COVID-19 VACCINE LOTTERY FIELD EXPERIMENT

Cassandra Pengelly | 20346212

Professor R. Burger

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1. Introduction

Coronavirus disease 2019 (COVID-19) has caused the largest public health crisis, and economic disaster of the 21st century so far (Kadkhoda, 2021: 471). According to the World Health Organisation (2021), COVID-19 has directly resulted in 4,859,277 deaths worldwide[1], and its impact on the global economy has been severe (World Bank, 2020). Policymakers are in urgent need of evidence-based strategies to contain the pandemic. As Fontanet & Cauchemez (2020: 583) report, one critical mechanism through which epidemics are controlled is herd immunity. Herd immunity arises when a sufficiently large proportion of the population achieves individual immunity to an infectious disease such that the transmission chain of the disease is halted (Kadkhoda, 2021: 471). One method of establishing herd immunity is through vaccination programs (Fontanet & Cauchemez, 2020: 583). Preliminary empirical evidence shows that infection detection and vaccination strategies could be critical tools in subduing COVID-19. For example the study by Aldila, Samiadji, Simorangkir, Khosnaw & Shahzad (2021) finds COVID-19 vaccines to be effective in Jakarta, Indonesia. Leaders of other countries have also implemented vaccine programs and the World Health Organisation (2021) reports that a total of 6,364,021,792 vaccine doses have been administered globally as of 10 October 2021.

In line with the international approach, South Africa has opted to issue vaccines in addition to social distancing and lockdown measures. The South African government has stated that it aims to have 67% of the population vaccinated by the end of 2021 (Department of Health, 2021a). However, many South Africans are hesitant to get the COVID-19 vaccine; the Department of Health (2021b) records that only 25% of South Africa's adult population has been fully vaccinated as of 11 October 2021. Burger, Maughan-Brown, Köhler, English & Tameris (2021) compiled a report, based on data from wave 5 of the NIDS-CRAM survey, and find that that around 20% of South Africans are concerned that COVID-19 vaccines are not safe. The report also shows that relatively few people in the sample registered to be vaccinated within two months after registration opened. Burger, Maughan-Brown, Köhler, English & Tameris (2021) conclude that a significant portion of South Africans still have to be convinced to take the vaccine[2]. While there are different ways to encourage vaccine uptake, such as mandatory vaccination or lump-sum transfers, insights from behaviourial economics could provide a more cost-effective solution: a vaccine lottery.

This essay[3] proposes a field experiment to investigate whether a vaccine lottery could improve vaccination rates in South Africa. The experiment explores the effect of three different lottery types - standard, regret and referral - on the take up of vaccines. This essay is structured as follows. Section 2 briefly reviews the relevant literature on behavioural economics and health incentives. Section 3

[1] As of 13 October 2021

[2] A sentiment report from Department of Health (2021c) shows an interesting break down of different communities' beliefs surrounding the vaccine

[3] This essay was written in R using the package Texevier by Katzke (2017)

elaborates on the South African context. Section 4 describes the design of the experiment and outlines the three types of treatment groups. Section 5 discusses how the treatment will be administered and how the data will be collected. Lastly, section 6 gives a pre-analysis plan of the empirical analysis that will be performed on the data, and the final section (7) concludes.

2. Behavioural Economics and Health Incentives

Health professionals and policymakers are increasingly turning to behavioural economics to understand how people make health decisions and how behavioural insights can be used to improve public health outcomes (Loewenstein, Asch, Friedman, Melichar & Volpp, 2012: 1). While neoclassical economics assumes that people are perfectly rational agents, behavioural economics relaxes this assumption and uses psychology and economic theory to create more realistic models of human decision-making (Rabin, 2002). As Khaneman and Tversky show, people are subject to certain biases and often make use of heuristics in their decision-making process, which can lead to predictable errors in judgment Kahneman & Tversky (1979). A large literature has developed in the field of behavioural economics to investigate how these biases can be combated and sub-optimal choices overcome to improve welfare. Thaler & Sunstein (2008) introduced the idea of a nudge[4] as a way to guide people to make better choices. For example, Thaler & Sunstein (2008: 176) proposed changing the default option for organ donation in America to opt-in as opposed to explicit consent. They found that many people who were willing to be organ donors did not take the necessary steps, and that the registration process appeared to deter otherwise willing donors. By changing the choice architecture to presumed consent (with an easy opt-out option), there would be more registered donors and more lives saved.

A similar type of nudge can be applied to flu vaccines. A study conducted by Chapman, Li, Colby & Yoon (2010) on a sample of 478 participants (split into two treatment groups of 239 each) found that vaccination rates increased by 36% under an opt-in default than under an opt-out condition. Madrian (2014: 9) proposes other interventions for promoting flu vaccination, such as moving the vaccination clinic to a central location for visibility purposes, reminding people more frequently to get vaccinated, and encouraging people to plan the time and location they will receive their flu vaccination. The last two nudges have been, to some extent, implemented in South Africa for the COVID-19 vaccine: the government has sent out SMS's encouraging South Africans to get vaccinated, and a self registration portal has been set up for citizens to enroll in the Electronic Vaccination Data System (EVDS) (Republic of South Africa, 2021). This portal can be seen as a type of commitment device, in addition to being a data collection mechanism.

Behavioural economic theory and empirical studies suggest that lotteries can be a useful device for

[4]Nudge: an intervention that alters behaviour towards a desired action. In order for an intervention to qualify as a nudge, it should be cheap and easy to avoid (Thaler & Sunstein, 2008).

public health interventions. A lottery system can be a cost-effective mechanism for changing behaviour compared to direct transfers because people tend to overweight small probabilities, which is a key insight from the work by Kahneman & Tversky (1979: 286) on prospect theory. Due to this nonlinear probability weighting, an individual overestimates her chances of winning a lottery. Björkman Nyqvist, Corno, Walque & Svensson (2018) ran an experiment in Lesotho, where participants were entered into a financial lottery and they could win a cash prize if they tested negative for sexually transmitted infections. In spite of the fact that the lottery had low expected payments, HIV incidence decreased by 21.4% over two years as a result of the intervention. Björkman Nyqvist, Corno, Walque & Svensson (2018) found that the lottery incentive worked particularly well at targeting participants who were more prone to risky sexual behaviour. This supports the theory that risk-seeking individuals value lotteries more. In a related study, Björkman Nyqvist, Corno, Walque & Svensson (2018) investigated the impact of a lottery intervention on the health choices of men living with HIV in South Africa. The paper found that the participants who were eligible for the lottery started antiretroviral therapy sooner than those in the control group (Björkman Nyqvist, Corno, Walque & Svensson, 2018: 49). This provides some indication that a vaccine lottery in South Africa could potentially be effective.

Drawing further on prospect theory, the concepts of loss aversion, reference dependence and regret avoidance can also be included in health interventions through a "regret lottery". Kahneman & Tversky (1979) describe loss aversion as a cognitive bias whereby people experience losses as more painful than the pleasure they receive from an equivalent gain. Thus, people are more willing to take on risk in order to avoid a loss, and are less risk seeking when pursuing gain (Kahneman & Tversky, 1979: 268). Reference dependence follows on from loss aversion and suggests that people define gains and losses relative to a reference point (Tversky & Kahneman, 1991: 1039). People are also subject to regret avoidance; where there is a significant emotional cost attached to regret and thus people will make decisions to avoid regretting alternative decisions in the future (Bailey & Kinerson, 2005).

A regret lottery takes advantage of these three principles by entering all participants into a lottery but the winner can only claim the prize contingent on some condition. If this condition is not met, a new winner is selected. By entering all participants, people's reference point is shifted to "I have a chance at winning the lottery". However, if a person is not eligible to claim the prize because he does not meet the required condition, he feels he is losing the chance to claim the prize. He is more likely to try and meet the condition in order to minimise the pain of this loss. Additionally, he will want to avoid the regret that would come from having missed the opportunity to claim the prize.

Several empirical papers investigate how "regret lotteries" can improve health behaviours. Humphrey, Small, Jensen, Volpp, Asch, Zhu & Troxel (2019) analysed the effect of a daily regret lottery on cholesterol-lowering, and heart medication adherence. Every day, members of the treatment group chose a two-digit number. If a participant's number matched at least one digit of the randomly drawn lottery number, she was eligible to win a cash prize. However, she could only claim her winnings if she had taken her relevant prescribed medication the previous day. The results of the paper show that the

treatment group better adhered to their medication regime than the control group. The authors also noted that participants appeared to be engaged even after 6 months of the program. In a different study, Husain, Diaz, Schwartz, Parsons, Burg, Davidson & Kronish (2019) found that implementing a weekly electronic regret lottery increased adherence to a self-monitoring study protocol.

Some states in America have attempted to run regret lotteries to encourage people to get vaccinated against COVID-19. An unpublished paper by Gandhi, Milkman, Ellis, Graci, Gromet, Mobarak, Buttenheim, Duckworth, Pope, Stanford, Thaler & Volpp (2021) evaluates the effect of weekly regret lotteries in Philadelphia. After giving away around $400,000 in cash prizes to residents, the authors did not find convincing evidence that the regret lotteries significantly increased first-dose vaccination rates for the treatment groups. Although, the authors do acknowledge that there were some design flaws in the experiment that could be clouding the results (Gandhi, Milkman, Ellis, Graci, Gromet, Mobarak, Buttenheim, Duckworth, Pope, Stanford, Thaler & Volpp, 2021: 3). Similarly disappointing results were found in Ohio, where randomly selected vaccine recipients could receive up to $1 million. The study by Walkey, Law & Bosch (2021) found no increase in COVID-19 vaccination rates following the lottery incentive. To the best of my knowledge, there have been no studies on COVID-19 vaccine lotteries in South Africa[5] - a gap which this experiment is intended to fill. This experiment would also contribute to the empirical literature on lotteries as public health interventions and the integration of behavioural economics into public policy.

3. The South African Context

National Lotteries Commission (2019) investigated the lottery habits and attitudes of South Africans based on a sample of 3,090 households randomly distributed across the country. The integrated report shows that around 35% participated in lottery activities in the year preceding the study (National Lotteries Commission, 2019: 78–79). This suggests that a significant amount of South Africans engage in lotteries, which supports the implementation of a vaccine lottery, as there is evidence of "demand" for lotteries. The average amount spent on lottery activities was R156 per month, whereas the average monthly winnings of lottery schemes was R110. A rational economic agent would recognize that the expected value for playing lotteries is negative (−R46) and not buy lottery tickets. The fact that people still play the lotto despite a negative expected value suggests that South Africans may not be rational, and behavioural economic insights are applicable. The gross revenue from gambling activities, excluding the National Lottery, amounted to R32.7 billion for the 2019 financial year (National Gambling Board, 2020: 3). This represents 0.64% of South Africa's 2019 nominal GDP (R5.1 trillion) (Statistics South Africa, 2020: 8), which suggests that gambling is a lucrative market in South Africa and a lotto device could be an appropriate tool for incentivising behaviour.

[5]It should be noted, however, that First National Bank is running a COVID-19 vaccine lottery for FNB customers, with total cash prizes amounting to R18 million

There vaccines which have been approved by the South African Health Products Regulatory Authority (2021) for use in South Africa include: Johnson & Johnson (J&J), Pfizer and AstraZeneca. COVID-19 vaccines are available free of charge, but citizens have to register on the EVID portal before receiving their dose. Due to supply constraints, vaccines were rolled out in phases and are currently available to individuals over the age of 18 only. The J&J vaccine only requires 1 dose; the Pfizer and AstraZeneca vaccines require two doses each. For this experiment, *fully vaccinated* refers to an individual who has had the maximum required doses of any vaccine. *Vaccinated* refers to an individual who has had 1 shot of any vaccine. According to Department of Health (2021b), 34% of South Africans are vaccinated, while only 25% are fully vaccinated. These low numbers indicate that an intervention is necessary to improve vaccination rates if South Africa wants to achieve herd immunity. Table 3.1 below gives the breakdown of vaccination rates by province.

Province	Total Adults Vaccinated	Adult Population	Percentage Vaccinated
Eastern Cape	1 603 045	4 099 543	39%
Free State	735 696	1 914 521	38%
Gauteng	3 523 373	11 311 326	31%
KwaZulu-Natal	2 170 526	7 219 795	30%
Limpopo	1 437 846	3 695 801	39%
Mpumalanga	831 759	3 039 520	27%
North West	835 206	2 693 247	31%
Northern Cape	290 962	847 545	34%
Western Cape	2 141 933	4 976 903	43%
Total	13 570 346	39 798 201	34%

Table 3.1: Vaccination Statistics

4. Experiment Design

4.1. Sample

The sample used will be the same sample used for the Coronavirus Rapid Mobile Survey (NIDS-CRAM). NIDS-CRAM was created in response to the pandemic as a way to build a representative data set of the South African population to inform decision-making (Ingle, 2021). Thus far, there have been five waves of NIDS-CRAM surveys, with wave 5 comprising a sample of 5,862 people being surveyed during 6 April to 11 May 2021 (Ingle, 2021: 14). Wave 3 consisted of a total of 8,157 potential participants, of which 6,130 were successfully interviewed. For the purposes of this field experiment, the 8,157 people from Wave 3 will be contacted and asked to participate in the experiment. It seems

reasonable to expect between 5,500 and 6,200 people to participate, given the previous rates of attrition experienced in NIDS-CRAM.

If we assume a conservative sample size of 5,500 and a vaccination proportion of 34%, then there will be 3630 eligible participants for the study, since we are interested in unvaccinated individuals. This sample will be split into 4 groups of equal size (907), and randomized according to technique proposed by Duflo, Glennerster & Kremer (2007). One group is the control group, where individuals will not be entered into any vaccine lottery. The other 3 groups are will receive different lottery treatments, which are explained below (4.2). There will be 3 monthly lotteries for each treatment group, which will run simultaneously. Thus, in total there will be 9 lotteries for this field experiment, with 3 lotteries every month. Each lottery winner will receive a cash prize of R1,000,000.

4.2. Treatment Groups

For the first treatment group (group 1), if an individual has received a vaccination shot within a given month, she will be entered into that month's vaccine lottery. At the end of the month, a winner is randomly selected from the lottery pool. Once it is verified that the winner has been vaccinated, she will be privately contacted and will receive a cash prize. The second lottery is a regret lottery. Every individual in the sample (group 2) is entered into a monthly lottery but an individual may only claim her prize if she has been vaccinated (i.e. had at least 1 shot of any vaccine). At month end, a winner is randomly drawn from the lottery pool. If the winner has been vaccinated, she will be privately notified and will receive a cash prize. If the winner has not been vaccinated, she will receive a "regret" message stating that she would have won the cash prize if she had been vaccinated.

The final treatment is a "referral lottery". An individual is entered into the monthly lottery if 2 conditions are met: he is vaccinated, and he refers a friend to get vaccinated and the friend gets vaccinated. Both the individual from the sample and his friend are entered into the lottery. At the end of the month, a winner is selected, and once he and his referral partner are verified to be vaccinated, he will be privately informed. An individual can refer more than friend to be vaccinated in any given month. However, only individuals from the treatment group can refer friends (i.e. people outside of group 3 will not be entered into the lottery for referring others to get vaccinated). Group 3 participants may not refer any person in the control group or in group 1 or group 2 (to avoid contamination).

Whenever a lottery is won, it will be announced via SMS to all participants in the relevant treatment group. The amount of the lottery prize and the winner's province will also be included in the SMS. This serves as a reminder of how large the cash prize is, and including the winner's province makes winning seem more tangible/possible. Group 2's SMS will include a reminder that only vaccinated individuals are eligible to win the lottery. Group 3's SMS will include a reminder that participants can refer as many friends as they like to be eligible for the following month's lottery. All SMS's will end

with: "Thank you for vaccinating and keeping our country safe!" as one final nudge to encourage/guilt participants to vaccinate.

Table 4.1 summarises the different treatments administered.

Group	Treatment
Control	No lottery
Group 1	Individual is entered into a lottery once they are vaccinated
Group 2	Everyone in the group is entered into a lottery; only vaccinated individuals can claim the prize
Group 3	Individual is entered if she is vaccinated and refers a friend, who gets vaccinated

Table 4.1: Treatment Summary

4.3. Theory of Change

Target Group The lucky draw is anticipated to attract people who are risk-on (they enjoy gambling, and are less worried about getting vaccinated), and poorer individuals for whom winning money is more attractive. These target groups are desirable as they are less likely to get the vaccine, and the government would like to maximise the number of vaccinated people. Additionally, if there are individuals who want to be vaccinated but procrastinate getting the vaccine (e.g. naïve hyperbolic discounters), setting a deadline for the lucky draw could increase the utility of getting the vaccine earlier enough to overcome the procrastination problem. There is no downside or extra cost for having people enter the lucky draw who would otherwise still have got the vaccine. It is reasonable to assume that the introduction of a lottery would not deter someone from

5. Treatment and Data

The two main partner institutions for this field experiment would be the South African government – the Department of Health in particular – and the CRAM team and partners[6]. Vaccine data is collected by health professionals at pharmacies, clinics and other vaccination sites around South Africa. Currently, the EVDS captures a vaccinee's names, Identity Number, medical aid details, residential address, email address, phone numbers, employment details, professional category, and health status. The only additional information needed for the experiment is the name, ID number,

[6]The CRAM project is supported by the Department of Planning Monitoring and Evaluation (DPME), the Research on Socioeconomic Policy (RESEP) group at Stellenbosch University, and the Southern Africa Labour and Development Research Unit (SALDRU) at UCT.

and phone number of the referring individual (from treatment group 3). The person receiving the vaccine is responsible for supplying these details to the vaccine administrator. An SMS will be sent to the friend getting vaccinated and the referring individual, both of whom will be asked to confirm that the details of the referring participant are correct. The name of the data collection agent at the vaccine site is also recorded. If the friend (the non-referring individual) wins the lottery, the person who captured the vaccine details will receive R10,000. This should act as an incentive for healthcare workers to correctly capture the referral details.

The other

Funding for the experiment would need to cover: R9,000,000 for the cash prizes, the admin fees associated with the SMS program and R90,000 in incentive fees for the personnel who captured the lottery winners' vaccine information. It is assumed that

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- an explanation of how the treatments will be administered and data gathered (including proposed partner institutions);

The CRAM survey exists to provide monthly nationally-representative data on topics such as unemployment, household income, child hunger and access to government grants.

funding

Partner with NIDS, department of health, vaccine administer, funding data collected at vaccine add 3 questions to NIDS data cram

6. Pre-analysis plan

- a pre-analysis plan of the empirical analysis that will be performed on the data.

https://jamanetwork.com/journals/jama/fullarticle/2781792 - method for analysis

Data Collection There is a data collection system already set up at the vaccination sites so this extra data point would not be difficult to collect within the current tracking system. Depending on costs, the referral friend could be sent an SMS thanking her for caring about others and getting them vaccinated, and letting her know that she has been entered into the draw. This is a positive reinforcement technique and shows people that the government is following up on their promise. This acknowledgement and transparency is expected to encourage more referrals. Once the lucky draw has been concluded, the data can be analysed, the purpose of which is to uncover whether the nudge

increased vaccinations.

7. Conclusion

If the experiment results provide enough evidence that a vaccine lottery is effective, the EVDS nudge is to rollout to whole country and possible

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