THE STRUCTURING OF AIR SOURCE HEAT PUMPS' PRICES IN A RETROFITTING RESIDENTIAL BUILDINGS MARKET: WHAT DID I PAY FOR?

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ECEEE Summer Study - June 2017
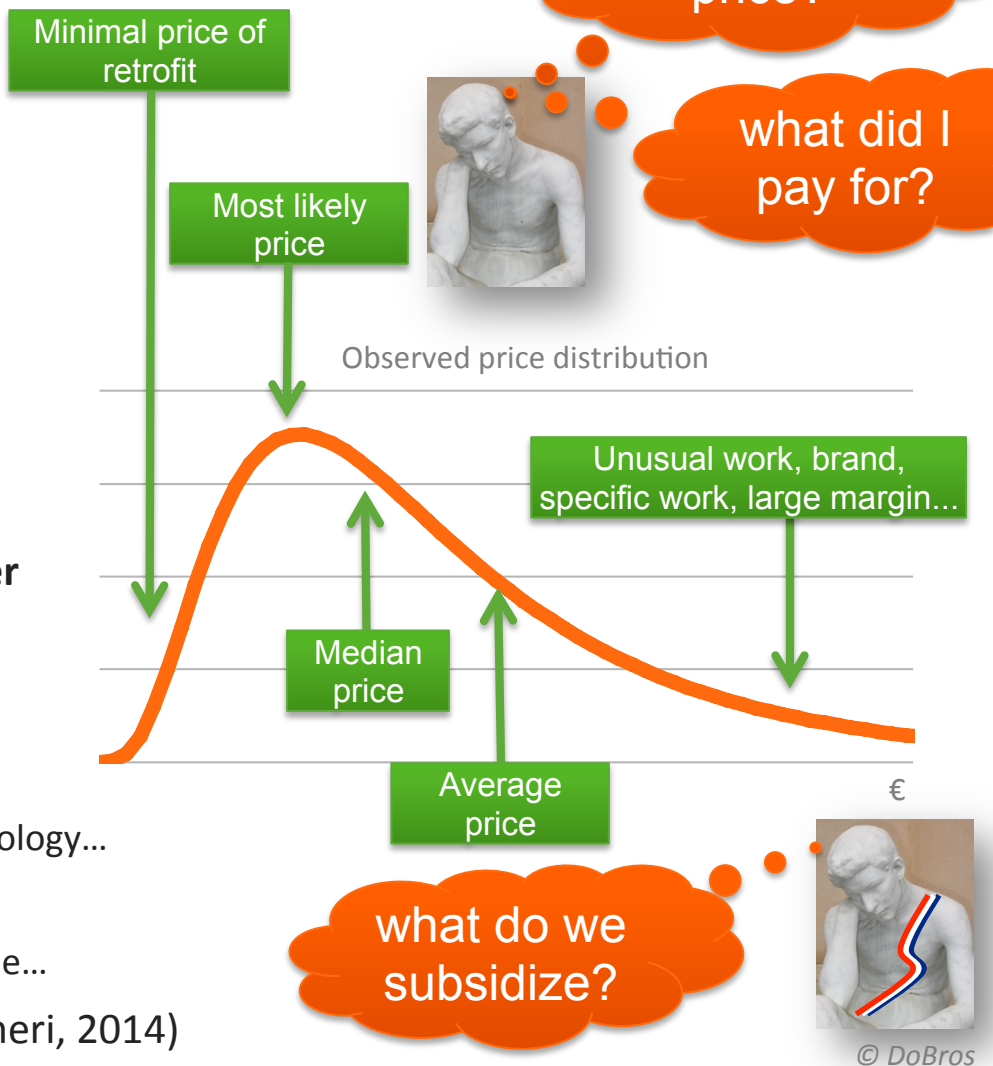
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USING THE MARKET TO ENCOURAGE HOME-OWNERS TO RETROFIT : WHAT DOES THE PRICE MEAN?

Price incentives to home-owners

- ☐ Incentive based on up-front cost - *f(€)*
  - Tax credit (*CITE in France*)
  - Soft-loan (*Eco-PTZ in France*)
- ☐ Incentive based on energy savings - *f(kWh)*
  - Energy Efficiency Obligation (EEO) (*CEE in France*)

- ▪ **What does the price mean to the decision-maker**
  - ☐ Higher price equal higher energy efficiency?
  - ☐ Higher price equal higher quality?
  - ☐ Technical reasons for deviation
    - Complexity of work, risk linked to innovative technology…
  - ☐ Economic reasons for deviation
    - difference in labour cost, company size, brand name…
  - ☐ « Unexplained cost » in previous study (In Numeri, 2014)

What's the price?

what did I pay for?

Minimal price of retrofit

Most likely price

Observed price distribution

Unusual work, brand, specific work, large margin…

Median price

Average price

€

what do we subsidize?

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AIR-SOURCE HEAT PUMP (ASHP)

- Air-to-water heat pump (w-ASHP)
- Air-to-air heat pump (a-ASHP)

- **Invoice analysis: two complementary approaches**

  - Detailed analysis w/ a limited sample [technical perspective]
    - Energy performance, installed power…
  - Limited analysis w/ a large sample [economic perspective]
    - Company's structure and activity…
  - Complementary databases [regional data]
    - Median income, regional added value…

a-ASHP

w-ASHP

ASHP type	Sample type	Sample size	Median price of work (in € ex. VAT)	absolute maximum difference (AMD*)	relative interquartile coefficient (RIC**)
a-ASHP	economic	7,181	3,733	10.9%	1.11
a-ASHP	technical	192	4,141		1.12
w-ASHP	economic	1,720	13,211	0.3 %	0.49
w-ASHP	technical	167	13,165		0.49

*AMD=|(P_main-P_subsample)|/Min(P_main,P_subsample). The calculation of the maximum absolute difference maximises the error between the two estimates.

**RIC= $(X{\downarrow}q3 - X{\downarrow}q1)/median\ X$

ANALYSIS OF COVARIANCE (ANCOVA)

- **Data cleaning**
  - ▫ Outliers removed, explained variable log-transformed

- **General linear model which blends ANOVA and regression**
  - ▫ "all other things being equal" approach

Price (€ or €/m²)

m², kW, unit…

error

$$\log(\text{explained variable}) = A + \sum_{j=1}^{N_j} a_j * (\text{quantitative variable})_j + \sum_{k=1}^{N_k} \sum_{l=1}^{m_l} b_{kl} * \text{qualitative variable}_k \text{ modality}_l + \varepsilon$$

climate zone, NACE activity, workforce, brand…

Qualitative data reference: zero sum of the coefficients b_{kl} of the different modalities (ie $\sum(b_{kl})=0$ with $l=1,…,m_l$)
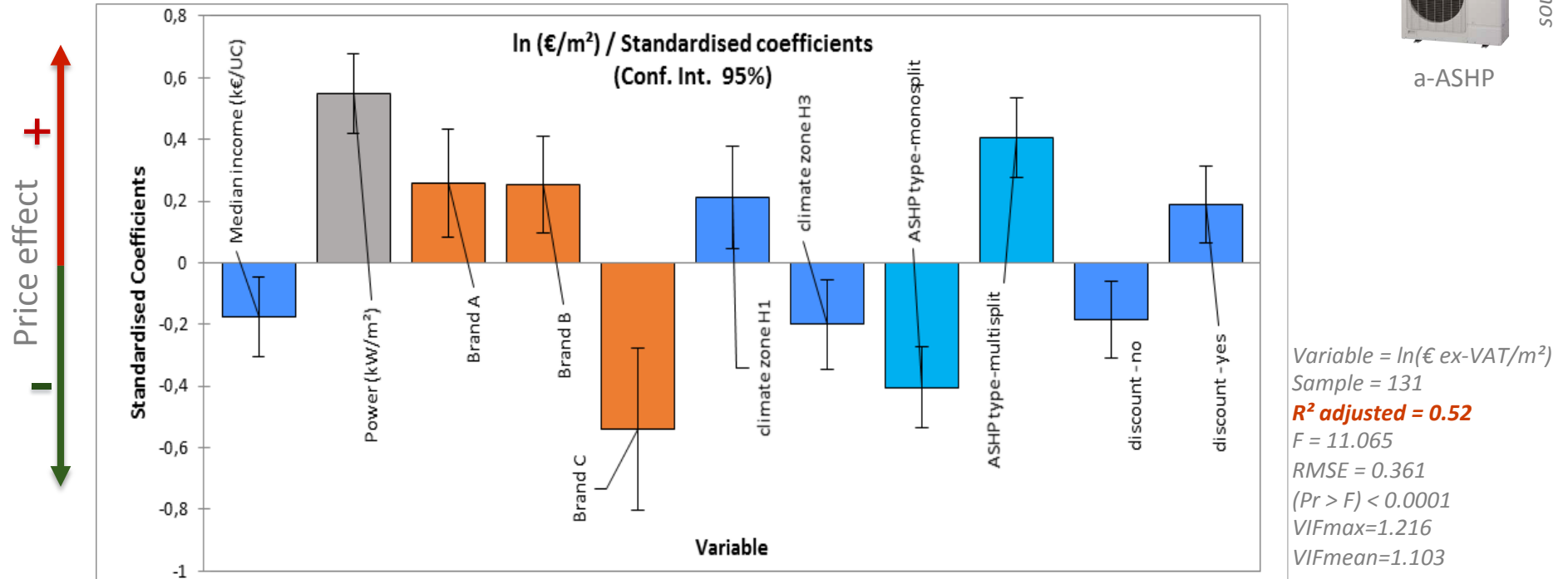
$$\text{explained variable} = e^A * \text{quantitative variable}^a * e^{\text{qualitative variable}^b}$$
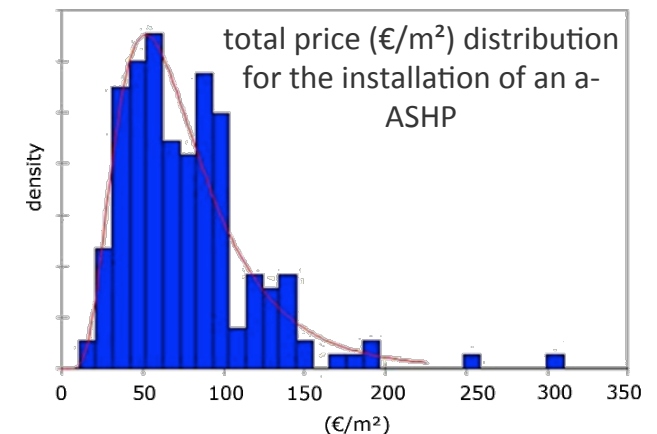
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A-ASHP – TECHNICAL SUBSAMPLE

Standardised coefficients of the ANCOVA model of the price (in € ex-VAT/m²)

source: Atlantic

a-ASHP

ln (€/m²) / Standardised coefficients
(Conf. Int. 95%)

Price effect

Variable = ln(€ ex-VAT/m²)
Sample = 131
R² adjusted = 0.52
F = 11.065
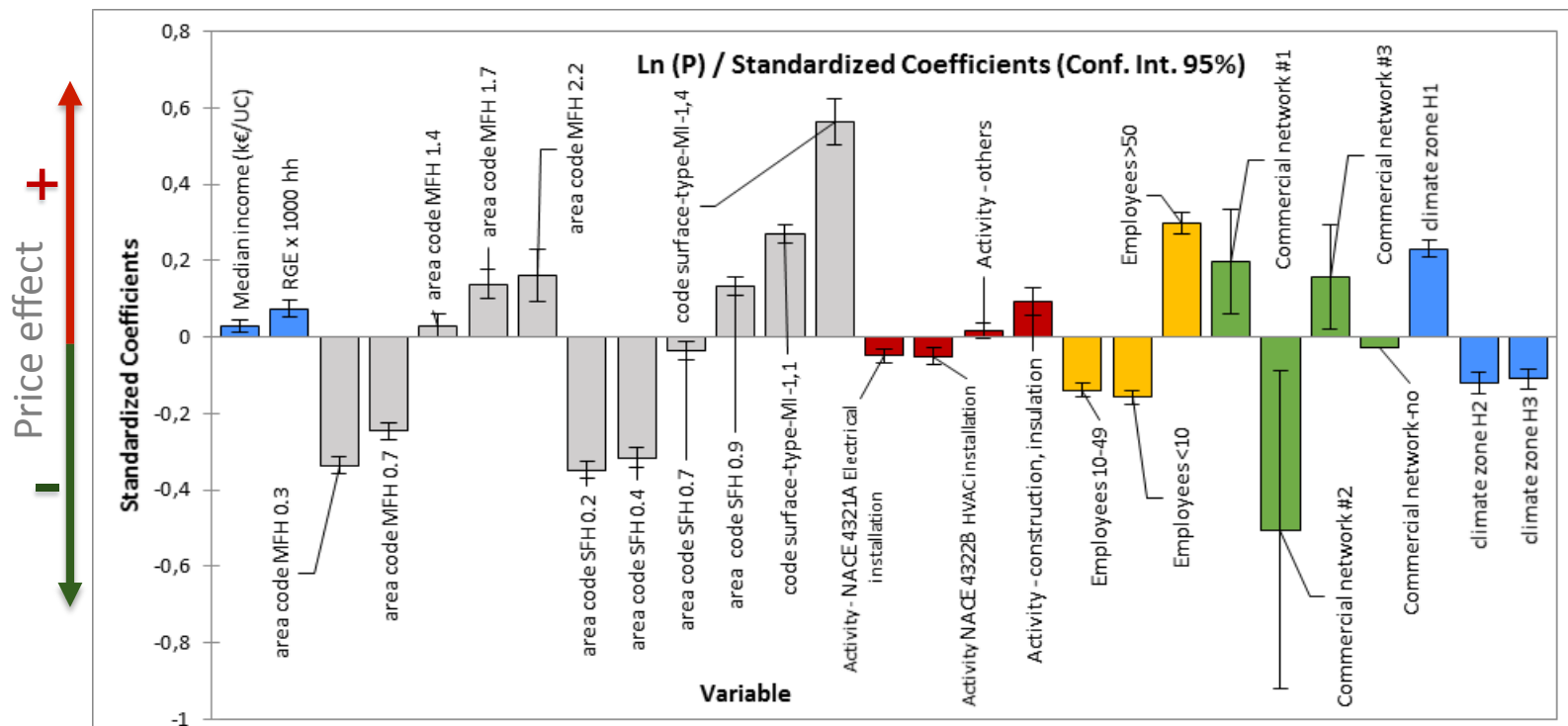RMSE = 0.361
(Pr > F) < 0.0001
VIFmax=1.216
VIFmean=1.103

Observed effect:
- ✓ Installed power (kW/m²)
- ✓ a-ASHP type (mono- vs. multi-split)
- ✓ Geoclimatic zone (cold, mild, warm)
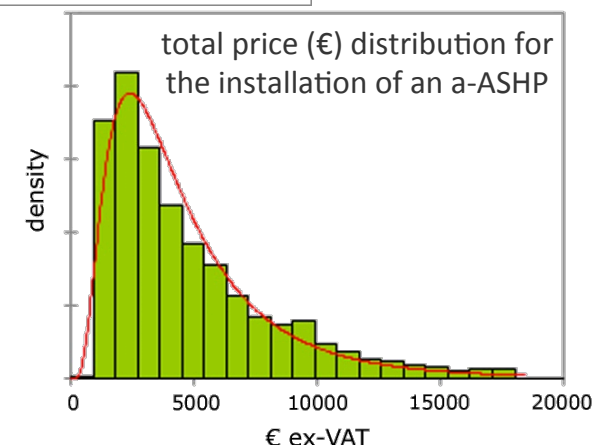- ✓ Median income in the municipality
- ✓ Brand
- ✓ Discount

total price (€/m²) distribution for the installation of an a-ASHP

A-ASHP – MAIN SAMPLE

Standardised coefficients of the ANCOVA model of the price (in € ex-VAT)

source: Atlantic

a-ASHP

Ln (P) / Standardized Coefficients (Conf. Int. 95%)

Variables (left to right): Median income (k€/UC), RGE x 1000 hh, area code MFH 0.3, area code MFH 0.7, area code MFH 1.4, area code MFH 1.7, area code MFH 2.2, area code SFH 0.2, area code SFH 0.4, area code SFH 0.7, area code SFH 0.9, code surface-type-MI-1,4, code surface-type-MI-1,1, Activity - NACE 4321A Electrical installation, Activity NACE 4322B HVAC installation, Activity - construction, insulation, Activity - others, Employees 10-49, Employees <10, Employees >50, Commercial network #1, Commercial network #2, Commercial network #3, Commercial network-no, climate zone H1, climate zone H2, climate zone H3

Variable = ln(€ ex-VAT)
Sample = 7,181
R² adjusted = 0.53
F = 293.469
RMSE = 0.462
(Pr > F) < 0.0001
VIFmax=2.172
VIFmean=1.145

Observed effect:
- ✓ Geoclimatic zone (cold, mild, warm)
- ✓ Median income in the municipality
- ✓ Regional labelled companies
- ✓ Activity (NACE)
- ✓ Number of employees
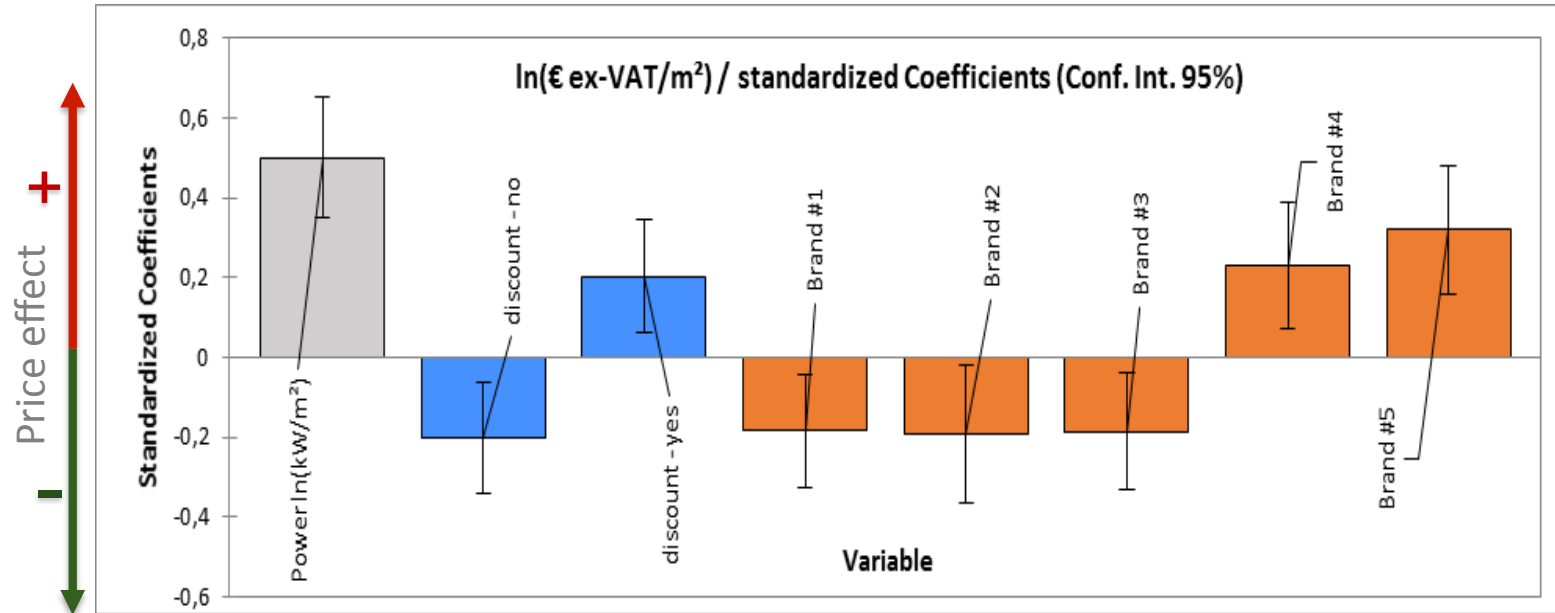- ✓ Commercial network
- ✓ Type and area of dwelling

total price (€) distribution for the installation of an a-ASHP

w-ASHP – TECHNICAL SUBSAMPLE

source: Atlantic

w-ASHP

Standardised coefficients of the ANCOVA model of the price (in € ex-VAT/m²)

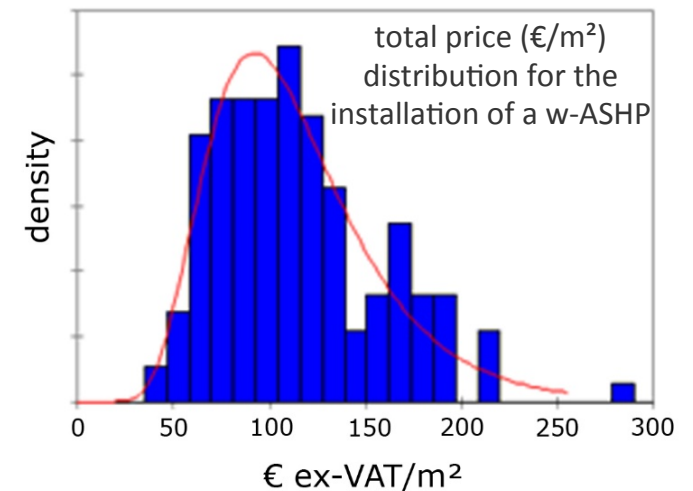ln(€ ex-VAT/m²) / standardized Coefficients (Conf. Int. 95%)

Variable = ln(€ ex-VAT/m²)
Sample = 134
R² adjusted = 0.45
F = 7.396
RMSE = 0.263
(Pr > F) < 0.0001
VIFmax=1.438
VIFmean=1.076

Observed effect:
- ✓ Installed power (kW/m²)
- ✓ Brand
- ✓ Discount

Sample limit:
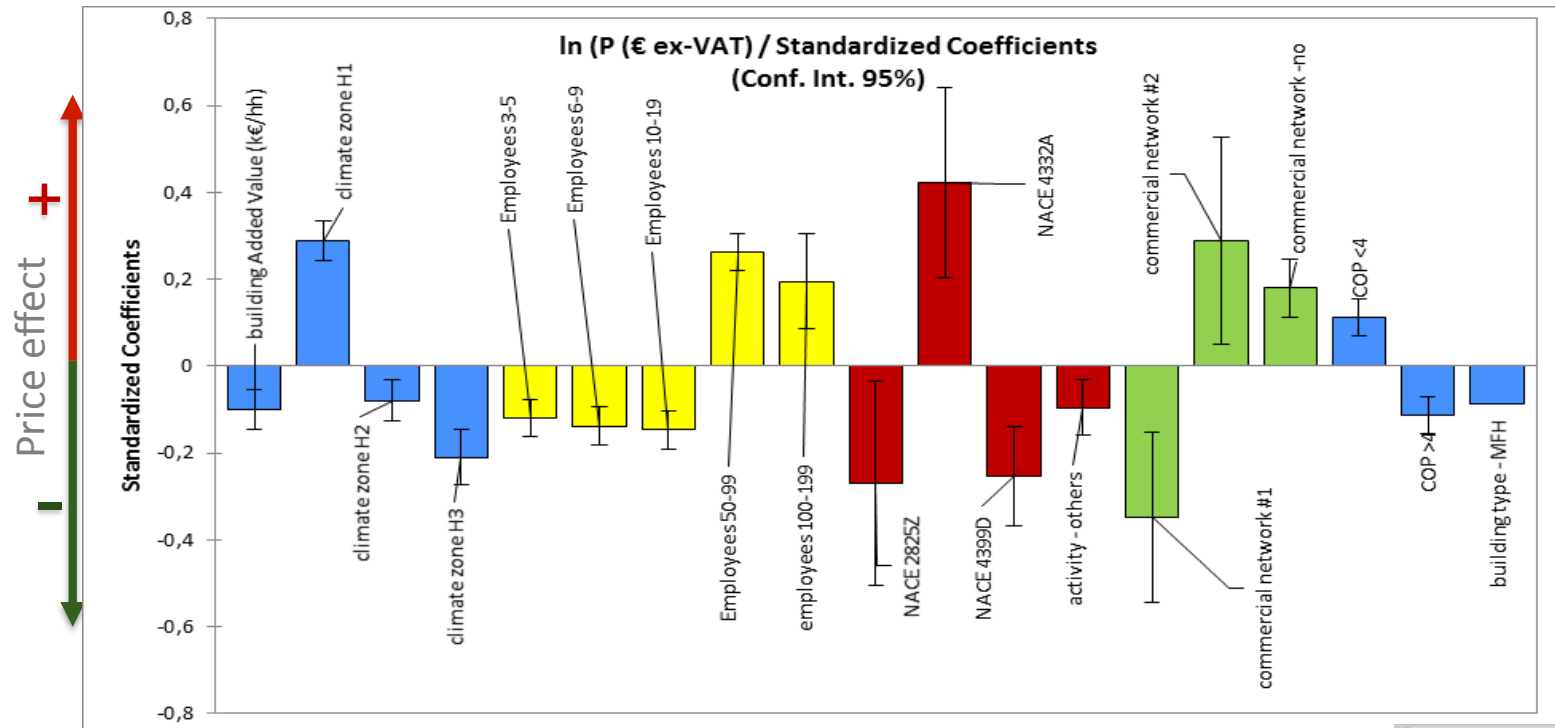- ✓ W_ASHP only in SFH
- ✓ Only in cold climate zone

total price (€/m²) distribution for the installation of a w-ASHP

w-ASHP – MAIN SAMPLE

Standardised coefficients of the ANCOVA model of the price (in € ex-VAT)

source: Atlantic

w-ASHP

Variable = ln(€ ex-VAT)
Sample = 1,720
R² adjusted = 0.35
F = 29.707
RMSE = 0.266
(Pr > F) < 0.0001
VIFmax=2.165
VIFmean=1.274

Observed effect:
- ✓ Geoclimatic zone (cold, mild, warm)
- ✓ Number of employees
- ✓ Activity (NACE)
- ✓ Commercial network
- ✓ Efficiency
- ✓ Regional added value of the building sector

total price (€) distribution for the installation of a w-ASHP
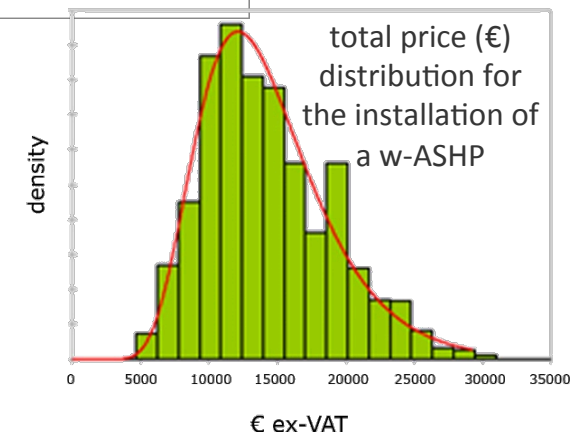
CONCLUSION – UNDERSTANDING THE EFFECTS

- **Technical variable**

  □ Installed output of thermal equipment (kW/m²): upward effect - energy demand

  □ Living area (m²): downward effect due to fixed cost – scale effect

- **Socio-economic variables**

  □ Geoclimatic zones (cold, mild, warm): willingness to pay to decrease one's energy bill is more valued in the cold zone than in the warm zone (upward effect in cold zone)

  □ Regional economic data: small upward or downward effects - difficult to interpret

- **micro-economic variables**

  □ Brand effect: public bodies subsidizing marketing position of companies -> conditional subsidy scheme (Laurent et al., ECEEE 2011)

  □ Commercial network: upward or downward effect - difficult to interpret

  □ Company workforce: upward effect – overhead cost

  □ Sector of activity: upward effect of companies practicing an activity other than the ones linked to the retrofit - risk covering

WHAT DOES THE PRICE OF RETROFIT WORKS MEAN? SOME LASTING UNKNOWNS

The explained price variation is limited ($R^2 < 0.5$)

The extremes of the price distribution should be explained in order to better understand the reasons of them:

- low prices: low quality, investment costs adapted to low income households, efficient structure of company or business model?
- high prices: overcharging and marketing position, complex retrofit or inadequate business model?

As numerous observed effects are not totally explained, especially the type of commercial network associated with the lower prices, further study in order to explain the observed downward effects should be realised

FINAL CONCLUSION – w-ASHP VALUE CHAIN

Distribution of the total market value between distribution and installation*
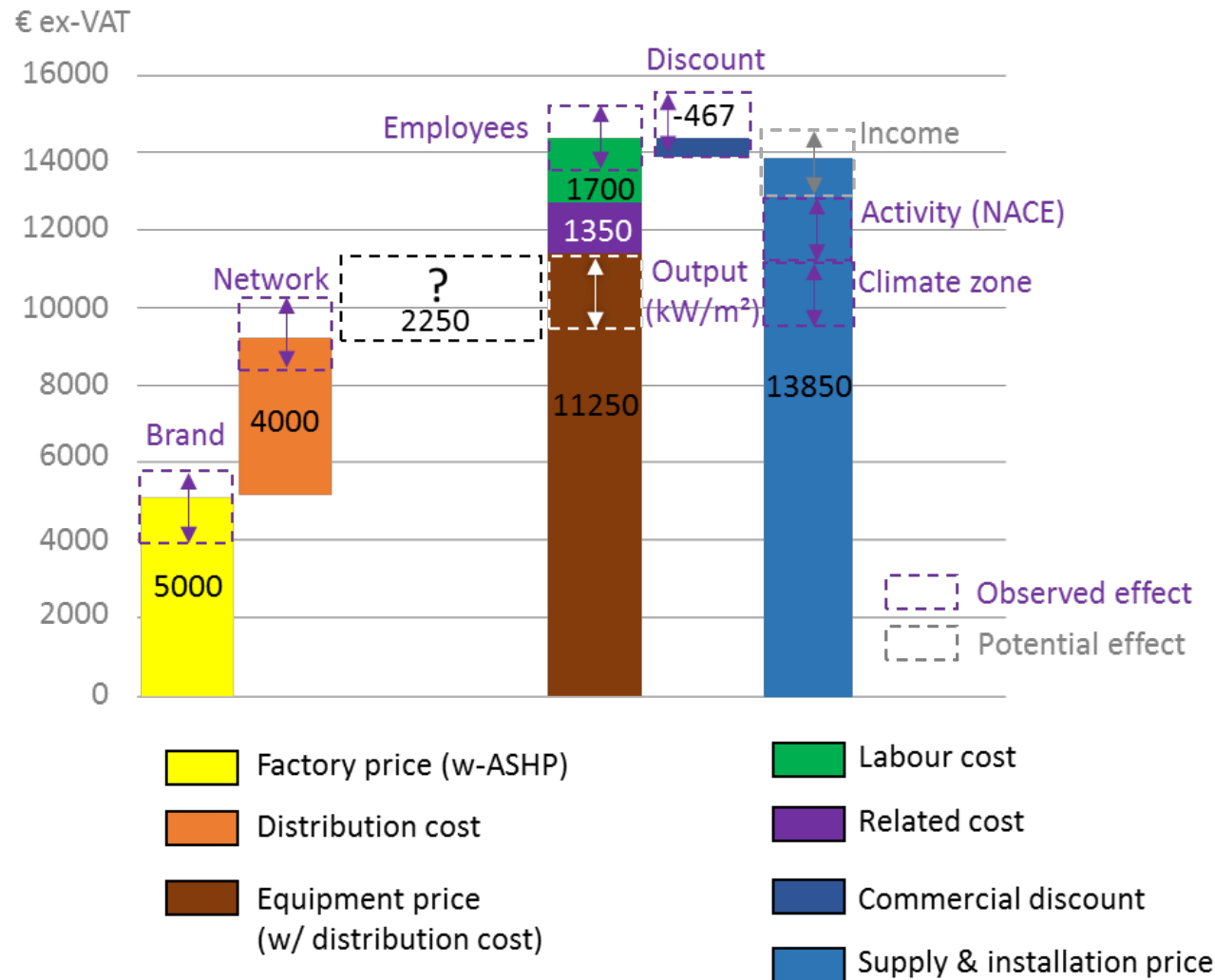
*Adapted from (In numeri, 2014) "Markets and jobs related to energy efficiency and renewable energies: situation 2012 2013 and short-term prospects"

Thanks

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