver, 1974). This is consistent with studies that find, for example, that if manufacturers distribute coupons with a redemption deadline, the deadline increases the probability of redemption (Silk, 2004); and that the longer students are given to complete a task, the greater the likelihood that they will fail to complete it (Tversky and Shafir, 1992).

No matter what prompts postponing and perpetually putting off an onerous task, procrastinators almost always experience regret for not getting things done in a timely fashion. Several studies found that this regret may cause anxiety, stress, and unhealthy behavior (Sirois et al., 2003; Tice and Baumeister, 1997). Sirois et al. (2003) also find empirical evidence that individuals also procrastinate with respect to decisions related to their own health.

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2 In his Late Night Show monologue, Johnny Carson said: “You know what's disappearing from the supermarket shelves? Toilet paper. There's an acute shortage of toilet paper in the United States.” The consequence of this statement made in the early 1970's, a time of shortages -- oil in particular --, was that the next morning many of the 20 million television viewers ran to the supermarket and bought all the toilet paper they could find. By noon, most of the stores were out of stock since, despite trying to ration it, they couldn't keep up with demand.

3 A County Public Health Department spokesperson said: "We knew that once people heard there was a shortage, more people would try to get the vaccine." San Francisco Chronicle, October 11, 2004.

4 This did not occur in the flu-vaccine shortage, since the price is fixed. There were, however, several cases of price gouging attempts and subsequent legal charges.
3. THE SHORTAGE AND THE EXPERIMENTAL DESIGN

3.1. Background, Time Line, and Information about Shortage

On Tuesday October 5, 2004, half of the U.S. supply of flu-vaccine was pulled back from the market because of possible contamination.\(^5\) Starting on Wednesday, October 6, numerous media articles about the flu-vaccine shortage informed the American public. The Center for Disease Control (CDC) devised and announced distribution guidelines and procedures to most efficiently allocate the scarce vaccine to people in high priority groups. The basic procedure during the first week of the shortage was for the CDC to appeal to the public to forego vaccination if not in the priority groups. On October 6, the university campus clinic in our experiment held the first of six previously scheduled and announced campus flu-clinics. For the flu-clinics, the center was open not only to the campus community (faculty, staff, and students), but also to the non-campus community. At the October 6 clinic, following CDC recommendations, voluntary restraint from people waiting in line at the clinic was advocated via a large poster indicating the priority groups. Three days later, on Saturday October 9\(^{th}\), the media announced that some California counties had declared an emergency to enforce a State directive so that flu-shots should be saved for the neediest. The county where the university is located did not at that time officially announce the enforcement of that same state directive.\(^6\) According to our research of the events at that time, we believe that there was general awareness about the shortage, but not about its seriousness. Moreover, there was little awareness about the subsequently implemented measures to distribute the vaccines via screening, so that they would reach the members of defined priority groups.

On Monday October 11, one week after the shortage was first announced, the two experimental treatment emails (T1 and T2) were sent out to the campus community. Monday the 11th was a national holiday and on the next day, Tuesday October 12, the

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\(^5\) British regulators cut the U.S. vaccine supply in half by condemning 48 million doses at a Liverpool factory (owned by a U.S. company based in Emeryville, CA) after bacterial contamination was found.

\(^6\) “There is a strong spirit of cooperation during this crisis,” said the respective County Public Health Officer. "We have no intention of taking any draconian steps to enforce this state of emergency." San Francisco Chronicle, October 9, 2004.
first clinic, henceforth referred to as clinic A, took place, offering flu-shots for the campus and non-campus communities but screening all candidates. This screening measure was not previously announced by the medical center to the campus and to the community. Individuals had to sign an affidavit declaring to meet the requirement of belonging to one of the priority categories. These categories were: children 6-23 months of age, adults 65 years and older, women expecting to be pregnant during the flu-season, health care workers with direct patient care, out-of-home care givers, individuals with household contacts of children less than 6 months, and individuals ages 2 through 64 with a chronic medical condition (such as asthma, diabetes, heart disease, chronic kidney disease, who had chemotherapy or immuno-compromised conditions).

On Wednesday the 13th, the campus medical center posted on its web-site that all remainder clinics were canceled and recommended the community to check for updates. The update came two weeks later. On Wednesday October 27, the campus community received a common email, originating from the medical center, informing about the date for a final clinic (hence, that there was a terminal deadline) and that, given the shortage, all candidates for a flu shot would be asked to sign an affidavit that they belong to one of the priority groups. By the time of this last clinic (that we henceforth call clinic B), screening of participants was common practice across the U.S. and, most likely, the information sent via email to the campus community was also known to the non-campus community at this point. In particular, at the time of clinic B, most U.S. counties had declared emergency to enforce directives for flu-shots to be saved for those most in need. On Monday, November 1, we conducted the second and last survey during clinic B.

Two months after the shortage was announced, with a reported mild flu activity, media articles pointed to doses of vaccine that were at risk of waste and the CDC recommended loosening the flu-vaccine restrictions. From a nation-wide CDC survey of health issues, conducted in December 2004, there was national level evidence that many people in priority groups still had not receive the vaccine. Several reasons were given by CDC-survey respondents and also by a telephone survey conducted by the Harvard

School of Public Health\textsuperscript{8}: respondents had not even tried, respondents were not able to get vaccination when they tried, some did not realize that they were eligible, and some reported that they were being cooperative (despite being in priority groups) and were abstaining to save vaccines for others.

3.2 The Experiment at Clinic A

Given distance to the campus medical center, departments were randomly allocated to three groups, and two of the groups received two different kinds of email treatments.\textsuperscript{9} Let us call the subset that received no email the control group C. One subset of departments received an email reminder about dates for the only two flu-clinics planned (henceforth called treatment one, T1), without explicitly mentioning the shortage. The third subset received a second email (henceforth called treatment two, T2). This email contained, at the bottom, a reminder about the flu-clinic dates (like T1) but at the top it provided more detailed information about the shortage situation. Also in T2, in accordance with CDC recommendations at that time, individuals were asked for voluntary cooperation in refraining from seeking vaccination if they did not belong to a priority group. The priority groups were described in detail in the T2 email.

We intended to treat everybody within the randomly selected departments, but obviously we did not expect everybody to have read their email (what matters to be treated is to have read the email before the actual clinic). There is, therefore, a difference between the intended treated and the individuals who were actually treated. Only a subset of members of the chosen departments read the email, but we believe that this selection was orthogonal to the treatment, so that what we find for the actually treated sub-group (subset of intended treated department who read the email) reveals as much about the


\textsuperscript{9} For the content of the two emails please see the appendix. A similar experimental design was used in Duflo and Saez (2002, 2003) who subjected a stratified subset of members of randomly chosen departments in a campus community to treatments sent via snail mail. Their objective was to access the role of information and peer-effects on the decisions to enroll in employer-sponsored Tax Deferred Account retirement plans.
average treatment as if we had treated the whole group. One final potential problem, though, is that some department members may have read the email and told others about it. If these social interactions are among co-workers within the same treated department then this is a less serious problem for measuring the average treatment than if interactions are across departments (that differ in intended C, T1, and T2 groups). Next we discuss how we treated the departments with the objective of minimizing this problem.

The emails were sent to faculty, staff, and graduate students by managing officers (MO) of the different departments. The emails to undergraduate students were sent by student affairs officers (SAO) or by the Dean of the school in question. All MOs, SAOs, and Deans we contacted and recruited were willing to participate in the distribution of our email to their faculty, staff, and students only. We explained what the study was about and gave them instructions on how to forward the email only to their administrative unit. When the emails were sent out, we were either blind cc-d or we ex-post confirmed with the SAOs and MOs whether the emails were in fact sent before the clinic date.

By sending this email through an official channel, we believe that this minimized the chances of social interactions (see Manski, 1996) within and across departments.

3.3 The Survey at Clinic A

All participants in clinic A were newly aware through the media that there was a vaccine shortage. For clinic A, no screening had been announced. Yet, the list of qualifying priority groups was posted at the entrance of the health center, and some screening was performed by the registration personnel. Among candidates for a flu vaccination, some

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10 Although this is not a guarantee that social interactions did not affect the experiment, clinic A occurred the day after a national holiday, giving people limited time to interact on the morning of October 12th, the day of clinic A, after they potentially read their emails. Staff are less likely to have read their campus-account email on the holiday (day it was sent), compared to faculty and students, and so faculty and students had a potentially longer time to interact, by forwarding the email to each others, than staff.

11 First, the reason not to forward the email to someone within the same department is that they observe that their friends/coworkers/co-workers received that same email (it is in the email alias). Second, there is less motivation to forward the email to outside the department since each email recipient believes it is likely other departments were also receiving such email from their official administrative units directly.
walked away upon reading the list of priority groups, others were screened out by the center personnel.

Our survey forms were distributed to people waiting in the long line and were filled out by basically everybody. This may be because either our survey looked official, or because the opportunity cost of completing the survey given the waiting period was very small. We also surveyed the people who came in and, upon seeing the poster and noticing the screening, decided on their own to forgo the vaccine.

In the survey questionnaire, we asked individuals to report their age, gender, campus affiliation including the department, whether they got a flu-shot in the last years, and whether it was at this same campus clinic if affirmative. We also asked them how they had heard about the clinic, in particular if it was through an email received from campus during the last two days (survey forms are in Appendix).

3.4 The Survey at Clinic B

Before clinic B, a campus wide email was sent, originating from the campus medical center (for the content of this email see the appendix). The email announced the date of the last clinic and clearly stated, this time, that the clinic would screen all recipients. On the day of clinic B, once again, we presented our survey forms to the individuals waiting in line. The response rate was once again close to 100% once we started distributing the survey.\(^\text{12}\)

Although only the campus community had received the email, all participants at clinic B were aware that there was a serious shortage and that available vaccines were reserved to members of the defined priority groups. The signature of an affidavit was required from all candidates, certifying membership in one of the priority groups. However, no hard proof of qualification in one of these groups was requested by the screening personnel.

\(^{12}\) This time, the clinic started about one hour earlier than announced to accommodate the long lines, so our survey team missed the first hour of people who got the shot during clinic B. But, for the other individuals who showed up (after we started surveying) with the intention of receiving a flu-shot, the response rate was close to 100%.
4. ANALYSIS OF BEHAVIORAL RESPONSES

4.1 Objectives

Using this design and the data collected in the two surveys, we proceed to analyze the differential behavioral responses to the shortage. We take the following four categories of hypotheses to the data.

- **Hypothesis I:** Cooperation did occur, that is appeals to voluntary restraints in demanding a flu vaccination were effective.
- **Hypothesis II:** Hoarding did occur, that is information on a shortfall in supply induced an increase in demand.
- **Hypothesis III:** Strict deadlines revealed the pervasiveness of procrastinators in the population. These procrastinators are individuals receiving a flu-vaccine for the first time this year (hence increasing demand), who are in the priority group this year and were also in the priority group last year, but in spite of this had not sought a vaccination.
- **Hypothesis IV:** Cheating was prevalent despite overall cooperation.

We are particularly interested in measuring the net effect of these contradictory behavioral responses, and in identifying which categories of individuals displayed which type of behavioral response.

The numbers of intended treated faculty, staff, and students in C, T1, and T2 groups are given in Table 1. At clinic A, seven hundred and thirty eight individuals filled questionnaires, with 498 from campus and 240 from the community. Out of the people surveyed, 73% of the people showing up did not receive an email, and are therefore in the control group, 16% of people showing up are in the treatment group T1, and 11% of the
people showing up are in the treatment group T2. At clinic B, six hundred and ten persons filled questionnaires, with 385 from campus and 225 from the community.

Because the randomization was based on departments and because the departments have different configurations in terms of faculty, staff, and student composition (see Table 1), then each of these groups gives rise to stratified samples of the campus population. For that reason, we use weights to obtain campus population statistics.

4.2. Testing Hypotheses of Behavioral Response

I. Cooperation: appeals to voluntary restraints in demanding a flu vaccination were effective

**Hypothesis:** There has been, overall, a strong cooperative response among members of the campus population to announcement that there was a serious shortage, and to appeals for voluntary restraint from those not in priority categories in order to save scarce flu vaccine supplies for the general population at risk in the State.

This hypothesis can be tested by comparing the percentages of the campus population that came for a flu shot among the T1 and T2 groups since these two groups differ randomly only in the appeal for cooperative restraint (Table 2). The percentage of the overall campus population demanding a flu shot decreased from 1.8% in T1 to 1.1% in T2, i.e., a significant 36.7% decline. Appeals to cooperative behavior were thus met with a strong positive response in the campus population.

The campus population is composed of 1,440 faculty, 5,852 staff, 9,618 graduate students, and 22,891 undergraduate students (Table 1). Comparing demands for a flu shot among the T1 and T2 groups in the campus population categories, shows that undergraduates were the ones with the largest (-45.9%) significant decline. The other three categories had non-significant declines of 31.2% for faculty, 33.9% for staff, and 31.9% for graduate students.
There is also an interesting contrast between old-timers (people who had a vaccination in 2003) and first-timers (people who did not). There was more cooperation among old-timers who reduced demand in response to appeals by 39.6% compared to first-timers who did not significantly reduce their demand.

II. Hoarding as a response to scarcity, that is information on a shortfall in supply induced an increase in demand

Hypothesis II: General awareness about the existence of a flu vaccine shortage obtained through the media increased demand, resulting in a sharp rise in first-timers for vaccination compared to previous years.

This can be seen (in Table 3) by the incidence of first-timers for a flu shot among participants this year, compared to the incidence of first-timers in the previous year, in the community and campus group C in clinic A, and in the community in clinic B. These are the three groups that did not receive any special information from campus about deadlines or affidavits, and hence who were responding to general knowledge about scarcity. At clinic A, 12.4% of community participants were first-timers in 2004, compared to a rate of first-timers of 3% the year before. In group C, 23.2% were first-timers in 2004, compared to a rate of 10.5% the year before. The phenomenon of rising demand was even sharper in Clinic B, with information on shortage more widely available in the press. At this clinic, 22.6% of community participants were first-timers in 2004 compared to a rate of first-timers of 4.4% the year before. Note that the rates of first-timers the year before are quite consistent between clinics A and B in the community, with 3% for the first and 4.4% for the latter. Note also that there were significant reported increases in first-timer demands between 2003 and 2004.

These sharp increases in first-timers for flu vaccines can be due to any of the 2004 year effects. However, the dominant phenomenon that year was greater information in the media about the existence and importance of flu shots, and about the existence of a shortage. We can thus conclude that the spread of information about a fall in supply led to a sharp increase in demand from people who had never requested a flu shot before. This is a well known response to non-market scarcity in motivating behavior: rising
scarcity increases demand, which is, for consumer goods, similar to stockpiling or hoarding.

III. Procrastination: strict deadlines revealed the pervasiveness of procrastinators

*Hypothesis III.1:* Deadlines induced demand.

Comparing demands for a flu vaccine at Clinic A between groups C and T1 (Table 4) shows a large increase in the overall percentage of the campus population that came in response to information about deadlines. Participation rates were 1.3% in group C and 1.8% in group T1, a significant 31.5% increase. While there were no significant changes for faculty and students, staff is the group that responded most positively with a near tripling in participation from 1.8% to 4.8%. This can indicate a “procrastinator” effect overcome with information about specific and terminal dates, resulting in an increase in demand. It can also result from a “rescheduling” effect for those who were intent on participating in one of the later clinics initially announced. Staff was the main participant in this behavioral response.

*Hypothesis III.2:* There was greater response to information about deadlines among people who never had a flu shot before compared to those who did.

In Clinic A, the percentage of first-timers increased from 22.4% in group C to 27.3% in group T1 (Table 4), implying that the number of first-comers in the campus population increased by 60.5%. Rising information about deadlines thus induced a sharp increase in demand among people who had never taken a flu shot before.

We can thus conclude that deadlines (T1 vs. C) and appeals to voluntary restraints (T2 vs. T1) induced two contradictory effects on aggregate demand: on the one hand cooperative behavior by many in curtailing demand, on the other hand mobilization of procrastinators and re-schedulers resulting in rising demand, i.e., in non cooperation. Happily for campus, the net of these two effects was one of curtailing aggregate demand. This can be due to civic behavior or to pressures to conform in a context where
anonymity on campus is not guaranteed and social capital can be undermined by unexpected encounters while failing to cooperate.

The contrast in responses to deadlines between first-timers and old-timers is also revealing. While old-timers represent a larger share of the campus population than first-timers, they showed a much smaller response (a 21.5% increase) to deadlines than the latter (a 60.5% increase). First-timers thus appear to be disproportionately made up of procrastinators responding to announcements of stricter deadlines.

**Hypothesis III.3:** The response to deadlines among people chronically in priority groups reveals procrastination.

In Clinic B, we have information about self-declared membership in priority groups among candidates for vaccination for this year and for last year. The questionnaire guaranteed anonymity, so self-reporting should be largely truthful. Clinic B announced a strict deadline: This was to be the last clinic offered on campus. First-timers, that is, people who did not get a flu shot in 2003, are reported in Table 5. There are three categories among current first-timer candidates for a flu shot. (1) People who are not in a priority group and who were not into one last year either. They represent 8.9% of candidates in the community and 21% in the campus. These are first-timers who are attempting to get a flu shot despite the rule. (2) First-timers who were not at risk last year, but are in a priority group this year. These are legitimate first-timers who represent 13.3% of the community participants and 34.7% of campus participants. (3) First-timers who were at risk last year (but in spite of this did not seek a vaccine) and who are again at risk this year. These are the true procrastinators who should be vaccinated, and are coming out in response to a strict deadline which they did not face last year. They represent 73% of community participants and 32% of campus participants, both surprisingly large numbers. The shortage thus acted as a natural experiment allowing to identify how large is procrastination among campus and community participants in obtaining proper medical treatment. Procrastinator response also contributed, along with hoarding, to the observed increase in demand induced by scarcity.
The incidence of first timers and, among those, of procrastinators mobilized by the strict deadline in Clinic B, differs across categories of participants (Table 6). As can be expected, the highest share of first-timers is among students, reaching 46.3%. There is no drastic pattern in the incidence of procrastination among categories of participants, else than noting that the incidence is double among staff (10.3%) than it is among faculty (5.8%): staff has more first-timers than faculty and, among them, more procrastinators. Among first timers, procrastinators are particularly important in the priority groups corresponding to out of home care-giver, chronic medical conditions, and age.

IV. Cheating: cheating was prevalent in spite of overall cooperation and effective screening

Among first-timers with complete information, categories (2) and (3) above are legitimate candidates for a flu shot, representing 90.7% and 76.1% of the community and campus participants for whom we have complete information, respectively. Cheating rates, by difference, are 9.3% in the community and a larger 23.9% among campus participants. These are lower bounds on the true incidence of cheating since there was some misreporting about membership to a priority group in the confidential survey (that we analyze below). There was, however, no reason to misreport membership to a priority group for 2003. Hence, underestimation of cheaters is in favor of new risk and does not affect our measure of procrastinators.

**Hypothesis IV.1:** The incidence of cheating was higher among those responding to deadlines (procrastinators) and to scarcity (hoarders).

How can cheaters be detected? The anonymous survey, filled by candidates for a flu shot while waiting on line to be interviewed by a nurse, asked for a self-declaration as to whether the person belonged to a priority category or of not. Some walked away after filling the questionnaire as they admitted not belonging to a priority category. For those who remained in line, the medical personnel engaged in verification that the individual qualified for receiving a vaccination or not. All candidates for a flu shot thus had to
officially announce membership in one of the priority categories in order to be considered for vaccination, had they declared confidentially in the survey that they were in one or not. The screening nurse then decided to accept or reject the candidate. We thus have information from each candidate for vaccination about: (1) whether self-declared in a priority group or not, and (2) whether the individual received a flu shot or was denied. This allows us to construct four categories in columns 1 through 4 of Table 7:

- **Effective screening:** These are the candidates not in priority groups who were not serviced, either because they walked away by themselves or were screened out by the center staff. Some of them might have been uninformed of the call for self-restraint and screening, while others probably came with the intention to cheat.
- **Legitimate service:** Those are the candidates who declared in the survey belonging to the priority groups and were indeed serviced.
- **Exclusion error (Type II):** Those are the candidates who declared belonging to the priority groups, but were however denied the flu-shot. While this could be a genuine exclusion error, it is more likely a category of persons that were properly detected not being priority while they self-declared being priority in an attempt to cheat.
- **Inclusion error (Type I):** non-priority that was serviced (cheaters). Those are people who probably spoke the truth in the survey, but still orally declared being in a priority group to the staff.

Effective screening, revealing lack of information or intention to cheat, was unimportant for community participants (column 1): the rejection rate was very low (2.9% in clinic A and 1.9% in clinic B). This was not the case among campus candidates in Clinic A where it reached 18.1% in group C and was higher in T2 (39%) than in T1 (36.8%). While non-priority candidates may have come to the clinics because of lack of information on the existence of priority groups, this could not be the case for at least campus group T2 in Clinic A and for the campus in Clinic B. And yet, it is interesting that screening was higher in the treatment than in the control group, and higher among those informed about priority groups (T2) than among the less informed (C and T1). This
result suggests attempt to cheat the system is reinforced by the anxiety created by the information on scarcity. The large number of intention to cheat in the T2 group is due to the selection process by which the cooperators indeed did not come to the clinics.

Legitimate service (in column 2) was almost universal in the community (92.5% at clinic A and 97.2% at clinic B). It was also high among campus participants in clinic B (88.2%). It was low, however, among campus participants to clinic A, and lower in the treatment groups T1 and T2 than in C. In the last column of Table 7, we measure efficiency as the ratio of legitimate services (column 2) to total services offered (column 2 plus column 4): it was high in the community (95.3% in clinic A and 99.1% in clinic B) and for campus in clinic B (95.5%). It was 87.6% among C in clinic A, and only 69.3% among T1 and 61% among T2. Efficiency thus fell as deadlines and appeals to voluntary restraint brought out more people anxious for a vaccination who did not qualify and yet who made it through the screening system.

Exclusion errors, whereby members of priority groups are denied a vaccination, were almost non-existent in both clinics and for all groups (see column 3). Screening was thus on the side of concern for exclusion errors, at the cost of greater inclusion errors. If the objective was to weight exclusion errors more heavily than inclusion errors, to make sure that a minimum of people at risk would be left un-serviced, then screening was indeed effective.

Finally in column 4, cheaters are those who self-declared not being in a priority group, yet were given a flu shot. There were very few in the community (4.6% in A and 0.9% in B) and few among campus participants to Clinic B as well (4.2%). Percentages are, however, important among campus participants in Clinic A, and higher when deadlines and scarcity are better known. Thus, the incidence of cheating reached 10.1% in C, 19.3% in T1, and 23.6% in T2. Once again, the incidence of cheaters rose with the pressures of deadlines (procrastinators) and appeals to restraint (hoarders). Non cooperation by these groups thus diminished, but did not erase, campus cooperative response.

The contrast between first-timers and old-timers is also quite revealing of who is this group of first timers. It is quite clear that it contains a greater share of individuals
uninformed and/or intent on cheating, both in the community and on campus. They are also more effective at cheating. As a result, the efficiency in servicing this group is notably low: the share of legitimate vaccinations among campus participants was only 64.9% (group C), 43.7% (T1 and T2, regrouped because of small sample size), and 89.4% (Clinic B). Low efficiency in the treatment groups shows their determination to obtain a vaccination given scarcity, deadlines, and in spite of appeals to cooperation.

**Hypothesis IV.2:** Cheating varies by demographic categories.

We contrast, in Table 8, cheaters by pairs of demographic categories. This allows revealing which categories are relatively more prone to cheating. Results indicate the following statistically significant contrasts in the incidence of cheating:

- More cheating among campus participants (10.1% in A and 4.2% in B) than among community participants (4.6% in A and 0.9% in B).
- More cheating in the treatment groups (T1 and T2) (21%) than in the control group (10.1%).
- More cheating among females (20% in A) than among males (10.7% in A).
- More cheating among first-timers (7.6% in B) than among old-timers (0.8% in B).
- More cheating among students (7.8% in B) than among faculty and staff (2% in B).

**Hypothesis IV.3:** Cheating on self-declared age to qualify in a priority category was extensive.

How else can cheaters be detected? What we used above to identify cheaters was presumed truthful self-reporting in the survey of not being in a priority category, and yet making it through scrutiny of the medical personnel and receiving a flu vaccine. There can, however, also be cases where self-reporting may not have been truthful. In this case, cheaters are people who falsely declared themselves to be in a priority category in the survey, did this again on the required affidavit, and were not detected by medical personnel because providing hard proof of being in the category was not demanded. How can we know that self-reporting was not truthful? Only if there are obvious
statistical irregularities in the risk categories invoked. Two priority categories were easier to use. One was a self-declared age of 65 when near that age. The others were categories of risk that showed an unusual increase between 2003 and 2004 among old timers. Note that new timers do not provide a “smell test” along this line as it is expected that they would show high rates of individuals at risk since the group is mainly composed of procrastinators and people newly at risk.

Figures 1 and 2 representing the distribution of self-declared ages are striking in showing a peak at age 65, preceded by a dip with missing numbers between ages 60 and 64.\(^\text{13}\) This is true for community as well as campus participants. The corresponding data are given in Table 9. We see that the ratio of number of participants 65 years old compared to average per age between 60 and 64 is, at clinic A, 3.9 for the community, 4.1 for campus group C, and 3.0 for the un-weighted campus population at large (the campus groups T1 and T2 have samples that are too small to perform an analysis by age in this age range); and at Clinic B, 8.2 for the community and 6.0 for campus. The 65 age group is also two to three times higher than the average per age between 66 and 70.

The existence of an abnormally high number of participants of age 65 is formally analyzed with the estimation of an age profile for participants. Since age 65 was a criterion for eligibility, we do expect a discontinuity in the number of participants between age 64 and age 65. The discontinuity must consequently be measured from above: To do this, we thus estimate the age profile of participants 66 years old and above only, and predict the participation at age 65 from above. We explored different functional forms (polynomials in age of 2nd, 3rd, and 4th degrees, \(1/(1+\text{age})\), and \(1/(1+\text{age}^2)\)), and retained the model that gave the best fit for age 65. The estimated curves are reported in Figures 1 and 2, and the corresponding predicted values are given in Table 10 where they can be compared with the observed values. In both clinics, the number of participants from the community is more than twice the predicted value (17 observed compared to a predicted value of 7.9 in clinic A, and 18 observed compared to

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\(^{13}\) In the context of evaluating training programs, several studies have found this regularity (see Ashenfelter, 1978 and for a survey Heckman, LaLonde and Smith, 1999), sometimes called the “Ashenfelter dip” or the “pre-program dip”. Individuals, after knowing the selection criterion, self select themselves into the program rather than being exogenously assigned to it: the observed mean in earnings in program participants declines prior to the entry into the program.
8.6 predicted in clinic B). The discrepancy is similar for campus participants, with a number of 19 for campus group C compared to 11.2 predicted, and observed 29 compared to 12.2 predicted in clinic B. The ratio is lower when one considers the campus participants to clinic A without sampling weights.

**Hypothesis IV.4:** High increases in the incidence of old-timers at risk between 2003 and 2004 raises suspicions of cheating.

While we have no way of verifying if reasons invoked for being in a priority group were truthful or not, we can infer cheating among old-timers from categories where there was a huge increase in self-declared priority condition between this and last year (Table 11). Categories that naturally change from one year to the next, such as pregnancy and caring for infants, cannot be used for this test. We see that age has a benchmark growth rate of 5.5%, including knowing that the category was abused by some. Suspicious are reported increases over one year in chronic aspirin therapy (25.3%), chronic medical condition (19.5%), out-of-home care giver (9.1%), and health care worker (5.2%). These large percentage increases suggest that these categories may have been used to qualify as member of a priority group.

**Hypothesis IV.5:** High anxiety not to miss days of work or study due to sickness was prevalent among campus participants not in priority groups.

Participants who self-reported that they were not in a priority category indicated “other reasons” to want a flu shot (Table 12). Most clear among them is “not being able to afford to miss days of work or study due to sickness”. At Clinic B, many also indicated that they had recently discovered the importance of flu shots, that they were concerned with an epidemic, and that they were particularly exposed to others. It is notable that a high share of these participants was denied a flu vaccine by the medical personnel. Anxiety about loss of days of work or study was even higher among those who were denied a flu shot. This indicates that, while the population at risk was effectively serviced, a large effective demand also exists among people not in priority
categories, yet considering that access to a flu shot is very important to them to meet their work and study plans.

5. IMPLICATIONS

Appeals to voluntary cooperation in response to a shortage situation and the accompanying distribution guidelines to reach the populations most in need may result in a net decline or in a net increase in demand. Assessing the overall behavioral effect is an empirical question of relevance for short-term scarcity response alleviation and for the design of effective and efficient distribution measures.

The flu vaccine shortage of October-November 2004, combined with a randomized treatment of information across departments on a California university campus to control for the effects of strict deadlines and appeals to voluntary cooperation, allowed us to identify separately the roles of cooperation, hoarding, procrastination, and cheating on the demand for flu shots and their allocation. The surveys implemented at the last two clinics offered on Campus revealed strong cooperative responses across all population categories, with a 37% decline in demand in response to appeals for restraint. Response was largest among undergraduates whose demand for vaccination fell by 46%. At the same time, we observed an increase in demand induced by the shortage and by strict deadlines that mobilized many first timers for vaccination and induced procrastinators to come out and also contribute to demand. Cheating, revealed by confidential self-declaration of non-membership in priority groups, and remaining undetected in screening by health personnel at the clinic, allowed many to receive a flu shot. Screening was also effective in rejecting candidates for a shot among those attempting to cheat.

Analysis at clinic A with the randomization set up among the campus population allows us to decompose these various effects as follows (Table 13). The first step is to project what would have been the population of candidates for a flu vaccination in “normal” times. Without any information from clinics in previous years, we use as a first
approximation the observed rate of first timers in 2003 within the control group that came
to the clinics. Applying the 10.5% rate of 2003 for the campus control group, rather than
the observed 2004 rate of 23.2% (Table 3), we compute what we referred to as the
“normal” population of candidates for flu vaccination of 1.17% campus members, and set
this number to 100 in Table 13. The increase in demand from this “normal” level to the
observed level of 1.3% of the campus population (Table 4, control group) which
represents a 14.6% increase is thus interpreted as a response to the scarcity as publicly
known at that time. The increase in demand between the control C and treatment T1
group (Table 4) translate into a 36 percentage points, attributed to the effect of the email
announcing the deadlines of what would most likely be only a couple of clinics. Adding
the call for cooperation in the treatment T2 group reduced the demand by 36.7% (Table
2) or 55.2 percentage points. Screening by the clinic staff of 39% of the candidate in that
group reduced total vaccination given by 37.3 percentage points. This resulted in a
decline in vaccination from what would have been 100 shots in a normal year without
any restriction to 58.2 shots. Note, however, that even among these 58.2 persons
serviced, 39% admit not belonging to a priority group (where this percentage is the
complement of the last column of Table 7 for the T2 group).

In reducing demand, voluntary restraints thus accounted for 60% of the total
effect and screening by medical personnel for 40%. Cooperation and screening
combined in achieving a 93 percentage points decline in demand once shortages and
deadlines were known. First timers for a vaccine were a population particularly strongly
determined to obtain a vaccination. They are the group that showed least cooperation,
more hoarding, more procrastinators, and more cheating compared to people who had a
flu shot the year before. More cheating was observed on campus than in the community,
among those more informed about deadlines (T1) and appeals to restraints (T2) than the
general campus population (C), among females than males, and among students than
faculty and staff. The age category of 65, out of home care-giver and chronic medical
problem were used - and abused - to qualify for a priority category.

Appeals for cooperation and effective screening helped save 61% of the vaccines
that would have been given in 2004 with knowledge of the shortage and deadlines.
While 39% of the vaccines were received by cheaters, virtually none of the population at risk desirous of obtaining a vaccination was left un-serviced. The left over of vaccines at the end of the last clinic also testified to effectiveness in servicing the informed and willing population at risk. Overall, appeals to cooperation and screening worked but could not prevent hoarding, procrastination, and cheating. If the objective was to minimize exclusion errors of populations at risk, while compensating for hoarding, procrastination, and cheating by appeals to cooperation and screening, the objective was met, with a 61% saving in flu shots to be made available to the general population at risk in the State of California.

REFERENCES


Table 1. Number of intended treated faculty, staff, and students by random treatment and control groups.

<table>
<thead>
<tr>
<th>Campus Categories</th>
<th>Group C</th>
<th>Group T1</th>
<th>Group T2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty</td>
<td>813</td>
<td>430</td>
<td>197</td>
<td>1440</td>
</tr>
<tr>
<td>Staff</td>
<td>5339</td>
<td>292</td>
<td>221</td>
<td>5852</td>
</tr>
<tr>
<td>Graduate Students</td>
<td>4431</td>
<td>3308</td>
<td>1879</td>
<td>9618</td>
</tr>
<tr>
<td>Undergraduate Students</td>
<td>8625</td>
<td>4001</td>
<td>10265</td>
<td>22891</td>
</tr>
</tbody>
</table>

C=control, T1= deadlines email, T2= Detailed shortage email and call on restraints.
Source: Campus profile database 2004.

Table 2. Evidence on cooperation by campus members (Clinic A)

<table>
<thead>
<tr>
<th>Demand by category of campus population (in percentage of each category campus population)</th>
<th>Demand for flu vaccine</th>
<th>t-stat on difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Treatment 1</td>
<td>Treatment 2</td>
</tr>
<tr>
<td>Faculty</td>
<td>8.8</td>
<td>6.1</td>
</tr>
<tr>
<td>Staff</td>
<td>4.8</td>
<td>3.2</td>
</tr>
<tr>
<td>Graduate students</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>Undergraduate students</td>
<td>0.9</td>
<td>0.5</td>
</tr>
</tbody>
</table>

In percentage of the campus population

<table>
<thead>
<tr>
<th>Demand by category of campus population</th>
<th>Demand for flu vaccine</th>
<th>t-stat on difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total demand</td>
<td>1.8</td>
<td>1.1</td>
</tr>
<tr>
<td>First-timers</td>
<td>0.48</td>
<td>0.38</td>
</tr>
<tr>
<td>Old timers</td>
<td>1.21</td>
<td>0.73</td>
</tr>
</tbody>
</table>

Table 3. Scarcity induced new demand

<table>
<thead>
<tr>
<th></th>
<th>Clinic A difference with previous year</th>
<th>Clinic A Community</th>
<th>Clinic B Community</th>
<th>Clinic B difference with previous year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Had shot in 2001</td>
<td>54.9</td>
<td>68.8</td>
<td>63.3</td>
<td></td>
</tr>
<tr>
<td>First time in 2002</td>
<td>4.4</td>
<td>2.6</td>
<td>2.2</td>
<td></td>
</tr>
<tr>
<td>First time in 2003</td>
<td>10.5</td>
<td>2.24</td>
<td>3.0</td>
<td>0.63</td>
</tr>
<tr>
<td>First time in 2004</td>
<td>23.2</td>
<td>2.78</td>
<td>12.4</td>
<td>3.37</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Percent of participants for 2001, percentage of all participants declaring having received a flu shot in 2001. First time in any other year means that the person received a shot in the current year, but not in the previous (computed among those with explicit information in both the previous and the current years). Percentages do not add to 100 due to standard errors clustered at the department*category level. Source: Flu-shot survey, Fall 2004.

Table 4. Deadlines induced demand (Clinic A)

<table>
<thead>
<tr>
<th>Demand by category of campus population (in percentage of each category campus population)</th>
<th>Control</th>
<th>Treatment 1</th>
<th>Difference (%)</th>
<th>t-stat on difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty</td>
<td>10.8</td>
<td>8.8</td>
<td>-18.5</td>
<td>-1.14</td>
</tr>
<tr>
<td>Staff</td>
<td>1.8</td>
<td>4.8</td>
<td>163.9</td>
<td>2.36</td>
</tr>
<tr>
<td>Graduate students</td>
<td>1.3</td>
<td>0.9</td>
<td>-25.8</td>
<td>-1.38</td>
</tr>
<tr>
<td>Undergraduate students</td>
<td>0.7</td>
<td>0.9</td>
<td>36.2</td>
<td>1.38</td>
</tr>
<tr>
<td>Total campus</td>
<td>1.3</td>
<td>1.8</td>
<td>31.5</td>
<td>1.87</td>
</tr>
<tr>
<td>First-timers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent in participants</td>
<td>22.4</td>
<td>27.3</td>
<td>22.0</td>
<td>0.82</td>
</tr>
<tr>
<td>Percent of campus population</td>
<td>0.30</td>
<td>0.48</td>
<td>60.5</td>
<td>1.36</td>
</tr>
<tr>
<td>Old-timers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent in participants</td>
<td>74.3</td>
<td>68.6</td>
<td>-7.6</td>
<td>-0.82</td>
</tr>
<tr>
<td>Percent of campus population</td>
<td>1.00</td>
<td>1.21</td>
<td>21.5</td>
<td>1.07</td>
</tr>
</tbody>
</table>

Table 5. Evidence on procrastination revealed by final deadlines (Clinic B)

Percentage of the participants that had not received a flu vaccine in 2003

<table>
<thead>
<tr>
<th>In risk category in</th>
<th>2003</th>
<th>2004</th>
<th>Community</th>
<th>Campus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at risk</td>
<td>No</td>
<td>No</td>
<td>8.9</td>
<td>21.0</td>
</tr>
<tr>
<td>New risk</td>
<td>No</td>
<td>Yes</td>
<td>13.3</td>
<td>34.7</td>
</tr>
<tr>
<td>Procrastinators</td>
<td>Yes</td>
<td>Yes</td>
<td>73.3</td>
<td>32.3</td>
</tr>
<tr>
<td>Unassigned</td>
<td>Yes</td>
<td>Missing information</td>
<td>4.4</td>
<td>12.1</td>
</tr>
</tbody>
</table>

Number of observations 45 124


Table 6. Share of procrastinators in different population groups (Clinic B)

<table>
<thead>
<tr>
<th>Population groups</th>
<th>Total participants</th>
<th>All first timers</th>
<th>Procrastinators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campus participants</td>
<td></td>
<td>(Percent of participants in each category)</td>
<td></td>
</tr>
<tr>
<td>Faculty</td>
<td>86</td>
<td>16.7</td>
<td>5.8</td>
</tr>
<tr>
<td>Staff</td>
<td>97</td>
<td>28.0</td>
<td>10.3</td>
</tr>
<tr>
<td>Students</td>
<td>142</td>
<td>46.3</td>
<td>9.9</td>
</tr>
<tr>
<td>U.C. spouse</td>
<td>68</td>
<td>33.3</td>
<td>16.2</td>
</tr>
<tr>
<td>Community participants</td>
<td>215</td>
<td>22.6</td>
<td>15.3</td>
</tr>
</tbody>
</table>

By priority group

| Adults 65 years of age or older | 283 | 19.1 | 14.8 |
| Under chronic medical conditions | 191 | 22.8 | 15.2 |
| Chronic aspirin therapy         | 48  | 15.9 | 12.5 |
| Health-care worker              | 48  | 27.3 | 10.4 |
| Out of home care giver          | 22  | 36.4 | 22.7 |
| Any of the above                | 499 | 21.2 | 14.4 |

Table 7. Evidence on effective screening, legitimate service, exclusion errors, and inclusion errors (cheating)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-declared priority group</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Excluding cheating</td>
</tr>
<tr>
<td>Received flu vaccine</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Including cheating</td>
</tr>
</tbody>
</table>

Clinic A: categories of participants

| Community                        | 2.9  | 92.5 | 0.00 | 4.6 | 95.3 |
|                                 | 18.1 | 71.4 | 0.41 | 10.1 | 87.6 |
|                                 | 36.8 | 43.5 | 0.41 | 19.3 | 69.3 |
|                                 | 39.0 | 36.9 | 0.50 | 23.6 | 61.0 |

Clinic B: categories of participants

| Community                        | 1.9  | 97.2 | 0.00 | 0.9 | 99.1 |
|                                 | 6.8  | 88.2 | 0.79 | 4.2 | 95.5 |

First timers

| Clinic A                        | Community                        | 7.1  | 89.3 | 0.00 | 3.6 | 96.2 |
|                                 | Campus - Control                 | 38.5 | 38.8 | 1.81 | 20.9 | 64.9 |
|                                 | Campus - Treatment               | 54.4 | 19.5 | 1.12 | 25.1 | 43.7 |
| Clinic B                        | Community                        | 4.4  | 91.1 | 0.00 | 4.4 | 95.4 |
|                                 | Campus                          | 13.2 | 76.9 | 0.83 | 9.1 | 89.4 |

Old timers

| Clinic A                        | Community                        | 2.4  | 92.9 | 0.00 | 4.7 | 95.2 |
|                                 | Campus - Control                 | 12.2 | 80.8 | 0.00 | 7.0 | 92.1 |
|                                 | Campus - Treatment               | 27.4 | 53.6 | 0.40 | 18.6 | 74.3 |
| Clinic B                        | Community                        | 0.7  | 99.4 | 0.00 | 0.0 | 100.0 |
|                                 | Campus                          | 3.3  | 94.6 | 0.83 | 1.2 | 98.7 |

### Table 8. Cheating by demographic category

<table>
<thead>
<tr>
<th>First and second group</th>
<th>First group</th>
<th>Second group</th>
<th>p-value on difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinic A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community vs. Campus control</td>
<td>4.6</td>
<td>10.1</td>
<td>0.04</td>
</tr>
<tr>
<td>Campus control vs. treatment</td>
<td>10.1</td>
<td>20.5</td>
<td>0.03</td>
</tr>
<tr>
<td>Male vs. female</td>
<td>10.7</td>
<td>20.0</td>
<td>0.08</td>
</tr>
<tr>
<td>First timers vs. old timers</td>
<td>22.2</td>
<td>13.7</td>
<td>0.25</td>
</tr>
<tr>
<td>Students vs. staff and faculty</td>
<td>16.5</td>
<td>18.3</td>
<td>0.70</td>
</tr>
<tr>
<td>Clinic B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community vs. Campus</td>
<td>0.9</td>
<td>4.2</td>
<td>0.03</td>
</tr>
<tr>
<td>Male vs. female</td>
<td>3.4</td>
<td>2.7</td>
<td>0.61</td>
</tr>
<tr>
<td>First timers vs. old timers</td>
<td>7.6</td>
<td>0.8</td>
<td>0.00</td>
</tr>
<tr>
<td>Students vs. staff and faculty</td>
<td>7.8</td>
<td>2.0</td>
<td>0.00</td>
</tr>
</tbody>
</table>


### Table 9. Number of patients by age: Observed peak at age 65 (both clinics)

<table>
<thead>
<tr>
<th>Age group</th>
<th>Community</th>
<th>Clinic A Campus Control</th>
<th>Campus non-weighted</th>
<th>Clinic B</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-64 (*)</td>
<td>4.4</td>
<td>4.7</td>
<td>4.0</td>
<td>2.2</td>
</tr>
<tr>
<td>65</td>
<td>17</td>
<td>19</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>66-70 (*)</td>
<td>6.4</td>
<td>8.7</td>
<td>7.6</td>
<td>7.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ratio of 65 over</th>
<th>60-64</th>
<th>66-70</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.9</td>
<td>2.7</td>
</tr>
<tr>
<td></td>
<td>4.1</td>
<td>2.2</td>
</tr>
<tr>
<td></td>
<td>3.0</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>8.2</td>
<td>2.6</td>
</tr>
<tr>
<td></td>
<td>6.0</td>
<td>3.2</td>
</tr>
</tbody>
</table>

(*) Average patients per age in relevant interval.
Table 10. Discontinuity analysis in demand around 65 years of age

<table>
<thead>
<tr>
<th>Observed and predicted participation</th>
<th>Clinic A</th>
<th>Clinic B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Community</td>
<td>Campus Control</td>
</tr>
<tr>
<td>Observed at 65 years old</td>
<td>17</td>
<td>19</td>
</tr>
<tr>
<td>3rd degree polynomial</td>
<td>5.6</td>
<td>11.2</td>
</tr>
<tr>
<td>Standard error</td>
<td>1.91</td>
<td>2.16</td>
</tr>
<tr>
<td>Predicted at 65 years old</td>
<td>7.9</td>
<td>9.1</td>
</tr>
<tr>
<td>Standard error</td>
<td>1.00</td>
<td>1.10</td>
</tr>
</tbody>
</table>

Best fit is shaded.

Table 11. Declared reasons for being in the corresponding priority group among old timers (Clinic B)

<table>
<thead>
<tr>
<th>Declared reason</th>
<th>Declared reason in 2004</th>
<th>Would have been in 2003</th>
<th>% increase 2004 over 2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults 65 years of age or older</td>
<td>53.7</td>
<td>50.9</td>
<td>5.5</td>
</tr>
<tr>
<td>Women who will be pregnant during the flu season</td>
<td>1.8</td>
<td>1.1</td>
<td>63.6</td>
</tr>
<tr>
<td>On chronic aspirin therapy</td>
<td>9.4</td>
<td>7.5</td>
<td>25.3</td>
</tr>
<tr>
<td>Health-care worker</td>
<td>8.1</td>
<td>7.7</td>
<td>5.2</td>
</tr>
<tr>
<td>Out-of-home care giver</td>
<td>3.6</td>
<td>3.3</td>
<td>9.1</td>
</tr>
<tr>
<td>Contacts with infant</td>
<td>6.6</td>
<td>1.7</td>
<td>288.2</td>
</tr>
<tr>
<td>With chronic medical conditions</td>
<td>35.5</td>
<td>29.7</td>
<td>19.5</td>
</tr>
<tr>
<td>Average number of observations</td>
<td>394</td>
<td>362</td>
<td></td>
</tr>
</tbody>
</table>

Table 12. Reasons for wanting to have a flu-shot among campus participants not member of priority groups

<table>
<thead>
<tr>
<th></th>
<th>Clinic A Control</th>
<th>Clinic B Treatment (1&amp;2)</th>
<th>Clinic B (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact with children</td>
<td>10.3</td>
<td>9.5</td>
<td>4.3</td>
</tr>
<tr>
<td>Can't afford to miss work or study</td>
<td>60.9</td>
<td>53.5</td>
<td>73.9</td>
</tr>
<tr>
<td>Believe shortage is just temporary</td>
<td>8.5</td>
<td>1.7</td>
<td>–</td>
</tr>
<tr>
<td>Recently discovered the importance of flu shots</td>
<td>15.2</td>
<td>8.7</td>
<td>28.3</td>
</tr>
<tr>
<td>Concerned by shortage</td>
<td>19.6</td>
<td>14.9</td>
<td>17.4</td>
</tr>
<tr>
<td>Concerned by potential epidemic</td>
<td>12.7</td>
<td>16.2</td>
<td>19.6</td>
</tr>
<tr>
<td>Particularly exposed to others</td>
<td>–</td>
<td>–</td>
<td>58.7</td>
</tr>
<tr>
<td>Other reasons¹</td>
<td>22.9</td>
<td>27.6</td>
<td>13.0</td>
</tr>
<tr>
<td>At least one of the above</td>
<td>88.7</td>
<td>88.0</td>
<td>91.3</td>
</tr>
<tr>
<td>Did not fill this part of questionnaire</td>
<td>11.3</td>
<td>12.0</td>
<td>8.7</td>
</tr>
<tr>
<td>Flu-shot was denied</td>
<td>64.2</td>
<td>63.3</td>
<td>56.5</td>
</tr>
<tr>
<td>Number of observations</td>
<td>67</td>
<td>120</td>
<td>46</td>
</tr>
</tbody>
</table>

- means category was not available in the questionnaire.

¹ Mostly "living in dorms", "in contact with people", "don't want to be sick", "always had a shot", "travel abroad"


Table 13. Decomposition of the effects of scarcity, procrastination, cooperation and screening on the number of flushots distributed

<table>
<thead>
<tr>
<th>Effect</th>
<th>Change</th>
<th>St. error</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projected normal population of candidates for flu vaccination, 2004*</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase in demand due to response to scarcity: hoarding</td>
<td>14.5</td>
<td>5.2</td>
<td>114.5</td>
</tr>
<tr>
<td>Increase in demand due to strict deadlines reducing procrastination</td>
<td>36.1</td>
<td>19.3</td>
<td>150.6</td>
</tr>
<tr>
<td>Voluntary restraints due to appeals to cooperation</td>
<td>-55.2</td>
<td>-24.4</td>
<td>95.4</td>
</tr>
<tr>
<td>Screening of intended cheaters by medical personnel</td>
<td>-37.2</td>
<td>-7.5</td>
<td>58.2</td>
</tr>
<tr>
<td>Vaccinations given to individuals in priority groups (% of vaccination)</td>
<td>35.8 (61%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaccinations given to cheaters (% of vaccination)</td>
<td>22.5 (39%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Assuming that the 2003 rate of new participants would have applied to 2004.

Source: Flu-shot survey, Fall 2004
Figure 1. Age profile and discontinuity analysis (Clinic A)
Figure 2. Age profile and discontinuity analysis (Clinic B)
APPENDIX

A.1 Treatment One (T1) Email – (Clinic A)

Date: Mon, 10 Oct 2004 09:08:13 -0700 (Pacific Standard Time)
From: XXX XXX@CCC.univ.EDU
To: destaff@CCC.univ.EDU, fac@CCC.univ.EDU, grads@CCC.univ.EDU
Subject: Fwd: reminder flu shot clinic at YXZ Center (fwd)
X-X-Sender: XXX@CCC.univ.edu
X-MIME-Autoconverted: from QUOTED-PRINTABLE to 8bit by univ.EDU id

> Flu Shot Schedule
> Two remaining dates are scheduled.
> Again, these clinics will be available to members of the campus and community
> college-age or above:
>   Tuesday, October 12
>   Friday, October 22
> The clinics are scheduled for noon - 6 pm (subject to vaccine availability), 1st f
> YXZ Center, 2222 XVV Way. The cost is \$20 (Students with Student Health Insurance
> Plan (SHIP) pay \$4).
> Pending any remaining vaccine supplies, the following clinic dates are tentatively
> scheduled:
>   Monday, November 1
>   Wednesday, November 10
>   Thursday, December 2
>
Management Services Officer, Department CCC
> Due to a national flu vaccine shortage, the Centers for Disease Control
> (CDC) is requesting cooperation with its interim recommendations for influenza vaccination.
> 
> Priority groups for influenza vaccination include:
> > all children aged 6-23 months
> > adults 65 years of age and older
> > persons aged 2-64 years with underlying chronic medical conditions
> > all women who will be pregnant during the influenza season
> > residents of nursing homes and long-term care facilities
> > children aged 6 months - 18 years on chronic aspirin therapy
> > health-care workers involved in direct patient care
> > out-of-home caregivers and household contacts of children aged less 6 months.
> 
> Persons who are not included in one of the priority groups are asked to forego or defer vaccination.
> 
> Flu Shot Schedule
> 
> Because of the limited vaccine supply, two remaining dates are scheduled.
> 
> Again, these clinics will be available to high-risk members of the campus
> 
> and community as explained above, college-age or above:
> > Tuesday, October 12
> > Friday, October 22
> 
> The clinics are scheduled for noon - 6 pm (subject to vaccine availability), 1st floor, YXZ Center, 2222 XVV Way. The cost is $20 (Students with Student Health Insurance Plan (SHIP) pay $4).
> 
> Pending any remaining vaccine supplies, the following clinic dates are tentatively scheduled:
> > Monday, November 1
> > Wednesday, November 10
> > Thursday, December 2
> 
> For more information on CDC guidelines for flu shots see http://www.cdc.gov/flu/

FGHIJ, Management Services Officer, Department DDD
A.3 Campus Wide Email Announcing Last Clinic - (Clinic B)

Date: Wed, 27 Oct 2004 12:14:40 -0700
Subject: Fwd: Final Campus Flu Clinic - Nov. 1
From: MSO@MMM.univ.EDU
To: destaff@MMM.univ.EDU, fac@MMM.univ.EDU, grads@MMM.univ.EDU

Subject: Fwd: Final Campus Flu Clinic - Nov. 1 (fwd)
X-X-Sender: MSO@MMM.univ.edu
X-MIME-Autoconverted: from QUOTED-PRINTABLE to 8bit by univ.EDU

> If you are a department contact, please pass this information on to others in your unit.

> FLU ADVISORY
> October 27, 2004
> Due to the limited flu vaccine supply, the University Health Services/YXZ Center will hold its final flu clinic of the year on Monday, November 1st. The clinic will be held noon -6pm or until the vaccine supply is gone.
> The clinic is open to members of the campus and community, college age and older. The cost is $20. Students with SHIP pay $4.

> UHS will be strictly adhering to the Centers for Disease Control criteria for high risk/high priority. You will be asked to complete an affidavit that you are a member of a priority group.
> The criteria are:
> Adults 65 years of age or older
> Persons 2-64 years of age with underlying chronic medical conditions
> Women who will be pregnant during the flu season
> Adolescents on chronic aspirin therapy
> Health-care workers with direct patient care
> Out of home care givers
> and household contacts of children less than 6 months.
> Check our web site for directions and additional information at www.uhs.univ.edu.

VV VVVV, Safety Coordinator
College of ABCDE
XYZ Center Survey on the Impact of the Flu Vaccine Shortage - 10/12/04

This study is to analyze the impact of the flu vaccine shortage on the Campus population. If you agree to take part, please fill out the survey below. All of the information is anonymous and your participation in this research is voluntary. If you have any questions, you may call Sofia Villas-Boas at (tel). If you have questions about your rights as a participant in this research project, you can call the University Committee for the Protection of Human Subjects at (tel).

Your affiliation: (Check one)
Faculty
Staff
Graduate student
Undergrad student
Community

Department:
Department:
Department:
Major:
Profession:
College:

Your age
Gender
Male
Female

Were you at City Name in the Fall of:
2001
2002
2003
Yes
No
Yes
No
Yes
No
Yes
No

Did you get a flu shot in the Fall of:
2001
2002
2003
Yes
No
Yes
No
Yes
No
Yes
No

If yes, did you get it at XYZ Center
2001
2002
2003
Yes
No
Yes
No
Yes
No
Yes
No

How did you obtain information about the dates for flu shots at the XYZ Center? (Check all that apply)
email reminder received from U today or yesterday
email received previously from U
I went on line
Daily Newspaper Campus
Posters on campus
Other source (specify)

The State emergency order on the distribution of flu shots was only introduced today, but the shortage has been known for some time. Could you tell us when and how you learned about the existence of a flu shot shortage? (Check all that apply)
I only learned about it upon arriving at the Center
From the newspapers and media
From the campus email I received yesterday or today

In which category at risk are you? (Check one)
You are in one of the following categories at risk:
Over 65
Chronic illness
Pregnant
Have an infant at home
Other category

You have children at home
You cannot afford to be sick and miss work or study days this year
You believe that the shortage is just temporary
Other reason

If you did not receive a vaccination last year, why are you getting one this year?
I was not in a category at risk last year
I recently learned about the importance of flu shots
I am concerned that vaccines may no longer be available later in the season
I am concerned that the shortage may increase the likelihood of an epidemic
XYZ Center Survey on the Flu Vaccine Shortage

This survey is ANONYMOUS and CONFIDENTIAL

Your participation in this research is voluntary. If you agree to take part, please fill out the survey below. If you have any questions, you may call Sofia Villas-Boas at (tel). If you have questions about your rights as a participant in this research project, you can call the University Committee for the Protection of Human Subjects at (tel). Thank you for your cooperation.

Date: 11/1/2004   Time of day: 

Your affiliation (check one):

U Faculty, emeritus       Department:       
U Staff                   Department:       or Campus service:       
U Grad student            Department:       
U Undergrad               Major:       If undeclared, College:       
U Spouse                  Community       Zip code:       

Your age:       

Gender:       Male       Female       

Were you at City Name or in the community in the Fall of:

2001 Y N  2002 Y N  2003 Y N

If not, please indicate which state you were in:

Did you get a flu shot in the Fall of:

2001 Y N  2002 Y N  2003 Y N

If yes, did you get it at XYZ Center:

2001 Y N  2002 Y N  2003 Y N

In which priority group are you? (Check Y/N to all)

Now Would you have been in this group last year?

65 or older       Y N       Y N
Will be pregnant during flu season       Y N       Y N
On chronic aspirin therapy       Y N       Y N
Health-care worker with direct patient care       Y N       Y N
Out of home care giver       Y N       Y N
With household contacts of children less than 6 months       Y N       Y N
2-64 with chronic medical condition       Y N       Y N

Specify which chronic condition

Check if Mild:   Severe:

If you did NOT receive a vaccination last year, why are you getting one this year? (Check Y/N to all)

I learned since last year about the importance of flu shots       Y N
The shortage helped me realize how important it is to be vaccinated       Y N
I am concerned that vaccines will no longer be available later in the season       Y N
I am concerned that the shortage may increase the likelihood of an epidemic       Y N

Your opinion about the current flu vaccine shortage and the selection process used (Answer all)

Do you believe that there should be stricter screening of flu shot recipients?       Y N

You may have reasons to get a flu shot now other than those officially recognized as priority. Please indicate what they are for you:

I have children at home       Y N
I had a bad case of flu last year       Y N
I cannot afford to be sick and lose days of work or study this year       Y N