RWI Positionen

Michael Grimm and Jörg Peters

Improved Cooking Stoves that End up in Smoke?

A comment on Hanna, Duflo and Greenstone (2012)

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Summary

More than 2.7 billion people in developing countries rely on biomass for cooking with profound implications for their well-being. Two million people die every year due to cooking related smoke emissions – more than are killed by malaria. In recent years, an international movement has gained momentum on the level of the United Nations that intends to combat this plight by the dissemination of improved cooking stoves. A recent study conducted by Hanna, Duflo and Greenstone based on a field experiment in India has attracted much attention, also in the popular press. It does not confirm the optimistic results on the impacts of improved cooking stoves that hitherto can be found in the literature. Editorial notes in newspapers like the New York Times took up findings from the study and vehemently criticized the international efforts to improve access to cleaner cooking fuels as ineffective. The present *RWI Positionen* policy paper argues that this journalistic verdict is premature and that the results of the study are overstressed. While the study is in principle a meaningful contribution to the improved stoves literature, its findings are very specific to the local environment in which it was conducted and as we argue the insights can barely be transferred to other areas in the developing world.

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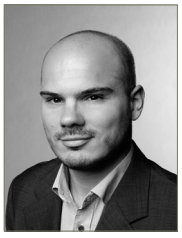

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1. The killer in the kitchen[1]

A recent study has apparently produced a disturbing insight into the challenge of translating plausible instruments for alleviating poverty from the drawing board into effective solutions in the field. However, as this comment will argue, the general implication this study has for the assessment of the effectiveness of current endeavours has been overstressed in the public reception. Much is at stake: today more than 2.7 billion people rely on biomass as their primary fuel for cooking, with profound implications for the environment and people's well-being (IEA 2011). Wood provision is often time-consuming and the emitted smoke has severe health effects – both burdens that afflict women in particular. According to the WHO (2009), two million people die every year due to household air pollution.

Many development and health experts see the dissemination of improved cooking stoves (ICS) as an effective remedy to these problems, based on the assumption that such stoves consume less wood fuels and reduce smoke emissions. The term ICS subsumes a wide range of technologies, reaching from very simple portable clay or metal stoves that just improve the heating process, over bricked stoves with chimneys leading the smoke out of the kitchen, up to sophisticated devices like gasifier or ethanol stoves that reduce smoke emissions almost down to zero.[2]

In September 2010, the *Global Alliance for Clean Cookstoves* was launched under the auspices of the *United Nations Foundation*, promoted by US Secretary of State Hillary Clinton as one of its prominent ambassadors. Funded by both public and private partners, among them many bi- and multilateral donors, the objective of the Alliance is to encourage 100 million households to adopt clean cookstoves by 2020. According to estimations of the International Energy Agency, nearly 7 billion USD are required to reach this objective.[3]

While the evidence on the claimed benefits of improved stove usage is generally thin, few studies have rigorously probed into the analysis of impacts. The results are not always euphoric, but mostly confirm the promising potentials the international community assigns to this technology (see, for example, Adrianzén 2010; Bensch, Peters 2011, 2012; Diaz et al. 2007; Mueller et al. 2012; Yu 2011). The flagship evaluation so far has been the RESPIRE[4] field experiment conducted in Guatemala (see, among others, Smith-Sivertsen et al. 2009, Smith et al. 2011). The study has found substantial effects of improved stove

1 *We are grateful to Eva Rehfuess and Christoph M. Schmidt for valuable comments.*

2 *See World Bank (2011) for further information on ICS and a more detailed presentation of existing stove types.*

3 *This number is based on the assumption that the 100 million homes are sustainably provided with advanced biomass stoves. It increases slightly if Liquefied Petroleum Gas is used and substantially for biogas stoves (as it is done in IEA's universal access scenario).*

4 *RESPIRE stands for "Randomized Exposure Study of Pollution Indoors and Respiratory Effects."*

usage on various health indicators, but has also been criticized for an unrealistic set-up that includes, for example, very close supervision of participating households potentially altering the behavior.

2. Up in Smoke

In a recent paper researchers from MIT and Harvard University have rung the alarm bell, emphasizing that these stoves may work well in laboratory settings, but not in real world situations, mainly because people would fail to use them properly, would neglect maintenance, or would refuse to adopt the technology in the first place (Hanna et al. 2012). The authors base their conclusion on a large scale experimental study undertaken in the Indian state of Orissa. According to them, if households are not nudged to use and maintain these stoves properly, which of course induces substantial additional costs, no major impacts can be expected from the dissemination of improved cooking stoves whatsoever, neither on wood fuel consumption nor in terms of health outcomes.

Within a few days after publication, the results were featured in the press, most prominently in the Washington Post, the New York Times and the Boston Globe. In the Boston Globe, Edward L. Glaeser concluded that *"The Hanna paper doesn't imply that we should give up trying to improve indoor air quality – but it does mean we need to think about behavior as well as technology. Dumping stoves into the developing world isn't going to alter the long-standing advantages of traditional methods."* This conclusion, however, is by no means a new insight but conventional wisdom among development practitioners since the first wave of improved cooking stove dissemination projects in the 1980s (see, e.g., the foreword in Barnes et al. 1994). Nonetheless, the study by Hanna et al. (2012) raises some very important issues that are often neglected in the debate around the dissemination of ICS. In particular, we believe that the adoption and usage of new technologies must be tested in field experiments, since laboratory experiments cannot provide more than a theoretical benchmark. Despite these merits, though, the evidence provided by this study is hardly sufficient to conclude whether ICS help to tackle the problems related to woodfuel usage for cooking. Most importantly, as we would like to argue, because the study by Hanna et al. (2012) is not exactly what it claims: an evaluation of "real-world" improved stove usage.

Above all, improved stoves are barely "dumped into the development world" anymore. The vast majority of improved stoves programs disseminate the devices by building up markets and people pay cost covering prices. Hence, the study by Hanna et al. (2012) does not really offer the possibility to evaluate the efforts that are made, for example, by most participating projects of the Global Alliance. The evaluation literature distinguishes internal from external validity. While the results derived in Hanna et al. (2012) are certainly valid for the 'field-laboratory-setting' that they created (internal validity), they cannot

easily be transferred to the rest of the world or even India as a whole (external validity). As we will argue below, the measured impacts in that study rather provide for a lower bound estimate of what can be expected in "real-world" settings.

Emphasizing the problem of translating the results of experimental studies to different settings is hardly a critique on the quality of the underlying research itself. Nevertheless, this is a limitation that all experimental research needs to address, and that all conclusions regarding their policy implications need to keep in mind. Prominent columnists, however, may not want to bother with this fine print that is the gist of any serious scientific discussion, eloquently dismissing the whole idea of ICS dissemination as unfounded. We believe, it would be wise to re-focus the debate on the actual insights provided by the Hanna et al. (2012) study – and to the reservations pertaining to it.

3. Returning to a sensible debate

Hanna et al. (2012) conducted a so-called "randomized controlled trial" (RCT) in Orissa, one of the poorest regions in India where most people rely on firewood for cooking purposes. The partner organization was a local, but internationally renowned NGO called Gram Vikas, which disseminates a simple improved brick stove with a chimney that is supposed to curb firewood consumption and smoke emissions, although it would not be comparable to an advanced biomass stove. The brick stove was randomly distributed among 2,600 households. It could be built using materials that are locally available and that were provided by the project. While costs accrued to a total of around USD 12, participating households only had to contribute USD 0.75 and some labor input to construct the stove. The stoves were assigned in three waves between 2006 and 2010.

The key finding of the experiment is that no significant and lasting reduction in firewood consumption could be detected among the stove users. There was also no effect on particulate matter emissions and exposure. The authors explain this disenchanting finding mainly with a strongly declining usage rate over the four years the stove owners were followed, and a lack of proper maintenance. Indeed, a year after the stove assignment when stoves were still in a good condition and usage rates relatively high, the researchers did find indications for an improved health status in the treatment group as compared to the control group. These improvements vanished with declining usage rates in the following years. However, we think these findings – interesting as they are – need to be interpreted with caution. A few issues have to be taken into account that are at least partly classical problems of RCTs and that cast doubt about the transferability of the findings to other "real-world" settings.

First, and most importantly, the improved stoves in this experiment have been offered almost for free. It is quite intuitive that paying a higher (monetary) price might alter the adoption and usage intensity and in particular the dedication that is assigned to the required maintenance work. Development practitioners are quite clear about that finding.

The tenor generally is "people only value what they have paid for" (Barnes et al. 1994, Martin et al. 2011, World Bank 2011), even if the empirical evidence that could back this claim is a bit more controversial. In fact, some papers find a relationship between paying a price and usage intensity, others do not (Ashraf et al. 2010; Cohen, Dupas 2010; Tarozzi et al. 2011). Anyway, the fact that the improved stoves are given away at a very low price might have, to say the least, implications for the usage and maintenance behavior. Hence, the issue should not be ignored. In particular, the paper should note that hardly any currently running improved stoves program gives away the stoves for free.

Second, and not less importantly, the traditional stove that has been replaced in "treated" households by the improved one is used outdoors in most of the cases (in the baseline situation, 12.6 out of 14 weekly meals are not cooked inside). For obvious reasons, outside cooking is less harmful in terms of particulate matter concentrations and respiratory diseases than inside cooking. The improved stove used in this experiment, though, is a brick stove that is installed inside of the homes. Although the stove has a chimney leading most of the smoke outside, the fact that it is used inside aggravates the effect of the remaining smoke emissions (which are also due to usage mistakes and improperly maintained chimneys). This, again, will reduce the potential impact that can be achieved with the improved stove in the specific set-up of this experiment. In other regions, where outside cooking is less common, impact potentials of the same improved stove would arguably be much higher. We think this is quite an important caveat of the experiment and it is, hence, a bit surprising that the problem of outside vs. inside cooking is mentioned by the authors only in a footnote.

Third, the paper does not take up an ongoing discussion in the improved cookstove community that is of crucial relevance for any evaluation of impacts in this field: What is an improved stove? As mentioned above, there is a wide range of stoves that are all labeled "improved", but that substantially differ in terms of potential fuel savings and emission reductions – as well as in terms of the price. The improved stove used by Hanna et al. (2012) is a relatively cheap one and much cheaper, as pointed out by the authors, as the one used in the RESPIRE study. The price, though, is only one feature that characterizes the stove within the range of existing improved stoves. In order to be able to transfer results from one improved stove type to others, the technical potentials in terms of fuel savings and emission reductions are required. Although, apparently, laboratory experiments had been conducted for the stove used by Hanna et al. (2012), the test results are not provided in the paper.

Fourth, 16 percent of all households that effectively received an improved stove were not trained at all in properly using and maintaining it. Most improved stove dissemination programs in the real world put much effort into training all households that obtain (in most cases: buy) an improved stove. Moreover, only 70 percent of those households that were randomly offered an improved stove (the "winners" of the lottery) also agreed to

take one. However, for the impact analysis, all "winning" households are then compared to the control group. In other words, the treatment evaluated in the paper in fact is not the improved stove, but the offer to get one. Obviously, evaluating this treatment yields lower impacts than the effective usage of improved stoves.

Fifth and finally, among the group of control households 25 percent of all households also used an improved stove (mostly electricity and kerosene, so even cleaner stoves than the randomized ones). It is easy to see that if the treatment group is compared to a control group of which 25 percent are already "treated", impact potentials are much lower as in an environment in which hardly any household is using a clean stove (like, for example, in rural Africa). As a remedy, Hanna et al. (2012) also provide Instrumental Variable (IV) estimates where having an improved stove is instrumented with having received an offer to obtain an improved stove or not. Although this is a straightforward solution to the problem, it can of course introduce new problems as discussed in detail for instance in Deaton (2010). Hence, while testing the robustness of the overall results to alternative assumptions does certainly add to the credibility of the study, it would definitely help if the limits of both the conditional mean comparison based on the RCT and the IV approach were discussed in more detail. It would also add to the clarity of the results if the authors distinguished more strictly between two different definitions of the treatment that are used, namely "improved stove users" and "households that were offered an improved stove". In the evaluation literature these two impacts are denoted as the "average treatment effect on the treated" and "the intention to treat effect". It is not always clear to which effect the authors are actually referring to.

In sum, all the issues we raised do not question the design of the study itself and, hence, do definitely not threaten the substantial contribution the study provides to the still limited rigorous evidence that exists on the impacts of improved stove usage. Rather, these issues underpin that researchers conducting field-experiments must be cautious in generalizing the results. It can be easily seen from the points above that the region in which the experiment was conducted does not represent the diverse world of cooking behavior in developing countries. Likewise, the way in which the treatment was designed for this experiment does not reflect typical improved stoves dissemination programs implemented by other organizations. As a consequence, a more profound discussion of these issues in the paper would lead to a more nuanced conclusion in the paper itself, and, definitely and more importantly, in the press. Therefore, the recommendation that Mr. Glaeser conveys in his editorial note in the Boston Globe to the advocates of improved stoves also applies to the academic community: some humility is in order. Counting on a false remedy can of course be fatal and it is the duty of researchers to uncover such errors. Rejecting a promising and simple technology too early, in contrast, can be fatal as well.

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