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HIGHLIGHT

In this Highlight, we quantify the impact of metering of electric tube wells on groundwater use in West Bengal, India. Quantification of impact was made feasible through surveys conducted in 2004 and 2007 and then again a follow-up survey in 2010 by revisiting the same villages and households. Difference in difference framework was used to quantify the impact. Our major result is that the expected impact on reducing pumping hours was felt only in the *boro* season. There is also some evidence that this decrease was not confined to irrigation on own-farm, but that water sales and purchases were also adversely affected as a consequence. Yet the metering did not influence either cropping patterns, or the output of *boro* paddy. The latter could well be explained by over use of water among those who irrigate their own farms, so that reductions in water use do not translate into decreased output. These impacts have to be seen against the backdrop of an overall decline in pumping hours that was seen in both control and treatment groups, which may have served to swamp the impact of the metering.

Impact of Metering of Tube Wells on Groundwater Use in West Bengal, India

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Impact of Metering of Tube Wells on Groundwater Use in West Bengal, India[1]

Research highlight based on Meenakshi et al. 2011[2,3]

Metering of electric tube wells and evaluation questions

In this Highlight, we evaluate the impact of metering of electric tube wells on groundwater use in West Bengal. According to the 4th Minor Irrigation Census (GOI, 2011), the state has a total of 5.19 lakhs[4] groundwater extracting mechanisms (GWEMs). Of these 5.19 GWEMs, approximately 1.09 lakh run on electricity and the rest run on either diesel or on kerosene or a mix of both.

The West Bengal State Electricity Distribution Company Limited (WBSEDCL) initiated the process of metering of electric tube wells in 2007. Till 2009-10, it had completed metering of around 70 percent of electric tube wells in the state. Of interest to us in this evaluation is the pumping behavior of electric pump owners in the aftermath of metering of electric tube wells. Why is the pumping behavior of pump owners likely to be changed by metering? Prior to metering of tube wells, all electric tube well owners in the state were subjected to a flat electricity tariff. This meant that there was no marginal cost of pumping and farmers were likely to keep pumping for as many hours as electricity was available. Farmers whose tube wells have been metered are now subjected to a time of the day tariff, while those whose tube wells have not yet been metered still continue to pay flat tariff. Table 1 shows TOD timings, metered tariff and flat tariff rates.

Following, standard economic theory, it is expected that the total number of hours pumped by owners of tube wells will decrease post metering. However whether this is reflected in reduced water sales will depend on a number of variables that are set out later in the section on the theory of change. Such a contraction will have significant economic consequence because of the 6.1 million farming households in West Bengal, more than half (3.1 million

Table 1: Time of the Day tariffs and flat tariffs in West Bengal, 2008-2011

	Metered Time of the Day (TOD) tariff			Unmetered (flat) tariff for a standard 5 HP pump	
Year	Normal Hours (06.00 a.m to 5.00 p.m) (In Paisa/unit)	Peak Hours(5.00 p.m to 11 p.m) (In Paisa/unit)	Off-peak Hours (11p.m to6 p.m) In Paisa/unit)	EC (in Rs/year)	ES in Rs/year)
2008-09	130	490	74	8800	10800
2009-10	140	510	79	8800	10800
2010-11	218	588	152	10736	13176

Source: West Bengal State Electricity Board State Electricity Company Limited

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[2]This paper is available on request from p.reghu@cgiar.org

[3]This work was done through a grant given by the International Initiative for Impact Evaluation (3ie Grant Number OW2.082. The authors are grateful to 3ie for their generous support. The full report is available on website http://www.3ieimpact.org/media/filer/2012/07/12/3ie_draft_report_v1_nov_2011_r2_mar2012.pdf

[4]One lakh = 0.1 million

households) report hiring irrigation services from other farmers (Mukherji 2008).

In view of this, our evaluation questions are:

1. How has the shift in policy from flat rate tariff to metered tariff influenced hours of pumping, and water sales?
2. What have been the effects of this policy change on water buyers?
3. What are the secondary impacts of the policy change, in terms of its impact on cropping patterns and crop output?

Why is energy-irrigation nexus in agriculture of policy interest?

Until the early 1970s, all state electricity boards (SEBs) charged their tube well owners based on metered consumption. However, as the number of tube wells increased manifold during the 1970s and the 1980s, the SEBs found the transaction costs of metering to be prohibitively high and in response, introduced flat tariffs for agriculture (Shah et al. 2007). While this solution lowered the transaction costs of bill collection, it resulted in a set of still graver problems affecting both the electricity and the groundwater sectors. For one, many state governments soon started using the electricity tariff as an electoral tool of appeasement and hence the flat tariffs remained perpetually low (Dubash and Rajan 2001), leading to financial insolvency of the electricity utilities. Unmetered electricity supply also became a convenient garb for the SEBs to hide their inefficiencies (Sant and Dixit 1996). Over time, the SEBs came to treat their agricultural consumers as a liability and quality of power supply to agriculture deteriorated rapidly. Since the marginal cost of extracting groundwater was close to zero, it provided incentive for over-pumping in many regions arid and semi-arid regions, though not necessarily so in water rich eastern India. In view of several criticisms of flat tariff and unmetered supply to agriculture, there is a growing pressure from the government of India and the international donor agencies to revert to metering. This is also clearly articulated in the Electricity Act of 2003. West Bengal is one of the few states that embarked on a path of universal metering – a path that all other states would have to accept sooner or later as a matter of exigency. It is therefore of great policy interest to understand the impact of metering of tube wells on groundwater use in West Bengal.

Theory of change and primary impact variable of interest

A few stylized facts about water markets will help us understand the context of metering and its impact. First, water sales and purchases are common: thus farmers who pump groundwater, not only use it to irrigate their own fields, but also sell water to other farmers. Conversely, pump owners may also buy water from other pump owners given that land is highly fragmented. Farmers who buy water typically tend to have smaller land holdings and are often unable to install tube wells and pump sets (Banerji et al. 2011; Mukherji 2007). In the pre-metering scenario, water buyers grew exactly the same crops as pump owners including water intensive crops such as summer boro paddy. It is to be noted that the increase in the importance of summer cultivation was enabled almost entirely through the use of groundwater. It is possible therefore, that the impact of a change in pricing regime is felt disproportionately in the summer season. Given these stylized facts, our primary impact variables of interest are:

- Total number of hours of groundwater pumped, by season. The hypothesis is that this would decrease, *particularly* in the summer season, where there are no alternatives to groundwater.
- Number of hours of groundwater used for irrigating one's own farm, by season. This can either stay the same or decrease.
- Number of hours of groundwater sold, by season. The expectation is that this would either decrease, or remain unchanged, depending on various factors.

Evaluation design and challenges

The evaluation design takes advantage of surveys conducted in 2004 and 2007, prior to the introduction of the power pricing reforms. The 2004 survey covered 40 villages in 14 districts and interviewed 580 respondents including pump owners and water buyers. The 2007 survey covered 15 villages in 5 districts and interviewed 155 respondents. Since the roll out of the metering was staggered, and only 70 percent completed by 2010, this provided a unique natural experiment setting to examine the impact of the metering on the set of impact variables described above. Through the resurvey in 2010 which involved revisiting the same households and villages as were visited in 2004 and 2007, it was possible to create a panel data use a difference-in-differences framework to analyze impact.

Our identification strategy can clearly fail if there were systematic patterns to roll out of the metering. The way in which metering was accomplished provided at least two ways to identify impact. In particular, the staggered and largely (but not entirely) non-systematic patterns of geographic coverage enabled us to define whether or not a village was metered; thus one of our treatment variables is defined at the village level. Furthermore, because one of the firms entrusted with providing meters often installed defective or non-operational meters, this provided yet another path to identification: it was possible for us to allocate *farmers* as belonging to either treatment or control groups depending on whether or not meters were installed *and* they received a bill based on unit pricing. This was done separately for 2008-09 and 2009-10 cropping years (Table 2 and Table 3). Our districts were divided into two stratum – new alluvium districts (dominated by electric centrifugal pumps) and old alluvium districts (dominated by electric submersible pumps).

Thus three different treatment definitions were used: at the village level, at the farmer level in 2009/10 and at the farmer level in 2008/09. In this Highlight, we present estimates based on the village-level treatment as this is based on the largest sample size. Further details on sampling design, power calculations, and questionnaire and data collection may be found in Meenakshi et al. 2011. Here, suffice it to say that loss due to attrition was minimal, even though we had accounted for attrition is our power calculations. All the estimates of impact presented in this report therefore do *not* account for attrition bias.

Table 2 Number of villages in treatment and control groups

Zone	Village classification	Number of villages with meters in 2009 (Treatment)	Number of villages with no meters in 2009 (Control)	Both*	Total
New Alluvium Zone (North 24 Parganas, Nadia and Bagri part of Murshidabad)	Baseline	9	4	1	14
	Augmented	2	2	0	4
Old Alluvium Zone (Birbhum, Bankura, Bardhaman and Rarh part of Murshidabad)	Baseline	11	10	1	22
	Augmented	3	11	0	14

*These are villages with some households reporting meters, and others with none or non-functional meters. In the analysis these were categorized as metered (treatment) villages.

Table 3 Number of baseline farmers who did or did not receive metered bills

	2008/09		2009/10	
	Received metered bills (Treatment)	Did not receive metered bills (Control)	Received metered bills (Treatment)	Did not receive metered bills (Control)
New Alluvium Zone	61	19	65	15
Old Alluvium Zone	52	51	61	42
Total	**113**	**70**	**126**	**57**

Results

Comparability of treatment and control groups in the baseline

Table 4 examines whether there are differences between the treatment and control groups of villages for several of the impact variables in the baseline. The standard errors are clustered and take into account the two strata, and the village clustering. It is clear that for nearly all the impact variables being considered, the difference between treatment and control villages in the baseline was insignificant, with the exception of the number of hours of irrigation pumped in the rabi season. However, *rabi* accounts for less than 10 percent of all the groundwater pumped, and therefore the lack of equality of means in

Table 4 Summary statistics, using village-level definitions treatment and control groups

	Baseline			Followup		
Col 1	**Col 2**	**Col 3**	**Col 4**	**Col 5**	**Col 6**	**Col 7**
	Control	**Treatment**	**p-value**	**Control**	**Treatment**	**p-value**
Total hours pumped (hours)	761 (131)	833 (86)	0.65	442 (76)	596 (61)	0.14
Hours used for irrigating own farm (hours)	289 (68)	355 (37)	0.40	173 (33)	251 (27)	0.08
Hours sold (hours)	472 (106)	477 (80)	0.97	269 (53)	344 (47)	0.32
Hours pumped in Kharif 2009 (hours)	124 (36)	114 (24)	0.82	97 (20)	110 (12)	0.60
Hours pumped in Rabi 2009 (hours)	51 (12)	100 (21)	0.05	60 (16)	123 (26)	0.05
Hours pumped in Summer 2010 (hours)	586 (117)	619 (0.83)	0.82	284 (57)	362 (40)	0.28
Only buyers						
Total hours purchased (hours)	167 (36)	267 (50)	0.12	165 (25)	225 (36)	0.21
Hours purchased in summer 2010 (hours)	119 (30)	179 (32)	0.18	84 (17)	122 (15)	0.12

The p-values refer to a test of equality of means in the baseline (column 4) and follow-up (column 7).

this variable is not economically significant. Thus the ex-post randomization seems to have worked.

Secular decline in the number of irrigation hours

Table 4 also highlights the substantial decreases in the total number of irrigation hours across *both* the treatment and control groups. This decrease is seen both in the number of hours used for irrigating own farms, as well as in the number of hours sold, with the decrease being slightly greater in the latter. Comparing across seasons, the summer season (which also accounts for the largest share of total irrigation hours) accounts for much of the decline. Thus the impact of metering needs to be understood in light of a *secular* decline in the number of irrigation hours pumped, used and sold, especially in the summer season. This appears to have been accompanied by a decrease in the area under cultivation (and under paddy in particular) between the baseline and endline surveys. Data from the West Bengal government's Directorate of Agriculture suggests that in 2010 area under paddy declined in Bankura, North 24 Parganas, Nadia and Murshidabad districts as compared to previous years and this is confirmed by remote sensing data on boro area by IWMI. In related work, we have shown that much of this contraction in irrigated area has had to do with restrictive groundwater policies followed by the state government since mid-1990s (Mukherji et al. 2012).

Calculating double-difference estimates of impact

If the treatment villages saw a greater decrease in the number of hours pumped or sold, as compared to the control villages, this could be attributed to the impact of metering, independent of the secular decrease mentioned in the previous paragraph. To evaluate this, the following sets of regressions were run:

1. $\Delta Y_{ij} =$ ✂ $\beta V_j \mathrm{E}_{ij} + \varepsilon$ where $\Delta Y_{ij} = Y_{ijf} - Y_{ijb}$ and V are as above, E_{ijSC} and is a dummy variable which takes value 1 if ith farmer in the jth village had either an electric submersible or an electric centrifugal pump. We label this the 'vtmt*EC/ES' treatment

2. $\Delta Y_{ij} =$ ✂ $\beta V_j E_{ijS} + \varepsilon$ where $\Delta Y_{ij} = \Delta Y_{ijf} - Y_{ijb}$ and V are as above, E_{ijS} and is a dummy variable which takes value 1 if ith farmer in the jth village had an electric submersible pump. We label this the 'vtmt*ES' treatment.

In all cases, the coefficient β represents the impact estimate, while ε refers to an error term where the farmer and location subscripts have been suppressed.

DID estimates for primary impact variables (irrigation hours pumped, sold and bought, by season)

In table 5, we present impact estimates (the estimated β) for a range of impact variables. Consider first the variables related to total pumping hours, and the allocation of hours pumped to self-irrigation and sales. None of the double difference impact estimates is significant at conventional levels, for formulation (2); the coefficient has a p-value of 22 percent. Thus at least as far as these aggregate figures are concerned, the metering appeared to have no impact. Note however, that all the signs are correct; it is therefore more accurate to say that the impact of the metering was overwhelmed by the decrease in irrigation pumping hours seen across the board.

When irrigation hours are examined by season, however, a different picture emerges. In the summer season, there is a statistically significant decrease in the number of irrigation hours among owners of electric pumpsets; this is also seen among owners of electric submersibles at a p-value of 0.20. Corroboration of a significant reduction in number of irrigation hours purchased is also seen among water buyers, but it is not statistically significant.

These results are consistent with the theory of change outlined above which suggests:

1. Reduction in pumping, both self and sold/bought, post metering; but the magnitude could be limited if the unit cost of electricity is low. This is so in off peak (Table 1), and about 80 percent of pumping happens during those off-peak hours. Also, for boro paddy cultivation, if summer acreage share falls over time as has happened in a large subset of our districts, this can dilute the treatment effect.
2. Exclusion of especially smallholders from water buying, if the cost of monitoring water trades is significant. This is mitigated if unit cost of electricity is low; if water buyers not that small; and if there is secular decline in paddy cultivation in boro anyway (since that's water intensive cost with possibly high monitoring cost of water trading).

Table 5. Difference-in-difference estimates of Impact, using village-level treatment

	Vtmt*Electric pumpset (a)	**Vtmt*Electric submersible pumpset (b)**
Impact on Pump Owners		
Total hours pumped	-232 (186) [0.22]	-51 (309) [0.87]
Hours used for irrigating own farm	-103 (71) [0.16]	-101 (85) [0.25]
Hours sold	-128 (157) [0.42]	-152 (261) [0.56]
Hours pumped in Summer 2010	-309 (145) [0.04]	-316 (241) [0.20]
Hours used for irrigating own farm in Summer 2010	-118 (59) [0.06]	-18 (75) [0.82]
Hours sold in Summer 2010	-191 (131) [0.15]	-298 (217) [0.18]
Impact on Water Buyers		
Total hours purchased in 2009/10	-42 (51) [0.42]	-87 (65) [0.18]
Total hours purchased in summer 2010	-28 (40) [0.50]	- 63 (50) [0.22]
Secondary Impact Indicators		
Rabi share in overall cropping pattern	-0.01 (0.02) [0.53]	-0.004 (0.02) [0.82]
Summer share in overall cropping pattern	0.01 (0.02) [0.45]	0.01 (0.03) [0.80]
Boro paddy share in summer cultivated area	-0.04 (0.09) [0.66]	0.09 (0.09) [0.34]
Boro paddy output	-368 (621) [0.56]	-537 (918) [0.56]

Notes: Coefficients of regression of difference in impact variable between followup and baseline on

(a) Village-level treatment dummy interacted with ownership of either electric submersible or electric centrifugal pumpset (specification 2)

(b) Village-level treatment dummy interacted with ownership of electric submersible pumpset only (specification 3)

Figures in round brackets are standard errors, those in square brackets are p-values associated with its significance.

DID estimates for secondary impact variables (cropping pattern and productivity)

It is of course possible that the adjustment to a changed tariff regime was felt though impact on cropping patterns, either by reducing reliance on boro cultivation with a corresponding increase in *rabi* shares, or a switch away from rice in the summer *'boro'* season. But the evidence in table 6 suggests otherwise: there was no statistically significant impact either on seasonal shares or on share of boro paddy. At the same time, the decrease in water use in the *boro* season, and in sales in that season, has not adversely affected paddy output; the impact coefficient although negative, is not significant. This is not entirely unexpected and may be symptomatic of the overuse of water under a flat rate regime. In that case, pre metering, with zero unit cost of extraction for self-irrigation, there may have been significant water 'overuse.' However, to the extent that buyers paid a markup price, there could not have been any overuse on buyers 'plots. Thus post metering, with a positive unit cost of extraction, overuse by self-irrigators could have been wiped out. By overuse we mean use of water beyond crop requirements; reduction would then show up as no significant decline in crop yield.

Conclusions and policy implications

As far as the impact of the metering of tube wells is concerned, our major conclusion is that the expected impact was felt only in the *boro* season, which saw a greater reduction in pumping hours in the treatment groups as compared to the control groups. There is also some evidence that this decreased was not confined to irrigation on own-farm, but that water sales and purchases were also adversely affected as a consequence. Yet the metering did not influence either cropping patterns, or the output of *boro* paddy. The latter could well be explained by over use of water among those who irrigate their own farms, so that reductions in water use do not translate into decreased output. The impact was insignificant for all indicators in the *kharif* and *rabi* seasons. This result is not surprising given the overwhelming reliance of boro paddy on irrigation water. Evidence of decreased sales and purchases potentially has implications for equity, especially if small farmers are being driven out of the market completely. Yet their decreased access to water does not seem to have altered cropping patterns.

References

Banerji, A, Meenakshi, J.V. and Khanna, G. 2011. Social contracts, markets and efficiency: Groundwater irrigation in North India, *Journal of Development Economics*, 98(2): 228-237.

Dubash, N.K.. and Rajan, S.C. 2001. Power politics: process of power sector reform in India. *Economic and Political Weekly*, 36 (35): 3367–3390.

GOI. 2011. Fourth Minor Irrigation Census, State Level Results (unpublished and shared by Member, Planning Commission)

Meenakshi, J V, Banerji, A., Mukherji, A. and Gupta, A. 2011. Does Marginal Cost Pricing of Electricity Affect Groundwater Pumping Behaviour of Farmers? Evidence from a Natural Experiment in West Bengal", final project report submitted to 3ie by International Water Management Institute., available at website http://www.3ieimpact.org/userfiles/doc/3ie_draft_report.pdf

Mukherji, A., 2007. The energy-irrigation nexus and its implications for groundwater markets in eastern Indo-Gangetic basin: evidence from West Bengal, India. *Energy Policy* 35(12): 6413–6430.

Mukherji, A. 2008. Spatio-temporal analysis of markets for groundwater irrigation services in India, 1976–77 to 1997–98. *Hydrogeology Journal*, 16(6):1077–1087.

Mukherji, A., Shah, T. and Banerjee, P. 2012. Kick-starting a Second Green Revolution in West Bengal. *Economic and Political Weekly*, 47(18): 27-30.

Sant, G. and Dixit, S. 1996. Beneficiaries of IPS subsidy and impact of tariff hike. *Economic and Political Weekly*, 31 (51): 3315–3321.

Shah, T., Scott, C., Kishore, A., Sharma, A., 2007. Energy-irrigation nexus in South Asia: improving groundwater conservation and power sector viability. In: Giordano, M., Villholth, K.G. (Eds.), *The Agricultural Groundwater Revolution: Opportunities and Threats to Development*. CABI Publishers, UK, pp. 211–243 (Comprehensive Assessment of Water Management in Agriculture Series No.3).

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The IWMI-Tata Water Policy Program (ITP) was launched in 2000 as a co-equal partnership between the International Water Management Institute (IWMI), Colombo and Sir Ratan Tata Trust (SRTT), Mumbai. The program presents new perspectives and practical solutions derived from the wealth of research done in India on water resource management. Its objective is to help policy makers at the central, state and local levels address their water challenges – in areas such as sustainable groundwater management, water scarcity, and rural poverty – by translating research findings into practical policy recommendations. Through this program, IWMI collaborates with a range of partners across India to identify, analyze and document relevant water-management approaches and current practices. These practices are assessed and synthesized for maximum policy impact in the series on Water Policy Highlights and IWMI-Tata Comments.

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