Is the income tax deduction is a good instrument to encourage renovations in the residential in France?

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Abstract

Energy consumption and GHG emissions are a key concern in France. To encourage households to undertake energy-efficient renovations or adopt renewable energies, the government introduced an income tax deduction in 2005. Our objective is to evaluate the effectiveness of this measure. We use households' level databases from 2005 to 2008 from *ADEME-SOFRES*, which regroup information on energy-efficient renovations and the use of financial support to carry out the renovation works. We apply matching method to estimate the impact of the income tax deduction on renovation expenditures. We show that the impact of the measure is mixed. It has a significant and positive effect on renovation expenditure but the free-ridership seems important.

Keywords: Policies evaluation, Matching method, Income tax deduction, Energy-efficient renovation
JEL Classification: Q58, H22, C13

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1. Introduction

In France, the government sets the objective to decrease significantly the energy consumption, especially cutting the energy consumption in the building sector by 38% by 2020 compared to 2008. The residential-tertiary sector accounted for approximately 43% of final energy consumption and 23% of GHG emissions in 2009 and the two-thirds are due to residential buildings (source: ADEME).

To reach this objective, it is crucial that households renovate their housing (Risch and Salmon, 2012). However, households do not invest in energy-saving measures even if it is profitable in the long term. Many authors (Brown, 2001; Jaffe and Stavins, 1994; Sanstad et al., 1995; Van Soest and Bulte, 2001) call this phenomenon the energy paradox and explain it essentially by market imperfections (as uncertainty on energy prices or irreversibility of the investment). To offset these imperfections, the government acts through environmental policies. Several measures have been introduced in recent years, including an income tax deduction and a zero bank loan to encourage households to undertake energy-efficient renovations and to adopt renewable energies systems. The aimed of this paper is to assess the effectiveness of the income tax deduction. Few studies estimate the impact of French policies. Two models of simulation show at an aggregate level that income tax deduction and zero bank loan allow decreasing energy consumption and GHG emissions and point out that these measures are not sufficient to reach government objective (Charlier and Risch, 2012; MEDDTL et al., 2011). To household level, Mouroux (2012) studies the raise in 2006 of the rate of the income tax deduction for some energy-saving and insulation renovations. This increase concerns owners living for less than 3 years in a housing built before 1977. She demonstrates the effectiveness of this change using fiscal data and matching models: one on fifteen households receiving the income tax deduction would not have renovated if the rate had stayed the same.

A similar measure was introduced in United States from 1978 to 1985: the federal Energy Tax Act. This aimed at encourage energy-saving investments and development of renewable energies in the residential sector. Several papers study the impact of this measure. Dubin and Henson (1988) find no evidence that credits had incentive effect on conservation expenditure using a tobit model on 1979 data. They point out a free-ridership effect showing that this measure provided windfall gains to households who would have insulated anyway. Hasset and Metcalf (1993) measure

the impact of both federal and state tax policies on the probability of making conservation investments, using a discrete choice model on panel data. They show that the conservation incentive programs have a statistically significant effect on investment once individual fixed effects are controlled. These different findings show that it is important to assess the impact of such measure.

In this paper we evaluate the effect of the French income tax deduction. Our objective is to study in what extent this measure allowed increasing the renovation expenditures. We also pay a particular attention to the characteristics of the households that received the financial support. Indeed, have a good understanding of who are the households that receive this measure and in which housing they live is important to judge the effectiveness of the policy. This paper provides a complementary to the existing studies and fills the gaps in the literature.

One difficulty related to the evaluation is that we cannot observe what would have been the renovation expenditures if the income tax deduction had not been introduced (Rubin, 1974). To overcome this problem and obtain unbiased evaluation we use matching method (Rubin, 1977; Heckman, Ichimura and Todd, 1997 and 1998). It consists to match household who benefits of the income tax deduction with a similar household who does not benefit of the measure. The match is realized on the basis of propensity scores. We first calculate these propensity scores, that is to say we estimates the characteristics of households who benefit of the income tax deduction. Then, they are used to calculate counterfactual renovation expenditures. The effect of the measure is the differential between expenditures observed for beneficiaries and the counterfactual situation. This methodology is largely used to face evaluation issue in environmental or labor economics (see for example Mouroux, 2012; Sabatier, 2012; Imbens and Wooldridge, 2009; Brodaty, Crépon and Fougère, 2002).
To conduct this study we use data from *ADEME-SOFRES Maîtrise de l'Energie* surveys from 2001 to 2008. It provides information on households and housing characteristics, on potential energy-saving renovations and potential financial supports.

The paper is structured as follows. The next section presents the French income tax deduction, section 3 focuses on data and statistical analysis, section 4 discusses the method and describes the methodology used and section 5 presents the results.

2. The income tax deduction

To increase the number of energy-saving renovations and decrease the energy consumption in building sector, the government put into place several measures. One of the most popular is the income tax deduction.

The income tax deduction has been introduced in 2005. The objective is to encourage households, owners or tenants, to renovate their main housing. Households can benefit of this measure mainly for heating equipment, insulation works and renewable energies and if building professionals make the renovations. The income tax deduction allows part of the expenses to be deducted from the income tax. A deduction rate of up to 50% depends of the kind of renovation carried out (change in heating system or improvement of the insulation) and the equipment chosen (adoption of renewable energy for example). The maximum amount of expenses deducted depends on the number of persons in the household (the maximum of the expenses deducted is 8000 € for a household with one person and 16000€ for a couple for example). This measure has known some modifications. The deduction rate increased in 2006 for some equipment, and then decreased in 2009.

From 2005 to 2008, 4.2 millions of French households received the income tax deduction (Clerc and Mauroux, 2010) and this represents a high cost for the government: the public cost reaches 7,8 billion euros on this period. Therefore, it seems important to assess its effectiveness.

Table 1: Presentation of the income tax deduction

Beneficiaries of the tax credit	Conditions to receive the measure	Main equipment concerned	Deduction rate	Changes in the measure
-Owners and tenants (fiscally domiciled in France) -Main housing	-Energy-saving renovations -Renovation realized by buildings professional	-Heating systems -Insulation materials -Renewable energies investment	From 10% to 50% depending on the kind of renovation	2006: increase of the deduction rate for some renovations 2009: decrease of the deduction rate

3. Data and statistical analysis

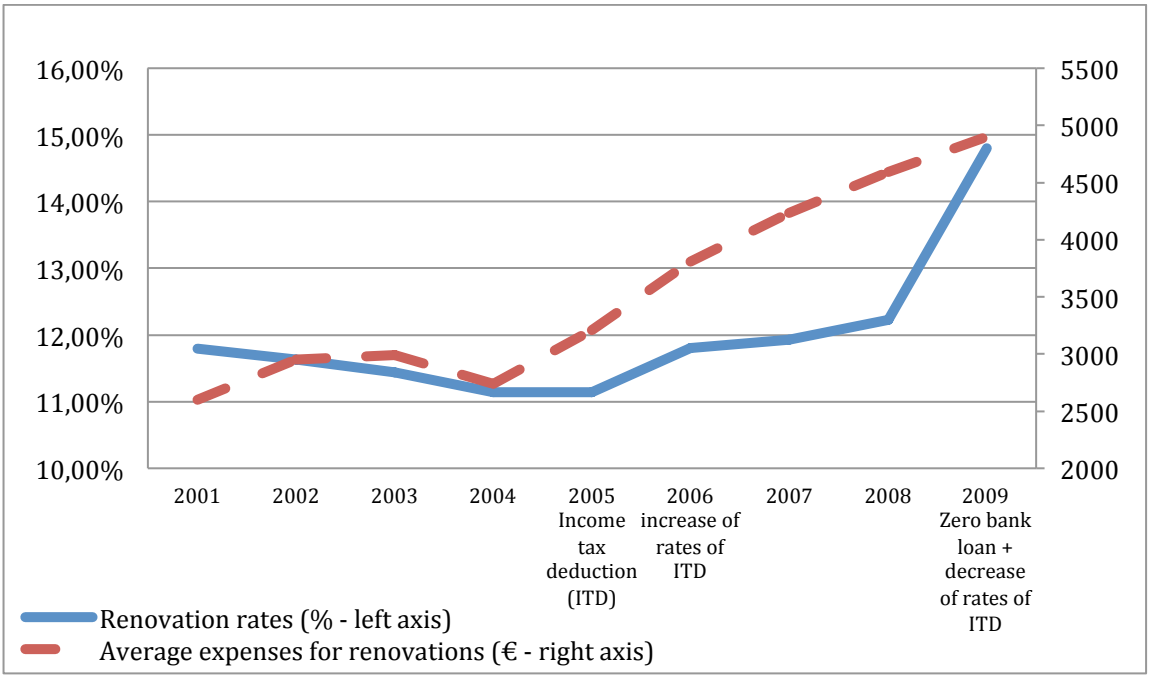
3.1. Data

To realize this study, we use *ADEME-SOFRES Maîtrise de l'Energie* surveys. Each year, a panel of households is surveyed about the realization or not of energy-savings renovations. Information is available on the realization or not of renovations, and the type of renovations undertaken (improvement of insulation, modification of heating system, adoption of renewable energy for example). We do not observe the same households on all the period. But information on households' characteristics (like income, occupational status, household size, age of reference person or tenure), housing characteristics (kind of dwelling –house or apartment-, surface area, year of construction or kind of heating system), geographic areas (climatic area or size of the urban area), and also on energy bill are available.

3.2. The income tax deduction efficiency and the free-ridership

From 2001 and 2009, around 7000 households replied to the survey each year. At a first glance, the income tax deduction seems to have a positive impact on renovations rate and on the amount spend by a household for a renovation. First, the expenses for a renovation on the 4 years following the introduction of the income tax deduction are significantly higher than on the 4 years before (3201 euros against 2645 euros) and the renovations rate is also slightly higher (12.8% against 11.8%). Second, the average amount spent for renovate the housing decrease in 2004 and then continually increases since the introduction of the income tax deduction (fig. 1). We observe a similar evolution for the renovations rate: it decreases until 2004, stabilizes in 2005 and then continually increases. The largest raise occur in 2009, year of the introduction of a zero bank loan. This zero rate bank loan is offered to homeowners who make several renovations or an energy saving investment.

Fig 1: The influence of public policies on renovations



Source: *ADEME-SOFRES Maîtrise de l'Energie* surveys

The continuous increase in the expenses for renovation and the renovations rate since 2005 can be linked to the popularity of this measure. Almost 85% of households surveyed reported knowing the income tax deduction in 2009 compared to 53% in 2005 (table 2). The number of households that forecast to benefit of the income tax deduction increase each year. In 2009, 60% of households who realized a renovation received or intended to request the income tax deduction. This represent 7,15% of the households surveyed.

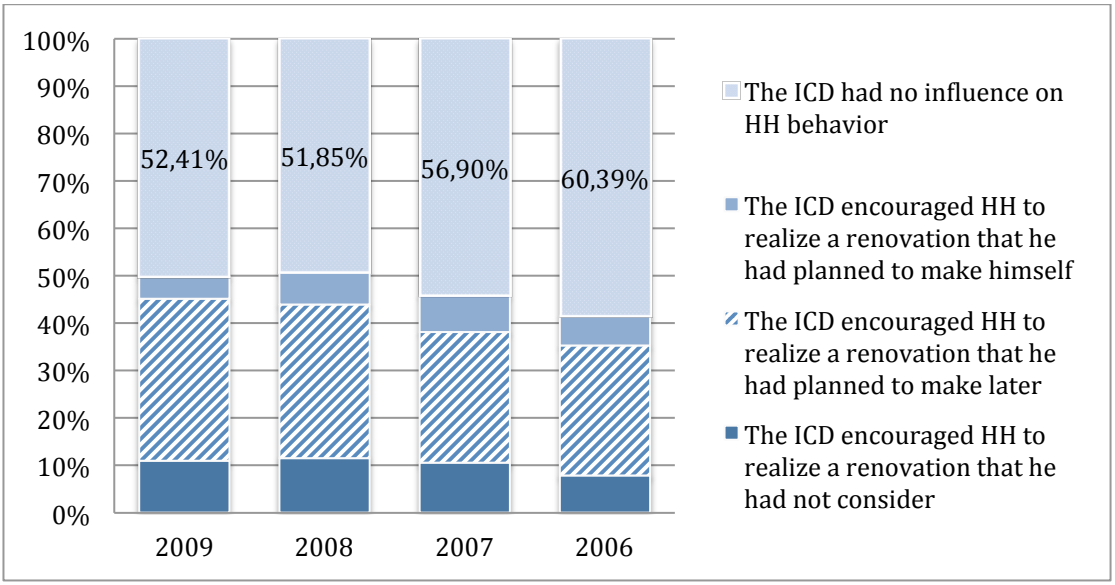
Table 2 – The popularity of the income tax deduction

	% of HH who know the income tax deduction	% HH who received / intend to request the ITD	
		among HH who have renovated	on total
2009	84,27 %	59,95 %	7,15 %
2008	77,77 %	60,32 %	5,93 %
2007	74,18 %	58,16 %	5,70 %
2006	62,56 %	50,94 %	4,60 %
2005	52,62 %	35,07 %	3,80 %

Source: *ADEME-SOFRES Maîtrise de l'Energie* surveys

The income tax deduction seems to be efficient, but this result has to be moderate. First, amongst households who received or intended to receive the income tax deduction, only 11% on average each year realized a renovation that they had not consider before the introduction of the measure. In contrast, more than 50% of these households declare that the income tax deduction had no effect on their behavior. This means that more of the half of households receiving the income tax deduction would have realized the renovation without this financial support (fig. 2). The free-ridership is important.

Fig 2: Income tax deduction and free-ridership



Source: *ADEME-SOFRES Maîtrise de l'Energie* surveys

3.3. Who renovates and who benefits of income tax deduction?

Every household can intend to request the income tax deduction if they decide to make an energy-saving renovation and if a building professional realizes this renovation. We focus only on these renovations to study the profile of households who undertake an energy-saving renovations and who intend to request the income tax deduction. We take into account surveys from 2005 to 2008. Expenditures in renovation are twice for households who planed to obtain the income tax deduction than the others. But, even after the introduction of the income tax deduction, most of the renovation works are still realized by richest households, owners, living in a house (table 3). Only 67.3% of potentially eligible households intend to request the income

tax deduction. This concerns in majority the wealthiest households. The measure seems to be not sufficient to reach poorest households, whereas they live in older and less energy-efficient housing.

Table 3 - Profiles of households making energy-saving renovations and who intend to request the tax credit, between 2005 and 2008:

	Households who do not renovate	Households who make renovations (*)	Households who make renovations and intend to request the tax credit	Households who make renovations and do not receive the tax credit
Renovation expenses	/	5063 €	5963 €	2958 €
Owners	59.7 %	89.1 %	97.5 %	74.26 %
Income				
- tranche 1 (the poorest)	13.5 %	6.6 %	3.8 %	11.4 %
- tranche 2	10.9 %	7.2 %	5.5 %	10.3 %
- tranche 3	10.9 %	9.0 %	8.0 %	10.7 %
- tranche 4	14.3 %	14.4 %	14.3 %	14.7 %
- tranche 5	30.3 %	36.5 %	38.4 %	33.0 %
- tranche 6 (the richest)	20.0 %	26.3 %	30.0 %	19.9 %
Age of reference person:				
- less than 35 years	19.0 %	14.7 %	11.5 %	20.1 %
- between 35-44 years	18.5 %	18.7 %	20.1 %	16.3 %
- between 45-54 years	18.7 %	18.7 %	18.8 %	18.4 %
- between 55-64 years	16.5 %	20.2 %	21.0 %	18.8 %
- 65 years or more	27.3 %	27.8 %	28.5 %	26.4 %
Nb persons in the household:				
- 1 person	32.5 %	23.5 %	20.4 %	28.7 %
- 2 persons	33.4 %	37.6 %	39.1 %	35.2 %
- 3 persons	14.9 %	16.9 %	15.7 %	19.0 %
- 4 persons or more	19.1 %	22.0 %	24.8 %	17.0 %
Socio-professional categories:				
- farmer	1.7 %	1.4 %	1.6 %	1.2 %
- storekeeper/ artisans	4.1 %	3.7 %	3.9 %	3.3 %
- liberal occupations	11.0 %	12.5 %	14.4 %	9.4 %
- intermediate occupations	13.9 %	15.3 %	16.2 %	13.6 %
- employee	11.4 %	8.9 %	7.1 %	12.1 %
- laborer	17.2 %	14.8 %	13.3 %	17.5 %
- inactive	40.7 %	43.4 %	43.6 %	43.0 %
House	53.2 %	75.2 %	81.4%	74.3 %
Years of construction:				
- after 1989	18.3 %	8.7 %	8.5 %	8.9 %
- between 1982-88	8.2 %	8.3 %	7.7 %	9.3 %
- between 1975-81	13.2 %	14.6 %	15.6 %	12.9 %
- between 1949-74	33.4 %	35.2 %	35.1 %	35.4 %
- before 1949	26.8 %	33.2 %	33.1 %	33.3 %
Nb of households	24,514	2,330 (or 9.5 %)	1,567 (or 67.3%)	763 (or 32.7%)

(*) We only take into account households who asked to building professionals to make the renovations. Indeed, it is the necessary condition to benefit from tax credit. This is represent 74.2% of renovations between 2005 and 2008.

Source: *ADEME-SOFRES Maîtrise de l'Energie* surveys

For all these reasons, in the following section we go further in the analysis and we assess the effectiveness of the income tax deduction *ceteris paribus*. Our objective is

to study the impact of the income tax deduction on the expenditures in energy-saving investments: Is this measure allows households spending more money for renovations and therefore undertakes renovations more energy-efficient?

4. Evaluation of the income tax deduction:

4.1. Evaluation problem

The impact of the income tax deduction is the differential between the renovation expenditures with the policy (y_1) and the renovation expenditures that would have been observed without the policy (y_0) (Rubin, 1974). The impact is thus unobservable since it is impossible to simultaneously observe both situations and it is specific to each individual. Moreover, the evaluation of public policies faced to two issues. First, a self-selection problem: request the income tax deduction is an individual choice. Second, the effect of the income tax deduction is heterogeneous and the consequences resulting from the measure are different depending on whether individuals request the income tax deduction ($T = 1$) or not ($T = 0$). For these reasons, we cannot study the effect of the income tax deduction with what we observe for the households that do not receive the measure. If households choose to request for the income tax deduction depending on their characteristics, consequences are not independent of their choice and non-beneficiaries are not representative of beneficiaries. To overcome the selection problem it is necessary to control for observable differences between beneficiaries and non-beneficiaries. We can assume that there is a set of observables variables (x) (such as income, age or socio-professional category) for which there is independence between the policy outcome and the fact to benefit of the income tax deduction. The random assignment to the measure is provided by these observable characteristics (Rubin, 1977).

In other words, the impact of the income tax deduction on renovation expenditure can be expressed as:

$$\Delta(x) = E[y_1 \,/\, T = 1, X = x] - E[y_0 \,/\, T = 1, X = x]$$

The second term is the counterfactual renovation expenditures and we have to calculate it. We use matching method, which involves matching each household who benefits of the income tax deduction with a household who has not benefit of the measure and having the same observable characteristics, x. A common way of matching households is propensity score matching. Indeed, as two households are not entirely similar in all observables characteristics, the matching is based on a single propensity scores, reflecting the probability of benefit of income tax deduction conditional on the observed characteristics x (Rubin, 1977; Rosenbaum and Rubin, 1983; Heckman, Ichimura and Todd, 1998).

As the matched households are considered to be identical, the renovation expenditures of households who do not benefit of income tax deduction is used to estimate the counterfactual renovation expenditures of households who benefit of the measure. To be efficient, this method has to respect two conditions. First, the conditional independence assumption means that benefit of income tax depends only on observables. Second, the common support condition implies the necessity of a substantial overlap between the characteristics of the beneficiaries and non-beneficiaries (the overlap is called the common support).

It exists different matching estimators to calculate the expenditure differentials: for example the nearest-neighbor estimator, the stratification matching or the kernel matching. The nearest-neighbor estimator consists, as its name suggests, to match each household who benefits of tax credit with the household who does not benefit and having the closest propensity score. It is one of the most frequently used but the disadvantage is that the difference in propensity score between a household who benefits of the measure and its closest non-beneficiary household may be high. Stratification matching estimator partitions the common support into different strata and estimate the effect of the measure within each interval. The risk is that only a small subset of non-beneficiaries will satisfy the criteria to fall within the common support and thus construct the counterfactual outcome. The last one is the kernel-matching estimator. It is a nonparametric estimator and it consists to use a weighted average of all non-beneficiaries to construct the counterfactual of each participant.

4.2 Estimation strategy:

For the estimation, we take into account in our sample only households who invest in an energy-saving renovation and asking to a building professional to realize it. We use databases from 2005 to 2008, to have information each year since the introduction of the income tax deduction. A zero bank loan was introduced in 2009. Therefore we do not take into account 2009 database because we may capture the effect of the two policies for these years and we want to isolate the impact of the income tax deduction. Finally, our sample is composed of 2,330 households eligible to the income tax deduction (including 1,567 households who benefit of the measure).

In a first step, we estimate the propensity score. The probability of request the income tax deduction is estimated using a probit model. We rely on statistical analysis above and include in this estimation variables on households characteristics (like tenure, income and socio-professional information, age of the reference person and the number of persons in the household) and housing characteristics (king of building: apartment or house, and the year of construction). We control for autocorrelation problem.
In a second step, we estimate the impact of the measure using several estimators: the nearest-neighbor matching, the stratification matching and the kernel-matching estimators.

5. Results

This section presents first the results of the propensity scores, or the probability of request the income tax deduction (table 4). This allows obtaining the profile of households who request the income tax deduction. Second, we focus on the calculation of the renovation expenditures differentials, in other words the impact of the income tax deduction on renovation expenditures (table 5).

The most striking result, is that the probability to benefit of the income tax deduction increase with the level of income. Wealthier the households are, higher the probability

that they benefit of the measure is. Also, the households belonging to the higher socio-professional categories (as liberal occupation) have more important probability to benefit of the measure. This means that the measure does not reach low income whereas they need it more. Therefore, the income tax deduction seems not able to encourage low-income to undertake energy-efficiency renovations.

Moreover, owners have a significantly higher probability of benefit the income tax deduction than the tenants. It is also the case that households living in a house compared to an apartment. This suggests that income tax deduction fails to encourage households who not used to renovate. A tenant has less incentive to make an energy-efficiency investment because the return on the investment is lower than for an owner. Indeed, a tenant does not see the value of his property increases due to renovation. In France, the problem is part of the population is tenant for life. That is why it is important to encourage tenants to renovate, and the income tax deduction seems to be insufficient for this. In the same way, apartments are often in collective buildings and some renovations cannot be decided at the household level but must be taken by the community. Thus undertake renovation is more difficult.

We can conclude that this measure seems to have a low impact on populations that need it more. The profile of households who benefit income tax deduction is the same that those who used to renovate (see Charlier (2012) for go further in the determinants of energy-efficient renovations). The income tax deduction benefits only households who renovate most without any incitation.

Table 4 – Probability to benefit of the income tax deduction

	Coefficient	Standard Error
Household characteristics		
Tenure		
owner	1.323	0.117 ***
tenant	*ref*	
Income categories		
income tranche 1	*ref*	
income tranche 2	0.094	0.154
income tranche 3	0.414	0.151 ***
income tranche 4	0.434	0.137 ***
income tranche 5	0.551	0.127 ***
income tranche 6	0.575	0.136 ***
Socio-professional categories		
intermediate occupations	0.177	0.094 *
liberal occupations	0.293	0.109 ***
inactives	0.026	0.120
others	*ref*	
Age of the reference person		
younger than 35 years	*ref*	
age between 35-44 years	0.110	0.109
age between 45-54 years	0.062	0.109
age between 55-64 years	0.114	0.127
older than 65 years	0.152	0.149
Number of persons in the household		
1 person in the HH		
2 persons in the HH	0.027	0.081
3 persons in the HH	-0.114	0.107
4 persons or more	0.118	0.110
Housing characteristics		
apartment	*ref*	
house	0.321	0.079 ***
construction after 89	*ref*	
construction between 1982-88	-0.0230	0.128
construction between 1975-81	0.161	0.114
construction between 1949-74	0.176	0.104 *
construction before 1948	0.071	0.103
constant	-1.784	0.199 ***
Log Likelihood	-1318.36	
Observations	2,230	
	Mean	Std. Err.
Propensity score	0.66	0.18
Number of blocks	6	
Balancing hypothesis	ok	

NB: *** significant at 1%, ** significant at 5%, * significant at 10%

These results are used to estimate propensity scores. The households are divided into six homogeneous blocks and the balancing assumptions for each block is valid. Therefore, the renovations expenditures of non-beneficiaries households can be used to estimate the counterfactual situation of tax credit beneficiaries. Three estimators are used to estimate the differentials in renovation expenditures of beneficiaries and the counterfactual. Results are presented in table 5.

Table 5 – Income tax deduction impact on renovation expenditures

	Nearest neighbor matching method	Stratification method	Kernel matching method
Result	0.675	0.693	0.689
Standard Error	0.065***	0.050***	0.063***

NB: *** significant at 1%, ** significant at 5%, * significant at 10%
For Kernel matching, bootstrapped standard errors is estimated.

Whatever the method used, the income tax deduction has a significant impact on renovation expenditures. Results obtained with the three estimates are very close and are in the range of 0.675 and 0.693. The differential is positive; this means that renovation expenditures are higher with the measure. The income tax deduction encourages households to spend more money in renovations and thus undertake more energy-efficient renovations.

Considering the results, the effectiveness of the tax credit is mixed. We observe a high free-ridership. It seems necessary to modify this public policy to target only households who need it most, especially in the current context.

It is important to put into place policies to aid the poorest households to renovate. These households live in less energy-efficient housing and they cannot undertake major energy-saving renovations without financial support. These households are often in energy poverty situation. Provide assistance to these households to renovate could have two positive effects: (i) it could allow decreasing significantly the energy consumption in the residential sector and (ii) it could be a good mean to fight energy poverty. However, the current income tax deduction does not encourage these households to renovate. An increase of the deduction rates for these households could address this. In the same way, the policy should target more tenants and households living in apartments. Today, 42.5% of households are tenants and 44% of main

housings are apartments. These households do not renovate in the absence of a more intensive public policy.

The income tax deduction is the most popular environmental policy in France, but it seems important to rethink the way it is dispensed. We recommend two orientations. First, the income tax deduction should target only households who do not renovate (lower income, tenants and households living in apartment). Second, increase the financial support for these households because the current policy is not sufficient to encourage them to undertake energy-saving renovations.

Conclusion

Income tax deduction was introduced in France in 2005 to encourage households to undertake energy-efficient renovations in their housing. This measure has known several changes, essentially concerning deduction rates, and it represents a high cost for the government. It seems important to evaluate it in order to guide policy maker. However, few studies aims at assess the effectiveness of French environmental public policies.

In this paper, we evaluate the impact of the income tax deduction on renovation expenditures. We use a household level databases on energy conservation, from 2005 to 2008. Matching method is appropriate to study the impact of this measure, *ceteris paribus*. We estimate in a first time the probability that a household benefits the income tax deduction using a probit model. This estimation allows calculating the propensity score matching, which is used to match a household who benefit of the income tax deduction with a household who does not receive this measure and having similar characteristics. This allows estimating the counterfactual renovation expenditures of households who benefit of the measure. We use three estimators to estimate the differential between what we observe for the beneficiaries and the counterfactual situation; this means the impact of the measure.

We show, on one hand, that the income tax deduction encourages households who used to renovate. This induces a free-ridership. The probability of benefit of this measure increases with the income level. This probability is also higher for owners,

living in a house. This measure does not reach households we need more financial support to undertake renovations. On another hand, the measure has a significant and positive effect on renovation expenditures.

It seems important to rethink the way the income tax deduction is dispensed. First, decrease the free-ridership, limiting access to the policy to households that not renovate normally without the measure. Indeed, to decrease significantly the energy consumption in residential sector it seems important to encourage households who not used to renovate. The households with lower income often live in less-energy efficiency housing and not renovate, even with the current policy. Second, it seems thus appropriate to increase the incentives to renovate for these households, increasing for example the deduction rates.
The next step of this research is to study the impact of the income tax deduction on the probability of renovate.

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