Opening the Retail Electricity Markets: Puzzles, Drawbacks and Policy Options

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Motivation and plan of the talk

- After **10 years of liberalization** the Italian retail electricity market is characterized by a **majority of households** still choosing the default **regulated contract**, and an **average annual bill more costly** than the regulated one for those who switched to the **free market**.
- Moreover, looking at retailers' offers in the free market, some contracts are significantly **cheaper** than the regulated one but others are much **more costly**.
- The paper presents **evidence** on gains and losses from switching to the free market and then constructs a **model** that replicates this evidence, drawing some **policy suggestions** to improve the retail market performance.

Literature

We contribute to two streams of literature:

- **Empirical analysis of retail (electricity) markets**: **CMA (2015), AEEGSI (2017),** Waddams Price et al. (2013), Hortaçsu et al. (2015), Flores and Waddams Price (2013), Giulietti et al. (2005), Ek and Soderholm (2008), Gamble at al. (2008), , Bladh (2005), Crampes and Waddams Price (2017)
- **Consumer search and market equilibria: Janssen et al. (2005)**, Varian (1980), Burdett and Judd (1983), Wolinsky (1984) and (1986), Anderson and Renault (1999), Stahl (1989) and (1996), Moraga-Gonzalez et al. (2016), Reinganum (1979), Bar Isaac et al. (2012), Burdett and Judd (1983), Armstrong (2016), Anderson and Renault (2016), Arbatskaya (2007), Grubb, 2015).

Institutional framework

- From July 2007 all consumers, including households and small firms, can choose their electricity provider
- To guarantee a default option it was introduced a **standard contract** where the price is set and updated quarterly by the Regulator
- The Government plans to **lift** the regulated contract by January 2019 (originally Jan. 2018)
- The Regulator has improved the **transparency** of the electricity bill and is planning to impose retailers to offer in their menu also a **standard contract** with fixed clauses, being free to choose only the price.

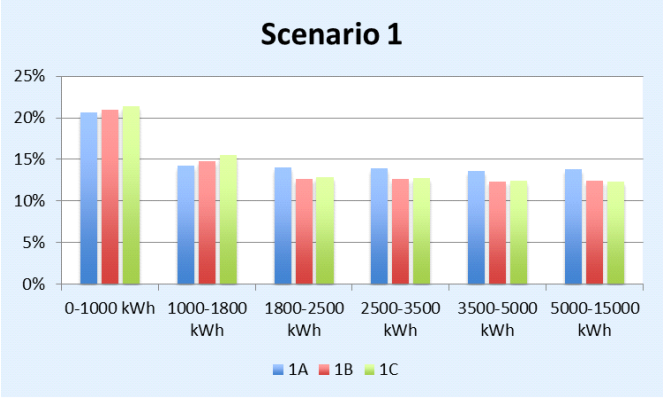
Empirical evidence

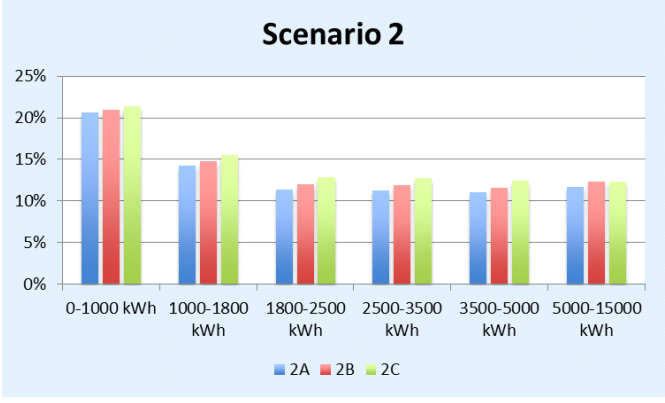
- The regulator runs **surveys** on energy retail markets: available evidence on 2012-13 and 2014-15.
- **Low participation** of **households** in the free market: in 2015 still 68% with the regulated contract
- **Low** and slowing down **switching rates** ($<5\%$) to the free market, and a percentage of switchers going back to the regulated contract
- The **average price of energy** of consumers on the **free market** 10-15% **higher** than the regulated one

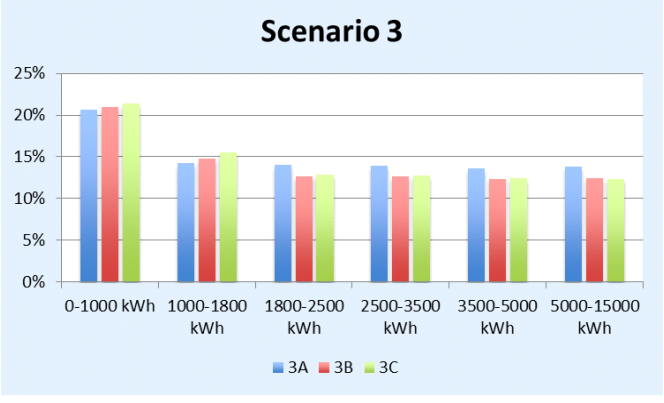
Bargains and ripoffs for switchers to the free market

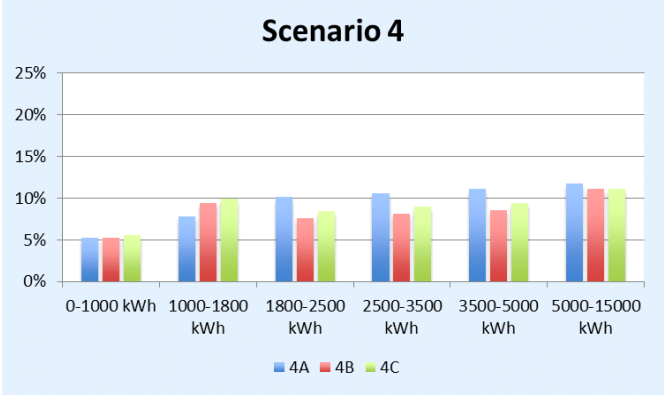
- **Analysis of contracts** for new clients offered in the free market (as in the CMA Energy survey), based on the Regulator's Price Comparison Website (March-April 2017)
- No available data on characteristics of households with the regulated contract: construct **consumer profiles**:
  - **Annual bill** of a given contract depends on the **power installed** and the annual **total and peak/off-peak consumption**.
  - We consider contracts for an **installed power** $\leq 3KW$ (77% households with the regulated contract)
  - Annual **average total consumption**: 6 classes
  - **Peak-off peak allocation** of consumption: three scenarios (85%, 70%, 50% off-peak)
  - **4 different consumer profiles**: those interested in **all** available contracts, those that look only for **single-price** offers, for **variable price** or for payments only through **postal paying-in slips**

Bargains: best offer among the contracts cheaper than the regulated one **(**$\sim$ **50%** of the offers in the PCW**)**

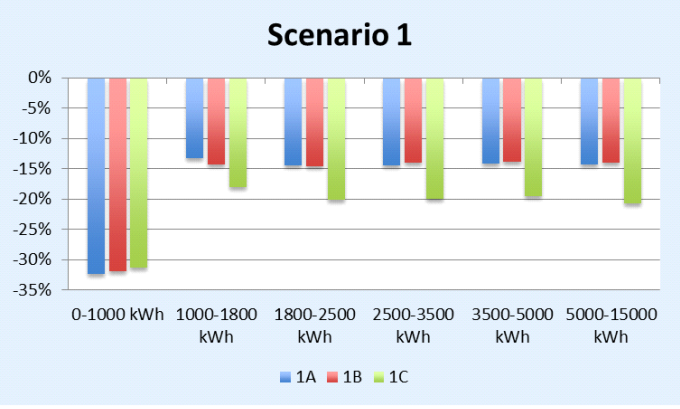


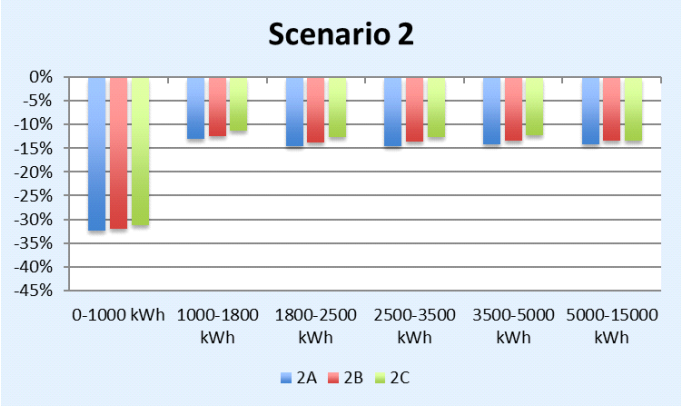


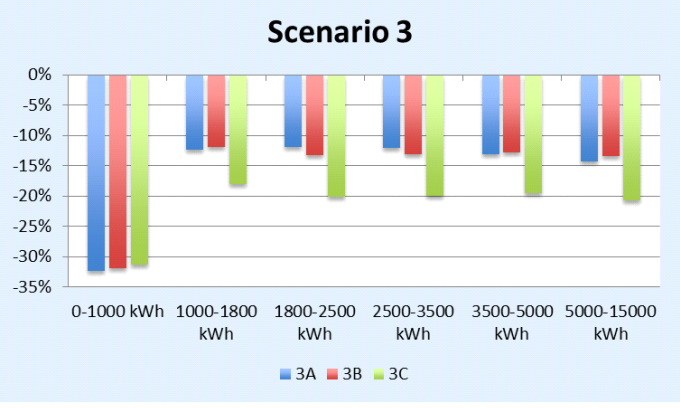


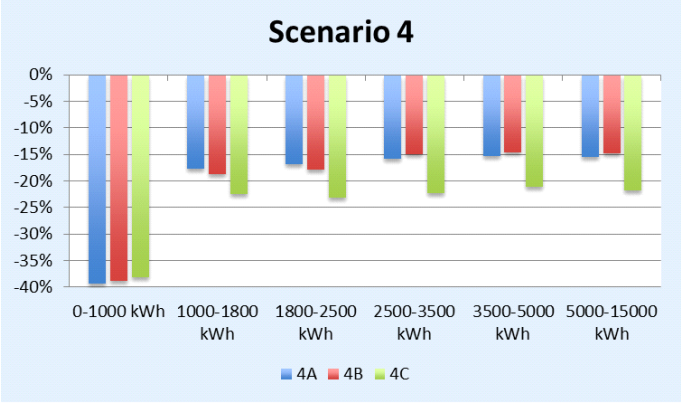


Ripoffs: worst offer among the contracts more costly than the regulated one **(**$\sim$ **50%** of the offers in the PCW, not exlained by additional services)









The **evidence** shows

1. **Price dispersion:** stronger for low consumption classes
2. **Low participation**
3. Contracts in some cases **cheaper** but in other cases **more costly** than the regulated price in the running contract

- While 1. and 2. may be obtained in a **standard model of sequential search** (e.g. Janssen et al. 2005) the last one does not.
- We introduce a perception bias on the current regulated price: some consumers have a **biased perception** of the current regulated price they are paying.
  - contract signed in the past and the price updated quarterly by the regulator. Not easy to take track of the changes or to identify the price from the electricity bill.

The Model (generalization of Janssen et al 2005)

- n **firms** offering a homogeneous product and competing in prices
- A mass of **consumers**, initially paying the **regulated price** p_R, that **search** sequentially with recall for quotes in the free market and **heterogeneous** under two dimensions:
  - The **search cost**: **shoppers** (S) have zero search costs, **non shoppers** (NS) have a search cost $c > 0$
  - The **perception** of the current **regulated price** in their bill:

$$p_0^i = \begin{cases} p_0^L = p_R - k & \textbf{low type } L \\ p_0^U = p_R & \textbf{unbiased type } U \\ p_0^H = p_R + k & \textbf{high type } H \end{cases}$$

  - **Shoppers** have **unbiased** perception of the regulated price: (S, U).
  - **Non-shoppers** have either an **upward** bias or a **downward** bias of p_R: (NS, L) and (NS, H)

The **timing** of the game is as follows.

- At **stage** 0 Nature draws **consumers' types** with $\Pr(S,U) = \mu$ and $\Pr(NS,L) = \Pr(NS,H) = \frac{1-\mu}{2}$. Consumers observe their type while firms know the distribution of types but not the individual realizations.
- At **stage** 1 **firms** $h = 1, .., n$ simultaneously choose a **price probability distribution** $f_h(p)$ and each firm h draws a price according to $f_h(p)$.
- At **stage** 2 **consumers** decide to carry on with the running regulated contract or to **search** sequentially starting from $t = 1, 2, ..$ given their type (S,U), (NS,L) and (NS,H), the firms' pricing strategies $F_h(p)$ and the set of available prices P_t^i.

Consumers' choices: participation and search

- **Shoppers** always search all prices and subscribe a contract if the **lowest price** is not higher than p_R.
- **Non shoppers:**
  - Given a symmetric mixed strategy $f(p)$ the **reservation price** r makes a **non-shopper** of either type **indifferent** between choosing r or searching one more time:

$$r = E(p) + c$$

  - **Optimal search:** after $t > 0$ searches
    - **Search** a new offer if the **lowest available price** $> r$.
    - **Stop and purchase** at the **lowest available price** if it is $\leq r$.
  - **Decision to participate (first search)**: if the **perceived initial price** $> r$ $(= r)$ non-shopper $i = L, H$ searches with probability 1 (with probability $\theta_1^i \in (0, 1)$.

Consumers' choices: participation and search

- Hence, given the mixed strategy $f(p)$ the **reservation price** r is **the same for all non-shoppers** but the **decision to participate** θ_1 running the first search **may differ** between **low** and **high type non-shoppers**.
- In any equilibrium $\theta_1^H \geq \theta_1^L$: if some non shoppers are active, at least some of them are high type.
- Since firms do not choose a price higher than r, **non shoppers search at most once**.
- **Participation on non-shoppers** is uniquely described by

$$\theta_1 = \frac{\theta_1^H + \theta_1^L}{2}.$$

Firms' strategies: symmetric mixed strategies given the reservation price r and the participation rate θ_1

- If $r \leq p_R$ the mixed strategy has a **continuous support** $\left[\underline{p}, r\right]$ and no atom (as in Janssen et al. 2005);
- If instead $r > p_R$ the mixed strategy has a **continuous support** up to p_R and an **atom** at r.
- Firm h **profits** when the other $n-1$ firms play the mixed strategy $F(p)$:

$$\pi_h = \begin{cases} p\left[\frac{(1-\mu)\theta_1}{n} + \mu(1-F(.))^{n-1}\right] & \text{if } p \in [0, min\{p_R, r\}] \\ p\frac{(1-\mu)\theta_1}{n} & \text{if } p \in (min\{p_R, r\}, r] \\ 0 & \text{if } p > r \end{cases} \tag{1}$$

- **Optimal mixed strategy** given the **reservation price** r and **participation rate** θ_1

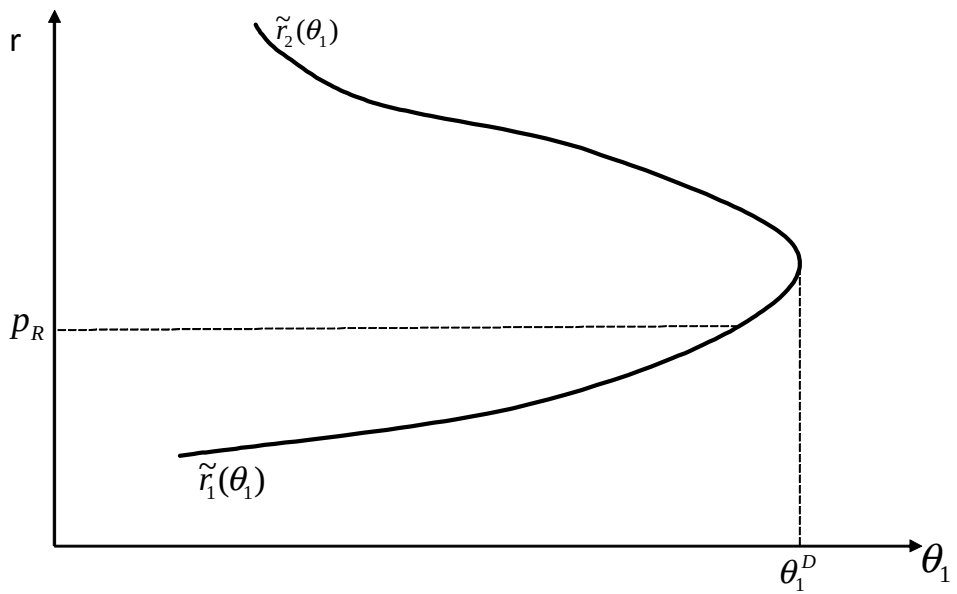
$$\widetilde{F}(p; r, \theta_1) = \begin{cases} 1 - \left[\frac{\theta_1(r-p)}{nbp}\right]^{\frac{1}{n-1}} & \text{if } p \in \left[\underline{p}, \min\left\{p_R, r\right\}\right] \\ 1 - \left[\frac{\theta_1(r-p_R)}{nbp_R}\right]^{\frac{1}{n-1}} & \text{if } p \in \left(\min\left\{p_R, r\right\}, r\right) \\ 1 & \text{if } p \geq r \end{cases} \tag{2}$$

- Plugging $\widetilde{F}(p; r, \theta_1)$ into the expression of the reservation price $r = E(p) + c$ and solving for r we obtain a locus :

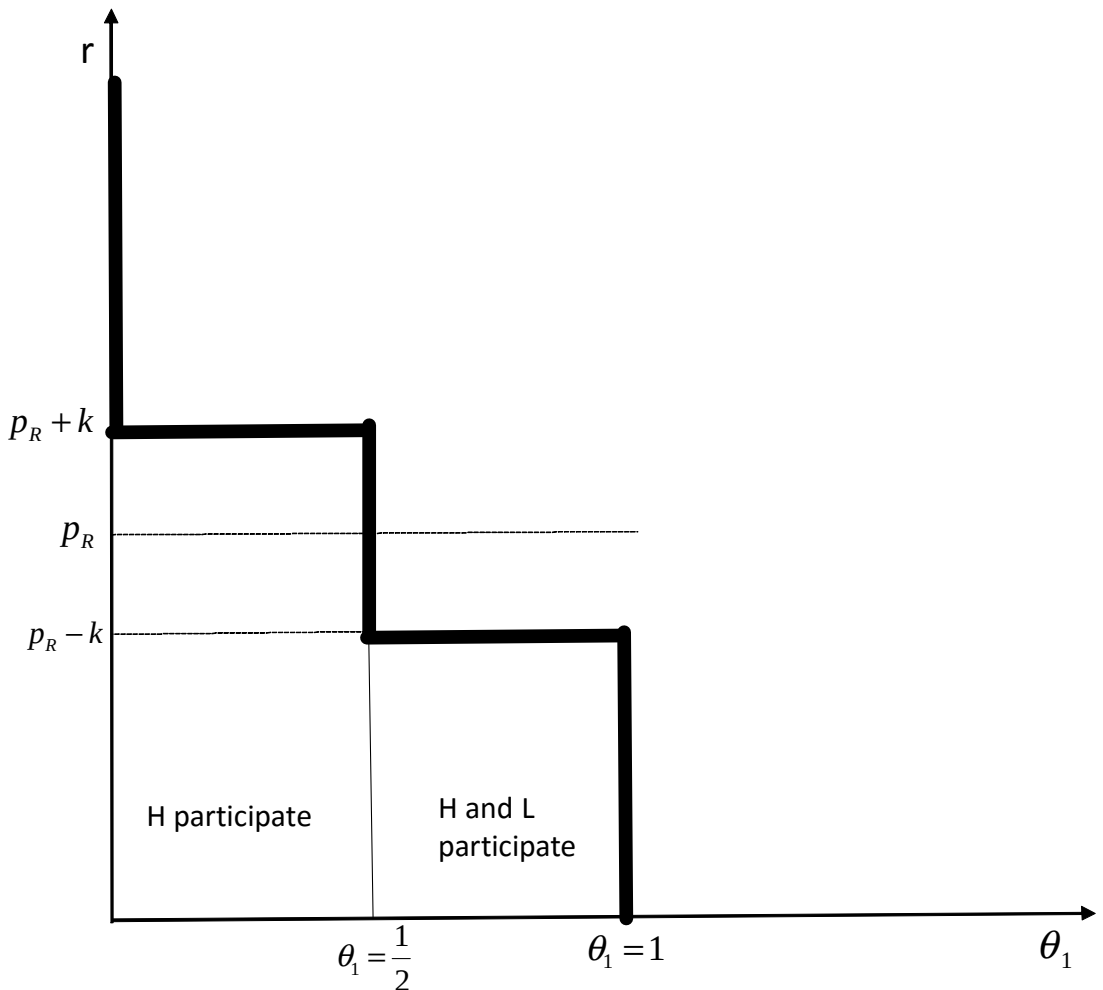
$$r = \widetilde{r}(\theta_1) \tag{3}$$

that describes **for given participation rate** θ_1 the **reservation price** r consistent with the **optimal mixed strategy** and the **optimal search behavior of non-shoppers**.

- $\widetilde{r}(\theta_1)$ is backward banning, with $\widetilde{r}_1(\theta_1)$ the increasing portion and $\widetilde{r}_2(\theta_1) > \widetilde{r}(\theta_1^D)$ the decreasing one.
- different equilibria depending on the value of θ_1^D.



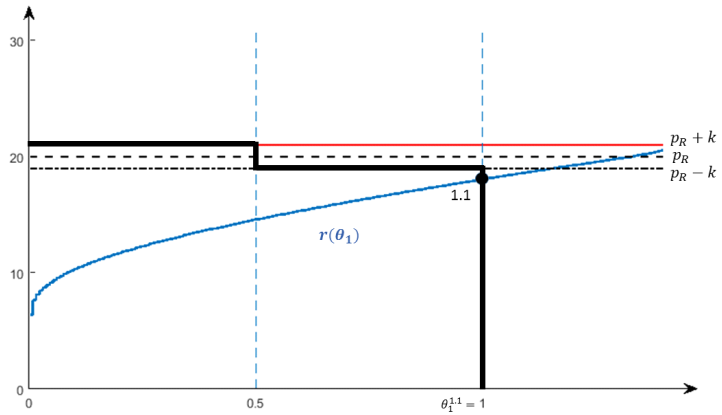
- To close the model, the **optimal participation rate** of **non shoppers** is defined by the function $\widetilde{\theta}_1(r)$:



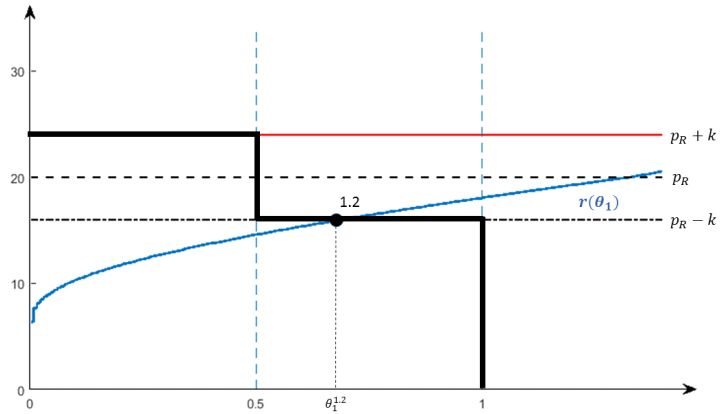
- Then, a Perfect Bayesian **Equilibrium** is a triple $\left\{F^*(p) = \widetilde{F}(p; r^*, \theta_1^*), r^* = \widetilde{r}(\theta_1^* F^*), \theta_1^* = \widetilde{\theta}_1(r^*, F^*)\right\}$
- Graphically, in the (θ_1, r) space the equilibria are the **points of intersection** between the **locus** $r = \widetilde{r}(\theta_1)$ and the **function** $\theta_1 = \widetilde{\theta}_1(r)$.
- Given p_R changes in k move the curve $\theta_1 = \widetilde{\theta}_1(r)$ while changes in c, μ and n shift the curve $r = \widetilde{r}(\theta_1)$ generating different equilibrium configurations.

Equilibria in Proposition 1: (simulation with Matlab)

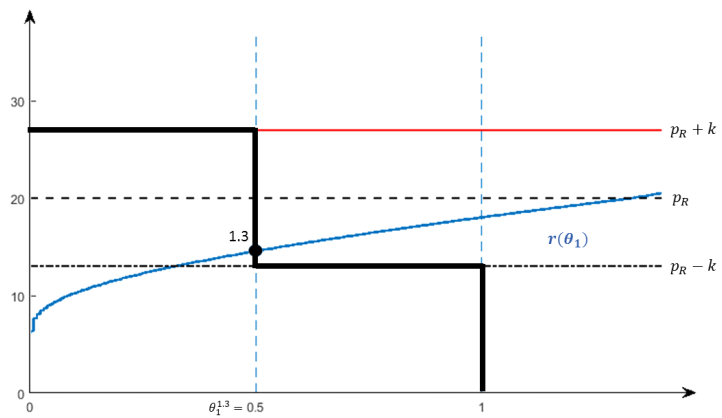
Case 1.1: $\mu = 0.5, n = 10, c = 4, p_R = 20, k = 1$



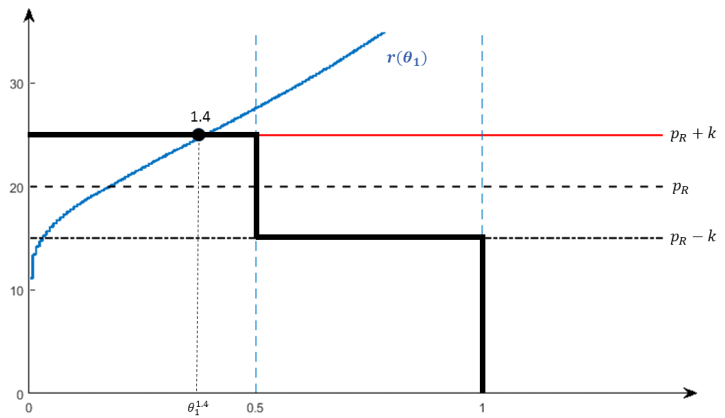
Case 1.2: $\mu = 0.5, n = 10, c = 4, p_R = 20, k = 5$



Case 1.3: $\mu = 0.5, n = 10, c = 4, p_R = 20, k = 7$

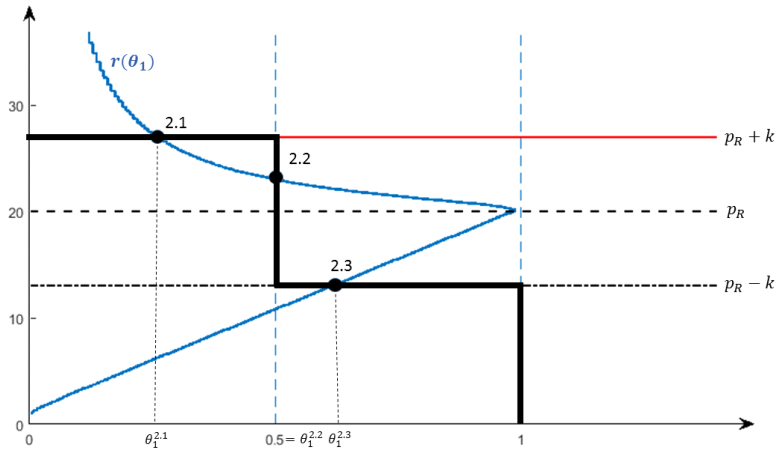


Case 1.4: $\mu = 0.5, n = 10, c = 7, p_R = 20, k = 5$

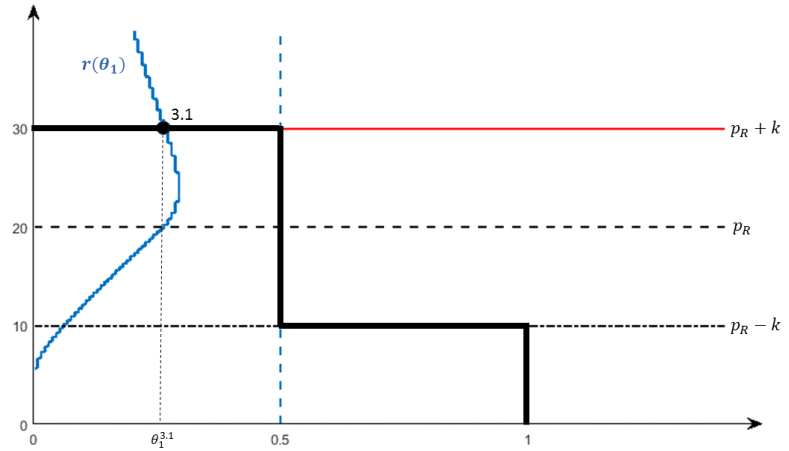


Equilibria in Proposition 2 (multiple equilibria) and 3 (simulation with Matlab)

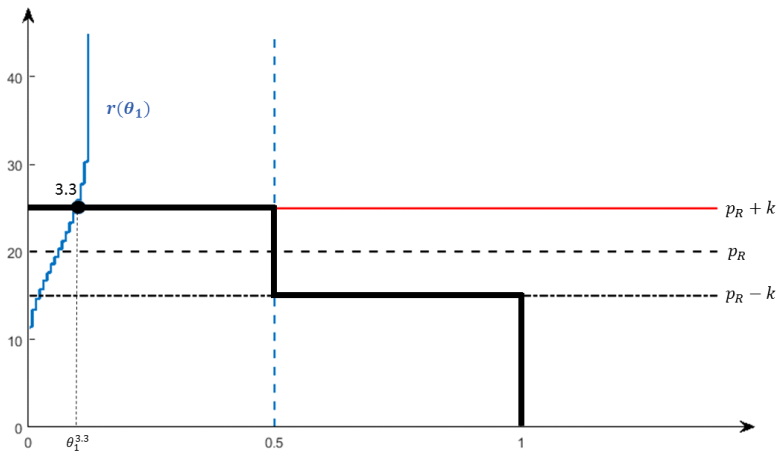
Case 2: $\mu = 0.05, n = 2, c = 1\ p_R = 20, k = 7$



Case 3.1: $\mu = 0.1, n = 3, c = 5\ p_R = 20, k = 10$



Case 3.3: $\mu = 0.1, n = 3, c = 10, p_R = 20, k = 5$



- In all the mixed strategy equilibria we have **price dispersion,** as observed in the market.
- Comparing the equilibria $1.1 - 1.3$, obtained for increasing values of the perception bias k, we observe that:
  - when the marginal consumer is the low type, an **increase in the noise** k makes him more optimistic and less willing to participate, with a **contraction in the size of the market**
  - **a larger market is less competitive**: when participation in the free **market**, $\mu + (1-\mu)\theta_1^*$, is **larger shoppers matter less** in the composition of active consumers, making firms competing less aggressively
- In equilibrium 1.4, 2.1, 3.1 and 3.3 there is **partial participation of high types** only and the **more costly contract** is **more expensive** than the **regulated price**: $\widetilde{r}_2(\theta_1^*) > p_R$ as we found in our empirical analysis
- In case 2 we have multiple-equilibria characterized by an **increasing participation** and **decreasing maximum and expected price**

Comparative statics: perception bias k

In the equilibria with **full participation** *of both types (*1.1*) or high types only (*1.3 *and* 2.2*) a marginal variation in the perception bias k does not affect the expected price $E^*(p)$ and participation rate θ_1^*.*

In the equilibria with **partial participation of low types** *(*1.2 *and* 2.3*) the expected price $E^*(p)$ and participation rate θ_1^* are decreasing in the perception bias.*

In the equilibria with **partial participation of high types** *the expected price $E^*(p)$ is always increasing in the perception bias while the participation rate is increasing in k in equilibria* 1.4 *and* 3.3 *and decreasing in k in equilibria* 2.1 *and* 3.1*.*

Comparative statics: perception bias k

$k \uparrow$	$\frac{\partial p_0^{i*}}{\partial k} > 0 \ (i^* = H)$	$\frac{\partial p_0^{i*}}{\partial k} < 0 \ (i^* = L)$
$\frac{\partial r^*}{\partial \theta_1} > 0 \ (r^* = \widetilde{r}_1(\theta_1))$	$E^*(p) \uparrow, \theta_1^* \uparrow$ eq. 1.4 and 3.3	$E^*(p) \downarrow, \theta_1^* \downarrow$ eq. 1.2 and 2.3
$\frac{\partial r^*}{\partial \theta_1} < 0 \ (r^* = \widetilde{r}_2(\theta_1))$	$E^*(p) \uparrow, \theta_1^* \downarrow$ eq. 2.1 and 3.1	

Comparative statics: search cost c

In the equilibria with **full participation** *of both types or high types only, if the entry condition is not binding, the participation rate is not affected by the level of the search cost while the expected price is increasing in* c *in equilibrium* 1.1 *and* 1.3 *and decreasing in equilibrium* 2.2.

In the equilibria with **partial participation** (1.2, 1.4, 2.1, 2.3, 3.1, 3.3) *both the expected price* $E^*(p)$ *and participation rate* θ_1^* *are* decreasing *in the search cost* c*. Equilibria with full participation and a binding entry condition (*$p_R - k = r(1)$ *or* $p_R + k = r(\frac{1}{2})$*), behave as partial participation equilibria.*

Comparative statics: search cost c

$c \uparrow$	$r^*(\theta_1^*) = r_1^*(\theta_1^*)$	$r^*(\theta_1^*) = r_2^*(\theta_1^*)$
$\theta_1^* = 1, \theta_1^* = \frac{1}{2}$ full participation	$E^*(p) \uparrow$, θ_1^* constant eq. 1.1 and 1.3	$E^*(p) \downarrow$, θ_1^* constant eq. 2.2
$\theta_1^* \in \left(0, \frac{1}{2}\right)$, $\theta_1^* \in \left(\frac{1}{2}, 1\right)$ partial participation	$E^*(p) \downarrow$, $\theta_1^* \downarrow$ eq. 1.2, 1.4, 2.3, 3.3	$E^*(p) \downarrow$, $\theta_1^* \downarrow$ eq. 2.1, 3.1

Policy implications: how to improve market performance

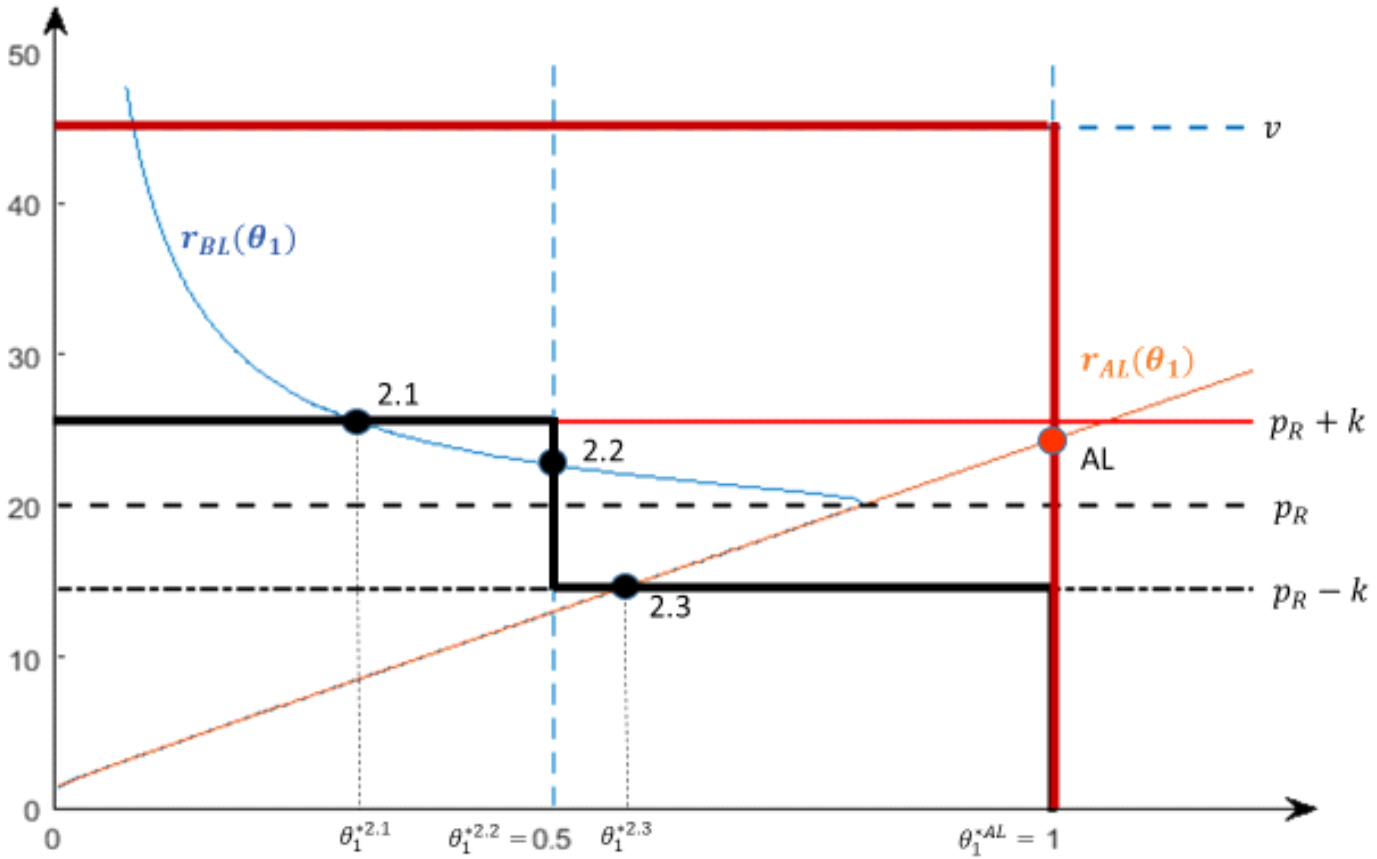
- Our model shows that a **poor information** on the **current price** paid deeply **affects the market equilibria**, even when the information on new contracts is (costly but) precise. Hence a **transparent bill**, possibly lowering the **perception bias** k, is as important as information on new contracts through **PCW**'s, that may reduce the **search cost**s c.
- We show, however, that the impact of a decrease in c or k depends on the **initial equilibrium** configuration and may display **unconventional comparative statics properties**, depending on which type of non-shopper is the marginal consumer.

Lifting the regulated price

- The government has planned to lift the regulated price by January 2019.
- Given the present performances of the free market, a concern that consumers will be worse off.
- Can we use the model to predict how the average price may change once we drop the regulated price?
- The multiplicity of equilibria and the non-conventional comparative statics properties suggest that a single answer is unwarranted.

Lifting the regulated price

Lifting the regulated tariff: $\mu = 0.05, n = 2, c = 1.2, p_R = 20, k = 5.5$



Lifting the regulated price

- If the level of participation is low (only pessimistic customers) at the time the regulated price is lifted prices may fall: the mixture of new customers exerts a competitive pressure on firms.
- If the participation is large (also optimistic customers already participate) then the price can raise: lifting the outside option of the regulated price leaves the customers unprotected.