Jabbing Together?

The Complementarity Between Social Capital, Formal Public Health Rules, and COVID-19 Vaccine Rates in the United States

Byron Carson, Justin Isaacs, and Tony Carilli

Abstract

COVID-19 vaccine rates provide a unique opportunity to explore vaccine hesitancy and potential interactions between social capital and individual, normative values, namely for public health and/or personal freedom. While economists and public health scholars realize the independent effects social capital and stringent public health rules have on prevalence and mortality rates, few recognize how these factors influence vaccination rates. We advance this literature with a novel framework to analyze these interactions. With county-level data on COVID-19 vaccinations, social capital, and measures of the values people have for personal freedom and public health, we find that vaccination rates depend on individual values, the level of social capital, and the interaction between the two. Social capital mediates the values people hold dear, which can influence vaccination rates in positive and negative ways. Our results are robust to the inclusion of relevant controls and under multiple specifications. These results suggest that individuals and the communities people enter into and exit out of play an important role in decisions to vaccinate, which are independent of formal, governmental public health measures.

Introduction

Vaccine hesitancy—among parents, among healthcare professional, and for particular diseases—is an ongoing public health concern (MacDonald and SAGE Working Group on Vaccine Hesitancy 2015). As useful as vaccines are, people eschew them because of religious values, perceptions of vaccine inefficacy, vaccine campaigns of the past that used coercion and/or fraud (Dubé et al. 2013; Ozawa and Stack 2013; Yaqub et al. 2014; Karafillakis et al. 2016; Cadeddu et al. 2021). While there are various definitions of vaccine hesitancy, there is no single set of factors that consistently explains differences in hesitancy or identifies policies to improve hesitancy (Larson et al. 2014; Eskola et al. 2015).[1]

Vaccine hesitancy becomes more pressing as we consider COVID-19 vaccination and especially relevant for minority populations who might face additional health burdens (Hildreth and Alcendor 2021; Khubchandani and Macias 2021). As it relates to COVID-19 vaccination, few studies indicate consistent factors of hesitancy. For example, Christian Nationalism is correlated with hesitancy (Corcoran, Scheitle, and DiGregorio 2021), as are socio-economic and education variables (Mollalo and Tatar 2021; Lazarus et al. 2020). Hesitancy also remains high in high-income countries, especially among younger, poorer, female, non-White, and less educated groups (Aw et al. 2021). Similarly, Hudson and Montelpare (2021) shows that while age, income, education, parental status, rurality, trust in authority, disgust sensitivity, and risk aversion can explain COVID-19 vaccination rates, these results are tentative given the lack of peer-review and the novelty of our experiences with COVID-19 vaccination. Moreover, studies that rely on theories of planned behavior consistently explain differences in hesitancy (Xiao and Wong 2020).

A related strand of public health research explores the role social capital—a kind of informal, social norm—plays in vaccination, disease prevention, and health promotion (see, for example, Putnam 2001). As it relates to vaccinations, higher levels of social capital lead to higher rates of second-round measles vaccinations (Nawa and Fujiwara 2019; Nagaoka, Fujiwara, and Ito 2012). Similarly, social capital influences vaccines for pneumonia among elderly populations in Japan (Iwai-Saito, Shobugawa, and Kondo 2021). Various measures of social capital also influence influenza vaccine rates in Taiwan (Chuang et al. 2015), and with H1N1 in Scandinavia (Björn Rönnerstrand 2013; B. Rönnerstrand 2014) (also, see Jung, Lin, and Viswanath 2013).

There is a growing consensus in public discourse and in scholarly work that social capital leads to good public health outcomes in the context of COVID-19 (Gopnik 2020; Imbulana Arachchi and Managi 2021; Pitas and Ehmer 2020; Wong and Kohler 2020; Borgonovi, Andrieu, and Subramanian 2021; Dutta, Makridis, and

[1] Vaccine hesitancy is "A behaviour, influenced by a number of factors including issues of confidence [do not trust a vaccine or provider], complacency [do not perceive a need for a vaccine, do not value the vaccine], and convenience [access]" (Larson et al. 2014: 2151).

Rao 2021). At the county level in the U.S. between March and July of 2020, for example, Makridis and Wu (2021) isolate the effect social capital and its components have on rates of COVID-19 prevalence and mortality with standard empirical techniques, e.g., fixed effects that might attenuate omitted variable bias and alternative measures of social capital. They report that the spread of COVID-19 falls by 18 percent (and deaths fall by 5.7 percent) as counties increase their social capital from the 25th percentile to the 75th percentile. Ferwana and Varshney (2021) shows that different components of social capital have differing effects.

We suggest, however, that social capital does not unambiguously confer positive public health outcomes. Social capital reinforces the subjective values people have. For instance, social capital might encourage the use of interpersonal networks to care for one another and provide support from a distance, but it can also reinforce beliefs within a community that prioritize personal freedom over public health. Following Carson, Isaacs, and Carilli (2021) and their framework on the interactions between individual values, formal public health rules, and social capital, we develop a framework to 1) assess the conditions under which social capital influences the magnitude of vaccination, and 2) compare the effects social capital has on vaccination relative to a community's taste for public health versus personal freedom.

With over one year's worth of county-level, daily data on COVID-19 vaccination rates, social capital, and regulatory stringency in the United States, we build a county-level, cross-sectional model to assess these relative effects. Our main result is that counties with stronger social capital (relative to the average) and higher values for public health namely COVID-19 prevention (relative to the average) are less hesitant to use vaccines. We also find that social capital reinforces beliefs of personal freedom, which increases hesitancy and a lower level of vaccination where those values are prevalent. Our results are robust across measured sub-components of social capital, to the inclusion of standard controls, and alternative measures of social capital. These results suggest that the values people have, their formal and informal rules, and their interactions play identifiable roles in the use of vaccines as a preventative measure in the fight against the spread of COVID-19.

Values, Social Capital, and COVID-19

Social capital encourages people to trust each other, which encourages various kinds of cooperation and even private health outcomes. People with greater social capital might have more financial resources, e.g., charity; they might have greater access to organizations that lower the cost of health care; they might be constrained by social norms that influence health; and they might have a greater ability to engage in political action

(Putnam 2001).

We argue that social capital complements or reinforces the underlying normative values people have for prevention and the subsequent actions they adopt, e.g., personal responses, public health rules, mandates, and vaccine use. We expect people to increase the magnitude of vaccination when 1) they place a higher value on prevention and 2) they have a higher level of social capital that reinforces such values, behaviors, and rules. While social capital reinforces preventative behaviors and vaccination in areas that value prevention, it can reinforce infectious behaviors in areas that value personal freedom. Our framework indicates the possibility of both positive and negative public health outcomes. That is, areas can experience a higher level of vaccination because of their general appreciation for public health over personal freedom and their higher level of social capital. At the same time, areas can experience a lower level of vaccination because of their general appreciation for personal freedom over public health and their higher level of social capital. Thus, the interaction between social capital and how people value public health over personal freedom become important determinants of the formal rules people favor and their vaccination behaviors.

We suggest the interaction between social capital, values for prevention, and formal rules influences the magnitude of vaccination because social capital raises the private costs to individuals of breaking the rules that a group perceives as legitimate, namely formal and informal public health rules. People with stronger levels of social capital are more likely to interact with each other—which can increase the spread of diseases like COVID-19—but they are also likely to follow public health suggestions and mandates they value (Carson, Isaacs, and Carilli 2021). The more people value disease prevention over other legitimate values like personal freedom, and the more they believe public health claims are also legitimate and valuable, breaking those rules is taken as an affront punishable informally by a personal rebuke, a worsening reputation, a refusal of service, or fewer social contacts. More formal measures of enforcement and punishment are also relevant, e.g., employer vaccination mandates and vaccine requirements to receive services in the "marketplace."[2] Relatedly, people are better able to monitor the behavior of others in areas with stronger social capital and numerous social ties; this suggests that infractions are more likely to be discovered in areas with stronger social capital. Thus, as strong as values for public health are and as severe as formal public health rules are, social capital will encourage individuals to engage in preventative behavior. All else equal, this interaction should increase the magnitude of vaccination.

Alternatively, a person's normative beliefs and attitudes can raise (or lower) the value of preventative behavior, which can encourage (or discourage) vaccination, in addition to other kinds of prevention. People might

[2]Whereas formal rules specify a primary directive and secondary qualifiers, a centralized enforcement mechanism, and it is a rule derived from some form of governing body, informal rules may only specify some type of suggested directive with no formal enforcement mechanism and is a rule derived from normative attitudes (Brennan et al. 2016).

value vaccination to improve their own health and the health of their friends and family. People might also legitimately value other goals over disease prevention, e.g., maintaining cultural practices, following religious observances, pursuing economic activity, and/or expressing political will. Given the values people have, then, the community and kind of social capital within which people pursue their individual and cooperative goals becomes relevant. That is, the quality, kind, or strength of social capital influences how well people achieve their goals, whatever those goals might be. Thus, the kinds (and amount) of bonds people form within and between groups acts to reinforce the perceptions and beliefs of the groups. In the context of COVID-19, communities with high levels of social capital should see their perceptions and values regarding public health reinforced. If a community values public health and has strong social ties then we would expect a high rate of vaccination. If a community has strong social ties but places a low value on public health (high value on personal freedom) then we would expect a low level of vaccination.

Table 1 adapts Table 1 of Carson, Isaacs, and Carilli (2021), p. 4, to visualize how these factors interact with each other and how they influence vaccination rates. The rows characterize groups by their strongly-held normative beliefs: individuals and groups in the top row place a higher value on public health and prevention while those in the bottom row place a higher value on personal freedom. The columns characterize groups by the strength of their social capital: individuals and groups on the left have stronger social capital relative to the average amount of social capital while those on the right have weaker social capital relative to the average.

Table 1: The Interaction between Social Capital and Normative Values on Vaccine Rates

	Strong Social Capital	Weak Social Capital
High Value for Public Health	I - Highest	II - Higher than IV; lower than I
High Value for Personal Freedom	III - Lower than I	IV - Lowest

Thus, the interaction between values for public health and social capital and its effect on vaccination rates varies by quadrant. We expect the interaction effect between values for prevention and social capital to have the strongest, positive effect on vaccination rates when people place a higher value on prevention and when they have stronger social capital (Quadrant 1). We expect the interaction effect between values for personal freedom and social capital to have the strongest, negative effect on vaccination rates when people place a lower value on preventative behavior, and they have have weaker social capital (Quadrant IV).

While the values people have for public health (and for personal freedom) and their level of social capital

might each exert independent effects on vaccination rates, there is ambiguity in the interaction between these variables in Quadrant III. That is, it is possible that Quadrant III has a vaccination rate that is lower than Quadrant IV because social capital can reinforce behaviors of personal freedom. However, even communities with a "taste" for personal freedom might have a greater desire to get vaccinated for their friends, family, and neighbors with relatively higher levels of social capital.

The following propositions guide our analysis below:

1. People that place a higher value on public health will have larger, positive effects on the magnitude of COVID-19 vaccinations than people that do not value public health, all else equal.
2. People with stronger social capital will have larger, positive effects on the magnitude of COVID-19 vaccinations than people with weaker social capital, all else equal.
3. People that place a higher value on public health and have stronger social capital will have the largest, positive effect on the magnitude of COVID-19 vaccines, all else equal.
4. People that place a higher value on personal freedom and have stronger capital will have the largest, negative effect on the magnitude of COVID-19 vaccines, all else equal.

Data, Model, and Results

We operationalize this framework in the context of COVID-19 by gathering data representing the rows and columns of Table 1. We then use ordinary least squares (OLS) to assess whether there is a statistical relationship between the values people have for public health health and personal freedom and their social capital.

We measure the rows of Table 1—the normative values people have for public health and personal freedom—with two proxies. First, we construct an index that represents the values people hold for public health. This index (measured in number of days) represents how long people were under the strictest kinds of COVID-19 restrictions. Specifically, we use data collected from the CDC on bar closures, restrictions on gatherings, masking orders, restaurant closures, and stay-at-home orders. We assume that people in counties where there were additional municipal, county, and state level restrictions, place a higher value on public health. Second, we use the percentage of Trump voters in the 2020 election in a county as a proxy for the values people hold regarding personal freedom. We use this measure as it follows Adolph et al. (2021) and Baccini

and Brodeur (2021) who find political affiliation of a governor influences the kind and timing of stringency measures.

We measure the columns of Table 1—the level of social capital—using the Joint Economic Committee's (JEC) social capital project, which reports an index of social capital across 3,142 counties. This index measures four main variables: family unity, community health, institutional health, and collective efficacy.[3] The JEC county-level index has a mean value of 0 and a scale between -4.3 and 2.9 that measures variance or how a county compares to other counties.

To visualize how social capital influences vaccine rates across various levels of personal freedom, we compile our data on social capital, the values for personal freedom, and vaccination rates.[4] Figure 1 shows a random selection of 20% of the counties in our full data, and an initial assessment of our hypotheses. For a given level of social capital, county-level vaccine rates tend to increase as counties have lower values for personal freedom (an upward movement in Figure 1). For a given level of personal freedom, county-level vaccine rates tend to increase with higher levels of social capital (a leftward movement in Figure 1). Finally, county-level vaccine rates tend to increase as counties have lower values for personal freedom *and* higher social capital (an upward and leftward movement in Figure 1).

To provide a more quantitative assessment of our hypotheses, we develop the following model, which specifies the basic functional form between the values people have for personal freedom and/or public health and their social capital:

$$Vaccination_{it} = \gamma_0 + \gamma_1(Individual\ Values)_{i,t-7} + \gamma_2(Social\ Capital)_{i,t} + \gamma_3(Individual\ Values_{i,t-7} * Social\ Capital_{i,t}) + v_{i,t}$$

where we measure vaccination as the magnitude of vaccination, i.e., the percentage of a county vaccinated on November 30, 2021. As of that date people had had about 10-11 months to become vaccinated.[5] This vaccination data was collected from the Centers for Disease Control (CDC) COVID-19 Vaccination Surveillance Database.

The interaction term between individual values and social capital allows us to investigate our theoretical

[3]Family unity is an index of the following variables: the share of births to unmarried women, the share of women who are married, the share of children living in a single-parent family. Community Health is an index of registered non-religious non-profits per 1,000 people, the number of religious congregations per 1,000 people, and a sub-index of informal civil society. Institutional Health is an index of the average number of votes in the 2012 and 2016 presidential elections, the mail-back response rate in the 2010 census, and a sub-index of confidence in institutions. Collective Efficacy is the number of violent crimes per 100,000.

[4]We do not show how vaccine rates change by social capital and values for public health because of the discrete nature of values for public health, which do not easily lend itself to visual interpretation.

[5]The FDA issued an EUA on Dec. 11, 2020 for the Pfizer vaccine.

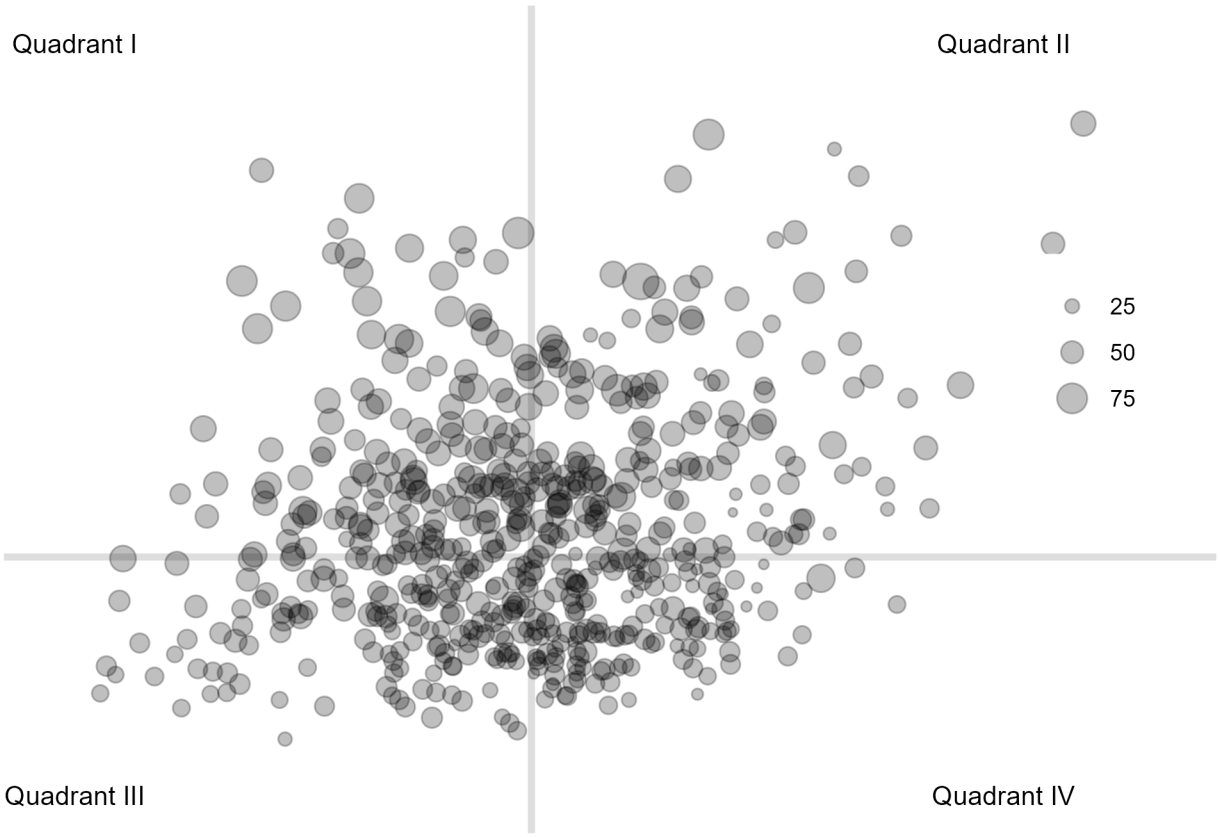

Figure 1: Vaccinations, Social Capital, and Personal Freedom

framework. That is, we can test the following four hypotheses:

1. Do counties that have a higher desire for public health have higher vaccination rates?
2. Do counties that have stronger measured social capital scores have more desire to protect their "connections" and, thus, higher vaccination rates?
3. Do counties with higher social capital and higher values for public health have higher vaccination rates?
4. Do counties with higher social capital and higher values for personal freedom have lower vaccination rates?

Table 2 provides the descriptive statistics of these variables for our sample dataset of 3,139 county-level observations.

Table 2:

Statistic	N	Min	Max	Mean	Median	St. Dev.
% Vaccinated	3,126	1	100	45.30	45	12.40
Bar Days	3,100	0.00	291.00	91.60	69.00	62.30
Gathering Days	3,099	0.00	296.00	206.00	269.00	102.00
Mask Days	3,100	0.00	266.00	132.00	169.00	90.30
Restaurant Days	3,100	0.00	131.00	53.80	52.00	20.40
Stay at Home Days	3,100	0.00	285.00	49.60	35.00	68.50
Stringency	3,099	0.00	1,003.00	533.00	599.00	229.00
County Level Index	2,960	−4.32	2.97	0.005	0.004	1.00
% Republican	3,099	8.73	96.20	65.10	68.40	16.00
% Bachelor's	3,100	4.90	80.20	20.80	18.50	9.12
% Fair/Poor Health	3,041	7.88	42.40	17.10	16.20	4.80
% Black	3,100	0.00	86.20	8.98	2.15	14.50
% Rural	3,100	0.00	100.00	58.50	59.40	31.40
% $>$ 65	3,100	5.90	57.30	17.40	17.00	4.41
Median Household Income	3,099	18,972.00	125,672.00	47,817.00	46,227.00	12,498.00

Table 3 presents results for the basic model and subsequent specifications, where the dependent variable is the magnitude of vaccination, i.e., the percentage of county population vaccinated on November 30, 2021.

Model 1 estimates equation 1 where individual values are the values for public health; Model 2 estimates equation 1 where individual values are the values for personal freedom; Model 3 estimates equation 1 with both measures of individual values; and Model 4 uses an instrumental variable technique.

All four regressions show statistically significant results and support our initial propositions. Model 1 in Table 3 shows that a one unit increase in the value for public health increases the magnitude of vaccination by 0.01%. The interaction between values for public health and social capital increases the magnitude of

Table 3: Regression Results

	Dependent variable:			
	Percentage of County Vaccinated			
	(1)	(2)	(3)	(4)
Constant	39.900***	78.700***	78.300***	48.300***
	(0.494)	(0.875)	(1.050)	(13.400)
Public Health	0.010***		0.0004	0.040***
	(0.001)		(0.001)	(0.016)
Personal Freedom		−0.510***	−0.507***	−0.345***
		(0.013)	(0.013)	(0.083)
Social K	0.213	7.400***	6.100***	3.850
	(0.486)	(0.749)	(0.844)	(15.000)
Social K * Public Health	0.003***		0.002**	0.038**
	(0.001)		(0.001)	(0.017)
Social K * Personal Freedom		−0.068***	−0.060***	−0.315***
		(0.011)	(0.011)	(0.120)
Observations	2959	2959	2958	2935
R2	0.053	0.418	0.42	
F Statistic	54.9***	708.8***	426.7***	91.2***

Standard errors are heteroskedasticity robust. *p<0.1; **p<0.05; ***p<0.01

vaccination by 0.003%. Model 2 shows that a one unit increase in the value for personal freedom decreases the magnitude of vaccination by 0.51%. A one standard deviation increase in social capital increases the magnitude of vaccination by 7.4%. The interaction between the value for personal freedom and social capital decreases the magnitude of vaccination by 0.07%. Model 3 of Table 3 specifies the basic model with both measures of individual values, along with both interaction effects. A one unit increase in the values for personal freedom decreases the magnitude of vaccination by 0.51%. A one standard deviation increase in social capital increases the magnitude of vaccination by 6.1%. Moreover, the interaction terms of Model 3 of Table 3 have the expected effect and are statistically significant. The interaction term between social capital and values for public health increases the magnitude of vaccination by 0.002%, and the interaction term between social capital and values for personal freedom decreases the magnitude of vaccination by 0.06%. These results suggest that social capital on net reinforces our values for public health and personal freedom, respectively.

Model 3 likely suffers from endogeneity as the values for public health and personal freedom depend on various demographic factors. With data from the US Census American Community Survey (2019), the Bureau of Economic Analysis, and the Bureau of Labor Statistics, we use the following variables to instrument for the values for public health and personal freedom: median family income, percent with a bachelor's degree, percent black, percent in poor/fair health, percent rural, and percent over 65. Our results suggest significant endogeneity. Model 4 shows the instrumental variable specification for model 3.

Model 4 appears to be a better specification for the relationship between our main variables of interest.[6] Moreover, Model 4 shows results that are consistent with the general implication of our previous models and provide a more robust analysis. A one unit increase in the value for public health increases the magnitude of vaccination by 0.04%. A one unit increase in the value for personal freedom decreases the magnitude of vaccination by 0.35%. The interaction between values for public health and social capital increases the magnitude of vaccination by 0.04%, whereas the interaction between values for personal freedom and social capital decreases the magnitude of vaccination by 0.32%.

Our results lend support for the social capital framework discussed above. In particular, it suggests that social capital has an ambiguous effect on vaccination rates. However, the level of social capital mediates the normative values people have and can amplify those values. Whereas people who value public health—and are more willing to use stringent public health measures—use higher levels of social capital to increase their magnitude of vaccination, people who value personal freedom—and who might be more hesitant towards

[6]The Wu-Hausmann test for weak instruments supports these results, which suggests our included variables are appropriate instruments.

public health—use higher levels of social capital to decrease their magnitude of vaccination.

Robustness Check

As Ferwana and Varshney (2021) suggests, the effect social capital might have on vaccination rates might vary depending a particular sub component used in its construction. Table 4 shows whether these sub components alone have a similar effect on the magnitude of vaccination. We analyze these components using our baseline specifications found in Model 1-3 of Table 3.

As we disaggregate social capital, personal freedom remains statistically significant and negative; a one unit increase in the value for personal freedom decreases the magnitude of vaccination by 0.55. The family unit and institutional health sub components are statistically significant; in Models 2 and 3 a one standard deviation increase in the family unit sub component increases the magnitude of vaccination by 9.2%-10.1% whereas a one standard deviation increase in the institutional health sub component decreases the magnitude of vaccination.

The interaction terms between the values for public health and personal freedom and the measured sub components also show statistically significant results. For example, a one unit increase in the interaction between community health and the values for public health increases the magnitude of vaccination by 0.003% and a one unit increase in the interaction between collective efficacy and the values for public health increases the magnitude of vaccination by 0.002%. A one unit increase in the interaction between family unit and the values for personal freedom decreases the magnitude of vaccinations by 0.11%, and a one unit increase in the interaction between institutional health and the values for personal freedom increases the magnitude of vaccination by 0.05%. These results are similar to Ferwana and Varshney (2021) which finds that institutional health positively influences vaccination rates.

Discussion and Conclusion

Our framework and results show that the normative values people hold and their formal and informal rules influence vaccine hesitancy. Specifically, we formally analyze how the interaction between the values people have for personal freedom over public health and their social capital influences the magnitude of COVID-19 vaccinations. As we use different proxies for the values people have and multiple specifications, we find suggestive evidence for our three main propositions: 1) counties where people have a larger value for public

Table 4: Regression Results

	Dependent variable:		
	Percentage of County Vaccinated		
	(1)	(2)	(3)
Constant	39.600***	81.700***	82.100***
	(0.501)	(0.986)	(1.230)
Public Health	0.011***		−0.0005
	(0.001)		(0.001)
Personal Freedom		−0.548***	−0.550***
		(0.014)	(0.015)
Family Unit	−2.150***	10.100***	9.250***
	(0.642)	(0.771)	(0.945)
Community Health	−0.543	0.304	−2.410
	(0.685)	(1.250)	(1.490)
Institutional Health	4.960***	−3.790***	−2.890**
	(0.603)	(0.953)	(1.180)
Collective Efficacy	−1.560**	0.609	−0.334
	(0.604)	(0.708)	(0.741)
Family Unit * Public Health	0.005***		0.001
	(0.001)		(0.001)
Community Health * Public Health	0.001		0.003***
	(0.001)		(0.001)
Institutional Health * Public Health	−0.004***		−0.001
	(0.001)		(0.001)
Collective Efficacy * Public Health	0.0002		0.002**
	(0.001)		(0.001)
Family Unit * Personal Freedom		−0.117***	−0.114***
		(0.012)	(0.012)
Community Health * Personal Freedom		0.012	0.030
		(0.017)	(0.018)
Institutional Health * Personal Freedom		0.057***	0.054***
		(0.014)	(0.015)
Collective Efficacy * Personal Freedom		0.001	0.004
		(0.011)	(0.010)
Observations	2875	2875	2874
R2	0.11	0.456	0.461
F Statistic	39.3***	266.8***	174.3***

Standard errors are heteroskedasticity robust. *p<0.1; **p<0.05; ***p<0.01

health experience more vaccinations, 2) counties where people have a higher level of social capital experience more vaccinations, 3) counties where people have both a higher level of social capital and a higher value for public health experience more vaccination, and 4) counties where people have both a higher level of social capital and a higher value for personal freedom experience less vaccination. Thus, we find that social capital mediates the values people have and encourages behaviors they find valuable; this might or might not encourage vaccinations and/or improvements in public health.

We suggest that disease prevention policies focusing primarily on formal, stringent measures are misguided when planners ignore social capital and the values people hold dear. Stringent measures are less effective when people have higher levels of social capital and when they value public health. Moreover, stringent measures might be a source of tension and less effective when people have higher levels of social capital and when they value personal freedom.

While we show the interaction between social capital and the value people have for public health, there are no clear policy levers. No one person or group has the ability to alter social capital, change the values people have for personal freedom over public health, or maintain the effectiveness of stringent policies given individual values. Social capital emerges when individuals value participating in social interactions; it is not clear how governmental officials, let alone public health officials, can know or can influence such values and interactions. Even if officials could alter social capital, our results suggest such policies would be effective only when people already value prevention specifically and public health more generally.

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