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AIR POLLUTION

PERSPECTIVE PAPER

Benefits and Costs of the Air Pollution Targets for the Post-2015 Development Agenda

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Post-2015 Consensus

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Introduction[1]

The assessment paper "Benefits and Costs of Air Pollution Targets for the Post-2015 Development Agenda: Post 2015 Consensus" provides an accessible entry into a problem of major global importance for both global health and environmental sustainability, that of household air pollution. It presents data on the magnitude and scope of the negative effects of pollution from household use of solid fuels. The assessment paper then addresses some of the complications associated with specifying pollution targets in this domain, and proposes that technology-based targets (concerning specific fuels or stoves) are likely most appropriate. In line with this recommendation of appropriate targets, it closes by demonstrating the economic case for higher-efficiency cookstoves, which are receiving increasing attention and support from the global community. Indeed, replacement of traditional stoves with cleaner cooking technologies has been called "low hanging fruit" (Rosenthal 2009), in part because they would deliver a diverse set of benefits – to health and well-being, local environmental quality, and mitigation of global climate change (GACC 2010, World Bank 2013).

This short response to the main assessment paper aims to provide additional perspective on the value of targets and interventions for reducing the negative effects of household air pollution (HAP).[2] Some of the comments seek to add nuance to the Larsen's arguments. Others however reflect a set of issues that have not received sufficient attention by those pursuing the objectives, policies, and interventions for improving household air quality, and that the paper is largely silent about. To that end, and responding to the structure of the main paper, we begin with a brief discussion of targets, reflecting specifically on their value while highlighting some of their inherent pitfalls. Then, we consider theory and evidence on the role of interventions to stimulate technology adoption and behavior change in the domain of HAP, which illuminate the critical challenges with technology-focused targets in particular, and promotion of clean stoves more generally. Finally, we discuss the plausibility of the benefit-cost calculations that are typically used to make the global case for improved cookstoves. These comments also highlight the inherent contradictions in separating ambient and household air quality.

Targets related to household air pollution

The value of targets

One of the main outcomes of the Rio+20 conference was an agreement to establish "an inclusive and transparent intergovernmental process open to all stakeholders, with a view to developing global sustainable development goals to be agreed by the General Assembly"

[1] Comments draw heavily on the results and findings from a series of recent studies conducted by researchers involved in the Duke Household Health and Energy Initiative (http://www.dukeenergyhealth.org/), but represent only the views of the author. Thanks are due to Subhrendu Pattanayak who provided helpful comments on the draft. For discussion only: Please do not cite or distribute without the authors' permission

[2] This perspective paper does not comment on the sections that discuss targets and costs and benefits in the domain of ambient air pollution control, which were not complete at the time of its writing.

(United Nations 2012). It remains to be seen how household air pollution will be reflected in these goals, but it appears almost certain that the issue will somehow be addressed. This is because emissions from solid fuel combustion affect the health and well-being of billions of people worldwide, many of whom live in what has been termed energy poverty (Birol 2007). As reflected in the UN agreement to develop a set of SDGs, the value of articulating aspirational targets is to provide a basis for global action on important development issues that is clear, manageable, and easy to communicate. And while such goals can help countries to establish priorities for intervention in particular domains, they must be flexible enough to allow for differences in national development realities, constraints, and policies.

Problems with targets for HAP

As discussed in the main assessment paper, there are a number of important challenges with setting targets related to HAP. Broadly speaking, these challenges can be categorized as relating to their efficiency, adequacy for meeting equity or distributional justice, and monitoring and measurement. As Larsen explains, progress on health outcome- and air-quality based targets, for example, would be difficult to track, because of challenges of attribution (in the case of health outcomes) and measurement (in both cases). He therefore favors targets related to sources of household air pollution (i.e., stove and fuel types being used), which could be monitored using surveys, and which would improve equity given that those lacking such technologies are largely the rural poor.

Unfortunately, the use of technology-based targets does not address the efficiency problem, and may even exacerbate it (Tietenberg 1990). This is because the technological solutions to the problem may have undesirable side effects, and because air quality and the costs and benefits of specific changes in stove and/or fuel types vary considerably across households and locations (Jeuland and Pattanayak 2012), an issue we will return to later. Technology-based targets may also unnecessarily rule out intermediate or incremental solutions that may be worthwhile prior to a wholesale switch to new technology. Admittedly, incremental changes can be folded into separate short- and long-term targets, in precisely the way Larsen proposes (e.g., starting with use of more efficient stoves that require solid fuels, and eventually moving to gas). Yet this type of transition erroneously assumes that households' undergo a linear (or energy ladder) fuel transition, an idea that fails to account for the prevailing reality of use of multiple fuels and stoves (Masera et al. 2000, Brooks et al. 2014). In addition, while targets for cooking technology are easy to understand, they ignore critical interactions with ambient air quality as well as household needs for heating or other benefits. Interestingly, and consistent with his selection of technology-based targets, Larsen partially incorporates community (or ambient) pollution into a set of exposure scenarios that are used to derive health benefits (his Table 6.2).[3] Thus, it is puzzling that this important variation does not figure in the subsequent benefit-cost analysis of clean cooking interventions, which instead looks like an analysis based on hypothetical air quality (not technology-based) targets. Specifically, the paper's analysis of costs and benefits assumes that high-efficiency biomass stoves cohabit with poor community air

[3] It is worth noting, however, that the analysis assumes that all clean biomass stoves reduce exposures to the same level, which neglects variation across stove types and the contextual factors that influence how stoves are used.

quality, while LPG stoves are accompanied by limited community pollution. These assumptions have little relationship with reality, since remote rural locations with more biomass use are likely to have better ambient air quality, while more well-connected locations with greater access to commercial fuels are likely to have relatively worse ambient air quality.

Finally, and perhaps most critically, technology-based targets remove behavior from the equation that governs generation of household air pollution, which is problematic for a number of reasons. This is the issue we turn to next.

Putting behavior back into the household air pollution equation

Given that the technologies analyzed in the assessment paper are household technologies, its most striking omission is the lack of significant discussion of the role and implications of behavior. In this regard, the paper says only that "partial conversions to improved stoves or clean fuels would result in lower benefits." Rather than assuming away behavioral feedbacks and responses, economists working on understanding environmental health behavior typically take as a starting point the idea that individual decisions to invest in preventive health or environmental improvements involve a rational tradeoff with consumption of other goods and leisure (Pattanayak and Pfaff 2009).[4] In this conception of the household air pollution generation problem, individuals or households maximize well-being by allocating resources – time and money – to these separate domains (Jeuland et al. 2014). Therefore, initial endowments of resources constrain behavior, and influence the extent of investment in environmental quality, which requires a mix of inputs (such as cleaner cook stoves) and spending on consumption.

This idea of production of environmental health is a useful device for thinking about why households often make decisions that would seem to endanger their well-being by compromising health and environmental quality. It acknowledges that preventive behavior may be low when the perceived returns (or marginal benefits) of these investments are limited. For example, Individuals may misunderstand the risks they face. Or, if the exposure-response function for fine particulate matter (PM2.5) is highly nonlinear, as the literature argues (Burnett et al. 2014), relatively large investments in PM2.5 reduction may not be sufficient to deliver substantial health benefits. Other competing risks – including perhaps those from poor ambient air quality – may also limit the marginal benefit of reducing pollution generated by cooking (Pattanayak and Pfaff 2009, Yarnoff 2011).

Similarly, if the costs of prevention are high relative to income, they will require greater and more substantial tradeoffs with consumption and leisure, because of the diminishing marginal utility of these. The problem is further complicated when consumption itself generates pollution, as is the case with cooking and heating. Here again, household preferences, and the non-health implications of preventive behavior (e.g., the taste of food

[4] This is not to say that households always behave rationally, or that they can even be considered as a unitary body that makes optimal decisions for the collection of people living under one roof. Despite not addressing such issues directly, the household production framework for health remains useful for understanding some of the basic drivers of health prevention behavior.

or the desire to have a warm indoor environment), may lead to situations where the demand for preventive behavior is relatively modest. Existing work that better documents limited private demand for cleaner cooking technologies offers support for the idea that there is something households and individuals like about traditional stoves (Mobarak et al. 2012, Jeuland et al. 2014). Thus, it is not generally correct to state, as the assessment paper does, that "less than full conversion in a community will result in lower benefit-cost ratios due to community effects of pollution from households that continue to use unimproved stoves." Such a statement assumes away behavior and preferences that may put a premium on consumption or the negative effects of clean stove adoption on well-being – i.e., missing out a set of benefits. It also ignores the fact that strikingly few households who obtain a cleaner biomass stove end up using it exclusively.

It is in this space that interventions such as subsidies, education and social marketing campaigns, etc., might help to move household behaviors in socially-desirable directions. These interventions might even enhance efficiency, if they help to correct or internalize externalities, relax household liquidity constraints, or correct other market failures (Pattanayak et al. 2009, Beltramo et al. 2014). They may also support goals of poverty-alleviation by encouraging investment by the poor that pay off only in the long run. Nonetheless, it is important to acknowledge that such external interventions only influence behavior, rather than determining it. That is, promotion campaigns may help to reduce the private costs of prevention, but the extent of investments to avoid pollution generation will also depend on myriad other factors that go into a household's calculation of their net benefits. Simply setting and marching towards technology-based targets for dissemination of stoves and/or clean fuels will not ensure that these technologies are used.

The role of intervention(s) in achieving air pollution targets

Are interventions to reduce household air pollution even successful?

In fact, surprisingly little is known at this time about how to induce the behavior change that effectively delivers long-term benefits in the domain of household cooking. A number of studies consider the role of demographic and socio-economic drivers of behavior, as well as supply-side factors like prices (Lewis and Pattanayak 2012), but there have been few systematic studies of the role of underlying preferences (including risk attitudes and time preferences) for different technologies (Jeuland et al. 2014, van der Kroon et al. 2014). As such, setting technology-based targets creates a risk that policies designed to reach them will repeat the hard failures of related domains (e.g., water and sanitation, and malaria prevention), which generally failed to incentivize the pursuit of locally-responsive and desired solutions (Therkildsen 1988, Pritchett and Woolcock 2004). In fact, several high profile studies have already raised this alarm (Hanna et al. 2012), and the number of rigorous research studies demonstrating that clean stove promotion delivers benefits are few (Smith et al. 2011, Bensch and Peters 2014, Jeuland et al. 2014). There is clearly a need for targets and policies that incentivize experimentation and testing of what works in a way that is sensitive to local realities and to preference heterogeneity (e.g., offering choices to households), rather than making prescriptive recommendations about the specific stoves that people should or should not own. The latter approach will likely result in dissemination of large numbers of stoves that households do not want or use.

The need for program evaluation

Of course, identifying solutions that are effective from a behavioral perspective does not exclude the need for standards on technical performance; indeed a particular challenge in the clean cooking technology space relates to the gap between the technologies that people actually want and those that deliver true health improvements and fuel savings to households. Technology standards, designed and implemented correctly, could spur innovation in product development and supply. It is also worth noting that effective external interventions to reduce health risks and improve environmental quality may reduce or crowd out private investment in prevention (and thereby harm cost-effectiveness) if the demand for such costly behavior decreases with a fall in disease prevalence. In the case of clean stove promotion, one example of this type of behavioral feedback would be if household members increase the amount of time spent and cooking done indoors, thereby offsetting anticipated reductions in harmful exposures. Finally, little is known about how to effectively deliver such interventions at the scale needed to reach the billions of poor beneficiaries facing problems related to solid fuel combustion. NGOs and governments have long tried to operate in this space but have often failed to achieve success at scale (Kishore and Ramana 2002), while private sector involvement remains timid and controversial (Bailis et al. 2009, Lewis et al. 2013). These obstacles are inherent to many of the world's most difficult environmental health problems because of the complexity of the causal chain linking intervention to impact (Pattanayak and Pfaff 2009). They should therefore motivate greater use of theory-based impact evaluation as well as implementation science methodologies (Sanders and Haines 2006). They also suggest a need for more substantial effort to understand the nature of the supply-side barriers that constrain the penetration of preventive health technologies.

The problem of external validity, and the meaning of global costs and benefits

In fact, underlying the call for more careful impact evaluation and implementation science in this domain is this author's deep skepticism about the meaning and usefulness of the types of deterministic benefit-cost calculations that many use to justify dissemination of cleaner cookstoves. Such deterministic calculations, even differentiated across developing regions, ignore the extreme heterogeneity in outcomes across space, time, beneficiaries, micro-institutional contexts, and markets. Prior work (including in previous Copenhagen Consensus Center projects) has helped to illustrate the extreme variation in potential outcomes (Whittington et al. 2009, Jeuland and Pattanayak 2012, Whittington et al. 2012), as has qualitative and mixed methods research that considers the many steps where environmental health interventions can go wrong (deWilde et al. 2008).

This skepticism is borne out by the history of failures in similar sectors (Pritchett and Woolcock 2004), and reinforced by the dramatic divergence between the implications of the analysis and actual behavior. Excluding spillovers of better health to neighboring households (which admittedly may in some circumstances be large), the costs and benefits included in the analysis of the assessment paper are almost exclusively private in nature. Yet poor households have not been found to easily adopt and maintain use of such technologies, which suggests that both short and long-term private net benefits are perhaps being mischaracterized.

In fact, non-deterministic benefit-cost analyses such as those cited above have demonstrated that heterogeneity in outcomes can arise from any of a very large set of parameters that underlie the calculation of costs and benefits. In addition to this, it is not hard to see that the global calculations in he assessment paper suffer from systematic misrepresentation of costs and benefits, particularly with respect to omitted impacts and improper transfer of key valuation parameters.

Improper benefit transfer

The variation in benefit-cost ratios across regions considered in the assessment paper is impressive and probably not intuitive to those unfamiliar with these types of calculations. A naïve interpretation of the large range (benefit-cost ratios vary from 1.1 to 18) would be that these suitably incorporate the heterogeneity in potential outcomes from clean cooking interventions. Yet the hidden drivers of this variation are limited to just two assumptions, about the value of life years lost, and of time savings benefits. These are themselves derived from a value of statistical life (VSL) parameter that depends on per capita GDP (as well as upper and lower bound values selected by the author)[5] and the average market wage in the countries or regions considered. Both suffer from severe external validity problems in this context, in that the measures are likely invalid when applied to beneficiaries – mostly rural and outside the formal labor market – of efforts to expand use of clean stoves.

The mortality benefits are obtained using benefit transfer techniques. Specifically, the analysis uses results from the most up-to-date and comprehensive meta-analyses available to obtain region-specific value of a statistical life (VSL) measures based on the relationship between GDP and VSL. The value of a life year lost is then derived from this by dividing by the remaining year of life expectancy. The problem with this approach is that national or regional averages for GDP gloss over substantial variation across time and space, and the fact that most solid fuel users have low incomes (and therefore lower VSLs).

For the value of time savings, the analysis derives wage rates for different countries from survey data, and, following some adjustments, uses these to estimate the cost of time spent collecting fuel. The adjustments are made to these estimates to account for the fact that: a) most solid fuel users are rural; b) many of the time savings accrue to women with a low opportunity cost of time; and c) time spent collecting fuel likely has a lower opportunity cost in the first place. These valuation assumptions are ad-hoc, and it is difficult to know what relationship they have with the time tradeoffs that households are really making. It is also problematic to use wage rates from official labor surveys in low-income countries as the basis for these calculations because so few people work in the formal labor market, especially outside of urban areas (where such time savings occur).

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[5] The specific range of this sensitivity analysis is $1,000 to $5,000 per life year lost.

Omitted impacts

One major problem with the application of benefit-cost analysis to goods of a largely private character (such as new cooking technologies) is that they do not easily incorporate key impacts that private individuals (and users) care about but that are difficult for analysts to observe or understand (Pant et al. 2014). On the demand side, there are a number of issues of relevance to a beneficiary household's well-being – discussed above – that are also routinely ignored. The basic need for lighting and heat are perhaps most obvious, but the adaptability of stoves for particular food preparations – issues known to anyone who routinely cooks different or multiple types of foods – are likely just as important. These behaviors are complex and culture-specific, and do not necessarily change with simple provision of new stoves. The consequence of this is that use of new technologies is typically far from universal, such that assuming a total switch to cleaner options represents a dramatic overstatement of benefits (Jeuland and Pattanayak 2012). Evidence from large data sets supports this idea; for example in India even among relatively wealthy rural households who own alternative stoves (mostly LPG), traditional stove use remains ubiquitous for cooking tasks such as making bread or simmering (Bhojvaid et al. 2013).

In addition to this, there is severe bias in the assessment paper's specification of the costs of interventions. Program and stove promotion costs are wholly ignored, despite the fact that cleaner cooking technologies are unavailable in many low-income settings. To be fair, there has been little to no research on these costs, and they are rarely borne privately (since promoting organizations usually absorb these costs), but evidence from other sectors – hygiene or sanitation promotion – suggests they are likely to be large.

Though it is likely that the analysis overstates the benefits of cleaner stoves, there are also omitted impacts that might make these interventions look more economically attractive, especially from a social perspective. Chief among these are environmental benefits (reduced black carbon emissions and forest degradation) (Geist and Lambin 2002, Ramanathan and Carmichael 2008), and long-term irreversible impacts on human capital development and chronic illness (Dickinson et al. 2014, Pant et al. 2014).[6] The latter include negative health consequences for children exposed to harmful air pollution in utero or during early infancy, potential epigenetic and multi-generation effects, or other hypothesized negative health impacts that remain poorly understood (e.g. asthma, or lung cancer) (Bruce et al. 2006, Hollingsworth and Martin 2011). All of these impacts are likely underappreciated by private individuals who face the tradeoff between consumption and investment in clean stoves, and therefore might warrant more aggressive support from donors and governments.

Conclusions

Household air pollution represents a major global environmental health challenge – perhaps the most important today. The use of solid fuels in inefficient stoves and heaters is

[6] Of course, the balance of global climate benefits would depend on what stoves and fuels replace biomass, and their specific contributions to global warming.

the leading environmental risk factor today in terms of contribution to the global burden of disease (Lim et al. 2013). Reducing reliance on such solid fuels would therefore generate important health benefits, and could also generate important environmental benefits.

In spite of the clear negative implications of household use of solid fuels, it has proven difficult for many to make the switch to cleaner technologies. Indeed, the challenge facing those working to set development targets in this domain is not to identify a sufficiently aspirational goal, but rather to use them to enable an approach will succeed in reducing reliance on traditional cooking methods. Such an approach must allow for tailoring of policies and interventions to local realities, must engage local institutions, and must acknowledge the fact that traditional technologies generate a large set of benefits for users that are systematically mischaracterized or ignored. Only then will the promise of better household air quality – and its many co-benefits – be achieved.

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This paper was written by Marc Jeuland, Assistant Professor at Sanford School of Public Policy and Duke Global Institute, Duke University. The project brings together 60 teams of economists with NGOs, international agencies and businesses to identify the targets with the greatest benefit-to-cost ratio for the UN's post-2015 development goals.

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