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Prosocial behavior in emergencies: Evidence from blood donors recruitment and retention during the COVID-19 pandemic

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ABSTRACT

The impact of COVID-19 represents a specific challenge for voluntary transfusional systems sustained by the intrinsic motivations of blood donors. In general, health emergencies can stimulate altruistic behaviors. However, in this context, the same prosocial motivations, besides the personal health risks, could foster the adherence to social distancing rules to preserve collective health and, therefore, discourage blood donation activities. In this work, we investigate the consequences of the pandemic shock on the dynamics of new donors exploiting the individual-level longitudinal information contained in administrative data on the Italian region of Tuscany. We compare the change in new donors' recruitment and retention during 2020 with respect to the 2017–2019 period (we observe 9511 individuals), considering donors' and their municipalities of residence characteristics. Our results show an increment of new donors, with higher proportional growth for older donors. Moreover, we demonstrate that the quality of new donors, as proxied by the frequency of subsequent donations, increased with respect to previous years. Finally, we show that changes in extrinsic motivations, such as the possibility of obtaining a free antibody test or overcoming movement restrictions, cannot explain the documented increase in the number of new donors and in their performance. Therefore, our analyses indicate that the Tuscan voluntary blood donation system was effective in dealing with the challenges posed by the COVID-19 pandemic.

1. Introduction

The SARS-CoV-2 (COVID-19) pandemic represented a new challenge for the blood donation system due to the large-scale restrictions imposed by governments and the specific health risks related to the donation environment and procedures (Haw et al., 2020). While health emergencies can typically trigger prosocial behaviors and stimulate blood donation (Glynn et al., 2003; Guo et al., 2012), an infection outbreak represents a specific case in which health risks contrast with altruistic intentions, as it previously happened with the SARS and the aviarian crises (Puterman et al., 2009; Masser et al., 2011). Potential donors may feel unsafe for the possible risk of infection, and donations might decrease due to intentions to protect themselves and others (Weidmann et al., 2021; Tripathi et al., 2021). Moreover, the interventions implemented to mitigate the COVID-19 spread imposed social distancing, contact tracing, and limited movements for unnecessary activities. Thus, together with the fear of contagion, these measures could have interfered with and possibly discouraged cooperative and altruistic behaviors.

Since March 11th, 2020, when the World Health Organization officially declared the global entity of the pandemic, the necessity to maintain a balance between blood supply and blood demand became a priority for the organizations involved in the transfusional system (Sah et al., 2021). National and regional health systems experienced a lack in blood supply, often being forced to cancel surgical operations. Blood Donation Agencies (BCAs) have been alerting public opinion to prevent the shortage of blood products via mass media declarations or collective calls to action (Haw et al., 2022). Despite an initial drop in blood donations experienced in the first weeks after the COVID outbreak, aggregate data on European countries showed a subsequent quick recovery of blood donations (ECDPC, 2020). The willingness to donate of regular donors, as measured by individual surveys, appeared to be reduced for those donors who were more concerned with the risks of infection and strictly followed COVID prevention guidelines (Chandler

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et al., 2021). In Italy, after an initial 10% drop in blood donation, an increase of blood collection in the second week of march was recorded after the appeal of the National Blood Center (Centro Nazionale Sangue) and the Italian government (Franchini et al., 2020; Mascaretti et al., 2020). Surprisingly, the only evidence based on microdata (for the Netherlands) shows an improvement in the registration of new donors, particularly for older-age groups (Spekman et al., 2021).

In this work, using longitudinal microdata on donors' behavior directly from the administrative database of the Italian Association of Blood Donors (AVIS) in Tuscany, we examine the impact of pandemic events as an external shock on the blood collection chain and demonstrate a positive response of the collectivity. We assess the extent to which the solidarity generated by the pandemic pushed novel donors towards the blood volunteer donor associations, finding a relatively long-lasting (not just limited to the contingency dictated by the public call to action) effect on their donation behavior. As shown by Figure A.1 in section Appendix A, during the pandemic the behavior of already affiliated donors did not change with respect to recent years and, therefore, it is not the focus of the paper. By employing both econometric and machine learning techniques, the fluctuation of donors' population is analyzed during the first year of the pandemic, focusing on the changes in new donors' enrollment and, for the first time in the blood donation literature (Tran et al., 2010; Bagot et al., 2016; Laermans et al., 2022), on their retention after the first donation during an emergency. We also study whether the effects of the pandemic are heterogeneous according to donors' and their municipalities of residence characteristics. We show that the emergency significantly increased the number of new donors, with a higher proportional variation (with respect the previous years) for the older cohorts of new donors. In section 4, we argue that this age-related pattern might be due to several potential reasons, such as age-related weakening of time constraints due to COVID-19 restrictions, an increase in altruism with age, differential exposure to traditional public communication channels by age, and the age-distribution of actual and perceived COVID-19 health risks.

Most importantly, when we consider the retention of new donors, we find that the altruistic effect connected to the pandemic situation is relatively long-lasting, with a generalized increase in the probability and frequency of their return to donate after the first donation, without heterogeneous effects for specific groups of donors. Finally, we also evaluate to what extent the existence of extrinsic incentives (i.e., bypassing movement restrictions or obtaining a free COVID-19 antibody test) can explain the observed donation behavior. We find that the positive effect of the exposure to the COVID-19 shock on the number of new donors and their retention rate is not driven just by these benefits, as it is estimated to be significant also in periods in which these measures were not in place.

The Italian transfusional system represents a paradigmatic context to analyze the response of blood donors to the COVID-19 pandemic, both because the country was the first to face the unexpected contagion in Europe, with a consequent severity of the impact on the population (Remuzzi and Remuzzi, 2020; Lugli et al., 2022; Schiroli et al., 2022), and for the importance of volunteers' associations, that could rely on an extensive network of habitual donors (Saturni et al., 2017). Our analyses suggest that a voluntary non-remunerated blood donation system, such as the Italian one, was able to face the pandemic situation, describing not only the immediate effects on donors' recruitment but also their subsequent donation behavior.

In section 2, we present the data and the methods used. The results of the empirical analyses are reported and commented in section 3. Finally, section 4 is dedicated to a further discussion of the results.

2. Data and methods

2.1. Data

We use anonymous data from the regional database called Dat@VIS, the digital platform service that records all donation activities in Tuscany. AVIS accounts for about the 75% of the total national supply of blood in Italy, and it includes about 1.4 million donors across the country (Saturni et al., 2017). Data includes all donations (of whole blood or blood components) by new volunteers from 2013 to 2020. Also, the dataset contains information relative to individual characteristics such as age, gender, blood type, and donation characteristics such as donation center and type of donation (i.e., if it is whole blood or plasma). The database that we use involves 9511 donors who became members of AVIS in 2017, 2018, 2019, or 2020. We also use aggregate data for Tuscan municipalities from the Italian National Institute of Statistics (ISTAT) website. The data includes information on the proportion of university graduates in 2017, the average per capita income in 2018, the population density in 2011, and mortality in 2017, 2018, 2019, and 2020.

2.2. Baseline specifications

We are interested in estimating the effect of the exposure to the COVID-19 shock on the number and the quality/performance of new donors. The main assumption of our identification strategy is that we can use the previous years as a counterfactual for what would have happened in 2020 being absent the COVID pandemic. Indeed, in all the empirical analyses, the number and the behavior of new donors donating for the first time during year 2020 are compared to those of the new donors starting their donation activity during the same months of years 2017–2019. Therefore, the treatment variable of interest is a dummy variable indicating whether a new donor started his activity during 2020, which we call "Year 2020".

The fact that the number of new donors in a given month is very stable from year 2013 to year 2019 suggests that the average donation behavior of the past three years is a good predictor for the donation behavior of the current year (e.g., using the average donation behavior in the interval $t\text{-}3$ to $t\text{-}1$ to predict donation behavior at time t) and therefore an appropriate counterfactual. Similarly, we have also successfully (i.e., without finding statistically significant effects) conducted in-time placebo falsification tests (Abadie et al., 2015) in which we have used the estimation strategy described below to study the effect of COVID in 2019 (using 2018–2015 as the counterfactual), in 2018 (using 2017–2014 as the counterfactual) and in 2017 (using 2016–2013 as the counterfactual). These results are not reported in the paper, but they are available upon request.

After describing the noteworthy increase in the number of new donors during the pandemic months of 2020 with respect the previous years (in Fig. 1 and in Table A.1; in Figure A.2 and in section Appendix A we also take into account possible age-specific effects), the baseline results on the retention of new donors are shown in columns 1 to 4 of Table 1, Table 2 and Table C.6. They are based on linear models estimated by OLS. In columns (1), we regress the relevant dependent variables on the treatment dummy without other controls. In columns (2), we control for age and dummy variables indicating gender, the month of the first donation, the blood type category, and if the donation is a whole-blood donation. In columns (3), we control for blood donation center fixed effects (we observe approximately 150 centers) while, in column (4), we additionally include interactions between our covariates and the treatment dummy.

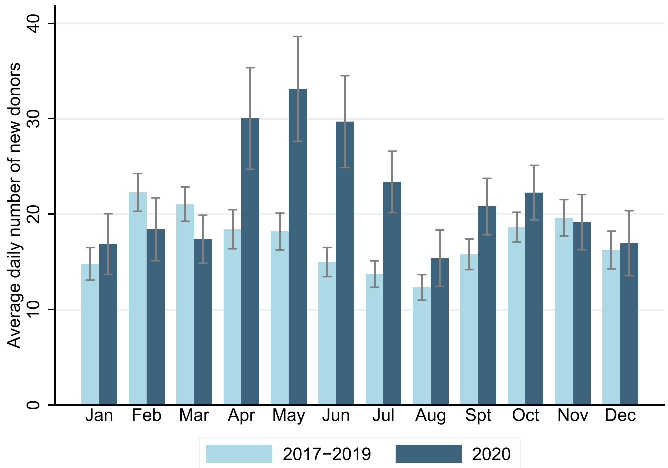

Fig. 1. Average daily number of new donors by month. Year 2020 vs. 2017, 2018, 2019. 95% confidence intervals are reported.

We study the probability of returning to donate and the number of times a new donor comes back to donate as proxies of donors' performance/quality. For the former, which we call the extensive margin, we use as dependent variable a dummy variable equal to 1 if a new donor comes back to donate within the following five months (see Table 1a) or seven months (see Table C.6. a). For the latter, which we call the intensive margin, we use as dependent variable the number of times a new donor comes back to donate within the following five months (see Table 1b) or seven months (Table C.6. b). When we use as outcomes the above variables based on a five months (seven months)-window, we consider new donors starting their donation activity from April to July (April to May) of 2020 as the treated group.

To test whether intrinsic motivations are important drivers of the behavior of new donors during the pandemic, we repeat the same analyses on the restricted sample of new donors who first donated during April, and we study their behavior at the extensive and intensive margins by focusing on donations during the days between May 4 and June 15 (see Table 2). The main extrinsic motivations to donate added by the pandemic context were the possibility of going out during the lockdown (donating blood was one of the few ways to escape the lockdown) and obtaining a free COVID-19 antibody test. The strict lockdown period ended on May 4, 2020, and the restrictions on mobility notably decreased. The possibility to receive a free COVID-19 antibody test was introduced only after June 15, 2020. Although we have used the timing of these two events related to the pandemic to study the relative importance of intrinsic motivations, we also acknowledge that we cannot disentangle the separate effects of the events connected to the pandemic shock: the mobility restrictions, the social distancing rules, the risk of contagion and the call to action of the association of donors (and other possible developments brought by the pandemic).

Finally, we also point out that with our identification strategy we are not able to differentiate between the selection and the behavioral change effects of the COVID-19 shock. On the one hand, the shock could have affected the number and the identity of the donors that started to donate in 2020, compared to what would have happened in a scenario without the COVID-19 shock. On the other hand, the shock could have changed the donors' behavior, increasing or decreasing their performance. By controlling for the observable individual characteristics of donors, their municipalities of residence, and donation centers, we take into account the possible selection effect of COVID-19 connected to these compositional effects. Still, we are unable to do it for other unobservable characteristics, such as the initial level of prosociality. The fact that controlling for observable characteristics diminishes the estimated effect of the COVID-19 shock on the retention of new donors suggests that this selection effect is positive.

2.3. *The AIPW-LASSO method*

We follow Farrell (2015) and Chernozhukov et al. (2018a) that combine the LASSO method for inference with the doubly robust augmented inverse-probability weighting (AIPW) estimator of Rosenbaum and Rubin (1983). We use LASSO techniques to select the explanatory variables in the outcome model for each treatment level (i.e., new donors of 2020 vs. new donors of the previous years) and retrieve the treatment-specific predicted outcomes for each donor observed in 2020. The LASSO technique is also employed to select variables in the propensity score specification (i.e., the probability of being a 2020 donor vs. a donor of the previous years), from which inverse-probability weights are obtained. The average treatment effect for 2020 donors is obtained as the inverse-probability weighted average of the difference between the treatment specific predicted outcomes.

The main advantage of using the AIPW estimator is its double robustness property: it is consistent if either the models for the outcomes or the propensity score are correctly specified. Moreover, by using the AIPW estimator, we allow the explanatory variables to have different effects for individuals for which the dummy variable *Year* 2020 = 1 and for individuals for which the dummy variable *Year* 2020 = 0. This is the same as interacting the explanatory variables with the dummy *Year* 2020. The main advantage of combining the AIPW estimator with the LASSO method is that it allows the possibility to consider flexible models with a high number of interactions between the discrete explanatory variables and the (powers of the) continuous explanatory variables (e.g., the variable "Age") without incurring in overfitting issues, which would generate failures of the common support assumption, because just the "relevant" interactions and higher order terms are retained. For these reasons we consider the AIPW-LASSO method as our preferred estimator. The results obtained with this estimation strategy are reported in column (5) of Table 1, Table 2 and Table C.6.

2.4. *The sorted effects method*

We perform a treatment heterogeneity analysis by using the Sorted Partial Effects (SPE) method introduced in Chernozhukov et al. (2018b). The SPE are defined as the percentiles of the distribution of the treatment effects and can provide a more detailed summary of the distribution of the treatment effects than the Average Partial Effect (APE), which is commonly employed in econometric analyses.

In a first stage, we estimate the individual partial effects by using a linear model in which our dependent variable is a function of a treatment dummy, the characteristics of donors and their municipalities of residence (listed in Table A.2), and of their interaction (we also control for donation center dummies). Defining α_i as the individual partial/treatment effects, the SPE are the percentiles of the distribution of α_i and can be indicated as $\alpha^*(u)$, with $u = \{2, 3, 4, \ldots, 98\}$. Therefore, for example, $\alpha^*(10)$ indicates the 10th percentile of the distribution of the individual treatment effects.

$$\alpha^*(u) = u^{th} \text{ percentile of } \alpha_i \quad (1)$$

Being summary statistics of the estimated α_i, the estimated $\alpha^*(u)$ are also a function of the characteristics of donors and their municipality of residence.

The estimated SPE can be compared to the estimated average partial effect (APE) to study whether the treatment effects display significant heterogeneity. Following Chernozhukov et al. (2018b), in the estimation we use sample analogs of $\alpha^*(u)$ and we provide standard errors and uniform confidence bands for $\alpha^*(u)$ by bootstrapping the entire estimation process, starting from the initial α_i estimation step. The estimated SPE are also used to do a classification analysis (CA) that allocates the new donors of 2020 into two groups, the least and the most affected by the COVID-19 shock, according to whether their α_i is lower than $\alpha^*(10)$ or greater than $\alpha^*(90)$, respectively. The definition of the most affected group as those individuals whose α_i lies in the right tail of the distribution of the α_i (i.e., the highest values of the distribution) is a convention based on the assumption that the sign of the average partial effect is positive. This CA is useful to investigate the determinants of treatment effect heterogeneity that are studied by comparing the means of the covariates (i.e., donors' and the their municipalities of residence characteristics) across the most and least affected groups by looking at the difference in means (*CADiff*). Also in this case, in the estimation we use sample analogs of *CADiff* and we calculate standard errors by bootstrapping the entire estimation process. Following Chernozhukov et al. (2018b), the p-values of the estimated *CADiff* are adjusted to account for joint testing of all the covariates considered in the *CADiff* final step (i.e., the observables we allow to be associated with treatment effect heterogeneity). In other words, the main idea is to test the null hypothesis of no difference between the value of these covariates in the most and the least affected groups, taking into account that we conduct simultaneous inference on multiple variables.

3. Results

3.1. The impact of the lockdown on the number of new donors

On March 9, 2020, the Italian government imposed a national lockdown that lasted until May 4, 2020. However, some restrictions on mobility lasted even further. Indeed, until June 3, 2020, movements across municipalities were allowed only for work and health reasons, and those across regions were still forbidden.

Fig. 1 shows, for each month, the average daily number of new donors in 2020 compared with the average daily number of new donors by month in the previous three years, i.e., 2017, 2018, and 2019. As depicted in the figure, we find a highly statistically significant increase in new donors from April to July 2020. Table A.1, in Appendix, reports the change in absolute and percentage terms between 2020 and 2017–2019 in each month. As shown, the most sizeable and statistically significant variations are the increases in April, May, June and July.

In May, for example, the number of new donors per day raised from an average of about 18 in the previous three years to about 33 in 2020, while in June the increase is from about 15 new donors per day to 30 in 2020. Starting from August, this average tended to return to the pre-lockdown levels. Instead, in the two months immediately before April, when the diffusion of COVID-19 in Italy was starting, we find a moderate and barely statistically significant decrease in the number of new donors (as expected, no COVID-19 effect is found for January). Table A.2 in section Appendix A reports the average number of new donations in 2020 and in the previous three years between April and July. While in this time-window we observe 3544 new donors in 2020, the average number of new donors in the same period of 2017–2019 is about 1992 (= 5975/3). This means that the exposure to the COVID-19 shock was associated with an increase in the number of new donors of about 78%. Table A.2 also presents the characteristics of new donors and their municipalities of residence to investigate whether they differ during the pandemic as compared to the recent past. On the one hand, new donors in 2020 are older than the previous years. However, they do not show substantial changes concerning other characteristics, as they are equally distributed by gender, blood, and donation type. On the other hand, according to the considered characteristics of the municipalities of residence (i.e., the proportion of university graduates in the year 2017, average per capita income in the year 2018, population density in the year 2011), no differences are found between the two subsamples. Nevertheless, looking at the average mortality—i.e., the mean number of deaths—it is evident that it is higher during the pandemic with respect to the 2017–2019 period. This information suggests that new donation activities in 2020 occurred despite the COVID-19 pandemic affecting the mortality of municipalities of residence.

Figure A.2 in section Appendix A graphically compares the mean values of daily number of new donors across the two subsamples by age category during the April–July period. The highest percentage effect of COVID-19 on the number of new donors is estimated for the group of people over 49 years old, as shown in Table A.3 of the Appendix. The daily number of new donors of the 50+ group increased by roughly 161%, while the same statistics amounts to about 110% and 107% for the 40–49 and 30–39 cohorts, respectively. In contrast, the percentage variation in the daily number of new donors across the two periods is much lower for the youngest group (+33%). To understand if the percentage changes estimated for different groups are statistically significantly different, Table A.3 also reports post-estimation pairwise tests between them. The percentage increase estimated for the oldest donors (50+) is higher with respect to the percentage variation estimated for all the younger categories. Moreover, also the increments estimated for the middle-aged donors (40–49 and 30–39) are higher with respect to the percentage change found for the youngest cohort (18–29). Finally, no statistically significant differences are found between the percentage changes estimated for the two middle-aged categories.

3.2. The retention effect

To study whether, in addition to an increase in the number of new donors, COVID-19 shock also changed the observed retention of new donors, we perform additional analyses. We focus on those individual first donating between April and July to study whether and how much they donate again in a five months-window. We cannot go further than five months due to both our data restriction (we observe availability until December 2020) and the need to have an equally long post-first-donation period for all new donors' monthly cohorts. Our dependent variables are, respectively, a dummy variable equal to 1 if a new donor comes back to donate within the five months after the first donation (extensive margin, Table 1a), and the number of times that a new donor comes back within the five months after the first donation (intensive margin, Table 1b). We employ OLS regressions and the AIPW-LASSO method. The variables selected by LASSO are available upon request.

Table 1
The effect of the COVID-19 pandemic on the retention of new donors (donating for the first time in April–July) at the extensive margin (1.a, upper panel) and at the intensive margin (1.b, lower panel).

	(1)	(2)	(3)	(4)	(5)
	Returned	Returned	Returned	Returned	Returned
Year 2020	0.039***	0.023*	0.033***	0.034***	0.028***
	(0.010)	(0.009)	(0.009)	(0.009)	(0.010)
Age		0.003***	0.003***	0.003***	
		(0.000)	(0.000)	(0.000)	
Female		−0.195***	−0.203***	−0.203***	
		(0.009)	(0.009)	(0.009)	
May		−0.004	−0.004	−0.006	
		(0.012)	(0.012)	(0.012)	
June		−0.006	−0.006	−0.007	
		(0.012)	(0.012)	(0.012)	
July		0.016	0.011	0.010	
		(0.013)	(0.013)	(0.013)	
A		−0.018	−0.019*	−0.018	
		(0.010)	(0.009)	(0.009)	
AB		−0.015	−0.016	−0.016	
		(0.024)	(0.023)	(0.023)	
B		−0.031*	−0.030*	−0.030*	
		(0.015)	(0.015)	(0.015)	
Blood		−0.189***	−0.175***	−0.177***	
		(0.019)	(0.018)	(0.018)	
Constant	0.257***	0.424***	0.425***	0.449***	
	(0.006)	(0.025)	(0.025)	(0.032)	
Interactions	No	No	No	Yes	Yes
Donation center FE	No	No	Yes	Yes	Yes
Obs.	9511	9511	9504	9504	9504
R^2	0.002	0.068	0.125	0.127	

	(1)	(2)	(3)	(4)	(5)
	Number	Number	Number	Number	Number
Year 2020	0.092***	0.065***	0.078***	0.080***	0.070***
	(0.018)	(0.017)	(0.018)	(0.018)	(0.020)
Age		0.006***	0.006***	0.005***	
		(0.001)	(0.001)	(0.001)	
Female		−0.277***	−0.289***	−0.291***	
		(0.016)	(0.016)	(0.016)	
May		−0.053*	−0.052*	−0.055*	
		(0.024)	(0.024)	(0.024)	
June		−0.127***	−0.127***	−0.128***	
		(0.023)	(0.023)	(0.023)	
July		−0.114***	−0.119***	−0.122***	
		(0.023)	(0.023)	(0.024)	
A		−0.028	−0.030	−0.028	
		(0.017)	(0.017)	(0.017)	
AB		0.011	0.001	0.004	
		(0.049)	(0.048)	(0.049)	
B		−0.024	−0.025	−0.026	
		(0.027)	(0.027)	(0.027)	
Blood		−0.385***	−0.361***	−0.366***	
		(0.041)	(0.041)	(0.041)	
Constant	0.363***	0.725***	0.724***	0.771***	
	(0.010)	(0.050)	(0.051)	(0.063)	
Interactions	No	No	No	Yes	Yes
Donation center FE	No	No	Yes	Yes	Yes
Obs.	9511	9511	9504	9504	9504
R^2	0.003	0.060	0.107	0.109	

Notes: Table 1.a: Regression results on the estimated probability of new donors (doing their first donation from April to July) to return to donate within 5 months in year 2020 compared to 2017, 2018 and 2019 (extensive margin). The dependent variable takes value 1 if a new donor doing her first donation in April–July donated again within 5 months. Table 1.b: Regression results on the number of times new donors (doing their first donation from April to July) return to donate within 5 months in year 2020 compared to 2017, 2018 and 2019 (intensive margin). The dependent variable is the number of times a new donor starting to donate in April–July returned to donate within 5 months. Table 1.a, Table 1.b: *Year 2020* is a dummy variable which takes value 1 if year is 2020, 0 if 2017, 2018 or 2019. Columns (1)–(4) report results from OLS regressions. Particularly, in column (3) we control for potential heterogeneity in the blood donation center, while in column (4) we also add the interaction between the covariates and the treatment variable. Column (5) reports instead results from the AIPW-LASSO method. Standard errors are in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

In column (1), we regress our dependent variables on the treatment variable, a dummy variable defined by the year of the pandemic (the variable "Year, 2020"). Across our sample, we find evidence that new donors registered during the most challenging months of the pandemic are, overall, returning to donate again within the following five months with a probability which is around 4 percentage points higher with respect to what happened during the same months in the previous years, when the observed probability of coming back to donate was approximately 0.26. Therefore, we estimate that the COVID-19 shock increases by 15% the probability of new donors returning to donate. Moreover, this result is confirmed when we consider the number of times donors return in the following months. In fact, new donors appear to donate more frequently after the first donation. The number of times new donors return is about 25% (0.092 divided by the average number of times new donors donate during the previous years, i.e. 0.363) higher with respect to pre-pandemic scenarios. In column (2), we test whether the previous findings can be attributed to composition effects related to donors' age and gender, the month of the first donation (with "April" as the reference category), the blood type (with "0" as the reference category) and the donation type (i.e., if it is a blood donation instead of a plasma donation). Estimated effects slightly decrease in magnitude but are still significant. Moreover, we find evidence of a negative and statistically significant impact of being a female donor (see the "Female" coefficient) and having donated blood (see the "Blood" coefficient). This suggests, as expected, that a lower number of females comes back to donate, as well as that a lower number of blood donations takes place with respect to plasma ones. The results on gender and type of donation plausibly derive from national AVIS rules. In one case, the maximum number of donations for a female is restricted. Indeed, female donors of childbearing age cannot donate blood more than two times per year. In the other case, looking at the type of donation, the minimum interval allowed between blood donations is 90 days, while for plasma ones is 14 days.

Furthermore, we find weak evidence that type "0" donors exhibit a higher probability of returning than donors with different blood types. Indeed, this difference is (weakly) statistically significant only at the extensive margins when comparing type "0" donors to type "B" donors. Our results align with the mixed evidence found in the literature about donations of type "0" blood. Given that this blood type can be transfused to individuals of all blood types, a relatively higher frequency of donation for type "0" donors has been connected to the existence of pure altruistic motivations. On the one hand, Sasaki et al. (2020) find that type "0" donors donate more than donors with other blood types, and the effect is higher for those perceiving the utility of being universal donors; on the other hand, Wildman and Hollingsworth (2009) do not estimate any differences between type "0" donors and donors with other blood types. Finally, starting donation activities in April, compared to starting in May, June, or July, positively affects the number of subsequent donations. We have checked that this is a stylized fact holding also for previous cohorts of new donors (e.g., for people donating for the first time between 2013 and 2016); therefore, it is a structural feature of the Italian donors' behavior that deserves further investigation. In columns (3) and (4), we control for blood donation center fixed effects, and, in column (4), we add the interactions between our covariates and the treatment dummy, finding similar results as in the previous regressions. Finally, we analyze the treatment effect of the COVID-19 pandemic on our measures of retention using the double-robust AIPW-LASSO method for inference described in Farrell (2015) and Chernozhukov et al. (2018a). We allow the LASSO to select among more than 3000 control variables resulting from all the possible interactions among the categorical control variables and the elements of a fourth-degree polynomial in age. We find a positive and statistically significant effect, in line with the OLS results.

To check the robustness of our results, in section Appendix C we consider a shorter range for the first donation—i.e., from April to May—and a longer period for coming back to donate—i.e., in the seven months following the first donation—. In this case, we cannot go further than seven months in analyzing the retention effect of April–May new donors, given the data availability until December 2020, and considering an equally long post-first-donation period for all monthly cohorts of new donors. As shown in Table C.6, we find similar results.

3.3. Heterogeneity analysis

To explore the degree of heterogeneity of the retention effect, we allow the COVID-19 effect to differ depending on donors' and their municipalities of residence characteristics listed in Table A.2 in the Appendix. We focus on the dependent variable number of donations of new donors (from April to July) during the five months following the first donation. After the first stage estimation step (in which we regress our dependent variable on the treatment status dummy, the levels of the explanatory variables listed in Table A.2, the interactions between the treatment status dummy and the explanatory variables listed in Table A.2, and donation center fixed effects), we test whether at least one of the coefficients associated to the interactions of the explanatory variables with the treatment indicator is different from zero. The corresponding F-test result ($F_{12,7327} = 1.55$; $p = 0.10$) implies that we cannot reject the null-hypothesis that all the coefficients of the interaction terms are jointly equal to zero at conventional significance levels, suggesting that individual and municipality characteristics used as explanatory variables are not associated to heterogeneous treatment effects. Following Chernozhukov et al. (2018b), we provide a picture of the distribution of the estimated partial effects of COVID-19 (not just the average one) by estimating the percentiles, $\alpha^*(u)$, of the estimated individual effects, α_i, obtained from the first estimation step. Fig. 2 plots the estimated average partial effect (APE), the sorted partial effects (SPE) and the corresponding confidence bands, considering as dependent variable the number of donations of new donors within five months. As shown in the figure, we do not find relevant heterogeneity associated to the considered explanatory variables in the COVID-19 effect, meaning that in our case, the SPE are not more informative than the APE. Indeed, the estimated value of the APE is contained in the 95% confidence bands of the $\alpha^*(u)$ for $u < 91$ and it is contained in the 99% confidence bands of the $\alpha^*(u)$ for any u, as detailed in Table B.5 in the section Appendix B. These conclusions are strengthened by the results presented in subsection C.2 of the Appendix, in which we consider the number of donations in the seven months after the first donation as the dependent variable. In that case, the estimated value of the APE is contained in the 95% confidence bands of the $\alpha^*(u)$ for any u.

To further explore these findings, in Table B.5 we report the estimates of the differences in the means of the new donors' characteristics between the 10% of new donors with the highest estimated effects and the 10% with the lowest estimated effects, and the associated joint p-values. In the table, a negative (positive) estimate reads as a stronger effect of the COVID-19 shock for those with a lower (higher) value of the considered variable. For instance, just by looking at the sign of the estimated difference in means, it appears that the most affected new donors tend to be those with a lower number of donations, as well as younger people, and females. However, none of these differences is statistically significant for any of the new donors' observables characteristics considered.

Therefore, these results suggest that the effect of COVID-19 is not heterogeneous with respect to the donors' and their municipalities of residence characteristics considered in the analyses. Nevertheless, it must be noted that our study does not consider differences in preference and psychological variables, including intrinsic motivations, that we cannot observe.

3.4. Extrinsic motivations?

In this section, we further investigate the nature of new donors' behavior by performing additional analyses. Indeed, we evaluate the possibility that both an increased number of new donations and an increased propensity to return donating could be just the results of extrinsic motivations such as the availability of taking free serological tests that look for antibodies against the COVID-19 virus, as well as the allowance to go out only for necessary reasons, one of which was donating blood. To analyze this aspect in relation to the number of new donors, we restrict the selected sample of new donors to those who first donated in a period with lower movement restrictions and no lockdown, hence from May 4, and simultaneously without the possibility to take free antibody tests, hence before June 15. In this period, new donors are on average about 34 per day in 2020 against a mean value of almost 18 per day in the earlier years. This corresponds to an increase in the number of new donors of more than 88% in 2020 during the May 4-June 15 window, which is not lower than the one estimated considering the whole period April–July reported in subsection 3.1. Moreover, to analyze this aspect also in relation to the retention effect, we restrict the selected sample of new donors to those who first donated during April 2020. As in subsection 3.1, we estimate both their probability to return donating again (extensive margin, Table 2a) and the number of times they return (intensive margin, Table 2b) from May 4 to June 15. The estimates are positive and statistically significant especially when considering the intensive margins (Table 2b) and when we applying the doubly robust AIPW-LASSO method (column 5). Also in this case, the probability of donating again in the considered period is around four percentage points higher than the pre-treatment levels. In percentage terms (the observed baseline probability of coming back to donate is approximately 0.04), this effect is about four times higher than the one estimated in Table 1 a for the new donors starting to donate in the months of April to July. These results show that for new donors donating for the first time in April, the increase in the probability to return to donate between May and the first half of June—i.e., a period in which free antibody tests and the right to go out could not drive their decisions—is not lower than the one estimated considering the whole period. Overall, these findings suggest that new donors' behavior cannot be explained just by extrinsic motivations.

Table 2
The effect of the COVID-19 pandemic on the number of donations from May 4 to June 15 of new donors donating for the first time in April at the extensive margin (2.a, upper panel) and at the intensive margin (2.b, lower panel).

	(1)	(2)	(3)	(4)	(5)
	Returned	Returned	Returned	Returned	Returned
Year 2020	0.030**	0.020	0.015	0.017	0.037***
	(0.011)	(0.011)	(0.012)	(0.012)	(0.010)
Age		0.001	0.001	0.001	
		(0.000)	(0.000)	(0.000)	
Female		−0.016	−0.019*	−0.019*	
		(0.008)	(0.009)	(0.009)	
A		−0.002	−0.004	−0.004	
		(0.009)	(0.010)	(0.009)	
AB		0.045	0.050	0.055	
		(0.028)	(0.030)	(0.031)	
B		0.004	0.000	0.001	
		(0.015)	(0.015)	(0.015)	
Blood donation		−0.147***	−0.145***	−0.146***	
		(0.027)	(0.027)	(0.028)	
Constant	0.039***	0.164***	0.167***		
	(0.005)	(0.030)	(0.031)		
Interactions	No	No	No	Yes	Yes
Donation center FE	No	No	Yes	Yes	Yes
Obs.	2558	2558	2536	2536	2536
R^2	0.024	0.063	0.113	0.115	
	(1)	(2)	(3)	(4)	(5)
	Number	Number	Number	Number	Number
Year 2020	0.040***	0.027*	0.022	0.024*	0.038***
	(0.011)	(0.011)	(0.012)	(0.012)	(0.011)
Age		0.001	0.001	0.001	
		(0.000)	(0.000)	(0.000)	
Female		−0.019*	−0.022*	−0.023*	
		(0.009)	(0.010)	(0.010)	
A		−0.006	−0.008	−0.008	
		(0.009)	(0.010)	(0.010)	
AB		0.057	0.062	0.069	
		(0.033)	(0.035)	(0.038)	
B		0.003	0.000	0.000	
		(0.016)	(0.016)	(0.016)	
Blood donation		−0.168***	−0.168***	−0.168***	
		(0.031)	(0.032)	(0.033)	
Constant	0.038***	0.181***	0.187***		
	(0.005)	(0.034)	(0.035)		
Interactions	No	No	No	Yes	Yes
Donation center FE	No	No	Yes	Yes	Yes
Obs.	2558	2558	2536	2536	2536
R^2	0.007	0.053	0.099	0.102	

Notes: Table 2.a: Regression results on the estimated probability of new donors (doing their first donation in April) to return from May 4 to June 15 in 2020 compared to 2017, 2018 and 2019 (extensive margin). The dependent variable takes value 1 if a new donor doing her first donation in April returned to donate within the period of interest. Table 2.b: Regression results on the number of times new donors (doing their first donation in April) return to donate from May 4 to June 15 in 2020 compared to 2017, 2018 and 2019 (intensive margin). The dependent variable is the number of times that a new donor donating for the first time in April donated again within the period of interest. Table 2.a, Table 2.b: *Year 2020* is a dummy variable which takes value 1 if year is 2020, 0 if 2017, 2018 or 2019. Columns (1)–(4) report results from OLS regressions. Particularly, in column (3) we control for potential heterogeneity in the blood donation center, while in column (4) we also add the interaction between the covariates and the treatment variable. Column (5) reports instead results from the AIPW-LASSO method. Standard errors in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

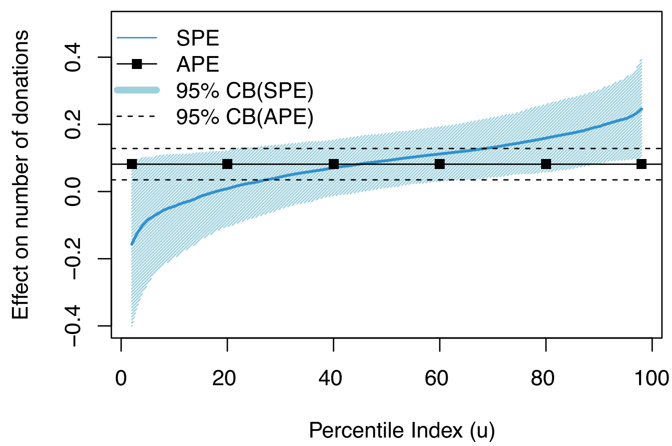

Fig. 2. APE (Average Partial Effect) and SPE (Sorted Partial Effects) of COVID-19 on the number of donations within 5 months by new donors donating the first time from April to July 2020. Partial effects are estimated from a linear model with interactions. 95% bootstrap uniform confidence bands are shown.

4. Discussion

This paper studies the effects of the COVID-19 pandemic on new blood and plasma donors. We exploit a longitudinal dataset comprising the behavior of all donors affiliated with the leading association of Italian Blood Volunteers (AVIS), focusing on Tuscany. We document two main facts. First, we find that, despite the generalized lockdown and the associated restrictions, the number of new donors, during the COVID-19 shock, increase by about 78% in the April–July window, with respect to the average of the previous three years. Interestingly, this increase is proportionally higher in the age group of donors over 49 years. Second, we show that the retention rate of new donors who began donating during the pandemic is greater than that of the new donors in earlier years. Precisely, it is estimated that the COVID-19 shock increased approximately by 15% the probability of new donors returning to donate.

These results help shed light on how prosocial behavior reacts to health emergencies characterized by growing anxiety and limited chances for social interactions, as happened during the first months of the COVID-19 emergency. Anecdotal evidence suggests that COVID-19 stimulated prosocial behaviors (e.g., compliance with public health measures, self-isolation adherence, neighbor and community support). However, one could have reasonably expected that the implementation of social distancing measures could have led to diminished prosocial behaviors that require individual physical presence and potential health risks (Rochira et al., 2022). Indeed, Haller et al. (2022) describe the frequency of self-reported prosocial activities during the first COVID-19 wave and observe that those less common are related to volunteering. Our analysis provides evidence based on administrative data showing that blood donation, a paradigmatic prosocial activity used in the economic literature as a leading proxy of social capital, has been fostered by the COVID-19 emergency in terms of quantity (i.e., number of new donors) and quality (i.e., their retention rate). The finding that the highest estimated percentage increase in the number of new donors is registered for those aged 50 or more corroborates the evidence from surveys on prosocial activities during the COVID-19 crisis (Cho et al., 2022; Cutler et al., 2021; Sin et al., 2021) that suggests that age is a critical determinant of prosociality.

Despite the administrative data used in this study do not allow to investigate the underlying mechanisms, some reflections may, however, be useful to suggest possible interpretations and future research questions. Difficulties to identifying active mechanisms stem from the close interplay between extrinsic and intrinsic motivations, which may even be co-present in the same action, making it difficult to impute observed behaviors to a type of motivation. Think of social distancing, which may be favored by both altruistic considerations (avoid the risk of infecting others) and egoistic ones (avoid the risk of being infected).

There are two main non-intrinsic benefits that could explain the increase of new donors and their more likely retention: the fact that donors were offered a free test for antibodies, which was much valued in the first months of the pandemic, and the fact that donors had the permission to ignore movement restrictions when moving due to donation activities. In order to explore these possibilities, we performed additional analyses restricting the sample to the period during which antibody testing and movement restrictions were not an issue. Results suggest that these two extrinsic motivations did not play a substantial role, thus indicating that we should look for other, possibly intrinsic, motivations. While the importance of these findings has to be stressed, we also acknowledge that the exact intrinsic motivations of such an increase in prosocial behaviors cannot be inferred from the employed administrative data.

For instance, being exposed to a common negative shock can trigger a sense of shared identity, stimulating the adherence to personal and social norms favouring acts of solidarity (Neville et al., 2021). Another factor that could have had a significant role relates to the call-to-action and the active promotion of blood and plasma donations during the emergency by volunteers and affiliated donors (Franchini et al., 2020; Grandone et al., 2020). Also, trust in blood collection agencies could have mitigated the perception of the health risk of donating blood during the pandemic. Further, the perceived value of blood and plasma might have changed because of the emergency, making the act of donation more valuable.

One issue that remains to be explained is the larger percentage increase in blood donation for the population aged more than 49 with respect to all the other age groups, and for those aged 30–49 with respect to the youngest part of the population. First, we note that adults (those aged from 30 to 49) and, even more, older adults (those aged from 50 to 65) are in the maturity of their working lives. Indeed, they typically have more busy lifestyles with respect to younger adults (those aged from 18 to 29), as documented by their higher occupation rate (ISTAT, 2020b), with time constraints limiting their donation activities (moreover, according to OECD, 2020, Figure 10.8, in Italy the youngest people are the age group with the highest amount of time dedicated to leisure, instead older adults are the one with the lowest amount of free time). Hence, this older part of the population may have benefited more from the increase in free time due to COVID-related restrictions, starting to donate. Second, a recent meta-analysis showed a general increase in altruism with ageing (Sparrow et al., 2021), which could be motivated by a greater value orientation or intrinsic motivation in older people. Indeed, the evidence of Politi et al. (2021) points to a growing endorsement of ego-transcending goals as a determinant of increases in prosocial attitudes during the COVID emergency. Third, according to the Italian annual survey “Aspects of daily life” collected by ISTAT (2020a), people of middle to old age are more exposed to selective and traditional public communication channels, such as TV news, which have been the main media to convey institutional COVID-related messages including those regarding the call to action to blood donation. Fourth, we note that mortality from COVID-19 infection increases more than proportionally with age, becoming really high only for those aged more than 65 (Ho et al., 2020). Moreover, according to Italian self-reported declarations, while the individual perception of risk severity remains stable from 40 to 69, the risk vulnerability perception of getting COVID-19 decreases progressively from 50 (Rosi et al., 2021). Therefore, there seems to be limited evidence to expect that age-related COVID-19 health risks may discourage potential new donors.

An important future step of this research would be to examine the longer-term dynamics of donors who started donating for the first time during the pandemic outbreak and to test if the quantity and quality of new donors is affected by the subsequent COVID-19 infection waves and calls to actions. Another possible direction of future research is extending the analysis to the national level.

CRediT author statement

Francesco Serti: Conceptualization, Methodology, Software, Validation, Formal analysis, Data Curation, Visualization, Writing - Original Draft, Writing - Review Editing, Project Administration Veronica Pizziol: Conceptualization, Methodology, Software, Validation, Formal analysis, Data Curation, Visualization, Writing - Original Draft, Writing - Review Editing Roberto Di Paolo: Methodology, Software, Validation, Formal analysis, Data Curation, Visualization, Writing - Original Draft, Writing - Review Editing Dario Menicagli: Resources, Writing - Original Draft, Writing - Review Editing Leonardo Boncinelli: Writing - Original Draft, Writing - Review Editing Emiliano Ricciardi: Conceptualization, Resources, Writing - Original Draft, Project Administration Ennio Bilancini: Conceptualization, Writing - Original Draft, Project Administration, Funding Acquisition.

Data availability

The data that has been used is confidential.

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Appendix A. Results: additional Tables and Figures

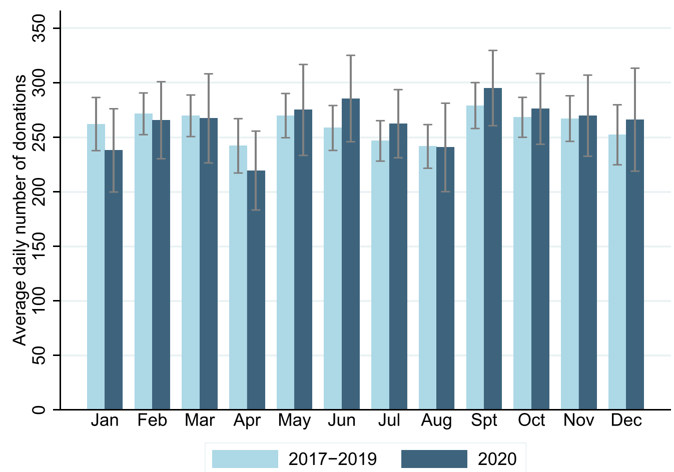

Figure A.1. Average daily number of donations of already affiliated donors by month. Year 2020 vs. 2017, 2018, 2019. 95% confidence intervals are reported.

Table A.1
Average daily number of new donors by month: 2020 compared with 2017–2019.

Month	2017–2019	2020	Δ	%Δ
January	14.40	16.87	2.06	13.94
February	22.28	18.41	−3.87*	−17.37*
March	21.05	17.38	−3.66*	−17.41*
April	18.42	30.03	11.61***	63.02***
May	18.18	33.12	14.94***	82.19***
June	14.98	29.07	14.71***	98.14***
July	13.73	23.38	9.65***	70.32***
August	12.33	15.38	3.05	24.76
September	15.80	20.80	5.00**	31.64**
October	18.64	22.25	3.61*	19.37*
November	19.62	19.16	−0.45	−2.32
December	16.24	16.96	0.72	4.43

Notes: Average daily number of new donors by month in 2017–2019 and in 2020. Column 4 reports the change, in absolute terms (Δ) of the average value of new daily donations from 2017 to 2019 to 2020. Instead, column 5 reports the change, in percentage terms (%Δ) of the average value of new daily donations from 2017 to 2019 to 2020. The changes and the corresponding p-values are obtained by running a Poisson regression of number of new donors on the dummy variable *Year 2020* (which is equal to 1 if year is 2020), month dummy variables, and the interactions between *Year 2020* and the month dummy variables. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Table A.2
Descriptive statistics of new donors and their donations.

Variable	2020			2017–2019		
	Mean	St. Dev.	Obs.	Mean	St. Dev.	Obs.
Individual Characteristics						
Age	36.47	12.18	3544	32.90	12.31	5975
Female	0.45	0.50	3544	0.46	0.50	5975
0	0.46	0.50	3544	0.45	0.50	5975
A	0.39	0.49	3544	0.39	0.49	5975
AB	0.04	0.19	3544	0.04	0.20	5975
B	0.11	0.31	3544	0.11	0.32	5975
Blood	0.91	0.29	3544	0.93	0.26	5975
Avg daily new don.	35.50	10.81	3544	20.94	7.97	5975
Returned	0.30	0.46	3544	0.26	0.44	5975
Municipality Characteristics						
Uni. Prop.	0.12	0.05	3542	0.12	0.05	5969
Mortality	1432.119	1408.375	3542	1061.744	1115.006	5969
Pop. Km^2	1015.01	1045.97	3542	864.46	927.54	5969
PCI	21674.81	2494.39	3542	21228.43	2387.481	5969

Notes: Descriptive statistics on donors and donations for new donors registered between April and July in 2020 compared to 2017, 2018, 2019. *Age* is the new donor's age at the time of her first donation; *Female* is a dummy variable that takes value equal to 1 if the new donor is female; *0, A, AB, B* are dummy variables taking value equal to 1 if the donor's blood type is of the considered category; *Blood* is a dummy variable taking value 1 if the donation is of whole blood (rather than other donations' types, such as plasma); *Uni. Prop.* Is the proportion of university graduates in the municipality of residence in year 2017; *Mortality* is the average number of deaths in the municipality of residence during the two periods; *Pop.* Km^2 is the population density of the municipality of residence in year 2011; *PCI* is the Per Capita Income in the municipality of residence in year 2018; *Average daily number of new donors* is the mean number of new donors in the two periods; *Returned* is a dummy variable taking value 1 if a new donor returns donating within five months after the first donation.

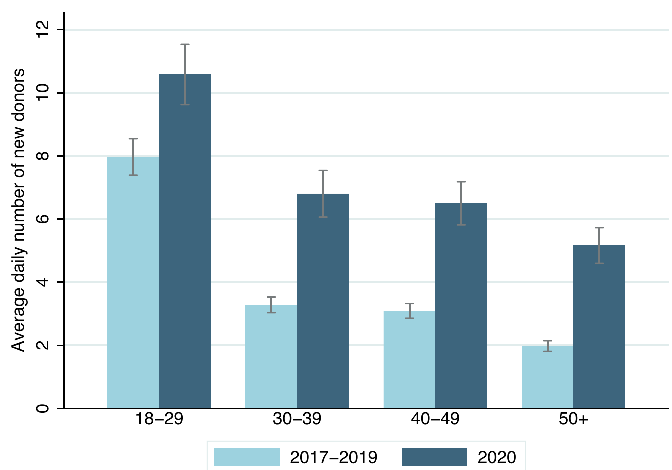

Figure A.2. Average daily number of new donors by age for the April–July interval. Year 2020 vs. 2017, 2018, 2019. 95% confidence intervals are reported.

Table A.3
Statistics of daily number of new donors by age group in the April–July window.

Age group	2017–2019	2020	Δ	%Δ
18–29	7.97	10.58	2.61***	32.77***
30–39	3.28	6.80	3.52***	107.15***
40–49	3.09	6.50	3.41***	110.15***
50+	1.98	5.16	3.18***	161.05***
Test of equality of the changes among Age groups				
A	*B*		Δ_A - Δ_B	$\%\Delta_A$ - $\%\Delta_B$
50+	40–49		−0.23	50.89**
50+	30–39		−0.34	53.89**
50+	18–29		0.57	128.28***
40–49	30–39		−0.11	3.00
40–49	18–29		0.80	77.39***
30–39	18–29		0.91	74.38***

Notes: Average daily number of new donors by age group in 2017–2019 and in 2020. Column 4 reports the change, in absolute terms (Δ) of the average value of new daily donations from 2017 to 2019 to 2020. Instead, column 5 reports the change, in percentage terms (%Δ) of the average value of new daily donations from 2017 to 2019 to 2020. The changes and the corresponding p-values are obtained by running a Poisson regression of the daily numbers of new donors by age group on the dummy variable *Year 2020* (which is equal to 1 if year is 2020), a dummy variable equal to 1 if the month is equal to April, May, June, or July, the age groups dummy variables, and the pairwise and triple interactions between them. The coefficients and p-values at the bottom of the table refer to two-tailed t-tests for post-estimation equality of coefficients. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Appendix B. Heterogeneity analysis: Tables

Table B.4
Sorted Partial Effects of COVID-19 on the number of donations within 5 months by new donors donating for the first time from April to July 2020.

Perc.	Est	SE	95% LB	95% UB	99% LB	99% UB
2	−0.16	0.07	−0.40	0.09	−0.43	0.10
3	−0.12	0.06	−0.34	0.09	−0.38	0.11
4	−0.10	0.06	−0.30	0.10	−0.33	0.11
5	−0.08	0.06	−0.28	0.10	−0.30	0.11
6	−0.07	0.05	−0.25	0.10	−0.27	0.11
7	−0.06	0.05	−0.23	0.11	−0.25	0.12
8	−0.06	0.05	−0.22	0.11	−0.23	0.12
9	−0.05	0.05	−0.21	0.11	−0.21	0.12
10	−0.04	0.04	−0.20	0.11	−0.19	0.12
11	−0.04	0.04	−0.19	0.11	−0.18	0.12
12	−0.03	0.04	−0.18	0.11	−0.17	0.12
13	−0.03	0.04	−0.17	0.11	−0.17	0.12
14	−0.02	0.04	−0.16	0.11	−0.16	0.13
15	−0.01	0.04	−0.14	0.12	−0.15	0.13
…						
25	0.03	0.03	−0.08	0.13	−0.09	0.15
…						
50	0.09	0.02	0.01	0.17	0.00	0.18
…						
75	0.14	0.03	0.05	0.24	0.04	0.25
…						
85	0.17	0.03	0.07	0.28	0.06	0.29
86	0.18	0.03	0.07	0.28	0.06	0.30
87	0.18	0.03	0.07	0.29	0.06	0.30
88	0.19	0.03	0.08	0.29	0.07	0.31
89	0.19	0.03	0.08	0.30	0.07	0.31
90	0.19	0.03	0.08	0.30	0.07	0.32
91	0.20	0.03	0.09	0.31	0.07	0.33
92	0.20	0.03	0.09	0.32	0.07	0.33
93	0.21	0.03	0.09	0.32	0.07	0.34
94	0.21	0.03	0.09	0.33	0.07	0.35
95	0.22	0.04	0.09	0.34	0.07	0.36
96	0.22	0.04	0.10	0.35	0.07	0.38
97	0.23	0.04	0.10	0.37	0.07	0.39
98	0.25	0.04	0.10	0.40	0.07	0.42

Notes: Sorted Partial Effects estimates and standard errors of COVID-19 on the number of donations within 5 months by new donors donating for the first time from April to July 2020. SE are obtained using 500 bootstrap repetitions. Column 3 and 4 report 95% bootstrap uniform lower (LB) and upper (UB) bands. Column 5 and 6 report 99% bootstrap uniform lower (LB) and upper (UB) bands. For reference purposes, the estimated APE is 0.08.

Table B.5
Classification Table – Difference in the average characteristics between the 10% most and the 10% least affected donors donating for the first time in April–July 2020 (the outcome is the number of donations within 5 month).

	Estimate	SE	JP-val.
Number of donations	−0.11	0.16	1.00
Age	−8.70	8.87	0.99
Female	0.30	0.29	0.98
April	−0.44	0.26	0.68
May	0.71	0.28	0.20
June	−0.27	0.22	0.94
0	0.43	0.30	0.83
A	−0.22	0.29	1.00
AB	0.01	0.16	1.00
B	−0.22	0.17	0.90
Blood donation	0.40	0.25	0.74
Uni. Share	−0.03	0.03	0.99
Excess Mortality	11.72	10.93	0.97
Pop. Km^2	273.39	717.20	1.00
PCI	−3314.35	1589.77	0.45

Notes: Estimate: Partial effects estimated from a linear model with interactions. SE: standard errors are obtained using 500 bootstrap repetitions. JP-val.: joint p-values adjusted to account for joint testing of all the variables.

Appendix C. Robustness Checks

To verify the robustness of our results, in this section we follow the analysis of the previous sections but we consider, instead, a shorter period of time for the first donation, i.e., April and May, and a more extended period for coming back, i.e., within a period of seven months.

C.1 Retention effect

In Table C.6 we estimate the effect of the pandemic shock on the probability of new donors to come back to donate, as well as on the number of subsequent donations. As in Table 1, for this purpose we use two different measures: a dummy variable equal to 1 if the new donor comes back to donate within the following seven months (extensive margin, Table C.6. a), and the number of times that a new donor comes back within seven months (intensive margin, Table C.6. b).

Table C.6
The effect of the COVID-19 pandemic on the retention of new donors (donating for the first time in April and May) at the extensive margin (4.a, upper panel) and at the intensive margin (4.b, lower panel).

	(1)	(2)	(3)	(4)	(5)
	Returned	Returned	Returned	Returned	Returned
Year 2020	0.070***	0.036*	0.054***	0.055***	0.032*
	(0.014)	(0.014)	(0.015)	(0.015)	(0.015)
Age		0.005***	0.005***	0.005***	
		(0.001)	(0.001)	(0.001)	
Female		−0.133***	−0.141***	−0.141***	
		(0.013)	(0.013)	(0.013)	
May		−0.003	0.005	0.004	
		(0.013)	(0.013)	(0.013)	
A		−0.022	−0.023	−0.022	
		(0.014)	(0.014)	(0.014)	
AB		−0.021	−0.028	−0.033	
		(0.034)	(0.033)	(0.033)	
B		−0.030	−0.038	−0.038	
		(0.023)	(0.022)	(0.022)	
Blood donation		−0.135***	−0.121***	−0.125***	
		(0.025)	(0.025)	(0.026)	
Constant	0.395***	0.424***	0.438***	0.451***	
	(0.008)	(0.034)	(0.034)	(0.045)	
Interactions	No	No	No	Yes	Yes
Donation center FE	No	No	Yes	Yes	No
Obs.	5275	5275	5267	5267	5267
R^2	0.005	0.046	0.126	0.127	
	(1)	(2)	(3)	(4)	(5)
	Number	Number	Number	Number	Number
Year 2020	0.153***	0.087**	0.114***	0.115***	0.097***
	(0.027)	(0.027)	(0.029)	(0.029)	(0.031)
Age		0.010***	0.009***	0.009***	
		(0.001)	(0.001)	(0.001)	
Female		−0.265***	−0.281***	−0.283***	
		(0.024)	(0.024)	(0.024)	
May		−0.060*	−0.051*	−0.053*	
		(0.024)	(0.024)	(0.024)	
A		−0.035	−0.035	−0.034	
		(0.026)	(0.026)	(0.026)	
AB		0.022	0.008	0.009	
		(0.073)	(0.073)	(0.077)	
B		−0.051	−0.066	−0.066	
		(0.042)	(0.042)	(0.042)	
Blood donation		−0.430***	−0.408***	−0.421***	
		(0.063)	(0.063)	(0.063)	
Constant	0.543***	0.798***	0.813***	0.863***	
	(0.014)	(0.073)	(0.074)	(0.094)	
Interactions	No	No	No	Yes	Yes
Donation center FE	No	No	Yes	Yes	No
Obs.	5275	5275	5267	5267	5267
R^2	0.007	0.064	0.126	0.127	

Notes: Table 4.a: Regression results on the estimated probability of the new donors (doing their first donation from April to May) to return within 7 months in year 2020 compared to 2017, 2018 and 2019 (extensive margin). The dependent variable takes value 1 if a new donor doing her first donation in April–May donated again within 7 months. Table 4.b: Regression results on the number of times new donors (doing their first donation from April to May) return to donate within 7 months in year 2020 compared to 2017, 2018 and 2019 (intensive margin). The dependent variable is the number of times that a new donor (donating for the first time in April–May) returned to donate within 7 months. Table 4.a, Table 4.b: Year 2020 is a dummy variable which takes value 1 if year is 2020, 0 if 2017, 2018 or 2019. Columns (1)–(4) report results from OLS regressions. Particularly, in column (3) we control for potential heterogeneity in the blood donation center, while in column (4) we also add the interaction between the covariates and the treatment variable. Column (5) reports instead results from the AIPW-LASSO method. Standard errors are in parentheses. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

All the results for the analyses shown in Table C.6 are in line with the results reported in Table 1 in the main test.

C.2 Heterogeneity analysis

To further explore the degree of heterogeneity in the retention effect with respect to the underlying donors' and municipality of residence characteristics, we replicate the heterogeneity analysis presented in the main text in subsection 3.3 for a shorter period of time for the first donation, i.e. April and May, and a more extended period for coming back, i.e. within a period of seven months.

After the first stage estimation step (in which we regress our dependent variable on the treatment status dummy, the levels of the explanatory variables listed in Table A.2, the interactions between the treatment status dummy and the explanatory variables listed in Table A.2, and donation center fixed effects), we test whether at least one of the coefficients associated to the interactions of the explanatory variables with the treatment indicator is different from zero. The corresponding F-test result ($F_{11,5101} = 0.94; p = 0.49$) implies that we cannot reject the null-hypothesis that all the coefficients of the interaction terms are jointly equal to zero at conventional significance levels, suggesting that individual and municipality characteristics used as explanatory variables are not associated to heterogeneous treatment effects. Figure C.3 plots the average partial effect (APE) and the sorted partial effects (SPEs) on the number of donations in the seven months following the first donation for the new donors who started their donation activity in April and May 2020. As underlined in the main text, and similarly to Fig. 2, we do not find significant treatment effect heterogeneity. Indeed, as detailed in Table C.7, the estimated value of the APE is contained in the 95% confidence bands of the $\alpha^*(u)$ for any u.

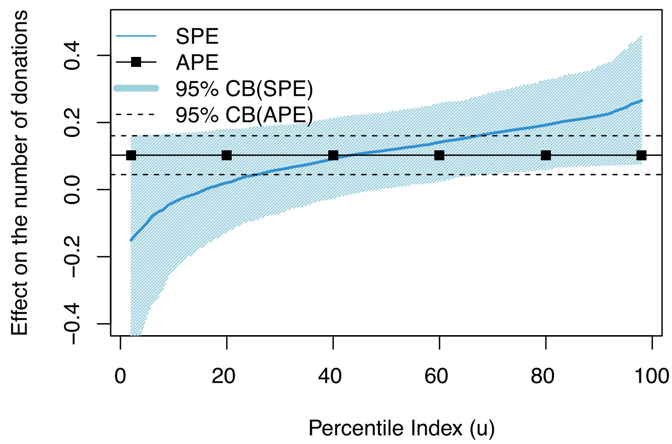

Figure C.3. APE (Average Partial Effect) and SPE (Sorted Partial Effects) of COVID-19 on the number of donations within 7 months by new donors registered in April and May. Partial effects are estimated from a linear model with interactions. 95% bootstrap uniform confidence bands are shown.

As in the main text, to further explore these findings, Table C.8 reports the p-values for the test of equality of means of the donors and municipality of residence characteristics between the 10% of new donors with the highest estimated individual effects and the 10% with the lowest estimated individual effects. Results are in line with the findings described in subsection 3.3, meaning that after controlling for simultaneous inference, our analysis does not identify any difference between the characteristics of these two groups of donors, confirming that treatment heterogeneity is not associated to these characteristics.

Table C.7
Sorted Partial Effect estimates for new donors returning within 7 months in 2020

Perc.	Est	SE	95% LB	95% UB	99% LB	99% UB
2	−0.15	0.10	−0.52	0.16	−0.65	0.20
3	−0.13	0.10	−0.47	0.16	−0.59	0.20
4	−0.12	0.09	−0.42	0.16	−0.54	0.21
5	−0.10	0.08	−0.38	0.16	−0.48	0.21
6	−0.08	0.07	−0.34	0.16	−0.43	0.21
7	−0.07	0.07	−0.32	0.16	−0.39	0.21
8	−0.06	0.07	−0.30	0.16	−0.36	0.21
9	−0.05	0.06	−0.26	0.17	−0.33	0.21
10	−0.04	0.06	−0.24	0.17	−0.30	0.21
11	−0.03	0.05	−0.22	0.17	−0.28	0.21
12	−0.02	0.05	−0.21	0.17	−0.26	0.21
13	−0.02	0.05	−0.20	0.17	−0.26	0.21
14	−0.01	0.05	−0.19	0.17	−0.24	0.21
15	−0.01	0.05	−0.18	0.17	−0.22	0.21
…						
25	0.04	0.04	−0.09	0.19	−0.13	0.23
…						
50	0.12	0.03	0.00	0.23	−0.03	0.27
…						
75	0.18	0.04	0.05	0.31	0.03	0.34
…						
85	0.21	0.04	0.07	0.34	0.03	0.38
86	0.21	0.04	0.07	0.35	0.03	0.39
87	0.21	0.04	0.07	0.35	0.03	0.39
88	0.21	0.04	0.07	0.35	0.03	0.40

(*continued on next page*)

Table C.7 (*continued*)

Perc.	Est	SE	95% LB	95% UB	99% LB	99% UB
89	0.22	0.04	0.07	0.36	0.03	0.40
90	0.22	0.04	0.07	0.37	0.03	0.41
91	0.22	0.04	0.07	0.37	0.03	0.42
92	0.23	0.04	0.07	0.38	0.03	0.42
93	0.23	0.05	0.07	0.39	0.03	0.43
94	0.24	0.05	0.07	0.41	0.03	0.44
95	0.24	0.05	0.07	0.42	0.03	0.46
96	0.25	0.05	0.07	0.44	0.03	0.48
97	0.26	0.05	0.07	0.44	0.03	0.50
98	0.26	0.05	0.08	0.46	0.03	0.54

Notes: Sorted Partial Effect estimates and standard errors of COVID-19 on the number of donations within 7 months by new donors donating for the first time from April to July 2020. Column 3 and 4 report 95% bootstrap uniform lower (LB) and upper (UB) bands. Column 5 and 6 report 99% bootstrap uniform lower (LB) and upper (UB) bands. For reference purposes, the estimated APE is 0.10.

Table C.8
Classification Table – Difference in the average characteristics between the 10% most and the 10% least affected new donors donating for the first time in April–May 2020 (the outcome is the number of donations within 7 month).

	Estimate	SE	JP-vals
Number of donations	−0.16	0.20	1.00
Age	−13.72	8.66	0.77
Female	−0.08	0.37	1.00
April	−0.59	0.30	0.54
0	0.54	0.35	0.80
A	−0.40	0.31	0.89
AB	0.03	0.19	1.00
B	−0.16	0.18	0.99
Blood donation	0.60	0.30	0.51
Uni. Share	−0.04	0.03	0.96
Excess Mortality	8.20	11.55	1.00
Pop. Km^2	1053.57	918.35	0.94
PCI	−2731.24	1968.09	0.87

Notes: Estimate: partial effects estimated from a linear model with interactions. SE: standard errors are obtained using 500 bootstrap repetitions. JP-val.: joint p-values adjusted to account for joint testing of all the variables.

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