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The green and the dark side of distance learning: from environmental quality to socioeconomic inequality

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Abstract
We assess the impact of e-learning during the COVID-19 analyzing a sample of Italian university students. In particular, we point out how the subjective distance-learning evaluation is determined according to: i) pro-environmental preferences and ii) socioeconomic concerns in the light of potential unequal access to digital learning resources. Our results show the relevance of the impact that green preferences have in fostering a post COVID-19 e-learning era, while some doubts on the potential future economic inequalities generated by an unequal access to educational resources are raised. From here, different policy implications are proposed to balance the pros and cons of distance learning, considering both social, financial, and technological factors.

JEL Classification: D6; H8; I24; 044

Keywords
distance learning — pro-environmental attitude — economic inequality — public policy

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Introduction

Distance learning – i.e. learning happening without the physical presence of students and teachers in the same place – vehemently revolutionized the educational world at the aftermath of COVID-19 (Qazi et al., 2021). On the one hand, it has offered the possibility to introduce a resilient school system, able to combine quality in learning and digital system, breaking down the borders of internationalization (Appolloni et al., 2021). On the other hand, it has led to several open questions on social distance (Alifano et al., 2020; Makki et al., 2020; Osman et al., 2020) and students' learning and satisfaction of such methodology (Cicha et al., 2021; Chatterji and Li, 2021). Different studies proposed efficient solutions to improve the quality of this teaching approach, discussing strengths and weaknesses. For instance, Alzahrani and Seth (2021) discussed how to develop tools and strategies to acquire familiarity with the methodology, and how to overcome potential perplexity on the digital interactive system. All these ingredients are used to discuss the future academic activities after the COVID-19 (De Angelis et al., 2020). Conversely, the opportunities and treats linked to future perspective of this approach has been scarcely investigated. In this paper, we address two points that are directly connected to the permanent future adoption of distance learning: the impact on i) the environment and on ii) future accessibility in labor market and so, future emergence of higher/lower socioeconomic inequality.

Green transition and technological change

A radical technological change is essential for the green economy, requiring policy interventions in different socioeconomic contexts. In the post COVID-19 world, this aspect has been remarked by the European Council, that has called for recovery through "green transition and the digital transformation" (European Council, 2020). It is then easy to include in this debate the potential role that digital distance learning might have in lessening climate change, favoring the sustainability of the entire economic system. Indeed, as reported in different studies (see, among others, Versteijlen et al., 2017), online education reduces the impact of carbon emission due to the impact of students and staff travel. It is then worthwhile to analyze whether students perceived this advantage and if their positive feedback in distance learning measures is based on such positive environmental externalities generated.

Equal access to opportunity and socioeconomic inequality

Equality of opportunity is crucial to reducing future economic inequality (Corak, 2013). Considering education, it is meant as the fair and equal access to a good-quality education, regardless of their own family condition, making it possible to have economic success only on the basis of their own effort and ability (Maclean, 2003). As discussed in Piff et al. (2018), there might be structural barriers in education that might lead to higher social inequality. In the case of distance learning, there might be different barriers, such as (i) the heterogeneity

of the technological instruments of both students (Mirza et al., 2019) and school system (González-Betancor et al., 2021), and (ii) pedagogical obstacles (Bashitialshaaer et al., 2021) due to a change in the didactic approach. Devkota (2021) firstly links these aspects to social inequality during COVID-19, discussing how a lack of proper infrastructure, policies and the absence of strong pedagogic support for students from disadvantaged and marginalized areas might foster inequality.

Environmental-socioeconomic trade-off of distance learning

With all this in mind, we analyze, from a student perspective, if the structural educational barriers to distance learning are perceived as real and greater enough to reconsider and counterbalance its positive environmental effect.

Literature demonstrated how these spheres are interrelated, since several studies figured out an inverse relationship between environmental quality and socioeconomic inequality (Wilkinson and Pickett, 2010a; Islam, 2015). In particular, Marsiliani and Renstrom (2003) discussed how subjects suffering from lower living conditions would claim for more effort in redistributive policies at the expense of public policies targeted at improving environmental quality. These findings might be adapted to our research hypothesis about the perception of distance learning: whether subjects perceived as real the threat of higher inequality due to an unbalanced access to learning resources, thus giving greater weight to the need to reduce future inequalities, at the expense of potential environmental benefits. We thus investigate this potential relationship collecting the individuals' perceptions about the impact of distance learning on socioeconomic inequality and environmental change.

Methods

The sample was collected through a social-media online survey conducted at the end of the second semester of the 2021-2022 academic year in Italy, on June 7, 2021. A total of 2,787 Italian students filled the online form, i) mainly female (59%), ii) with an average age of 23 years old and iii) distributed in different universities around the country (51% North, 24% Center, 25% South). These characteristics are in line with national data provided by different data sources. Due to the previous COVID-19 outbreak, all participants declared to have recently experienced distance learning, predominantly with live on-line lectures.

We measure the distance-learning overall evaluation (henceforth DLE) on a likert scale from 1 to 5, resulting with an average value of 3.4 (SD = 1.4). Our survey elicited different characteristics which might be related with DLE. In particular, we focused on personal factors and incentives, such as the distance from the university, calculated as the minutes needed to reach the place [1], and the type of students, distinguishing between full-time and part-time/working student.[2] Additionally, we collected information on the subject's financial wellbeing (1-5 likert scale), living conditions (e.g. the number of housemates), and on the technological instruments at disposal to attend on-line courses. In this case, we asked whether they shared their device with other flatmates in order to attend lectures.

Environmental preferences (EP) are measured though the question: "Distance learning might reduce the impact of climate change", while the expectation towards future socioeconomic inequality (SEI) have been asked as follows: "Distance-learning might create difficulties in equal access to labor market and then, it can enhance economic disparities". Both questions are collected on a Likert scale from 1 to 5.

Drawing on the mentioned literature, we formulate the following hypotheses:

H1. The higher the savings deriving from staying at home, such as a reduction of the traveling cost and the possibility to spend more time in other alternative activities (such as those of part-time students), the higher is the distance-learning evaluation (DLE).

H2. Environmental preferences (EP) in terms of e.g., climate change benefits, are positively associated with higher DLE, the latter seen as a technological solution to stimulate the green transition.

H3. In accordance with theories relating equal opportunity to the reduction of socioeconomic inequality, a negative DLE signals inequality of (learning) opportunity which reflects into higher economic inequalities (SEI).

Results

We ran three separate OLS regressions with different specifications, in order to test our three hypotheses. Table 1 outlines the main results. In particular, the first column identifies H1, where individual traits are used to explain DLE; the second column identifies H2, where we include environmental preferences (EP) as explanatory variable. Finally, in the third column we change the dependent variable since, following the existing literature, we hypothesize that potential unequal access to resources, proxied by the DLE variable, might explain the variation in the socioeconomic inequality (SEI) indicator. Here, following a similar empirical strategy as in Caferra et al. (2021), we remove the effect due to the other potential variables explaining both DLE and SEI, including the residuals of the model estimated in the second column as the new variable identifying DLE preferences (hereafter DLER).[3]

[1] We organize a numerical variable ranging from 1 to 5, indicating respectively 1 = less than 10 minutes, 2 = 10-20 min, 3 = 20-40 min, 4 = 40-60 min, and 5 = more than 1 hour.

[2] Students are also disentangled as on-site (31%), out-side (31%) and commuter (38%).

[3] For robustness, we repeat a similar empirical exercise by employing an Ordered Probit model, obtaining identical conclusions. Results are available upon request. We expose the result employing a simple OLS for at least three reasons: i) the easier interpretability of the results, ii) the absence of excessive skewness and the resulting appropriateness of the model, as it is

Dependent Variable	DLE	DLE	SEI
Part-time student	.327***	.228***	-.12**
	(.056)	(.05)	(.061)
Traveling time	.134***	.073***	-.086***
	(.016)	(.015)	(.017)
Age	.063***	.05***	-.048***
	(.004)	(.003)	(.005)
Female	.133***	.029	.046
	(.041)	(.038)	(.044)
Financial wellbeing	.04	.047**	.015
	(.026)	(.024)	(.027)
Housemates	-.011	-.015	.017
	(.016)	(.014)	(.017)
Device sharing	-.16**	-.126*	.242***
	(.079)	(.073)	(.077)
North	-.12**	-.089**	.079
	(.05)	(.045)	(.053)
South	-.095	-.12**	.205***
	(.058)	(.053)	(.062)
EP		.427***	-.217***
		(.017)	(.022)
DLER			-.437***
			(.023)
Constant	1.516***	.352**	4.703***
	(.15)	(.142)	(.17)
Observations	2787	2787	2787
R-squared	.142	.3	.221

Table 1. OLS results. Robust standard errors are in parentheses. *** $p < .01$, ** $p < .05$, * $p < .1$

As one can see from Table 1, the results of the econometric model support our hypotheses. Regarding H1, the first column reports that diverse sorts of students differently evaluate distance learning. In fact, DLE significantly increases among part-time students compared to full-time ones, and among those who take more time to reach the university, namely who lives farther. We expected these results because some students could benefit from staying at home rather than traveling to reach university, both in terms of monetary savings given the reduction of the travelling cost, and in terms of time saving given the possibility to spend more time on alternative activities. The latter reason might also explain the relatively larger DLE among part-time students. Other significant determinants of DLE are the age and the gender status (female).

done in similar studies employing Likert scales (see, for instance, Ferrer-i-Carbonell and Frijters, 2004), iii) we easily obtain the residuals of the DLER measure.

In particular, DLE significantly increases with age, and this could be explained since older students might have acquired a stronger university experience during the previous years. This leads them to tackle the distance-learning activities and exams in a relatively quieter and more experienced way with respect to younger students, who instead still need to get confidence in the teaching methods and with exams. As for gender, the fact that female subjects showed a higher evaluation of distance learning might be due to higher addiction to smartphone, tablets and computers during the COVID-19 outbreak (Attanasi et al., 2021). Another important result is that hardware availability matters: students who share their devices during distance-learning periods evaluate it relatively worse than those who do not share them. Moreover, the family's financial wellbeing positively affects DLE, although its coefficient is statistically significant only when we consider the environmental benefits perception (EP) as control variable. In general, DLE significantly varies across country's geographical areas. Furthermore, increasing the number of flatmates negatively affects the DLE, although this effect is not statistically significant.

As regards our second hypothesis, H2, the estimated coefficient for environmental preferences (EP) confirms that environmental benefits are positively related with students who appreciate distance learning, since they might see it as a technological solution to stimulate the green transition. This result is in line with previous literature reporting positive correlation between education and green behavior (Cosic et al., 2018).

From the last column, one can see that also the third hypothesis, H3, is confirmed: considering SEI as dependent variable, it significantly decreases when the individual's distance learning evaluation (DLER) increases, once we took away the effects of the other potential variables on both DLE and SEI. Moreover, the concerns about the distance-learning effects on socioeconomic inequality are significantly lower among older students, part-time ones, and across those who take more time to reach the university. Rather, these concerns are stronger for students sharing their devices and living in southern (and also poorer) Italian regions. The last result is in line with a plethora of empirical studies on the North-South divide in Italy (Bigoni et al., 2019; Del Monte and Papagni, 2007; Lisciandra and Millemaci, 2017; Rose-Ackerman, 2007). Finally, and more importantly for the original contribution of our study, a further insight emerging from the results is that the EP coefficient negatively affects the proxy of socioeconomic inequality (SEI) at the 1% level, supporting the empirical trade-off between environmental quality and socioeconomic inequality (Islam, 2015). We focus on this negative relationship in Figure 1, which shows the distribution of the individual differences between the SEI and EP score disentangled by the DLE score. A net positive SEI-EP value indicates a prevailing concern on future socioeconomic inequality, conversely, a negative one evidences how subjects weight more the potential positive externality on the environment rather than future possible

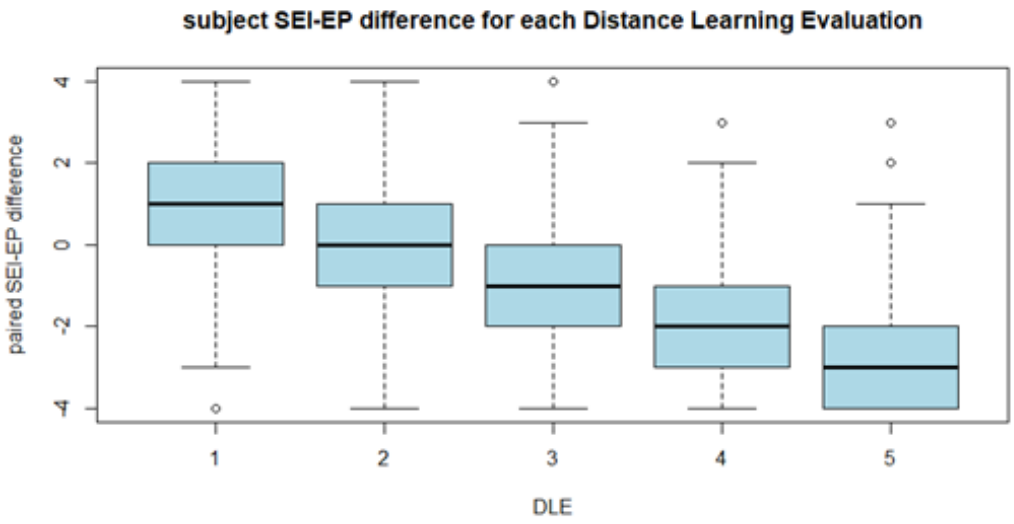

Figure 1. Distribution of the individual differences between the concern of increasing socioeconomic inequality (SEI) and the opportunity of a climate change reduction (EP) for each level of distance-learning evaluation (DLE). T-tests report statisticall significance at any level for each pairwise comparison.

income inequality. Figure 1 shows how the SEI-EP value significantly decreases with the DLE score.

Conclusion

The results of our study confirm our behavioral hypotheses: moving from lower to higher distance-learning evaluation, we observe a monotonic increase of the environmental positive effect, while the weight of future socioeconomic uncertainty is higher for low level of distance-learning approval. This further confirms the negative correlation that links environmental and inequality preferences (Marsiliani and Renstrom, 2003). The impacts of a technological change could be essential in shaping the behavior and preferences of individuals, and they can differently affect production factors shares and, hence, the pattern of income level and its distribution (UN General Assembly, 2015; Van Reenen, 2011). In fact, while some positive aspects can arise - as the positive environmental externalities - these might offset other potential priorities on the policy maker's agenda - such as the reduction of income inequalities - and it is a policy maker's task to balance them in an efficient and socially desirable way.

Our results show that diverse sort of individuals, although all students, differently evaluate the technological change (in this case represented by the distance learning) and that, according to the subjective perceptions, some negative aspects (potential rise in social and economic inequalities) may offset the positive ones (potential reduction of climate change). It is not easy to balance these two aspects. Indeed, despite several theoretical and empirical works attempted to grasp the relationship between income level and environmental quality (see, for instance, the well-known inverted U-shaped Environmental Kuznets Curve (EKC), it is unclear what the link is between income inequality and environmental quality. One can argue that low pollution is obtained for higher levels of economic development which, in turn, are characterized by low income inequalities and higher levels of well-being. Therefore, a sustainable growth and stable reduction of pollution goes through the crucial reduction of socioeconomic inequalities. This is why, as discussed above, those suffering from greater inequality prefer investment in income redistribution policies (Wilkinson and Pickett, 2010b, Islam, 2015). Hence, also for these reasons, the reduction of inequalities is becoming predominant in public policy goals, both at country and at international level (UN General Assembly, 2015), especially after the end of the COVID-19 pandemic. The reduction of inequality might be itself a policy that, in turn, will be reflected in future positive externalities: literature agrees on the fact that societies that are more equal have also smaller ecological footprints, recycle more, and their populations take less frequently flights, consume less water and less meat, and produce less waste (Wilkinson and Pickett, 2010a).

In lights of our empirical results, which confirm that the negative relationship between environmental quality and inequality appears in subjects' preferences when they evaluate a technological change, it seems clear that, for public policy makers, it should be paramount to account for this trade-off in setting the political agenda goals. All in all, it can be concluded that distance-learning policies might have future perspective "without leaving anyone behind" and guaranteeing equal access to all the population classes since, in the opposite case, the expected positive environmental externalities would be neutralized by the flourishing of social inequalities,

hence a consequent slowdown of the sustainable economic growth. In this regard, given that our study was implemented during the COVID-19 outbreak, in line with other studies on behavioral economics for policy (Alifano et al., 2020; Altman, 2020; Baddeley, 2020; Foster, 2020; Martignon et al., 2021; Buljat et al., 2022; Czap and Czap, 2022; Mefford, 2023), our work also contributes to suggesting that behavioural economics can provide rich insights for policy makers to use in adapting their policies to limit the negative economic, social and psychological impacts from anomalous behaviours during pandemics.

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