CENTRE INTERNATIONAL DE RECHERCHE SUR L'ENVIRONNEMENT ET LE DÉVELOPPEMENT

C.I.R.E.D.

Inertia and Effectiveness Of Tax Credits For Home Insulation: a French Case Study

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1. Introduction

French **residential sector** =

- 29% of energy consumption, 16% of CO2 emissions (SOeS 2011).
- high energy savings potential (Levine & al. 2007)

⇒ - 38% reduction in French final energy consumption by 2020 ("Grenelle de l'Environnement " 2009).

⇒ Implementation of **numerous public policies** to promote energy efficiency investments.

In France :

- reduced VAT (1999),
- income tax credit "CIDD" (Crédit d'Impôt Développement Durable) (2005),
- zero rate loan « EcoPTZ » (2009),
- other specific subsidies…

1. Introduction

Focus on income tax credit systems, the most implemented economic incentives.

In France over 2005-2011):

CIDD = the most known, used and costly economic incentive:

=> Households aware of CIDD : from 57% in 2005 up to 85% in 2009,

=> Participation rate (for all retrofitting investments):

> 50% for CIDD

<5% for all other subsidies, even less for the EcoPTZ,

=> Public costs of 13,5 billions of euros.

Policy design:

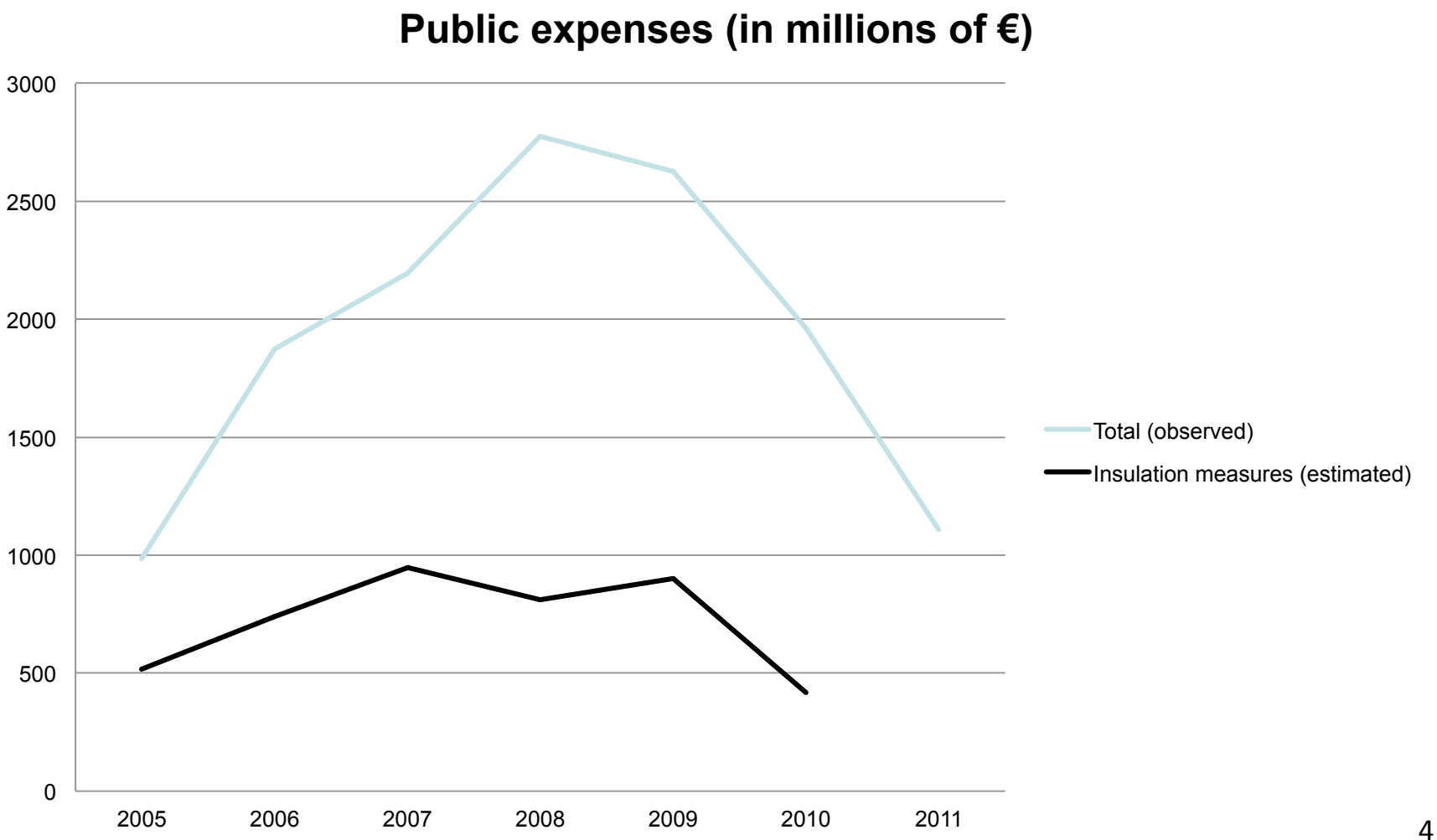
- introduction in 2005,
- for all households investing in their main home,
- for energy efficiency investments =

energy conservation measures (insulation, energy efficient heating systems, etc.),

systems producing renewable energy,

- with rates ranging from 13 to 50% of material cost.

1. Introduction



1. Introduction

However, concerns about free-riding:

Free-riding = behavior occurring when the agents targeted by the policy take the incentives but would have made the investment anyway

Consequences of free-riding:

- overstatement of the cost-efficiency,
- marginal cost of public funds > 1 and/or indirect program costs (tax distorsions) => welfare loss introduced by transfers to free-riders (Boomhover & Davis 2014),
- potential anti-redistributive effects (Mauroux & al. 2010).

1. Introduction

Emerging consensus in recent literature towards high level of free-riding?

- In Germany, Grösche and Vance (2009), Grösche & al. (2013):

- 50% of free-riding

- decreasing share of free-riders with the level of subsidy

- In Italy, Alberini & Bigano (2013):

- higher free-riding for heating system replacement than for window replacement

- In France:

- On the CIDD 2006 reform (CIDD rate increase in specific cases), Daussin Benichou & Mauroux (2013, 2014) : 2/3 of participants would have participated even without the reform,

1. Introduction

Contributions of the paper:

To assess the effect of the CIDD subsidy on occupying homeowners' decision to invest in residential energy efficiency and to measure free-riding.

-panel dataset from surveys dedicated to residential energy consumption and investment,

- focus on the timing of the impact,

- focus on insulation measures.

Data

Data from the annual "Energy Management" (EM) survey (ADEME / TNS Sofres) :

2 waves in the survey :

- 10000 households suveyed in a 1st wave => data on socio-economic variables and housing information

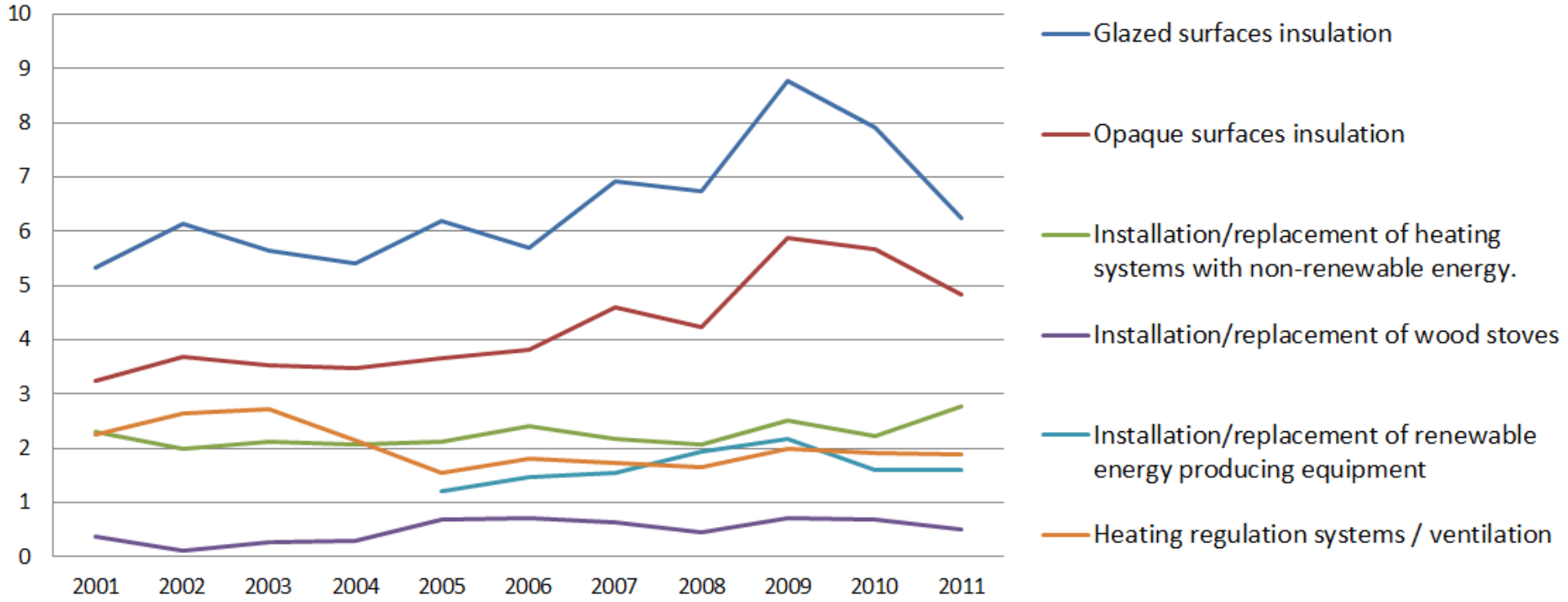
- panelists having invested in retrofitting : 2nd survey => more information on the energy efficiency investments.

Data collected over 2001/2011 :

- unbalanced panel of 23,879 households,

- average period of observation of 2.4 years.

Data : annual retrofitting rates per retrofitting type in % among occupying homeowners.



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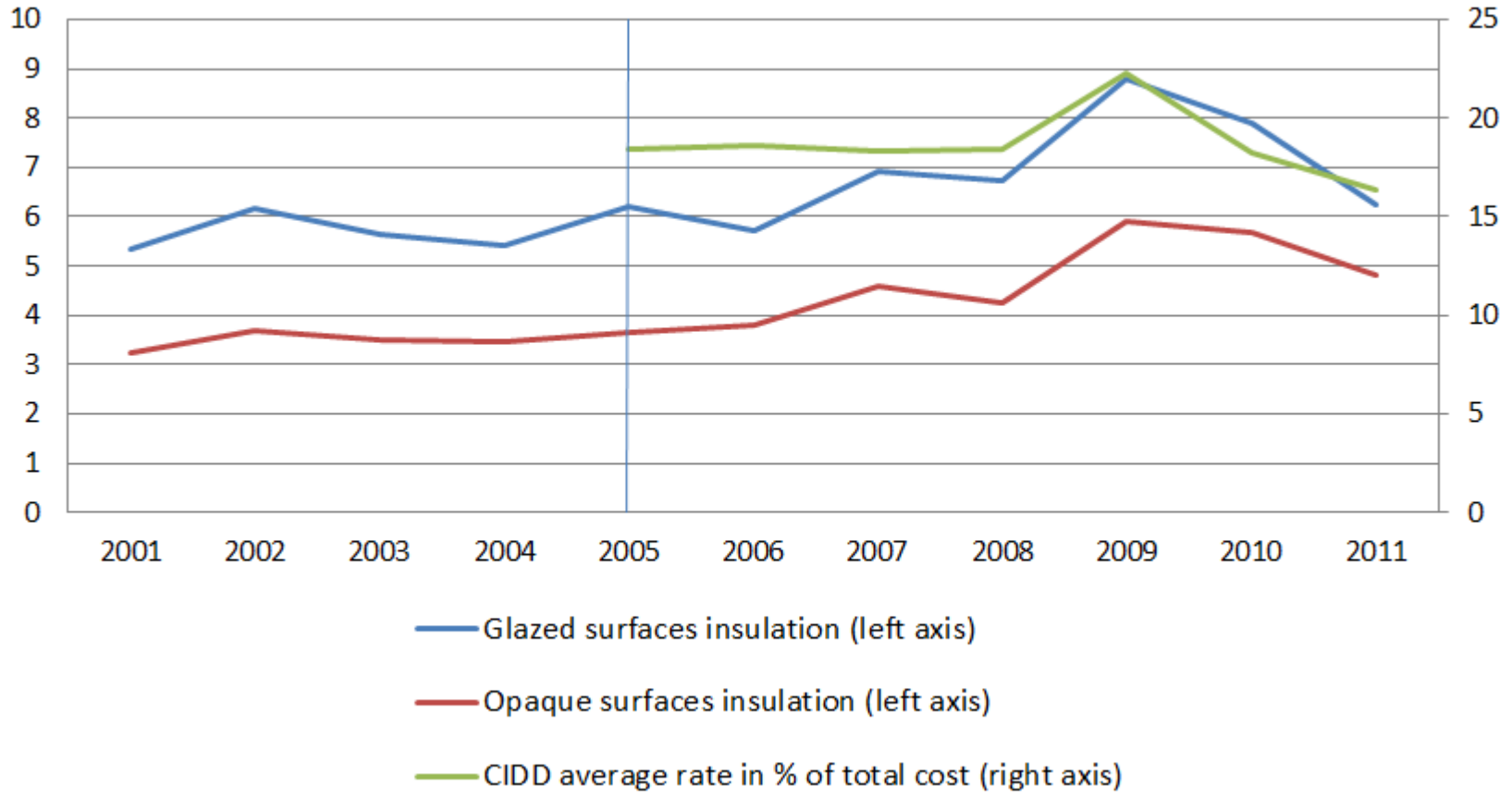


Methodology

The difference estimation principle.

"Naïve" estimator:

$$\hat{\Delta} = \overline{I_{it}^{CIDD_{it}=1}} - \overline{I_{it}^{CIDD_{it}=0}}$$

- I_{it} the retrofitting investment decision (binary variable)
- $\overline{I_{it}^{CIDD_{it}=1}}$ and $\overline{I_{it}^{CIDD_{it}=0}}$ the empirical means of I_{it} over the periods respectively after and before the introduction of CIDD.

=> Unbiased identification if the estimator is implemented in a model in which **all unobserved explanatory variables are constant over time**.

Methodology

The probability of investing in retrofitting is written (Random effect (RE) dichotomous logit model) :

$$P(I_{it}=1 \mid T_t, CIDD_t, X_{it}, u_i) = \frac{e^{\alpha + \sum_{t=2002}^{2004} \gamma_t T_t + \sum_{t=2005}^{2011} \delta_t CIDD_t + \beta X'_{it} + u_i}}{1 + e^{\alpha + \sum_{t=2002}^{2004} \gamma_t T_t + \sum_{t=2005}^{2011} \delta_t CIDD_t + \beta X'_{it} + u_i}}$$

With

$(T_t)_{t=2002,..,2004}$ annual dummies referring to the period before CIDD,

$(CIDD_t)_{t=2005,..,2011}$ annual dummies during the CIDD period,

$X_{it} = (x_{1it}, \ldots, x_{kit})$ the control variables,

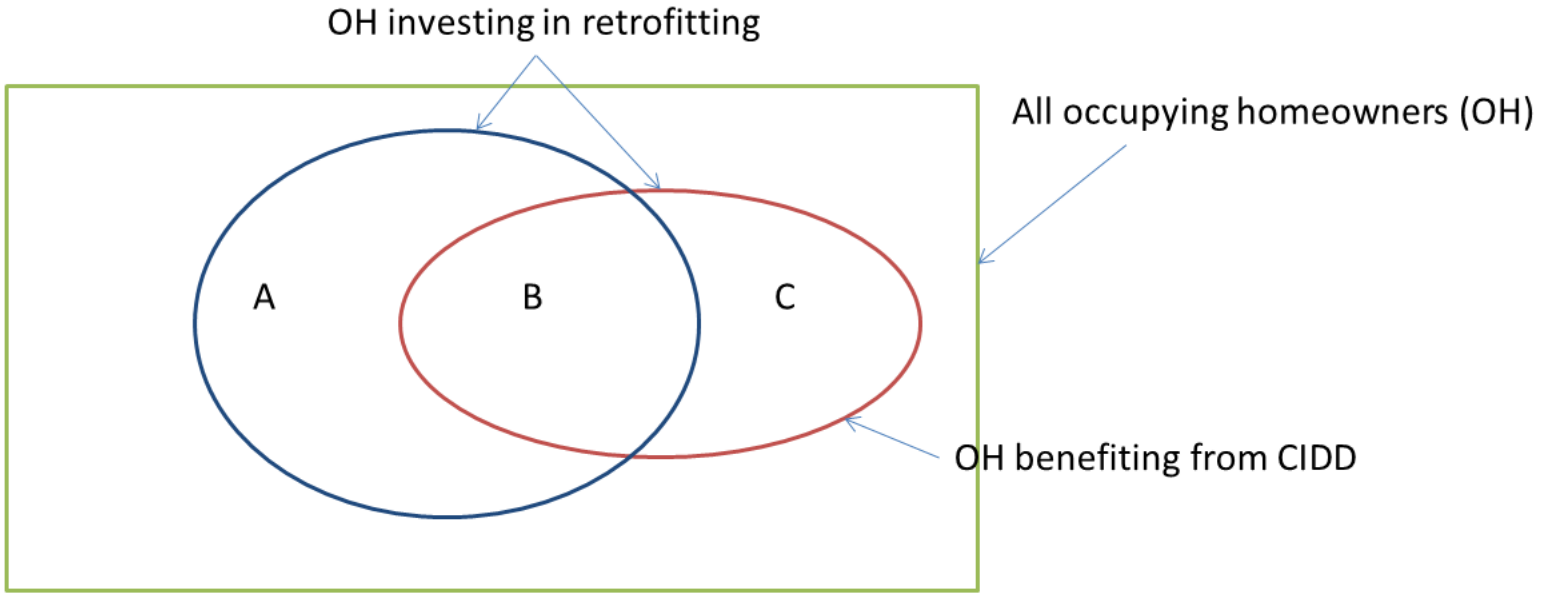
u_i the random individual effects.

Methodology

The control variables :

- **Socio-demographic variables** : the Annual income of the household, the Socio-professional category, the Family size and the Age of the head of the household, the move-in-date
- **Individual preferences** : dummies for Environmental concern and Economic concern,
- **Home characteristics variables** : the Building completion date, the Building type, the Dwelling size,
- **Annual heating energy price** (determined on the basis of the main energy source),
- **Climatic and spatial characteristics:** the regional Heating degree days and the Location Category.

Methodology : free-riding estimation.



A + B + C = the total number of investors in retrofitting (observed)

B + C = the number of households benefiting from CIDD (observed)

C = Δ, the number of additional investments due to the CIDD (estimated)

Free-riding share: $$FRS = \frac{B}{B+C} = 1 - \frac{\Delta}{B+C}$$

Computation of FRS confidence interval by the delta method.

Results : estimated marginal effects for opaque & glazed surface insulations.

Logit with random effect estimation

Variables	M.E.	S.E.	**Variables**	M.E.	S.E.
Environmental concerns	0.005**	(0.00237)	HDD	0.005	(0.00429)
Economic concerns	0	(0.00239)	Energy price variation	0.008	(0.00751)
Annual income of the dwelling *(ref : <18500 euros)*			Dwelling size	0.001**	(0.00039)
18500 /36 300 euros	0.01***	(0.00302)	Building completion date *(ref : < 1974)*		
>36 300 euros	0.008**	(0.00381)	*1975/1988*	-0.022***	(0.00334)
Move in date *(ref : < 3 years)*			*1989/last year*	-0.065***	(0.00286)
3 / 10 years	-0.062***	(0.00668)	Collective flat	-0.031***	(0.00289)
> 10 years	-0.082***	(0.00697)	Category of city *(ref : Parisian agglomeration)*		
Socio-professional category *(ref : Entrepreneur)*			*> 20.000 inhabitants*	0.008**	(0.00374)
Managers	0.023***	(0.00604)	*<20.000 inhabitants / rural*	0.009**	(0.00405)
Employees	0.018***	(0.00598)	Family size *(ref : 1 person)*		
Inactive	0.014**	(0.00583)	*1 couple*	0.004	(0.0035)
			>2 persons	0.004	(0.00406)

*(resp. ** and ***) significant at 10% level (resp. 5% and 1%).

N = 36367 observations and 13116 households

Results : the estimated marginal effects of CIDD on the decision to retrofit for opaque & glazed surface insulations.

	Logit without random effect	Logit with random effect
Annual dummies *(ref:2002)*		
2003	0.001	0
2004	-0.002	-0.006
CIDD dummy*2005	0.002	0
CIDD dummy*2006	-0.002	-0.004
CIDD dummy*2007	0.011*	0.006
CIDD dummy*2008	0.013*	0.008*
CIDD dummy*2009	0.043***	0.031***
CIDD dummy*2010	0.038***	0.025***
CIDD dummy*2011	0.018***	0.015***

*(resp. ** and ***) significant at 10% level (resp. 5% and 1%).

Results : the estimated marginal effects of CIDD on the decision to retrofit for opaque & glazed surface insulations.

Glazed and opaque surface insulation		
Variables	M.E.	M.E.
CIDD * 2005/2007	0.004	
CIDD * 2008/2011	0.021***	
CIDD		-0.047***
CIDD * rate		0.003***

Over 2008/2011 : 23% of the retrofitting rate is due to CIDD (given an average retrofitting rate of 9%).

Results : free-riding estimation.

	2005	2006	2007	2008	2009	2010	2011
All retrofit incl. Insulation (opaque and glazed surfaces)							
Estimated free-riding rate in % of CIDD beneficiaries	-	-	-	85.37	64.24	61.76	70.3
Confidence interval	-	-	-	[69 - 100]	[52.4 - 76.1]	[47.8 - 75.8]	[51.7 - 88.9]
Opaque Insulation							
Estimated free-riding rate in % of CIDD beneficiaries	-	-	77.61	71.01	46.06	43.01	41.94
Confidence interval			[48.7 - 100]	[42.3 - 99.7]	[25.3 - 66.8]	[17.6 - 68.4]	[11.8 - 72]

5. Results : free-riding declaration.

Table 8. Declared percentage of free-riding among CIDD beneficiaries in the EM survey.

	2006	2007	2008	2009	2010	2011
Glazed and opaque surface insulation						
% of free-riders*	61.4	56.2	48.8	55.1	52.4	61.8
N**	255	310	335	425	398	275
Opaque surface insulation only						
% of free-riders*	66.9	60.6	60.1	58.3	48.7	65.1
N**	123	169	142	227	224	167

*% of CIDD beneficiaries stating that CIDD had no effect on their decision. ** Number of respondents to the question "What was the effect of CIDD on your decision to retrofit?"

5. Extensions : free-riding heterogeneity.

Variable	Renovation rate	Subsidized retrofit	Estimated FRS	FRS Confidence interval
Move-in date				
*CIDD * < 3 years*	6.57	59.53	0.27	[0 - 0.54]
*CIDD * > 3years*	5.80	65.70	0.64	[0.5 - 0.78]
Socio-professional category				
*CIDD * Business*	6.47	58.97	0.65	[0.49 - 0.81]
*CIDD * Professionals & Employees*	5.95	58.41	0.35	[0.13 - 0.57]
*CIDD * Inactive*	5.76	73.81	0.50	[0.32 - 0.68]
Annual income of the dwelling				
*CIDD * <18500 euros*	4.23	59.02	0.44	[0.11 - 0.77]
*CIDD * 18500 /36 300 euros*	6.54	64.07	0.59	[0.35 - 0.83]
*CIDD * >36 300 euros*	7.24	68.02	0.65	[0.43 - 0.87]

5. Extensions : free-riding heterogeneity.

Variable	Renovation rate	Subsidized retrofit	Estimated FRS	FRS Confidence interval
Category of city				
*CIDD * Parisian agglomeration*	4.04	73.27	0.48	[0.25 - 0.71]
*CIDD * > 20.000 inhabitants*	5.10	70.80	0.49	[0.28 - 0.7]
*CIDD * <20.000 inhabitants / rural*	7.37	57.76	0.55	[0.35 - 0.75]
Building type				
*CIDD * Multi-family housing*	2.82	73.40	0.60	[0.44 - 0.76]
*CIDD * Single-family home*	8.33	61.91	0.68	[0.55 - 0.81]
Building completion date				
*CIDD * <=1948*	7.60	57.96	0.47	[0.29 - 0.65]
1949/1988	6.50	70.67	0.47	[0.29 - 0.65]
*CIDD * 1989/last year*	2.00	42.28	0.46	[0.26 - 0.66]

Discussion & conclusion

Limits :

Intrinsic limits of the difference estimation => potentially conservative estimates of the CIDD impact

Implications on the policy design:

- Implement consistent and simple tax credit design,

- To improve the cost effectiveness of the policy :

high levels of subsidies

+

more strengthened eligibility requirements (or targeted groups where the number of likely non-additional participants is low)

Thank you for your attention.

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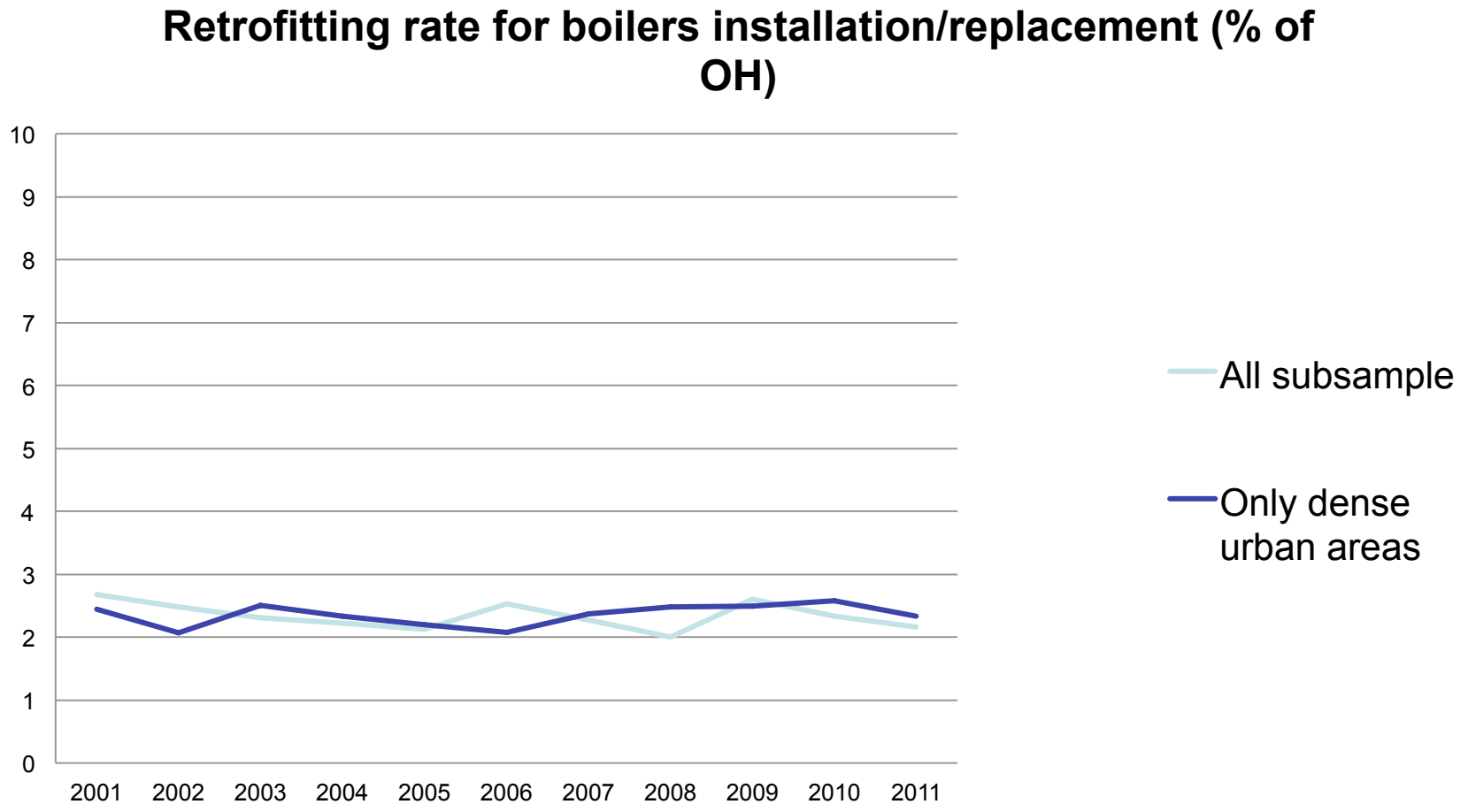
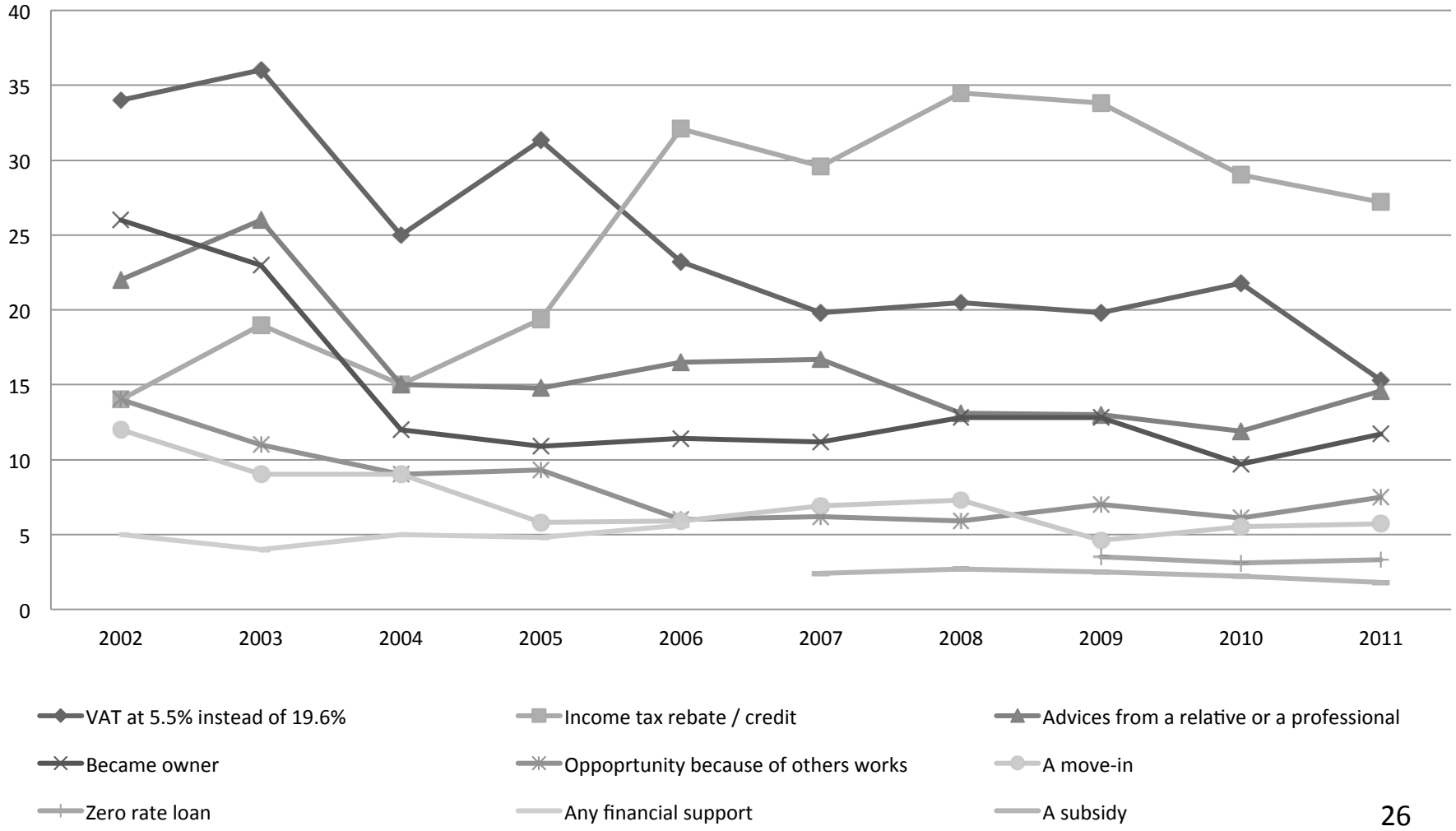
Appendix

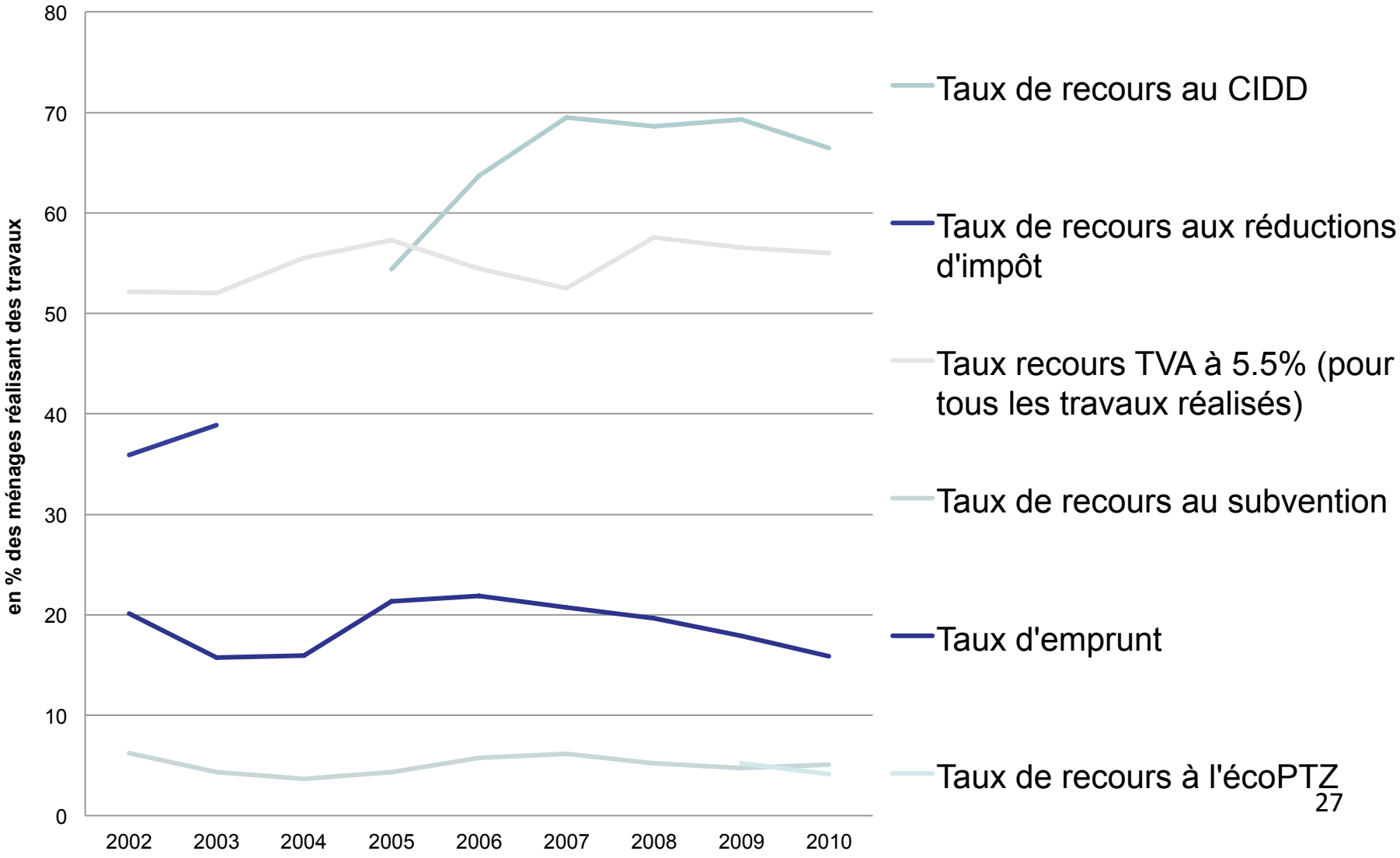
Data : annual retrofitting rates per retrofitting type in % among occupying homeowners.



What were the main incentives/opportunities in your decision to retrofit?”



The share of beneficiaries among all retrofiters depending on the economic instrument.



5. Results : estimated marginal effects for opaque & glazed surface insulations.

	logit (1)		**logit RE (2)**		**logit RE EcoPTZ excl. (3)**	
Variables	M.E.	S.E.	M.E.	S.E.	M.E.	S.E.
2003	0.001	(0.0062)	0	(0.00464)	0.003	(0.0044)
2004	-0.002	(0.0067)	-0.006	(0.00455)	-0.004	(0.0043)
CIDD dummy*2005	0.002	(0.0068)	0	(0.00477)	0	(0.0044)
CIDD dummy*2006	-0.002	(0.0063)	-0.004	(0.00451)	-0.004	(0.0042)
CIDD dummy*2007	0.011*	(0.0065)	0.006	(0.00462)	0.004	(0.0043)
CIDD dummy*2008	0.013*	(0.0066)	0.008*	(0.00465)	0.008*	(0.0043)
CIDD dummy*2009	0.043***	(0.0074)	0.031***	(0.00538)	0.025***	(0.005)
CIDD dummy*2010	0.038***	(0.0075)	0.025***	(0.00531)	0.02***	(0.0049)
CIDD dummy*2011	0.018***	(0.0066)	0.015***	(0.00502)	0.013***	(0.0047)

5. Results : estimated marginal effects for opaque & glazed surface insulations.

	logit (1)		logit RE (2)		logit RE EcoPTZ excl. (3)	
Variables	M.E.	S.E.	M.E.	S.E.	M.E.	S.E.
Environmental concerns	0.006*	(0.0034)	0.005**	(0.00237)	0.004*	(0.0022)
Economic concerns	-0.001	(0.0034)	0	(0.00239)	0.001	(0.0022)
Annual dummies *(ref:2002)*						
Annual income of the dwelling *(ref : <18500 euros)*						
18500 /36 300 euros	0.01**	(0.0046)	0.01***	(0.00302)	0.007**	(0.0028)
>36 300 euros	0.007	(0.0057)	0.008**	(0.00381)	0.006*	(0.0035)
Move in date *(ref : < 3 years)*						
3 / 10 years	-0.071***	(0.0076)	-0.062***	(0.00668)	-0.042***	(0.0059)
> 10 years	-0.095***	(0.0078)	-0.082***	(0.00697)	-0.058***	(0.0061)
Socio-professional category *(ref : Entrepreneur)*						
Managers	0.029***	(0.0092)	0.023***	(0.00604)	0.022***	(0.0054)
Employees	0.026***	(0.0091)	0.018***	(0.00598)	0.019***	(0.0054)
Inactive	0.021**	(0.0091)	0.014**	(0.00583)	0.014***	(0.0052)
Family size *(ref : 1 person)*						
1 couple	0.008*	(0.0048)	0.004	(0.0035)	0.005	(0.0032)

5. Results : estimated marginal effects for opaque & glazed surface insulations.

	logit (1)		logit RE (2)		logit RE EcoPTZ excl. (3)	
Variables	M.E.	S.E.	M.E.	S.E.	M.E.	S.E.
HDD	0.0002	(0.006)	0.005	(0.00429)	0.008**	(0.004)
Energy price variation	0.008	(0.0102)	0.008	(0.00751)	0.011	(0.007)
Dwelling size	0.001**	(0.0005)	0.001**	(0.00039)	0.001**	(0.0004)
Building completion date *(ref : < 1974)*						
1975/1988	-0.027***	(0.0045)	-0.022***	(0.00334)	-0.016***	(0.0031)
1989/last year	-0.087***	(0.0033)	-0.065***	(0.00286)	-0.054***	(0.0027)
Collective flat	-0.041***	(0.0044)	-0.031***	(0.00289)	-0.024***	(0.0027)
>2 persons	0.01	(0.0063)	0.004	(0.00406)	0.003	(0.0037)
Category of city *(ref : Parisian agglomeration)*						
> 20.000 inhabitants	0.004	(0.0059)	0.008**	(0.00374)	0.006*	(0.0034)
<20.000 inhabitants / rural	0.008	(0.0062)	0.009**	(0.00405)	0.006*	(0.0037)
sigma_u			1.111	(0.04651)	1.085	(0.0496)
rho			0.273	(0.01661)	0.264	(0.0177)
Nb of observations	36367		36367		35977	
Nb of individuals			13116		13023	
Log likelihood	-11714.13		-9432.6265		-8617.8839	

*(resp. ** and ***) significant at 10% level (resp. 5% and 1%).

col (1): logit estimates; (2) RE logit estimates; (3) RE logit estimates on the subsample exluding retrofitting measure eligible to EcoPTZ

5. Results : estimated marginal effects for opaque & glazed surface insulations.

	logit (1)		**logit RE (2)**		**logit RE EcoPTZ excl. (3)**	
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2004	-0.002	(0.0067)	-0.006	(0.00455)	-0.004	(0.0043)
CIDD dummy*2005	0.002	(0.0068)	0	(0.00477)	0	(0.0044)
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CIDD dummy*2007	0.011*	(0.0065)	0.006	(0.00462)	0.004	(0.0043)
CIDD dummy*2008	0.013*	(0.0066)	0.008*	(0.00465)	0.008*	(0.0043)
CIDD dummy*2009	0.043***	(0.0074)	0.031***	(0.00538)	0.025***	(0.005)
CIDD dummy*2010	0.038***	(0.0075)	0.025***	(0.00531)	0.02***	(0.0049)
CIDD dummy*2011	0.018***	(0.0066)	0.015***	(0.00502)	0.013***	(0.0047)

5. Results : free-riding estimation.

All retrofit incl. Insulation (opaque and glazed surfaces)							
	2005	2006	2007	2008	2009	2010	2011
τ_R *	6.77	6.59	8.22	7.99	10.91	9.61	7.8
α_{CIDD} **	62.88	67.57	67.52	68.46	74.29	73.43	64.79
Estimated CIDD M.E.	0	-0.004	0.007	0.008	0.029	0.027	0.015
Standard errors	0.0047	0.0044	0.0044	0.0046	0.0049	0.005	0.0048
Estimated free-riding rate	-	-	-	0.8537	0.6424	0.6176	0.703
Confidence interval	-	-	-	[0.6904 - 1]	[0.5238 - 0.7611]	[0.4776 - 0.7575]	[0.5174 - 0.8885]

Opaque Insulation							
	2005	2006	2007	2008	2009	2010	2011
τ_R *	2.91	2.83	3.7	3.51	4.93	4.6	3.89
α_{CIDD} **	.	29.96	36.29	39.37	48.83	42.02	39.95
Estimated CIDD M.E.	0.001	-0.001	0.003	0.004	0.013	0.011	0.009
Standard errors	0.002	0.0019	0.002	0.002	0.0026	0.0025	0.0024
Estimated free-riding rate	-	-	0.7761	0.7101	0.4606	0.4301	0.4194
Confidence interval			[0.4865 - 1]	[0.4232 - 0.997]	[0.2532 - 0.668]	[0.1762 - 0.6839]	[0.1184 - 0.7203]

(*) the retrofitting rate in % among occupying homeowners, (**) the % of households having invested in retrofitting who apply for CIDD.

Marginal effects in logit models

Marginal effects :

$$\frac{\partial P(I_{it}=1 \mid X_{it}, u_i)}{\partial x_{kit}} = \beta_k (1 - P(I_{it}=1 \mid X_{it}, u_i)) P(I_{it}=1 \mid X_{it}, u_i) .$$

In order to estimate Δ, we compute the average of all the individual marginal effects.