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Soft governance against superbugs: How effective is the international regime on antimicrobial resistance?

Mirko Heinzel[1,2] · Mathias Koenig-Archibugi[2]

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Abstract

Antimicrobial resistance (AMR) and the declining effectiveness of antibiotic medicines due to misuse are among the biggest threats to global health and a major challenge for global governance in this century. Since drug-resistant bacteria spread easily across borders, government policies that exacerbate or mitigate AMR affect other countries. International organizations and governments addressed the global public good of maintaining antimicrobial protection by creating a soft governance regime largely devoid of legally binding rules and enforcement mechanisms. This article presents a cross-national empirical assessment of the effectiveness of the international AMR regime combining novel data on national action plans and data on antibiotic consumption in 191 countries between 2000 and 2018. We find that the regime sets ambitious goals and achieves broad participation, substantial implementation, and meaningful change in the use of antibiotics. The involvement of the largest consumers of antibiotics has been crucial for both effectiveness and equity.

Keywords International regimes · Regime effectiveness · Soft law · World Health Organization · Global health · Antimicrobial resistance · Antibiotics

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✉ Mathias Koenig-Archibugi
m.koenig-archibugi@lse.ac.uk

Mirko Heinzel
m.n.heinzel@lse.ac.uk

1 University of Glasgow, Glasgow, Scotland

2 London School of Economics and Political Science, London, UK

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1 Introduction

Safeguarding the effectiveness of antibiotics is one of the biggest challenges for global governance in the twenty-first century. Antimicrobial resistance (AMR) happens when microorganisms such as bacteria, viruses, and fungi evolve to become resistant to antimicrobial medicines. AMR is accelerated by the use, and especially the overuse and misuse, of antibiotics in health care and farming. It also worsens through insufficient access to sanitation, clean water, and infection control, increasing its prevalence in low-income countries (Savoldi et al., 2019). Scientists warn that AMR could lead to a future without effective antibiotics. It directly caused 1.27 million deaths and was associated with a further 3.68 million deaths in the year 2019 (Murray et al., 2022). The death toll includes 214,000 newborns killed each year by blood infections caused by resistant pathogens (Laxminarayan et al., 2016). Experts estimate that, in the absence of remedial action, AMR would lead to 10 million annual deaths by 2050, cause an additional 24 million people to become extremely poor, and bring about a global cumulative GDP loss in the order of US$85 trillion during 2015–50 (Ahmed et al., 2018; Review on Antimicrobial Resistance, 2016).

Drug-resistant bacteria spread easily across borders (Abd El Ghany et al., 2020; Bokhary et al., 2021; Frost et al., 2019). Hence, government policies that exacerbate or mitigate AMR profoundly affect other countries. Maintaining antimicrobial protection is a global public good (Sandler & Arce, 2002). Producing the good involves two types of costs: the cost of developing new antibiotics and the cost of conserving the efficacy of existing antibiotics, which requires fundamental changes in the way they are used in health care and agriculture. Antibiotics have become an integral part of the meat production process, and agriculture lobbies in many countries succeeded in preventing legislation that would restrict antibiotic use in livestock and poultry production (Kahn, 2016). Opposition to the regulation of antibiotic use in humans has been less organized, but highly decentralized antibiotic prescription and sales systems make regulation, monitoring, and enforcement very challenging. Health professionals can refuse to cooperate with attempts to restrict their discretion in prescribing and selling antibiotics for various reasons. Physicians commonly prescribe antibiotics inappropriately due to patient pressure and concerns about complications from “missed” bacterial infections, which may lead to lawsuits (Stivers, 2007). Financial incentives also play a role in many health systems, as the revenues of doctors, pharmacists, hospitals, and other formal and informal health providers are affected by the volume of prescriptions and sales (Blaser et al., 2021; Kahn, 2016; Kotwani et al., 2021; Lin et al., 2020). Interventionist governments face the cost of devoting scarce financial and administrative resources to building and running a complex system for the surveillance and enforcement of a dispersed industry as well as the political cost of discontent with that regulatory system. The benefits of new antibiotics can be excludable if developers are willing and able to enforce intellectual property rights. But no one can be excluded from the benefits of action aimed at conserving the efficacy of existing antibiotics. The relationship between the drivers of resistance and the externalities they produce shows that the domestic and international dimensions of AMR are intimately connected.

This pattern of costs and benefits means that AMR prevention is prone to be undersupplied if governments are left to address the issue unilaterally (Baekkeskov et al., 2020, 2023; Laxminarayan, 2016; Rönnerstrand et al., 2022; Smith & Coast, 2003). To overcome this cooperation problem, governments and international organizations have responded to the growing threat of AMR by creating an international regime based on "soft" governance instruments: guidelines that are not legally binding and involve low delegation of monitoring functions and no adjudication functions (Abbott et al., 2000). The regime lacks both enforcement mechanisms and regular funding for country implementation. Some experts consider this system insufficient to tackle the problem of AMR and advocate higher levels of legalization, notably the adoption of a binding international treaty (Hoffman et al., 2019a), and there is an ongoing debate about whether and how the international AMR regime should be reformed (Baekkeskov et al., 2020; Pitchforth et al., 2022; Rochford et al., 2018; Rogers Van Katwyk et al., 2020; Weldon et al., 2022).

We argue that pessimism about the global soft governance regime to combat AMR is premature. In a first step, we present a theoretical framework specifying the conditions under which international cooperation effectively promotes global public goods. We draw on theoretical building blocks developed by political science, a discipline that has devoted very little attention to AMR.[1] To be effective, international regimes must achieve three things simultaneously: they must demand ambitious policy commitments from governments, attract the participation of all essential countries and achieve a thorough implementation of the commitments that have been made (Barrett, 2008). In principle, this "ambition-participation-implementation triad" could be a "trilemma": it may be possible to achieve any two of those objectives, but only at the expense of the third. However, we hypothesize that the mix of state preferences and institutional design enables the AMR regime to largely avoid the trilemma and achieve progress on all three elements of the effectiveness triad. We expect the non-binding nature of ambitious commitments to encourage participation, and we predict that the included coordination and monitoring provisions increase governments' willingness to put those commitments into action within their territories. Formal enforcement mechanisms should not be necessary to ensure implementation because governments do not have incentives to defect once they receive reassurance that most other states are acting as well. However, we also expect that the absence of regular funding mechanisms embedded in the global AMR regime limits its ability to promote national implementation in countries with low bureaucratic capacity.

In a second step, we empirically test these hypotheses by providing the first systematic cross-national analysis of the effectiveness of the global AMR regime. This is an urgent task since, as a recent analytical overview of international AMR policies

[1] Out of over 990,000 peer-reviewed articles listed in the Worldwide Political Science Abstracts, only five mention "antimicrobial resistance" in the abstract (as of February 19, 2021). For comparison, 4923 abstracts mention "climate change". Those numbers do not include articles published by political scientists in interdisciplinary journals, sometimes as members of multidisciplinary teams. See also Frid-Nielsen et al. (2019).

has summed up the state of knowledge, "it remains unclear what impact the extension of international AMR governance has had at the national and regional levels" (Overton et al., 2021, p. 10). In line with our hypotheses, we find that the Global Action Plan on Antimicrobial Resistance (GAP) issued by the World Health Organization (WHO) in 2015 prompted widespread adoption of national action plans, that those plans are being implemented in most countries, that implementing national action plans is associated with reduced human use of antibiotics, especially in countries with higher per-capita use, and that countries' ability to implement the actions they have committed to is linked to their bureaucratic capacity.

These findings are relevant to the debate on reforms of the AMR regime. Most states have committed themselves to take action, and we found little evidence of *voluntary* defection from such commitments. By contrast, we found that bureaucratic capacity matters for AMR policy implementation. As we note at the end of the article, this finding suggests that the main advantage of a legally binding treaty on AMR over the current institutional design might be the formalization of an obligation of high-income countries to support the capacity of low-income countries and to share the associated financial burden. In contrast, the value-added of formalization in deterring voluntary defection from national conservation measures seems more doubtful.

Our research also has broader relevance beyond debates on global health governance. In recent decades, soft governance institutions have become more popular tools than traditional international law and treaties to address global problems (Pauwelyn et al., 2014; Reinsberg & Westerwinter, 2021; Roger & Rowan, 2022; Vabulas & Snidal, 2021). While some scholars point at the potential advantages of non-binding agreements and informal international organizations in providing effective solutions to global problems, others are more skeptical (Abbott & Faude, 2021; Morin et al., 2019; Roger, 2020; Vabulas & Snidal, 2013). Compared to the literature on the effectiveness of international treaties (Hoffman et al., 2022), less is known about the actual impact of such soft institutions on the problems they are supposed to address, with few studies examining the question systematically (e.g., Böhmelt & Pilster, 2010; Köppel & Sprinz, 2019; Tveit & Tørstad, 2023). We contribute to this debate by developing an analytical framework to understand the effectiveness of the global regime to counter AMR and by testing the effectiveness of a soft governance regime in this important case. In the concluding section, we briefly discuss the implications of our findings for the broader debate on the effectiveness of international soft governance.

2 History and contours of the global AMR regime

Antibiotics have been used since the 1940s and concerns about AMR are nearly as old. Alexander Fleming concluded his Nobel Prize acceptance speech in 1945 by warning that negligent use of the substance he discovered, penicillin, could change the nature of microbes and make them resistant to the drug (Podolsky, 2015, p. 143). The global nature of AMR became evident to doctors in 1953, when an epidemic of penicillin-resistant Staphylococcus aureus spread globally and caused mastitis in breastfeeding mothers worldwide (Gradmann, 2013, p. 560). The WHO's engagement with AMR conforms to a "punctuated equilibrium" pattern, as detected in the policy process of various international organizations (Lundgren et al., 2018). The WHO provided a forum for international discussions on AMR among antibiotics experts between the late 1950s and early 1970s, but these discussions did not produce coordinated action across borders (Gradmann, 2013). AMR reacquired salience on the WHO agenda in the late 1990s, and in 2001 the organization published a Global Strategy for Containment of Antimicrobial Resistance, but this remained an "abortive call for action" (Overton et al., 2021, p. 4). Global action on AMR received a boost in 2015 when the WHO adopted the GAP, which was endorsed by FAO and OIE. The GAP received political backing in 2016 from a Political Declaration adopted by the United Nations following a high-level meeting on AMR of its General Assembly.

The GAP was designed to provide fresh impetus to anti-AMR activities worldwide and to consolidate the One Health principle, whereby human, animal, and plant health are treated as interconnected and needing a coherent governance framework (Hannah & Baekkeskov, 2020). The World Health Assembly urged states "to implement the proposed actions for Member States in the global action plan on antimicrobial resistance, adapted to national priorities and specific contexts" (WHO, 2015b, p. 18), but it did not create a treaty with binding obligations for ratifying states. The AMR regime is a clear instance of soft governance, as its prescriptions are legally non-binding, involve low delegation of monitoring and no delegation of adjudication functions, and are not supported by enforcement mechanisms (Abbott et al., 2000). This institutional design is typical of global health initiatives, where few legally binding treaties exist (Hoffman et al., 2019b; Worsnop, 2017).

The GAP prescribes a broad set of costly actions that states should perform, but it does not specify quantitative targets they should aim for. The actions fall under five strategic objectives: improvements in awareness and understanding of AMR; improvements of knowledge and evidence through surveillance and research; reductions of infection through sanitation, hygiene, and infection prevention; optimizing the use of antimicrobial medicines in human and animal health; and increased investment in new medicines, vaccines, and other interventions. Under the GAP-centered regime, states are expected to submit periodic self-assessments based on a standardized questionnaire, whose results are published online (WHO-FAO-OIE, 2022). States also regularly report AMR data to the WHO-led Global Antimicrobial Resistance and Use Surveillance System. The process is managed by a joint secretariat provided by WHO, FAO, and OIE.

3 Theory and hypotheses

To be effective in producing transnational public goods, international regimes must meet three conditions simultaneously: they must demand action that would lead to substantial progress towards reaching the goals of the regime, they must ensure the participation of all countries or at least those whose contribution is most essential, and they must achieve a thorough implementation of relevant commitments (Barrett, 2008). Meeting all three conditions simultaneously can be very difficult. In cases where many states join and comply, this may be because the regime expected very little from them (Downs et al., 1996). If states expect to have to put ambitious commitments into practice, they may decide not to make them in the first place (Bernauer et al., 2013; Spilker & Koubi, 2016). If an ambitious regime attracts broad participation, this may be because many adopters do not expect to invest substantial resources to implement it fully (Hironaka & Schofer, 2002).

The difficulty of achieving all three conditions at the same time has led some analysts to ask whether the production of global public goods involves a trilemma, or "impossible trinity": any two, but only two, conditions for effectiveness can be met at the same time (Dimitrov et al., 2019; Tørstad, 2020). International institutional design can be conceived as an attempt to push the boundaries of political feasibility and achieve the best possible mix of ambition, participation, and implementation.[2]

In the following, we explain why we expect the AMR regime to be largely successful in avoiding the trilemma and achieving progress on all three elements of the ambition-participation-implementation triad. Our expectation centers on *the specific mix of state preferences and institutional design features* that underpins the regime, while considering also *bureaucratic capacity* constraints that can affect implementation. We first present the theoretical logic and then show how it applies to the case of AMR.

Building on collective action theory, we posit that international regimes typically face three types of actors: unconditional noncontributors, unconditional contributors, and conditional contributors (Buchholz & Sandler, 2021; Hale, 2020; Martin, 1992; Marwell & Oliver, 1993; Taylor, 1987). Unconditional noncontributors are states who would never contribute to a global public good voluntarily unless they face side payments or sanctions. By contrast, unconditional contributors always contribute. Conditional contributors would contribute to the global public good, provided that enough other actors are also contributing. The group of conditional contributors can be quite diverse in their cooperation thresholds, i.e., the proportion of other actors that need to contribute to make them prefer contributing to not contributing. This diversity of orientations has important implications for the success of cooperation. Initial moves by unconditional contributors may be sufficient to prompt some conditional contributors to join the action. The result can be a snowball effect, where more and more conditional contributors are satisfied with the number of cooperating actors and start cooperating as well (Granovetter, 1978). Finally, the proportion of cooperators may grow large enough to put unconditional contributors under material and moral pressure to follow suit. But even if the snowballing process does not flip all actors from noncooperators to cooperators, the number of contributors may grow enough to reach a critical mass sufficient to produce what can be considered an acceptable level of the public good (Marwell & Oliver, 1993).

[2] Of the elements of the triad, only the level of ambition can be directly determined at the institutional design stage. While institutional designers can specify membership rules and enforcement mechanisms (if any), actual participation and actual implementation ultimately depend on decisions made by each state.

How much of a public good will be provided in any given circumstance depends on actor types, benefits, and institutional context. The first factor is the proportion of actors that belong to each of the three types: a higher proportion of conditional and (especially) unconditional contributors facilitates high provision. The second one is whether contributing entails selective benefits for contributors (Buchholz & Sandler, 2021; Hale, 2020). The third factor is the institutional context where the actors find themselves, which we discuss more closely in the following.

As International Relations scholars often note, global cooperation cannot rely on a world government with the authority to compel other actors to contribute to public goods—it is "cooperation under anarchy" (Oye, 1986). The early literature on international regimes focused on their ability to promote cooperation by providing information to states, thereby facilitating reciprocity strategies in response to cooperation or defection by other states (Axelrod & Keohane, 1985; Keohane, 1984; Oye, 1985). Later literature added important dimensions (Simmons, 2010), of which we highlight three. The first is that the deficit of compliance with international agreements is not always voluntary—it can also result from capacity constraints (Chayes & Chayes, 1995; Tallberg, 2002). The second dimension relates to the influence of competing domestic constituencies on governments' compliance decisions (Dai, 2005). The third dimension concerns the form of the commitments made by states and, specifically, whether they generate a legal obligation (Abbott et al., 2000; Abbott & Snidal, 2000).

The question of the legal status of the international regime highlights the potential for trade-offs discussed earlier. Current scholarship on international cooperation expects *participation* to be higher in international regimes based on soft governance compared to legally binding obligations enshrined in an international treaty (Spilker & Koubi, 2016). This is mainly because soft governance regimes are typically "low-cost institutions" (Abbott & Faude, 2021). Specifically, soft governance institutions tend to have lower transaction costs (fewer diplomatic formalities and less intensive bargaining), domestic approval costs (avoiding hurdles like high-level executive clearance and legislative approval), operating costs (salaries and offices), change costs (modifying features in response to changed conditions or preferences), exit costs (including diminished reputation for reliability) and sovereignty costs (loss of discretionary authority) (Abbott & Faude, 2021). These lower costs increase the likelihood of participation by making policy-makers more willing to create or join them and by placing fewer hurdles along the way. Due to these benefits, informal rule-making has proven more popular among states than formal treaty-making during the past two decades—in health and a variety of other issue areas (Pauwelyn et al., 2014; Reinsberg & Westerwinter, 2021; Roger & Rowan, 2022; Vabulas & Snidal, 2021; Westerwinter, 2021). By contrast, the trend towards increased delegation observed in formal intergovernmental organizations since 1950 stopped in the 2010s (Lenz et al., 2022).

Conversely, it is often thought that governments are more likely to *implement* commitments made under a hard law regime, since violations of binding agreements can expose governments to costly litigation and censure by judicial bodies, and they are more likely to undermine a government's international reputation, trigger enforcement measures and attract domestic audience costs than noncompliance with soft commitments (Köppel & Sprinz, 2019, pp. 1863–1865). This view highlights a potential trade-off between the elements of the effectiveness triad. If the choice for soft governance with ambitious demands ensures wider participation, it may do so at the expense of implementation.

We argue that such a trade-off in institutional design does not need to materialize when state preferences are favorably distributed, specifically when a relatively high proportion of conditional cooperators are present. Under such conditions, all three elements of the triad become achievable. First, the regime can be *ambitious* in the sense of soliciting demanding commitments. Ambition corresponds to what Downs et al. (1996) called "depth":

> "the depth of an agreement refers to the extent to which it captures the collective benefits that are available through perfect cooperation in one particular policy area. Given the difficulties involved in identifying the cooperative potential of an ideal treaty, it is most useful to think of a treaty's depth of cooperation as the extent to which it requires states to depart from what they would have done in its absence" (Downs et al., 1996, p. 383).

We consider an agreement ambitious when it requires countries to change their policies and perform actions that would substantially contribute to reaching the agreement's goal (Barrett, 2008, p. 243).[3] Unconditional noncontributors will be wary about joining ambitious regimes if they believe they must honor their commitments. By contrast, unconditional and conditional contributors generally prefer regimes to be ambitious, all else being equal, but for the latter group it also matters who else participates.

Second, an institutional design that combines non-binding commitments with monitoring mechanisms can lead to high levels of *participation* because it facilitates the snowballing dynamic discussed earlier. The launch of the regime signals to states that a wave of commitments is imminent or underway, and monitoring mechanisms help them ascertain whether this wave has materialized. This signal is especially important for conditional contributors, who seek reassurance that a sufficiently large proportion of other states are also joining. For conditional contributors, the non-binding nature of the regime mitigates the risk of joining: even if they join and others do not, they still retain the option of reneging on their commitments without incurring high costs, at least compared to the consequences of violating international law.

Finally, monitoring mechanisms in regimes promote *implementation* by helping governments to obtain information on whether other states have put their commitments into practice. For states that are conditional contributors, as opposed to free-riders, reassurance of widespread implementation is sufficient to ensure their

[3] Note that we treat the ambition of an international agreement as conceptually distinct from its legal bindingness. Scholars have interpreted agreements as ambitious hard law (e.g. the Montreal Protocol), ambitious soft law (e.g. the Financial Action Task Force Money laundering recommendations), unambitious hard law (e.g. the Kyoto Protocol), and unambitious soft law (e.g. the Plan of Action of the United Nations Forum on Forests) (Barrett, 2008; Dimitrov, 2020; Gonzalez et al., 2015; Morse, 2019).

own sustained cooperation, provided that they have the capacity to do so. To facilitate a snowballing dynamic, an international institution needs to enable conditional contributors to assess whether enough other countries are taking action to make it worthwhile for them to do the same. By contrast, the typical functions of hard law—raising the international and domestic cost of non-implementation by defining it as a breach of international law and legitimizing retaliatory measures—are less important when the number of unconditional noncontributors is low, and the number of conditional contributors is high.

Our focus so far has been the *choice* between implementation and abstaining from it. An influential strand of research on international regimes has emphasized that compliance is not only a matter of choice, but also of capacity (Chayes & Chayes, 1995). Accordingly, the analysis of regime effectiveness should consider both voluntary and non-voluntary sources of implementation deficits.

We now apply this framework to the global AMR regime. As a first step, we explain why we should expect the proportion of conditional contributors to be high in this case. This expectation is based on two features of the global AMR situation. First, levels of AMR prevalence vary considerably across countries. Higher prevalence is partly due to a larger volume of antibiotics used and a higher proportion of clinically inappropriate use of these antibiotics (Hendriksen et al., 2019; Savoldi et al., 2019). Hence, "[n]ational efforts to curb the abuse of antibiotics use domestically will prolong the lag phase of resistance beyond that determined by the least global effort to curtail this abuse" (Sandler & Arce, 2002, p. 212). Selective benefits generally mitigate the under-provision of public goods (Buchholz & Sandler, 2021; Hale, 2020).

Second, the selective benefits of acting against AMR make some countries unconditional contributors, but they are insufficient for other countries. An example of an unconditional contributor is the United Kingdom, which adopted a NAP early and started implementing it before any sign that other countries would follow suit (Hopkins, 2016). As we will show in the next section, most other countries acted only as part of a global cascade. The analytical framework suggests that, for each country, the benefit of protective measures increases if other countries implement them as well because it reduces the risk that the type of drug-resistant pathogen prevented domestically is imported from abroad sometime in the future (Abd El Ghany et al., 2020; Bokhary et al., 2021; Frost et al., 2019). AMR containment can be classified as a weaker-link public good (Sandler & Arce, 2002, p. 212).[4] Accordingly, policy-makers are sensitive to the AMR measures put into action by other governments (Rönnerstrand et al., 2022). Given that implementing changes in the use of antibiotics can entail substantial short- and medium-term economic and political costs, some governments will be ready to pay them only if they can be confident that a sufficiently large proportion of other governments are also taking action. In other words, attempts at countering AMR face a large share of conditional contributors.

[4] In contrast to weakest-link public goods, where the overall level of the public good depends only on the smallest contribution, in weaker-link situations the contributions above the minimum add progressively less to the overall level of the public good (Buchholz & Sandler, 2021).

This distribution of preferences has implications for ambition, participation, and implementation. Regarding *ambition*, the WHO reasoned that most member states would not be interested in having an "empty institution" (Dimitrov, 2020) and that it had the mandate to build a demanding regime. Hence, the GAP asks countries to implement thirty-one key actions to raise awareness, increase surveillance, reduce infection, optimize antimicrobial medicines use, and increase sustainable investment. For instance, the GAP requests the "development and implementation of national and institutional essential medicine lists guided by the WHO Model Lists of Essential Medicines, reimbursement lists and standard treatment guidelines to guide purchasing and prescribing of antimicrobial medicines, and regulation and control of promotional practices by industry" (WHO, 2015a, p. 17). Most states had not already implemented these actions at the time of the GAP's adoption (Podolsky, 2018).

We also expect the AMR regime to attain high levels of *participation*. The regime has all the features of a "low-cost institution", as defined by Abbott and Faude (2021), which are suited to attract broad participation. States can demonstrate their commitment to the regime by adopting NAPs that meet the demands of the GAP, but they do not need to fear that lack of implementation will incur penalties. They also have the freedom to adjust the content of their commitments in response to epidemiological, economic, and political development without having to wait for a formal multilateral renegotiation of the rules. Furthermore, the WHO provided a temporal focal point by requesting states to produce the NAP with a two-year deadline, and it publicized information on which states met that expectation.

We further envisage the AMR regime to achieve a high level of voluntary *implementation.* The regime is designed to provide exactly the information conditional contributors need to initiate implementation. The regime provides information on how many states have committed to act and to what extent they comply with those commitments. The GAP reduces ambiguity about what AMR action should consist of by providing a framework for the content of NAPs. The WHO, FAO and OIE collect and publishes NAPs, and states are expected to submit periodic self-assessment documents, whose results are published online (WHO-FAO-OIE, 2022). In sum, the regime promotes transparency and facilitates comparisons of commitments and implementation based on standardized reporting categories.

Based on these arguments, we formulate our first hypothesis:

> Hypothesis 1: The AMR regime effectively combines substantial ambition, broad participation, and high levels of voluntary implementation.

The argument so far has considered the potential lack of implementation that could derive from voluntary defection from commitments. As noted earlier in this section, unwillingness constitutes one of the main potential obstacles to implementation, the other being capacity constraints (Chayes & Chayes, 1995). Involuntary noncompliance due to low capacity is relevant to the case of AMR, because we should expect a state's administrative capacity to affect its ability to implement a NAP. Implementation involves a wide range of complex tasks requiring high degrees of coordination between multiple agencies and decision-making levels (Anderson et al., 2019). Many national administrations struggle to perform these tasks. For instance, Shabangu et al. (2023) interviewed 36 policymakers responsible for developing and implementing AMR NAPs in South Africa and Eswatini and documented significant capacity constraints to implementation. One South African health policy-maker reported that “There is a shortage of qualified microbiologist[s] in the state sector and experienced pharmacists with clinical pharmacy qualification to manage stewardship programs by providing rational antibiotic use interventions to reduce AMR” (Shabangu et al., 2023, p. 132). Similarly, many AMR policy-makers in Pakistan interviewed by Khan et al. (2020, p. 979) suggested that “doctors and the pharmaceutical and livestock industries may be too powerful for government agencies to enforce rules on; the latter was presented as under-resourced, poorly organized and lacking in authority to implement the existing regulations.” Lack of resources and expertise in national administrations is a recurring theme in case studies on the development and implementation of NAPs in other countries, such as Bangladesh, Benin, Brazil, Burkina Faso, Ghana, Kenya, Mali, the Philippines, and Tanzania (Ahmed et al., 2022; Corrêa et al., 2023; Frumence et al., 2021; Godman et al., 2022; Hein et al., 2022; Lota et al., 2022; Sariola et al., 2022; Song et al., 2022; WHO, 2022a, c cf. also Thomas & Lo, 2020).

Therefore, we expect implementation to be more challenging in countries with lower bureaucratic capacity.[5] Sandler and Arce (2002, p. 212) note that the effectiveness of international arrangements for producing weaker-link public goods such as AMR depends on the transfer of assistance from high-income to low-capacity countries. However, the regime does not guarantee financial or technical assistance, and international aid for building countries’ capacity to implement AMR policies is limited and episodic (Micah et al., 2023). Accordingly, we argue that the regime is less effective in removing obstacles to implementation due to capacity rather than willingness. Thus, we formulate our second hypothesis:

> Hypothesis 2: The AMR regime is less effective in achieving implementation when country-level bureaucratic capacity is low.

Finally, we test an observable implication of our argument that the AMR regime combines substantial ambition, broad participation, and high levels of voluntary implementation. If that is the case, we should expect considerable progress toward the outcome the regime is meant to attain (Barrett, 2008, p. 243). Specifically, we expect progress towards a key policy outcome that the GAP highlights: the “extent of reduction in global human consumption of antibiotics (with allowance for the need for improved access in some settings)” (WHO, 2015a, p. 17). Accordingly, we formulate our last hypothesis:

> Hypothesis 3: Implementing national action plans reduces human consumption of antibiotics.

[5] By contrast, low administrative capacity is less of an obstacle to participation because the GAP provides a template that low-capacity states can draw on in drafting their NAP (Munkholm et al., 2021; Rubin & Munkholm, 2022).

4 An empirical assessment of the global AMR regime

We hypothesized that the international regime against AMR effectively achieves high levels of participation, voluntary implementation—hindered mainly by low state capacity—and that the prescribed actions are sufficiently ambitious to induce substantial progress toward the regime's goals. In this section, we subject these hypotheses to empirical testing.

4.1 Participation in the global regime on AMR

The GAP is not an international treaty, and a country's decision to participate in the regime is not an act of formal ratification. Between 1998 and 2014, WHO resolutions and documents were limited to urging member states to take action to contain AMR. In 2015, the World Health Assembly made a more specific demand: member states should "have in place, by the Seventieth World Health Assembly [May 2017], national action plans on antimicrobial resistance that are aligned with the global action plan on antimicrobial resistance and with standards and guidelines established by relevant intergovernmental bodies" (WHO, 2015b, p. 18). Therefore, we interpret the *adoption* of a NAP as the way states commit themselves to the regime and as the primary indicator of participation. To assess the level of participation empirically, we collected data on NAP adoption from the WHO website (WHO, 2022b), the Global Database for the Tripartite AMR Country Self-assessment Survey (TrACSS) conducted periodically by the WHO, FAO, and OIE (WHO-FAO-OIE, 2022), as well as an online search for information on countries' national AMR strategies. The full list can be found in the supplemental material (Table A25).

Figure 1 displays the percentage of WHO member states that adopted NAPs before and after the GAP. Less than 15% of countries could be seen as unconditional contributors as they started developing NAPs without the assurance of global coordination. After the introduction of the GAP in 2015, the number of NAPs increased more than five-fold, and by 2021, 75% of countries had introduced NAPs to counter AMR.[6]

[6] The WHO asked for the NAPs to be "aligned with the global action plan" (WHO, 2015b, p. 18). To measure alignment, we construct a measure from responses submitted by national AMR authorities to the TrACSS. We calculate this indicator by taking the average across ten binary variables, each of which captures whether national policy covers one of ten critical actions recommended by the GAP. The ten actions relate to the following: (1) national monitoring system on consumption in human health, (2) national monitoring system on consumption in animal health, (3) national monitoring system on consumption in plan health, (4) national surveillance of AMR in humans, (5) national surveillance on AMR in animals, (6) infection prevention and control in human health care, (7) optimizing antibiotic use in humans, (8) optimizing antibiotic use in animals, (9) optimize antibiotic pesticide use, (10) adoption of AWaRe classification of antibiotics (which was not part of the 2015 GAP but was first introduced by the WHO in 2017). The indicator could, in principle, range from 0 (no critical action covered) to 1 (all critical actions covered). The actual range is from 0.4 to 1, with an average of 0.95. These empirical patterns indicate that the NAPs are broadly in line with the GAP and that the regime has attained high levels of participation not only in terms of country coverage but also in terms of substantive commitments.

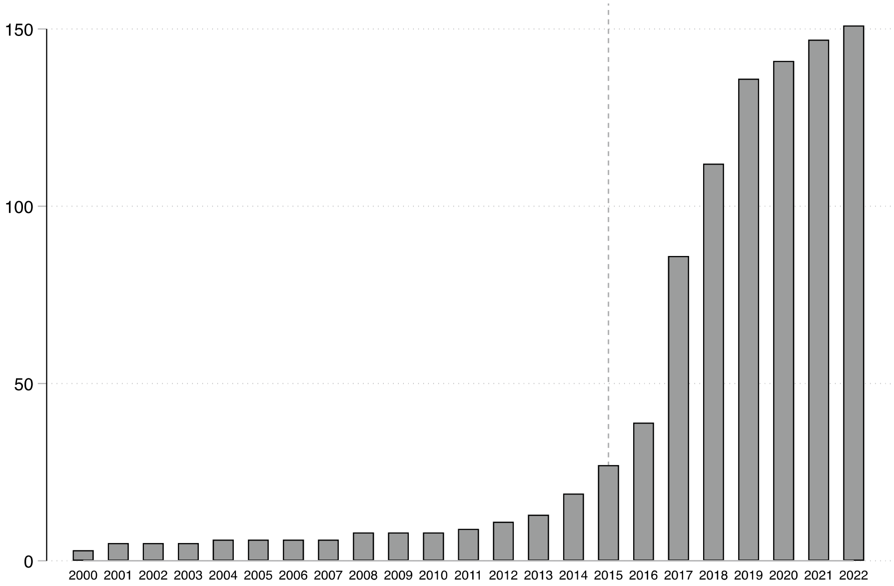

Fig. 1 Number of WHO member states that adopted a NAP between 2000 and 2022

We probe the drivers of NAP adoption more systematically using regression analyses, to help us assess the argument that the proportion of conditional contributors is large enough to create favorable conditions for an adoption snowballing effect. Our primary dependent variable is the adoption of a NAP, and our unit of analysis is the country-year. Since reversals do not occur, countries drop from the sample if they had a NAP the previous year. We estimate linear probability models with country fixed effects as maximum likelihood approaches would drop countries that never adopted a NAP. Standard errors are clustered at the country-level. We regress NAP adoption on two key independent variables to test the GAP-induced snowballing dynamic: a binary variable that is coded as one from 2015 onwards to estimate the impact of the GAP on the adoption of NAPs and a measure of peer influence that consists of the share of NAP adopters among all other countries in the focal country's WHO region.

To mitigate omitted variable bias, we include seven control variables. First, we control for a measure of bureaucratic capacity by using a variable from the V-Dem dataset that indicates the extent to which appointment decisions in the state administration are based on personal and political connections, as opposed to skills and merit (Coppedge et al., 2021). Second, we include a measure of the level of democracy since democracies tend to invest more in public goods, but they also offer more opportunities for opponents of policy change to slow down the process, and their leaders may be more reluctant to expose themselves to audience costs from non-compliance (Böhmelt & Butkutė, 2018). We use the electoral democracy index from V-Dem (Coppedge et al., 2021). Third, we account for the domestic political economy of healthcare systems by including a measure of government health expenditure as a share of total national health expenditure (Global Burden of Disease Collaborative Network, 2021). There is much evidence that the overuse of antibiotics is partly the result of economic incentives of doctors, pharmacists, hospitals, and other formal and informal healthcare providers (Blaser et al., 2021; Kahn, 2016; Khan et al., 2020; Kotwani et al., 2021; Lin et al., 2020), and such economic interests could be an obstacle to the adoption of a NAP. Finally, we control for GDP per capita (logged) and economic growth to account for crucial differences between countries in their access to antibiotics as well as population (logged) to adjust for differences in the size of countries' populations. All control variables are lagged by one year.

Table 1 displays the results from five models. In Models 1 and 2, we estimate the association of the GAP with countries' likelihood of adopting NAPs. Models 3 and 4 focus on the importance of regional peers. Finally, Model 5 includes both variables on the right-hand side of the equation. The regressions estimating the role of the GAP do not include year fixed effects since the GAP does not vary cross-sectionally. The regressions align with our theoretical expectations. Every year under the GAP increases countries' likelihood of adopting a NAP by

Table 1 Predicting NAP adoption

	(1)	(2)	(3)	(4)	(5)
Global Action Plan	0.1785***	0.1662***			0.0838***
	(0.0121)	(0.0153)			(0.0172)
Adoption by regional peers			0.3170*	0.3551+	0.6533***
			(0.1303)	(0.2026)	(0.1249)
Population (log)		0.0091		0.0023	0.0496
		(0.0433)		(0.0758)	(0.0488)
Government expenditure as a share of total health expenditure		0.0244		0.0430	0.0715
		(0.0759)		(0.0812)	(0.0824)
Bureaucratic capacity		0.0280+		0.0284	0.0306
		(0.0169)		(0.0183)	(0.0188)
GDPpc (log)		0.0892***		0.0802**	0.0521*
		(0.0210)		(0.0287)	(0.0253)
Economic growth		-0.0450		-0.0467	-0.0311
		(0.0309)		(0.0367)	(0.0345)
Democracy		-0.1045+		-0.0691	-0.0722
		(0.0621)		(0.0679)	(0.0690)
Antibiotic consumption		-0.0004		-0.0020	-0.0016
		(0.0022)		(0.0027)	(0.0023)
Country fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	No	No	Yes	Yes	No
Observations	3593	2567	3399	2567	2567
R^2	0.198	0.173	0.257	0.280	0.218

Country-clustered standard errors in parentheses; $^{+}p<0.1$, $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

between 8% and 18%, depending on the model specification ($p < 0.01$). Furthermore, countries appear to care about what their regional peers do. The estimations presented in Table 1 show that a 10% increase in the share of regional peers with NAPs is associated with a 3–6% increase in the likelihood that a country will develop a NAP in the next year. Together, these results indicate that the global AMR regime led to snowballing in the adoption of NAPs and the widespread participation of countries globally. This finding is consistent with our argument that the regime faces a substantial number of conditional contributors.

4.2 The implementation of commitments to address AMR

NAPs need to be implemented to make a meaningful difference against AMR. Our measure of implementation is based on TrACSS responses about the country's progress with developing a national action plan on AMR. Possible responses are: (a) the country has no NAP, (b) a NAP is being developed, (c) a NAP has been adopted, (d) a NAP was approved, budgeted, is aligned with GAP objectives and has an operational plan, and (e) a NAP was approved, has funding, involves relevant sectors, and monitoring and evaluation is in place. We coded the implementation variable as one from when countries answered either (d) or (e) for the first time. For the few countries with a NAP before 2016, we combined information from their first survey with online searches to identify their first known implementation date.[7]

We find that implementation is now widespread. 111 out of 159 countries with an adopted NAP scored one on the implementation variable in 2022. Furthermore, they cover most of the human antibiotic consumption globally. We use data from the most comprehensive effort to estimate human antibiotic consumption to date (Browne et al., 2021). Figure 2 shows that countries implementing NAPs accounted for 90% of the global consumption of antibiotics in 2015. These findings indicate that the achievement of high participation has not come at the expense of implementation, in line with our Hypothesis 1.

Our argument posited that the regime should minimize lack of implementation due to an unwillingness to implement, but also that implementation may still be hampered by capacity constraints. For instance, the NAP adopted by Cameroon in 2018 was scheduled to be implemented by 2020, but implementation did not occur. Amin et al. (2021, p. 1231) identified several problems with national planning in Cameroon: "There was no timeline of activities set per year, the chronology of activities was not consistent, there were no activities or objectives to ensure the sustainability of the National Action Plan like creating awareness on antimicrobial resistance and the indicators for impact evaluation were not included… there was no clear source of funding, and stakeholders at the primary level of the various sectors responsible for implementation were not clearly defined." Similarly, a study of the

[7] We coded implementation as 0 if a country did not indicate implementation in the first tripartite survey they answered in 2016-17. For all NAPs that were adopted before 2016, we conducted online searches for academic articles, official evaluations or other official sources that indicate when actions towards implementation were taken and code the implementation year accordingly.

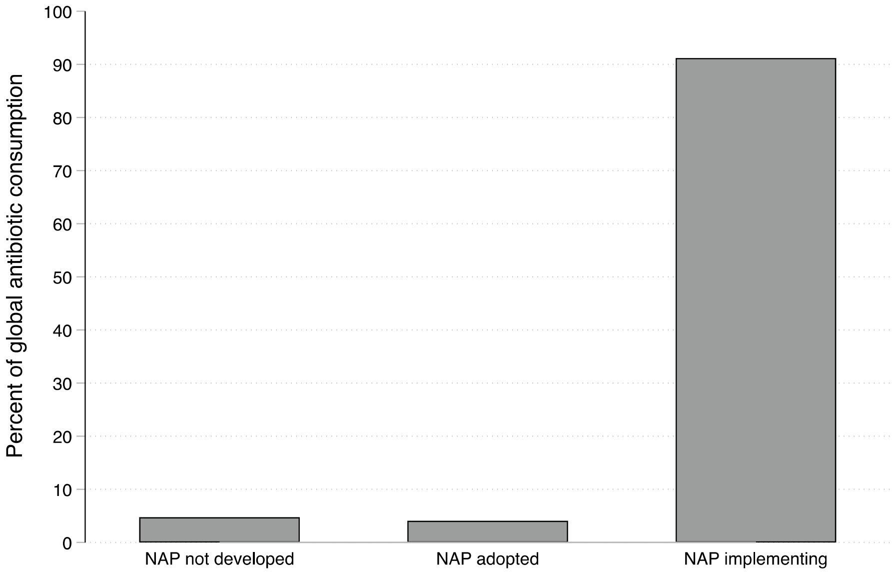

Fig. 2 Percent of global human antibiotic consumption (in 2015) for different groups of countries

implementation process in Benin and Burkina Faso noted "the lack of resources and initiative from institutional bodies responsible for the implementation of the NAP" (Sariola et al., 2022, p. 4).

We test Hypothesis 2 on bureaucratic capacity in the models presented in Table 2. We employ three main independent variables in these models. First, we use our measure of bureaucratic capacity based on Coppedge et al. (2021) because lower-skilled officials will find it more challenging to perform the complex tasks involved in implementing NAPs (Anderson et al., 2019). Second, we include per-capita antibiotic consumption as a proxy for potential free-rider incentives. The logic of our argument implies that free-rider incentives should be less important drivers of implementation than capacity constraints. We assume that if governments were to expect benefits from free-riding, such benefits would be higher when the costs of acting against AMR are higher. These costs are higher for countries with high per capita consumption of antibiotics since countries with lower consumption need to do less to align their practices with internationally accepted scientific standards for antibiotic use. Third, we again include a measure of the behavior of regional peers—in this case, the share of all other countries in the same WHO region that have started implementing their NAPs.

We estimate a set of OLS models to predict whether countries have started implementing NAPs as of 2022. NAPs seldom vary between years and, therefore, we estimate cross-sectional models. Table 2 presents the results from four models, including the control variables mentioned in the analysis of adoption. Model 6 focuses on antibiotic consumption, Model 7 on bureaucratic capacity, Model 8 on regional peers, and Model 9 includes all three key independent variables. The results again align with our main theoretical expectations. First, weak bureaucratic

Table 2 Implementation of NAPs

	(6)	(7)	(8)	(9)
Antibiotic consumption	0.0111*			0.0075*
	(0.0038)			(0.0020)
Bureaucratic capacity		0.0847+		0.0630*
		(0.0403)		(0.0209)
Implementation by regional peers			0.5881*	0.4019*
			(0.1469)	(0.1298)
GDPpc (log)	0.0681	0.0707	0.0812	0.0516
	(0.0566)	(0.0619)	(0.0529)	(0.0552)
Democracy	0.1677	-0.0496	0.2617	0.0810
	(0.2188)	(0.2242)	(0.2132)	(0.2082)
Economic growth	-0.6081	-0.9394+	-0.4896	-0.6721
	(0.4287)	(0.3930)	(0.3819)	(0.3829)
Government expenditure as a share of total health expenditure	-0.3715	-0.3535	-0.3969	-0.4403
	(0.3253)	(0.2884)	(0.2819)	(0.2923)
Population (log)	0.0847+	0.0819	0.0849+	0.0771+
	(0.0399)	(0.0407)	(0.0400)	(0.0379)
Constant	-0.7345	-0.1377	-1.1964	-0.5360
	(0.6153)	(0.7331)	(0.6311)	(0.6599)
Observations	169	169	169	169
R^2	0.181	0.179	0.197	0.212

Region-clustered standard errors in parentheses; $^{+}p<0.1$, $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

capacity appears to hold back the implementation of NAPs. Second, potential free-rider incentives are not associated with lower NAP implementation—on the contrary, countries that consume more antibiotics appear more likely to implement NAPs. Third, we again find evidence for a snowballing dynamic: countries appear more likely to implement their NAPs when more regional peers have also done so. These results lend evidence to our proposition that many countries are conditional contributors and, hence, that capacity constraints are more important for implementation than free-rider incentives.

4.3 The effectiveness of NAPs in reducing antibiotic consumption

The ambition of the GAP has not deterred most countries from participating in the regime. But was it enough to induce substantial progress towards a key goal of the GAP: reducing antibiotic consumption? In our assessment of whether NAPs contributed to achieving that goal, our dependent variable is the consumption of antibiotics in DDD per 1000 population per day (Browne et al., 2021). The unit of analysis is the country-year, and our sample includes 191 WHO member states between 2000 and 2018—the years for which data on antibiotic consumption is available. We estimate a set of two-way fixed-effects (TWFE) regressions that model whether the adoption or implementation of NAPs is associated with countries' per capita consumption of antibiotics. Our empirical approach builds on recent advances in the literature on the effects of development finance (Isaksson & Kotsadam, 2018; Knutsen et al., 2017). Specifically, we leverage the fact that NAPs are often adopted and implemented in different years and compare the antibiotic consumption in countries where NAPs are currently implemented and the antibiotic consumption in countries where NAPs have been adopted but not yet implemented. Our primary independent variable is a dummy that indicates whether a NAP has been implemented. We include a second binary variable coded as one if a country has adopted a NAP but has not started implementing it (yet). By comparing the estimates from these two coefficients, we can grasp how antibiotic consumption changed after NAP adoption and after NAP implementation.

Table 3 presents the results from four models regressing antibiotic consumption on NAP implementation. Model 10 only includes our primary variable of interest. Model 11 further includes the NAP adoption-without-implementation variable and

Table 3 National action plans and antibiotic consumption

	(10)	(11)	(12)	(13)
NAP implementation	-1.1195*	-1.1876**	-0.9129***	-0.3558*
	(0.4612)	(0.4170)	(0.2664)	(0.1638)
NAP adoption without implementation		-0.0578	-0.2140	-0.1501
		(0.3403)	(0.2630)	(0.1576)
Population (log)		3.1097+	-4.0789	-1.6474
		(1.8372)	(3.3816)	(1.4221)
Government expenditure as a share of total health expenditure		1.1546	1.2359	0.3634
		(1.6474)	(0.9881)	(0.5113)
Bureaucratic capacity		-0.7197	-0.0913	0.0540
		(0.5793)	(0.2137)	(0.1197)
GDPpc (log)		0.9741	0.9499*	0.0552
		(0.7279)	(0.4284)	(0.2091)
Economic growth		-0.1407	0.4028	0.4429+
		(0.6226)	(0.3747)	(0.2296)
Democracy		3.6160	0.4935	-0.2310
		(2.6730)	(0.7961)	(0.4009)
Lagged DV				0.6604***
				(0.0461)
Country fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Country-specific time trends	No	No	Yes	Yes
Observations	3629	2816	2816	2816
R^2	0.924	0.940	0.984	0.991

Country-clustered standard errors in parentheses; $^+p<0.1$, $^*p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

the other control variables. In Model 12, we also include country-specific linear time trends to ensure that the results are not affected by long-term changes in each country—towards antibiotic access or stewardship—that could also drive NAP adoption or implementation. Finally, in Model 13, we further include a lagged dependent variable to adjust for different levels of antibiotic consumption. The estimates indicate that NAP implementation is associated with a substantial reduction in antibiotic consumption. The coefficient is statistically significant at conventional thresholds ($p < 0.05$ or lower) and substantial in size. They imply that every year of NAP implementation is associated with approximately a 5% decrease in antibiotic consumption.[8] NAP adoption without implementation, by contrast, does not seem to be associated with reductions in antibiotic consumption. Equivalence tests show that NAP implementation is significantly different from NAP adoption at $p < 0.05$ in all four models.

The results support the statement that the AMR regime is making a difference. But can we expect a 5% average yearly difference to be enough to address the global overconsumption of antibiotics? Unfortunately, there is no globally agreed-upon optimal level of antibiotic consumption against which the performance of the AMR can be compared. In its absence, we rely on a widely discussed article by AMR policy specialist Ramanan Laxminarayan and several co-authors as a first approximation of an AMR consumption goal. They proposed that no country consumes more than the current (2015) median global level (Laxminarayan et al., 2016, p. 874). Our sample's median per capita consumption in 2015 was 13.1 DDD per 1000 daily.

Our models would predict that assuming continuing current trends, approximately 60% of countries would consume less than 13.1 DDD per 1000 per day by 2030. However, if all countries that currently have adopted a NAP but have not started implementing it would do so, we would expect 75% of countries globally to have reached the goal of 13.1 DDD per 1000 per day. Since countries with NAPs cover over 90% of total global consumption, our estimates imply that the current regime will produce substantial and meaningful progress toward limiting antibiotic consumption if the early trends of the regime were to continue.

So far, we have assumed that a reduction in antibiotic consumption is progress towards achieving the goals of the GAP. An important consideration for the governance of antimicrobials is that while AMR is accelerated by overuse and misuse of antibiotics among some populations, other populations suffer from insufficient access to antibiotic treatments (Baekkeskov et al., 2020; Laxminarayan et al., 2016a). The GAP acknowledges this inequity: "The actions to optimize use of antimicrobial medicines and to renew investment in research and development of new

[8] Our estimate that NAP implementation leads to a decrease in consumption of approximately 5% every year is broadly in line with interrupted time-series analyses of the effect of Japan's adoption of a NAP in 2016, which is one of the few countries where the association has been estimated systematically. Kusama et al. (2021) estimate an antibiotic use reduction of 15.0% for total antimicrobials, 26.3% for cephalosporins, 23.5% for fluoroquinolones, and 24.6% for macrolides between 2013 and 2020 (but an increase of 17.4% for parenteral antimicrobials). Konishi et al. (2023) estimate an 1.9% annual decrease of (clinically often unnecessary) broad-spectrum antibiotics administration for mastitis following NAP adoption, accompanied by a 1.3% annual increase of first-choice antibiotics.

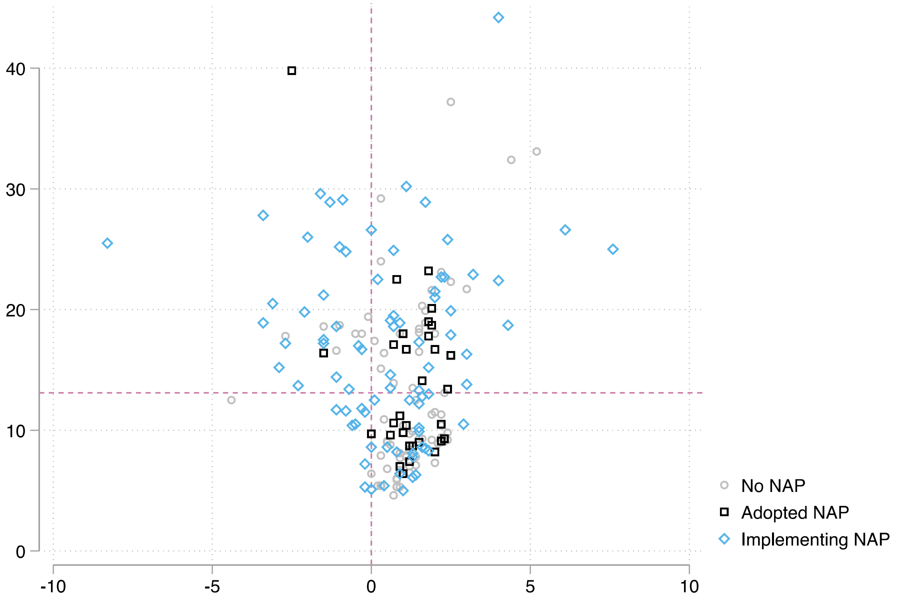

Fig. 3 Countries' change in antibiotic consumption 2015–2018. Note: the unit of measurement is daily defined doses per 1000 population per day

products must be accompanied by actions to ensure affordable and equitable access by those who need them" (WHO, 2015a, p. 2). The GAP can be seen as effective if high-consuming countries reduce their consumption but not necessarily if it were to further suppress access in countries where patients already lack access to antibiotics.[9]

Figure 3 illustrates the relationship between initial consumption levels and reduction since the GAP. The figure plots countries' 2015 antibiotic consumption (y-axis) and their cumulative change in antibiotic consumption in the years following the GAP (x-axis). The reference lines denote the antibiotic target formulated by Laxminarayan et al. (2016a, b) and zero cumulative change in consumption since the GAP. Countries that have not adopted a NAP are illustrated by light gray circles, countries that have a NAP but are not implementing by black squares, and countries that are implementing their NAP by blue diamonds. The figure shows that most countries under the 13.1 DDD goal have slightly increased antibiotic consumption since 2015

[9] The costs and benefits of global collective action can be shared in different ways, and each possible distribution can approximate diverse equity criteria to various degrees. Equity criteria proposed for global public goods include allocating costs in proportion to benefits, the ability to pay, developmental needs, and historical responsibility for generating the problem. While an in-depth analysis of alternative equity criteria is not possible here, we formulate a minimal requirement of equity—minimal in the sense that it is entailed by all plausible formulas for equitable burden-sharing. This criterion requires countries with higher per capita consumption of antibiotics to reduce antibiotic consumption more than countries with lower per capita consumption.

(bottom right quadrant). The figure further illustrates that most of the reduction in antibiotic use has been achieved by high-consumption countries (top left quadrant). At the same time, it also becomes apparent that several high-consumption countries have not meaningfully reduced their use (top right quadrant). Whether the GAP can induce these countries to reduce their antibiotic use in the coming years remains to be seen. Together, the patterns illustrated in Fig. 3 imply that a minimal requirement of equity—the international regime attains larger reductions in high-consumption countries while allowing people in low-consumption countries to increase their access to antibiotics—is met in the case of the global regime to fight antibiotic resistance.

The discussed equity constraint is a minimal criterion, and it is possible that more demanding requirements would not be met—for instance, a requirement for countries with historically high antibiotics consumption and, thus, larger cumulative contributions to AMR to shoulder the cost of global mitigation. While important, we leave the empirical assessment of alternative equity conditions to future studies.

4.4 Robustness checks

The Online Appendix displays descriptive statistics for all variables used in the main part of the manuscript (Tables A1 and A2) and the results of a range of robustness checks conducted to verify the models explaining antibiotic consumption and the adoption, alignment, and implementation of NAPs.[10] First, we verify the common trend assumption of TWFE models by estimating the model with several leads and lags (Fig. A1) and re-estimate models using recent advances in the econometric literature that relax several key assumptions of the estimator (Figs. A2-A5, Table A3) (Blackwell & Glynn, 2018; De Chaisemartin & d'Haultfoeuille, 2020; Goodman-Bacon, 2021; Imai & Kim, 2021; Liu et al., 2022). Second, we provide additional tests and estimations to reduce the risk of endogeneity (Tables A4-A5), utilize an instrumental variable approach leveraging the adoption of NAPs by regional peers as a plausibly exogenous instrument (Table A6), and quantify the risk of endogeneity in Table A7 (Oster, 2019). Additionally, we verify our participation, implementation, and ambition models using a range of alternative specifications—including alternative estimation procedures, additional control variables, different time trends, alternative independent and dependent variables, and alterations in the samples used (Tables A8-A24) (Heinzel & Koenig-Archibugi, 2022; Lindberg et al., 2022; Micah et al., 2023; PRS Group, 2021; World Bank, 2022). The results presented in the Appendix are in line with our main findings, with the partial exception of the link between bureaucratic quality and NAP implementation, which fails to attain statistical significance at conventional thresholds with certain control variables and when we replace the bureaucratic capacity measure based on V-Dem with one drawn from on the (methodologically less transparent) International Country Risk Guide (Models 57, 58 and 68).

[10] The Online Appendix is available on the *Review of International Organizations*' webpage.

5 Conclusion

This article has shown that the global regime to address AMR has prompted wide-ranging national participation through the adoption of NAPs, that bureaucratic capacity constraints slowed down the implementation of NAPs, but they are currently put into practice in most countries, and that implementing NAPs is associated with reduced human consumption of antibiotics. The countries with the largest shares of global antibiotic consumption and the largest per-capita consumers are fully engaged in the regime. Therefore, the global soft governance regime to address antibiotic resistance appears to have been effective at achieving participation and implementation. At the same time, it seems to have been ambitious enough to contribute to a substantial reduction in the consumption of antibiotics—an important step towards producing the global public good of safeguarding antibiotic effectiveness.

We end our study by pointing out some limitations, implications, and directions for future research. One limitation is that the analysis of the implementation of NAPs mainly relied on the information reported by national governments to the WHO, FAO, and OIE. Self-reporting to international organizations can be problematic (Oechslin & Steiner, 2022). However, case studies of NAP implementation in specific countries do not provide reasons to believe that the situation is systematically misrepresented (Ahmed et al., 2022; Corrêa et al., 2023; Frumence et al., 2021; Godman et al., 2022; Hein et al., 2022; Lota et al., 2022; Sariola et al., 2022; Song et al., 2022; WHO, 2022a, c). Nevertheless, we hope that the substantial resources needed to build a nongovernmental monitoring system will be available over the next few years.

Two further limitations should be mentioned. First, our analysis of the effect of NAP implementation on antibiotic consumption covers all antibiotics without distinguishing between the three categories of antibiotics specified by the WHO from 2017 onwards: “access”, “watch”, and “reserve” (the AWaRe framework). Future research could perform a more disaggregated global analysis subject to data availability. Second, the GAP and NAPs promote various outcomes beyond human antibiotic consumption, notably a reduction and modification of the use of antibiotics in agriculture. Subject to data availability, future research could examine to what extent NAP implementation makes a difference for those other outcomes.

As noted in the introduction, several experts advocate institutional changes in the AMR regime, such as the inclusion of legally binding elements (Hoffman et al., 2019a; Pitchforth et al., 2022; Rochford et al., 2018; Rogers Van Katwyk et al., 2020). In contrast to studies comparing the effectiveness of hard and soft international agreements while controlling for other factors (Böhmelt & Pilster, 2010; Köppel & Sprinz, 2019; Parente, 2022; Tveit & Tørstad, 2023; Zangl, 2008), we cannot empirically assess the counterfactual effectiveness of a legalized AMR regime. However, we can note some implications of our theory and findings for institutional reform. The benefits of legalization need to be assessed carefully because a legally binding agreement may fail to be ratified widely and achieve lower participation compared to the current regime, especially if it were to include penalties for non-compliance, such as trade sanctions, as some have suggested (Hoffman & Behdinan, 2016, p. 532). Our findings are particularly relevant to two provisions that treaty proponents would like to see included. The first is the regulation of antimicrobial prescription and availability for humans (Hoffman & Behdinan, 2016, p. 519). Our research suggests that the existing soft governance regime has made significant progress in getting states to make policy commitments, implement them, and reduce domestic antibiotic consumption. Thus, the added value of legalization for that aspect is unclear. However, legalization could facilitate sustained implementation, for instance, by helping domestic actors who prefer robust public action to overcome opposition and inertia, as has been documented for human rights treaties (Simmons, 2009). Legalization could also make implementation resilient to an increase in ambition, such as the adoption of explicit antibiotic use targets.[11] The other proposed treaty provision is a commitment by high-income countries to support capacity building in low-income countries, including AMR surveillance systems, laboratory capacity, and infection prevention programs (Hoffman & Behdinan, 2016, p. 523). Such funding commitments are sometimes included in international agreements mandating costly contributions to transnational public goods.[12] We found that bureaucratic capacity deficits are associated with significantly less implementation of national action plans, which points to the usefulness of external assistance. Our finding that countries implementing their NAPs account for more than 90% of global consumption of antibiotics (summarized in Fig. 2) may give the impression that current implementation deficits have only local rather than global relevance, but that would be a rash conclusion. As noted earlier, the level of AMR prevention in weaker-link countries disproportionately impacts the success of efforts to preserve antibiotic efficacy globally (Sandler & Arce, 2002). A treaty that made funding streams more sizeable and less volatile—for instance, by mitigating burden-sharing conflicts among donors—could substantially improve the sustainability of global collective action.

Finally, an important implication of our study concerns broader debates about soft governance in international relations. Against suspicions that non-binding initiatives promoted by multilateral organizations amount to inconsequential "bluewashing", we found that the processes led by the WHO, FAO, and OIE had a real impact on antibiotic consumption. We argued that soft governance is effective in this case because the collective action problem raised by AMR involves many conditional contributors, and the regime includes monitoring mechanisms that allow them to verify the implementation status of other countries. The empirical findings indicate that soft governance can produce meaningful results toward solving global collective action problems under these conditions. In future work, researchers could systematically compare soft governance institutions to determine which proportion of unconditional and conditional contributors is necessary and sufficient for such

[11] Edry (2020) shows that initially limited commitments can become more ambitious over time as a result of mobilization of and pressure by domestic groups.

[12] In the sample of 211 environmental treaties coded by Bernauer et al. (2013), twenty-three per cent have provisions about technical and/or financial assistance to meet the treaty's goals.

institutions to bring about successful international cooperation. Climate change is an important example. Researchers usually assume that states have strong incentives to free-ride concerning mitigation efforts, which has led some to interpret global collective action as facing the effectiveness trilemma discussed earlier in this article (Dimitrov et al., 2019). According to Hale (2020), however, the incentive structure of climate mitigation has three features—joint goods, preference heterogeneity, and increasing returns—that make it more similar to the AMR cooperation problem than to a straightforward Prisoners' Dilemma. A systematic comparison of global collective action problems across issue areas would be fruitful, but an assessment of the scope conditions for effective soft governance would also need to take similarities and differences in domestic interests, power distributions, and problem salience into account (e.g., Colgan et al., 2021). We hope that our work contributes to demonstrating the importance of this research agenda by showing that the ambition-participation-implementation triad does not have to be a trilemma. In the case of AMR, the global soft governance regime has been successful in eliciting commitments and attaining a substantial improvement in the use of antibiotics.

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Data availability Replication code and dataset for this study will be made available on publication at Harvard Dataverse.

Declarations

Conflict of interest/competing interest The authors have no relevant financial or non-financial interests to disclose.

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