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The devastating effects of climate change are becoming increasingly evident. It is difficult to accurately predict or even quantify the risks. Despite this threat, the pace of change is slow. Why is the world failing to tackle this problem collectively and effectively? What constraints are holding us back? How can we overcome them and contribute to the formulation of a credible and acceptable climate policy? What policy instruments can help pave the way to the green transition?

This issue of EconPol Forum brings together several economists and policymakers, to not only critically discuss these important issues, but also to offer some helpful concrete policy suggestions. In particular, the questions of whether the green transition is market-friendly and stimulates economic growth, how the costs of the green transition can be made politically and socially acceptable, and whether the green transition promotes global cooperation are explored in depth.

In “Economic Policy and Its Impact,” the authors examine the extent to which apprenticeship skills pay off on the labor market in Germany. “Institutions Around the World” compares the historical development of Russians’ support for liberal economic and political values since 1990 with those in other former socialist countries in Europe. Finally, in “Big-Data-Based Economic Insights,” we offer evidence supporting the role of arrests in disrupting the repetitive pattern of domestic violence.

POLICY DEBATE OF THE HOUR

Green Transition: How to Make It Finally Happen?

ECONOMIC POLICY AND ITS IMPACT

INSTITUTIONS ACROSS THE WORLD

BIG-DATA-BASED ECONOMIC INSIGHTS

Introduction to the Issue on

Green Transition: How to Make It Finally Happen?

Niko Jaakkola and *Riccardo Rovelli*

The world is not on track to stop climate change within safe limits (IRENA 2023). Despite the widely shared concern that the costs of inaction or of delayed action would be enormous, policies and public debates still fall short of what has been promised.[1]

Achieving the Green Transition, in a timely and orderly manner, is in the national interest of each and every country. With the disruptive effects of climate change becoming increasingly apparent, a future in which the Green Transition is not made poses very real risks to the economic well-being of nations, even if these risks are difficult to quantify or forecast precisely.

So, why is the world still failing to effectively tackle this collective action problem? Which constraints are slowing us down? How can we overcome them, and contribute to the formulation of feasible and acceptable climate policies? Which policy instruments can help unlock the path to the Green Transition?[2]

Economists often tend to isolate questions (including climate-related ones) into bite-size chunks so as to understand them better. But climate change and climate policies affect the economy and society through many different avenues – linking together many fields within and beyond economics. This includes environmental disciplines as well as the study of technologies and technological change, and of public policies, political choices, and international relations.

In October 2023, we convened a workshop – "Shared Perspectives 2023: How to Make the Green Transition Happen?" – assembling mostly economists and policymakers, to discuss such issues in relation to five specific questions:

1. Can the Green Transition be pro-competitive and market-friendly?
2. Will the pursuit of climate sustainability deter or spur economic growth?
3. Are public and private investors penalizing future generations by discounting the future too much, and if so, what should be done to change this?
4. How can the costs of the Green Transition be made politically and socially acceptable?
5. Will the Green Transition foster global cooperation or division?

In this Policy Debate of the Hour, Lorenzo Forni (with Massimo Tavoni) reviews some debates focusing on question 1. Karen Pittel and Alessio Terzi (with Roger Fouquet) propose their views on question 2. Daniele Franco (with Luisa Carpinelli) re-examines question 3. Simone Borghesi (with Alberto Ferrari) examines question 4 in relation to the social dimension of the ETS and on the uses of revenues originated from that system. Niko Jaakkola, Rick van der Ploeg and Anthony Venables also consider political fea-

KEY MESSAGES

- **The Green Transition is in every country's national interest. "Business-as-usual" is no longer possible; the alternative is a future with costly climate impacts**
- **The Green Transition requires public investments and a sizeable increase in public debt**
- **Strong and coordinated policy signals and actions are required to shape expectations, and to thus avoid unnecessary delays and irreversible costs**
- **Economists should promote an interdisciplinary assessment on the growth implications of the Green Transition**
- **The transition will be more politically acceptable if seen to involve "green and inclusive growth" rather than stagnation**

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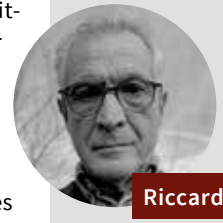

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[1] Following the 2015 Paris Agreement (a legally binding international treaty), more than 70 countries, including the biggest polluters – China, the United States, and the European Union – have set a net-zero target, covering about 76 percent of global emissions. The EU and the US have set their goals to Net-Zero for 2050; China for 2060 and India for 2070.

[2] We discuss the Green Transition mainly in terms of a path toward a climate-neutral economy and society, which is further defined in terms of Net-Zero greenhouse gas emissions (GHG). The European Green Deal is a major example of such a transition, to be achieved by 2050. The Green Transition also involves tackling other pressing environmental problems.

sibility, emphasizing the centrality of expectations and how radical climate policy may be required to shift them in favor of a Green Transition. Gianmarco Ottaviano assesses question 5, focusing on the relations between and mutual implications of the EU's CBAM and the US's IRA. Finally, in this contribution, we pick up some of the remaining themes, and draw on some lessons learned from the extensive debates had during the workshop.

A COSTLY CHALLENGE, OR AN OPPORTUNITY TO GROW?

The costs of many clean technologies have fallen rapidly, even unexpectedly so, which has both contributed to, and been the result of, the widespread deployment of these technologies (IEA 2023). Current developments have continued to vindicate previous hopes that "renewables could easily become by far the cheapest electricity source in history" (IEA 2021).

It is still unclear how far this trend of cost reductions will continue, and what the costs of renewable energy are when the technology is implemented at very large scale. However, even in the favorable scenario of a continued reduction in the average cost of producing renewable energy, the Green Transition will require substantial investments: "renewables-based electrification would require massively expanded and strengthened power grids and the growing role of hydrogen would need pipelines, electrolyzers, and storage facilities" (IRENA 2023). In particular, the development and deployment of effective long-term energy storage solutions are critical to achieving the sustainability goals of the Green Transition (WEF 2023).[3]

In this scenario, the annual global investment in energy transition technologies could be of the order of USD 4–5 trillion by 2030, for a 1.5°C-compatible or net-zero pathway (IRENA 2023; IEA 2021). This is approximately equivalent to an astonishing 4–5 percent of today's global GDP.[4] Comparable estimates are available for many individual countries.[5]

It is clear that financing these investments will pose enormous challenges to the financial systems and to public finances (which we will briefly discuss in the next section).

Moreover, these are not the only costs of the Green Transition. To accompany these investments, educational systems will have to be upgraded and the incumbent labor force will require new training and re-skilling. The likely relocation of a lot of energy-related and agricultural production activity will require costly initiatives to help the orderly phasing out of old activities and the phasing in of the new ones. Older workers in obsolete sectors will be pre-pensioned, and this will add to the strain that population ageing poses to the pension and welfare systems.

We conclude this section with two observations. Even if the costs and challenges of the Green Transition may seem daunting, they need to be openly faced. By laying out what has to be done, and hence how much it will cost, policymakers must be able to speak and act clearly, and link current (individual and public) costs to the expectation of future benefits. In this respect, moreover, it is important to remark that the opportunity cost of doing nothing (that is, the cost of not actively pursuing the Green Transition) is not "business as usual" – rather, it would be a dismal scenario of ever harder to mitigate (and also to adapt to) adverse climate events.

Second, some regions and some countries will bear a greater share of the costs of the Green Transition – no matter what we measure the share against: population, GDP per capita, or in terms of how each region has contributed historically to the accumulation of pollutants in the atmosphere. In this respect, international cooperation will be essential, not only as an ethical requirement but also more pragmatically to acquire the support of those regions and countries to pursue their way to the Green Transition. Within the EU, for instance, this is happening with the Just Transition Mechanism and will happen with the Social Climate Fund (to be financed with funds from the new ETS 2). However, similar policies (supporting peoples and also investments) should be adopted worldwide, on a much larger scale.

PUBLIC POLICIES, FISCAL POLICIES, AND THE GREEN TRANSITION

In the previous section we argued that, even if cost reductions imply that "scaled up" green energy will soon be absolutely less costly than fossil energy, public policies will be still required to speed up the transition and to make it socially and politically acceptable. Path dependence and technological complementarities may require policies to break the historically determined reliance on fossil energy and technologies (Acemoglu et al. 2012; see also Jaakkola, van der Ploeg and Venables, in this issue).

In this vein, appropriate policy solutions are needed to support and orient renewables-related R&D; to build public infrastructures (such as electricity grids) that complement privately deployed renewable energy production; to achieve a gradual elimination of stranded assets and – in parallel with this

[3] Importantly, the Green Transition also involves protecting the world's biodiversity, something to be taken into account as the global search for raw materials critical to renewable technologies takes off around the world.

[4] However, not all of these investments would be "additional" – some would replace depreciating old capital.

[5] For France, Pisani-Ferry and Mahfouz (2023) estimate that the additional investment needed in the decade 2021–30 is EUR 60–70 billion annually, equivalent to more than 2 percent of GDP, only to replace fossil fuels with unchanged total output. For Italy, Noera et al. (2023) estimate the total yearly investment needed to adapt the Italian energy and industrial policies to the EU decarbonization targets over the current decade to be EUR 122–134 billion (equivalent to 1.7–2.4 percent of GDP) – which amounts to about 25–30 percent of Italy's total investments.

– a timely phasing out of fossil-fuel reserves;[6] and to provide solutions to mitigate the climate impacts from hard-to-abate sectors.[7] In all of these cases, powerful conflicts of interests may pose political obstacles to completing the Green Transition.

In this respect, we stress that the key to acceptability of such policies may be twofold: first, direct losers must be compensated or given a clear opportunity for improvement; second, imposing costs is only acceptable when clearly linked to future benefits. This is something that too many current political narratives seem reluctant to acknowledge.

In any case, the real and financial costs of the Green Transition should not be presented as part of a necessary package of "austerity" measures: firms can only be persuaded to take on their share of additional investments in the expectation of an expanding, not a stagnating economy.[8]

A probable consequence of the public sector undertaking its share of the necessary investments will be an increase in public debt ratios. In this case, this will be justified by the fact that this debt will bring no harm to future generations – indeed, it will be used to invest in more benign climate conditions – and that it will generate necessary public capital. Appropriate financial instruments are available for this purpose. Also, policymakers, public watchdogs, and public opinion must be prepared for such changes. Fiscal policy rules will need to allow for such increases.

A critical question thus naturally poses itself: how much more debt should we be prepared to accept? The answer depends, as often, also on how much (de-?) growth will accompany the Green Transition. We discuss this issue below.

THE PROSPECT OF GREEN GROWTH MATTERS

Most scholars, and indeed most educated people, would accept that (i) the Green Transition is necessary; (ii) given sufficient time, it would likely happen anyway for reasons of technological progress and resource scarcity; (iii) nevertheless, to avoid unnecessary and irreversible costs, strong policies are required to accelerate the Green Transition, so as to achieve climate neutrality at the world level by 2050 or as soon as feasible.

On the other hand, not everybody accepts the idea that the Green Transition is also an opportunity for growth. While the European Commission defines (correctly, in our view) the European Green Deal (that is, the EU's policies for the Green Transition) as "Europe's new growth strategy" and as a boost to the European economy,[9] not everybody shares this view. In this respect, there are two alternative views.

One is technological skepticism, the other is the belief that degrowth would be necessary to achieve sustainability. Technological skepticism accepts the fact that, by now, energy produced using renewable resources (especially solar and wind energy) has already achieved cost competitiveness relative to fossil energy. Nevertheless, skeptics remain unconvinced that these marginal cost advantages can be fully scaled up to become "systemic advantages" – and help us build an economy around clean and environmentally friendly energy that is also cheaper than fossil fuels. Agreement on whether this skepticism is founded or unfounded should be obtained as soon as possible. Economists should lead an interdisciplinary effort (including physicists, engineers, and scholars of technological progress) to jointly seek clarity, combining expertise from their diverse perspectives, and to help us (and policymakers) reach a confident answer as soon as possible.[10]

Why do we stress the importance of a rapid convergence of expectations on the likelihood that the Green Transition will actually promote growth? While we admit being captured by the notion that "renewables could easily become by far the cheapest electricity source in history" (IEA 20210), we may be at risk of falling into an alternative future, created by self-fulfilling expectations. Economic and technological progress depends on investments, which depend on growth expectations. By optimistically reaching for ambitious climate goals – net-zero by 2050, in a rapidly growing economy – we may encourage firms to invest more in rapid, green innovation and thus reach the future we seek. Instead, if pessimism or skepticism prevails, the Green Transition will be delayed. Then, the worsening impacts of climate change will lead to economic costs, including both direct damages and adaptation costs, which will reduce the resources available to invest in the Green Transition. Rent-seeking behavior in stagnant economies suffering from adverse climate events will further consume resources that could otherwise be used for investment, leading us into a climate poverty trap.

More prosaically, there are four reasons (at least) why growth will impact favorably on the path of the Green Transition:

(i) For a given path of public and private investments, the implied debt ratios would be lower

[6] Similar to what we argued in the previous section, we believe that also in this case international cooperation should seek to compensate, at least in part, those countries that have not benefited in the past but now stand to lose more from the phasing out of fossil "wealth."

[7] Sectors such as iron, steel, cement, and building materials. According to some estimates, these may account for about 20 percent of global GDP and 85 percent of global greenhouse gas emissions (McKinsey 2022).

[8] If the financing needs of the Green Transition were to lead to stagnation over a timescale of a decade or so, this would both discourage many necessary "green" private investments and also build substantial political discontent targeted at the transition.

[9] https://reform-support.ec.europa.eu/what-we-do/green-transition_en.

[10] Some academics and activists have been advocating a stop to economic growth, a view commonly called degrowth (e.g., Hickel et al. 2022). In our view, degrowth does not offer effective, pragmatic policy guidance; furthermore, it will not be politically or socially feasible, including in the international arena.

(hence, more financially sustainable) the higher growth is;

(ii) For a given path of total required investments, the share of private investments would be higher (and hence the burden on public finances would be lower) the higher growth expectations are;

(iii) Job transitions would be easier in a growing economy, and more generally the social costs of the Green Transition would be more widely acceptable;

(iv) The prospect of a "green growth dividend" would reduce the numbers of skeptics and supporters of degrowth.

POLICY CONCLUSIONS: HOW TO PICK THE "RIGHT" POLICIES?

Whereas the Green Transition would probably happen anyway, the need to strongly accelerate it to steer the world's economies toward a fast (by 2050) net-zero emissions path requires the adoption of strong policy packages. There is no single policy that can take on the burden of steering the economy in the right direction and with the required speed:

- Carbon pricing, or more generally Pigouvian taxes and subsidies, are necessary but will not be sufficient, especially in the beginning. The Green Transition will not get started by simply inducing consumers and producers to purchase or produce different bundles of existing alternative goods. It starts with the invention of new technologies and "commanding" their use to change the way we obtain our fundamental factor of production – energy.
- This change requires an enormous amount of "directed" and coordinated research and investments – and of policies targeted to these purposes, such as targeted subsidies, standards, and bans (see Blanchard et al. 2023).
- To the extent that these policies are intended to stimulate research and/or investments, it is important that they be perceived as long-term commitments, supported by adequate financial resources.
- In addition, specific policies are required to compensate the losers from the Green Transition and facilitate their transitions, whether to new jobs (and new skills), new locations, or both.
- As many policies that induce de-investments from fossil-fuel-related sectors will create losers, to ensure their social and political acceptability it is necessary that they be presented as part of a package that includes appropriate compensations over a sufficiently long horizon.

Again, we stress that, whereas almost every single policy creates winners but also losers, the social and political acceptability of policies will undoubtedly increase as the Green Transition will be perceived to be a recipe for "Green Growth," rather than for a "Green Stagnation."

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Lorenzo Forni and *Massimo Tavoni*

How to Overcome the Short-term Costs of the Climate Transition?

KEY MESSAGES

- **Transitioning to a climate-resilient future can offer significant economic benefits when compared to maintaining current emissions levels. Renewables and electrification promise reducing dependence on fossil fuels, benefiting both the environment and human well-being**
- **The transition to a green economy, however, faces short-term challenges, including stranded assets and skill obsolescence. Overcoming these obstacles requires securing public buy-in, addressing the disparity between private costs and societal benefits, and developing comprehensive policy strategies**
- **Public acceptance of climate policies hinges on perceived fairness and policy efficacy, with effective communication about benefits playing a pivotal role. While carbon revenue recycling can gain short-term public support, a holistic approach, integrating various mitigation strategies and transparent communication, is vital for a sustainable transition**
- **Several authors emphasize the importance of aggressive early action for a successful green transition, highlighting the momentum and cost reductions achieved with the diffusion of green goods and technologies**
- **Challenges such as political divides, economic disparities, and the interplay between market and government failures can potentially hinder the positive feedback loop and derail green transition efforts. To ensure success, a concerted effort from both the public and private sectors, backed by rigorous research to understand societal behaviors and attitudes, is necessary**

THE BENEFITS OF THE GREEN TRANSITION

Understanding the economic implications of transitioning toward a climate-resilient future is intricate and complex. Yet, there is now consensus that such a transition is economically favorable if well executed. The latest assessment report of the IPCC states for the first time that the economic benefits of stabilizing climate change at safe levels outweigh the costs, provided policies are well designed and international cooperation holds.

The economic case for climate action arises because the economic repercussions of climate-induced events are profound. Natural disasters bring immediate damages and long-term economic downturns, affecting infrastructure and human lives. The economic costs associated with rising global temperatures are uncertain but expected to be significant, and higher than those needed to transition to net-zero (Drouet et al. 2022). Investments dedicated to climate adaptation involve two main areas: preventive measures, like bolstering infrastructure; and remedial actions, which encompass post-disaster relief and rebuilding. Catalano et al. (2020) emphasized that proactive, preventive interventions spur higher GDP growth when juxtaposed against remedial measures or outright inaction. However, the steep initial costs of such preventive measures and budgetary constraints have led many nations to prioritize post-disaster interventions, often complemented by international financial assistance.

It is worth noting that there is a disparity in how different economic models perceive and account for climate impacts. For instance, most models used in ex-ante evaluation of climate policies focus only on the net-costs of the transition without including climate damages. Such omissions render these models unable to quantify the negative growth ramifications associated with escalating temperatures and subsequent natural disasters. In contrast, Integrated Assessment Models adeptly encapsulate the harmful growth effects of rising temperatures and associated climatic disruptions. As illustrated by Catalano et al. (2021), these models show that scenarios championing emissions reduction outperform "business-as-usual" models regarding long-term economic growth.

The second compelling reason for advocating for a shift toward renewables stems from their inherent sustainability. According to the International Energy Agency, solar energy has become the cheapest source of electricity generation in human history, a process arguably accelerated by climate protection policies. Unlike fossil fuels, renewables predominantly harness solar power, eliminating the need to extract, import, and process vast quantities of nonrenewable resources. This shift carries pronounced distributive implications across nations. Countries that traditionally import oil, including numerous European nations and emerging giants like China and India, stand to gain substantially in the long run. These countries can bolster their energy autonomy by cutting down on energy import expenses, thereby fortifying their economic resilience. Conversely, nations endowed with rich fossil fuel reserves and extensive processing infrastructures might encounter challenges. They face the risk of considerable stranded assets and the accompanying economic repercussions as the global momentum leans toward green energy alternatives.

Yet, it is pivotal to recognize that the advantages of transitioning to greener energy sources extend beyond mere economic metrics. The broader environment, encompassing natural capital and biodiversity, can reap significant rewards from such a shift. Measures ensuring forest conservation, water preservation, pollution reduction, and the protection of diverse natural habitats play a crucial role. These actions not only safeguard our planet's invaluable biodiversity but also complement the economic dividends of a green transition. This is especially true for air pollution, whose health impacts have significant repercussions for well-being and productivity (Aleluia et al. 2018).

THE SHORT-TERM COSTS THAT ARE SLOWING THE TRANSITION

While the advantages of the green transition appear evident, its journey is fraught with numerous obstacles. A transition of this magnitude and depth inevitably implies costs that are either economic, political or hedonic. The concept of "stranded assets" is an often-quoted example of these transitionary expenses. As we grapple with the urgency of environmental challenges, certain assets, despite being operational, may become redundant before completing their anticipated lifecycle. This spectrum of stranded assets ranges from apparent candidates like fossil fuel reserves to broader categories like equipment slated for early retirement. For instance, firms producing components for combustion-engine vehicles face considerable risks with the rapid diffusion of electric vehicles. Similarly, buildings with poor energy efficiency might necessitate significant investments to enhance their efficacy or risk plummeting in market value. Both cases highlight the economic advantages of the green transition: electric vehicles are three times more efficient than international combustion engines. And energy-efficient buildings can help save on energy bills.

Alongside assets, there is a parallel risk of skill obsolescence and the need for new competencies. As specific sectors scale down in alignment with green objectives, the workforce, adept in those sectors, might discover their skills becoming increasingly irrelevant - requiring layoffs or reskilling. However, for both capital and skills, the need for renewal to sustain economic progress and create new industrial and occupational sectors suggests ways the energy transition can be beneficial in the short term, provided it can foster industrial progress toward more productive activities. In this sense, the transition toward renewable energy and electrification would have happened anyway as nonrenewable scarcity increases; the green transition is significantly accelerating this process given the urgency of the climate challenge.

The transition adjustments manifest in political or financial terms and ripple through economies, sectors, and households. Understandably, there is hesitation to shoulder the initial costs, juxtaposed against the broader and collective benefits of reduced emissions and cleaner, domestic energy sources. The traditional view from economics is that while businesses and households grapple with these immediate financial implications, potentially with some assistance from public coffers, the advantages of their actions – reduced emissions and a healthier environment – benefit society at large. This discrepancy between private costs and public benefits underscores a classic economic conundrum: the challenge of externalities. When individuals or entities do not directly reap the full rewards of their positive actions or, conversely, bear the brunt of their adverse actions, they might be less incentivized to act responsibly. This inherent discord paves the way for "free riding" behavior, where economic agents evade bearing the costs, hoping others will step up, thereby exacerbating the challenges of the green transition.

Though these arguments are still valid, especially in the international context, the rapid advancement of low-carbon technologies and increased geopolitical energy risks offer a fresh look into the economics of short-term climate action. Many of the actions and strategies needed to reduce emissions - at least initially - are now affordable and in most cases more efficient than fossil fuels, especially for regions - like Europe - that depend almost entirely on imports. The shift from environmental to industrial policy is evident as major economies compete in a global clean energy race for technology supremacy and market share acquisition.

Navigating the complexities of the green transition needs to account for the iron laws of climate dynamics. We are grappling with the aftermath of historic emissions that have lingered in the atmosphere, already causing a temperature rise of over one degree Celsius. This shift, regretfully, is near irreversible. The emissions of today promise further warming, making the journey even steeper. While slashing emissions can decelerate the rate of temperature escalation, the ambitious goal of net-zero emissions, at its most optimis-

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tic, would merely stabilize temperatures at elevated levels. In other words, the efforts and investments poured into emission reductions today are juxtaposed with a relentless upward trajectory in global temperatures. This dichotomy underscores an urgent need: not only to achieve net-zero emissions, but also to address excess CO_2 concentrations using negative emission technologies, without diminishing mitigation efforts.

Yet, the challenges do not end with the generational equity concerns or the complexities of externalities. Public awareness, or the lack thereof, exacerbates the difficulty. Many remain uninformed or apathetic about the climate crisis despite the global stakes. Organizational hurdles further impede progress. The logistical challenges of securing permits for large-scale renewable energy projects are significant. Furthermore, while there is broad consensus about the need for renewable energy, local opposition often arises when these projects are slated for specific regions – a phenomenon aptly coined "not in my back yard" (NIMBY). The influence of powerful lobbying groups, with vested interests in maintaining the status quo, further muddies the waters. They often wield considerable sway in shaping public opinion and policy directions which lock in fossil energy and make the transition more difficult. And as if these weren't enough, there is considerable debate about the best policy strategies. Should the emphasis be on carbon pricing, serving as a deterrent to carbon-intensive activities? Or should the focus shift to incentivizing innovation and fostering nascent sectors and technologies? This highlights the necessity of building upon the increasing consensus that a comprehensive policy portfolio, encompassing market instruments, regulation, and innovation, is essential to address the climate challenge. Communicating the scope of such a policy reform is challenging and demands substantial political will which is severely compromised by several weaknesses.

In essence, the road to a green economy is generally advantageous but also fraught with multifaceted economic, social, organizational, and political challenges. Yet, despite these hurdles, the imperative for transition remains clear and compelling. The intricate challenges culminate in one overarching problem: securing public buy-in for climate policies. When individuals face immediate sacrifices and an uncertain future, rallying them behind climate initiatives is a formidable task. So, how do we bridge this disconnect between short-term sacrifices and long-term advantages?

PUBLIC ACCEPTANCE OF CLIMATE POLICIES

Recent studies offer fresh perspectives on how public acceptance of climate policies, especially carbon pricing, can be fostered. A salient theme from this literature is the pivotal role of perceived fairness and policy efficacy. As posited by Bergquist et al. (2022), the public's perception of a policy's fairness and effectiveness emerges as a cornerstone in determining its acceptance. In other words, if people believe that a carbon tax is not just equitable but also effective in achieving its environmental goals, they're more likely to support it.

Dabla-Norris et al. (2023) delve deeper into this aspect, highlighting that the underlying beliefs about the tangible outcomes of such policies, be it their costs, benefits, or their progressive nature, are instrumental in molding public sentiment. An important insight from their research is that the way the revenue from carbon pricing is utilized plays a decisive role in shaping its public perception. If the revenues from such initiatives are funneled into rectifying distributional disparities or into the economy via green infrastructure projects and low-carbon technology subsidies, public endorsement is likely to be higher. Their study underscores the profound impact of strategic communication. Simply put, if the public is made acutely aware of a policy's benefits and effectiveness, their support swells.

Further accentuating the importance of equitable distribution, Colantone et al. (2023) spotlight the distributive repercussions of green policies. Their research suggests that the political viability of such initiatives is linked with their distributional outcomes. In essence, policies that are perceived as imposing undue burdens on specific segments while benefiting others disproportionately are less likely to secure widespread public endorsement.

In synthesis, while steep, the road to winning public support for green transitions is not insurmountable. Through a blend of equitable policies, strategic communication, and a genuine commitment to sustainability, it is possible to align public sentiment with the long-term imperatives of a sustainable future. The dichotomy here is the tug-of-war between short-term appeasement and long-term transition objectives. The sentiment of fairness becomes paramount in this discussion. When people feel they are being treated justly, they are more likely to buy into an initiative, even if it demands personal sacrifices. Recycling carbon revenues is one such avenue that holds promise. When citizens can see tangible benefits from policies, such as receiving direct financial transfers, reductions in their taxable income, or community-level programs that directly improve their surroundings or quality of life, their resistance to such policies may diminish. This approach capitalizes on the political economy of the situation by giving people an immediate reward, or at least a cushion against the short-term costs.

EVIDENCE ON CARBON REVENUE RECYCLING

Carbon revenue recycling, while a seemingly attractive strategy to gain public support for carbon pricing, is not a one-size-fits-all solution. It is evident from

the mixed results in the literature that the success of such policies can vary significantly based on regional differences, cultural perspectives, and political leanings. The literature is divided. Mildenberger et al. (2022) find limited evidence that individual, or household, rebates have increased public support for carbon taxes in Canada and Switzerland. Similarly, Fabre and Duenne (2022) find that after the Yellow Vests movement, French people would largely reject a tax and dividend policy, i.e., a carbon tax whose revenues are redistributed uniformly to each adult.

Some studies find mixed evidence. For example, Jagers et al. (2021), based on survey experiments administered in the United States, Canada, and Germany, find that while public opinion is sensitive to the cost attributes of carbon taxes, in some cases, opposition to carbon taxes can be offset by a reduction in income taxes. However, these effects tend to be modest in size, limited to some ideological groups, and varied across countries. They also show that fairness perceptions are a crucial mechanism linking revenue recycling to carbon tax support in all countries examined.

Finally, other studies find more support for revenue recycling. Beiser-McGrath and Bernauer (2019), for example, based on choice experiments with representative samples of citizens in Germany and the United States, find that revenue recycling could help achieve majority support for carbon tax levels of up to USD 50–70 per metric ton of carbon, but only if other countries join forces and adopt similar carbon taxes. Nowlin et al. (2020) argue in the case of the US that conservatives and Republicans are more supportive of a carbon tax when revenues go toward a tax rebate or deficit reduction.

However, while this might gain traction in the short run, does it compromise long-term objectives? From a purely efficiency-driven standpoint, using carbon revenues for more direct emission reduction methods seems more sensible. Investing in research and development (R&D), fostering green industries, or even directly intervening in emission-heavy sectors holds the potential for a rapid and significant reduction in emissions. Such strategies accelerate the shift toward a more sustainable economy. By redistributing carbon revenues back to the people, we may inadvertently be putting the brakes on the green transition. With more money in their pockets, consumers will naturally increase their consumption. In an economy still dominated by high-emitting technologies and not yet fully transitioned to green alternatives, this would mean a higher demand for emission-intensive products and services.

In essence, the dilemma is clear. On the one hand, there is the need to earn public support by ensuring perceived fairness, and on the other, the imperative to drive an efficient and rapid green transition. Striking the right balance requires nuanced policymaking, where immediate public benefits are coupled with a concerted push for sustainable transformation. Policy architects need to consider the economic implications and the sociopolitical fabric that influences public opinion. We can only navigate the intricate challenges of transitioning to a green economy with this comprehensive approach.

Also, focusing solely on carbon revenue recycling can be a narrow approach when considering the broader picture. Carbon pricing is one instrument in the vast toolkit of mitigation strategies, and not all these tools come with fiscal revenues that can be channeled back to the public. For instance, regulations, standards, and incentives might not generate direct fiscal revenues but can still be pivotal in driving a country's green transition.

Moreover, redesigning crucial markets, like the electricity sector, is another way to allocate the benefits of the transition to specific groups. Furthermore, in an age of information overload, the narratives championed by interest groups, lobbyists, and incumbents can significantly influence public opinion. The challenge, then, is designing effective policies and ensuring they're communicated authentically and transparently to the public.

In conclusion, while carbon revenue recycling has its merits, it is imperative to understand its limitations and the broader context in which it operates. Relying solely on it as the primary strategy to gain public support might be overly optimistic. It should be considered as a part of a comprehensive suite of policy tools, each tailored to the unique circumstances and requirements of individual nations and their citizens, including both pre-distributive and re-distributive elements.

DO WE NEED A MORE AMBITIOUS APPROACH?

Van der Ploeg and Venables (2023) advocate a radical approach that underscores the need for an aggressive intervention at the very beginning of the transition toward a greener economy. By taking bold steps initially, the momentum created can sustain and propagate further green actions in the economy. Positive production complementarities are grounded in the reality that as green technologies proliferate, there are cost reductions due to economies of scale and ongoing innovation. We have seen this in action with solar panels, windmills, batteries, etc., which have drastically fallen prices as more units are produced and efficiencies are found.

However, as is the case with any technological revolution, the rise in efficiency of brown technologies might give a false sense of progress and deter innovation in the green space. Indeed, van der Meijden and Smulders (2022) and Smulders and Zhou (2022) caution against optimism in this regard, as an efficiency increase in brown technologies can delay technological improvements in the green ones. It is a delicate balancing act where progress in one sector

may inadvertently slow advancements in another, especially when accounting for political economy issues.

On the consumer side, green goods becoming "trendy" or normative as more people adopt them seems intuitive. Once a critical mass is achieved, these green goods can become the norm rather than the exception. Though the adoption of electric vehicles is an example of how fast things can abruptly change, whether these "positive tipping points" can be generalized remains largely speculative and needs empirical backing. Moreover, any perceived elitism or exclusivity around green goods can deter their widespread adoption. This is where government incentives can play a critical role, helping to normalize these goods in the eyes of consumers and make them more accessible.

However, even with these measures in place, challenges persist. Political divides, perceived elitism around green products, and economic disparities can hinder the kind of positive feedback loop van der Ploeg and Venables envision. This is further complicated when one considers the potential interaction between market failures (like information asymmetry) and government failures (like policy myopia). These issues can derail even the best-laid plans for a green transition. Besley and Persson (2021) show – in a model that entails positive strategic complementarities – that market and government failures can interact to prevent a welfare-increasing green transition from materializing or make an ongoing green transition too slow.

POLICY CONCLUSIONS

Van der Ploeg and Venables's vision of radical climate policies is enticing. Start strong with aggressive carbon taxation and substantial renewable subsidies to push the economy toward the green equilibrium. As the production and consumption of green goods become more widespread, the necessity for aggressive policies diminishes. This is because positive strategic complementarities reduce production costs for green products as the amounts produced increase, while enhancing their perceived value, making consumers more inclined to purchase them. This proposal is predicated on the strength of the strategic complementarities they posit. While empirical evidence supports the production side of the equation, the consumption side remains more nebulous. It is, in essence, what the European Union 2030 policy package is trying to do: policy evaluation of this unique endeavor will tell whether this is working as expected.

For such policies to be successful, there needs to be a concerted effort from both the public and private sectors, backed by rigorous research, to understand societal behaviors and attitudes. It requires more investigation to understand consumer behavior and how to design policies that can foster these social norms on the consumption side. It must account for special interests' strategic action in response to governmental efforts. And to account for global geopolitical competition and its repercussions for the clean technology race. Only with this holistic approach can we hope to usher in a sustainable green transition that's both inclusive and enduring. As climate policies hopefully become entrenched in societal goals, their impact on economic progress becomes endogenous and driven by policy choices and societal responses. The paradigmatic shift from correction of market failures toward a welfare-centered industrial strategy does not mean that the two visions of the green transition are mutually exclusive. By uniting the climate-environment cause with the recognition that policies need and can deliver benefits on a sufficiently wide basis we can help make progress on climate action. Independent and objective research on policy effectiveness is now more important than ever to support decision-makers in best allocating limited economic and political resources while recognizing the urgency of rapid action.

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Karen Pittel

Can or Should We Assess the Growth Impacts of Climate Protection?

KEY MESSAGES

- **Predicting long-run growth effects of decarbonization is subject to high uncertainty**
- **Awareness of limitations of growth forecasts should be raised**
- **Scientific communication should aim at forecasts being misused in the political debate**
- **Comparative analysis of growth effects can have value for policy design**
- **A focus on absolute limits to growth can potentially be detrimental to decarbonization**

The discussion about climate targets, whether on a European or on a national level, is more often than not accompanied by the question of what the implications are going to be on economic growth and other key economic variables. There is also a growing number of people who argue that economic growth and reaching climate neutrality cannot go hand in hand and that so-called green growth is not possible. The following article first addresses the question of the predictability of growth impacts of climate change as well as decarbonization. It then briefly addresses growth skepticism and the stipulation that growth should be limited.

IMPACT OF CLIMATE CHANGE ON ECONOMIC GROWTH

Assessing the growth impacts of climate protection should take into account not only the impact of climate policy on the economy but also the question of what would happen in the absence of climate policy. Therefore, the comparison of a world with and without climate policies should consider the damage that we can avoid by pursuing climate policy to limit the temperature increase. The Intergovernmental Panel on Climate Change (IPCC), as an aggregator of scientific knowledge in this area, provides some answers on the question of climate impacts on the economy. It stresses that "under high warming (>4°C) and limited adaptation, the magnitude of decline in annual global GDP in 2100 relative to a non-global-warming scenario could exceed economic losses during the Great Recession in 2008–2009 and the COVID-19 pandemic in 2020" (IPCC 2022, 67) where the "severe risks are more likely in (typically hotter) developing countries" (IPCC 2022, 67). However, it also states that "estimates of the global effects of climate change on aggregate measures of economic performance and gross domestic product (GDP) range from negative to positive, in part due to uncertainty in how weather variability and climate impacts manifest in GDP" (IPCC 2022, 54). Of course, the impact of climate change will also depend on the economic, technological, societal, and institutional means of adapting to climate change, which vary from region to region.

Even with adaptation, however, limiting temperature increases will likely avoid substantial damage and, while relatively low increases in temperature might have positive effects on the economy in some regions, limiting climate change to such temperature increases seems hardly realistic given that temperatures have already increased by about 0.8 to 1.3°C compared to preindustrial times (IPCC 2023).

IMPACT OF CLIMATE PROTECTION ON ECONOMIC GROWTH

Like the impacts of climate change, the impacts of the decarbonization and transformation of economies are subject to uncertainty. Technological development and the costs of alternative technologies matter. At the same time, the impact on economic performance and growth will be determined by the choice and implementation of policy instruments as well as by the question of whether these policies are implemented unilaterally or globally. Most assessments come to the conclusion that reducing emissions will be costly in the short run and potentially have at least a negative transitory effect on growth (e.g., IMF 2022).

Impact of Climate Policies

The IMF (2022) highlights the potentially very heterogeneous impact of different policy packages on GDP development as well as other macroeconomic indicators. This holds true despite the fact that the policies considered by the IMF differ solely with respect to the use of revenues from the only climate policy instrument employed, namely gradually increasing

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the price put on greenhouse gases. In the real world, however, policy packages are much more complex. The policy mix consists of an almost unmanageable number of individual – often technology- and even region-specific – measures, whose overall effect on the macroeconomy is not entirely estimable. Even highly advanced numerical models cannot account for this diversity and quantity of measures, making it hard to assess the interaction effects of the policies.

Regarding policy design, economic logic compellingly suggests that technology-open emission reductions, as for example accomplished by carbon pricing, will lead to minimal-cost decarbonization pathways by incentivizing usage of the cheapest emission reduction technologies first. In comparison, the efficiency of technology-specific regulation relies on the regulator's usually incomplete knowledge about abatement costs and technology development potential. It thereby runs the risk of incurring higher costs and thus negative GDP and growth effects for the same emission reduction.

However, disruptive technology switches, for example from fossil-based to hydrogen-based steel production, might require additional support in the form of R&D and innovation policies as laid out by Acemoglu et al. (2012). Also, some technologies require infrastructure as in the case of hydrogen or charging stations for EVs. Fast scaling up of these technologies is unlikely to happen when relying on private investment only, especially in early stages. Given the limits of public budgets, however, this not only requires a smart incentive system to activate private capital, but might also limit how many technologies could be supported simultaneously. In this context, technology-specific regulation can have a signaling effect that might trigger investment with lower public support.

It is, however, not only the policy mix that determines growth effects but also uncertainties regarding its implementation that are usually accompanied by delays to the transformation. The IMF (2022) showed that delaying emission reductions while still aiming to reach the climate targets will shorten the time frame for the transformation and thus very likely increase its cost in terms of GDP.

Impacts of Technological Development

The policy mix naturally also influences the type of technologies that attract investments and the rate at which they are adopted. However, it is unclear how costs of low-carbon technologies will develop in the future. For some technologies, like PV and onshore wind, large cost reductions have already been achieved through learning and upscaling. While we are likely to see some more cost decreases, forecasts of future cost developments are less prone to large errors than those for a number of other technologies that we will also have to rely on in the future. Without going into too much technological detail, just consider hydrogen-based steel production or alternative power sources for aviation. At the moment, some of these technologies exist only on the prototype level, making forecasts about their future cost and thus contributions to value added highly uncertain. As a consequence, the technological path toward climate neutrality is by no means predetermined. While we will, for example, surely see more electrification (transport, heating, industry), there is still considerable uncertainty regarding the choice between, for example, electricity or hydrogen/e-fuels for a number of uses (e.g., in transport and process heat; see Ueckerdt et al. 2021). Models used to assess the GDP and growth effects of decarbonization often do not account for these uncertainties or, if they try to, open up a large range of potential GDP impacts.

The Impact of International Developments

A further complication in the assessment of the growth effect of decarbonization, especially on the national level, is the uncertainty regarding developments on international markets. This concerns the questions of competitiveness due to different climate policy ambition levels, different access to technologies, and the choice of climate policy instruments (just compare the Inflation Reduction Act in the US and the NextGenerationEU package). But this also concerns risks from geopolitical developments. The energy crisis following Russia's attack on Ukraine has demonstrated this clearly, and has also raised awareness of potential supply-chain risks from high supply-side market concentrations, for example with respect to raw materials.

In particular, the issue of future international cooperation raises a lot of questions. While cooperation will surely increase the chances of reaching the climate targets and will lower the global cost of decarbonization, short-term thinking about local economic advantages was a major factor in preventing efficient cooperation in the past. The shift in geopolitics toward an even more multipolar world following the energy crisis makes effective international cooperation even more unlikely. A strong climate club with unified carbon pricing as Nordhaus (2015) suggested does not seem to be a realistic short-term option, making the growth impacts of climate policy even more uncertain.

Relative and Absolute GDP Impacts of Decarbonization

Accounting for all sources of uncertainty makes the GDP impacts of climate policy exceedingly difficult to predict, even in the rather short-term up to, say, 2030. Naturally, the longer the time frame, the more uncertainties arise. Efforts to assess GDP and growth effects of complex and long-term projects like combatting climate change should therefore being taken

with a large degree of caution – regardless of whether they are positive or negative. Modeling efforts can, however, still be of interest when the focus is less on absolute numbers and more on relative effects. For instance, how does one policy package fare compared to another or how might international cooperation affect the implications of climate policy. Also, careful and well-calibrated economic modeling might give insights into bottlenecks (e.g., due to low empirical values of substitution elasticities) as well as flexibilities (e.g., due to import substitution). Yet, the energy crisis has shown clearly, how important it is to delve deeper into the modeling and calibration assumptions made when assessing the impacts of a crisis or the even more complex impacts of decarbonization. Especially in the early stages of last year's crisis, forecasts of GDP effects varied widely (see e.g., German Council of Economic Experts 2022 and citations within). Without a very good understanding of the causes of these differences, the danger of misuse of the generated figures is high.

CAN OR SHOULD WE GROW IN THE LONG RUN?

In the climate debate, however, the focus is often not on analyzes as described above. Rather, it is either on whether decreasing emissions and growth are incompatible per se or on whether growth impacts should be at the forefront of the debate.

Development of CO_2 Emissions, Innovation and Economic Growth

A decomposition of the drivers of carbon emission changes in the Synthesis Report to the IPCC's Fifth Assessment Report shows that the increase in global emissions in the period 1970–2010 was primarily driven by the increase in GDP per capita and the increase in global population (IPCC 2014). At the same time, the energy intensity of GDP decreased substantially as did the CO_2-intensity of energy use. However, the latter two factors were not strong enough to offset the first two, and overall emissions increased as a result. Building on this kind of decomposition, the main argument behind growth skepticism in the context of climate and resources is that an absolute decoupling of emissions and GDP growth is not possible.[1] If that were indeed the case, GDP growth would necessarily go along with ever increasing emissions. However, even a shrinking economy would not lead to zero emissions without technical and social innovations. So, in order to stay within the planetary boundaries and stabilize global temperatures, we need to focus on incentives to innovate and transform our economy.

Now, incentives for innovation do not rely on a growing economy per se and could also be compatible with a zero-growth world in which firms compete, for example, for market shares. The question is whether growth is something that can – or should – simply be switched on or off. Growth is the endogenous outcome of interaction of agents on markets and thus the result of a process rather than an input. From an economic perspective, the challenge is to maximize welfare under given constraints set by a number of targets ranging from environmental to social. Whether or not long-run economic growth is possible under such restrictions is nothing we can sensibly predict. Putting the focus of policies on limiting growth might, however, have serious consequences with respect to the design of smart policies to incentivize innovative activities and thus to our potential to meet the climate targets. The focus should therefore rather be on creating a framework for economic activity that ensures that we can achieve the climate (and other sustainable development) targets while maintaining incentives to innovate.

Is Economic Growth the Best Indicator for Welfare?

Much of the discussion about growth is, however, also driven by the question of whether ever increasing levels of GDP lead to an ever-increasing level of welfare – essentially, whether we should be focusing on growth at all. Results from empirical research on the impact on higher income on happiness or life satisfaction is at best mixed (see e.g., Easterlin et al. 2010 and Stevenson et al. 2008). Yet, no one can seriously question that perpetual growth at the expense of the climate or, more generally, the environment would naturally come at the expense of welfare. As John Stuart Mill stressed back in the 19th century: "If the earth must lose that great portion of its pleasantness which it owes to things that the unlimited increase of wealth and population would extirpate from it, …I sincerely hope, for the sake of posterity, that they will be content to be stationary, long before necessity compel them to it" (Mill 1852, 321). This is why getting the framework conditions for economic activities is so important. In Mill's words, economic development at the expense of the environment is to be avoided and not economic development per se.

[1] Absolute decoupling refers to a reduction of emissions in absolute terms even if GDP is rising.

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Alessio Terzi and *Roger Fouquet*

The Green Industrial Revolution: Lessons from the History of Past Energy Transitions*

KEY MESSAGES

- **The challenges associated with today's green transition echo dynamics during past energy revolutions**
- **Improvements in energy efficiency and sobriety can be part of a decarbonization strategy but with muted impact**
- **An effective and credible climate policy must be chiefly targeted at accelerating a Green Industrial Revolution**
- **Governments have many tools to do so, including taxation, regulation, public investment, and industrial policy**
- **Cushioning blows to income and consumption of low-income households will be important in avoiding social backlash, slowing decarbonization**

"What experience and history teaches us is that people and governments have never learned anything from history, or acted on principles deduced from it."

Georg Wilhelm Friedrich Hegel

Climate change is upon us: 2023 is virtually certain to be the warmest year since records began in the mid-1880s, and likely in the millennia before (Hausfather 2023). This has already resulted in unprecedented wildfires, droughts, floods, and hurricanes across the globe. In order to avoid even worse consequences, political leaders in over 110 countries have agreed to reach climate neutrality by mid-century. This is no minor feat given that we currently effectively live in a fossil fuel civilization, meaning that directly or indirectly, close to everything we do relies in one way or another on burning fossil fuels and emitting greenhouse gasses.

Becoming climate neutral will require a complete transformation of energy generation, transport, housing, agriculture, manufacturing, and more (Terzi 2022a) – all to be achieved in only three decades. When framed this way, the societal challenge seems daunting, if not impossible. And yet, it gives us some comfort to note that structural transformations on a similar scale have happened before, notably during past Industrial Revolutions (Terzi 2022b).

In this short essay, we draw a set of lessons from past energy transitions to help design credible and efficient strategies to achieve climate neutrality in the 21st century. By observing and analyzing the rapid uptake of technologies and energy sources for the provision of energy services,[1] an understanding can emerge of when and why radical change in the energy system occurred. Doing so will require understanding the contribution of various channels in breaking previous technological lock-ins and catalyzing an accelerated switch to new energy sources. When thinking about decarbonization strategies, the focus on energy seems particularly appropriate as power, transport, and heat are collectively responsible for over two-thirds of global greenhouse gas emissions (Liu et al. 2023).

THE VALUE OF A HISTORICAL PERSPECTIVE

Ever since the goal of achieving climate neutrality was established, policymakers, private sector leaders, and academic experts have been constantly discussing the many challenges associated with the green transition. These include:

- the successful uptake or failure of a specific technology;
- problems of technological lock-ins and path dependency;
- the importance of market structure;
- the appropriate degree of government involvement in the economy;
- the role of incumbents, such as Big Oil, often trying to slow down the transition, including through lobbying; and
- security of energy supply, particularly in the aftermath of Russia's invasion of Ukraine.

These problems are all very important and represent fundamental challenges. They also feel like unique predicaments of our era, and yet each of these elements has parallels with past energy system transformations. For instance, in 1865, William Stanley Jevons published *The Coal Question* to shed light on the risks of exhaustion of coal resources that were cen-

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[1] Following an energy economics approach, it is worth highlighting that in this piece we speak of energy services, which encompasses both goods and services used to satisfy an energy demand or need. After all, as Alfred Marshall noted: "in one sense all industries provide services" (Fouquet 2008, 8).

tral to Britain's economic supremacy (Missemer 2012). At the same time, smoke abatement societies were forming across Britain with the aim of encouraging local authorities and the national government to introduce legislation to reduce air pollution (Fouquet 2012). Meanwhile, industrialists were lobbying policymakers to either not introduce legislation or water down any laws such that they were unenforceable. As a result, civil society, industrialists, and government battled over air pollution policies for around a century.[2] Eventually, after the dramatic experience of the Great Smog of London, which was associated with thousands of additional deaths (Fukushima 2021), the Clean Air Act of 1956 was the first legislation in Britain that genuinely enforced air pollution standards, marking the beginning of the transition to cleaner energy sources (Fouquet 2012).

Explorations of historical patterns are central to anticipating developments in future energy systems and their environmental impact (Grübler et al. 1999). Considering very long-run trends allows us to see technological revolutions as recurring events, cycles of economic transformation, rather than unprecedented discontinuations of business-as-usual scenarios (Freeman and Louçã 2002). While the usual lament goes that history never repeats itself, it does often rhyme, to quote Mark Twain. The reason it rhymes is because the fundamental forces at play across various technology transformations are essentially the same, as we will detail shortly. Even the First Industrial Revolution responded to the recursive logic of an evolutionary process (Galor 2022; Perez 2009). As Wrigley (1988) famously noted, the processes surrounding it were the result of "continuity, change, and chance."

SOBRIETY AND ENERGY EFFICIENCY IMPROVEMENTS

Attempts at devising a strategy to achieve climate neutrality have typically encompassed a mix of at least three elements (Pisani-Ferry and Mahfouz 2023): (i) voluntary reductions in energy use beyond gains from efficiency (sobriety); (ii) improvements in energy efficiency; and (iii) technological progress toward carbon-free energy sources and services.

Placing these various tools in historical context already provides some food for thought. First, Fouquet (2008) details how past experience with declines in energy consumption are uncommon, and rarely happen as a consumer choice. This suggests that the main channel for decarbonization in the 21st century is unlikely to be "sobriety," i.e., consumers voluntarily giving up energy services in the name of a greater good (Vogel and Hickel 2023). This might work over short periods of time, and in conditions that have been framed as war-like (as happened in Europe in 2022), but will be difficult to maintain over prolonged periods of time. Likewise, without sustained public support, it will be challenging for a government to impose a reduction in energy services on its citizens, especially within democracies. Nevertheless, when managed, temporary and sporadic reductions in consumption (as occurred during Covid-19 restrictions) combined with effective substitution policies can help realign economies onto lower energy-intensity pathways and minimize vulnerability to energy price shocks, inflation, trade balance deficits, political pressures from energy companies, and environmental pollution associated with energy intensive economies (Fouquet 2016; O'Garra and Fouquet 2022). Indeed, the International Energy Agency expects sobriety, as part of behavioral changes, to be responsible for just 8 percent of CO_2 reductions in its roadmap toward net zero by 2050 (International Energy Agency 2021).

Second, efficiency improvements have occurred frequently throughout energy history. The efficiency of steam engines was transformed by a series of scientific and technological innovations over more than one hundred and fifty years (Crafts 2004; Fouquet 2008). Similarly, a whole set of innovations led to efficiency improvements in the transport sector. Advances in the energy efficiency of lighting have been underway since the late 1700s, improving efficiency more than one thousand-fold. However, the savings from efficiency improvements are often modest due to so-called "rebound effects," which lead to increases in the consumption of energy services (Chitnis et al. 2020). Nevertheless, there is evidence that these rebound effects decline with economic development, implying that some energy savings can be achieved, all other things being equal (Fouquet 2014). However, in the long run, rising income and the associated increasing demand for energy services tend to outpace any energy savings. This is because "when prices rise and resources become scarce, ingenuity will be directed towards discovering more resources and developing ways to use them more efficiently. When resources are abundant, creativity will be aimed at offering ways to use them" (Fouquet 2008, 380).

[2] The Sanitary Act of 1866, the Public Health Act of 1875, and the Public Health (London) Act of 1891 were weak policies avoiding impact on industrialists – as an example, the term "black smoke" was placed in the text to ensure that it could be argued that the smoke was not black, and it took until 1926 for legislation to legislate against non-black smoke, but any enforcement required the go-ahead from the Ministry of Health (Thorsheim 2018, 131).

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Effectively, what this implies is that sobriety and energy efficiency could very well be pursued as part of a decarbonization strategy, but their effect will be contained in scale and limited in time. They might be worthwhile pursuits in order to buy some time, but, on their own, sobriety and energy efficiency improvements will have limited impact as a strategy to contain catastrophic climate change. They should therefore be seen as complements while fast-tracked technological transformation unfolds. Put differently, a switch to carbon-free energy sources and services should be seen as the main realistic strategy to achieve long-run climate neutrality.

ROLLING OUT GREEN TECHNOLOGIES

In light of the considerations above, it becomes evident that a successful climate policy should focus squarely on accelerating the development and deployment of carbon-free energy sources and services. In other words, it should spark a new Green Industrial Revolution. In order to understand what set of policies can accelerate the rollout of renewables, and green technologies more broadly, it is worth considering the mechanism through which, historically, most energy transformations took place. In this section, we will do so first in general terms and then through a few examples.

As discussed in Fouquet (2010), new energy sources or technologies generally provided the same service (i.e., heating, power, transport, or lighting), but in a way that offered superior or additional characteristics (e.g., easier, cleaner, or more flexible to use). Frequently, the high price of the service (i.e., the combined energy price and efficiency) made it initially accessible to only a few consumers. The energy price, or its inefficiency at converting energy into the service, limited its market to a niche of consumers willing to pay a premium for those characteristics.

This niche of early adopters was however important because it allowed the energy sources and technologies to "survive" at a higher price than the incumbent sources and technologies. Economies of scale, learning by doing, and technological refinements could then take place in a relatively protected market. Early adopters were typically either relatively well-off private consumers, or governments, very often for military reasons. Military expenditure was particularly well positioned for this purpose, given that broader security considerations typically allow for spectacular budgets that go beyond the logic of the cheapest available alternative.

Eventually, lower prices meant that the new technology crossed the threshold of price parity with the incumbent technology, allowing for it to spread to the wider population. In all of the 14 major energy transitions that took place over the last 1,000 years, cheaper or better services were key to the switch. In a majority of cases, the initial driver was better or different services. In all cases, a lower energy service price was necessary to achieve the energy transition (Fouquet 2010). Without a lower service price, the new energy technology is simply unlikely to be adopted by most of the population, preventing it from replacing the incumbent technology. The price of the service is therefore crucial (Fouquet 2008). Incidentally, this explains why successful technologies are known for following a so-called "S-curve," meaning they spread slowly at the beginning (thanks to early adopters), at some point they reach price parity and spread at an exponential rate, only to flatten out once they reach full market capacity.

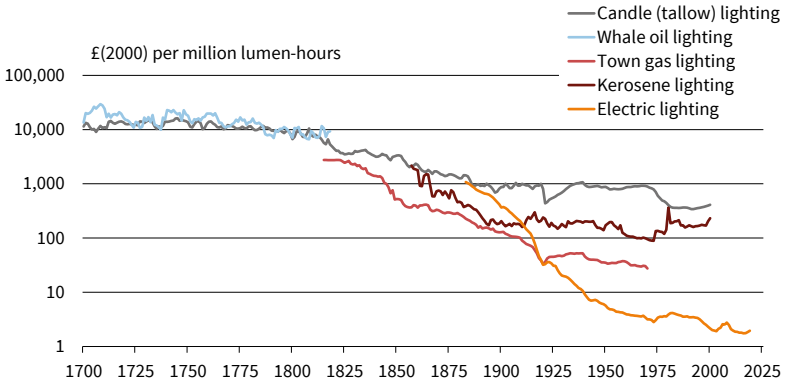
Let us showcase this dynamic with two specific historical examples related to the transitions in lighting and in transport.

Candles had been providing lighting at least since 3,000 BCE (Nordhaus 1996). However, they were extremely expensive, to the point that centuries later they were occasionally used as status marker to signal wealth.[3] Alternative technologies and energy sources were tested. Whale fat made modest inroads (see Figure 2), as it was a technological alternative that could not scale due to the biological limits of the whale population and, ultimately, the ecological and energy inefficiency of converting solar power into plankton into whales into a lighting fuel. As a result, the price never became competitive in a way that allowed the full rollout across society, and it fluctuated greatly as a population of whales was decimated and a new population was found further afield (see Figure 1).

In nineteenth century Britain, town gas (derived from coal) became the dominant source of lighting (Fouquet and Pearson 2006). This success was the result of the combination of a large source of energy supply and improvements in lighting technology. In 1830, a town gas lamp would have generated 130 lumen-hours per kWh; by 1916, the "Welsbach Mantle"

Figure 1

Price of Lighting by Energy Source in the UK, 1700–2019



Source: Fouquet and Pearson (2006); Chitnis et al. (2020).

[3] This can be inferred for instance from the old Neapolitan expression: "Un nobile che vale due candele" (an aristocrat worth two candles), based on the fact that the aristocracy would place candles in front of their balcony seats at San Carlo theater, to signal status and wealth.

gas lamp generated 870 lumen-hours per kWh, roughly six times more light (Nordhaus 1996). Combining the energy efficiency with the gas prices provides an estimate of the price of lighting – the price of gas lighting in 1830 was £2,700 (in 2000 money) for one million lumen-hours (equivalent to leaving-on a 100-watt incandescent bulb for 30 days) and, in 1920, it was £40 (see Figure 1).

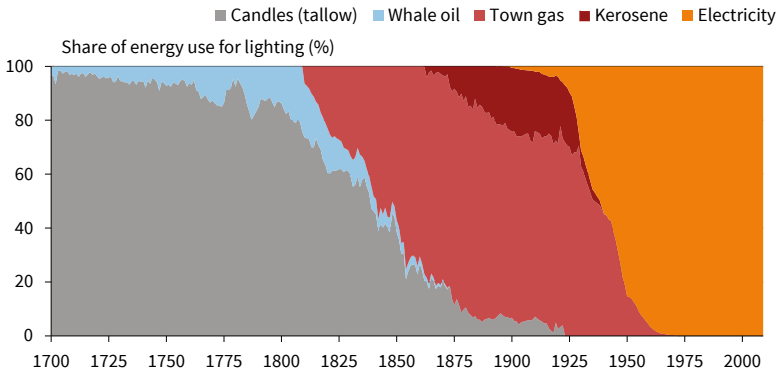
It is worth noting that, because of the relatively large capital investment associated with installing gas pipes in a residential building, gas lighting tended to be used first in affluent and, a few decades later, in middle-class homes. In poorer accommodation, kerosene lamps were used instead. As shown in Figure 1, the price of kerosene lighting was greater than that of gas lighting, implying a substantial variation in the cost and (undoubtedly) consumption of lighting according to income. Roughly eighty years after the introduction of gas lighting, poorer homes were fitted with pipes, as gas companies felt the competitive threat from electric lighting (Fouquet and Pearson 2006).

Electric lighting was initially very expensive compared to the prevailing alternative – in the 1880s, it cost the same as generating light using a candle (see Figure 1). The initial switch constituted an extreme example of the fact that superior characteristics lead some consumers to adopt a technology in spite of a higher price. Large-scale gas lighting, for example in theaters, created heat and depleted oxygen. Simply flicking a switch to turn on the electric lamps made lighting up a room much easier. It also reduced the amount of preparation, maintenance, and cleaning required, as well as the smell of burning tallow candles, animal or vegetable oil, or gas (Fouquet and Pearson 2006). As a result of these considerations, certain customers – especially restaurants, theaters, and wealthy house owners – were therefore willing to pay many times more for the exclusive features of electric lighting (Fouquet 2010). Only later, thanks to significant efficiency improvements and price reductions did electric lighting scale up. By 1960, virtually all lighting in the UK was electric (see Figure 2). Today, with LED lighting, generating 66,000 lumen-hours per kWh, it costs around £1 per million lumen-hours.

The story of transport is similar. New technologies were adopted by the affluent, then by the middle class, and, decades later, by the poor. Before the mid-nineteenth century, land transport was either by foot or, for the affluent and middle classes, horse-drawn stagecoach. Meanwhile, sea travel was dependent on wind power to push sailing ships (Fouquet 2008; Smil 2017). The introduction of the railways on land and steam ships on the sea ensured faster and (generally) more reliable services. The success of these technologies led to the transition to coal as the dominant energy source by the late nineteenth century (see Figure 3).

Figure 2

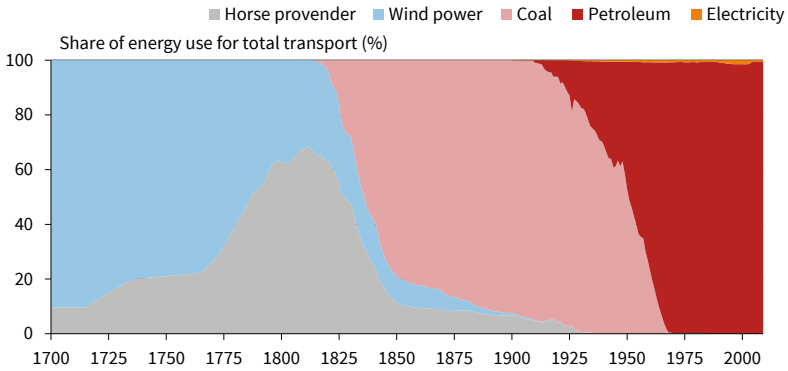
Share of Energy Consumption for Lighting in the UK, 1700–2019



Source: Fouquet and Pearson (2006); BEIS (2020).

Figure 3

Share of Energy Consumption for Land, Sea, and Air Transport in the UK, 1700–2019



Source: Fouquet (2008); Chitnis et al. (2020); Fouquet and O'Garra (2022).

Again, for the first two decades of the twentieth century, the car existed as a niche technology, with the rich willing to pay substantially more for the pleasures of racing and touring (Fouquet 2010). Car prices fell thanks to the famous Ford Model T, setting the scene for more widespread adoption. High population density made the horse, which for hundreds of years had played a crucial role, an inferior transport technology. Improvements in the car's engine made the technology more reliable, and an option for long-distance travel.

We can expect green technologies to follow a similar path. Let us take electric vehicles (EVs) as a transport service example that provides for easy parallels with the car era.[4] In the early stages, EVs entered the market as a more expensive technology, but one that was seen by some early adopters as superior. This created a niche market for early movers (e.g., Tesla). The realization that there were large gains to be made in such markets attracted new producers, which entered into a price competition war. They then strived to further increase the quality of the product offer, with longer range, faster recharging, greater in-vehicle experience, and more. This process drove the quality of EVs up, and their price down. Price par-

[4] Terzi (2023b) traces a similar path ahead for carbon-free aviation.

ity is now expected to be reached within the coming 1–2 years, paving the way for widespread adoption along the S-curve.

ROLE OF CONSUMERS AND GREEN VALUES

Technological progress is often pictured as a way to address societal issues with a minimal toll on people and their habits, particularly vis-à-vis energy sobriety. While this is broadly true, it should be evident from the section above that consumers do play a fundamental role in energy transformations. In particular, the previous section showed how a subset of early-adopting consumers effectively pave the way for wider society. This however requires initially paying a higher price for the new technology. Bill Gates refers to this as the "green premium" (Gates 2021). This extends to governments both in their role as consumers and their willingness to use public funds to incentivize green options, for instance through subsidies for renewable energy sources.

The more willing consumers are to pay for climate stability, the greater the protection will be for the niche market enabling low carbon energy sources and technologies to be developed and refined (Fouquet 2010). Recent academic research has carefully modeled how consumer preferences and technology crucially influence each other (Besley and Persson 2023; Mattauch et al. 2018). Specifically, green technologies are more profitable when the share of the population holding green values is broader, and green values are more attractive when green technologies are (cheaply) available. We would specifically maintain that recurrent extreme weather events associated with climate change already baked into the atmosphere will only accelerate this process of green value shifting, leading the green option to be seen as superior (Terzi 2020) along the lines of what happened in the aftermath of the Great Smog of London.

More broadly, from a historical perspective, the superior characteristics offered by a new technology can vary substantially: "the steam engine offered a more reliable source of power (compared with water); the car allowed personal control; electric lighting provided exclusivity. For these superior attributes, certain customers were willing to pay more" (Fouquet 2008, 369). For example, in 1900, above what they had to pay for these services (i.e., the price) and the value of the incumbent energy technology and source, consumers were willing to pay roughly 6 percent of GDP for gas lighting and 15 percent of GDP for railway travel, and in 1950, around 5 percent of GDP for electric lighting and 10 percent of GDP for car use (Fouquet 2018). In other words, these new energy technologies and sources dramatically improved consumers' lives and people were willing to pay significant proportions of their income for these superior characteristics.

Likewise, some consumers in our era will be willing to pay more for green products because they offer some superior characteristics, such as less noise pollution or zero emissions at the point of use. The fact that they are expensive and associated with modernity also primes them for being status-signaling devices among the elite. A warm-glow effect of helping fight climate change can also not be excluded (Taufik et al. 2016). From there, emulation of the consumption patterns of richer cohorts can also be expected along the lines of well-documented human psychological emulation behaviors (Henrich 2016).

ROLE OF GOVERNMENT

When reflecting on the role of government with regard to the green transition, the standard economics answer is to implement carbon prices aimed at aligning personal and social benefits / costs of greenhouse gasses and therefore energy uses (Stern and Stiglitz 2017). While this consideration continues to hold its wisdom, there are reasons to expect political economy limits to what can credibly be achieved with them (van Reenen 2023) given that taxing carbon (beyond low levels) remains unpopular in several jurisdictions (Blanchard et al. 2023; Tagliapietra 2020).

The other classic role cut out for government when thinking about the green transition is regulation – specifically prohibiting or setting quantitative limits on some polluting production or practices (Blanchard et al. 2023). Once again, a historical perspective suggests a degree of caution in this respect. Specifically, Fouquet (2012) shows in detail how regulation typically arrives at the end of an energy transformation process, rather than serving as a spark. The history of the car is instructive in this respect (Standage 2021). As touched on above, cars were initially adopted by the rich as a form of entertainment or status-signaling device. Eventually, they were considered a more practical alternative to the horse in densely populated cities. This, combined with increased affordability, paved the way for their adoption. Regulation typically arrived only at the end of this process, to eventually ban the coexistence of horse and cars on urban streets at the expense of the former. In other words, regulation served as a final coordination device aimed at laggards, rather than as a mandate for a transportation revolution. To an extent, current bans to cars with internal combustion engines, as adopted in California, the EU, or the UK, follow a similar trend insofar as they are set for 2035, when EVs will already be the cheaper, better, and most widely spread personal transport technology.

In other words, while maintaining an important role, there are reasons to suspect that there are limits to what can be achieved by governments through carbon taxation and regulation. In light of the realization that an effective and credible climate policy will entail unleashing a Green Industrial Revolution,

the best course of action to leverage and maximize the impact of government resources is to keep the focus on accelerating the technology transformation process (Aghion et al. 2009). In the words of Fouquet (2008, 366–367): "Market forces will push us on to the next [energy] system, and beyond. The best that governments can seek to achieve is to direct these forces in the long-term interest of the public."

Specifically, in all the 14 energy transitions that took place over the last 1,000 years, possibly with the exception of the switch from the ox to the horse, the method of energy supply needed to be changed. This generally involved new producers, distributors, and retailers – often (and particularly since the Industrial Revolution) requiring major infrastructure investments such as the gas, railway, or electricity networks. Existing energy infrastructure contributes to technological lock-in effects and path dependence, making public investment aimed at their renewal a particularly useful avenue for government intervention. A current example of this is the large-scale effort to expand the electricity grid or install EV charging points.

Likewise, governments can use substantial industrial policy tools to accompany the development and deployment of green technologies (Rodrik 2014), along the lines of measures taken under the US Inflation Reduction Act or the EU's Net-Zero Industrial Act (Terzi 2023a; Terzi et al. 2023).

Finally, it is worth underscoring that all major technological transformations have to some degree shattered previously existing professions, industries, and value systems. Analyzing over 600 years of technology history, covering innovations including the printing press, electricity, farm mechanization, mechanical refrigeration, and more, Juma (2016) shows that when large sections of the population fear that the benefits will be reaped only by a small cohort, they will oppose them. In our context, it implies that governments must earmark a portion of their limited financial resources to accompany the green transformation, helping poorer citizens and cushioning any potential blow to their income and consumption. The alternative would be to face mounting opposition that would impede a rapid rollout of green technologies, and therefore a speedy decarbonization process.

POLICY CONCLUSIONS

The scale of the challenge of abandoning fossil fuels and achieving full climate neutrality by mid-century to avoid a climate catastrophe seems daunting. However, a long-term reading of history reassures us that energy systems are in constant flux. The challenge is therefore to accelerate this economic transformation to align it with political targets set in agreement with climate scientists. Here again, history offers scope for hope. The fastest energy transitions of the past, from horse to railway and from steam to electricity, took place over periods of roughly 30 years, despite requiring an infrastructure to accommodate the new energy source or technology (Fouquet 2010). It has happened in the past and it can happen again.

In this essay, we have considered the three main avenues that governments are considering to fast-track decarbonization, namely energy efficiency, sobriety, and the speedy development and deployment of carbon-free energy sources and services.

Historical experience suggests that voluntary energy reductions (sobriety) and improvements in energy efficiency can surely play an ancillary role and will inevitably buy some time given their short-term effectiveness. This implies that a successful climate policy will essentially have to focus primarily on accelerating technological transformation. In other words, a policy bent on fast-tracking a new Green Industrial Revolution.

To accompany this process, governments can surely implement carbon pricing and environmental regulation, in line with standard policy recommendations. Going beyond that, we highlight an important role for public investment aimed at developing the infrastructure network for a new green economy, contributing to the breaking of technological lock-ins and path dependence. On top of this, industrial policy should also play a role, together with social policies aimed at spreading the benefits of the new green economy and cushioning any potential hit to low-income households' earnings and consumption during the transition process. Failing to do so will lead to social backlash and an inevitable slowdown in the decarbonization process.

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Luisa Carpinelli and *Daniele Franco*

Strengthening Decision-making Processes to Address the Climate Challenge

KEY MESSAGES

- **In spite of the dramatic implications of current climate trends, global action to reach net-zero objectives remains inadequate**
- **While the transition challenge is of an eminently technological and financial nature, the decision-making process is fundamental to effectively address climate issues, both at the national and international levels**
- **It is crucial to transfer scientific information to the general public in a systematic way, not only on the risks of climate change but also on climate and compensation policies. This can increase acceptability of immediate climate action, whose benefits will be more evident in the future**
- **The weight given to the future in the decision-making process should be strengthened through borrowing mechanisms from other fields, via legislation, procedures, and technical bodies**
- **In parallel, international coordination is fundamental. Voluntary UN level agreements are the ideal venue for cooperation, and should be pursued courageously, with the G20 in a leading position to aggregate political consensus. Climate clubs may represent a second-best solution that should be tested quickly**

THE CONSENSUS ON CLIMATE CHANGE IS NOT BEING TRANSLATED INTO ADEQUATE POLICIES

Over the past few decades, consensus among scientists on the course and causes of global warming has gradually increased. Five points are now largely agreed upon: (1) the global temperature has risen by more than 1 degree Celsius compared to the pre-industrial era; (2) greenhouse gas emissions – mostly attributable to human activities – are the main cause; (3) in the absence of a reduction in the volume of emissions, the temperature could rise by 4–5 degrees by the end of the century; (4) the effects of this development on the well-being of the world's population would be very profound, in terms of health, physical risks, forced migration, and loss of production; and (5) to contain global warming in the 1.5–2 degrees range, emissions would have to be abated massively over the next few years and then brought to zero within the next few decades.

The international community has responded to these prospects primarily within the United Nations. In 1988, an intergovernmental infrastructure (the Intergovernmental Panel on Climate Change, or IPCC) was created with the aim of aggregating the scientific consensus on climate change. In 1995, annual meetings between countries have been launched (Conferences of the Parties, or COPs), where important agreements were signed (Kyoto in 1997, Paris in 2015). In parallel with the commitments made under the Paris Agreement, targets have been set for net zero emissions at the national or regional level (2050 for the EU and the US, 2060 for China, 2070 for India). Governments also adopted carbon-pricing measures (such as the European ETS), major packages of investments to facilitate the energy transition (such as the NGEU in the EU and the Inflation Reduction Act in the United States), and regulatory measures (such as those on vehicle emissions).

In advanced countries, the transition process is underway, as evidenced by the reduction in the carbon intensity of economic activity: for example, between 1990 and 2021, EU CO_2 emissions fell by 28 percent against an increase in GDP of 65 percent. Nevertheless, the results achieved so far and the progress expected for the coming years at the global level are still far from sufficient to contain the increase in temperature within 1.5–2 degrees. The latest IPCC report leaves no room for doubt: without a strong acceleration in climate action, the planet is bound to undergo dramatic climate changes. The impact would be largest in the already less temperate areas, where the world's population is expected to increase most. This could lead to severe geopolitical tensions, for example through migration phenomena.

The relatively slow reaction to climate change of single countries and of the global community is due to many factors, which can be traced back to two areas.

The first is of a technical-financial nature. There is an enormous technological challenge to be faced: decarbonization[1] implies a radical transformation of energy sources and modes of production, consumption, and transportation. In the past, the transition from one primary source of energy to another took several dec-

[1] Decarbonization technically refers to the process of abating carbon dioxide (CO_2) emissions, stemming in particular from the burning of fossil fuels (such as coal, oil, and natural gas) and other activities that release CO_2, and making up about 75 percent of total greenhouse gases (GHG) emissions. In the common language it is used more generally to refer to the process of reducing or eliminating all GHG emissions through various means, including transitioning the energy system towards renewables (solar, wind, hydro), improving energy efficiency, and adopting carbon capture and storage technologies. For simplicity, we will use the term decarbonization in the latter broader sense.

ades. This transformation also involves huge financial costs: for the EU, it is estimated that annual investments of 2 percentage points of GDP will be needed. The effort in terms of research and development, investment, and mobilization of resources is enormous. In some cases, for example air travel, there are still no technological solutions that avoid emissions.

The second is of a political nature: the allocation of the costs of the transition. In the first place, it revolves around the distribution within countries. At the static level, high-emissions sectors are severely penalized and – lacking a systematic framework of compensation policies – may strongly oppose measures reducing emissions; at the dynamic level, the interests of the current generation and future generations may diverge. Secondly, the distribution of the burden across countries is also problematic: incentives to undertake ambitious climate action are weakened by the fact that, against positive externalities of mitigation policies distributed globally, costs are instead borne at the level of individual jurisdictions. This prisoner's dilemma setup induces free-riding behavior.

Against the backdrop of these two major challenges, some external factors further complicate decarbonization. Some are structural features, such as population aging – underway in advanced as well as in some emerging countries – which is increasingly stressing public budgets. Others are geopolitical factors, such as the effects of the Russian invasion of Ukraine, which highlighted the importance of security in energy supply, and in 2022 pushed fossil fuel consumption subsidies (Muta and Erdogan 2023) as well as coal-fired generation and related CO_2 emissions (International Energy Agency 2023) to an all-time high.

This note focuses on the obstacles related to the decision-making processes, at national and international levels, and on some solutions that can mitigate them.

OBSTACLES WITHIN COUNTRIES

The Perception of the Gravity of the Phenomenon

The prerequisite for a growing ambition in climate policies is a strong political commitment to pursue them. This in turn requires that the fight against climate change be a priority felt with urgency by citizens, whose preferences influence the economic decisions of the private sector and, especially in the case of democracies, orient electoral programs and government agendas. It is therefore important that widespread awareness of the existential threat posed by climate change takes hold.

The obstacles to the perception of climate risks are varied. It is a relatively new issue that requires a radical change of perspective on the interplay between the economy and the ecosystem: while economic growth has for a long time been a primary goal, allowing humanity to overcome poverty and starvation, suddenly growth is conditional on tight environmental constraints. As Nordhaus (2018) pointed out in his Nobel Lecture, climate change threatens to take humanity back to the Stone Age. In addition, since emissions are not seen or heard, the connection between the various human activities that produce them, the rise in temperatures, and the consequences for human existence in different parts of the planet cannot be easily perceived by most citizens. How can we trace, for example, the intensification of droughts in Africa or floods in Pakistan to the growth of greenhouse gases due to a coal-fired power plant in China or cattle ranching in Brazil? This difficulty in perception distinguishes climate change from other global challenges.

Surveys that measure public perception of climate change reveal widespread concern about the severity of the phenomenon. In The Peoples' Climate Vote (2021), a large survey conducted in February 2020 in 50 countries by the United Nations Development Programme (UNDP), 64 percent of respondents said that climate change is an emergency. Even in advanced countries, perception is still heterogeneous. While the sense of urgency seems to be particularly felt in the EU, with 77 percent of EU citizens believing that climate change is a very serious problem (Eurobarometer), in the United States just under half think that global warming poses a serious threat to their lifestyle and 40 percent believe that the severity of global warming reported by the media is exaggerated (Gallup 2023).

Hence there are ample margins for improving information flows, even in advanced countries. In particular, reports by the IPCC, which provide an account of the scientific consensus and its progress, are relatively unknown. Outreach programs, also in educational contexts, and a systematic and thorough effort of dissemination on the science of climate change, could contribute to greater awareness.

Compensation for Negative Effects and Carbon Pricing

Secondly, it is crucial that those who are most harmed by the transition are supported and compensated in some way for the costs they bear.

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The structural transformation associated with decarbonization involves a radical sectoral re-composition of economies. Some industries – such as fossil fuel power generation and the traditional automotive sector – will shrink significantly, while others – such as renewable energy production and innovative means of transportation – will expand. This results in the obsolescence of a significant fraction of the existing capital stock and massive job losses in some industries. To give an order of magnitude, in the EU, it is estimated that by 2030, in the scenario with a 55 percent emissions reduction, employment in the coal sector will decrease by about 50 percent compared to a baseline of no action (Erbach et al. 2022).

In addition, some climate policies, in particular price-based instruments that make fossil fuel energy more expensive (carbon pricing), generally have a regressive impact, as low-income households spend a larger share of their income on essential goods such as energy. In this case, too, compensatory mechanisms are needed, which can also benefit from the revenue generated by carbon taxes.

Interventions that mitigate the employment and distributional effects of the transition, in addition to responding to the legitimate demand for a just transition, contribute to making more acceptable among citizens.

As a consequence, in the design of policies, it is essential to also consider how they are interpreted by society. In a survey of over 40,000 people from 20 countries, Dechezlepretre et al. (2023) find that a decisive factor underlying support for climate policies is the perception of their impact on low-income households. Projects that are perceived as more effective and redistributive are met with less resistance.

A particularly critical issue is the acceptability of carbon pricing, especially if applied through taxation. While most economists (see "Economists' Statement on Carbon Dividends" in the Wall Street Journal 2019) and climate experts agree that significant results in decarbonizing the economy cannot be achieved without a large increase in emissions prices, the application of a carbon tax remains rather unpopular among the public, although, as mentioned, it is possible to devise compensating mechanisms.

Carbon taxes meet with opposition because they are associated with directly observable increases in energy prices. Other policies, potentially just as costly for citizens – for example, carbon pricing through cap-and-trade mechanisms that operate via production costs – generate less aversion. It is less clear that the costs of their implementation are borne, at least in part, by consumers.

At the same time, Dechezlepretre et al. (2023) also show that explaining in detail how policies operate and how different groups are affected is key to gaining support for climate policies. It is therefore necessary to include compensation instruments in the design of the most regressive measures while also disclosing who benefits, who is temporarily penalized, and how this latter category is to be compensated. Furthermore, fundamental information to be conveyed without complacency is that every measure has a cost: one person's subsidy is always another person's tax, and the emission of debt is a tax on a future generation.

Dynamic Inconsistency, External Authorities and Rules

A third obstacle to the adoption of ambitious mitigation policies is the different distribution of costs and benefits over time. Costs are mostly concentrated in the short term, whereas the benefits will be appreciated only in the medium to long term. The inability to achieve tangible results within the horizon of decision-makers, tied to electoral cycles, weakens their incentives to take the necessary steps. This misalignment is not specific to the climate challenge. It is in fact a feature of many areas of public policy. For example, it finds analogies in public finance, where budgetary targets often suffer from a tension between short-term political considerations and medium- and long-term economic, financial, and social needs (Di Bartolomeo et al. 2018). Another example concerns monetary policy: the tendency to produce higher inflation than is socially optimal that characterized the actions of several central banks for many years was the result of a suboptimal strategic interaction that led to giving weight to short-lived benefits.

Some proposals to overcome time inconsistency can therefore be borrowed from other contexts.

In fiscal policy, the goal of strengthening medium- and long-term considerations has been addressed within the European Union by mandating specific responsibilities to technical bodies (such as the EU Commission and the national fiscal councils) and by introducing budget procedures and rules that make it more difficult to neglect medium-term objectives. In monetary policy, the same goal has been addressed by strengthening central banks' independence and thus their credibility.

Drawing on the success of central banks in taming inflation thanks to their independence from political power and to a medium-term horizon, Delpla and Gollier (2019) propose the establishment, within the EU, of a Carbon Central Bank (CCB). The CCB would receive a mandate from the European political authorities to reduce CO_2 emissions at a given rate each year, and would hold a monopoly on the issuance of CO_2 permits in the EU. Operationally, the CCB would translate this objective into a universal carbon price policy paid by selling CO_2 permits at a single price, both at the borders and within the Union. The institutional design would aim at maintaining a balance between democratic legitimacy and the technical profile of its management body. This would allow the CCB to implement a credible long-term strategy, with a ris-

ing carbon price trajectory. A stable and well-defined profile of future prices is key to guide economic actors in planning investments and consumption.

Finally, pressure to strengthen policy action can also come from the judiciary branch. One specific example concerns constitutional principles. In April 2021, the German Constitutional Court issued a ruling in which the judges stated that the climate policies approved by the government were insufficient on the basis of the right of young people to live their future life in an undamaged environment. The government reacted by strengthening its commitments. In recent years, courts from Australia to Pakistan and across Europe have issued similar rulings in favor of climate policy, putting pressure on their respective governments.

INTERNATIONAL COOPERATION MECHANISMS

At the global level, a cooperative solution faces many obstacles, in particular the impasse on how to allocate the burden of decarbonization between the block of advanced economies and low- and middle-income countries, with the former being the main party responsible for the stock of emissions of the past and the latter substantially contributing to the current flow of emissions.

Plenary Mechanisms and Climate Clubs

Given that global temperature is a global public good, affected by any emission and by any abatement irrespective of its location, climate negotiations and agreements should take place at the widest possible scale, like the COPs under the UN hat.

Enforceability is one of the core problems: Who has the authority to impose sanctions on those who violate the agreements or on those not subscribing to the agreements? Gollier and Tirole (2015) identify the World Trade Organization and the International Monetary Fund as playing a fundamental role in this regard. The former should consider non-compliance with a climate agreement as a form of dumping, with subsequent sanctions. In addition, the IMF could consider the same violation as a liability for future administrations and treat it as sovereign debt.

The slow progress made so far suggests that the free-riding problem, exacerbated by the voluntary nature of membership and the impossibility of sanctioning commitments made, is particularly acute. For that reason, alternative coordination mechanisms should be considered. Even if they are suboptimal in terms of representativeness, they can be more effective from a practical point of view.

A proposal that has been discussed for some time is that of climate clubs. In this setting, a subgroup of countries unilaterally decides to reduce emissions on the basis of an agreement that strengthens the benefits for those who participate, but also imposes a penalty on those who do not join.

The concept of agreements between clubs of countries, widely used in the field of international relations, has become particularly well-known with the formalization of Nordhaus (2015 and 2020). In his proposal, the mechanism would be based on carbon pricing, to which a second distinctive element would be added, the sanctioning one: countries that do not participate or that do not achieve the objectives would be penalized. This solution gives rise to a structure of incentives that would encourage non-member countries, acting in their own interest, to join the club and undertake more ambitious climate policies. The penalties to which Nordhaus refers are generally of a commercial nature, such as tariffs and duties. In principle, these should be linked to the carbon content of imports, but the complexity of such calculation could make a uniform tariff more acceptable.

The climate club model is not without questionable implications and implementation problems. It is no coincidence that it has been discussed for many years and it is only now taking a concrete form.

The EU Fit for 55 Package, in broadening the scope and ambition of the EU Emissions Trading System (ETS), will substitute free allowances to firms most exposed to international competition with the Carbon Border Adjustment Mechanism (CBAM). The EU CBAM requires EU importers of certain carbon-intensive products to pay a fee equivalent to the carbon price differential between the EU scheme price and that of exporters. The objective is twofold: ensuring not only that importers pay the same carbon price as domestic producers, thus avoiding carbon leakage, but also incentivizing non-EU countries to implement stricter climate policy as well, in a spirit akin to a climate club. The transitional phase of the CBAM, in which firms are only required to provide information on the carbon content of their import, started in October 2023; the policy is set to take full effect in 2026. It remains to be seen how CBAM will fare in achieving its two objectives, as well as the implications it will have for EU external trade, absent the mechanism of compensation of free allowances for exporters and given the WTO rules.

In December 2022, upon the proposal of the German Presidency, the G7 launched a climate club project. Its initial focus was to be on energy and industrial sectors and not necessarily based solely on carbon-pricing measures, inviting interested states that pursue an ambitious climate policy to join. The degree of ambition of the policies would be differentiated by the level of income of participating countries, and thus encourage the participation of low- and middle-income countries. In addition, reaching an agreement could eliminate the application of existing carbon border adjustment mechanisms between participating countries. At the current stage, the proposal is still on paper.

Creating International Consensus and the Role of the G20

While it is important to pursue policies at the regional level or climate clubs, which are more politically feasible, a global agreement remains the best solution to address the climate emergency. The case of ozone emissions shows that voluntary international agreements reached through the UN plenary mechanisms can be effective. The Montreal Protocol of 1987 (joined by 197 countries), which provided for restrictions on the use of chlorofluorocarbons (CFCs), has had very satisfactory results: the ozone hole is expected to close by mid-century.

In order to broaden the convergence between countries as much as possible, it is therefore essential to support dialogue and create consensus in the political arena. For these purposes, the role of the G20 is decisive. For one thing, it brings together the world's leading economies, so its actions can truly have an impact at global scale: G20 countries represent 60 percent of the world's population, 75 percent of global trade, over 80 percent of global GDP, and, importantly, almost 80 percent of emissions. At the same time, the dialogue takes place between a limited number of participants.

The G20 agenda is set by the rotating presidency and is fundamentally political. However, being a very lean structure, without a permanent secretariat, the support of international institutions and technical bodies is essential for the political discussion to focus on concrete proposals, based on in-depth analysis and shared in the various competent forums. The negotiation on the taxation of multinationals is a positive example of the role of the G20, which strongly supported the OECD in reaching agreements within the Inclusive Framework, which now includes 140 countries.

POLICY CONCLUSIONS

The consensus view among scientists is clear: net emissions should be reduced as soon as possible. Nevertheless, in spite of some relevant progress, the will to take climate action is still largely lacking.

The transition challenge is primarily technological and financial. Solving this puzzle requires several pieces: R&D investment, rules – both price- and non-price-based – public investment, finance mobilization. This massive transformation cannot be achieved unless supported by strong political commitment within each country and by tighter international cooperation.

Bolstering society's support of climate action is key. This requires a thorough and granular effort of public dissemination of the enormous risks posed by climate change, of the nature of climate policies, and of the compensating schemes supporting the most vulnerable in the transition.

Building trust in government-led climate action is even more important because climate negotiations occur at the international level. This additional level of interlocution poses a very delicate challenge for decision-making processes, because of the tension between the legitimacy of international agreements and the full exercise of national sovereignty (the Westphalian dilemma).

Pursuing citizenship support is made all the more urgent in a landscape of increased geopolitical fragmentation, which has tilted the balance between efficiency and strategic autonomy and further complicates addressing global issues through cooperative solutions.

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Simone Borghesi and *Albert Ferrari*

Can the EU ETS and Its Revenues Tackle the Impact of High Carbon Prices?*

KEY MESSAGES

- **The EU ETS with companion policies is more robust than relying solely on either regulatory or carbon-pricing interventions**
- **Policies should be developed to account for the disparate impacts of the EU ETS across firms and regions**
- **Acceptability of carbon pricing depends on how the carbon price is communicated and revenues used**
- **The EU ETS revenues might decrease at higher carbon prices following a carbon Laffer curve**
- **Beyond revenues, policymakers may have to consider additional sources for funding distributional compensations in the long run**

Emissions trading systems (ETS) have been around for a while and are spreading. Today, 28 ETS are in force, 12 are under development, and 8 are under consideration (ICAP 2023). Altogether, they cover 17 percent of the world's emissions of greenhouse gases (GHG).

The first one established, the European Union Emissions Trading System (EU ETS), has officially come to adulthood: it started in January 2005 and so is now 18 years old. The EU ETS is the cornerstone of European climate policy. Until the European Green Deal, its scope included power, heat generation, industrial manufacturing and, since 2012, aviation. It covers 40 percent of the EU's GHG emissions.

* This post builds upon insights from the session "Are Carbon Pricing and Emissions Trading Market-Friendly and Growth-Effective?" of Shared Perspective 2023.

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The EU is often considered a role model for its innovative and ambitious climate policies. At this age of majority in the era of the European Green Deal, it is worth taking stock of the features and place of the EU ETS in the policy mix, its economic and social impacts,[1] and the role of revenues as a support policy for carbon pricing.

THE MATURITY OF THE EU ETS

Maturing Prices in the European Green Deal

In the early stages, the price of the EU ETS allowances was low due to the overallocation of permits. During Phase 2 (2008–2012), prices fluctuated but increased, particularly during the latter half, as the market started to respond to regulatory adjustments and improved understanding of the system. During Phase 3 (2013–2020), prices saw significant fluctuations. Initially, prices were low due to a surplus of allowances, the inclusion of international credits, and the economic downturn. Then, prices started to increase over the years thanks to market reforms and reduced surplus: in 2021. The EU ETS entered Phase 4 with more ambitious emissions reduction targets, fluctuating between EUR 81 and EUR 105 in 2023. Although the price-increasing trend is global, the era of high carbon prices is mainly limited to Europe so far.

Prices in the EU ETS are expected to rise further due to measures aimed at tightening the cap and aligning with the EU's long-term climate goals. After two years of negotiations of the Fit for 55 Package (FF55), in 2023 the EU ETS is set to accompany the EU in reaching carbon neutrality by 2050. This is in line with the legal objective of the EU Climate Law of reducing emissions by 55 percent by 2030 compared to 1990. Notably, the system is expanding its coverage to include new sectors, reaching 75 percent of EU emissions.

The scope of the existing EU ETS will be expanded to the maritime sector, and the cap will be reduced by 62 percent by 2030 compared to 2005. This is to be supplemented by the creation of a second EU ETS (EU ETS 2) for buildings, road transport, and small non-ETS industries. Its aim is to reduce emissions of these sectors by 42 percent in

[1] Economic and social impacts of the ETS are explored by EUI in LIFE COASE, a project assessing the performance and impacts of the EU ETS co-financed by the EU Life Programme (see https://lifecoase.eui.eu).

2030 compared to 2005. It will be operational as of 2027. Moreover, there are plans to include methane and nitrous oxide for shipping starting in 2026.

The EU ETS in a Net Zero Policy Mix

The most effective and efficient policy mix includes carbon pricing in the form of a market or tax (van den Bergh et al. 2021). This is aligned with what the European Commission found when developing the European Green Deal. According to its impact assessment (European Commission 2020), the impact of the European Green Deal on real GDP was projected to be relatively limited. The models conveyed a consistent message: the type of policies implemented to achieve greater GHG reductions determine the overall impact on GDP. Economy-wide impacts are the smallest if policies that put a price on the externality address and reduce distortionary taxes in other fields through support policies like revenues.

The expansion of emissions trading is accompanied by a series of complementary policies, notably the Carbon Border Adjustment Mechanism, but also a series of support policies like the Modernisation, Innovation, and Social Climate Funds and regulatory policies such as emissions standards or the ban on internal combustion engines sales by 2035 (FSR 2023). In sum, the EU ETS and its companion policies is more robust than relying solely on regulatory or carbon-pricing interventions.

THE IMPACTS OF HIGHER CARBON PRICES

Disparate Economic Impacts

Before the scope extension of the EU ETS and price increase, the primary group directly affected by carbon prices were firms that saw an impact on their competitiveness. In that respect, one of the EU priorities was and still is mitigating the risk of carbon leakage by carefully considering the competitiveness of industries within the EU, preventing the shift of emissions to regions with weaker climate regulations.

The EU ETS appears to be effective in reducing emissions. ETS installations reduced emissions by 37 percent between 2005 and 2022, while sectors under the effort-sharing legislation reduced theirs by only 10 percent between 2005 and 2021 (EEA 2023). The overall impact of reducing industrial emissions is often praised and may give a misleading impression. Research shows an evident heterogeneity across firms in emissions reduction (Vieira et al. 2021). Many installations have not started their decarbonization journey.

Moreover, Vieira et al. (2021) identified the existence of so-called “super polluters”: most emissions are caused by just a few installations. For instance, 1.9 percent of companies’ accounts in the EU ETS emit 42.5 percent of emissions in the industrial manufacturing sectors. From a competition perspective, this may be a sign of concentration in the EU ETS market.

Within the EU, sustainability transition pathways vary from region to region. According to Mura et al. (2021), the EU ETS was instrumental in triggering a reduction in carbon emissions intensity among the regions. Still, the policy impact seems to differ across areas if simulated across NUTS 1, 2, or 3. Furthermore, data indicates that a significant portion, around 56 percent of the regions, are moving toward a trajectory characterized by green growth, showcasing a positive correlation between economic expansion and reduced emissions (Mura et al. 2023). However, 24 percent of regions are experiencing economic growth while simultaneously witnessing an increase in CO_2 emissions, highlighting a disconnect between economic progress and sustainability efforts. A smaller fraction, 6 percent, represents regions following a black degrowth pattern, where economic output and emissions are declining. In contrast, 15 percent of regions exemplify a path of green degrowth, demonstrating a simultaneous reduction in economic activity and carbon emissions. These divergent pathways underscore EU regions’ complexity and diverse impacts and strategies in pursuing sustainability goals.

It appears fundamental to address the diversified impacts of the EU ETS on different firms and regions. Policies are to be developed in such a way as to account for these differences.

Social Impacts and Acceptability

The literature shows that, without redistributional policies, higher energy and carbon prices are likely to have regressive effects. Domestically, the social ecosystem around firms is also impacted: workers facing the costs of the economic transition and associated job loss, and local communities sharing a fair distribution of pollution and co-benefits. In addition, lower-income households spend a more significant share of their income on energy- and carbon-intensive goods, and they face higher financial constraints on adopting low-energy and low-carbon technologies.

The acceleration of decarbonization, scope extension to new sectors (e.g., EU ETS 2), and high carbon prices risk exacerbating the impact of carbon pricing on households. Tackling the distributional effects of carbon pricing puts much pressure on the success of the EU’s carbon neutrality ambition. On the one hand, the increase in energy prices shows the need to accelerate the transition process to move away from the current energy dependence. On the other hand, energy price records may hinder climate policies that tend to increase carbon prices. If not tackled properly, the energy price hikes combined with the high carbon prices would affect the acceptability of climate policies. To increase acceptability, it is fundamental to communicate to the broad audience how carbon pricing works and what it can bring.

THE USE OF AUCTION REVENUES ACROSS THE WORLD

General Considerations on the Use of Carbon Revenues

Revenues can build political support among the public and other constituencies. Acceptability of carbon pricing depends also on how revenues are used and how the carbon price is communicated (Baranzini and Carattini 2017).

Spending priorities will depend on the policy objectives of the jurisdiction. Auction proceeds can be used in different ways: 1) funding climate action by investing in renewable energy, low-carbon technologies, adaptation, energy efficiency, forestry, or transport; 2) contributing to the public budget by reducing other taxes, financing other public priorities, or reducing debts; and 3) financial assistance to disadvantaged groups. In this last case, governments can support low-income households to counter rising energy costs and facilitate the transition to a low-carbon economy. This spending can be targeted at the local, statewide, national, and international levels.

In general, revenues are reinvested to further climate action but are not necessarily earmarked (Borghesi and Ferrari 2023). From an economic point of view, the optimal use of revenues would be toward the general budget. Still, the political economy finds green earmarking and ad hoc funds appealing from a regulator's point of view.

Within social expenditures, although direct rebates and compensation to consumers could be seen as the most visible option and are critical at the early stages of a carbon market, they are considered non-efficient as they tend to mute price signals. Instead, support for equipping households with green and efficient appliances has a great long-lasting benefit. Some studies (e.g., Berry 2018) estimate that only a limited share of carbon pricing revenues would be sufficient to compensate for the negative distribution impacts on households.

Different Practices Worldwide

High carbon prices and new revenue streams raised a record USD 63 billion globally in 2022 (ICAP 2023). Among the total revenues raised by ETS since 2008 (USD 224 billion), more than half were collected in 2021 and 2022. The way auction proceeds are used across countries varies.

The Regional Greenhouse Gas Initiative (RGGI) operates under a cap-and-invest framework, strongly emphasizing investment. Approximately 80 percent of the proceeds have been directed toward consumer benefit programs. This approach underscores the program's dedication to leveraging funds for initiatives that benefit communities and individuals affected by climate and environmental efforts.

In California, stringent statutory requirements dictate the allocation of revenues. Revenues generated are channeled into a fund that supports a range of initiatives, including clean transportation, sustainable communities, clean energy, energy efficiency, natural resources, and waste diversion. It demonstrates California's commitment to funding projects that align with its environmental and sustainability objectives.

In Quebec, auctioning revenues are directed to a dedicated fund, pivotal in supporting climate change programs and aligning with the goals outlined in the Climate Change Action Plan. The allocation of revenues to the fund reinforces the province's dedication to achieving its climate objectives and implementing strategic initiatives to combat climate change effectively.

These examples highlight the adaptability and innovation in revenue allocation, tailored to specific regional needs and priorities, in the global pursuit of unique environmental goals.

USE AND EXPECTATIONS OF REVENUES IN EUROPE

The Use of Revenues in the Fit for 55 Package

The EU ETS alone, with USD 40.8 billion in 2022, represents two-thirds of the total ETS revenues raised globally and is split between EU funds and member states (MS). The Innovation Fund, funded by 530 million allowances, aims to propel innovation in low-carbon technologies throughout MS. Additionally, the Modernisation Fund, fueled by 4.5 percent of total allowances from 2021 to 2030, finances innovation in low-carbon technologies, modernization of energy systems, and energy efficiency, with a focus on lower-income MS. The Social Climate Fund (SCF), to be established in 2026, will address the social impacts stemming from the EU ETS 2. This fund will provide temporary, direct income support for vulnerable households and support measures to reduce emissions in road transport and buildings. The SCF will be financed to the tune of EUR 86.7 billion (EUR 65 billion from auctions, plus 25 percent from MS) between 2026 and 2032.

Once proceeds for these European funds are deducted, the rest of the allowances (approx. EUR 400–500 billion) are expected to be allocated to MS. MS possess autonomy in deciding how to allocate auction revenues. With the FF55, the MS are more bound to use EU ETS revenues toward climate action: the new legal phrasing transforms the "50 percent [of the revenues] should be used" into "100 percent shall be used" for climate and energy purposes. This intricate framework illustrates the EU's dedication to supporting policies fostering innovation, social progress, and climate resilience.

Of the total revenues generated between 2013 and 2021, 75 percent was used for climate and energy-related purposes. However, additionality cannot

be assessed when MS do not earmark their revenues. Tracking the use of revenues is challenging in most countries because of the lack of available data across different systems.

Are Auction Proceeds a Real Panacea?

Auction revenues are expected to increase with higher prices. At the same time, the tightening of the cap reduces the number of allowances and pushes regulated entities to abate their emissions rather than purchase additional allowances. This questions how revenues are linked to ETS prices and the number of allowances in circulation.

It is worth noting that the EU ETS data could indicate a possible stabilization of the revenues. Mazzarano and Borghesi (2023) investigate the current trend of price evolution in the auctions and raise the possibility of a carbon Laffer curve. If confirmed, a Laffer curve applied to carbon pricing would demonstrate that there is an optimal carbon pricing that maximizes government revenues. Initially, as price rates increase, revenues also increase. However, beyond a certain point, higher rates can discourage economic activity and ultimately reduce revenues. The challenge lies in finding the most effective design of a carbon pricing policy – setting a carbon price aimed at achieving environmental goals while considering economic implications.

A stabilization or decline of revenues in the long run may not always be problematic. First, a reasonable revenue pool can be preserved by extending the scope of the EU ETS, such as to buildings, transports, and small industries. Second, as decarbonization occurs, one could argue that a lower number of allowances will be needed, eventually reducing the impact on firms' costs. Still, decarbonization will also increase the price of allowances, thus leaving the overall effect on firms' costs a priori ambiguous.

Auction revenues should not be the sole source for financing the EU's decarbonization or social compensation. The EUR 400–500 billion allocated to MS is significant compared to the EU's coronavirus aid package worth EUR 750 billion, but still insufficient. For instance, the additional public and private green investment needs in the EU are estimated to be around EUR 520 billion per year over the 2021–2030 period (European Commission 2021).

POLICY CONCLUSIONS

Because the EU ETS is more mature, prices are more significant and substantially impact firms and regions. Policy design and actions should be implemented differently to reflect the differences in those impacts. The presence of super polluters may require policymakers to reconsider the influence of such players in the markets, and across regions, different levels of governance show disparate impacts of specific policies. All this means it is imperative to identify the right policy mix accompanying the EU ETS, including support measures, so as to assist the various actors in their decarbonization efforts.

High carbon prices can raise distributional and social acceptability concerns, but effective redistribution policies can play a pivotal role in ensuring the acceptability and success of ETS. Nonetheless, it is important to consider potential limits to this revenue growth, as revenues may plateau or decline at higher carbon price levels, following a pattern akin to the carbon Laffer curve. If that is confirmed, researchers and policymakers should investigate alternatives to carbon revenues for financing domestic and international climate action in the long run.

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Niko Jaakkola, Frederick van der Ploeg and *Anthony Venables*

"Big Push" Green Industrial Policy

KEY MESSAGES

- **Carbon pricing is a central part of climate policy, but is politically difficult while the economy is still reliant on fossil fuels**
- **The long-lived green investments required to break the carbon lock-in depend on expected taxes, not current taxes**
- **Policies which target the expectations of the private sector can shock the economy and move it onto a green path**
- **Green industrial policy can leverage technological/political feedbacks to kick-start the transition**
- **Fossil fuel bans can help break the technological and political lock-in into carbon reliance**

THE ORTHODOX CLIMATE POLICY PRESCRIPTION: PRICE CARBON!

Economists have been actively engaged with the question of climate policy for at least 30 years (Nordhaus 1991). The main product of this engagement has been vocal and wholehearted support of carbon pricing according to standard economic principles. A carbon price should make the private users of a polluting resource take into account the expected discounted costs they impose on outside parties, by putting an additional price on the use of the good, corresponding to the monetary value of the cost. Such costs to third parties are termed external costs and a carbon price internalizes them as part of the decision of how much carbon-emitting activity to undertake.

Such a price on pollution can be implemented as a Pigouvian tax (Pigou 1920) on polluters equal to the external cost. Alternatively, the policy can impose a cap on total emissions, allocate the right to emit as permits (each allowing the emission of one metric ton of CO_2), and then allow market participants to trade these permits. The price of acquiring a permit on the market (e.g., in the EU Emissions Trading System) then reflects the associated carbon price. If the cap is set correctly, this permit price again equals the external cost of the last (or marginal) unit of emissions. This is also called the social cost of carbon.

We refrain from considering the relative merits of these ways of implementing a carbon price. However, both of these market-based instruments have strong advantages over other ways of controlling pollution (Blanchard et al. 2023). In particular, they ensure that pollution is reduced where it is least costly to do so; they impose small informational requirements on under-resourced public administrators, who do not have to become experts in industrial engineering and economics; and they provide valuable tax revenue for the public treasury. By increasing the cost of using fossil fuels, they also incentivize locking up more fossil fuel in the earth, and pursuing more innovation in green R&D.

This elegant solution to controlling pollution may work when it is easy for emitters to adjust the activity that produces the external cost. For example, congestion charging (here, the external cost is associated with additional traffic congestion) can be avoided by using public transport options or by avoiding entering the congestion charging zone at peak times. Similarly, acid rain-causing sulfur and nitrogen emissions were reduced in the 1990s by installing relatively inexpensive "scrubbers" to existing infrastructure. Unfortunately, avoiding greenhouse gas emissions is less easy,

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making it harder to succeed with ambitious climate policy – such as achieving net zero by 2050 – by relying on market-based instruments alone.

CLIMATE POLICY: NOT YOUR USUAL PUBLIC POLICY PROBLEM

Climate policy is different from many previous environmental problems and requires instruments beyond carbon pricing to bring about the transition needed. We highlight three main issues, and then explain their implications for climate policy.[1]

First, note that climate action is likely to remain policy-driven. The world has relied on fossil fuels because the private costs of using them are very low. If one ignores the external costs – as private agents will do in the absence of carbon pricing – the chemical and physical properties of fossil fuels make them very convenient and effective to use. This translates into low costs per unit of energy, which are further diminished by decades and even centuries of development of advanced fossil energy technologies. To be competitive, renewables (such as solar or wind) must enter a level playing field, one on which carbon pricing policies force users to face the true social cost of fossil fuels.

Second, climate policies involve what economists term strategic complementarities (or positive feedback effects). These are situations in which a private action to shift energy production from fossil to renewable sources will give other agents an additional incentive to follow suit. We highlight a few important channels here (van der Ploeg and Venables 2023).

Technological complementarities arise if the development of green technologies – essentially, new ideas on how to generate cheaper renewable energy – can be further developed by other innovators (Acemoglu et al. 2012; Harstad 2020). There is thus a technological externality in addition to the global warming externality, since green R&D leads to more green R&D. Closely related, network effects are present if deployment of green technologies makes it more convenient for others to adopt the same, or a complementary, technology. For example, a higher penetration of electric vehicles may encourage firms to build more charging stations, which in turn encourages more consumers to switch to electric vehicles, and so on.

Social complementarities follow from the desire of consumers to make consumption or production choices in line with their peers (e.g., Besley and Persson 2023). If consumers are switching to fuel efficient vehicles en masse, large petrol-guzzling sports utility vehicles may become démodé. Thus, green ways of living may sustain themselves by pure social pressure. This is yet another externality stemming from peer effects in consumer demand.

Furthermore, there are likely to be substantial political complementarities. Carbon pricing is costly and unpopular when most people live in energy-inefficient buildings, far from their place of work and from services, to which they drive in large gas-powered vehicles (Douenne and Fabre 2022). In this situation, politicians may refrain from implementing carbon pricing, and in the absence of carbon pricing, people may continue to choose carbon-intensive lifestyles. Moreover, the influence of powerful fossil business interests works to entrench the carbon-intensive status quo. On the other hand, if society adapts to a low-carbon lifestyle, and has large renewable energy producer lobbies, policymakers face little opposition to pricing carbon. A green economy and green politics go together, or not at all.

Such policy complementarities imply that our society may be locked into path dependence. Past carbon-intensive consumption and investment choices support carbon-friendly technological development and deployment, and generate political opposition to aggressive mitigation of climate change. This makes fossil fuels cheap to use due to past advances in technology and a lack of regulatory measures such as carbon pricing, which in turn perpetuates the carbon-intensive lifestyle.

Third, this path dependence is made worse by the fact that climate policy involves a radical restructuring of our energy infrastructure and the investments required to achieve this. Importantly, a carbon-intensive economy needs many extremely long-lived assets. The mean lifetime of fossil-fuel power plants is close to 40 years (Cui et al. 2019; Tong et al. 2019). The skills built up by a trainee starting their career at an oil refinery can be used for many decades, but are largely useless outside the refinery. A city structure and a motorway network designed around private motoring persists for many, many decades. Many of these assets would become stranded – their value prematurely reduced – under ambitious carbon pricing policy (von Dulong et al. 2023).

EXPECTATIONS: THE KEY TO ACHIEVING THE GREEN TRANSITION

Together, the presence of long-lived assets and complementarities implies that our future may be a self-fulfilling prophecy – whether green or brown. In the jargon of economics, we face a situation of multiple equilibria. If consumers, workers, and investors expect toothless climate policy, and a continuation of technological development in a carbon-intensive direction, they will continue to invest in long-lived dirty assets and skills (e.g., Kalkuhl et al. 2020; Smulders and Zhou 2023). Looking to the future, political constraints imply that carbon pricing still cannot be implemented in the presence of all these assets (despite

[1] We ignore here the problem of international free riding. Greenhouse gases are global pollutants, and controlling climate change is a global collective action problem. Arguably this is the biggest obstacle to climate action.

earlier, vehement commitments made by previous governments). And this will have justified the investors' decisions – their predictions of a brown future turn out to be correct!

On the other hand, if private agents start expecting – really expecting – the green transition to happen rapidly, they will invest in renewable power generation, electric vehicles, and energy-efficient homes, and they will train as wind power technicians rather than as coal miners. And, in the future, governments will face demands to make the green technology competitive – to level the playing field for green energy, and to make any remaining fossil users face the full external cost of burning carbon.

This situation of different, self-fulfilling futures means that it is crucial to force private agents to shift their expectations – to make them believe that we are now on the verge of a rapid green transition.

Shifting expectations is also essential because the ultimate climate outcome depends less on emissions in the near future – in the next few years – than on emissions in the longer term. Climate change depends on cumulative emissions that we emit until we reach net zero. Emissions in 2024 do not matter much; what matters is how much we continue to emit in the 2030s and 2040s. Moreover, energy demand is not very responsive to prices in the short term: people still have to heat their homes and drive to work, even if doing so is expensive.

This means that carbon pricing in the short term is not only unpopular, but it will also remain an ineffective way to meet our climate goals unless the technological, social, and political externalities are internalized as well. It may be politically easier, and more effective, to focus on policies that will shift expectations in the longer term. We will now turn to recommendations on how policymakers could act to shift expectations – to guide our society onto a trajectory of green transition, rather than staying on a path of continued fossil dependence and climate inaction.

POLICY CONCLUSIONS

Green Industrial Policy to Kick-Start the Transition

The past two years have seen the return of large-scale industrial policy – specifically, "green" industrial policy. The Inflation Reduction Act (IRA) in the United States is intended to channel vast amounts of federal subsidies (in the form of tax credits) into the deployment of renewable electricity technologies and into the production of renewable energy. The European Union's response to the IRA, the Net-Zero Industry Act (NZIA), is intended to open the doors to EU member states providing similar support. While there has been a vocal argument over whether these policy packages are useful or a costly waste, here we emphasize their potential impact in terms of setting these two large economies on green trajectories.

First, it is widely understood that policymakers often find "carrots" easier to implement than "sticks." Subsidies have often been easier to implement than carbon pricing policies: while they are typically at least as costly, these costs are paid for through general taxation and thus may stand out less to voters than carbon prices (Blanchard et al. 2023). Thus, these large-scale industrial policy packages may offer the benefit of being more politically feasible than ambitious near-term tightening of carbon pricing schemes.

Second, by supporting the deployment of renewable energy production, the improvement of energy efficiency, the expansion of electric vehicles, and so on, these industrial policy measures will generate interest groups that in the future will work to defend their own interests while also slowly eroding the constituency that opposes carbon pricing. This is the process that has made Germany a leader in the production of renewable energy: early subsidies to a fledgling industry turned into investment, which turned into political power, which helped the industry resist later attempts by conventional utilities to strangle the sector (Jacobsson and Lauber 2006). The choice is therefore not between efficient carbon pricing versus costly subsidies. Rather, subsidies paid today can act as the key to open the political lock on more ambitious carbon pricing in the future (broadening the scope and raising the carbon price level). This argument about policy sequencing has been made by, for example, Meckling et al. (2017).

Third, it is important to understand that, with multiple equilibria, it is not sufficient to pursue marginal climate policies. Because the different equilibria are stable – that is why they are equilibria – small adjustments are unlikely to fundamentally change the trajectory of the politico-economic system. Rather, to give the system a push big enough to shift it to a different trajectory, climate policies must be radical (van der Ploeg and Venables 2023). For example, carbon prices may have to be larger – at least for some time – than the Pigouvian price, and/or supplemented with large enough renewable subsidies to shift the economy from a carbon-intensive to a green equilibrium. The recent green transition policy packages, some implemented (NextGenerationEU, IRA), others under discussion (NZIA), are hopefully large enough to sufficiently shock private sector expectations and actions in order to shift the economy into a green direction.

Fourth, to maximize their impact on expectations as well as on the future path of climate policies and economic decisions, these green industrial policies should be designed consciously with the intent of pushing the various complementarities over the hump to where the green equilibrium outcome becomes self-sustaining. Such strategic policy design must consider where the most likely social, technological,

and political complementarities and tipping points are. The policies should be designed with an eye on building up future political coalitions in favor of, and disarming political resistance toward, carbon pricing policies. Such political strategies would have to be designed jointly by economic and political experts (Acemoglu and Robinson 2013) to take into account both the economic effects and political consequences of green industrial policies. Because resources are limited, policymakers must also think about how to achieve the biggest "bang for the buck" – taking into account not only the direct economic and environmental impact of, say, subsidizing renewables, but also the subsequent effects on political constraints that future policymakers must contend with.

Fifth, economists realize that poorly designed industrial policies can turn into costly "white elephants," swallowing more and more public money. Supporting some projects that turn out to be disappointing is to be expected when optimally investing in the development of new technologies. The larger problem is that industrial policy is "sticky," because of political capture of the regulators. Thus, green industrial policy must be designed with a set of institutions that allow support to be terminated according to well-defined conditions and by technocratic program managers isolated from political pressure (Rodrik 2014).

Technological, social, and political complementarities also mean that support can be removed once the transition becomes self-sustaining. It is unclear how to identify when a particular technology has crossed the tipping point, but some indicators include observing an acceleration of the transition without an accompanying increase in policy support – which could indicate that expectations are starting to drive the transition by themselves – or an increase in unsubsidized investments into capital that is complementary to the supported investment.

The End of the Fossil Era Must Start Now

In addition to nurturing green technologies and giving the related special interest groups space to develop, policymakers should also ensure that the dirty technologies of the past, and their associated interest groups, are no longer allowed to recreate themselves. This will reduce future resistance to carbon pricing, which is at least as important as allowing support to grow.

Carbon pricing is politically difficult, and part of the reason is collaboration among well-resourced corporate and labor interest groups in the fossil sector in opposing climate action (e.g., Mildenberger 2020). Existing vested interests will naturally be defended. However, it may be easier to limit the continued reproduction of such interest groups by banning new investment into fossil fuels. This is because of sunk investment costs. Before investment, the holder of a fossil asset (such as a plot of land containing a fossil deposit) stands to lose the net profit they could gain from this investment, i.e., in terms of revenue, operating profits, and investment costs. Once the investment cost is sunk, the value at risk of stranding is then the gross profit – revenues minus operating profit. The owner of a developed fossil fuel asset will hence resist a carbon pricing policy much more fiercely than the owner of an undeveloped asset. To the extent that banning further fossil development generates temporary scarcity, which pushes prices up, the owners of operating fossil assets could even support a ban on further development (Baldwin et al. 2020).

CONCLUSIONS

While carbon pricing is a central tool to achieving the green transition, attempts to implement it to date have been limited in both scope and level, largely for political reasons. We argue that short-term carbon pricing is the wrong focus if we want to pursue effective climate policies: it is both politically difficult, and not the main determinant of the degree of climate change that we will end up suffering.

The green transition requires large and long-lived private investments, which take account of technological, political, and social complementarities. This means that there are multiple possible future trajectories that our politico-economic systems can take. Which one is chosen depends largely on private sector expectations. The implication is that effective climate policy needs to be radical enough to fundamentally shock climate policy expectations onto a new trajectory. Green industrial policy can help by laying down undeniable facts on the ground, e.g., by supporting rapid green technology development, or strategically supporting renewable energy deployment to create interest groups. In the future, these groups will then lobby for ambitious carbon pricing. Once private sector agents at large appreciate that these new facts on the ground spell the imminent end of fossil fuels, they will take care of the remaining green transition, even without additional support.

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Gianmarco Ottaviano

The EU Carbon Border Adjustment Mechanism between Ambition and Delusion

A GLOBAL SOLUTION FOR A GLOBAL PROBLEM

The European Union is adamant about the fact that climate change is a global problem that calls for global solutions. An important cause of climate change are the greenhouse gas (GHG) emissions associated with carbon-intensive production. Left to their own devices, firms typically do not consider the negative impact their emissions will have on the climate when making their production decisions. Hence, the idea of levying a "carbon tax" on GHG emissions to make firms face a "fair price" for such emissions forces them to internalize the damage carbon-intensive production has on the climate.

Unfortunately, not all countries tax carbon. As a result, according to the World Bank, less than 25 percent of global emissions are taxed, and only 5 percent of them face a carbon price compatible with achieving the Paris Agreement's goal of ensuring that global temperatures this century rise no more than 2 degrees Celsius above pre-industrial levels. Moreover, countries with higher carbon taxes face the risk of "carbon leakage," which occurs when their domestic companies move carbon-intensive production abroad to countries with lower or no carbon taxes, or when their products are replaced by more carbon-intensive imports.

AMBITIOUS GOALS

Due to its carbon taxation ambitions, the European Union would be particularly exposed to that risk. For this reason, it has planned the introduction of the Carbon Border Adjustment Mechanism (CBAM), whereby a carbon tariff is imposed on imported carbon-intensive products that are at risk of carbon leakage (such as cement, iron and steel, aluminum, fertilizers, electricity, and hydrogen). As part of the European Green Deal, CBAM entered into force last May and will take effect in 2026.

By requiring that certain imports pay a price for the embedded carbon emissions generated during their production, the objective of CBAM is to make sure that the carbon price of imports is equivalent to the carbon price of EU domestic production. That way, by putting a "fair price" on the carbon emitted during the production of goods entering the single market, CBAM should make the pursuit of the EU's climate ambitions incentive-compatible for domestic firms and, hopefully, encourage cleaner industrial production in non-EU countries that pay less attention to emissions. CBAM's "fair price" will be linked to the price of the EU allowances as determined within the European Union Emissions Trading System (ETS) and its gradual introduction will parallel the phaseout of the free allocation of those allowances.

KEY MESSAGES

- **Climate change is a global problem that calls for, among other measures, global carbon taxation**
- **As not all countries tax carbon, those with higher carbon taxes, such as the EU members, face the risk of "carbon leakage"**
- **The Carbon Border Adjustment Mechanism (CBAM) makes the carbon price of imports equivalent to that of EU domestic production, and creates incentives for its trade partners to tax carbon to improve access to the single market**
- **It does little, however, to help EU firms compete in foreign markets with producers from countries that do not tax carbon**
- **Moreover, as trade relations increasingly follow geopolitical fault lines, the EU might overestimate the incentives CBAM creates unless its coordination with the US improves**

DELUSIONAL OUTCOMES?

As highlighted in a recent review by the French economists Lionel Fontagné and Katheline Schubert, while there is broad agreement that the risk of leakage is real, whether CBAM will succeed in removing it is the subject of intense debate.

Two main aspects have been stressed by its critics. First, taxing imports to ensure that their carbon price is equivalent to the carbon price of domestic production may succeed in leveling the playing field in the EU domestic market. However, it does little to help EU firms compete in foreign markets with producers from countries that do not tax carbon. This would require an export subsidy, which is hardly compatible with the rules of the World Trade Organization.

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Second, the EU might be overestimating the incentive to introduce adequate carbon taxes that CBAM creates for countries that do not have any. The idea is that the single market is important enough to incentivize such countries to price carbon so as to avoid compensation through CBAM. In a changing world economy, in which trade relations are reorganizing around geopolitical fault lines, the attractiveness of the single market is fading for several lower carbon tax countries, and with it also the incentivizing leverage of CBAM.

POLICY CONCLUSIONS

A briefing by the European Parliamentary Research Service stresses the importance of tighter coordination with the US. As one of the world's largest markets and emitters, the US should be a key partner in bringing the world closer to reaching the goals of the Paris Agreement. However, so far it has largely gone its own way, especially after the Inflation Reduction Act (IRA) invested billions of dollars of public money to favor clean energy and technology "made in America."

Christina Langer, Jakob Peiffer and *Simon Wiederhold*

Apprenticeship Skills Pay Off on the Labor Market*

KEY MESSAGES

- **Apprenticeship plans provide the basis for reliably and comprehensively classifying the skills of a large share of Germany's workforce**
- **In total, we classify more than 13,000 different skills and the duration of learning each skill based on the apprenticeship plans**
- **Workers who have acquired higher cognitive, social, or digital skills during their apprenticeship earn higher wages in the short and long term**
- **In particular, the value of digital skills has risen sharply since the 1990s, parallel to the increasing use of computers in the workplace**
- **The speed at which apprenticeship plans are modernized is crucial for how well the German apprenticeship system can prepare its graduates for the future labor market**

Workers' skills are essential to their success on the labor market (Schultz 1961; Becker 1962; Mincer 1974). Higher skills not only have a positive impact on individual labor productivity (Hanushek et al. 2015), but also influence career choices (Deming 2017; Deming and Noray 2020), career trajectories (Arellano-Bover 2022; Adda and Dustmann 2023), and vulnerability to technological change (Cortes 2016; Braxton and Taska 2023). However, the empirical evidence on the economic impact of higher skills is still limited due to how skills are measured. Most existing studies measure skills according to the number of completed years of schooling or test scores. Both are incomplete measures of an individual's actual skill level. First, skills vary considerably among individuals with the same level of formal education. Second, skill assessment tests cover only basic skills (typically in math and reading) and thus comprise only a small part of an individual's entire skill spectrum.

In our research project, we develop novel measures of workers' skills that are comprehensive, highly detailed, and directly relevant to the labor market. To this end, we leverage the characteristics of the German apprenticeship system, which offers three main advantages for measuring skills and analyzing their labor market potential.

First, the qualification requirements are set out in state-approved, nationally standardized apprenticeship plans. This uniform system ensures that a given apprenticeship imparts the same practical and theoretical skills regardless of the training location. In addition, the apprenticeship plans precisely specify the period over which the skills are learned. Second, since about 60 percent of workers in Germany have completed vocational training (IAB 2017), we can measure the skills of a large part of the German labor force. Third, apprenticeships typically commence immediately after secondary education, so apprenticeship plans provide information on what skills individuals have at the beginning of their careers. Measures of workers' skills when entering the labor force are rarely found in the previous literature.

* Details of the study reported here can be found in Langer and Wiederhold (2023). This project is funded by the European Union under the Horizon 2020 Research and Innovation Program under Grant Agreement No. 101004703, PILLARS – Pathways to Inclusive Labor Markets.

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INSTITUTIONAL BACKGROUND

People usually start an apprenticeship at the age of 16 to 18 years, directly after completing secondary education. The majority of those who complete an apprenticeship have already obtained a lower or intermediate secondary school qualification. Thus, individuals enter the apprenticeship system with very similar levels of education. The length of an apprenticeship varies between two and four years, with most apprenticeships lasting three years. The German apprenticeship system combines theory and practice in the form of a "dual system": one part of the apprenticeship (approx. 3–4 days per week) consists of on-the-job training at a company, while the other part (approx. 1–2 days per week) is made up of courses at a public vocational school.

The skills learned during training at the company and at the vocational school are codified in state-approved apprenticeship plans. Each training occupation is assigned exactly one apprenticeship plan. To ensure that the skills acquired during apprenticeships are relevant to the labor market, apprenticeship plans are developed jointly by employer associations, experts from the vocational training sector, and the Federal Institute for Vocational Education and Training (BIBB) and are authorized by the federal government, making them legally binding (BIBB 2017).

The apprenticeship system is standardized throughout Germany in accordance with the Vocational Training Act. This act stipulates that companies that offer apprenticeships must comply with the requirements set out in apprenticeship plans to ensure the quality of training regardless of where in Germany it is provided (Janssen and Mohrenweiser 2018). In addition, nationally standardized final examinations guarantee that apprentices have acquired the skills specified in the plans. These exams are monitored and graded by the Chamber of Commerce and Industry (IHK) or the Chamber of Commerce (HK), ensuring compliance with nationwide standards. Given these characteristics of the German apprenticeship system, it is reasonable to assume that companies impart the skills outlined in the apprenticeship plans. This enables us to gauge the labor-market-relevant skills of individuals who have completed such apprenticeships.[1]

[1] The approach of using apprenticeship plans to infer worker skills was pioneered by Eggenberger et al. (2018) for Switzerland.

SKILL MEASUREMENT

As discussed in the previous section, apprenticeship plans specify what material apprenticeships cover and how long they last. We analyzed the plans for the 165 largest apprenticeship occupations in Germany, which cover more than 85 percent of those members of the German workforce who have completed vocational training. Each plan consists of, on average, seven pages totaling 850 words. It also contains information on how many weeks apprentices spend learning a particular skill. The plans thus provide information not only about which skills are acquired during the apprenticeship, but also the intensity with which these skills are learned. On average, 120 different skills are listed in each plan. In total, we classified over 13,000 skills that are taught in the German apprenticeship system.

For our further analysis, we group the individual skills into more general skill groups. For this purpose, we take the classification used by Deming and Kahn (2018), which was developed for highly skilled occupations in the United States. After tailoring the classification to fit the German low- and medium-skill apprenticeship context, we identified six distinct skill groups as outlined in Table 1: cognitive, social, digital, manual, management, and administrative.

Cognitive and administrative skills are taught in every apprenticeship, while social and digital skills are more occupation-specific. Manual skills are also strongly occupation-specific, as they are learned particularly in craft apprenticeships (e.g., plumbers, carpenters, or joiners).

DATA

In the next step, we link our skill measures to comprehensive labor market data to investigate how different types of skill are rewarded over individuals' careers after entering the labor market. In the following, we focus on cognitive, social, and digital skills, as these have been discussed as important determinants of labor market success in the previous literature (Weinberger 2014; Hanushek et al. 2015; Deming 2017; Falck et al. 2021).

To analyze the labor market returns to skills, we draw on administrative data in which workers are

Table 1

Skill Classification Based on Apprenticeship Plans

	Keywords and phrases
Cognitive	Math and statistics, critical/analytical thinking, problem solving and decision making, language, creativity, innovation, economics, accounting, business analysis, evaluation
Social	Teamwork, communication, negotiation, presentation, consultation and advice, customer service, service orientation, time management, adaptability, flexibility, stress tolerance
Digital	Basic computer skills, office software, data analysis, data security, software
Manual	Construction, transportation, general physical activities, maintenance, installation, repairing, tools
Management	Management of personnel and financial resources, project management
Administrative	Writing, scheduling, support activities, law and regulations

Source: Authors' own compilation.

tracked throughout their careers. More specifically, we use the Sample of Integrated Labor Market Biographies (SIAB), provided by the Institute for Employment Research (IAB).[2] This is a 2 percent sample of all employees subject to social security contributions in Germany (Antoni et al. 2019; Frodermann et al. 2021). As a consequence of the legal obligation to report the beginning and end of every employment relationship subject to social insurance and the wages paid, the SIAB data is the largest and most reliable source of labor market information in Germany. Furthermore, the SIAB includes information on basic demographic characteristics such as worker age, gender, nationality, and education. Establishment characteristics such as the number of employees, age, and industry affiliation are also part of the SIAB. All of these are important for dealing with worker selection for apprenticeships.

For our study, one crucial detail is that the SIAB provides data on an employee's apprenticeship occupation down to the 5-digit level. Given that apprenticeship plans are also available at this granular level, there is no need for aggregating the apprenticeship skill data when merging them to the worker data in the SIAB.

We focus on full-time employees who have completed an apprenticeship.[3] Our sample contains only workers whom we can observe in full-time employment at least once in each of the four consecutive five-year periods after labor market entry. This allows us to observe the same workers over a period of more than 15 years after the end of their apprenticeship.

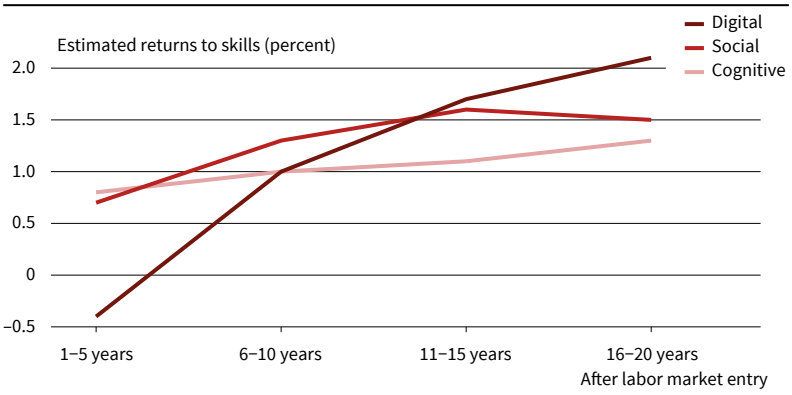
DO THE SKILLS TAUGHT DURING APPRENTICESHIP PAY OFF ON THE LABOR MARKET?

Returns to Skills during a Career

Our results show that employees who have acquired higher cognitive, social, or digital skills during their apprenticeship perform better on the labor market (see Figure 1). While the labor market returns to all three skills are still relatively low in the first few years after completing an apprenticeship, they increase significantly over the course of a career. At the end of our observation period, 16–20 years after entering the labor market, wages increase by 1.3 percent with each additional month of acquiring cognitive skills. This corresponds to additional earnings of about EUR 500 annually. The wage increases associated with an additional month of learning social and digital skills are even higher, at 1.5 percent (approx. EUR 550) and 2.1 percent (approx. EUR 800), respectively. Thus, the wage increases of an additional month of skills acquired in apprenticeship correspond to between 16 percent and 27 percent of the return to an entire additional school year. This illustrates the high value on the labor market of the skills learned during apprenticeship.

Figure 1

Returns to Skills over the Career



Note: The figure shows the percentage increase in earnings for an increase in cognitive, social, and digital skills by one month over the first 20 years after labor market entry. The sample consists of full-time employees with completed apprenticeship education. The estimates account for the other skill groups (manual, management, administrative), demographic factors (gender, nationality, age fixed effects, and pre-apprenticeship educational degree), the year and county of apprenticeship completion, and apprenticeship field (1-digit level).
Source: Sample of Integrated Labor Market Biographies (SIAB); authors' own calculations. © ifo Institute

The wage gradient associated with an additional month of learning skills is most pronounced for digital skills (Figure 1). One explanation for this pattern is that workers with higher digital skills are more likely to obtain a university degree and to participate in on-the-job training later on, possibly because their skills become obsolete more quickly. This has been suggested in recent work by Deming and Noray (2020).

When calculating the relationship between wages and skills, we accounted for wage differences due to gender, age, nationality, and education. Additionally controlling for the year and district of training completion also ensures that our results are not skewed by cohort effects or regional differences in average establishment quality, industry structure, or labor demand. In addition, we compare wages only within occupational groups – i.e., we compare different craft occupations with each other, rather than juxtaposing craft occupations with IT occupations.

In subsequent analyses, we shifted our focus from wage levels to wage growth over workers' careers, relative to the period immediately after labor market entry. While higher cognitive skills are associated with only modest wage increases, wage growth is substantially more pronounced for workers with higher social or digital skills.

[2] Philipp vom Berge, Corinna Frodermann, Tobias Graf, Stephan Grießemer, Steffen Kaimer, Markus Köhler, Claudia Lehnert, Martina Oertel, Alexandra Schmucker, Andreas Schneider and Stefan Seth (2021), *Weakly Anonymized Version of the Sample of Integrated Labor Market Biographies (SIAB) – Version 7519 v1*, Research Data Center of the Federal Employment Agency (BA) at the Institute for Employment Research (IAB), DOI: 10.5164/IAB.SIAB7519.en.v1. The access to the SIAB data was provided via on-site use at the Research Data Centre (FDZ) of the German Federal Employment Agency (BA) at the Institute for Employment Research (IAB) and subsequently remote data access.

[3] The analysis of full-time employees is a standard procedure, since the SIAB includes daily wages, but no information is available on the daily hours worked by the employees. This limits the comparability of daily wages of part-time workers in the SIAB.

Skill Complementarity

In addition, we examined factors that influence the labor market returns to skills. First, we looked at whether employees who acquire certain combinations of skills during their apprenticeship are paid higher wages. It turns out that the combination of cognitive and social skills is particularly valuable on the labor market. This result corroborates previous findings on the complementarity of cognitive and social skills from the United States (Deming 2017; Deming and Kahn 2018) and Switzerland (Kiener et al. 2023). One interpretation of this finding is that workers who have both cognitive and social skills can take on more complex tasks at work, thereby increasing their productivity (see Deming and Kahn 2018, for a similar argument). In contrast, other combinations of skills acquired during apprenticeship are not associated with a wage advantage.

Moreover, we find that cognitive skills acquired during apprenticeship pay higher returns when they are actually needed in the worker's current job. For this analysis, we determined companies' demand for skills from more than 18 million online job postings provided to us by the US firm Lightcast.

Robustness Checks

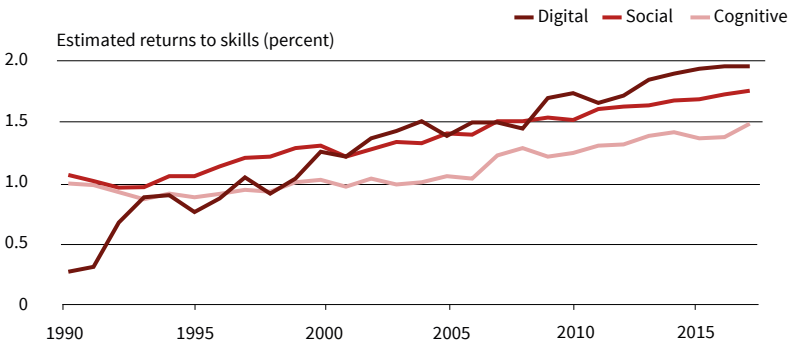
Several further analyses reported in Langer and Wiederhold (2023) illustrate that our results are highly robust. For example, we use supplementary survey data that allow us to account for workers' family background, final high school grades, and non-cognitive skills. The family background controls are particularly important in the context of Germany, which is characterized by a high intergenerational persistence of economic success.[4]

To account for the possibility that our results are explained by the selection of workers into more productive (and thus better paying) apprenticeship establishments, our empirical analysis also controls for establishment characteristics such as size, age, industry affiliation, and overall productivity. Our results remain robust even if we compare only those workers who completed their apprenticeship within the same establishment.

[4] In Germany, it takes 6 generations for those born in low-income families to approach the mean income in their society, longer than in the United States (5) and the OECD average (4.5) (OECD 2018).

Figure 2

Returns Over Time: Prime-aged Males and Females



Note: The figure shows the percentage increase in earnings for a one-month increase in cognitive, social, and digital skills for each year from 1990 to 2017. The sample consists of full-time workers with a completed apprenticeship training aged 35–54 years in a given year. Estimated returns are conditional on the other skill domains (manual, management, admin), worker characteristics (gender, nationality, age fixed effects, and pre-apprenticeship educational degree), and apprenticeship characteristics (year of completion, county of training establishment, and occupational field (1-digit)).
Source: Sample of Integrated Labor Market Biographies (SIAB); authors' own calculations. © ifo Institute

Returns to Skills over Time

Thus far, we have examined how the labor market returns to higher skills evolve over workers' careers. However, to answer the question of how the value of skills is affected by societal and technological change, it is necessary to observe the development of returns over time. Figure 2 shows the returns to skills per year, from 1990 to 2017.[5] The graph illustrates a marked rise in returns to cognitive, social, and digital skills over the past three decades. The surge in the returns to digital skills stands out: by 2017, these returns had increased sevenfold from their 1990 value. Interestingly, the ascent in digital skill returns began in the early 1990s, coinciding with the growing prominence of computers in the workplace. This suggests a complementarity between workplace computer usage and workers' digital skills.

DISCUSSION

We construct novel measures of workers' skills based on apprenticeship plans, which outline apprenticeship requirements in a standardized manner throughout Germany. From these plans, we identified over 13,000 specific skills, which can be categorized into cognitive, social, digital, manual, management, and administrative domains. For each skill, the apprenticeship plans also indicate the learning duration, so that the skill measures can be intuitively interpreted as months of skill acquisition during the apprenticeship.

Workers who acquire higher cognitive, social, or digital skills during their apprenticeship earn significantly higher wages throughout their careers. However, the labor market rewards for various skills differ noticeably. For instance, dedicating an extra month to cognitive skill development during an apprenticeship is related to a 1.3 percent wage increase roughly two decades later. The long-run returns to social and digital skills, however, are even more pronounced, at 1.5 percent and 2.1 percent respectively. When compared to the wage increase from an entire additional year of schooling, which is around 8 percent, it is evident that the labor market highly values all three skills.

Investigating drivers of returns to skills, we find evidence for skill complementarities: workers who simultaneously acquired cognitive and social skills

[5] These estimates are based on a sample of prime-aged workers (35–54 years) in the respective year. Previous evidence indicates that observed wages during prime age are a particularly good proxy for lifetime wages (Hanushek et al. 2015).

during apprenticeship are particularly valuable on the labor market and can maintain this pay advantage throughout their careers. Linking our skill data with job vacancy data, we also provide evidence for skill-technology complementarities. We show that workers with higher cognitive skills earn higher wages when a company's production technology is more likely to require these skills.

Examining long-term patterns, we find that the returns to cognitive, social, and digital skills have increased over the past 30 years. The growth in the returns to higher digital skills is particularly pronounced, suggesting that the increasing diffusion of computer technology is a driving force behind the increased economic value of digital skills.

POLICY CONCLUSIONS

Our study aims to contribute to the understanding of the sources and possible future developments of labor market returns to vocational education. For example, analysis of changes of returns to different types of skills over time may help to forecast the impact of technological change on differently-skilled workers and to determine the feasibility of reskilling. Our finding that cognitive, social, and digital skills acquired through apprenticeships are valued on the labor market also suggests that the German apprenticeship system – which is highly praised internationally (The Economist 2018) – can indeed serve as a role model. In fact, several countries are currently debating whether or not to implement an apprenticeship system. In the US, for instance, apprenticeships have recently been advocated as a means to decrease youth unemployment, increase workforce quality, and provide in-demand skills (Lerman 2022). By offering insights into the suitability of apprenticeship programs to prepare individuals for the demands of the labor market, our results can provide guidance for the design of vocational training curricula.

Our study also shows which skills taught as part of an apprenticeship are mainly responsible for the labor market returns to vocational education. For example, while digital skills are highly rewarded on the labor market, they are taught only for a relatively short period – averaging just two months of a three-year apprenticeship. For the future viability of the German apprenticeship system in times of increasingly rapid technological change, the speed with which apprenticeship plans are modernized is crucial with a view to keeping up with companies' changing skills requirements. Thus, our future research aims to delve into past apprenticeship plans to gauge how effectively the German apprenticeship system equips its graduates for evolving labor market demands.

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Michael Alexeev, William Pyle and *Jiaan Wang*

Russia's "Impressionable Years" and Putin's Inheritance

KEY MESSAGES

- **In Russia, where the early transition's economic pain was not alleviated by the same emotive high of "liberation and independence" experienced elsewhere in post-communist Europe, the drop in support for liberal economic and political values was comparatively steep and enduring**
- **Evidence from the Integrated Values Survey (a combination of the World Values Survey and the European Values Study) demonstrates that Russians de-prioritized democratic freedoms and increased their support for an interventionist state in the economy between 1990 and 1995**
- **The "values gap" that grew dramatically in the early 1990s between Russians and post-communist citizens elsewhere in Europe has persisted through the most recent wave of the Integrated Values Survey**
- **This pattern – a "values gap" that opened in the early 1990s and persisted to the present day – is observable among men, women, and across different age cohorts**
- **Within Russia, the degree to which regions' electoral support for Boris Yeltsin dropped between the 1991 and 1996 presidential elections explains more illiberal attitudes in the most recent wave of the Integrated Values Survey**

Just over three decades ago, a new era appeared to have dawned in Europe: The Cold War had wound down, the Soviet Union's empire had broken apart, and democratic capitalism stood poised to sweep aside ossified communist systems. History, however, as we should have known, neither quickly nor completely turns a corner. The past can linger on in profound and complex ways. In Eastern Europe and the former Soviet Union, formal structures of governance may have abruptly changed, but communism still cast a long shadow. Its anti-market and anti-democratic ethos, for one, endured in the worldviews of many post-communist citizens into the twenty-first century (Pop-Eleches and Tucker 2017).

Though its legacy would endure, communism's disappearance as a governing system, was greeted, broadly speaking, with relief and jubilation across Eastern Europe and most post-Soviet successor states. In Russia, however, its collapse, in conjunction with the break-up of the Soviet Union, resonated differently: "What was initially celebrated [elsewhere] as liberation and independence ... was mourned in Russia as a loss of territory, population and global stature (Krastev and Holmes 2019)." Even in the first half of the 1990s, one could find ample evidence that Russians were ruing the Soviet Union's break-up and losing faith in the proposition that greater freedom would bring about a better society. In 1994, the country's leading independent pollster released data showing that 75 percent of Russians thought that the disintegration of the Soviet Union had brought more harm than benefit, whereas only 8 percent thought the opposite. A solid plurality, moreover, felt the introduction of multi-party elections had resulted in more bad than good (Levada 1996).

To a degree that surprised rulers and ruled alike, the exit from communism was accompanied by a not insignificant amount of pain and dislocation. Per capita income plummeted and inequality soared. As a consequence, public support for the de-statization of the economy and the democratization of the polity waned across the region, but perhaps nowhere more so than in Russia. There, the economic shock of the early transition was not cushioned by the sorts of national narratives of "liberation and independence" that buoyed populations elsewhere (Brudny and Finkel 2011; Krastev and Holmes 2019; Gaber et al. 2019).

As communism endured in the beliefs and attitudes of the peoples that lived through it, so, we hypothesize, did the potentially wrenching experience of leaving it behind. In Russia, where the economic pain was not alleviated by the emotive high of "liberation and independence" experienced elsewhere, we suspect that (1) the early drop in support for the transition era's liberal project was greater than in other post-communist countries and (2) any illiberal turn in worldviews in those initial post-communist years reverberates into the present day.

In this note, we present and interpret evidence from the Integrated Values Survey (i.e., a combination of the World Values Survey and the European Values Study) consistent with these two hypotheses. Between 1990 and 1995, relative to citizens in other post-communist economies, Russians' attitudes on fundamental questions of economics and politics became markedly more illiberal. In just five years, in a manner that stood out in a region becoming more aware of the limitations of democracy and markets, Russians in the early 1990s increased their support for an economically interventionist state and de-prioritized political freedoms. Evidence from the most

recent wave of the Integrated Values Survey, moreover, shows that the attitudinal gap that opened up between Russia and other post-communist successor states over two decades earlier has remained stable. The illiberal turn that Russia took in the early 1990s has endured.

Consistent with this latter finding, we use geographic markers in the most recent wave of the Integrated Values Survey to show that, within Russia, the drop in a region's electoral support for Boris Yeltsin between the presidential elections of 1991 and 1996 strongly predicts its degree of illiberalism in 2017. On balance, where faith in the politician who launched marketization and democratization declined most dramatically is where we continue to observe the greatest skepticism for his liberal project. The pattern laid down in the early 1990s persists.

RUSSIA'S "IMPRESSIONABLE YEARS" AND PUTIN'S INHERITANCE

Both ethnographic evidence and "harder" social indicators suggest that the first half of the 1990s was a "critical juncture" for Russia (Gaber et al. 2019). After peaking in 1989, Russian per capita GDP slid into a protracted decline. Neither perestroika, Mikhail Gorbachev's partial reform measures, nor Boris Yeltsin's big push to liberalize the Russian economy, achieved their aim, at least in the short to medium run. Both leaders presided over economic free-fall and social collapse. According to the World Bank, between 1990 and 1994, real GDP per capita fell by 35 percent, and life expectancy declined by 4.4 years.

Ethnographers and sociologists underscore how disorienting those years were for Russians. Arriving to carry out interview-based research in 1998, Russia's post-communist economic nadir, Shevchenko (2008, 39–40) describes a society as having settled into a state of routinized emergency: "The stability [prevailing only a decade earlier], predictable (although modest) incomes, relative social equality, and personal social security ... [had given way to a] time of rampant crime, social polarization, and insecurity, both in terms of personal situations and of the larger political and economic realities."

And yet she finds that by the late 1990s, the "crisis" (krizis) of the decade's first half had become normalized. By 1998, the pain of the earlier emotional gut punch had passed and the pathologies of post-communism – corruption, economic uncertainty, frequent political shake-ups – had "ceased to surprise." "Could it be," she wonders, "that the shocks of the late 1990s simply faded in comparison with the magnitude of economic and political turmoil that preceded them?" Acknowledging that the answer could be "yes," she concludes that the late 1990s were not unusual. The late Soviet and early post-Soviet years, however, were. Those were the years of the true disruption; those were the years that shook Russians up the most. Parsons (2014) would likely agree. In her ethnographic study of Russia's mortality crisis, she points to how the economic turmoil of the early 1990s, by disrupting individuals' ties to a long-standing social order, produced not only shorter-term material, but also longer-term psychological, hardships.

To presume that the exit from communism would similarly disrupt the psychologies of citizens elsewhere in Eastern Europe and the former Soviet Union would risk eliding an important distinction about Russians' experience. As Shevchenko (2008) puts it, "Russian citizens faced a rapid restructuring of social forms ... unaccompanied by a legitimating rhetoric of national liberation … As a result, post-socialist Russians experienced [those years] as a form of betrayal and loss." When Putin, in 2005, famously described the collapse of the Soviet Union as "a major geopolitical disaster," he was only giving voice to a sentiment held by a solid majority of Russians. Russians had, after all, occupied positions of privilege in both the Soviet Union and the socialist world, more generally. As the Soviet external and internal empires dissolved about them, Russians may have been uniquely prone, when confronted by acute economic hardship, to fall back on illiberal "Soviet values."

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Drawing on a retrospective survey administered in 2006, Pyle (2021) shows that many Russians continued to bear scars from their life experiences, particularly in the labor market, in the early 1990s. Their individual fates during those "impressionable years," when so much was so new for so many, forged their thinking as to the fundamental economic and political values that animated Russia's transition away from communism. The same survey data, moreover, reveal that relative to the citizens of other post-communist nations, the emotional weight of those years, their capacity to transform lived experiences into enduring lessons, was particularly great for Russians.

Much has been written of late about the successes of neo-authoritarian regimes generally, and Putin's government specifically, in exploiting control over television and other media to mold popular attitudes (Guriev and Treisman 2022). While not disputing the power of state propaganda in the hands of a popular dictator, we would highlight that in some very important respects, the Russian worldview in the Putin years remains quite consistent with that of Russians in the mid-1990s.

In their recent book, *Putin v. the People*, Greene and Robertson (2019) write that "in prioritizing an aggressive foreign policy, Putin is responding to – and seeking the support of – a large constituency within Russia itself." The findings of Alexeev and Pyle (2023) comport with this perspective. Drawing on three waves of the International Social Survey Program from 1995 to 2013, they show that relative to a diverse group of middle- and high-income countries, Russia's population has consistently been characterized by an exceptionally blind and militant form of patriotism. They thus concur with the conclusion of Greene and Robertson (2019) that "we need to think not of Putin's Russia, but of Russia's Putin. We need to understand that Putin is not above the country; he is of the country, of its politics, its society, and its history." A primary point of ours here as it was in that earlier article is that Putin did not so much create as inherit a population with an unusually illiberal worldview.

DATA

We use the Integrated Values Survey (IVS), a combination of the European Values Study (EVS) and the World Values Survey (WVS), both of which are large-scale, cross-national, and repeated cross-sectional surveys that include many questions replicated over several decades. Russia's inclusion in the IVS commences in 1990. Our focus here is on three waves, which we refer to below using their WVS wave numbers: 2, administered 1989–1993; 3, administered 1994–1998; and 7, administered 2017–2022. The Russian surveys, specifically, were carried out in 1990, 1995, and 2017. For comparison purposes, we incorporate responses from the eleven other post-communist countries that participated in the same three waves: Belarus, Bulgaria, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia.

We create variables from four questions that address attitudes towards fundamental matters of politics and economics, with each coded such that higher values represent less support for the liberal economic and political project that animated the transition away from communism.

Two questions explore preferences over the proper role of the state in the economy. Both ask respondents to place their views on a 1–10 scale, with "1" in the first question representing "private ownership of business should be increased" and "10" representing "government ownership of business should be increased." The average across all respondents is 5.30.

The scale on the second question ranges from "1," "people should take more responsibility to provide for themselves," to "10," "the government should take more responsibility to ensure that everyone is provided for." The average across all respondents is 5.77.

We use two other questions to gauge the degree to which respondents attach importance to democratic freedoms relative to other possible social objectives. For both, respondents are asked to select from a list of four possible responses the ones that they consider their first and their second priorities. One question, prefaced by the statement that "[p]eople sometimes talk about what the aim of the country should be for the next ten years," asks, "Would you please say which one of these you consider the most important?" The possible responses include: (1) "a high level of economic growth," (2) "making sure this country has strong defense forces," (3) "seeing that people have more say about how things are done at their jobs and in their communities," and (4) "trying to make our cities and countryside more beautiful." Respondents are then asked which of the four they consider second most important. We code their responses in the following way: "1" if their top priority is something other than response (3), "0.5" if their second priority is response (3), and "0" otherwise. The average across all respondents is 0.77.

The second question asks, "If you had to choose, which one of [these] would you say is most important?" The possible answers are: (1) "maintaining order in the nation," (2) "giving people more say in important government decisions," (3) "fighting rising prices," and (4) "protecting freedom of speech." Respondents are then asked which of the four they consider second most important. We code their responses in the following way: "1" if their top priority is either response (1) or (3) and their second priority is also (1) or (3), "0.66" if their top priority is either response (1) or (3) and their second priority is either (2) or (4), "0.33" if their top priority is either response

(2) or (4) and their second priority is either (1) or (3), and "0" otherwise. The average across all respondents is 0.63.

We simplify the data by using factor analysis to combine the answers within each of the two pairs of questions.[1] One "factor" derives from the questions that reflect greater preference for an economically interventionist state; the other "factor" comes from the two questions that capture a lower prioritization of democratic outcomes relative to other social objectives.

After comparing Russian responses to those from other post-communist countries, we exploit regional location information in WVS Wave 7 to explore whether the decline in regional support for a liberal social order in the early 1990s explains more illiberal preferences in Wave 7. WVS Wave 7 respondents represent roughly three-quarters of Russia's regions, with each region contributing on average about 30 respondents to the analysis.[2]

Our measure for a region's drop in support for a liberal social order is the decline in its vote share for Boris Yeltsin between 1991 and 1996. Regional voting results come from the Electoral Geography project. For 1996, we use the results from the first rather than the second round because the 1991 election itself was the first round of a potential two-round election. Since Yeltsin garnered a majority in the first round in 1991, there was no need for a second. Another reason we do not use the second round of the election in 1996 is that it was dogged by improprieties (Myagkov and Ordeshook 2008).

[1] Factor analysis is a commonly used statistical technique to reduce the dimensionality of a set of variables while retaining as much of the original information as possible. We use Stata's "factor" and "predict" commands to generate factor scores that estimate the underlying latent variable (the factor) that was extracted from the original variables.

[2] We are unaware of the degree to which the WVS in Wave 7 was designed to select representative samples of the population within each of the regions; we are also unaware of the degree to which WVS Wave 7 selected a representative sample of regions.

RESULTS

Table 1 presents rankings of post-communist countries according to how much their citizens embrace a state that plays a large role in the economy. In 1990, a year before the collapse of the Soviet Union, Russian respondents rank third in support for an economically interventionist state, behind both Poles and Belarussians. By 1995, they stand in the top position and remain there in 2017. Although the change in Russia's rank between 1990 and 1995 is not substantial, the change in the numeric strength of their pro-statist orientation is. In 1990, the Russian index is only slightly higher than the average for the other countries in the sample. Between 1990 and 1995, the index jumps substantially. And between 1995 and 2017, it remains more or less stable.

We observe a similar pattern in Table 2. Russia ranks second across all three waves in terms of the degree to which its citizens de-prioritize democracy relative to other social objectives. However, the index measuring this attitude jumps for Russia from 0.02 in 1990 to 0.13 in 1995. In 2017, the index increases to 0.16, but the change compared to that in the early 1990s is quite modest.

Figure 1, by comparing Russians to the average across all the other post-communist countries, illustrates even more clearly that a large early-1990s shift in Russians' attitudes preceded an extended period of more modest attitudinal change. This pattern certainly is suggestive of the possibility that Russians' relative illiberalism in 2017 reflects more the gap that opened up in the early 1990s than any developments since that time. In other words, a possible reading of Figure 1 is that Russia's illiberalism

Table 1

Strong Preference for State Role in Economy

	Wave 2		Wave 3		Wave 7
	1990		1995		2017
Belarus	0.21	**Russia**	0.18	**Russia**	0.17
Poland	0.14	Slovakia	0.15	Slovakia	0.08
Russia	0.08	Belarus	0.09	Latvia	0.06
Slovakia	0.07	Estonia	0.04	Poland	0.05
Lithuania	0.06	Hungary	0.02	Bulgaria	-0.01
Latvia	0.06	Latvia	0.00	Romania	-0.03
Hungary	0.02	Czechia	-0.07	Czechia	-0.04
Romania	-0.03	Poland	-0.08	Hungary	-0.06
Slovenia	-0.05	Bulgaria	-0.08	Lithuania	-0.11
Bulgaria	-0.05	Lithuania	-0.12	Estonia	-0.11
Estonia	-0.06	Slovenia	-0.15	Slovenia	-0.12
Czechia	-0.22	Romania	-0.22	Belarus	-0.13

Note: See text for description of variable that determines ranking.
Source: Authors' own calculations.

Table 2

Weak Preference for Democracy

	Wave 2		Wave 3		Wave 7
	1990		1995		2017
Romania	0.25	Hungary	0.16	Bulgaria	0.19
Russia	0.02	**Russia**	0.13	**Russia**	0.16
Hungary	0.02	Bulgaria	0.12	Romania	0.08
Estonia	0.02	Belarus	0.05	Belarus	0.08
Latvia	0.00	Romania	0.02	Lithuania	0.01
Czechia	0.00	Slovakia	0.00	Czechia	0.01
Slovakia	-0.01	Lithuania	0.00	Slovakia	0.00
Belarus	-0.03	Latvia	-0.02	Latvia	-0.07
Poland	-0.04	Poland	-0.07	Hungary	-0.13
Bulgaria	-0.05	Estonia	-0.08	Poland	-0.19
Lithuania	-0.05	Czechia	-0.09	Estonia	-0.24
Slovenia	-0.12	Slovenia	-0.31	Slovenia	-0.36

Note: See text for description of variable that determines ranking.
Source: Authors' own calculations.

under Putin, at least through 2017, is the outcome of an attitudinal shift that preceded his tenure as president.[3]

[3] In unreported results, we explore whether the patterns observed in Figure 1 can be observed in distinct sub-groups of the population. In general terms, we observe the same patterns across both genders and across different generational cohorts.

Figure 1

Preferences across Time

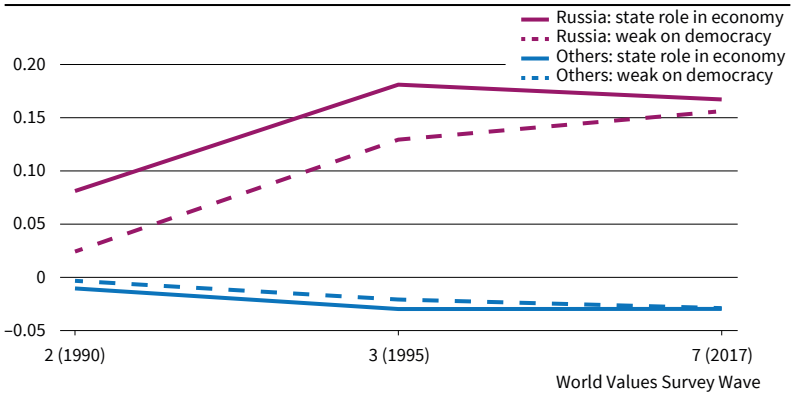

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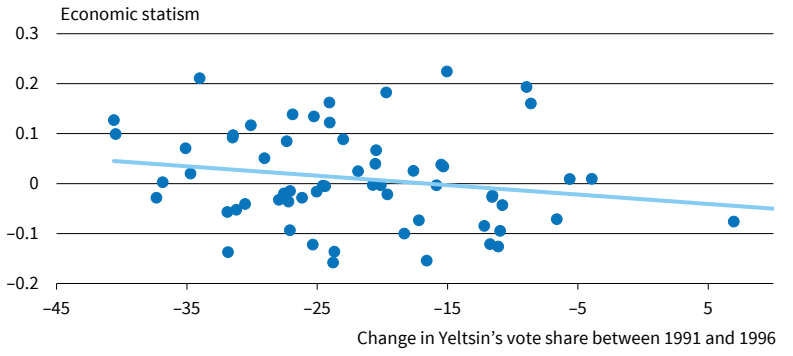
Figure 2

Economic Statism by Region in 2017



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To explore this possibility further, we investigate whether a similar pattern holds within Russia itself. In other words, do attitudinal changes at the sub-national level in the early 1990s explain regional differences in illiberalism in 2017? Unfortunately, though we know the region in which respondents are located in Wave 7, we do not have that information for Waves 2 and 3. Instead, to assess the degree of early-1990s decline in support for the values that animated Russia's exit from communism, we use the decline in regional electoral support for Boris Yeltsin who fought his illiberal opponents for market economic reforms and greater democracy.

In line with the pattern in Figure 1, Figures 2 and 3 turn up evidence consistent with the crucial role of the "impressionable years." Respectively, they show that the decline in support for Yeltsin between the presidential elections of 1991 and 1996 explains greater illiberalism of WVS respondents in Wave 7. Circa 2017, regions in which Yeltsin's support dropped the most between 1991 and 1996 are, on balance, more supportive of an economically interventionist state and less likely to prioritize democratic freedoms over other social objectives.[4]

DISCUSSION AND POLICY IMPLICATIONS

One reason for the early-1990s attitudinal shift in Russia could have been a backlash to the developments that followed in the wake of the Soviet Union's collapse at the end of 1991. WVS Wave 2 took place in 1990 when Russia was still a part of the Soviet Union and many respondents may still have held high

[4] In simple bivariate regressions of average regional attitudes (first, with respect to economic statism, and second, with respect to the de-prioritization of democracy) on the change in Yeltsin's share in the presidential election between 1991 and 1996, the latter is a statistically significant predictor of the former at the 1 percent level of significance.

hopes for the transition to markets and democracy. Post-independence economic dislocation and political in-fighting likely dampened those hopes and soured the population on Yeltsin's liberal project. Indeed, in confirmation of the former, Natkhov and Pyle (2023) demonstrate that Yeltsin's support fell most dramatically between 1991 and 1996 in those sub-regional districts of Russia that were ex ante most vulnerable to market liberalization.

It is important to note, however, that the economic and political challenges of post-communist Russia were far from unique in the region. The countries in the comparison group here also experienced economic contraction and political in-fighting in the early 1990s. And yet Russia uniquely experienced a profound and enduring attitudinal shift. To sort out why, we believe it is important to return to what others have already highlighted. In Russia, the economic shock of the early 1990s was not cushioned by the sorts of national narratives of "liberation and independence" that sustained populations elsewhere in Eastern Europe and the former Soviet Union (Brudny and Finkel 2011; Krastev and Holmes 2019; Gaber et al. 2019). For Russians, almost uniquely, the economic shock was compounded by a shock to their national identity.

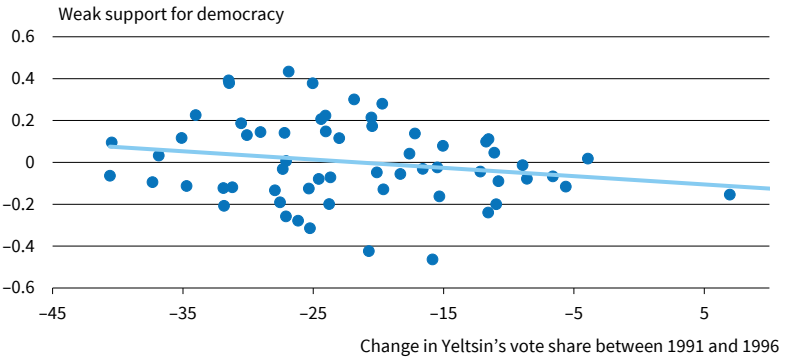
It is well known that soon after the turn of the century, Putin and his allies in the political and media elite began using the 1990s for political purposes as a kind of foil, referencing it as a decade synonymous with social disorder and economic collapse (Belmonte and Rochlitz 2019; Sharafutdinova 2020; Malinova 2021; McGlynn 2023). In using the 1990s for the purposes of a broader illiberal project, however, the evidence we provide here suggests that Putin et al. have been pushing on an open door. Russian society, primed by the economic and identity shocks of the early 1990s, Russia's "impressionable years," was already ready to be led in the direction that Putin chose to take it.

For policymakers, it is important to be clear-eyed about the Russia that eventually emerged from the Soviet Union's collapse. Should Putin somehow leave the scene in the near to medium term, the world would still be confronted by a deeply illiberal society, one whose core beliefs run very much counter to those in the countries to its west. Indeed, there is a strong case to be made that Russia's illiberalism is more Putin's inheritance than his creation.

The brutal and unprovoked invasion of Ukraine places in sharp relief the frustration of hopes held for Russia, both at home and abroad, just over three decades ago. Instead of becoming a more open and peaceful society in the aftermath of the Soviet Union's collapse, Russia quickly made an illiberal turn and, with time, became more bellicose and hostile to its neighbors. Putin's decision to invade a peaceful Ukraine in February 2022 has led to unimaginable suffering in the months since. He alone is responsible. And nothing that we have written here should distract from that fact. Nor should anything we have written distract from the fact that many Russians do not support his illiberal regime. Indeed, even during the war, tens of thousands have courageously spoken out publicly against it. But, alas, Russia is a country of tens of millions and history's hand is heavy.

Figure 3

Weakness of Democratic Support by Region in 2017



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Sofia Amaral, Gordon B. Dahl, Timo Hener, Victoria Kaiser and *Helmut Rainer*

Emergency Calls Reveal the Importance of Arrests in Reducing Repeat Domestic Violence*

KEY MESSAGES

- **Domestic violence is a pervasive threat to women's well-being worldwide and many victims are repeatedly abused by their partners**
- **One possible but controversial police measure to deal with this problem is to arrest suspects immediately on the spot**
- **Geo-coded 999 emergency call data can be used not only to identify victims and repeat offenders, but also to monitor the impact of officers' actions at the scene**
- **Recent research shows that arresting the marginal suspect is effective and reduces the number of repeat assaults by about 50 percent in the following year**
- **Arrests contribute to a cooling-off period in the short term, in addition to deterring abuse in the long term**

Domestic violence (DV) is a serious human rights violation affecting roughly one-third of women worldwide (WHO 2021). In addition to the severe humanitarian consequences, there is also a significant economic impact not only for the individual, but also for society and the economy as a whole. Physical and psychological injuries that can lead to missed work days, reduced productivity, and, in some cases, even job loss are but some of the major consequences. Also, institutions such as the police, specialized services, the health and legal sector, and the allocation of their resources are affected. Therefore, it is one of the costliest crime types (Bindler et al. 2020; Chalfin 2015). The European Institute for Gender Equality (2014) estimates that the implied costs of gender-based violence (GBV) in an average European country amounts to EUR 4.5 billion per year. Against this background, it is important to investigate how to prevent DV cases.

* This column is based on our research (Amaral et al. 2023), which uses data generously provided by the West Midlands Police. This article draws upon the summary of our work appearing in a VoxEU column.

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A HIGHLY CONTROVERSIAL POLICE RESPONSE

Domestic violence primarily affects women, who often find themselves trapped in a cycle of abuse perpetrated by the same partner (Tjaden and Thoennes 2000; Aizer and Dal Bo 2009). One of the central questions surrounding this problem is how law enforcement should respond to it effectively. In particular, the controversial strategy of making provisional arrests on the spot has stirred debate within both academic and political circles.

Proponents of the arrest approach argue that it serves a dual purpose. First, it temporarily incapacitates the offender, ensuring the immediate safety of the victim. Second, it sends a strong signal that repeat incidents will come at a high cost, potentially deterring future offenses (Berk 1993). Critics of arrest, however, fear repercussions. They worry that while an arrest may provide immediate relief, it could lead to an escalation of violence over the long term (Schmidt and Sherman 1993; Goodmark 2018). It has also been argued that arrest might affect victims' willingness to report future incidents of domestic violence. Some argue that it encourages women to do so, and others believe that it prevents future calls to the police because women fear the reaction of their partners.

It has proven difficult to empirically assess the impact of arrest on repeat victimization. The cornerstone of the existing evidence comes from the "Minneapolis Domestic Violence Experiment" of 1981 (Sherman and Berk 1984), as well as similar studies conducted in other US cities and counties. In these experiments, patrol officers encountering violent situations were instructed to randomly implement one of three responses: arrest, separate the victim and offender, or provide advice. While innovative at the time, these studies faced several obstacles. They

produced inconsistent results, struggled with small sample sizes, and often encountered noncompliance in treatment assignment – meaning that patrol officers frequently deviated from the randomly assigned response. Related work has looked at the impact of various other law enforcement policies and strategies on revictimization. This includes investigations into the effects of "no drop" policies (Aizer and Dal Bo 2009), specialized domestic violence courts (Golestani et al. 2021), and the use of criminal charges (Black et al. 2023).

USING EMERGENCY CALLS TO OVERCOME ESTIMATION CHALLENGES

Estimating the consequences of an arrest on subsequent victimization poses a dual challenge. First, the scarcity of large datasets simultaneously encompassing details on domestic violence incidents, police responses, and recurring victimization complicates the analysis. Second, arrests are not random actions taken by police officers; they are more likely in cases with a high probability of repeat victimization, potentially leading to an underestimation of any deterrent impact.

In a recent study (Amaral et al. 2023), we tackle both challenges using data on emergency calls in the United Kingdom. Our data dataset spans a whole decade (2010–2019) and covers all emergency calls received by the police in West Midlands, the second most populous county in England. Initially, we compile a dataset that records emergency calls and officer involvement, including details on officers, case IDs, and timestamps for call placement, dispatch, arrival on scene, and departure. This is then merged with call-handler data, specifying how the call was categorized and providing incident geo-coordinates. Given the high priority of domestic violence in the UK, it is singled out by call handlers as a distinct crime category. In the next step, we link this data with information on the on-site actions of first-response officers, including whether a suspected offender is arrested. Finally, we merge the dataset with a database detailing whether a criminal investigation is initiated later and, if so, whether offenders are charged with a crime. This approach results in 631,834 officer-case level observations of domestic violence cases as identified by call handlers.

Measurement of Repeat Victimization

In many datasets, identifying domestic violence directly as a crime category is not possible; it must be inferred from incident characteristics. Furthermore, researchers typically observe cases where criminal charges are filed, but in domestic situations, victims often avoid pressing charges. Additionally, establishing a link between repeat victimization and a prior incident is challenging; datasets that track victim identities usually record them only in the presence of documented criminal charges. To classify cases as domestic violence, we leverage call-handler information. To create a linked panel of domestic violence incidents over time, we match cases through the precise geo-location at which they occurred. This approach offers the key advantage of being able to track repeat domestic violence even without a formal criminal charge. Consequently, our analysis captures a significantly higher fraction of repeat cases compared to other datasets based on criminal charges.

Addressing Endogeneity

Arrests are not random events, but are more likely in situations where the likelihood of repeat victimization is high. To address this, we leverage the extensive officer-level police database and capitalize on two aspects of our settings. First, given the unpredictable nature of when and where demands for police intervention will arise, the availability of police officers that can be dispatched to an incident is random once we account for observable case characteristics (time, location, and priority assigned by call handlers). Second, police officers exhibit different propensities to make arrests. We calculate the average arrest propensity in other cases handled by police officers during the ten-year observational period and employ this as an instrumental variable for predicting whether an arrest will occur in the current case. As multiple police officers can respond to an incident, we use the weighted average arrest rate of all dispatched police officers. The rationale for the instrumental variable is that of-

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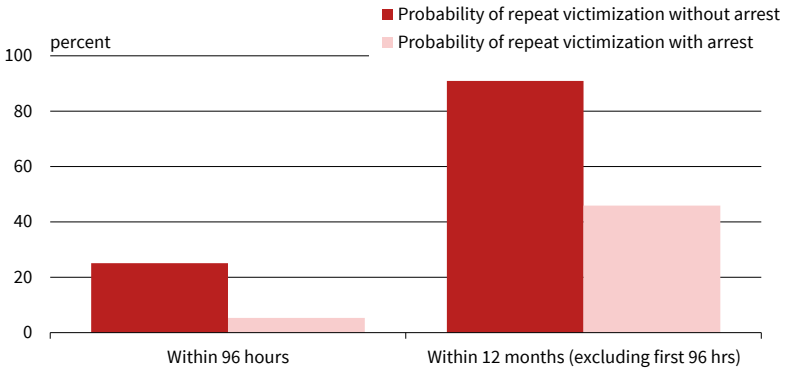
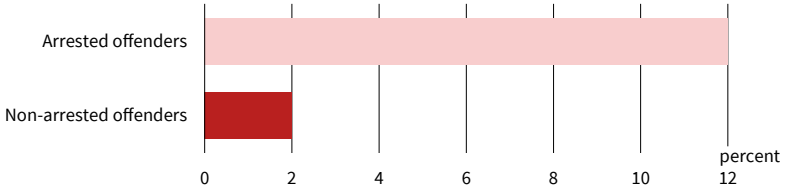
Figure 1
The Effect of Arrest on Repeat Victimization



Source: Authors' calculations. © ifo Institute

Figure 2
Probability of Criminal Charge



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ficers with a higher arrest propensity in other cases are more likely to make an arrest in the current case. However, since officers are randomly assigned to cases, a higher arrest propensity should not be linked to the characteristics of the current case. We show that the instrumental variable indeed strongly predicts whether there will be an arrest in the current case but exhibits no correlation with observable case characteristics.

A REDUCTION IN DOMESTIC VIOLENCE CALLS

Our primary finding underscores the significant impact of arrest in the context of domestic violence. After an arrest, the likelihood that domestic violence will occur again in the following 12 months drops significantly by 49 percentage points. This translates to a substantial 51 percent drop in repeat offenses. We also examine the timing of this decline. In the absence of an arrest, one-quarter of perpetrators tend to engage in violent behavior once again within just 96 hours. However, when an arrest is made, it acts as a strong deterrent and prevents almost all these immediate recurrences. Beyond this short-term effect, we also observe a sustained reduction in repeat offenses over the course of the following year, indicating a lasting impact (Figure 1).

A CHANGE IN ABUSE OR A CHANGE IN REPORTING BEHAVIOR?

Whether the decline in the frequency of recurrent domestic-violence-related 999 calls after an arrest is a positive or negative development depends on whether it represents a true decline in abuse or merely a shift in victims' reporting behavior. To distinguish between these two possible explanations, we construct a simple reporting model based on a threshold concept. In this model, victims who face adverse consequences after an arrest may choose to endure a higher level of abuse before feeling compelled to report it in the future. Conversely, victims who draw strength from the deterrent effect of an arrest may choose to report future abuse at a lower threshold.

Using a measure for the severity of repeat emergency calls, we observe an average reduction in reporting thresholds following an arrest. Specifically, there is a notable decline in severe domestic violence calls and an increase in less severe domestic violence calls. This shift in composition is statistically significant. When viewed through the lens of our threshold reporting model, it implies that the decrease in domestic-violence emergency calls can be attributed not to changes in reporting behavior but rather to a reduction in the incidence of violence.

As a second test, we examine the differences between calls initiated by victims themselves and calls initiated by third parties, such as neighbors. The rationale behind this comparison is that victims may be more reluctant to report repeat offenses for fear of retaliation, while third parties may be less concerned. However, we find an opposite trend: a larger (though not statistically significant) decrease in reports made by third parties compared to those made by victims. This observation is consistent with a decrease in actual abuse.

POSSIBLE MECHANISMS

Our analysis addresses several mechanisms that could explain the decline in repeat victimization. The significant decrease in domestic violence cases in the first four days after an arrest indicates a cooling off period – a time when the perpetrator is temporarily incarcerated and removed from the scene. However, the persistent reductions observed over the subsequent year also point to a more enduring deterrent effect. Consistent with a deterrent effect, we show that an arrest significantly increases the likelihood that the offender will be formally prosecuted. Among those who are not arrested, only 2 percent are formally charged with a crime. In stark contrast, this likelihood increases to 12 percent for those who have been arrested (Figure 2). These results refute the claim that arrests have weak consequences and are therefore ineffective in addressing domestic violence.

POLICY CONCLUSION

Our study offers evidence supporting the role of arrests in disrupting the repetitive pattern of domestic violence. These findings counter recent propos-

als advocating for the complete decriminalization of domestic violence. Instead they propose that, in our context, an effective police response involves lowering the threshold for arrests and taking resolute measures against perpetrators. It is important to note, however, that our results should not be extrapolated to imply that arrests should be the default response in every case and every setting. For instance, in countries with high arrest rates, the balance may have shifted excessively in the other direction.

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September 12

Can Economic Growth and Ecological Sustainability Coexist?

Is long-term economic growth compatible with ecologically sustainable development? This question stands as one of the most debated issues of our time. Over the past decades, growth driven by economic liberalization and globalization has brought prosperity to billions and reduced global poverty. However, this positive trajectory has come at a high cost to the environment and the depletion of natural resources.

July 06

Four-Day Work Week? No Longer in Keeping with the Times!

Debates about the number of working days per week are nothing unusual in Germany. In the 1950s, the six-day week was the norm until the unions pushed through the reduction of working hours with the slogan “On Saturday, daddy belongs to me.” After many decades in which the five-day week was the norm, Germany and other countries are now intensively discussing the introduction of a four-day week.

June 19

The German Economic Model – Decline or Second Economic Miracle?

What is the future of Germany’s economic model? The Russian attack on Ukraine has triggered a debate about the further development of prosperity in Germany. There are growing concerns about economic decline. Rising energy prices, the high costs of climate protection, an increase in geopolitical conflicts, and a shrinking workforce could put an end to the successes of the German economic model.

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