The Effect of Metering on Water Consumption - Policy Note

Carmine Ornaghi and Mirco Tonin, University of Southampton
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Economics Department, School of Social Sciences, University of Southampton, SO17 1BJ, Southampton, UK. Tel: +44 (0)2380592550 Email: C.Ornaghi@soton.ac.uk and M.Tonin@soton.ac.uk This Project is supported by the ESRC [grant ES/K01210X/1]

In 2010 Southern Water started a programme to meter households across its supply area in the South East of England, an area classed by the government as under water stress. This *Universal Metering Programme* (UMP) entails the installation of nearly 500,000 meters by March 2015, when more than 9 out of 10 households in the region will be metered, compared to the rate of about 40 per cent at the beginning of the programme.

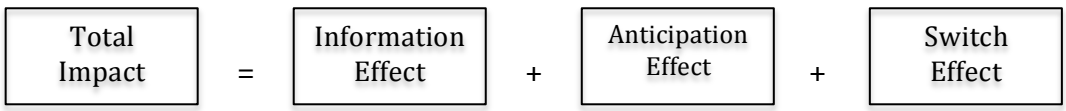
In this policy note we present a preliminary analysis of the impact of metering on water consumption. We first introduce the methodology and then present the results.

1. Methodology

For obvious reasons, we observe water consumption at the household level only after a meter has been installed. In particular, for households subject to the UMP, we observe consumption under four different phases, the first three lasting for around 3 months:

- Between meter installation and switch of contract. In this period a meter has been installed, but water charges are still based on the previous contract (i.e. on the rateable value of the house) and not on metered consumption.
- Between switch of contract and 3-months letter. In this period water charges are based on metered consumption, but customers have not received any information about their consumption level.
- Between 3-months letter and first bill. Customers have received a letter with information about their water usage since the switch of contract and, based on that, a projection about their first metered bill.
- After first bill. Customers receive a bill every six months based on their actual consumption.

We can split the total impact of the UMP into three different components:



The first component, the "Information Effect", arises because, in conjunction with meter installation, Southern Water conducts an information campaign about the benefits of water conservation. This campaign may affect consumption either because it provides information (on the ecological impact of water consumption, on ways to save water, etc.) or because it draws customers' attention on water consumption. Note that this campaign also affects already metered households in areas subject to the UMP.

The second component, the "Anticipation Effect", is related to the fact that households may start adjusting their consumption behaviour already in the period between meter installation and switch of contract. Although in this period customers are still subject to unmetered charges, they may take into account that changing water consumption patterns takes time and, therefore, they may modify their consumption before the actual change in pricing.

The third component, the "Switch Effect", reflects changes in water consumption due to the actual change in the pricing scheme experienced by UMP customers.

As the UMP is gradually implemented in Southern Water supply area, households go through the process outlined above at different points in time. Moreover, we also observe consumption for households living in the areas where the UMP installs that are already metered and, thus, do not switch contract. Thanks to these two facts, we can separate the effect of the UMP from any seasonal variation in water consumption, and also account for geographical variation in average consumption.

To assess the impact of introducing metered charges on consumption, we trace daily consumption as households' progress through the different stages of UMP and compare it to the evolution of consumption in the same period by already metered households living in the same geographical area. This latter group of households allows us to capture variation in average consumption at the postcode level and also changes in consumption due to seasonality (e.g. temperature or precipitation) or to aggregate economic conditions (e.g. unemployment), thus making it possible to isolate the effect of the UMP. In the Technical Appendix, we provide details about the equations we estimate and the econometric methodology we use.

It has to be taken into account that, for the purpose of this note, we only look at areas already affected by the UMP. As such, our estimates, for instance of average consumption, do not reflect the whole of Southern Water customers.[1]

2. Results

The data refer to the period from January 2011 to September 2014. The first set of results we present is based on all UMP customers.[2] Table 1 reports the number of observations available for the different phases of the UMP programme. For obvious reasons, the number of UMP customers that have already received the 2nd bill is lower than the number of those who have received their 1st bill and so on. The reason why we have fewer observations for the pre-switch period is because for some customers the meter was set to zero on the day of the "switch

[1] Note also that it is standard in the water industry to perform various technical adjustments when calculating average consumption. For instance, a meter under-registration allowance should be added to the recorded consumption given that meters cannot record very low flow rates. These adjustments are not relevant for the purpose of the current note and, as such, are ignored.

[2] For sample selection criteria, see the Technical Appendix.

of contract" and the actual reading was not recorded. Fortunately, this issue involves only a relatively small number of households.[3]

Table 1: UMP Phases

Description	Sample Size
Pre-Switch	220,172
3M letter	230,486
1st Bill	226,534
2nd Bill	175,477
3rd Bill	137,560
4th Bill	89,176
5th Bill	54,664

This sample also includes approximately 280 thousands additional households who are already metered (labelled as *No UMP* customers). Note that in this sample, identification of the effects of the UMP programme rests on the assumption that pre-switch consumption is a good proxy for consumption when unmetered. In other words, we assume there is no anticipation effect.

We then use the subset of households for which we have multiple observations of pre-switch consumptions to analyse whether households start changing their behaviour even before the switch of contract. This subsample includes around 200 out of 220 thousands households for which we have some pre-switch information, plus the same 280 thousands *No UMP* households.

Finally, to identify the information effect, we will look at changes in the water consumption of already metered households around the period where the UMP installs in their area.

After analysing these three effects separately, in the last section we put the results together and look at the overall effect of the UMP.

2.1 Switch Effect

We first look at the effect of switching contract from unmetered to metered charges. Column 1 of Table 2 below shows that the average daily water consumption for metered households not involved in the UMP is 263 litres. *UMP* households consume 110 litres more than the reference group of *No UMP* customers. Looking at the impact of the meter, the coefficient associated with the first bill shows that there is a reduction in daily consumption of around 34 litres of water during the six-months period that goes from switch of contract to the 1st bill. Similarly, the coefficients associated with subsequent bills show that, compared to their pre-switch consumption level, UMP customers consume, respectively, 43, 47, 51 and 50 litres of water less in the periods leading to the 2nd, 3rd, 4th and 5th bill.

The figures above suggest that, due to the switch of contract from unmetered to metered charges, two years and half after the installation of a meter (i.e. when

[3] Results are almost unchanged if we restrict the analysis to the sample of UMP customers whose pre-switch consumption is not missing.

the 5th bill arrives), a "typical" UMP household consumes 13.5% less water than they used to do, from 373 to 323 litres.

Table 2: Household Consumption

Variable Description	Name	(1)	(2)
Average Consumption for No UMP		263***	-
		(2.09)	
UMP – Pre-Switch	D_{UMP}	110***	45***
		(0.56)	(0.49)
3M letter	D_0	-30***	-30***
		(0.28)	(0.29)
1st Bill	D_1	-34***	-33***
		(0.28)	(0.29)
2nd Bill	D_2	-43***	-40***
		(0.33)	(0.34)
3rd Bill	D_3	-47***	-44***
		(0.38)	(0.39)
4th Bill	D_4	-51***	-46***
		(0.45)	(0.47)
5th Bill	D_5	-50***	-44***
		(0.56)	(0.58)
Number Of Obs.		2,774,202	2,196,221
Periodic Consumption[1]		No	Yes

RE Estimator. Standard Error in Parenthesis *** p<0.001
[1]The second column includes nine dummies computed using periodic consumption: the first dummy takes a value of 1 for percentile 1-10 of periodic consumption, the second dummy takes a value of 1 for percentile 11-20 of periodic consumption, etc.

There are good reasons to think that the higher water consumption of UMP customers during the pre-switch period compared to already metered customers is partially due to differences in the characteristics (e.g. number of occupants) of the households in the two groups. In fact, customers that were metered prior to UMP consist of 'Households living in New Dwellings' and 'Optants' (i.e. customers who chose to be metered) and the latter are typically low-occupancy households in properties with high rateable value who are likely to save money by moving on to metered charge. To account for some of the unobserved differences between UMP and No UMP customers (in particular, in the number of household members) in column 2 of Table 2, we also control for ex-ante expected consumption (known as "periodic consumption").[4] Doing this, and thus

[4] "Periodic consumption" is an estimate of the expected consumption at the beginning of a contract, with main inputs the information provided by the owner about the number of household members, plus, potentially, some characteristics of the property (e.g. presence of a garden or swimming pool or dishwasher usage). Note that this variable is determined before observing the actual consumption of the households, and it is not changed afterward.

comparing more like-for-like households, the ex-ante difference between UMP and non UMP customers is smaller than in column 1, consistently with the fact that UMP household are on average more numerous, but is still large, at 45 litres per day.

The results in column 2 also show that from bill 3 onwards the consumption of UMP households is very similar to that of already metered customers. In other words, one and a half years after the change in the price structure, UMP households behave as any other metered customers.

2.2. Anticipation Effect

To look at whether there is an anticipation effect, we can use a subsample of data for which we have multiple observations within the pre-switch period. In particular, we split this period into three sub-periods of one month each.[5] What clearly emerges from Table 3 is that indeed households start changing their behaviour even before the switch of contract.

Compared to consumption in the first month after installation of the meter, consumption falls by 37 litres the following month and 50 litres after two months, even if no switch of contract has taken place yet. The figures below suggest that consumption falls by 12.5% because of the anticipation effect. This estimate assumes that consumption in the first month after installation is a good proxy for consumption when unmetered. If, however, households start cutting their water consumption immediately after installation, then this would represent a lower bound of the true anticipation effect.

When using multiple observations for the pre-switch consumption, we observe that the total decrease in water usage is around 16.5%. The results in Table 3 show that a large part of the reduction actually kicks in before customers experience the actual switch of contract, indicating that anticipation effects are indeed important.

Results in the second column confirms that, when we control for unobserved differences in household characteristics by controlling for periodic consumption, we find that water consumption of UMP almost converges toward the consumption level of already metered customers.

[5] For the UMP households whose pre-switch period lasts less than one month (1.5% of the observations) or less than two months (3.5% of the observations), we use only one or two sub-period indicators, respectively. For the UMP household whose pre-switch period is longer than 4 months (around 20% of observations), we still use three sub-periods of equal length but longer than a month.

Table 3: Household Consumption – Monthly Data

Variable Description	Name		
Average Consumption for No UMP		263***	-
		(2.09)	
UMP – Pre-Switch 1	D_{PS1}	134***	72***
		(0.63)	(0.59)
UMP – Pre-Switch 2	D_{PS2}	-37***	-40***
		(0.39)	(0.42)
UMP – Pre-Switch 3	D_{PS3}	-50***	-52***
		(0.41)	(0.44)
1st Bill	D_1	-54***	-57***
		(0.41)	(0.43)
2nd Bill	D_2	-62***	-63***
		(0.44)	(0.45)
3rd Bill	D_3	-67***	-67***
		(0.48)	(0.50)
4th Bill	D_4	-69***	-68***
		(0.54)	(0.56)
5th Bill	D_5	-67***	-65***
		(0.62)	(0.66)
Numb Of Obs		2,732,792	2,211,438
Periodic Consumption[1]		No	Yes

RE Estimator. Standard Error in Parenthesis *** p<0.001
[1]The specification includes nine dummies computed using periodic consumption: the first dummy takes a value of 1 for percentile 1-10 of periodic consumption, the second dummy takes a value of 1 for percentile 11-20 of periodic consumption, etc.

2.3 Information Effect

To look at the information effect, we exploit the fact that there are already metered households in the areas where the UMP is implemented. These households do not experience any change in their pricing structure, but do experience (part of) the information campaign rolled over by Southern Water in conjunction with meter installation (e.g. leaflets, street signage, customer information point during installation, mobile exhibition unit in the area of installation).

We investigate whether these customers reduce their consumption around the period when UMP installs in their area (postcode) compared to other customers that were also metered prior to UMP but live in areas not yet affected by the UMP. Preliminary results do not show any significant effect of information campaigns.

Concluding Remarks

To summarise, we find evidence that the UMP program has had a significant effect on water consumption, starting immediately after installation and continuing after the switch of contract. All in all, our estimates suggest an overall reduction in consumption of around 16.5% due to the Universal Metering Program.

The analysis presented above thus suggests that households are responding to the installation of meters. These are preliminary results that need to be investigated further. In particular, the data used refer to the period up to September 2014 and only around 50 thousands UMP households have received a 5th bill. As new data become available, these estimates will be updated.

Technical Appendix

We estimate equations of the following type:

$$c_{i,t} = \alpha_i + \gamma * D_{UMP} + \sum_{j=0}^{3} \beta_j * D_j + \gamma X_i + \eta_t + \eta_p + \varepsilon_{i,t} ,$$

where $c_{i,t}$ is the average daily consumption of household *i* in period *t*, D_{UMP} is a dummy variable taking value one for UMP customers and zero otherwise, D_j is a set of dummies taking value one when the household is at phase *j* of the UMP, with *j=0* indicating that households have received the 3-months letter, and *j=1,2,3,4* indicating that households have received the first, second, third and fourth bill. The estimation includes a complete set of monthly dummies, η_t, and (4-digit) postcode dummies, η_p.

We estimate the equation above using panel data regression techniques, with standard errors clustered at the household level. In particular, we use Random Effects (RE) models. Fixed Effects (FE) estimates for the trend in consumption are very similar. This suggests that the behavioural response estimates reported in the Tables above are robust to unobserved characteristics that are invariant over the time window considered. With Fixed Effects it is of course not possible to identify the difference in the level of consumption between customers subjects to UMP and customers already metered.

The initial dataset includes around 250 thousands UMP customers. The analysis presented in this Policy Note does not include households with zero consumption or consumption above 1,500 litres per day in any given period of the programme (around 5 thousands customers). We also exclude all households living in flats (around 8 thousands customers).