

Supplemental Materials for “Analyzing Causal Mechanisms in Survey Experiments”

Avidit Acharya,^{*} Matthew Blackwell,[†] and Maya Sen[‡]

February 10, 2018

A Multilevel mediators

In this section, we generalize the discussion in the main text to allow for mediators with more than two levels. Now, the mediator can take values $m \in \mathcal{M}$, where there are $|\mathcal{M}| = J_m$ possible values $\{m_1, \dots, m_{J_m}\}$. The potential values of the outcome and the mediator remain similarly defined as above and the assumptions should be slightly modified to hold for all values $m \in \mathcal{M}$. We also extend the notation of the manipulation variable so that D_i takes on one of $J_m + 1$ values $\{d_*, d_1, \dots, d_{J_m}\}$. We assume that the ordering of these values of D_i are such that d_k corresponds to setting $M_i = m_k$ and d_* remains the natural-mediator arm. Finally, it is most intuitive to apply these methods to situations where there is an ordering to values of the mediator so that m_{J_m} refers to a “higher” value of the mediator than m_1 . With nominal mediators, it is often more useful to use a series of binary mediators.

All of the quantities of interest in the main text remain the same with this new mediator except for the reference interaction. For a given mediator level, m , the reference interaction at the individual

^{*}Assistant Professor of Political Science, Stanford University. email: avidit@stanford.edu, web: <http://www.stanford.edu/~avidit>.

[†]Assistant Professor of Government, Harvard University. email: mblackwell@gov.harvard.edu, web: <http://www.matblackwell.org>.

[‡]Associate Professor of Public Policy, Harvard University. email: maya_sen@hks.harvard.edu, web: <http://scholar.harvard.edu/msen>.

level becomes:

$$RI_i(t_a, t_b, m) = \sum_{\tilde{m} \in \mathcal{M} \setminus \{m\}} \mathbb{I}\{M_i(t_b) = \tilde{m}\} [CDE_i(t_a, t_b, \tilde{m}) - CDE_i(t_a, t_b, m)] \quad (1)$$

Taking averages, we get the the ARIE in this setting:

$$\begin{aligned} & \mathbb{E}[RI_i(t_a, t_b, m)] \\ &= \sum_{\tilde{m} \in \mathcal{M} \setminus \{m\}} \mathbb{E}[CDE_i(t_a, t_b, \tilde{m}) - CDE_i(t_a, t_b, m) | M_i(t_b) = \tilde{m}] \mathbb{P}[M_i(t_b) = \tilde{m}] \end{aligned} \quad (2)$$

This new reference interaction can be interpreted as the weighted average interaction for those units whose natural value of the mediator is not equal to m . As with the binary case, this quantity will be equal to zero when either (1) there is no treatment-mediator interaction for this particular CDE, or (2) there is zero probability of the natural value of the mediator under t_b being equal to anything other than m . Under perfect manipulation of the mediator, the decomposition in (8) remains valid with this updated definition of the reference interaction (VanderWeele, 2015, p. 606).

B Proof of imperfect manipulation decomposition

Here we develop the technical details of the imperfect manipulation with multileveled mediators. The binary mediator results will follow. First, we state a more general version of the monotonicity assumption:

1. Monotonicity (i): $M_i(d_1) \leq \dots \leq M_i(d_m)$
2. Monotonicity (ii): $M_i(t, d_*) = m_j \implies M_i(d_j) = m_j$

Here, we extend monotonicity to rule out situations where a respondent naturally believes mediator to take value m_j , but changes that belief when they are told it is that value ($D_i = d_j$). In a binary setting, the second two assumptions are equivalent to Assumption 3. Finally, there is a possibility of a indirect effect in the manipulated-mediator arms, so we define a more general natural indirect effect that can depend on the experimental arm: $NIE_i(t_a, t_b, d) = Y_i(t_a, M_i(t_a, d)) - Y_i(t_a, M_i(t_b, d))$.

We show the decomposition of the difference between the total effect and the controlled direct effect at the lowest level of the mediator, d_1/m_1 :

$$Y_i(t_a) - Y_i(t_b) - [Y_i(t_a, M_i(t_a, d_1)) - Y_i(t_b, M_i(t_a, d_1))] \quad (3)$$

By adding and subtracting $Y_i(t_a, M_i(t_b, d_*))$ and $Y_i(t_a, M_i(t_b, d_1))$, we can see that this is equivalent to:

$$\begin{aligned} NIE_i(t_a, t_b, d_*) - NIE_i(t_a, t_b, d_1) \\ + [Y_i(t_a, M_i(t_b, d_*)) - Y_i(t_b, M_i(t_b, d_*))] \\ - [Y_i(t_a, M_i(t_b, d_1)) - Y_i(t_b, M_i(t_b, d_1))] . \end{aligned} \quad (4)$$

For any respondents with $M_i(t_b, d_*) = M_i(t_b, d_1)$, the latter two terms of this expression will be equal to each other and so will cancel to 0. Furthermore, because of the above monotonicity assumptions, we know that $M_i(t_b, d_*) \geq M_i(t_b, d_1)$. With this in hand, we can rewrite the decomposition as:

$$\begin{aligned} NIE_i(t_a, t_b, d_*) - NIE_i(t_a, t_b, d_1) \\ + \sum_{j=1}^{J_m} \sum_{k=j+1}^{J_m} \mathbb{I}\{M_i(t_b, d_*) = m_k\} \mathbb{I}\{M_i(t_b, d_1) = m_j\} [CDE_i(t_a, t_b, m_k) - CDE_i(t_a, t_b, m_j)] \end{aligned} \quad (5)$$

Taking expectations of the second part of this expression, we are left with the following version of the imperfect manipulation reference interaction:

$$\begin{aligned} RI^*(t_a, t_b, d_1) = \sum_{j=1}^{J_m} \sum_{k=j+1}^{J_m} (\mathbb{E} [CDE_i(t_a, t_b, m_k) - CDE_i(t_a, t_b, m_j) | M_i(t_b, d_*) = m_k, M_i(t_b, d_1) = m_j] \\ \times \mathbb{P} [M_i(t_b, d_*) = m_k, M_i(t_b, d_1) = m_j]) \end{aligned} \quad (6)$$

Putting this all together, we are left with the following decomposition:

$$TE(t_a, t_b) - CDE^*(t_a, t_b, d_1) = NIE(t_a, t_b, d_*) - NIE(t_a, t_b, d_1) + RI^*(t_a, t_b, d_1) \quad (7)$$

The result given in the main text easily follows by restricting M_i to be binary and D_i to take on three possible values (with a slight adjustment to notation where d_1 here corresponds to d_0 in the binary

case given in the main text).

C Democratic Peace Survey Instrument

The survey was implemented in Qualtrics and broken down into the following question categories:

- Consent information
- Age screen
- Attention check
- Treatment/outcome
- Political questions
- Demographic questions
- Comment box

Below we give the main questions and text in the survey. For each binary choice in the treatment condition, each respondent was randomly assigned to either condition with probability 0.5.

1 Treatment

There is much concern these days about the spread of nuclear weapons. We are going to describe a situation the United States could face in the future. For scientific validity the situation is general, and is not about a specific country in the news today. Some parts of the description may strike you as important; other parts may seem unimportant.

Please read the details very carefully. After describing the situation, we will ask your opinion about a policy option.

Here is the situation:

- A country is developing nuclear weapons and will have its first nuclear bomb within six months. The country could then use its missiles to launch nuclear attacks against any country in the world.

- This country **[has/ does not have]** a military alliance with the United States.
- This country **[is a democracy and shows every sign that it will remain a democracy / is not a democracy and shows no sign of becoming a democracy]**
- This country's nonnuclear forces are half as strong as those of the United States.
- This country **[has / does not have]** high level of trade with the United States.
- **[The country's motives remain unclear, but if it builds nuclear weapons, it will have the power to blackmail or destroy other countries/ The country has stated that it is seeking nuclear weapons to aid in a conflict with another country in the region]**
- The country has refused all requests to stop its nuclear weapons program.

By attacking the country's nuclear development sites now, the United States could prevent the country from making any nuclear weapons.

Would you favor or oppose using the U.S. military to attack the country's nuclear development sites?

- Favor strongly
- Favor somewhat
- Neither favor nor oppose
- Oppose somewhat
- Oppose strongly

2 Political questions

We will now ask you some questions about your background and political views.

1. Some people seem to follow what's going on in government and public affairs most of the time, whether there's an election going on or not. Others aren't that interested. Would you say you follow what's going on in government and public affairs?
 - Most of the time
 - Some of the time
 - Only now and then
 - Hardly at all
2. On the ideological scale, where would you place the two major parties? (NOTE: asked for each party separately)
 - Strongly Liberal
 - Somewhat Liberal

- Lean Liberal
 - Moderate; Middle of the Road
 - Lean Conservative
 - Somewhat Conservative
 - Strongly Conservative
 - Don't Know
3. Generally speaking, do you usually think of yourself as a Democrat, a Republican, an independent, or something else?
- Republican
 - Democrat
 - Independent
 - Something else
4. (If “**Democrat**”) Would you call yourself a strong Democrat or a not very strong Democrat?
- Strong Democrat
 - Not very strong Democrat
5. (If “**Republican**”) Would you call yourself a strong Republican or a not very strong Republican?
- Strong Republican
 - Not very strong Republican
6. Do you think of yourself as closer to the Republican Party or to the Democratic Party?
- Closer to the Republican Party
 - Closer to the Democratic Party
 - Neither

3 Demographic questions

1. What is your gender?
- Male
 - Female
2. What racial or ethnic group or groups best describes you?
- White, non-Hispanic
 - Black/African-American, non-Hispanic
 - Hispanic, Latino/a, or Chicano/a

- Asian, non-Hispanic
- Native American or American Indian, non-Hispanic
- Two or more groups (multiracial or multi-ethnic)
- Other

3. Which of the following best describes your current employment status?

- Full-time
- Part-time
- Temporarily laid off
- Unemployed
- Retired
- Permanently disabled
- Homemaker
- Student
- Other

4. What is the highest level of education you have completed?

- Some high school
- High school graduate
- Some college
- 2-year college graduate
- 4-year college graduate
- Some post-graduate education
- Post-graduate degree

D Additional figures

Bibliography

- Sen, Maya. 2017. “How Political Signals Affect Public Support for Judicial Nominations: Evidence from a Conjoint Experiment.” *Political Research Quarterly* 70(2):374–393.
- VanderWeele, Tyler J. 2015. *Explanation in Causal Inference: Methods for Mediation and Interaction*. Oxford University Press.

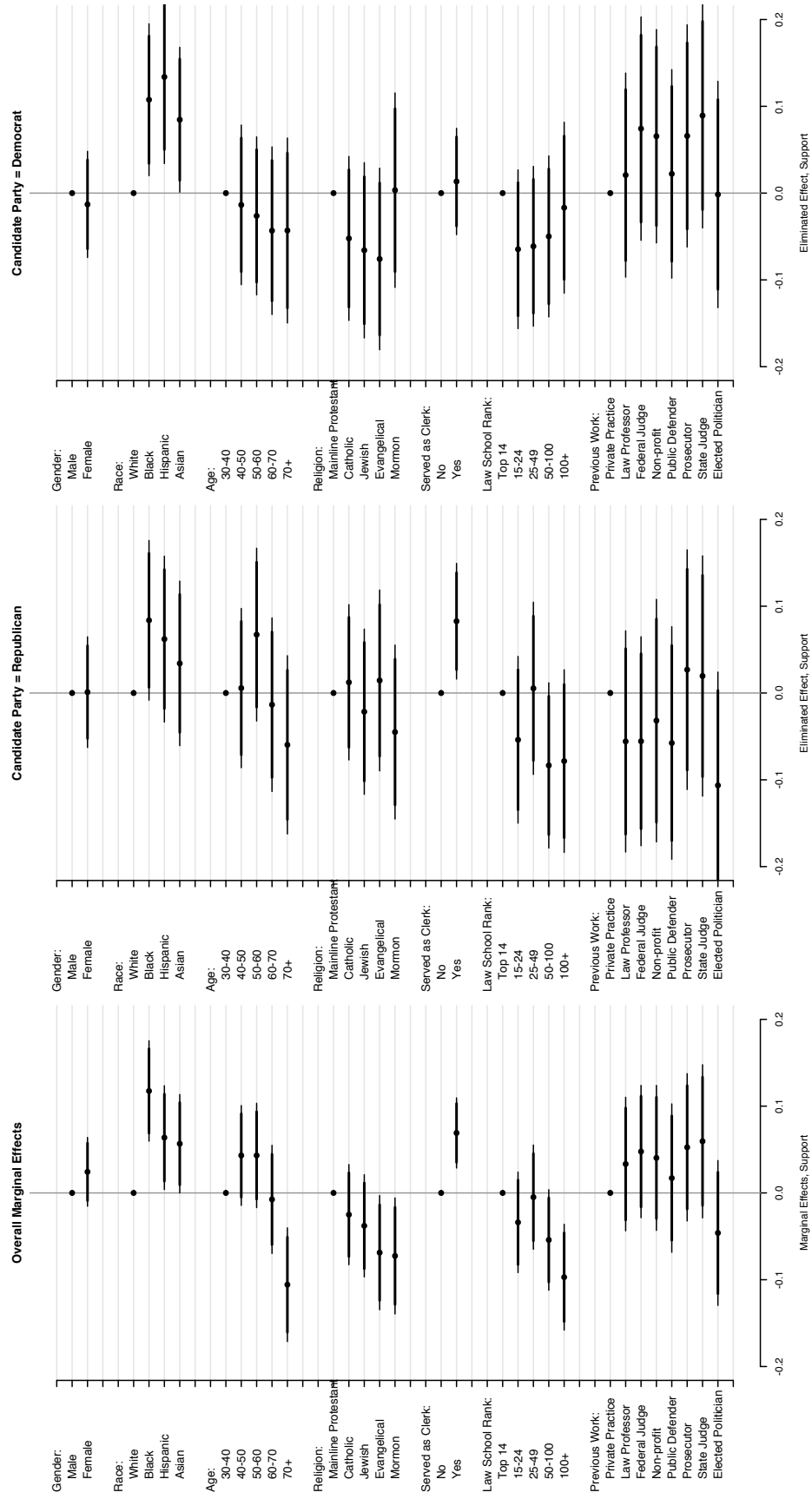


Figure A1: Full results from the conjoint analysis of Sen (2017).