Which British SMEs might benefit from electricity dynamic tariffs?

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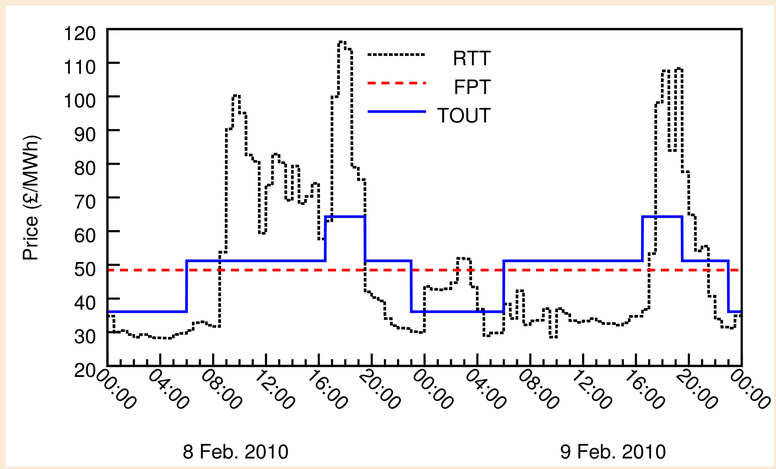
Introduction

Dynamic electricity tariffs may incentivise consumers to modify their consumption habits or patterns. This may reduce their costs and help balance the peak load of the grid. Although the consequences of dynamic tariffs for residential consumers have been analysed, little attention has been paid to small and medium enterprises (SMEs). We study whether a SME will get an financial benefit or not when they switch from a fixed-price tariff to a dynamic one, using smart-meter readings of more than 7500 British SMEs. We are examining three broad tariff types:

Fixed price tariff (FPT) Time-of-use tariff (TOUT) Real-time tariff (RTT)



First, we perform a comparison between the 'winning' and 'losing' SMEs based on their daily load profiles in three distinct tariff-change scenarios. Secondly, we try to predict which SMEs will win or lose from these tariff changes making use just of simple pieces of information that can be found in their electricity bill.

The data set

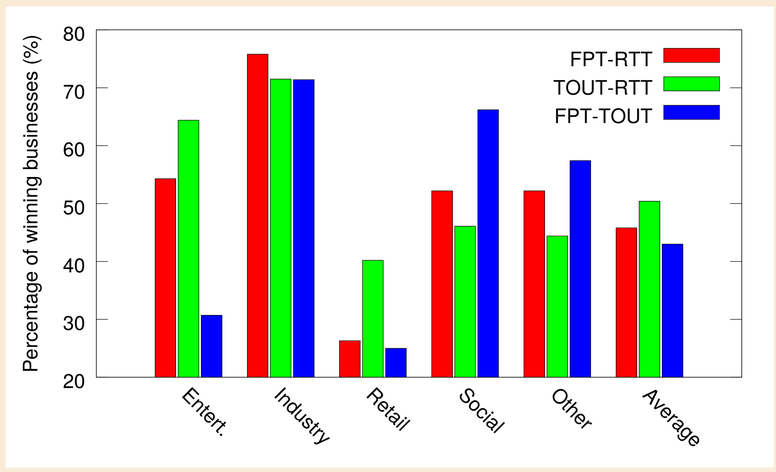
- The data set comprises half-hourly electricity use for 12056 different UK business from 2006 to 2010.
- Subsets (of the full data set) were created using a threshold τ of the minimum number of readings available per business.

τ (months)	0.5	1	2	3	6	9	12
#Businesses	10,478	10,206	9,651	9,169	7,527	5,893	4,339

- These businesses represent 44 categories, but we aggregate these into five sectors: Entertainment, Industry, Retail, Social and Other.

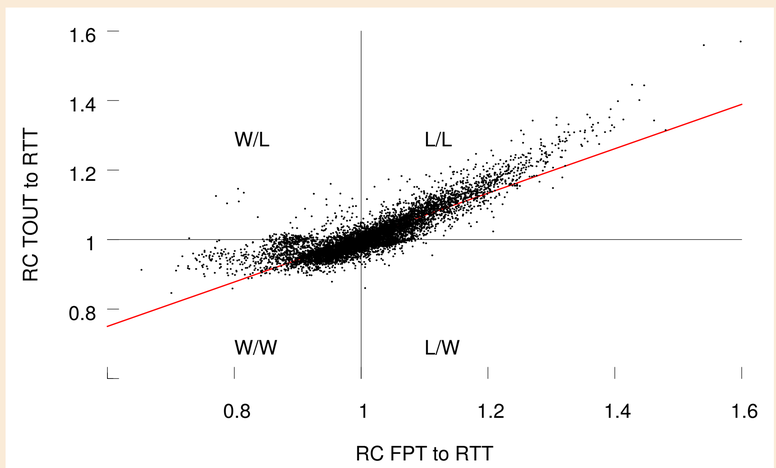
Tariff switching: winners and losers

- To quantify the economic benefit of changing from a generic tariff A to tariff B, for each businesses, a **'ratio of cost' (RC)** of the tariff change was calculated from dividing the cost of tariff B by the cost of tariff A $\rightarrow$ **Winners** if $RC < 1$ and **Losers** if $RC > 1$.
- The tariffs changes that we are going to investigate are **FPT-RTT**, **TOUT-RTT** and **FPT-TOUT** change.
- The Experiments are performed over the data-set with $\tau = 6$ month (7,527 businesses with 16.0% Entertainment, 16.0% Industry, 40.8% Retail, 10.5% Social, and 16.6% Other).



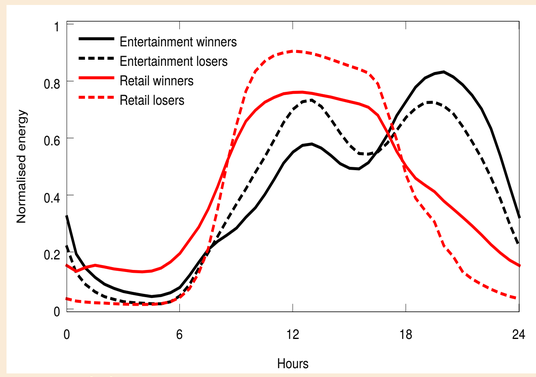
We have also analysed SMEs that simultaneously win with two tariff changes:

- **FPT-RTT and TOUT-RTT:** they will win when they change to RTT independently of previous tariff. Results $\rightarrow$ 51.0% Entertainment, 67.4% Industry, 23.2% Retail, 43.2% Social, 40.7% Other, and 39.7% Average.
- **FPT-RTT and FPT-TOUR:** they will win when they change from FPT independently of new tariff. Results $\rightarrow$ 25.7% Entertainment, 65.3% Industry, 16.2% Retail, 46.8% Social, 46.1% Other, and 33.7% Average.

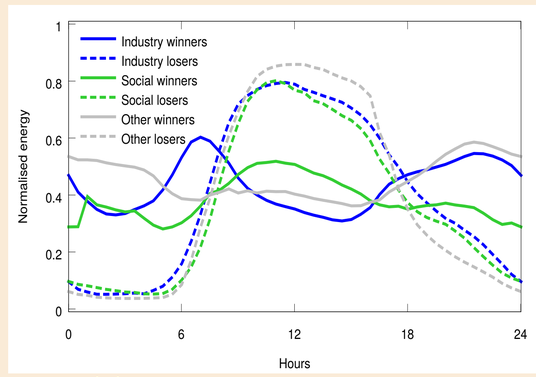


What usage pattern makes a winner?

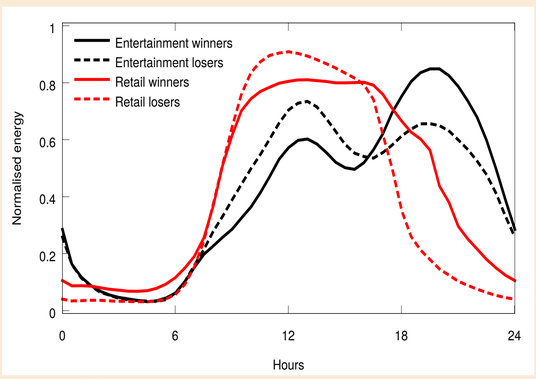
- The averaged power-use daily profile of each business is computed during weekdays and linearly normalised.
- The profiles are grouped and averaged by both: 1) business sector and 2) whether a winner or loser when tariff is switched.



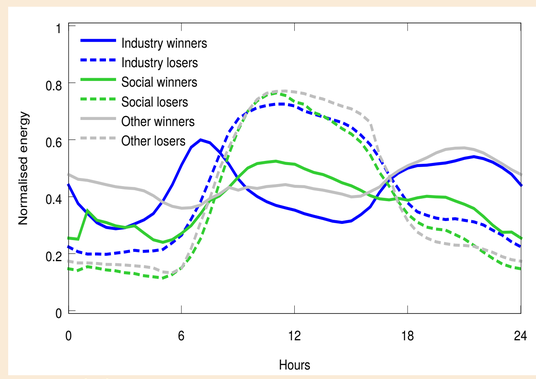
(a) Daily profiles FPT-RTT change



(b) Daily profiles FPT-RTT change



(c) Daily profiles TOUT-RTT change



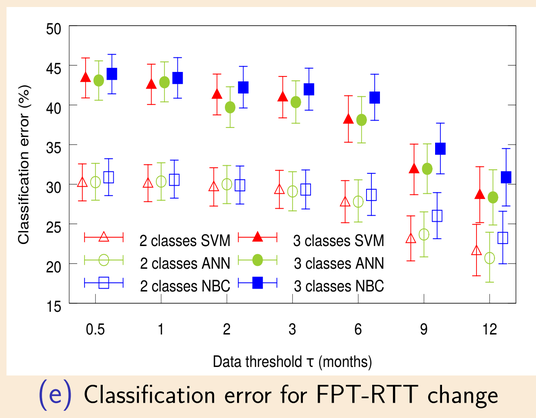
(d) Daily profiles TOUT-RTT change

Can we predict the winning and losing businesses?

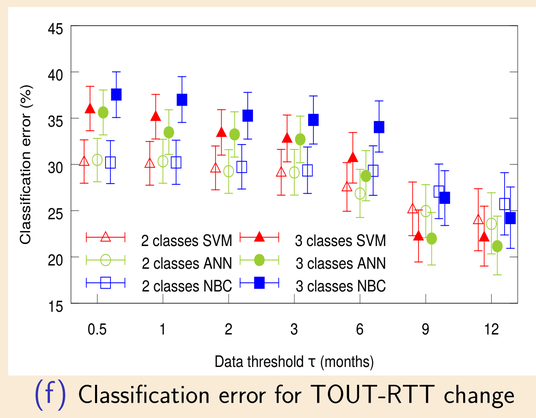
An additional analysis we performed is to automatically predict if a business will be a **winner** or **loser** with the tariff change using three basic pieces of information that are available in the electricity bill: the businesses category (44 categories), the half-hour mean consumption (continuous) and the load profile category (4 categories). There are two classification problems:

- **The binary classification problem**: Winners ($RC < 1$) and losers ($RC > 1$).
- **The three-classes classification problem**: Winners ($RC < 1 - \epsilon$), neutral businesses ($RC \in [1 - \epsilon, 1 + \epsilon]$) and losers ($RC > 1 + \epsilon$) where $\epsilon = 0.05$ based on previous work about price elasticity.

We use three Machine Learning techniques: Artificial Neural Networks (ANN), Support Vector Machines (SVM) and Naive Bayes Classifier (NBC).



(e) Classification error for FPT-RTT change



(f) Classification error for TOUT-RTT change

- **The regression problem:**: We try to predict the exact value of RC given the three bill features of a business. Regression models are ordinary least squares (OLS) and Support Vector Regression (SVR). SVR models perform better than OLS and R^2 of both models increases with the amount of power demand data (τ).

Conclusions

- We have performed an analysis of the SMEs that win or lose when switching from static to dynamics tariffs based on a large real data-set of UK businesses.
- There are winning and and losing businesses in all sectors, with small differences in consumption placing a business in one or the other category.
- We used only 3 bill features to predict the winners and losers when switching tariffs.
- A minimum of 9 months' data is needed to make switching decisions because the accuracy varies with the amount of power demand data (τ) used.

Our papers

→ Ramon Granell, Colin J. Axon, David C.H. Wallom, and Russ Layberry (2016). Power-Use profile analysis of non-domestic premises for electricity tariff switching. *Energy Efficiency*, 9 (3) 825–841.

→ Ramon Granell, Colin J. Axon, and David C.H. Wallom (2014). Predicting winning and losing businesses when changing electricity tariffs. *Applied Energy*, 133, 298–307.

Acknowledgements

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