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TEMPORARY INPUT SUBSIDIES HAVE LASTING IMPACTS ON TECHNOLOGY ADOPTION AND POVERTY IN MOZAMBIQUE

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CAN TEMPORARY INPUT SUBSIDIES PROMOTE LEARNING AND LASTING CHANGE?

Policies in many countries have been designed as if the answer were 'no.' Responding to stagnant crop yields and persistent rural poverty, many African countries instituted permanent input subsidies in an effort to boost the use of improved seeds and fertilizers in the small farm sector (in sub-Saharan Africa in 2009, fertilizer use per-hectare stood at only 10% of its level in other developing regions). Unfortunately, these permanent subsidies come at a huge fiscal cost, and in some countries, input subsidies now consume nearly all government expenditures on agriculture, leaving little for public goods like research, extension and infrastructure development.

So is there any logic to permanently subsidizing a private investment good like fertilizer? Can the goals of input subsidy programs be achieved more cheaply with once-off, temporary subsidies? This brief reports the results of a 5-year randomized controlled trial in Mozambique that explores the short and medium term impact of a temporary, two-year voucher subsidy program. While only about 40% of those offered the subsidy coupons use them, the coupons have substantial impacts on fertilizer use both during and after the subsidy period. The coupons also cause substantial and persistent impacts on assets and other measures of household economic well-being. These findings are consistent with a learning model as our estimates show that coupons cause an increase in farmers' expected returns to fertilizer by more than 1.2 tons/hectare. Importantly, these results are corroborated by our data, which show that, if anything, returns to fertilizer are even higher than what farmers believe after the voucher learning period.

THE MOZAMBIQUE EXPERIMENT WITH TEMPORARY INPUT SUBSIDIES

Fertilizer usage among smallholder farmers in Mozambique is limited, thus maize yields are generally below one ton per hectare compared to up to 8 tons per hectare in the most productive developing coun-

KEY POINTS

The pattern of these results suggest that the temporary voucher subsidy not only improved maize productivity, but that it also put voucher users on a transformational path, shifting them from near-subsistence farmers to farmers selling more of their output on the markets.

The treatment effect on per capita daily household consumption amounts to a 36% increase over the control group mean, indicating that the vouchers had an impact on poverty's incidence and its depth.

tries. The nascent input market is small and its network sparse. While rural poverty levels dropped slightly as conditions stabilized following the 1994 elections, technological change has been modest and yields stagnant, thereby threatening the sustainability of agricultural growth.

In an attempt to jump start agricultural growth the Mozambican government in collaboration with the EU and FAO implemented a two-year voucher coupon subsidy program for the 2009-10 and 2010-11 seasons. The program targeted 25,000 farmers nationally, of which 15,000 received a subsidy for maize production. Among the recipients of the maize production subsidy, 5,000 were in Manica province. In cooperation with the Ministry of Agriculture and the International Fertilizer Development Center, the research team designed and implemented a randomized controlled trial in Manica. Mozambique's input subsidy program provided farmers with a voucher to purchase a technology package designed for a half hectare of improved maize production: 12.5 kg of improved seeds (either open pollinated variety or hybrid) and 100 kg of fertilizer (50 kg of urea and 50 kg of NPK 12-24-12). The market value of this package was MZN 3,163 (about USD 117). Farmers were required to co-pay 27% of the total value, with the voucher coupon covering the balance. Lists of eligible farmers were created jointly by government agricultural extension officers, local leaders, and agro-input retailers. Individuals were eligible for a voucher coupon if they met the following criteria: 1) farming between 0.5 hectare and 5 hectares of maize; 2) being a "progressive farmer", a producer interested in modernization of their production methods and commercial farming; 3) having access to agricultural extension and to input and output markets; and 4) being able and willing to make the 27% co-payment. Only one person per household was allowed to register.



Participants were informed that a lottery would be held and only half of those on the list would win a voucher given the program's limited budget. The research team conducted the randomization lottery and the list of

voucher winners was provided to agricultural extension officers, who were responsible for voucher distribution. Because the 2009/10 agricultural year was marred by a severe drought, the beginning of the study and data collection were put off until the 2010/11 crop year, the second and final year of the voucher programs. Baseline data were collected on past agricultural seasons, and follow-up surveys on agriculture and household economic well-being were carried out following the harvests in 2011, 2012 and 2013.

VOUCHER UPTAKE AND SHORT-TERM IMPACTS

Not all voucher winners used the voucher. Under the research team's supervision, extension agents held distribution meetings in each village to which all voucher winners were invited. The requirement to co-finance the input package meant that some winners might not accept the voucher. In practice, 48.7% of voucher winners actually showed up to receive their voucher.

In addition, despite our randomization design, some voucher lottery losers (our control group) received vouchers. This deviation likely resulted from incentives

faced by extension agents who were actually distributing vouchers. Extension agents were each given a certain number of vouchers to distribute prior to the December 2010 planting period including in areas outside the study villages. The fact that voucher take-up was less than 100% in the study villages meant that the national government and donor agencies funding the program expected the un-

used vouchers to be distributed to other farmers. Our research team emphasized that these unused vouchers should only be distributed outside the study villages. However we were not fully successful in ensuring this. In the end, 13% of control group participants received vouchers.

In our underlying statistical analysis, we account for both the partial program uptake and this program leakage. These 'partial compliance' problems weaken the statistical power of our analysis, but as we shall see, we

nonetheless detect significant impacts of the voucher coupons.

For the 2010/11-crop year—the second and final year of the voucher program—we find that on average voucher lottery winners increased fertilizer use on maize by 67% or about 12 kg/hectare. Because not all lottery winners actually used the coupon, these ‘intention to treat’ (ITT) estimates understate the impacts that the coupons had on those that used them. Statistically adjusting these ITT results, we can arrive at the policy relevant mea-

“For 2010/11 year, these ATT estimates imply that coupons boosted fertilizer use by 33 kg/hectare. Total maize output per-hectare rose significantly by 58% (an increase of 490 kg/hectare). We thus have strong evidence that the voucher coupons effectively boosted fertilizer use and output, at least for those who ultimately used them.”

sure of the ‘average treatment on the treated’ (ATT) impacts, which is the impact among those that used their voucher (compared to a similar population which did not use their voucher because they were not selected to receive it). For 2010/11 year, these ATT estimates imply that coupons boosted fertilizer use by 33 kg/hectare. Total maize output per-hectare rose significantly by 58% (an increase of 490 kg/hectare). It is important to note that if the vouchers were simply crowding out private investment in fertilizer that would otherwise occur, then these impact estimates would be zero. We thus have strong evidence that the voucher coupons effectively boosted fertilizer use and output, at least for those who ultimately used them.

In the remainder of this report, we will report ATT estimates as measures of the causal impacts of vouchers on those that used them. We turn now to see if these short-term impacts persisted after the voucher coupon program ended and farmers had to pay the full market price of improved seeds and fertilizer.

PERSISTENT IMPACTS OF THE VOUCHERS ON USE OF IMPROVED TECHNOLOGY

While there is some variation between 2012 and 2013, we will focus our discussion here on average post-voucher impacts by averaging results for those two years. Impacts on fertilizer use persist in the subsequent

2012 and 2013 seasons, the vouchers distributed in 2011 increased fertilizer use on all crops by 48% or 47 kilos). This is not much smaller than the impact in 2011 (58 % increase or 62 kilos compared to the controls group).

In contrast to these results on fertilizer, we do not find that the coupons had lasting impacts on the use of improved seeds in the post-voucher period. In the season prior to the intervention, 22% of the households were using fertilizer for maize cultivation compared to 53% for improved seeds. Given the high usage of improved seeds prior to the intervention, it may be that improved seed utilization was already near optimal levels, while fertilizer use was not.

PERSISTENT IMPACTS OF THE VOUCHERS ON AGRICULTURAL PRODUCTION

The pattern of maize yield increases continues in the post-voucher years. On average, our estimates indicate that maize yields were 48% (or 613 kg/hectares) higher among those who used their voucher. Total maize production is also estimated to be higher by 828 kg, when averaged over the two post-voucher years.

Interestingly, our estimates also indicate that the vouchers caused an increase in the production of crops other than maize in the post-voucher years. Treated farmers increased their use of fertilizer on non-maize crops in these latter two years, and the overall value of the agricultural production increased by 41% for treated farmers (or 9,631 MZNs roughly equivalent to 357 USD or 3 times the market value of the input package) and the annual sales of all crops have increased by 3,120 MZN. The pattern of these results suggest that the temporary voucher subsidy not only improved maize productivity, but that it also put voucher users on a transformational path, shifting them from near-subsistence farmers to farmers selling more of their output on the markets. This finding is especially interesting as one of the main objectives of the subsidy program was the transformation of subsistence farmers into commercial farmers who sell their output in markets.

VOUCHER IMPACTS ON HOUSEHOLD ECONOMIC WELL-BEING

In addition to farm data, the study also collected information on household consumption, savings, assets and housing. The ATT impact estimates reveal an important

pattern. In the voucher year (2011), there were no significant impacts on these measures of household economic well-being. However, positive impacts emerge

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in the following two post-subsidy years. The treatment effect on per capita daily household consumption amounts to MZN 26 per day, a 36% increase over the control group mean. With the average household in the study hovering a bit above the conventional poverty line, an increase of this magnitude indicates that the vouchers had an impact on poverty’s incidence and its depth.

These consumption impacts are perhaps the best overall indicator that the voucher coupons had a significant impact on economic well-being. Looking further into the structure of household wealth and finance, we also see positive voucher impacts on total household savings, livestock, food stocks, and total assets, as well as improvement in the housing conditions the voucher beneficiaries.

VOUCHERS IMPACTS ON LEARNING ABOUT RETURNS TO FERTILIZERS

Our finding that the voucher coupons had large and long-lasting effects is especially striking because farmers faced full, unsubsidized market prices in the post-subsidy period. In our theoretical work, we show that such persistent effects could either be due to the once-off subsidies boosting farmer wealth (so that they can

subsequently sustain adoption of improved technologies), and/or because it allows them to inexpensively experiment and learn about the returns to the technology.

To shed light on whether a learning channel is operative, we asked farmers in all three survey rounds the following questions about perceived returns to fertilizer: “In the first field where your household planted maize this year, if you use improved seed and fertilizer, what is the total production that is expected in: a) average year, b) very good year, and c) very bad year?” Respondents also gave estimates assuming that no improved inputs had been used, and they were asked to indicate how many years out of 10 they expected to be average, very good and very bad years. These probability elicitation allow us to calculate farmers’ expected returns to improved seeds and fertilizers.



Analysis of this data shows that winning the voucher lottery consistently boosts expectations of returns to fertilizer and improved seeds. Looking at the results from the two post-subsidy seasons, we see that a treated farmer would expect yields with fertilizer to be 2828 kg/hectare, which is 51% higher than yields expected by a control group farmer. Control group farmer expectations of yields using fertilizer also rose over the study period, from 1633 to 1874

kg/ha (a 15% increase). If we treat the control group 2011 expectations as a good proxy for true baseline expectations, then treatment increases expected returns to fertilizer by 1195 kg/ha or 73%.

These substantial increases in expected returns to fertilizers are consistent with what farmers actually experienced. Our econometric estimates of the returns to fertilizer indicate that 100 kg of fertilizer would boost expected yields by 1660 kg, an amount well above the cost of the additional inputs. Given these results and the learning that followed from them, it is perhaps not surprising that farmers continued to utilize fertilizers well after the expiration of the short-term subsidy experi-

ment.

SMART SUBSIDIES CAN WORK (AND WORK EVEN BETTER)

Economists often look askance at the public subsidy of private investment goods—like fertilizers—that generate private returns for farmers. However, the economic argument for smart subsidies has always been that subsidies can be justified if they break a low technology, poverty trap by (1) making technology affordable for low income farmers who otherwise cannot afford initially afford it; (2) sharing the risk of experimentation; and, (3) reducing learning costs and breaking the vicious circle where everyone wants someone else to pay the costs and bear the risk of experimentation with a new technology. Note that these are all arguments for once-off, not permanent subsidies.

Given this argument, the question has been whether smart, temporary subsidies can work to induce technological change and reduce poverty in areas of lagging agricultural productivity, such as central Mozambique. In contrast to some other recent work in this area, the answer from this research has been a resounding “yes,” with strong evidence that the temporary subsidies operate through a strong learning channel.

While these results are encouraging from both anti-poverty and government fiscal perspectives, can even better results be obtained? In the Mozambique experiment, a narrow majority of voucher lottery winners chose not to use or even pick-up the valuable subsidy coupons they had won. A likely explanation is that these non-participants found the required voucher co-payment daunting for either risk or liquidity reasons. Per-

haps a different program design such as free vouchers the first year would have induced greater participation and socio-economic impacts.

There is also much still to learn about spillover learning to those who lost the voucher coupon lotteries. Results reported in our full paper identify strong spillover effects through the social networks of voucher winners. Learning how best to harness the power of these learning channels is another promising way to make smart subsidies work even better.

FURTHER READING

Carter, Michael R., Rachid Laajaj, and Dean Lang. “Subsidies and the Persistence of Technology Adoption: Field Experimental Evidence from Mozambique,” NBER Working Paper 20465.

Duflo, Esther, Michael Kremer, and Jonathan Robinson, “Nudging Farmers to Use Fertilizer: Theory and Experimental Evidence from Kenya,” *American Economic Review*, 2011, 101 (6), 2350-2390.

Jayne, T.S. and Shahidur Rashid, “Input Subsidy Programs in Sub-Saharan Africa: A Synthesis of Recent Evidence,” *Agricultural Economics*, 2013, (44).

Lunduka, Rodney, Jacob Ricker-Gilbert, and Monica Fisher, “What are the farm-level impacts of Malawi’s farm input subsidy program? A critical review,” *Agricultural Economics*, 2013, 44, 563-579.

Marenya, P. and C. B. Barrett, “State-conditional Fertilizer yield response on western Kenyan farms,” *Amer. J. Agr. Econ.*, 2009, 91 (4), 991-1006.



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Publication made possible by support in part from the US Agency for International Development Cooperative Agreement No. AEG-A-00-08-00008-00 through the Assets and Market Access Collaborative Research Support Program.

All views, interpretations, recommendations, and conclusions expressed in this paper are those of the authors and not necessarily those of the supporting or cooperating organizations