consistent with accounts of how Greta Thurnberg's activism led her parents to change their behaviours[18], studies have found that when youth participate in activism, it is associated with their parents also getting more involved[19]. As such, one of the unexpected consequences of the #FridaysforFuture movement is that these young activists' parents are likely to become more politically involved. Since most parents are old enough to participate fully in the political system today, the effects may be particularly important in a case like climate change where immediate action is needed.

Time to study youth activists

So far, we know very little about how this nascent movement is creating a cohort of citizens who are active participants in democracy. Research is needed to understand what it means to the young people involved, their friends and families, their civic and environmental behaviours, how it connects to more established climate movements, and, of course, to political outcomes more broadly.

Although we have some knowledge as to how adult activists mobilize to participate in protest and social movements[20], research has yet to devote much attention to understanding how well these findings apply to young people when they engage in activism (for some early efforts, see refs. [9,12]). This work is particularly important because research has found that social movement organizations, such as Friends of the Earth, which aim to cultivate long-term activism and engagement[21], are not as effective at mobilizing young people as adults[12]. Indeed, as more and more young people get involved in the youth-driven #FridaysForFuture movement, they are channelling their efforts into new organizations that focus specifically on mobilizing youth. Without learning how these new groups are working and engaging their members, it is unclear if this movement will have the same broader consequences for participants. At the same time, youth communicate about activism predominantly through social media, without connections to more traditional and established social movement organizations[12,22]. Overall, the ways participants in #FridaysForFuture communicate, how they connect with youth-led organizations, as well as how these organizations form and function, are not well understood. To appreciate the social and political effects of this movement — how individuals are participating now, what it will mean for them over their lives and the political outcomes of their activism — research is greatly needed.

It is worth noting that there is such limited work on youth in the climate movement, and in social movements more generally, due, in part, to the rules governing research that involves human subjects in most countries. Collecting data from individual activists that are under the age of 18 requires parental consent and, as such, is very difficult to carry out successfully. In my experience, the process of securing parental consent drastically reduces participation rates and is sometimes unmanageable. For example, it is just not practical to try to contact a parent to get written consent to study their children when they are being randomly selected by a research team to participate in a survey in the streets during a day-of-action (for example, ref. [21]).

As more and more of the world's youth get involved in this young movement, the onus is on us to overcome these research challenges. It will require innovation on the part of the scientists to figure out how to collect data on these young participants in a way that is ethical and protects their identities. Researchers have started to expand how they study activism and protest, but more research is needed. It is well worth the time and effort to figure out how to study youth movements like #FridaysforFuture so we can understand how our social world is changing and what we can hope for in the future. ❒

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Climate-conscious consumers and the buy, bank, burn program

Manipulation of European Union emission trading systems (ETS) by the buy, bank, burn program compensates unregulated emissions while regulated sectors carry a large part of the burden. This distorts the balance between regulated firms and non-regulated projects, so parties outside the EU ETS can be virtuous at the cost of others.

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A substantial fraction of global CO_2 emissions is not covered by emission trading systems (ETSs). In the European Union, for instance, only 45% of greenhouse gas emissions are regulated by EU ETS, the flagship European climate policy, and notable unregulated sectors include agriculture, road transportation and flights outside the European economic area[1]. Reducing emissions by non-ETS parties can come about in two ways: abatement outside ETS through emission reduction projects, for example, reducing highway speed limits or substituting bikes for cars; and abatement through the ETS by buying allowances from it and annihilating them, a practice we call 'buy and burn'. As of 2018, the rules in EU ETS have changed, temporarily suppressing the effectiveness — that is, the decrease in aggregate emissions per unit of permits burned — of traditional carbon burning. Yet the new rules also open up possibilities for strategic programs, leveraged to more than 100% effectiveness.

The general idea behind allowance burning is rooted in basic economics: an agent trades off ETS versus non-ETS offsetting costs. This yields a simple optimization problem admitting an intuitive outcome: burn allowances, as long as this is cheaper (at the margin) than abatement outside the ETS. Let outside-ETS costs of one additional unit of abatement (marginal costs) be φ per ton, and p the per ton ETS price (that is, p is the price of a ton-worth in ETS-allowances, which one could buy for purposes of annihilation). Since emission reductions inside and outside the ETS are substitutes, the additional costs incurred from one more unit of abatement will tend to converge between the two: $\varphi \approx p$. Note that households can buy and burn allowances, but so can firms or sovereign states. When cutting down CO_2 emissions in the agricultural sector by x tons costs more than buying and burning x tons worth of allowances from the ETS, the latter policy secures an effective emission reduction of x tons at lowest cost.

Until recently such schemes indeed delivered on their promise, as ETS emissions could be reduced one-to-one through buy-and-burn programs — a defining feature of all quota systems. Reforms adopted by the European Parliament in February 2018 yield this observation untrue. In response to large private banking (holdings of unused allowances) of over 2 billion tons of CO_2 by 2013, the European Commission introduced a market stability reserve (MSR)[2]. The MSR starts with an initial balance of 900 million allowances, taken from the 2014–2016 auctioning volumes. Starting in 2019, allowances will be transferred from auctioning volumes to the MSR if the bank exceeds 833 million tons of CO_2; initially by 24% of banked allowances, then by 12% as of May 2024. The allowances thus contained are returned a few years down the line when demand is higher — specifically, an additional 100 million tons will be auctioned from the MSR when bank holdings fall below 400 million tons. The initial proposals only constituted backloading, which does not alter cumulative supply. A qualitatively more important revision was implemented under the most recent regulations: not all allowances in the MSR will be returned. Rather, part will be canceled when the MSR exceeds the amount of allowances allocated in the previous year[2]. The ultimate effect is then this: a decreased allowance demand in early years leads to increased banking, which leads to a larger MSR, resulting in more canceling, that is, a decrease of the cumulative amount of allowances allocated. Importantly, the inflow and canceling of MSR-held permits is only temporary, due in part to an exogenously declining trend in allowance allocations, though when exactly it will end is subject to substantial uncertainty. The new rules constitute a substantial welfare-gain compared to existing practices[3]. Here, we report the unforeseen side effects for burning.

In simplified two-period notation (a more general analysis can be found in the Supplementary Information), the process can be described as follows: a_t allowances are auctioned in period t, firms regulated by the ETS emit verified emissions q_t (so that cumulative emissions are $E = q_1 + q_2$) and are allowed to bank, that is, transfer b unused allowances from period 1 to period 2. Non-ETS parties can buy and burn k_t units in period t:

$$q_1 + b + k_1 = a_1 \quad (1)$$

$$q_2 + k_2 = a_2 + b \quad (2)$$

It is immediate that $dE/dk_t = -1$, that is, if one ton of emissions is bought and burned at any time, aggregate emissions also decrease by one ton. This one-to-one relationship changes under the new rules, though, as second-period allowance auctioning decreases in banking, $a_2 = \bar{a}_2 - \zeta b$, with $\bar{a}_2$ the number of allocated allowances absent a surplus in the first period ($b = 0$). With ζ, the fraction of banked allowances that is destroyed, which was estimated to be initially about 0.8 for EU ETS[4]. As a result, second-period emissions increase less than banking:

$$q_2 + k_2 = \bar{a}_2 + (1-\zeta)b \quad (2')$$

These reforms mangle the effectiveness of traditional allowance burning for an obvious reason: burning k_1 reduces the first-period bank b (equation (1)), and thus increases future allowance allocations, $da_2/dk_1 > 0$. The net effect on cumulative emissions $E = a_1 + a_2 - k_1$ will be less than one-to-one. Formally:

$$\lambda_1 \equiv -\frac{dE}{dk_1} : \lambda_1 < 1 \quad (3)$$

In words, λ_1 measures the net decline in aggregate emissions if one additional allowance is burned in period 1. A precise derivation of equation (3) as a function of fundamental model parameters taking into account price- and demand-effects on banking b is presented in the Supplementary Material, equation (14), and gives $\lambda_1 = 1/3$. Hence, if an agent were to burn one ton of emissions (worth in allowances) in the first period, this would reduce emissions in the aggregate only by one third of a ton. Why? Because burning one allowance decreases the bank by one, and this translates into an increased second-period allocation — we calculate this feedback-effect to be as strong as two thirds initially. Thus, carbon burning has become substantially less effective. The resulting marginal costs of reducing emissions in the ETS are p/λ_1, against φ for non-ETS abatement. This changes the buy-and-burn trade-off for agents outside the ETS. Convergence of marginal abatement costs inside and outside ETS implies $p/\lambda_1 \approx \varphi$, so the market has become distorted. Allowance burning is ineffective and abatement becomes more expensive overall. This observation led several European institutions that facilitate carbon burning to postpone activity or close down altogether.

However, smart use of the new rules can make allowance burning much more efficient than ever before. Key to this increased efficiency is the buy, bank, burn program where, as the name suggests, one buys and banks allowances to be burned only in the future, once the emission cap has become exogenous; that is, when emission flows into the MSR end so that changes in private banking do not affect canceling of permits in the MSR. Said strategy works because these allowances will count toward banking b for the ETS so, when allocations are updated, these will be lowered in response to the buy, bank, burn reserve, $db/dk_2 > 0 \rightarrow da_2/dk_2 < 0$. In particular, if k_2 allowances are bought, banked and burned through the program, we have:

$$\lambda_2 \equiv -\frac{dE}{dk_2} : \lambda_2 > 1 \quad (4)$$

with an explicit formulation for equation (4) given by equation (23) in the Supplementary Material. Implicit in the model is the assumption that the agent who engages in the buy, bank, burn project can commit to its future actions and publicly announces them. The objective of the buy, bank, burn is to affect current market decisions by influencing the perception of future market conditions, and so this assumption is naturally satisfied. Marginal costs of emission reductions are now p/λ_2 in the ETS, versus φ for outside project abatement. Plugging the estimates from ref. [4] into equation (23) in the Supplementary Material, we find that $\lambda_2 = 5/3$. In order to offset 1 ton of emissions, an agent need only buy and bank 3/5 tons worth of allowances. The remaining 2/5 tons of reductions are entirely borne by regulated industries. Smart free-driving allows unregulated agents to impose part of the private abatement costs on regulated bodies: climate-conscious consumers can be virtuous at the cost of others.

In conclusion, recent EU ETS reforms introduce dynamic response mechanisms that strongly impair the efficacy of traditional carbon burning initiatives. This could lead to an increase in overall abatement costs and a reduction in abatement efforts. However, smart use of the new rules resolves this supposed impotency. Parties outside EU ETS can burn allowances at more than 100% efficiency, partly paid for by regulated industries. The buy, bank, burn program is maximally effective if parties buy permits as soon as possible, and announce and commit to burning these allowances once the MSR stops taking in new permits, that is, once the cap has become exogenous again. The program also carries a social cost: it could crowd out emission reductions that have lower social marginal costs but a higher effective price. The new EU ETS rules introduce a risk to the system as they distort the market for emission reductions. Finally, we suggest caution before engaging in large-scale buy, bank, burn programs: the ETS is an artificial market, subject to future policies changes that may adapt to the offset practices discussed herein. ❐

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Additional information

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