Coverage for fuel poverty

Corinne Chaton[1] Marie-Laure Guillerminet[2]

[2]FiME ; [3]ADEME

April 2023

Table of Contents

Table of Contents

Context: rising energy prices

Since 2019, rising energy prices

- Demand $>$ Supply
- Tight liquefied natural gas market, storage levels at their lowest in years, and moderation of Russian exports due to the fire in the Yamal-Europe gas pipeline
- Electricity - merit order

Since March 2022, the war in Ukraine has accentuated this price increase
$\rightarrow$ rising prices of raw materials and manufactured goods
$\rightarrow$ loss of purchasing power

Context: Energy Tariff Shield

To cope with rising energy prices,

Context: Energy Tariff Shield

To cope with rising energy prices,

In 2021 Jean Castex announced an energy tariff shield for 2022 (2022 Finance Act)

Context: Energy Tariff Shield

To cope with rising energy prices,

In 2021 Jean Castex announced an energy tariff shield for 2022 (2022 Finance Act)

In 2022 Gabriel Attal announced that this energy price cap would carry over into 2023 in order to "*continue to protect the French households and their purchasing power*"

Context: Energy Tariff Shield

To cope with rising energy prices,

In 2021 Jean Castex announced an energy tariff shield for 2022 (2022 Finance Act)

In 2022 Gabriel Attal announced that this energy price cap would carry over into 2023 in order to "*continue to protect the French households and their purchasing power*"

Since the fall of 2021, this policy has cost 24 billion euros, including 10.5 billion euros to cap the increase in electricity rates at 4% (Ministry of Economy and Finance)

Tariff Shield: **an emergency and short-term measure that benefits every household**

Aim

Proposition: an insurance against fuel poverty **(FP)**[1]:

- an in-kind insurance that guarantees "minimum energy": $\underline{e}$
- for "well-off" households
- according household and housing characteristics

[1] *"Is in fuel poverty* [...] *a household that has difficulties obtaining the necessary energy to satisfy his basic needs due to inadequacy of his resources or his living conditions."* Grenelle 2 (July 12, 2010)

Interest

This coverage: an ex-ante measure to prevent FP (costly for society)

Facts:

- in 2018, 17% of the French households in FP = about 5 millions households = 11 millions people (Chaton & Gouraud, 2020)
- in 2018, 9.3 millions poor people[2] = about 15% of the total population (INSEE, 2020)

Impacts of the FP:

- on health (Lacroix & Chaton, 2015 ; Kahouli, 2020 ; Awaworyi Churchill & Smyth, 2021)
- cash flow problems for energy suppliers, social and private landlords...

[2] i.e. those living below the income poverty line, which is set at 60% of the median median standard of living.

Modelling strategy

- 2-goods and 2-periods insurance model (Schlesinger & Zhuang, 2014, 2019), (Alasseur et al., 2022)
- Utility function with "essential baskets" of energy and composite good $(\underline{e}, \underline{x})$
- $\underline{e}$, $\underline{x}$ household-specific
- Probability of loss of purchasing power (uncertainty about future income)
- Calibration using data from the Statistics on Resources and Living Conditions (2018SRCV and 2019SRCV)

Focus on non-fuel-poor households living in an all-electric dwelling, with an EDF's Blue peak/off-peak tariff

Table of Contents

Assumptions

2 years ($t = 0, 1$), a discount rate (β), 2 goods (x_t, e_t), 2 markets (p_t^x, p_t^e), 2 essential baskets ($\underline{e}$, $\underline{x}$)

- Non-fuel-poor household in $t = 0$, i.e. $w_0 > p_0^x \underline{x} + p_0^e \underline{e}$
- Separable utility function, $U(x_t, e_t) = u(x_t) + \alpha v(e_t)$ with for all $e_t < \underline{e}$, $v(e_t) < 0$ and for all $x_t < \underline{x}$, $u(x_t) < 0$
- $w_1 = \widetilde{\omega} w_0$
- Coverage against the fuel poverty, $(p^I, \underline{e}, \overline{\omega})$

$$e_1^I(\omega, w_0) = e_1^{'}(\omega, w_0) + \underline{e} 1_{I=1, \omega \leq \overline{\omega}} \tag{1}$$

Remark

If $\overline{\omega} \to \infty$ the insurance is equivalent to a prepayment

Household decisions

In $t = 0$ the household takes out an insurance if $(EU^{I=1}) \geq (EU^{I=0})$

- Without insurance:

$$V^0(w_t) := \max_{(x_t, e_t) \in \mathbb{R}^2_+} U(x_t, e_t), \quad \text{u.c.} \quad p^x_t x_t + p^e_t e_t \leq w_t$$

$$\text{EU}^{\emptyset}(w_0, \omega) := V^0(w_0) + \beta[V^0(\omega w_0)]$$

- With insurance : $\text{EU}(w_0, p^I, \omega, \bar{\omega}) := V_0(w_0, p^I) + \beta[V_1(w_0, \omega, \bar{\omega})]$ with

$$V_0(w_0, p^I) := V^0(w_0 - p^I),$$

$$V_1(w_0, \omega\bar{\omega}) := \max_{(x_1, e^{'}_1) \in^2_+} U(x_1, e^{'}_1 + \underline{e}1_{I=1, \omega \leq \overline{\omega}})$$

$$\text{u.c.} \quad p^x_1 x_1 + p^e_1 e^{'}_1 \leq \omega w_0$$

Household preferences

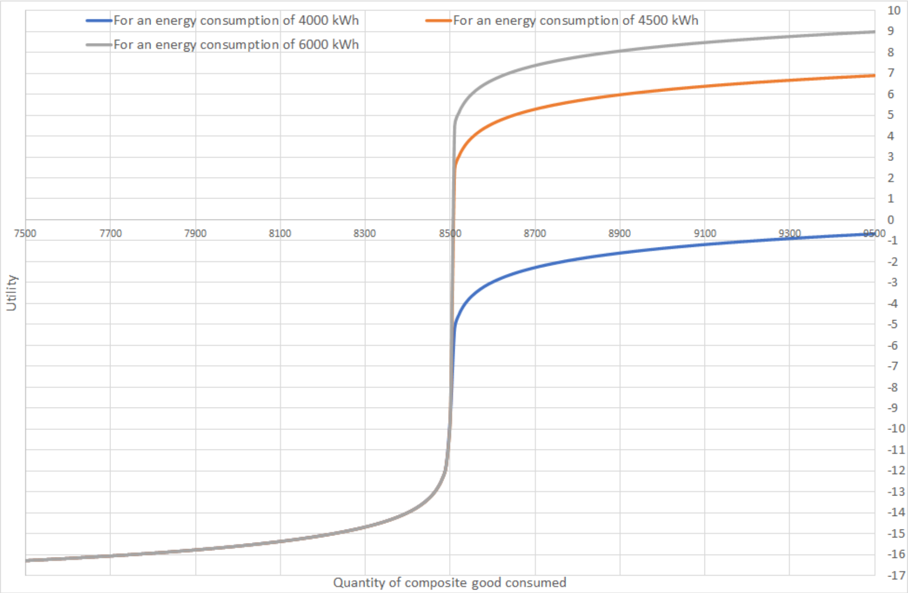
- Prospect theory (Kahneman & Tversky, 1979)

$$u(y) := v(y) := \begin{cases} \nu_m(y) := -\ln\left(1 - y + \underline{y}\right) & \text{if} \quad 0 \leq y < \underline{y}, \\ \nu_M(y) := \ln(1 + y - \underline{y}) & \text{if} \quad y \geq \underline{y}. \end{cases} \tag{2}$$

- **H1.** $\forall x < \underline{x}$, $e_t = 0$.
- Under H1 and with the specifications of $u(.)$ and $v(.)$ defined by (2), we consider

$$U(x_t, e_t) = \begin{cases} U_{m,0}(x_t, e_t) = \nu_m(x) - \alpha_m \ln(1 + \underline{e}) \text{ if } 0 \leq x_t < \underline{x} \quad (\forall e_t), \\ U_{M,m}(x_t, e_t) = \nu_M(x) + \alpha_m \nu_m(e) \text{ if } x_t \geq \underline{x} \text{ and } 0 \leq e_t < \underline{e}, \\ U_{M,M}(x_t, e_t) = \nu_M(x) + \alpha_M \nu_M(e) \text{ if } x_t \geq \underline{x} \text{ and } e_t \geq \underline{e}. \end{cases}$$

α_M: **parameter of energy saving** ; α_m: effort to obtain $\underline{e}$.



Utility function

Household preferences

- If $e_t \geq \underline{e}$ and $x_t \geq \underline{x}$ the indifference curve is convex; if $e_t < \underline{e}$ and $x_t \geq \underline{x}$ it depends on α_m (convex if $\alpha_m > 1$)
- **Notation**:
  - $(m, 0)$: $x_t < \underline{x}$ and $e_t = 0 \rightarrow$ poor households
  - (M, m) : $x_t \geq \underline{x}$ and $e_t < \underline{e} \rightarrow$ fuel poor ones
  - (M, M) : $x_t \geq \underline{x}$ and $e_t \geq \underline{e} \rightarrow$ non-fuel-poor ones

Household's choice

- **Definitions**:
  - "disposable" (missing) income in t, $W_t^d(w_t) = w_t - (p_t^x \underline{x} + p_t^e \underline{e})$
  - in precarious situation in t if $W_t^d(w_t) < 0$
- Consumption when the household does not purchase fuel insurance $\rightarrow$ conditions on income and on α_M
  - **H2.** $p_t^e < p_t^x + \max(W_t^d; 0)$ and $\alpha_M \in \left[\frac{p_t^e}{p_t^x + W_t^d}; 1\right]$
  - H2 + $W_t^d(w_t) \geq 0 \Rightarrow x_t \geq \underline{x}$ and $e_t \geq \underline{e}$
  - Existence of an interval $= [p_t^e \underline{e} + p_t^x \underline{x} + p_t^e - \alpha_m p_t^x; p_t^e \underline{e} + p_t^x \underline{x}]$ for which there is no equilibrium $\rightarrow$ additional hypothesis about the behavior of the household (specifically on the effort parameter)

Selected utility function

- Income-dependant parameters (w)
  - **H3**: if $e_t < \underline{e}$ then $x_t \leq \underline{x}$
  - H3 + the equilibrium in $(M, m) \Rightarrow \alpha_m(w_t) = \underline{x} + \frac{p_t^e(1+\underline{e})-w_t}{p_t^x}$
  - $\bar{\alpha}_m = \alpha_m(p_t^x \underline{x}) = \frac{p_t^e}{p_t^x}(1+\underline{e})$

$$U(x_t, e_t) = \begin{cases} U_{m,0}(x_t, e_t) = \nu_m(x) - \bar{\alpha}_m \ln(1+\underline{e}) & \text{if} \quad 0 \leq x_t < \underline{x} \quad (\forall e_t) \\ U_{M,m}(x_t, e_t) = \nu_M(x) + \alpha_m(w_t)\nu_m(e) & \text{if} \quad x_t \geq \underline{x} \text{ and } 0 \leq e_t < \underline{e} \\ U_{M,M}(x_t, e_t) = \nu_M(x) + \alpha_M \nu_M(e) & \text{if} \quad x_t \geq \underline{x} \quad \text{and} \quad e_t \geq \underline{e} \end{cases}$$

Consumption without insurance

$$x_t^{\emptyset}(w_t) := \begin{cases} x_t^{(m,0)} = \frac{w_t}{p_t^x} & \text{if } w_t < p_t^x \underline{x} \\ \underline{x} & \text{if } p_t^x \underline{x} \le w_t < p_t^e \underline{e} + p_t^x \underline{x} \\ x_t^{(M,M)} & \text{if } w_t \ge p_t^e \underline{e} + p_t^x \underline{x} \end{cases} \quad (4)$$

$$e_t^{\emptyset}(w_t) := \begin{cases} 0 & \text{if } w_t < p_t^x \underline{x} \\ (w_t - p_t^x \underline{x})/p_t^e & \text{if } p_t^x \underline{x} \le w_t \le p_t^e \underline{e} + p_t^x \underline{x} \\ e_t^{(M,M)} & \text{if } w_t \ge p_t^e \underline{e} + p_t^x \underline{x} \end{cases} \quad (5)$$

with

$$x_t^{(M,M)}(w_t) = \underline{x} - \frac{p_t^x \alpha_M - p_t^e}{p_t^x(\alpha_M + 1)} + \frac{W_t^d(w_t)}{p_t^x(1 + \alpha_M)} \quad (6)$$

$$e_t^{(M,M)}(w_t) = \underline{e} + \frac{p_t^x \alpha_M - p_t^e}{p_t^e(\alpha_M + 1)} + \frac{\alpha_M W_t^d(w_t)}{p_t^e(1 + \alpha_M)} \quad (7)$$

Consumption with insurance

- **Household likely to be covered**:
  $W_0^d(w_0) \geq p^I + \max\left(\frac{p_t^e}{\alpha_M} - p_t^x; -p_t^e + p_t^x \alpha_M\right)$
- Consumption in $t = 0$: $(x_0^{(M,M)}(w_0 - p^I), e_0^{(M,M)}(w_0 - p^I))$
- **Insurance trigger**: $W_1^d(w_1) < 0 \Leftrightarrow \omega < \overline{\omega}(w_0)$ with

$$\overline{\omega}(w_0) = \frac{p_1^e \underline{e} + p_1^x \underline{x}}{w_0} \qquad (8)$$

- **H4**: $U_{m,\underline{e}}^I(x_1, e_1) = \nu_m(x)$ if $0 \leq x_1 < \underline{x} \quad (\forall e_1)$

Consumption with insurance

$$x_1^1(w_0,\omega) := \begin{cases} x_1^{(m,\underline{e})} = x_1^{(m,0)} & \text{if } \omega < \frac{p_1^x \underline{x}}{w_0} \\ x_1^{(M,\underline{e}^+)} = \underline{x} + \frac{W^{d_x}(\omega) - p_1^x \alpha_M + p_1^e}{p_1^x(\alpha_M+1)} & \text{if } \frac{p_1^x \underline{x}}{w_0} \leq \omega < \overline{\omega}(w_0) \\ x_1^{(M,M)} & \textit{otherwise} \end{cases}$$

$$e_1^1(w_0,\omega) := \begin{cases} \underline{e} & \text{if } \omega < \frac{p_1^x \underline{x}}{w_0} \\ e_1^{(M,\underline{e}^+)} = \underline{e} + \frac{(W^{d_x}(\omega) + p_1^x)\alpha_M - p_1^e}{p_1^e(\alpha_M+1)} & \text{if } \frac{p_1^x \underline{x}}{w_0} \leq \omega < \overline{\omega}(w_0) \\ e_1^{(M,M)} & \text{otherwise} \end{cases}$$

where $W^{d_x}(\omega) = \omega w_0 - p_1^x \underline{x}$

Willingness to pay for fuel insurance

$$\Delta U = \mathbb{E}U(w_o, p^l, \omega, \bar{\omega}) - \mathbb{E}U^0(w_0, \omega)$$

$$= \Delta V_0 + \beta \int_{\omega^m}^{\frac{p_1^x \underline{x}}{w_0}} \bar{\alpha}_m \ln(\underline{e} + 1) f(\omega)\, d\omega + \beta \int_{\frac{p_1^x \underline{x}}{w_0}}^{\overline{\omega}(w_0)} \Delta V_{M,m}(\omega, w_0) f(\omega)\, d\omega$$

with $\Delta V_0 = (1+\alpha_M) \ln \left(1 - \frac{p^l}{W_0^d(w_0) + p_0^e + p_0^x}\right)$ and

$$\Delta V_{M,m}(\omega, w_0) = \alpha_M \ln\left(\frac{\alpha_M}{p_1^e}\right) - \ln(p_1^x) + \frac{(p_1^e - W_1^d)}{p_1^x} \ln\left(\frac{p_1^e - W_1^d}{p_1^e}\right) + (1+\alpha_M) \ln\left(\frac{\omega w_0 + p_1^e + p_1^x(1-\underline{x})}{1+\alpha_M}\right)$$

Table of Contents

Parameters of the utility function

- 2019SRCV to determine $\underline{x}$, $\underline{e}$ and α_M
- 10,176 out of 11,737 households are above the poverty line
- 2 types of households characterized by their perception of their current financial situation
  - "We are struggling but are getting by"; "Things are okay but they should be careful" $\rightarrow$ *"strained" households* $\rightarrow$ $\underline{x}$ and $\underline{e}$
  - "We are fine"; "We are rather confortable"; "We are really confortable" $+ W_0^d(w_0) > p^I$ $\rightarrow$ *"well-off" households* $\rightarrow \alpha_M$

Parameters of the utility function

Living standards for composite good $\underline{x}$

- **H5.** If $CU_i = CU_j \Rightarrow \underline{x}_i = \underline{x}_j$
- 4,935 *"strained"* households
- The minimum level of the composite goods per CUs in $t = 0$: $p_0^x \underline{x}_i / CU_i \approx (w_{0,i} - p_0^e e_i)/CU_i$
- $p_{2019}^x = 1$
- mean$(p_0^x \underline{x}_i / CU_i)$ =19,724; median$(p_0^x \underline{x}_i / CU_i)$ =19,257 $\rightarrow$ **1,644 €/month in 2019** (1,474 €/month in 2014 according to Observatoire National de la Pauvreté et de l'Exclusion Sociale (ONPES))

Parameters of the utility function

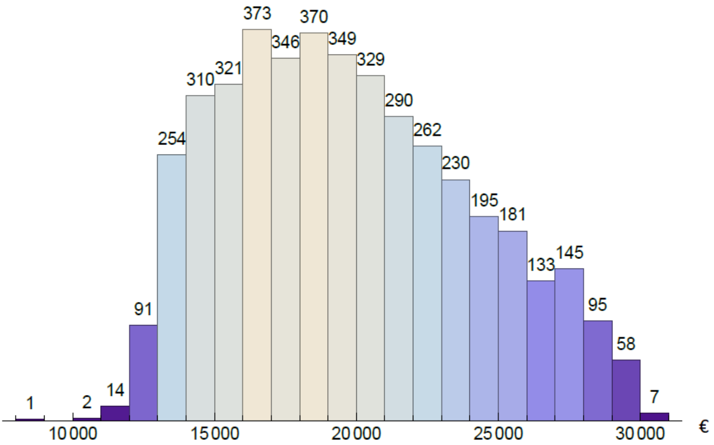


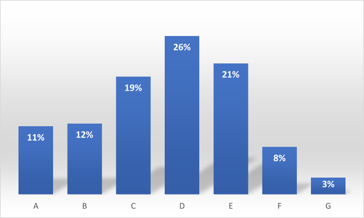
Figure: Frequency histogram of observed $(p^x_{2019}\underline{x}_i/CU_i)$

Parameters of the utility function

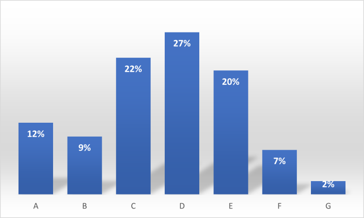
The decent level of energy for *i*

- $\underline{e} = f(\text{characteristics of the dwelling})$
- All-electric dwelling
- To determine $\underline{e}_i$: *"strained"* households (1,150 out of 4,935 *"strained"* households in all-electric dwellings)
- Expenditure data → price assumption → price = EDF's Blue peak/off-peak tariff
  - Lump-sum fee and variable parts
  - Lump-sum fee: the power subscribed, according to the surface
  - Energy demand + tariff → $e_{2019,i}$
  - $\underline{e}$ depends on the surface and the energy efficiency (EPC score) of the dwelling
  - $\epsilon_i = 2.58 \times \frac{e_{2019,i}}{\text{surface}}$ (Annex 3.2 of the decree of 2/8/2012)

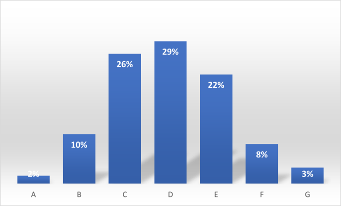
Percentage of households living in all-electric dwellings at each EPC score and for different types of households



“Strained” households



“Well-off” households



All households

Parameters of the utility function

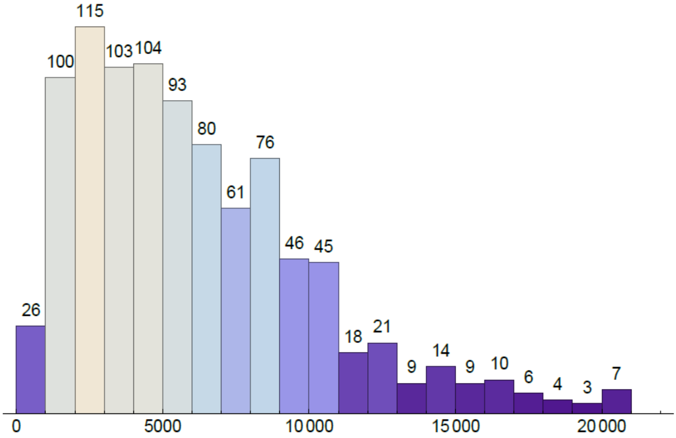
The decent level of energy for the household i

EPC score	A	B	C	D	E	F	G
$\underline{\epsilon}_j$	30.75	70.97	121.62	189.62	268.27	363.57	544.09

Table: Average primary energy consumption ($kWh_{pe}/m^2/year$)

$\rightarrow$ the "well-off" household i living in a dwelling with a EPC score j and a surface s needs a minimum energy level: $\underline{e}_i = 2.58 \times s \times \min(\underline{\epsilon}_j; \epsilon_i)$

Histogram of the minimum energy levels of "well-off" households ($\underline{e}_i$)



The energy saving parameter, α_M

From the equilibrium consumption $e^{(M,M)}_{2019,i}(w_{2019})$, denoted by e_i, we deduce for the "well-off" households

$$\alpha_{M_i} = \frac{(1 + e_i - \underline{e}_i)p^e_{2019,i}}{(\underline{e}_i - e_i)p^e_{2019,i} + 1 + W^d_{2019,i}(w_{2019,i})}$$

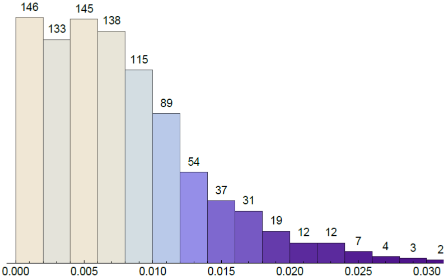


Figure: Histogram of $\alpha_{M,i}$

Illustration for the median household

The median household

- 2-person households
- All-electric dwelling of 80 m^2
- Blue peak/off-peak tariff (40% in off-peak h/ 60% in peak h); subscribed power of 9kVA

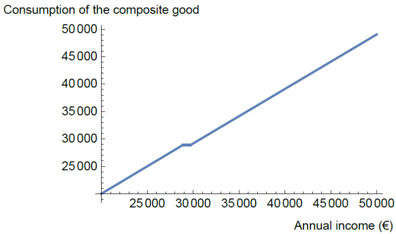
$\rightarrow \underline{x} = 1,644 \times 1.5 = 2,466€/\text{month}$

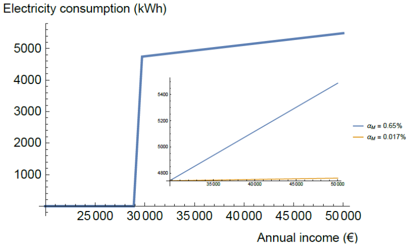
$\rightarrow \underline{e} = 4,744$ kWh/year and p^e_{2019} =17.6 c€/kWh

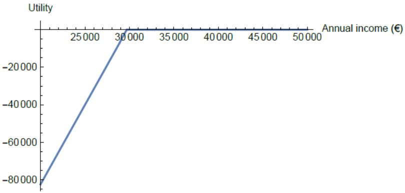
- A "good" D-score dwelling (153 $\text{kWh}_{\text{pe}}/\text{m}^2/\text{year}$)
- α_M = the median of α_M of the 2-person households living in an all-electric dwelling of 80 $m^2 = 0.65\%$

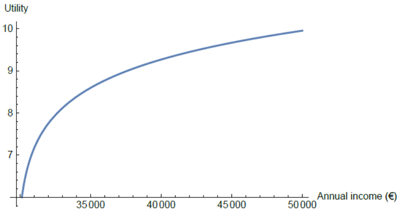
$\rightarrow$ An household is poor if $w_{2019} < 28,890$ €/year and fuel poor if $w_{2019} \leq 29,724$ €/y

Optimal consumption and utility of the median household









Income and its evolution

Probability of income change: $\omega_{i,t} = \frac{w_{i,t+1}}{w_{i,t}}$

2018SRCV and 2019SRCV data

Estimation of the distribution f_{2018} of $\omega_{i,2018}$ (for D3 to D10): t-Student distributions except for D4 which is a mixture of Laplace and Cauchy distributions

Padé approximation for an analytical expression

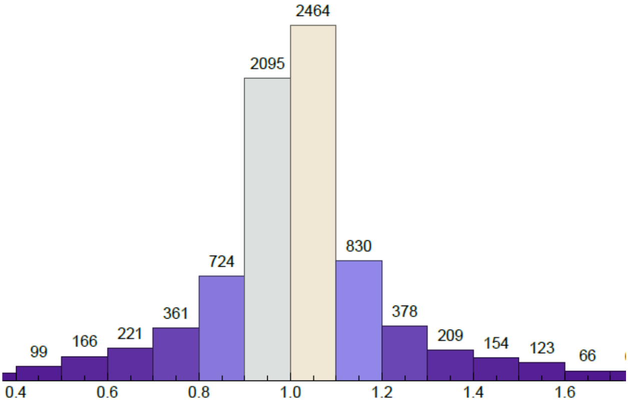
Assessing the willingness to pay for insurance

$$\Delta U = \mathbb{E}U(w_o, p^I, \omega, \bar{\omega}) - \mathbb{E}U^0(w_0, \omega)$$
$$= \Delta V_0 + \beta \int_{\omega^m}^{\frac{p_1^x \underline{x}}{w_0}} \bar{\alpha}_m \ln(\underline{e} + 1) f(\omega)\, d\omega + \beta \int_{\frac{p_1^x \underline{x}}{w_0}}^{\overline{\omega}(w_0)} \Delta V_{M,m}(\omega, w_0) f(\omega)\, d\omega$$

with $\Delta V_0 = (1+\alpha_M) \ln\left(1 - \frac{p^I}{W_0^d(w_0) + p_0^e + p_0^x}\right)$ and

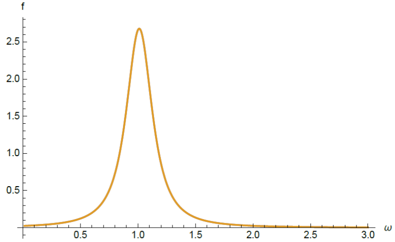
$$\begin{aligned} \Delta V_{M,m}(\omega, w_0) &= \alpha_M \ln\left(\frac{\alpha_M}{p_1^e}\right) - \ln(p_1^x) + \frac{(p_1^e - W_1^d)}{p_1^x} \ln\left(\frac{p_1^e - W_1^d}{p_1^e}\right) \\ &+ (1+\alpha_M) \ln\left(\frac{\omega w_0 + p_1^e + p_1^x(1-\underline{x})}{1+\alpha_M}\right) \end{aligned}$$

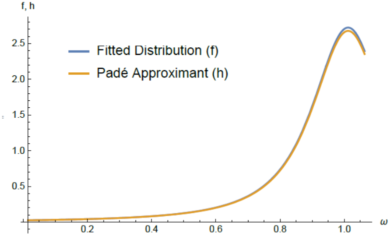
Illustration for all income deciles

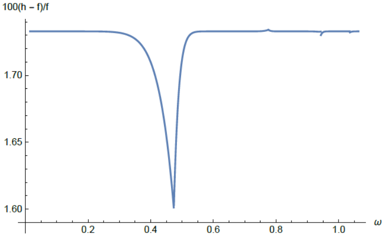


Note: The histogram of $\omega_i = \frac{W_{i,2019}}{W_{i,2018}}$ (the change in income) is truncated on the right for readibility reasons. 6,113 out of 8,368 households have an ω_i value between 0.8 and 1.2

Illustration for all income deciles



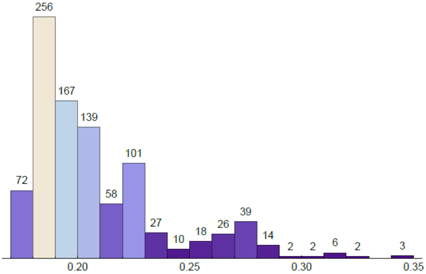




Insurance taken in late 2021 for 2022

Electricity price in December 2021

2021: EDF's Blue peak/off-peak tariff (lump-sum fee for 9 kVA = €183.68; pour 12 kVA = €221.5; pour 15 kVA = €258,07; pour 18 kVA = €292,35; and price in peak hours (resp. off-peak h) 18.21 (resp. 11.93) c€/kWh



Statistics	€/MWh
min	17.22
max	34.57
mean	20.85
median	19.88

Average electricity prices in Dec. 2021 for the "well-off" households

The coverage - The price of goods

Electricity prices in 2022

- Tariff shield (Finance Act 2022) - 4% cap on electricity tariff increase
- Without the tariff shield: 35% increase (CRE)

Illustration: Median household bill ($\underline{e} = 4,744$ kWh/year)

- in 2021: 921 €, i.e. 19.41 c€/kWh
- in 2022:
  - with the tariff shield, 943.78 €, i.e. 19.89 c€/kWh
  - without it, 1,243 €, i.e. 26.21 c€/kWh
- for "well-off" households, the change in average electricity prices between Dec. 2021 and Sep. 2022 ranges from 0.93% to 2.95% (mean = 2.33%; median = 2.44%)

The coverage - The price of goods

The price of the composite good: $p^x_{2019} = 1$; $p^x_{2021} = 1.01964$; $p^x_{2022} = 1.0685$ and $p^x_{35\%} = 1.084$ (calculation based on INSEE data)

First results – ceteris paribus (same income ...)

Percentage of households living in all-electric housing that fall into FP

- 3.05% between 2019 and 2021 (0.24%)
- 5.64% between 2021 and the second quarter of 2022, despite the tariff shield (0.45%)
- 8.46% between 2021 and the second quarter of 2022, without the tariff shield (0.68%)

The coverage - The price of goods

In 2022, 8.05% of 29 million households are “well-off”, live in all-electric dwellings and have subscribed the regulated tariff

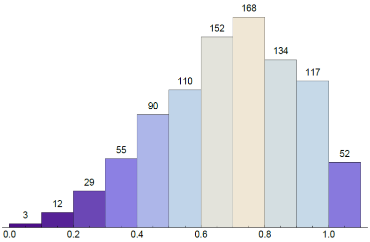
Other results

Cost of the tariff shield for these households $\approx$ 1.66 billion € including 0.43 billion € for the price effect

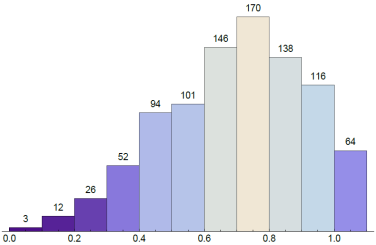
Ministère de l’économie et des finances (Sept. 1, 2022): Cost of the tariff shield = 10.5 billion € to cap electricity price increases at 4% (24 billion € since the beginning of the tariff shield in the fall of 2021)

1.66 billion € = a lower boundary (announcements on the expected increase in the price of electricity = 100% + even partial withdrawal of supplier from the residential market, e.g. Iberdrola)

The coverage - The insurance trigger



Distribution of $(\overline{\omega}_{2022,i})$



Distribution of $(\overline{\omega}_{35\%,i})$

With (resp. without) the tariff shield:

- $\min(\overline{\omega}_i) = 0.427\%$ (resp. 0.441%)
- $\max(\overline{\omega}_i) = 104.67\%$ (resp. 107.94%)
- $\text{mean}(\overline{\omega}_i) = 0.687\%$ (resp. 0.695%)
- $\text{median}(\overline{\omega}_i) = 0.704\%$ (resp. 0.712%)

The coverage - Expected cost to the insurer

For each well-off household i, the insurer

- knows $\underline{e}_i$
- does not know its cost
- can estimate $\overline{\omega}_i$ with price scenarios
- can estimate the probability distribution of income variations ω_i

$\rightarrow$ and calculate $\underline{e}_i \mathbb{E}(\omega_i < \overline{\omega}_i)$

Example: with and without the tariff shield

In 2022: 29 millions households, the quantity of electricity that the insurer must guarantee so that all-electric households do not fall into FP is about 1.517 TWh with the tariff shield and 2.061 TWh without

The insurance is "less expensive" than the tariff shield if

the sourcing price is lower than 803 €/MWh! But ...

Household contribution (Maximum price)

Require some modifications (**extension**)

- Poverty $\rightarrow$ aids (minimum integration income, housing allowances, energy voucher) $\rightarrow$ modifications of w_1 and

$$U(x_t, e_t) = \begin{cases} U_{m,0}(x_t, e_t) = \nu_m(x) - \bar{\alpha}_m \ln(1 + \underline{e}) \text{ if } 0 \leq x_t < \underline{x} \quad (\forall e_t) \\ U_{M,m}(x_t, e_t) = ... \\ ... \end{cases}$$

Reminder: $\alpha_m(w_t) = \underline{x} + \frac{p_t^e(1+\underline{e}) - w_t}{p_t^x}$ hence
$\bar{\alpha}_m = \alpha_m(p_t^x \underline{x}) = \frac{p_t^e}{p_t^x}(1 + \underline{e})$

Remarks

Aids for x are the same with or without insurance $\Rightarrow$ no impact on WTP
Aids for e (energy voucher or minimum service) are different if the household is insured or not $\Rightarrow$ reduction of $\underline{e}$ in $U_{m,0}(.)$ and $U_{M,m}(.)$

Household contribution

The WTP of "well-off" households is approximated in two ways

Method 1: $p_i^l \approx \min(W_{2021,i}^d, \tilde{p}_i)$ with

$$\tilde{p}_i = \text{Prob}(\omega_i < \overline{\omega}_i(w_{0,2021,i}))\mathbb{E}(p_{2022}^e) \times \underline{e}_i$$

.

Mean = 13.23 €/month; Median = 5.93 €/month

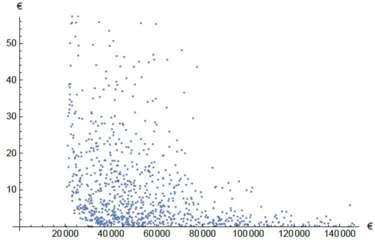
ENGIE (Assurance Facture)

- 5 €/month
- maximum reimbursement of 5,000 euros for a maximum of 1 year (833 euros pour a hospitalization)

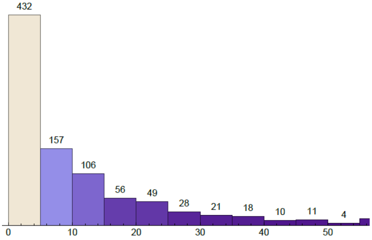
EDF (Assurénergie)

- between 2 €/month and 8 €/month
- reimbursement from 25 €/month to 200 €/month

Household contribution - Method 1



$\tilde{p}_i$ according to income



Distribution of $\tilde{p}_i$

Household contribution - Method 2

Based on equation

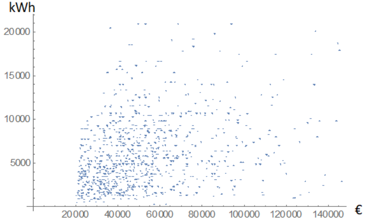
$$\overline{p} = \left(1 - \exp\left(-\frac{\beta W}{1+\alpha_M}\right)\right)\left(W_0^d(w_0) + p_0^e + p_0^x\right) \qquad (9)$$

with

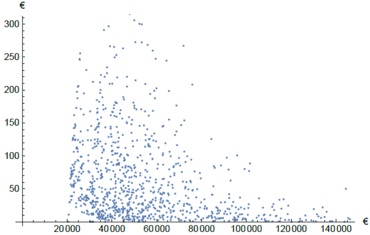
$$W = \int_{\omega^m}^{\frac{p_1^x \underline{x}}{w_0}} \bar{\alpha}_m \ln(\underline{e}+1) f(\omega)\, d\omega + \int_{\frac{p_1^x \underline{x}}{w_0}}^{\overline{\omega}(w_0)} \Delta V_{M,m}(\omega, w_0) f(\omega)\, d\omega. \qquad (10)$$

- $p^l_{M2,i} > \tilde{p}_i$
- Hyp.: Energy consumption subsidy
  - If the subscribed power $= \xi$ kVA, than the aid will be $\frac{e}{\xi}$.
  - $\underline{e} \rightarrow \frac{(1-\xi)e}{\xi}$ = a "quick" approximation of the amounts of energy and non-monetary (but dedicated) subsidies that the precarious household might receive

Household contribution - Method 2



$\underline{e}$ according to income



WTP

Focus on the median household

$p^x_{2021}\underline{x} = 29,587$; FP if $w_{2021} < 31,089$
$p^x_{2022}\underline{x} = 32,954$; FP if $w_{2022} < 33,897$ (with the tariff shield)
$p^x_{35\%}\underline{x} = 33,434$; FP if $w_{2022} < 34,678$ (without)

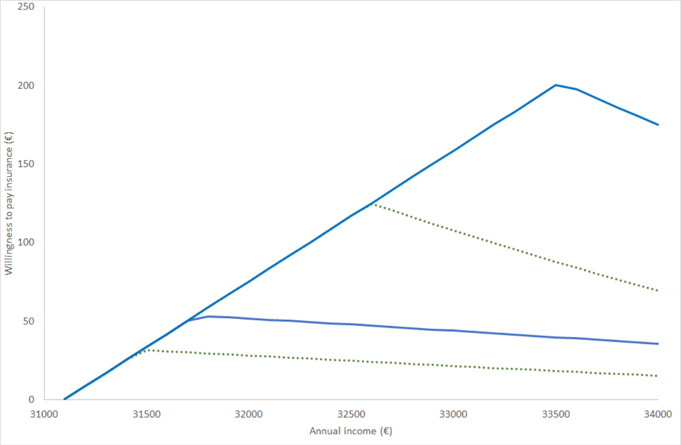


Table of Contents

Conclusion

- Energy insurance system / preserve the purchasing power of households that are not in financial difficulty but could become so
- A differentiated risk-sharing instrument
- Probable losses if no obligation all the more high if supply on the wholesale market
- Private insurers take up the challenge??????
  - Insurance exists but its coverage is limited → do not prevent subscribing households from falling into FP
  - Cost of the fuel insurance = 2.061 TWh (without the tariff shield)
  - Deficit of a private insurer with sourcing on the wholesale market!
  - Compulsory insurance for "well-off" households → legal issue (liability insurance)
  - Yet the French people want to reduce their insurance!

Conclusion

- If the insurer's sourcing price is below a certain threshold (803 €/MWh in the simulation), the insurance system is less costly to society than the tariff shield
- The tariff shield limits fuel poverty
- Possible deficit of the insurer → mechanism to be put in place should be linked to public-private risk sharing
  - The public authorities could top up and guarantee the insurance fund
  - A system of compensatory public insurance remains possible (e.g. crop insurance: the State contributes to the fund to limit farmers' insurance premiums)
  - The State could also play a role in the sourcing price of the insurer

More

Differentiated policy based on the essential baskets for each household

- SRCV data and comparison with results from ONPES, 2014–2015
- In a society where energy saving will become more important, and for a fair transition, it seems to us really important to determine the basket of essential goods and its cost
- EPC scores

Extensions

- Include energy voucher, transport item in essential basket or change in household's behavior
- Problems of moral hazard (modifications of the behaviors of the household after the signature of the contract) and adverse selection (which may be due to asymmetric information as to the distribution of income or utility function parameters)
- Alasseur et al. (2022): effectiveness of in-kind insurance but the need to regulate this insurance market
- Questions of regulation and public policies have to be answered in regards to the risk sharing between private and public regarding energy efficiency in dwellings