

Expert Meeting on Traditional and Non-Traditional Sampling Methods for Population Aging Research on Small Populations

The National Academies of Sciences, Engineering, and Medicine
Committee on National Statistics

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Web Conference

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Meeting Summary

Introduction

In its 2019 review of the National Institute on Aging (NIA) Division of Behavioral and Social Research (BSR), the National Advisory Council on Aging (NACA) strongly recommended that BSR increase and improve research on health disparities in aging.¹ BSR could improve the representativeness of the data in the national surveys it sponsors by adding disparity group oversamples and small, local samples via existing or new studies. These additions would not only support analytical efforts to document disparities, but also create a data infrastructure that sheds light on mechanisms throughout the life course that produce or prevent health disparities.

The BSR data infrastructure seeks representation of diverse populations in numbers adequate for statistically powered studies of within- and between-group variation at multiple levels of analysis and across the life course. The current NIA portfolio already includes several nationally representative surveys that use area-based probability sampling methods to recruit minority groups (e.g., Hispanics, African Americans). However, this type of sampling is not ideal for recruiting small, targeted populations (e.g., Asian American and Hispanic subgroups, sexual and gender minorities, socioeconomic status [SES] subgroups, geographical subgroups, or older contingent workforce members).

The NIA therefore commissioned the Committee on National Statistics (CNSTAT) to convene an Expert Meeting to consider alternative sampling methods to address the challenges of studying small, targeted populations. The meeting was held via web conference on May 6, 2020, in conjunction with CNSTAT's spring annual meeting. Invited experts presented on methods for surveying small, hard-to-reach populations; respondent-driven sampling; and coordinated screening and recruitment methods for small and hard-to-reach populations. The Expert Meeting identified a broader set of methodological implications that can guide future endeavors. The meeting agenda and list of participants are included as Appendices 1 and 2.

Methods for Surveying Small and Hard-to-Reach Populations Among the Elderly

Sunghee Lee, University of Michigan

Surveys aim to characterize a target population. The study team begins by developing a sampling frame, which is a pool of individuals that covers the entire or close to the entire target population. From this sampling frame, the study team samples individuals. If the frame includes the general population and the target population is a subgroup of the general population, the study team then screens individuals for eligibility, and if eligible, seeks to persuade them

¹ See the 2019 BSR Review Committee report on the [NIA website](#).

through materials or incentives to participate in the survey. If individuals agree and do respond, they become respondents.

Various characteristics of populations can complicate each stage of this process. For example, a population is hard to:

- *sample*, if researchers cannot build a frame that adequately captures the target population (e.g., if they cannot target people with a rare cancer without screening all people diagnosed with cancer)
- *identify*, if members of a population wish to remain anonymous (e.g., persons who inject drugs [PWID], men who have sex with men [MSM])
- *reach*, if members are busy or transient (e.g., homeless persons)
- *persuade*, if members do not wish to participate in research activities for a variety of reasons (e.g., lack of trust in researchers)
- *interview*, if members cannot fully respond (e.g., poor English comprehension, cognitive disabilities)

Sampling methods alone cannot address these challenges. They must be supplemented by a thorough analysis of the total survey conditions, including the unique barriers to surveying a target population (e.g., lifestyles), but also the unique tools that facilitate access to that population—such as external data (e.g., commercial data), social networks, social behaviors, and technological advances. Through *formative research*, researchers can define a target population, understand the factors that drive its members' behavior, and determine the facilitators that best help to reach them.

Formative research can be executed as a systematic methodology, but in practice it does not follow a standard set of formulaic procedures; it combines various methods, including ethnographic approaches, researcher judgment, quantitative and qualitative data collection and analysis, and use of informants and field observations. Formative research is subject to two main kinds of error: (1) inadequate coverage and sampling of the target population perspective during informant selection and (2) measurement error stemming from inaccurate ethnographic reports, biased focus group responses, and other factors. The recent literature describes three different sampling methods that leverage facilitators of access to specific target populations: venue-based sampling, time-location sampling, and web-based sampling.

Venue-Based Sampling

Venue-based sampling—also called facility-based, community-based, or community venue sampling—leverages the gathering behaviors of a population at a specific virtual or physical venue. An exit poll is a classic example of a venue-based sample. This sampling method counts the number of visits to a venue and not individual visitors (i.e., visitors may be counted multiple times if they visit more than once during the sampling period). During the first stage of the process, researchers select venues with characteristics similar to those of the primary sampling unit. In the second stage, individual visits are selected from the sampled venues. Depending on the implementation, venue-based sampling has potential to yield probability sampling. For

example, in the first stage, if the researchers have an exhaustive list of venues the target group visits and ascertains the number of visits to all venues, they can sample venues using the *probability proportional to size* method (PPS) (i.e., they ensure that the probability of a visit to a selected venue matches the proportional size of that venue within the larger sampling unit). In the second stage, researchers then collect visit data through systematic on-site sampling. However, if the implementation deviates from these conditions, venue-based sampling turns into nonprobability sampling.

Successful venue-based sampling assumes that the formative research performed is high-quality, the venues are accessible to the researchers and target population, and all population members visit the venues in a similar pattern across the venues. Under the assumption of meeting probability sampling as noted above, researchers can weight a venue-based sample to create a probability sample, based on the PPS method and to account for under- or over-coverage of venue visit patterns. Three examples presented by Lee (in studies on maternal mortality, Korean and Chinese immigrants, and HIV-positive smokers) illustrate different levels of effort to achieve this goal.

Time-Location Sampling

As an extension of venue-based sampling, the time-location method presumes that the intensity of visits to a venue differs across the day or week and thus samples visits to venues over a specified range of times (i.e., to capture flow of populations). To perform time-location sampling, researchers conduct formative research on the time and locations of visits by the target population to various venues; then, based on their findings, they perform multi-stage sampling. During the first stage, researchers consider target group's visit patterns, identify combinations of location and time of target groups' visit patterns and sample from the combination. Just like the venue-based sampling, this process has the potential to draw a PPS sample. During the second stage, researchers visit the locations during those selected times and sample visits. This may use systematic sampling. Lee presented a time-location survey of MSM in a national HIV-positive behavioral surveillance survey to illustrate one approach to determining location and timeslots as well as to weighting responses based on individuals' visitation patterns.

Web-Based Sampling

Web-based sampling concentrates on data collection over the Internet. This sampling became popular because certain small populations (e.g., MSM) began to utilize websites and mobile phone apps as virtual venues of communication and gathering. No standardized method for conducting web-based sampling exists. The most convenient recruiting platforms are email blasts, chat rooms, instant messenger services, banner ads, and social media. Therefore, most of these samples are convenience samples, not probability-based samples. Lee described a web-based sampling of MSM from the San Francisco area that demonstrated various methods of recruitment and their comparative success at reaching the target population.

Choosing a Sampling Method

Researchers have not settled on standard definitions of any of these sampling methods. The actual methods implemented under each of venue-based sampling, time-location sampling and web-based sampling vary widely in their depths and breadths of formative research and potential representation properties. However, each of them has the potential to generate probability samples. Researchers must make sampling decisions based on a careful assessment of both the target population (e.g., barriers to surveying) and non-sampling aspects of the survey (e.g., interview mode, recruitment materials). As new communications and other technologies emerge, researchers will likely identify new sampling methods.

Discussion

Researchers face sampling challenges related to the COVID-19 stay-at-home orders. The methods described above, particularly venue-based sampling, assume that a target population is visiting a physical location, which under quarantine is no longer true. To combat this challenge, the Health and Retirement Study (HRS) has shifted with some success to conducting more telephone interviews. Further, unpublished research suggests that HRS's experimentation with web-based surveys since 2018 has yielded higher response rates than phone-based or in-person interviews.

The success of technology-based sampling varies by population. For instance, Lee's analysis of the American Community Survey found that some minority elderly populations have higher Internet access rates than non-minority elderly populations (93.3% for Chinese, 93.1% for Korean, and 89.8% for non-Hispanic whites). To access populations that cannot be reached via the Internet, studies can use non-probability sampling, which leverages community member lists, referrals, or venue-based non-probability sampling from churches or community centers.

A participant cautioned that venue-based sampling can encounter weighting challenges, even when following a probability sampling scheme, specifically with estimating how often a given individual in a target population is likely to visit the chosen venue during the sampling period. This type of sampling measures visits rather than visitors, but to arrive at a probability sample of a population, inferences about the visitors (e.g., number and frequency of visits) and a resulting weighting model are necessary. Researchers could theoretically create research questions to enable these inferences, but most venue-based sampling currently does not tackle this challenge.

Respondent-Driven Sampling – Strengths, Weaknesses, and Current Research

Krista J. Gile, University of Massachusetts, Amherst

Respondent-driven sampling (RDS) is often used for hard-to-sample, well-networked, high-risk populations (e.g., HIV-positive individuals, MSM, PWID). Traditional survey sampling does not work in these "hidden" populations, because it is difficult to define a sampling frame and to collect a probability sample with plausible weights. Instead, researchers rely on small

convenience samples of the population that leverage an existing social network of relationships—a method known as link-tracing sampling.

RDS is one form of link-tracing sampling that aims to approximate probability sampling. RDS begins with a small set of respondents, or seeds. These seeds receive a small number of uniquely identified coupons that they share with a first wave of contacts who are members of the target population. This first wave of contacts receives its own coupons to distribute to a second wave of contacts, and so on until a sufficient sample is reached. RDS has proven effective in obtaining large, varied samples and has been implemented in more than 30 countries, typically among sensitive, high-risk groups (e.g., people at risk for HIV).

Making Inferences about a Respondent-Driven Sample

In practice, RDS is a challenging sampling technique, because it leaves much outside of the researcher's control. Its sampling is driven by survey respondents; respondent trees are branching (although the degree of branching can be limited by using a small number of coupons), have a non-regular number of connections to each other, and exist in a population with unclear overall dimensions. All of these factors make it difficult to predict the probability that a particular respondent will be selected and thus to make inferences about the resulting sample.

One way to manage this difficulty is a *random walk model approximation*. Researchers approximate the population structure as a graph representing individuals, or nodes, in the target population, with the assumption that every individual is connected to at least one other individual in the population, and reachable from every other individual. Each step of recruitment and subsequent sampling is approximated as a step in this random walk. Moving to a node connected to the active node, selected at random. The sequence of moves across nodes in this random walk can be thought of as a mathematical *Markov chain*: a randomly determined sequence of possible events in which the possibility of any event occurring (i.e., an individual being selected for participation) depends on previous events (i.e., whether and how they are connected to an individual chosen during the previous sampling round). A property of a Markov chain is that after many steps, the probability that the process lands on a particular unit (here, a node or individual) does not depend on where the process started. In the case of the random walk model, the probability of landing on any given unit is proportional to the *degree* of the node—that is, the number of connections that node has to other nodes in the community.

Researchers must make three key assumptions for a respondent-driven sample to be consistent with a random walk model. First, they must assume that the network size is significantly larger than the sample size; such a large ratio brings RDS closer to a true random walk. Second, they must assume that seed dependence can be overcome as subsequent waves move further away from the initial convenience sample, both in distance and in degree of similarity, which depends on having a well-connected network. Third, they must assume that probabilities of selection can in fact be measured through reported degrees of connection. This assumption holds only if all social connections are reciprocated, degree of connection is accurately reported by survey participants, and referrals through connections are made at random. With these assumptions in

place, researchers can use a variety of methods to make inferences about the population. Most inferential methods focus on estimating population proportions, although methods for estimation population sizes, multivariate patterns, and network properties have also been considered (and in some cases require additional considerations when setting up a study).

Applying RDS Models to Older Populations

RDS has proven effective in collecting data on many hard-to-reach populations. However, because the sampling and therefore inferential validity of RDS depends on features of the target population, researchers must ensure that the characteristics of the population of interest are amenable to that activity. Researchers working on older populations must ask whether their target population has the following specific characteristics:

- Is the population sufficiently connected to mix well and recruit enough respondents?
- Are there critical bottlenecks or disconnected subpopulations that would prevent recruitment from continuing across the full population of interest?
- Is there a survey modality that will work for the population—will they come to a study center or be reached by a web-based survey?
- Will the population be motivated by survey incentives?
- Will population members be willing to recruit their contacts into the study?
- Can the method move sufficiently beyond the initial convenience sample to overcome the biases inherent in that sample?

If these considerations can be addressed, then the robustness of RDS may be leveraged to sample populations of older adults.

Discussion

Neutralizing Social Isolation

One challenging aspect of surveying older populations is social isolation, which may reduce the size of social networks. However, RDS does not require an individual to have numerous social connections; instead, it requires that any single connection be strong enough to enable access to individuals. Entirely isolated individuals will not be reached through an RDS approach.

Researchers could mitigate the challenges posed by social isolation by expanding a sample to include family members of older adults, but this solution increases costs. Alternatively, researchers could ask individuals outside of the target population to identify contacts to continue the chain. Under this approach, researchers do not waste survey resources on non-targeted individuals but can use those individuals to sustain their identification of respondents. However, no methods currently exist to estimate sampling probabilities in this setting.

Preventing Premature Chain Endings

Researchers who utilize RDS should plan for preventing premature ending of a chain. Not all RDS respondents will reliably recruit new contacts; in fact, studies have shown that only about one-third of the recruitment coupons are actually used. Researchers should thus provide respondents with at least three coupons to ensure their movement beyond the original

convenience sample to more distant waves. Further, when selecting a sampling *method*, they should consider whether the target population will be incentivized to perform the steps needed within that method to continue the recruitment waves. In many populations, a formal incentive is important. Other factors that encourage successful recruitment are community buy-in and an understanding by community members that the study is in the community's best interest.

Overcoming Wave Biases

Biases can arise from irregularities in the sampling process. For example, one study of undergraduates at a large university resulted in the overrepresentation of men and engineering students. Researchers determined that the online survey, which was distributed overnight via email, was shared more quickly by male and engineering students, who were most likely to be at their computers late at night. In another example, young Ugandan male villagers were underrepresented in a study of heads of household. These men did not share the researchers' definition of a head of household, so they did not self-report. These examples illustrate the challenges associated with RDS approaches. Researchers should account for differential motivation to participate, the attractiveness of the survey, and interpretation of survey terminology to counteract some of these problems.

Some debate persists among researchers about the utility of using degrees of connection within the social network to create sampling weights. If degrees of connection are not related to the population status of interest (e.g., HIV infection), then applying degree-based weighting makes no statistical difference to the expected bias of point estimates. However, if degrees of connection *are* related to the status of interest, then participants have a "differential tendency" that must be measured and weighted. Although noisy, degree weights and variants on them are the only established practice to address this differential tendency. Much of the research in this area has not focused on subpopulations of older adults.

Along with having a large population and sampling multiple waves, obtaining original seeds through a probability sample can mitigate some sampling challenges. Beginning with a probability sample allows researchers to avoid the biases inherent in an initial convenience sample, but it does not eliminate seed dependence. One school of thought to reduce the effects of this dependence is to wash out the data from the first few waves of sampling. However, in doing so, researchers may drop large portions of the sample and even entire sample trees, biasing the data in a new direction.

Coordinated Screening and Recruitment Methods for Small and Hard-to-Reach Populations

Colm O'Muircheartaigh, University of Chicago

To date, discussions of technical dimensions of probability sampling have generally unfolded separately from social science research on specific hard-to-reach populations. Yet combining the technical and population perspectives can help researchers in both areas to improve outcomes. Finding ways to work across data sets, for example, can offer both a technical improvement and a great practical benefit at the population level. The feasibility of this

approach for older populations is particularly promising, because these populations develop stronger and more stable traces in databases and on the Internet.

One successful collaboration comes from a 2003-2004 effort by the National Social Life, Health, and Aging Project (NSHAP) to work with the Health and Retirement Study (HRS). At that time, NSHAP was targeting individuals ages 55-84 for its first cohort, and HRS was targeting individuals ages 50-56 for a new cohort. Realizing that the costs to screen a national sample are high, the NSHAP team approached the HRS team about sharing the costs to co-screen individuals for the two cohorts. Researchers negotiated how the two studies could co-recruit, coordinate data transfer, and reduce survey burden. For example, NSHAP redefined its target population as ages 57-84 to avoid overlap with the HRS population. Although challenging, this effort was successful. The teams halved their screening costs and successfully enrolled patients in both studies. This success illustrates the benefits that multiple studies targeting small populations (e.g., LGBT individuals, individuals with rare diseases) can realize when teaming their resources.

Despite its promise, few collaborations of this sort have occurred, largely because of the number of inherent considerations that must be addressed. Researchers must consider the target population size relative to the total population, distribution of the target population, ease of identifying the target population (i.e., amount of required screening, complexity and sensitivity of identification), ideal screening mode, and cost of identification.

Another collaborative approach involves blending samples. Some targeted sampling methods use vague population definitions, which undermines the ability to draw inferences about a population from the sample. However, researchers can blend samples to best cover the target population. To do so, researchers must be able to calculate the joint probability of selecting a single element (i.e., the probability of selecting a single element across two or more frames), which increases sampling precision. Although blending requires a common base for all samples included, it results in a properly screened national probability sample for multiple studies. In fact, creating such a sample for a single small, hard-to-reach population seems wasteful by comparison.

To successfully coordinate screening for multiple studies, researchers must consider various parameters, such as overlap of the target populations of the distinct studies (e.g., both studies including individuals ages 55-56). Other considerations include stability of the screening information over time, the sensitivity of the screening to identify the target populations, reports completed by proxy, portability of databases across organizations and funders, mode dependency of screening types, and data collection synergies. This list is an initial collection of parameters for consideration, and others will arise as collaborations become more commonplace among studies of small, hard-to-reach populations.

Discussion

The concept of survey collaboration is not unique to social science research. In the past, marketing researchers have leveraged multi-purpose surveys of households. However, concerns about timing and populations complicate overlap in social surveys. Collaborations

should occur at the screening level, with different modes of data collection occurring on different schedules once the population has been identified and interested parties have enrolled. Successful collaboration depends on how well the mode of contact maintains interaction with the survey population over time. For example, in its collaboration with HRS, NSHAP reported a 75 percent response rate to measures performed 6-8 months after the initial screening—only 1 percent different from a later cohort that only the NSHAP team recruited.

Researchers can also leverage commercial data to aid screening efforts. Although commercial data is improving, its quality varies enormously depending on the characteristics of interest to researchers. For example, the ability to identify racial subgroups in commercial data is easy, but the ability to identify ethnic subgroups varies by data source. Older populations are typically better represented in commercial data because their tracing history has accumulated over longer periods of time. In these older populations, specificity and coverage of data points are increasing, such as for income class and property ownership.

Wrap-up and Final Discussion of Traditional and Non-Traditional Sampling Methods for Population Aging Research on Small Populations

Moderator: Graham Kalton, Westat

Kalton presented an overarching schema of the challenges and solutions involved in conducting research on special populations, such as older adults, which highlighted the need to clearly define six key dimensions: (1) target population characteristics, (2) data collection methods, (3) study aims, (4) sample framing, (5) screening and identification methods, and (6) existing resources that can be leveraged.

Researchers can use probability and non-probability sampling methods to help address the challenges of screening and identifying survey participants. The simplest way to create a *probability* sample is to construct a sampling frame that contains mostly target population members and a high proportion of them (for example, through administrative records). If such a frame is not available, additional methods include:

- using multiple frames that complement each other's strengths and limitations
- screening a large sample to find members of the small population
- using disproportionate stratification to reduce the amount of screening needed to identify special population members
- using two-phase sampling to build a pool of candidate special population members
- using a multipurpose survey for screening

All of these methods entail a variety of logistical challenges, including the expense of large-scale sampling, the potential for low response rates at the screening or main data collection stages, and the challenge of ensuring coverage both when constructing a sampling frame and when identifying members within it who qualify for the study.

Non-probability sampling methods—including venue-based, respondent-driven, and internet sampling—offer an alternative approach to studying special populations. However, because these methods do not allow the researcher to predict the probability of selecting a respondent, they require assumptions about the sample characteristics. To use these methods, researchers must therefore generate an account of precisely how survey results can be used to create descriptive, analytic, and size estimates.

Participants collectively discussed several questions about how to apply these techniques to older populations.

Defining Populations of Interest to NIA

Georgeanne Patmios explained that NIA has not pre-identified specific subpopulations of older adults to reach. NIA leadership may seek further consultation with interested parties (e.g., researchers, funding partners) to identify small populations of interest. Patmios suggested that a grid of subpopulations of interest, with information addressing the dimensions mapped in Kalton’s presentation, could help in analyzing how to move forward.

Leveraging Resources to Sample Subpopulations

Participants discussed whether subpopulations could be captured by add-ons to existing surveys or whether each population would require its own study design, with the understanding that sampling methods may depend on the context and aims of the studies in question. Given the constraints of funding and resources, it is not possible to conduct a separate representative study of each hard-to-reach population of interest. However, rare populations require screening of large populations to identify the target subpopulations. This challenge can be addressed in part through non-probability sampling (e.g., sampling based on last name to identify Korean Americans). Cooperative screening across studies can also address this challenge. O’Muircheartaigh noted that remote data collection creates the possibility of accumulating enough data to construct samples of small populations across multiple distinct studies.

Managing Practical Challenges

Participants discussed the uncertain size of many specific small populations and the impact that this uncertainty can have on inferences from data sets. For example, venue-based sampling assumes that a population is concentrated in a particular location; if that assumption is inaccurate, the study will fail to account for many population members who are more broadly distributed and will thus limit estimates of the overall population size. This limitation can affect studies of older populations, particularly during a health crisis such as the COVID-19 pandemic. A venue-based sample focused on nursing homes would produce a distorted estimate of the older population’s risk of death from the disease.

Other aspects of health care may affect samples of older populations, as well. For example, demographic information about nursing home residents can be somewhat challenging to obtain, complicating researchers’ ability to define nursing home residents as a sampling frame. In addition, physical or cognitive illness affecting older populations can make it difficult for

population members to participate fully in a survey, and caregivers may not always be able to provide the desired data.

Outside of health, urban and rural distinctions also affect the design of studies of older populations: the rural old are a non-trivial fraction of the rural population, while the urban old are a small fraction of the urban population. The subpopulations of interest to NIA will likely be distributed across both urban and rural areas.

Next Steps

Moving forward, NIA may explore subpopulations of greatest interest, because target population will dictate sampling techniques. Some populations may be identifiable through add-ons to existing NIA-funded surveys, while others will require new sampling methods. Determining the best approach to sampling these populations may ultimately require assessing whether misperceptions of key populations are embedded in existing surveys (e.g., MSM research designs are often based on HIV/AIDS findings, potentially conflating two non-identical populations). New population-level research may also be needed to ensure that populations are not misconstrued.

The expert meeting identified a broader set of methodological implications that can guide future endeavors. NIA will consider exploring ways to combine RDS and probability sampling methods, the different types of screening necessitated by distinct methodologies, opportunities for collaboration intramurally and extramurally to reduce sampling burden, approaches to leveraging informants to assess barriers and facilitators in small populations, and new technological advances that may make collaborations and sampling methods easier and more reliable.

Appendix 1.

Meeting Agenda

Expert Meeting for NIA

Traditional and Non-Traditional Sampling Methods for Population Aging Research on Small Populations

- 1:00 Welcome and Opening Remarks
- 1:00 Welcome, Brian Harris-Kojetin, Director of CNSTAT
 - 1:05 Welcome, Georgeanne Patmios, Population and Social Processes Branch, Division of Behavioral and Social Research, NIA
- 1:10 Methods for Surveying Small and Hard to Reach Populations Among the Elderly
- 1:10 Introduction by moderator, Sharon Lohr, Arizona State University
 - 1:15 Presentation by Dr. Sunghee Lee, University of Michigan
 - 1:45 Discussion
- 2:10 Break
- 2:30 Respondent-Driven Sampling – Strengths, Weaknesses, and Current Research
- 2:30 Introduction by moderator, Sarah Nusser, Iowa State University
 - 2:35 Presentation by Dr. Krista Gile, University of Massachusetts
 - 2:55 Discussion
- 3:15 Break
- 3:35 Coordinated Screening/Recruiting Methods for Small and Hard to Reach Populations
- 3:35 Introduction by moderator, Graham Kalton, Westat
 - 3:40 Presentation by Colm O’Muircheartaigh, University of Chicago
 - 3:55 Discussion
- 4:20 Wrap-up and Final Discussion of Traditional and Non-Traditional Sampling Methods for Population Aging Research on Small Populations. Moderator Graham Kalton, Westat
- 5:00 Adjourn

Appendix 2.

List of Participants

Presenters (*Planning Committee)

Krista J. Gile, University of Massachusetts

*Graham Kalton, Westat

Sunghee Lee, University of Michigan

*Sharon Lohr, Arizona State University

*Sarah Nusser, Iowa State University

*Colm O’Muircheartaigh, University of Chicago

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