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Economic and Fiscal Additionality in Italian Tax Credit on Dwellings Renovation*

Marco Manzo† Daniela Tellone ‡

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Abstract

In June 2012, the fiscal policy for the renovation of dwellings has changed considerably with respect to two main aspects: i) the tax credit share has increased from 36% to 50% and ii) the total amount of renovation costs that can benefit of the tax credit increased from 48000 euros to 96000 euros. The aim of this work is to provide an ex-post analysis of this policy change. The policy effect is evaluated on: the increase in dwellings renovation probability (economic additionality), the increase in the level of renovation expenses and the decrease in underground economy (fiscal additionality). We found that the policy stimulated the likelihood of renovation in terms of fiscal additionality but in terms of economic additionality had a limited effect.

Keywords: Residential Sector, Tax Credit, Dwelling Renovation Policy, Italy
JEL Classification: D12, H31, E62

1 Introduction

In 1997 the Italian government introduced for the first time an annual fiscal incentive for the renovation of both dwellings and condominiums (Law no. 499, 27 December 1997). Although some thresholds changed over the years, the following financial laws extended this tax relief every year, until Financial Law no. 214/2011 made the policy permanent

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(see Table A.1). In the present paper, we will focus on the economic effect of the 2012 policy change (D.L. n.83/2012), which concerns both the maximum amount of tax benefit and the tax credit share: from 26 June 2012 to 30 June 2013 the maximum amount of renovation costs that can benefit from the tax relief increased from 48000 euros to 96000 euros and the share of the tax credit increased from 36% to 50%. The following financial laws extended these maximum levels from 30 June 2013 until to 31 December 2020.[1] To assess the economic effect of the 2012 policy change we focus our analyses on the period between 2010 and 2014. During this period the main features of the policy scheme doesn't change, and they are: i) the tax relief must be lower or equal to the gross income tax amount; ii) the tax relief must be lower or equal to the maximum spending amount. In the period under investigation, the tax credit relates to expenses borne for[2]

- not ordinary or non-routine maintenance, such us: works for renovate and replace parts of building structure, to build bathroom, to install technological device, splitting up or merge of dwellings, construction of internal stairs, etc;
- restorative and preservative works: interventions aimed at preventing degradation situations, adjustment of the heights of the floors, building of new windows for room ventilation needs, etc;
- building renovation works: demolition and reconstruction, modification of the facade, construction of an attic or a balcony, etc.

The renovation works can be carried out on individual dwellings of any cadastral category, including both rural ones and other house's related properties. Routine maintenance works may benefit from tax credit only if they concern shared parts of condominiums and they are: painting of walls and ceilings, internal and external fixtures, new internal plasters, the waterproofing of roofs and terraces, painting of garage doors, etc. Most importantly, the type of non-routine maintenance work eligible for the tax credit did not change during the period under consideration and they are specify in Law n.449/1997 art. 1.
The individual income tax returns show that 27.1 million renovations were carried out for the recovery of housing stock over the period between 2005 and 2016.[3] The total amount spent for renovation works is more than 115.8 billion euros with an average expenditure

[1] See Law 147/2013, Law 190/2014, Law 208/2015, Law 232/2016, Law 205/2015 and Law 145/2018, Law 160/2019.

[2] A full description of the expenses for renovation work are available on the web site of the Revenue Agency.

[3] For further details see "*Gli immobili in Italia*" 2019, Ch 5 [9].

of 4.276 euros per work; 5.3 billion euros is the total amount of the fiscal relief with an average of 196 euros per work per year. The number of renovation works increased significantly between 2012 and 2013, then it remained substantially stable between 2013 and 2014, and finally it continued to grow until 2016 (see Figure A.1). It is important to underline that during this period more than 90% of renovation works were aimed at the upgrade of dwellings and only a small share of works concern renovation of building other than dwellings. For example, in 2016, 90.5% of the renovation works are aimed at the upgrade of dwellings, for an overall amount of 12.4 billion euro and an average expense of 9.100 euro; the buildings other than dwellings show a very high average expense for works (22,100 euros), although performed on a limited number of buildings. This is also reflected in the distribution of the average fiscal relief which amounts to 461 euros for dwellings and 952 euros for buildings other than dwellings.[4] Furthermore, works and expenses were realized mainly by taxpayers with real estate located in the Central-Northern part of Italy; in the Southern part, the Provinces of Naples and Bari are distinguished for the greatest number and the greatest amount of expenditure made (see Figure A.2).

Behind the 2012 policy change there is the intention of the policy-maker to stimulate the building sector, severely struck by the recent crisis and to fight more strongly the underground economy. To achieve these goals the government relied on the so-called *conflict of interest policy* between taxpayers and firms. The aim of this work is to contribute to the debate on tax credit effects providing an ex-post analysis of the 2012 policy change in Italy. The efficiency of the tax relief is analysed in terms of additionality, with the aim of assessing the policy effect on: the renovation probability (*economic additionality*), the renovation expense, the undeclared economy (*fiscal additionality*) and, as a consequence, on tax evasion. To evaluate these effects, we will rely on both administrative data and survey data. We get the former data from tax declarations and the latter from two surveys: the EU-SILC -*Statistics on Income and Living Conditions* - and HBS - *Household Budget Survey*. In the EU-SILC survey there are several useful questions to address the policy evaluation. First of all it is asked: "In the last 12 months, has your family incurred expenses for ordinary maintenance (for example, shutters, sinks, glass, locks, etc.)?" and then "In ... (year), did your family incur expenses for the renovation of condominium or house you live in (for example renovation of the condominium facade or of the roof, renovation of the bathroom)?" If yes, then it is asked "How much did you spend?" Thanks

[4]Each dwelling or building may be subject to more than one renovation work. For more descriptive information on tax credit for renovation works see "*Gli immobili in Italia*" edition 2019 Ch 5 [9].

to these questions we are sure to select only works for not ordinary maintenance, namely those that benefit from the tax credit. A crucial information in our analysis is the possible discrepancy between survey data and administrative data. *The main idea behind the estimations is to use this difference as a measure of undeclared economy.*

In the following section we review the related literature on tax evasion, and the studies on the effect of tax credit policies on renovation activities (Section 2). Then we present the dataset used in estimations (Section 3) and our empirical approach (Section 4). We discuss our results in term of economic, fiscal and total additionality (Section 4) and offer some conclusions (Section 5).

2 Related Literature

Tax Evasion According to Allingham & Sandmo's [2] seminal paper on tax evasion, taxpayer compliance can be seen as a gamble between two alternatives: the taxpayer can choose to declare either her real income or a share of it. In the former case she pays the whole tax. In the latter case, she pays a share of it, but she could face a sanction with probability p. If the taxpayer has to pay a sanction, her payoff (π) is lower with respect to the case in which she declare her real income. This problem can be clearly modified to take into account a tax credit scheme, and to this end we propose a simple theoretical exercise.[5] We assume that there are two players: the dwelling owner h, who renovates, and the business b, who carries out works. The two players must pay taxes on the renovation works: the dwelling owner has to pay VAT (τ_h) and the business has to pay personal income tax (τ_b). Moreover, the owner can enjoy a tax credit (α) on the renovation cost. However, the owner and the business can collude agreeing not to declare a share of the renovation works and, thus, they can evade taxes. Nevertheless, if the owner decides to declare a share of the transaction (d), the business must pay the personal income tax only on that share. To induce the owner to evade taxes, the business can apply a discount rate (δ). To make the problem as simple as possible, we assume that there are both no audit and no sanction: the incentive to pay taxes relies exclusively on the tax credit α that the owner can enjoy. Moreover, we do not take into account the temporal difference between the discount, immediately granted, and the tax relief, which takes effect in 10 equal annual installments. The business's payoff π^b is given by:

- the net revenue from the renovation works not evaded (1-ξ), namely, the dwelling

[5] Maddaloni *et al.* [11] and Santoro [14] discuss similar examples.

owner payments Y minus the personal income tax τ_b;

- the revenues from evading tax (ξ), net of the discount the business has to offer to the dwelling owner, and the tax the business has to pay because the owner wants to declare a share of the renovation cost.

Accordingly,

$$\max_{\xi} \ \pi^b = (1-\xi)Y(1-\tau_b) + \xi Y\left[(1-\delta) - d\tau_b\right]$$

the f.o.c. is

$$\frac{\delta \pi^b}{\delta \xi} = -Y(1-\tau_b) + Y\left[(1-\delta) - d\tau_b\right] = 0$$

Since the π^b is linear in ξ, we have a "bang bang solution": either b fully evades tax ($\xi = 1$) or she pays the personal income tax on the full transaction amount ($\xi = 0$). Therefore,

$$\xi = 1 \ \text{ if } \ \delta < (1-d)\tau_b$$

for the business to be convenient to fully evade, the discount value must not exceed the return from the tax evasion. The dwelling owner payoff π^h is given by:

- the amount from the works not evaded (1-ξ), namely, the renovation cost (Y), the cost of paying the VAT rate (τ_h) on the declared cost share (d), the tax credit (α) on the declared cost share;

- the amount from the works evaded (ξ), namely, the discount applied by the business, the lower VAT paid, the lower tax credit enjoyed on the tax base evaded.

We have

$$\max_{\xi} \ \pi^h = -(1-\xi)Y(1+\tau_h)(1-\alpha) - \xi Y\{(1-\delta) - d\left[\alpha(1+\tau_h) - \tau_h\right]\}$$

the f.o.c. is

$$\frac{\delta \pi^h}{\delta \xi} = Y(1+\tau_h)(1-\alpha) - Y(1-\delta) + dY\left[\alpha(1+\tau_h) - \tau_h\right] = 0$$

As for the business payoff, the owner payoff is linear in ξ, thus either she fully evades or she fully declares the renovation works

$$\xi = 1 \ \text{ if } \ \delta > (1-d)\left[\alpha(1+\tau_h) - \tau_h\right]$$

it is convenient for the dwelling owner to evade taxes if the value of the discount compensates the loss of the tax credit, minus the VAT which she must pay if she does not evade

taxes. In equilibrium, it is convenient to evade taxes if the discount is in the following range

$$\xi = 1 \text{ if } [\alpha(1+\tau_h) - \tau_h] < \delta < \tau_b$$

it is convenient not to evade taxes if

$$\xi = 0 \text{ if } [\alpha(1+\tau_h) - \tau_h] \geq \tau_b \quad \text{that is} \quad \alpha \geq \frac{\tau_b + \tau_h}{1+\tau_h}$$

Using a VAT rate equal to 0.10, and a personal income tax at 0.4, it is possible to see that $\alpha^* = 0.45$: the optimal choice is to fully declare the cost share if the tax credit is equal to, or higher than, 45%. As already mentioned, in this simple exercise we did not take into account any audit and any sanction. However, both variables reduce the revenue from tax evasion, and depending on agent's risk aversion, a lower tax credit will suffice to induce h to declare the renovation works. In 2012, the tax credit on renovation rose from 36% to 50%, therefore according to this simple exercise, we might expect to find some positive effects on fiscal additionality.

The traditional microeconomic literature has deeply analysed taxpayer's behavior and tax evasion determinants like probability of detection, sanctions, amount of tax to be paid, etc. However, the predicted level of tax evasion does not seem to match the real one. Therefore, a new type of literature, called behavioral tax evasion, developed. Hashimzade *et al.* [8] has provided a survey of this recent literature, where the authors divide behavioral tax evasion into two main branches: non-expected utility theory and social effects.

According to the first branch, taxpayers tend to overweight their probability of detection in case of tax evasion. Interestingly, the authors point out that the average taxpayer may not know her probability of detection.

The branch of the literature that deals with social effect, takes into account also cultural aspects. An empirical work that estimates the Italian households's propensity to evade tax by using this new approach is given by Cannari & D'Alessio [6]. They found that the propensity to evade is reduced with higher educational attainment, and it is lower in areas where there is more employment and less criminality.

Tax Credit and Renovations Empirical studies concerning tax credit effects on house renovation are rather limited. This lack of attention is probably due to the few fiscal policies in the area. Instead, the fiscal policy for energy-saving renovations is much more widespread and the empirical literature on this topic is therefore, much more developed. Many empirical studies analysed tax incentives for energy house improvements. For example, in the United States, in the 1978 - 1985 period, the Energy Tax Act attempts to

increase private investments in energy improvements of residential sector. In the same period, also some federal states provided additional tax credit, leading the final amount of tax reductions to vary among taxpayers of different states. Therefore, researchers investigated whether a higher tax benefit[6] may be linked to either a higher probability of renovation or higher level of renovation expenses. Dubin and Henson [7] [7] and Walsh[8] [16] contributions use the variation of tax credit across United States but failed to find a strong or significant link between higher tax incentives and, respectively, energy renovations probability or renovation expenses. On the other hand Hasset and Metcalf [13] use a fixed effect logit regression model on panel data (1979-1981), finding a positive effects of higher tax incentives on the probability of energy renovations.

In France, Mauroux [10] and Nauleau [12] investigated the French tax credit scheme for energy improvements (*Crédit d'Impôt Développement Durable*), and both authors focused on households' main residence. In particular, Mauroux [10] focuses on the *variation* in tax credit scheme from 25% to 40% that may be enjoyed by households living in dwellings for less than 3 years and in a building completed before 1977, whereas Nauleau [12] studies the impact of the *introduction* of the fiscal relief. Additionally, Mauroux [10] uses tax data for the period between 2006 and 2008 whereas Nauleau [12] uses survey data for the period 2005-2011. Both authors found an important free riding share, namely taxpayer that would have done the renovation works in any case, and have benefited from the tax credit, even though Nauleau [12] states that the share of free riders is decreasing over time.

In Italy, Alberini *et al.* [1] developed an empirical model to study the effect of the energy saving policy on the house improvement probability. In particular, the authors studied the tax credit impact on the replacement probability of both door/windows and heating systems. They used repeated cross-section data for the period from 2004 to 2009 and estimated both a linear probability model and a probit model. They found that tax credit effectively stimulated renovation of door/windows, while evidence for heating systems entails that either the policy has no effect or free riding is an important issue. However, the authors point out that the latter effects may not have been properly estimated due to the low rate of replacement of heating systems in the sample. Berton and Cavallari [5] studied the effect of the 2003 tax credit change on building renovations, namely that taxpayers over 75 years old may enjoy a more favourable tax relief, as they may recover renovations costs in 3/5 years instead of 10 years. The authors found a positive but *limited* effect of

[6] Given by federal relief plus national government tax credits.

[7] The authors used a probit and logit model specifications on cross section data.

[8] The author used a tobit model specification on cross section data.

such fiscal measure.

As a result, there seems to be a broad consensus in the literature, on the *limited effect of tax credit on the economic incentive for building renovations* but, to the best of our knowledge, *there are no empirical studies that analyzed the effect of tax credit renovation on the reduction of undeclared economy.* Therefore, below we will study the 2012 policy change with the aim of assessing both the *economic additionality* (i.e. the change in renovation probability) and the *fiscal additionality* (i.e. the reduction in the undeclared economy).

3 Dataset and selected variables

3.1 Data Sources

The analysis is carried out for the years 2010, 2012 and 2014, using administrative data and survey data. The former concern both income tax data and cadastral information; in the income tax data group we have taxpayers' gross annual income, income from buildings, tax credit for renovation works and renovation costs to which tax credit applies, whereas the cadastral data provide information on buildings such as cadastral category, the main use of the building (main residence, second home, etc.) and their location within the Italian territory.

Two survey data are used in the analysis: the European Union Statistics on Income and Living Conditions (EU-SILC) and the Household Budget Survey (HBS), both carried out by the Italian Statistics Institute (ISTAT). EU-SILC contains information on taxpayers' socio-economic characteristics, as well as the year of construction of the building, monthly cost of house management, etc. HBS refers to the households consumption behaviour and provides information on food consumption and non-food non-durable consumption. As remarked by Andeoni *et al* [3] surveys data can be most useful when matched with those from tax returns.

It is important to point out that the integration between administrative data and EU-SILC data is an exact matching since it is based on *tax codes*: for each unit in the survey we have an identification code which is used to obtain the fiscal data form the Department of Finance database. Therefore all the sampling units included in the EU-SILC survey were matched with the fiscal database. Once the matching between EU-SILC and administrative data is achieved, for each household we attached the information from the HBS survey. The latter correspondence is a statistical one, meaning that we use microdata on consumption of some households to impute the consumption on different

households belonging to equivalent groups.

As regards the dataset construction, the correspondence between renovation costs and dwellings is an important issue. Table 1 shows the construction of the dataset used in the analysis, and, in particular, the number of households in the Italian population using the sample weights provided by the Italian Statistics Institute.[9] The initial sample consists of more than 25 million of households per year; then we restrict our focus to those families which have at least one cadastral record - it can be observed that more than 75% of Italian families own at least one building. Since 2013, the information reported in income tax returns are such that it possible to achieve the exact correspondence between renovation costs and dwellings. Therefore, if a family owns more than one house, it is possible to know in which house the renovation work is performed. For the previous years, if a family owned more than one building and benefited from tax credits, it is not possible to identify which building was subject to renovation. Due to this problem, we can only use the information on households that own exclusively their main residence, as for this group of taxpayers we are always able to correctly impute the renovation costs with the (only) dwelling the family owns (row (d) in Table 1). Finally, we discard all those households for which some information is missing. We get a weighed sample of more than 10 million families for 2010 and 2012 and more than 8 million families for 2014. Thanks to the information reported in EU-SILC we can ascertain whether or not households did perform renovation works on their main residence. On the other hand, in income tax returns, we are able to find out whether or not the same household benefited from the tax credit for renovation works during the period considered. Therefore, the possible discrepancy between EU-SILC statements and income tax return declarations may be considered as an indicator of undeclared economy. It is worth noting that in our sample, while the number of dwellings subject to renovation is almost stable (row f, Table 1), the number of tax credits considerably increased from 2010 to 2014 (row g, Table 1).

In the literature, it is well known that the underground economy is one component of non-observed economy, and it can be used to estimating the tax gap, or the compliance gap. In particular, the tax gap is defined as the difference between the taxes actually paid and the taxes that taxpayers would have had to pay under full compliance with the tax obligations provided by the current legislation. According to this definition the tax gap may be used to approximate tax evasion. Therefore, it is possible that if the tax credit

[9]The same table concerning only the households in the sample, i.e. without ISTAT sample weights, is provided in Appendix A, Table A.2.

Table 1: **Number of households in the Italian population using ISTAT sample weights, number of dwellings subject to renovation and number of dwellings for which tax credit has been requested.**

		2010	2012	2014
(a)	Households in the population	25,175,793	25,419,672	25,772,996
(b)	Households owning at least one buildings	19,095,751	19,522,692	19,810,941
(c)	Percentage of matches with the initial pop.	75.85%	76.80%	76.87%
(d)	Households who *only* own their main residence	11,796,027	11,478,431	9,186,885
(e)	Households for which we can match all data	10,557,593	10,516,017	8,282,173
(f)	Number of renovations	1,418,701	1,732,501	1,724,756
(g)	Number of tax credits	545,306	760,715	1,075,879

Note: i) households in no tax area are not included in (g) ; ii) data are weighed using Italian Statistics Institute weights.

affects underground economy, then it is also possible that it has an effect on tax evasion. Our analysis investigates this latter effect.

3.2 Descriptive statistics

Tables 2 and 3 show the descriptive statistics for dwellings owned by households that only own their main residence and for which we are able to attribute all characteristics. In particular, Table 2 illustrates the number of buildings by type per year and it can be observed that dwellings are almost equally divided among the four categories concerned. Table 3 shows the number of dwellings by buildings characteristics (building type, year of construction of the building and location inside the Italian territory) and provides information on renovations and on the tax credits. It is possible to remark that dwelling renovations and tax credits are not equally distributed between the different building types: renovations and tax credits are more common in the case of dwellings in large blocks of flats. This may be due to different reasons: the apartment block administrator may be more active for maintenance work with respect to individual owners; condominiums can ask tax relief also for ordinary maintenance works in addition to not ordinary maintenance ones. Concerning the building's year of construction, it can be highlighted that houses were built mainly between the sixties and the eighties. Finally, concerning the building's location, houses are mostly located in the North-West part of the country.
Table 4 concerns the classification of households according to their socio-economic characteristics (numbers of years in the same house, household highest education degree, basic activity status), and provide information on renovations and tax credits. It can be seen that for more than 10 million households, the most common highest level of education is upper secondary school. Finally, the most frequent household basic activity is "employed" and this is also the category with more renovation works and tax credits.

Table 2: **Numbers of buildings type by year using ISTAT sample weights.**

	2010	2012	2014
Detached house	2,907,253	2,312,892	1,701,865
Semi detached	2,070,125	2,782,357	2,297,975
Flat in building with < 10 dw.	2,565,476	2,469,721	1,817,803
Flat in building with ≥ 10 dw.	3,014,738	2,951,047	2,464,530
Total	10,557,593	10,516,017	8,282,173

Table 3: **Number of dwellings, renovations and tax credits, by buildings characteristics using ISTAT sample weights.**

	Dwellings	Renovations	Tax Credits
Building type			
Detached house	6,922,010	725,800	226,833
Semi detached	7,150,457	842,623	325,242
Flat in building with $<$ 10 dw	6,853,000	1,053,619	518,175
Flat in building with $\geq$ 10 dw	8,430,315	2,253,916	1,390,494
Year of construction of the building			
Does not know	1,109,046	149,218	85,734
After 2010	2,418,754	219,784	99,539
2000 - 2009	2,272,752	290,989	140,440
1990 - 1999	2,166,611	310,460	167,851
1980 - 1989	4,071,484	745,390	344,133
1970 - 1979	4,868,846	943,748	521,180
1960 - 1969	4,898,475	1,009,976	538,918
1950 - 1959	3,048,466	550,604	274,040
1900 - 1949	3,042,288	456,616	207,023
Before 1900	1,459,059	199,172	81,887
Location			
Islands and South	8,396,205	911,200	318,290
Center	5,873,277	954,261	480,011
North East	6,677,534	1,213,129	629,837
North West	8,408,766	1,797,368	1,032,606
Total	29,355,783	4,875,958	2,460,744

Table 4: **Number of households, renovation and tax credits, by socio-economic characteristics using ISTAT sample weights.**

	Households	Renovations	Tax Credits
Years in the same house (*Duration*)			
less than 5 years	4,706,959	866,097	461,337
more than 5 & less than10 years	4,727,947	743,419	362,892
more than 10 & less than 20 years	6,285,493	1,048,214	524,960
more than 20 & less than 50 years	11,677,948	2,000,835	1,018,903
more than 50 years	1,957,436	217,392	92,653
Household highest degree			
Primary school	5,488,104	625,573	184,532
Lower secondary	8,342,355	1,185,128	529,577
Upper secondary	10,403,771	1,936,181	1,042,177
College degree	4,146,700	888,404	539,148
Specialization	974,854	240,673	165,310
Household basic activity			
Employed	18,682,119	3,275,160	1,706,394
Unemployed	855,954	98,948	40,350
Retirement	7,602,059	1,246,862	604,558
Inactive	2,215,650	254,988	109,442
Total	29,355,783	4,875,958	2,460,744

3.3 Selected variables

The explanatory variables that compose the dataset can be divided into two groups: one that describes the dwelling characteristics and the other that describes the socio-economic conditions of households.

In particular, among the former group, we have: building construction year, dwelling type (single house, semi detached house, flat in a building with less than 10 dwellings, flat in a

building with 10 or more dwellings), cadastral category (A1 - Luxury dwelling, A2 - Well-finished dwelling, A3 - Economic dwelling, A4 - Cheap dwelling , A5 - Ultra cheap dwelling, A6 - Rural dwelling, A7 - Detached house, A8 - Villas, A9 - Castles, A11 - Traditional local dwelling), dwellings' square meters and number of rooms, noise from neighbours or from the street (*Noise*), leaking roof or damp walls/floors/foundation or rot in window frames or floor (*Moisture*), and finally the dwelling location in the Italian territory divided into macro-areas (Islands and South, Centre, North East and North West).

The household's socio-economic conditions are described in the second group of variables which includes: the highest level of age in the household, the highest level of education in the household (primary school, lower and upper secondary school, degree, postgraduate degree), basic activity status (employed, unemployed, in retirement or early retirement or has given up business, other inactive person), ability to keep home adequately warm (related to the affordability of this kind of expenses), number of years of occupation of the dwelling (*Duration*), estimated potential monthly market rent of dwelling (*Subjective rent*), monthly costs connected with the households living in the house[10] (*Total housing costs*), total gross income (*Taxable income*), dwelling cadastral income revalued to 5% (*Income form buildings*), food consumption and non-durable non-food consumption.

4 Econometric Approach

In order to assess the effects of tax credits, a key issue concerns the fact that it is not possible to use a counterfactual approach: given the universal nature of the policy, it is not possible to identify a control group, i.e. all taxpayers who cannot benefit from the tax relief. As a matter of fact, the policy under examination potentially affects all taxpayers, especially all those who have performed a renovation. Thus, the econometric analysis tries to estimate the effects of the 2012 change in tax credits (from 36% to 50%) using repeated and independent cross-sections.

As already mentioned, due to the correspondences problems between houses and renovation works, the sample consists only of households which own their main residence.

Usually, in the empirical literature on tax credits effects there are: year dummies or trend variable to check for trend effect; policy dummy to divide the sample into two periods, the first period coincides with the lack of policy and the second one coincides with the change

[10]The costs of utilities (water, electricity, gas and heating) resulting from the actual use of the accommodation are also included.

or the introduction of the policy.[11] In our analyses, we follow the empirical literature and a trend variable has been included in order to avoid attributing undue effect to the policy variable. Our variable of interest is given by the *Policy* dummy for the only year in the sample in which the policy is at work, i.e. the year 2014:

$$\text{Policy dummy} \begin{cases} 1 & \text{if year is 2014} \\ 0 & \text{otherwise} \end{cases}$$

The last key issue concerns the period under analysis: it immediately follows the 2008 financial crisis. It is well known that the crisis had a significant impact on both incomes and expenses of households. Therefore, to face this problem, and to better isolate the policy effect, many control variables are included in the empirical model. In particular, there are variables which allow taking into account job positions, and households' income and consumption.[12]

The policy evaluation is divided into three parts and in all of them the variable of interest is always given by the *Policy* dummy. The first part of the analysis concerns the effect of tax credit change on both the probability to renovate (*economic additionality*) and the change on renovations expense. In particular, the policy impact on the renovation probability is estimated using binary choice models, where the dependent variable assumes value one in the renovation case and zero in the non-renovation case. The policy effect on renovations expense is estimated by OLS and by Poisson model where the dependent variable is the vector of the renovations expense. For this part of the analysis, the information on the renovation needed for the construction of the dependent variables are taken from EU-SILC.

The second part of the analysis concerns the investigation of the *fiscal additionality*, namely the effect of the tax credit change on probability of using the fiscal relief. For this purpose, we use a *limited set of data* concerning only those households who have renovated their main dwelling at least once in the period under examination (2010 - 2014). In particular, we compare the renovations information from EU-SILC with that from income tax: if a household declares to have undergone a renovation work in EU-SILC but the household does not enjoy a tax credits we may be in the presence of undeclared economy. Therefore, the dependent variable is equal to one if a household enjoyed the tax relief and zero otherwise.

In order to estimate both economic and fiscal additionality, the following linear probability

[11] See Alberini et al. [1], Berton e Cavallari [5], Nauleau[12].

[12] The consumption variables concern both consumption goods and non-durable non consumption goods.

model (LPM) is estimated:

$$y = \alpha + X'\beta + T'\gamma + \text{Policy}'\delta + \epsilon$$

where the dependent variable is either the EU-SILC renovation information or the fiscal renovation information; the dataset for the economic additionality is composed by those households who only owns their main residence, and we can match all relevant information (see Table 1); the dataset for the fiscal additionality is the previous one but restricted to take into account only those households who have ever renovated. In both economic and fiscal additionality, the dependent variable is dichotomous. The X-matrix is related to the characteristics of both households and dwellings; T is the vector of the *Trend* and ϵ represents the error. The objective of the analysis is to test the null hypothesis that the *Policy* coefficient is different from zero. The LPM has many limits, for instance the probability that the dependent variable is a linear function of the explanatory variables. Many of the LPM limits can be overcome by estimating logit and probit models,[13] as in the following formulation:

$$P(y = 1|X, T) = G(\alpha + X'\beta + T'\gamma + \text{Policy}'\delta)$$

where the function $G(z)$ takes values strictly between zero and one for all z real numbers and, in the probit model, $G(z)$ is the standard cumulated normal distribution function, whereas in the logit model corresponds to the logistic function.

In order to check the consistency of results, three econometric models are estimated: the linear probability model (LPM), the probit model and the logit model. Thus, the economic and the fiscal additionality are also estimated thanks to models for binary variables (like probit and logit).

The last part of the policy evaluation regards the effect of the tax credit change on the following decisions: 1) no renovation; 2) renovation and no declaration of expenses in the income tax return; 3) renovation and recording of the fiscal relief in the income tax return. By using multinomial models (multinomial probit and multinomial logit), we try to estimate the economic and the fiscal additionality at the same time.

[13] See Wooldridge [17] for a description of the models.

5 Results

5.1 Economic Additionality

The results on the variables of interest are shown in Table 5 while the complete results are shown in Table A.3. It is possible to remark that there is a considerable consistency among the results estimated in each model, given that the same explanatory variables are statistically significant and with the same sign.

The *Trend* coefficient is always positive and significant but its economic effect is pretty small: it is in the range of less than one percentage point per year. Conversely, the *Policy* variable, which relates to the policy change, is never statistically significant. This result implies that the fiscal relief change has not been effective in inducing taxpayers to renovate: the likelihood of renovation does not increase after the policy change. However, it is important to remark that this model tries to capture *only* the economic additionality stimulated by the *change* in tax credit, from 36% to 50%: we say nothing concerning the first policy introduction in 1998.

Now, we will briefly overview the impact of the others explanatory variables. In particular, owning a house built after the 1990s reduces the probability of renovation; conversely, if the dwelling was built before the 1990s, the likelihood of renovation increases. If the dwelling is less isolated there is a significant increase in the probability of renovation and the maximum value is observed for flats in buildings with more than ten dwellings. This effect is expected: as we already mentioned in Section 1, condominium can enjoy tax relief also for ordinary maintenance works; additionally, the condominium administrator could be more active in carrying out maintenance works. Finally, all cadastral categories of dwellings have a lower probability to renovate with respect to luxury dwellings (which is the base category).

As regards the *basic activity status* and taking the people "employed" as a reference group, it is possible to see that the probability to renovate is higher for those in retirement. All models also show a negative relationship between the number of years of dwellings ownership and the probability to renovate (*Duration*). For this regressor, there could be two effects that work in opposite directions: on the one hand, if you own a dwelling for a long time, the renovations should be more pressing; on the other, it can increase the likelihood of no longer having to use the dwelling. Looking at the results, the latter effect seems to prevail. The taxpayer *Age* is in quadratic form and the coefficients show that the probability of renovate will increase, but less than proportionally, with age. The variables

that may be related with the economic wealth of the household (*subjective rent*, *total housing cost*, *taxable income*) positively affect the probability of renovation. The variables that point out some problems of the dwelling (*Noise*, *Moisture problems*) also positively affect the renovation probability.

Regarding the explanatory variables that try to capture the economic cycle, it is possible to remark that an increase of yearly income raises the likelihood of renovation. On the contrary, the increase in money spent on *Food consumption* reduces the probability of renovation. Therefore, the results seem to suggest that the economic well-being of the household has positively affected the probability of restructuring.

Finally, in terms of geographical location of the dwelling, the probability of renovation is higher in the North-East, followed by North-West, Centre, South and Islands (the reference category).

Table 5: **Renovation probability**

Dependent variable: SILC renovation			
Independent Variable	LPM (OLS)	Probit (MLE)	Logit (MLE)
Trend	.0076***	.04***	.08***
	(.0025)	(.014)	(.026)
Policy	-.0058	-.025	-.067
	(.0097)	(.053)	(.098)

Standard errors in (), * (resp. ** and ***) significant at 10% level (resp. 5% and 1%).

5.1.1 Economic Additionality and Expenses

We have found that the increase in tax credit does not lead to an increase in the number of renovations carried out. A further question is whether the change in the policy induced to spend more on the renovation works that would have been carried out anyway. The results to this question are show in Table 6, while the complete results are shown in Table A.4. In Table 6, it is possible to see that while there is no effect for the Trend variable there is a positive effect for the *Policy* variable. The increase in the tax credit lead to spend extra 217 euros according to the OLS model and extra 246 euros according to the Poisson model. Therefore, the renovation works are done out of necessity, but the increase in the fiscal benefit leads to spend more.

Concerning the other explanatory variables, we can remark that for the renovation of older houses the level of expenses is higher than newly built houses. If the dwelling is less isolated the expenses are lower: the minimum cost are supported by households with a flat in building with more than ten dwellings. All cadastral categories have lower expenses with respect to the reference group (luxury dwellings). Age and Food consumption have a negative effect on renovations expenses. As it could be expected, all the explanatory variables that identify wealthier households (like Subjective rent, Non-durable non-food consumption, etc.) have a positive sign.

Table 6: **Tax benefit effect on renovation expenses**

Dependent variable: SILC renovation expenses		
Independent Variable	OLS	Poisson (MLE)
Trend	-12	-.015
	(25)	(.045)
Policy	217**	.41**
	(97)	(.17)
Policy marginal effect	217**	246**

Standard errors in (), * (resp. ** and ***) significant at 10% level (resp. 5% and 1%). The policy marginal effect is computed by leaving the values of the covariates as they were observed.

5.2 Fiscal Additionality

The fiscal additionality may take place in two cases: 1) the amount of renovations declared in tax returns increases while the total amount of renovations remains unchanged; 2) the amount declared is driven by a parallel increase in the total amount of renovations.
The analysis is run by comparing the data from the EU-SILC survey with those from the income tax: if someone reported in EU-SILC that she had carried out a renovation but she did not benefit from the tax credit, then there may be a possible compliance gap. However, this kind of analysis presents some limitations, and caution must be used in reading the results because there can be many distortions due to measurement errors, response or recall bias. Nevertheless we are not the first ones to try to estimate underground economy using the comparison between surveys and fiscal income data: in Italy, Baldini *et al.* [4]

are among the first ones using the exact matching between the two type of data.[14] It is important to remember that in the EU-SILC survey there are two questions related to the nature of maintenance works, one which explicitly ask for *ordinary maintenance* work, and the other one which ask for renovation work like the makeover of the bathroom or of the roof. The former question is important because allow us to be sure to select only non ordinary maintenance work. About the econometric strategy, in order to estimate the potential reduction in underground economy, the sample is limited only to households that have at least restructured once, during the reference period (3,986 households). In this case the binary dependent variable, *Tax evasion*, assumes value one if the household has not benefit from the tax credit and value zero otherwise. Also in this case the explanatory variable of interest is the *Policy* dummy.

In order to achieve a complete analysis, three econometric models have been estimated: the linear probability model (LPM), the probit model, and the logit model. The main results are displayed in Table 7 while the full results are in Table A.5.

As in the previous paragraph, there is a remarkable consistency between the models results, and all explanatory variables have the expected sign. Most importantly, the policy change decreases the probability of not declaring the renovation: depending on the model, this drop goes from 38 to 41 percentage points.

Now, we briefly discuss the impact of the others explanatory variables. It can be remarked that the probability of not using the fiscal relief increases for higher *Total housing costs* and in presence of problems of *Noise* and *Moisture*. There is an important reduction in the underground economy if the dwelling is less isolated, in particular for those dwellings which are in buildings with more than ten flats. The reason for this important reduction in the underground economy in less isolated houses, with respect to detached houses, it could be attributed to the fact that condominiums can enjoy tax relief also for ordinary maintenance work; additionally, there may be also a positive effect played by the condominium administrator, who could be more active in carrying out maintenance works; moreover, as the renovation works must be approved by the owners' assembly, they must be regularly certified; last but not least, the policy maker state that households may choose to pay the firm that provide the renovation works with their tax credit if: i) the households live in an apartment complex; ii) the households did renovation works concerning the apartment complex (jointly with all owners of dwellings in the block of flats); iii) the households are

[14] They compare the survey data on the economic conditions of households living in the Province of Modena in 2002 (ICESMO, *Indagine sulle Condizioni Economiche e Sociali delle famiglie della provincia di Modena*) with fiscal data in order to evaluate the absolute and the relative tax evasion.

Table 7: **Probability not to declare the renovation into the income tax**

Dependent variable: Tax evasion			
Independent Variable	LPM (OLS)	Probit (MLE)	Logit (MLE)
Trend	-0.017*	-0.045	-0.073
	(.009)	(.027)	(.045)
Policy	-0.38***	-1.3***	-2.4***
	(.033)	(.12)	(.22)
Policy marginal effect	-0.38***	-0.40***	-0.41***

Standard errors in ( ), *(resp. ** and ***) significant at 10% level (resp. 5% and 1%). The policy marginal effect is computed by leaving the values of the covariates as they were observed.

in the "no tax area" so that they cannot enjoy the tax credit. Most importantly, with the increase in education, there is a reduction in the underground economy and therefore there is a higher probability to enjoy the tax credit (households with primary school is the reference group). The others explanatory variables that have a positive impact on the use of the fiscal relief are all the variables that identify households with higher wealth (*Ability to keep home warm*, *Subjective rent*, *Income from buildings*, *Taxable income*, *Non durable, non-food consumption*). Lastly, the location of the dwelling affects the use of the tax credit: the probability to use the fiscal relief is higher if the dwelling is located in the North West of Italy.

5.3 Total Additionality

A more comprehensive analysis is given by the overall estimation of the fiscal and the economic additionality namely the total effect of the increase in the tax credit on the likelihood of both renovation activity and use of the tax credit. Therefore, we turn our attention to multiple choices models (multinomial probit and multinomial logit) where the dependent variable is composed of three response categories.

The first response category is given by the decision of *not to renovate*: this is the base category and the dependent variable assumes a value of zero. In the second response category, households *renovate but do not enjoy the tax relief* and in this case the dependent variable is equal to one. Finally, in the third response category, households *renovate and do enjoy the tax relief* and the dependent variable is equal to two. This last category

allows us to identify the fiscal and economic additionality as a whole. The main results and marginal effects are shown in Table 8 while the models complete results are shown in Table A.6. From Table 8 it is possible to remark that the probability of renovation and no use of the tax relief, depending on the model, has decreased in 2014 by 3 percentage points while the probability of renovation and declaring has increased in 2014 by 11-12 percentage points. The *Trend* variable, even though always statistically significant, has a small economic impact: the *Trend* marginal effect for the second category accounts for less than half percentage point, while it accounts for 1 percentage point for the last category. For response categories one and two, the house construction year has a similar effect: relative new houses have a lower probability to renovate with respect to the old ones. Houses in block of flats have a higher probability to renovate for either category: there may be a positive effects due to the condominium administrator, who may be more active in carrying out maintenance works and in requesting the tax benefit. Also in these models, like the models that try to capture the economic additionality, all dwellings cadastral categories have a lower probability to renovate with respect to luxury ones (reference group).

Studying the socio-economic variables, the household's education degree does not affect the first response category while it positively affects the probability of renovation and use of the tax credit (second category). Therefore, the education variable positively influences the household's behaviour in the direction of greater fiscal compliance. People in retirement have a higher probability to renovate and to use the fiscal relief: even though the fiscal credits is divided into ten years. This may be due to the fact that the fiscal credits not used by the retiree can be transferred to home buyers or their heirs.

Figure 1 shows the renovation probability as a function of taxable income. It is possible to see that households with higher incomes are more likely to renovate their houses and to use the tax credit, and that probability is higher for 2014; while in 2012 the probability of renovation and not to enjoy the tax relief is greater than the probability of renovation and use of the tax relief. Regarding the effect of non food non durable consumption (Figure 2), the renovation probability with the use of the tax credit is higher in 2014 with respect to 2012 for all consumption values; and the probability of not using the fiscal relief in 2014 has fallen with respect to the same probability for 2012.

Table 8: **Fiscal and economic additionality**

Dependent variable: SILC renovation				
Independent Variable	Multinomial Probit (MLE)		Multinomial Logit (MLE)	
0 = No Renovation = Base category				
1 = Renovation no tax credit				
Trend	0.05**	(0.02)	0.061**	(0.029)
Policy	-0.14*	(0.08)	-0.29**	(0.11)
Trend marginal effect	0.003	(0.002)	0.003	(0.002)
Policy marginal effect	-0.03***	(0.007)	-0.03***	(0.007)
2 = Renovation with tax credit				
Trend	0.13***	(0.023)	0.013***	(0.02)
Policy	1***	(0.087)	1.3***	(.12)
Trend marginal effect	0.012***	(0.002)	0.013***	(0.002)
Policy marginal effect	0.12***	(0.012)	0.11***	(0.012)

Standard errors in ( ), *(resp. ** and ***) significant at 10% level (resp. 5% and 1%). The policy marginal effect is computed by leaving the values of the covariates as they were observed.

Figure 1: Renovation probabilitiy & gross income (ln)

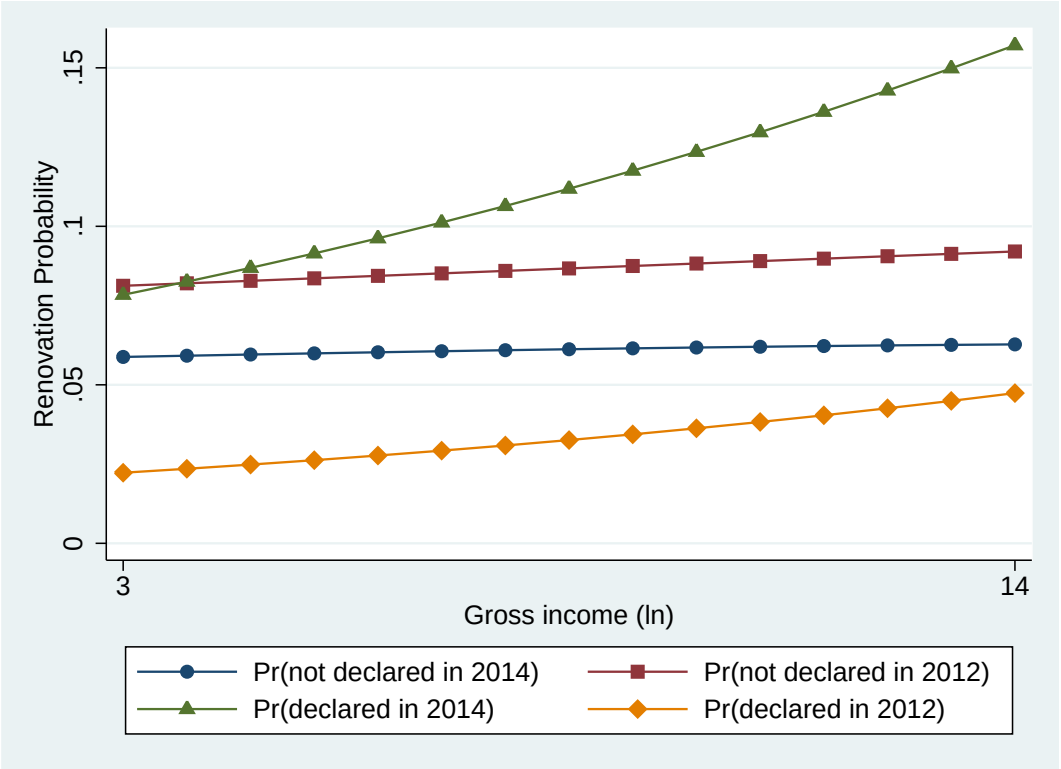
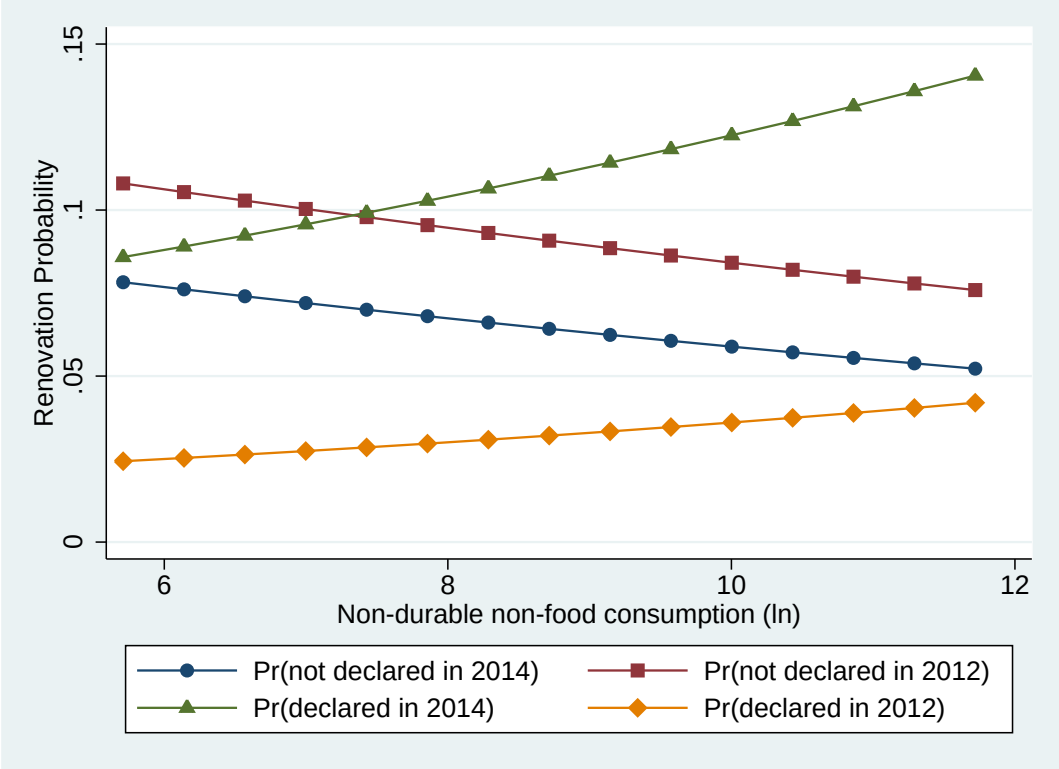


Figure 2: Renovation probability & non-durable non-food consumption (ln)



6 Conclusion

Since 1997, Italian governments have introduced annual fiscal incentives for the renovation of both dwellings and shared parts of residential buildings. This fiscal policy has been used to achieve many goals, such as upgrading old houses, supporting to the construction sector and, last but not least, curbing the underground economy. In this work we run an ex-post analysis of 2012 policy change in Italy and we evaluate it in terms of economic and fiscal additionality. We found that the 2012 policy change stimulated the likelihood of renovation in terms of fiscal additionality but the positive effect on economic additionality is quite limited and only concerns the amount of renovation expenses, not the number of renovations work. In recent years, the number of renovation works reported in income tax has increased considerably (see Figure A.1) therefore the lack of a strong impact on economic additionality is quite remarkable. The change in tax credit did not lead to new renovations for the main dwelling, i.e. the number of works carried out would have been the same. However, a more in-depth analysis revealed that the increase in the benefit led to an increase in expenses for the renovation works, therefore the building sector partially benefited from the fiscal policy. Although the frequency of renovations is not affected by

the increase in the tax credit from 36% to 50%, it could nevertheless be influenced by the first introduction of the tax credit itself. Unfortunately, nothing can be said about the latter point with our data. The result on the fiscal additionality is consistent with the theoretical prediction discussed in Section 2: the increase in the tax credit above the 45% threshold it is crucial to positive stimulate the taxpayers. Additionally, renovations are more likely for people with higher yearly income and able to afford non-durable non-consumption goods, with respect to the renovations carry out by "inactive" persons, and households with a relatively high share of food expenditure, i.e. the class of less wealthier people. We found also that if in the households there are components with higher education then these households are more likely to declare the renovation works in the income tax. A number of "barriers" have been identified for energy makeover that prevent consumers from making interventions. Some of them concern the high cost of implementation and information asymmetries (Murphy and Meier, 2011). Such barriers are also present for building renovations. Moreover, consumers give more relevance to actual savings than possible future ones; additionally for renovation works, income and price elasticity are relatively high (Hausman, 1979). As a matter of facts, the results confirm what could be expected from a theoretical evaluation of this fiscal policy: leaving the burden to fully support the initial costs to consumers, the most favoured ones are those who can support the initial costs (Du Can et al., 2014).

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Appendix A

Table A.1: Main legislation history for renovations

Years	Regulations Laws	Tax Credits	Maximum amount (euro)
January 1998 December 1999	Law n.449/1997	41%	77,468.53
January 2000 December 2001	Law n.488/1999 Law n.388/2000	36%	77,468.53
January 2002 December 2002	Law n.448/2001	36%	77,468.53
January 2003 December 2003	Law n.289/2002	36%	48,000
January 2004 December 2004	Law n.350/2003 Law n. 47/2004	41%	60,000
January 2005 December 2005	Law n.311/2004	36%	48,000
January 2006 September 2006	Law n. 266/2005	41%	48,000
October 2006 June 2012	Law n. 248/2006 ... Law n. 214/2011	36%	48,000
June 2012 December 2016	Law n. 134/2012 ... Law n. 208/2015	50%	96,000
since January 2017	Law n.232/2016 Law n. 205/2017 Law n. 145/2018 Law n. 160/2019	many tax credits	96,000

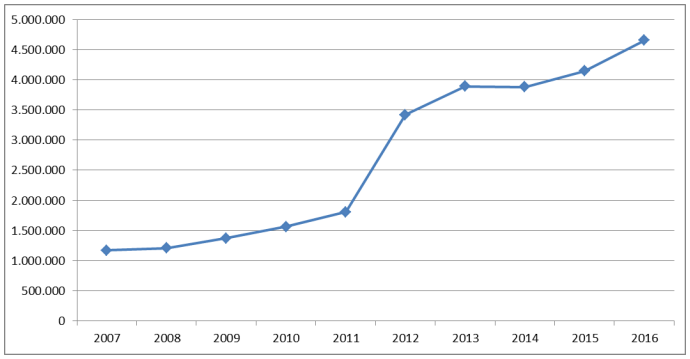

Figure A.1: Number of renovation works for the years 2005-2016. Source: "Gli immobili in Italia" 2019.

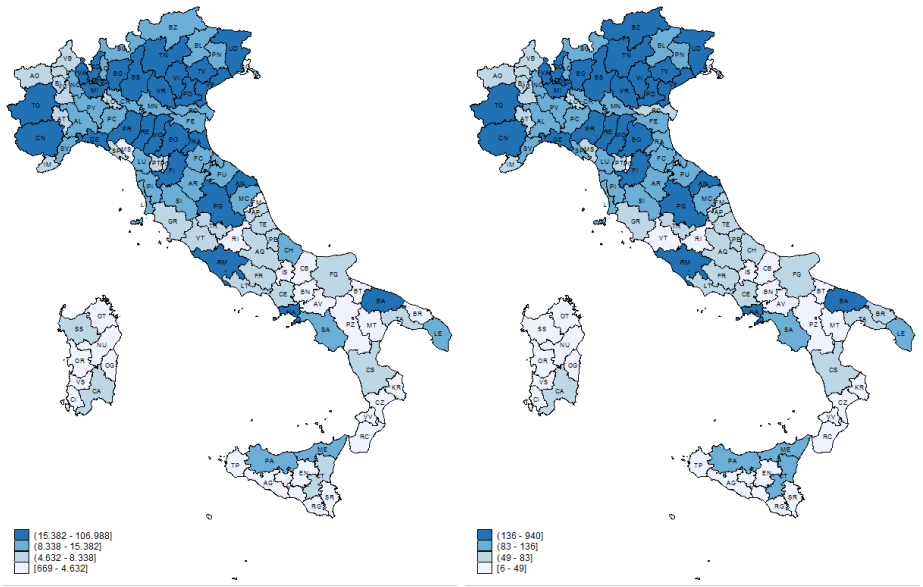

Figure A.2: Frequency (left panel) and total amount of expenses (right panel) for the renovation of buildings, by Province (2014) - millions of euro. Source: "Gli immobili in Italia" 2019.

Table A.2: **Numbers of observations in the sample.**

	2010	2012	2014	Total
Households in the sample	19,147	19,579	19,663	58,389
Households owner of a least buildings	15,164	15,656	15,972	46,792
Households for which we can match all info	8,303	8,308	6,625	23,236

Table A.3: **Renovation probability**

Dependent variable: SILC renovation						
Independent Variable	LPM (OLS)		Probit (MLE)		Logit (MLE)	
Trend	.0075***	(.0025)	.04***	(.014)	.081***	(.026)
Policy	**-.0058**	**(.0097)**	**-.025**	**(.052)**	**-.068**	**(.098)**
After 2010	-.064***	(.012)	-.38***	(.085)	-.77***	(.17)
2000 - 2009	-.039***	(.012)	-.2**	(.082)	-.38**	(.16)
1990 - 1999	.0004	(.012)	.042	(.079)	.093	(.15)
1980 - 1989	.034***	(.011)	.21***	(.072)	.42***	(.14)
1970 - 1979	.04***	(.011)	.23***	(.071)	.45***	(.14)
1960 - 1969	.04***	(.011)	.23***	(.071)	.44***	(.14)
1950 - 1959	.034***	(.012)	.21***	(.074)	.4***	(.15)
1900 - 1949	.022*	(.012)	.13*	(.076)	.25*	(.15)
Before 1900	.024*	(.013)	.15*	(.083)	.3*	(.16)
Semi detached	.0023	(.0053)	.027	(.034)	.048	(.068)
Building with < 10 dw	.021***	(.0058)	.13***	(.035)	.27***	(.068)
Building with ≥ 10 dw	.069***	(.0064)	.34***	(.033)	.65***	(.064)
Well finished dw	-.15**	(.074)	-.56**	(.25)	-1**	(.42)
Economic dw	-.14*	(.074)	-.53**	(.25)	-.95**	(.42)
Cheap dw	-.15**	(.074)	-.58**	(.25)	-1**	(.43)
Ultra cheap dw	-.15*	(.077)	-.57**	(.29)	-1.1**	(.51)
Rural dw	-.13*	(.075)	-.44*	(.26)	-.79*	(.45)
Detached house	-.17**	(.074)	-.68***	(.25)	-1.2***	(.43)
Villas	-.27***	(.076)	0	(.)	0	(.)

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Castles	-.14*	(.074)	0	(.)	0	(.)
Unemployed	.0046	(.012)	.014	(.07)	.034	(.13)
Retirement	.011*	(.0066)	.062*	(.034)	.12*	(.064)
Inactive	.008	(.0093)	.019	(.057)	.047	(.11)
Duration	-.00056***	(.00017)	-.0026***	(.00097)	-.0047**	(.0018)
Age	.0022*	(.0012)	.015**	(.0067)	.028**	(.013)
Age Square	-.000019*	(.00001)	-.00012**	(.000057)	-.00023**	(.00011)
Noise	.037***	(.0062)	.17***	(.028)	.32***	(.051)
Moisture problems	.041***	(.0058)	.22***	(.028)	.4***	(.051)
Subjective rent (ln)	.02***	(.0059)	.1***	(.032)	.2***	(.061)
Total housing cost (ln)	.056***	(.0041)	.32***	(.024)	.61***	(.046)
Income from build.s (ln)	.0021**	(.00085)	.012**	(.0049)	.021**	(.0091)
Taxable income (ln)	.0012**	(.00061)	.0091**	(.0041)	.018**	(.008)
Food consumption (ln)	-.0078*	(.0045)	-.041*	(.023)	-.081*	(.043)
Centre	.0072	(.006)	.057	(.036)	.13*	(.07)
North East	.031***	(.0063)	.18***	(.035)	.36***	(.067)
North West	.02***	(.0066)	.12***	(.036)	.23***	(.069)
Cons	-15***	(5)	-84***	(28)	-169***	(52)
Number of observations	23236		23223		23223	
Percent correctly predicted	79.77%		82.34%		82.35%	
Log-likelihood value	-		-7863.27		-7860.56	
Pseudo R-squared	0.0449		0.0636		0.0639	

Standard errors in ( ), *(resp. ** and ***) significant at 10% level (resp. 5% and 1%).

Table A.4: **Tax benefit effect on renovation expenses**

Dependent variable: SILC renovation expenses				
Independent Variable	OLS		Poisson (MLE)	
Trend	-12	(25)	-.015	(.045)
Policy	**217****	**(97)**	**.41****	**(.17)**
After 2010	-448***	(131)	-1.1***	(.35)
2000 - 2009	-335**	(132)	-.72**	(.29)
1990 - 1999	-109	(130)	-.11	(.28)
1980 - 1989	132	(119)	.35	(.25)
1970 - 1979	252**	(117)	.53**	(.25)
1960 - 1969	224*	(117)	.48*	(.25)
1950 - 1959	183	(123)	.4	(.26)
1900 - 1949	219*	(123)	.43*	(.26)
Before 1900	242*	(136)	.45	(.28)
Semi detached	-157***	(58)	-.25**	(.11)
Flat in building with $<$ 10 dw	-234***	(61)	-.42***	(.11)
Flat in building with $\geq$ 10 dw	-314***	(61)	-.56***	(.11)
Well finished dw	-709	(560)	-.61*	(.35)
Economic dw	-607	(560)	-.43	(.35)
Cheap dw	-596	(563)	-.42	(.36)
Ultra cheap dw	-860	(608)	-1.3***	(.48)
Rural dw	-782	(580)	-1**	(.42)
Detached house	-742	(565)	-.7*	(.37)
Villas	-1652	(1058)	-23***	(.47)
Castles	-389	(3159)	-20***	(1.1)
Age	-5.5***	(1.5)	-.0092***	(.003)
Noise	147***	(54)	.26***	(.091)
Ability to keep home warm	102	(65)	.29**	(.13)

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Subjective rent (ln)	273***	(52)	.47***	(.1)
Total housing cost (ln)	303***	(41)	.57***	(.088)
Income from build.s (ln)	28***	(8.8)	.054***	(.015)
Food consumption (ln)	-135***	(47)	-.2***	(.073)
Non-durable non-food consumption (ln)	89**	(41)	.15**	(.074)
Cons	23241	(50055)	31	(91)
Number of observations	23480		23480	
chi2			5083	

Standard errors in ( ), *(resp. ** and ***) significant at 10% level (resp. 5% and 1%).

Table A.5: **Probability not to declare the renovation into the income tax**

Dependent variable: Tax evasion						
Independent Variable	LPM (OLS)		Probit (MLE)		Logit (MLE)	
0 = No Renovation = Base category						
1 = Renovation no tax credit						
Trend	-.017*	(.0092)	-.045	(.027)	-.073	(.045)
Policy	**-.38*** **	**(.033)**	**-1.3*** **	**(.12)**	**-2.4*** **	**(.22)**
Semi detached	-.0079	(.024)	-.037	(.075)	-.06	(.12)
Flat in building with < 10 dw	-.1***	(.024)	-.32***	(.075)	-.53***	(.12)
Flat in building with ≥ 10 dw	-.18***	(.022)	-.53***	(.069)	-.88***	(.11)
Well finished dw	-.31**	(.14)	-1.1**	(.51)	-1.8**	(.89)
Economic dw	-.32**	(.14)	-1.1**	(.51)	-1.9**	(.89)
Cheap dw	-.32**	(.14)	-1.1**	(.52)	-1.9**	(.9)
Ultra cheap dw	-.39**	(.16)	-1.3**	(.61)	-2.2**	(1)
Rural dw	-.24	(.15)	-.68	(.55)	-1.1	(.96)
Detached house	-.32**	(.14)	-1.1**	(.52)	-1.8**	(.9)

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Noise	.036**	(.017)	.1**	(.052)	.17**	(.086)
Moisture problems	.087***	(.018)	.27***	(.055)	.44***	(.092)
Ability to keep home warm	-.072***	(.025)	-.23***	(.082)	-.38***	(.14)
Subjective rent (ln)	-.081***	(.02)	-.24***	(.061)	-.41***	(.1)
Total housing cost (ln)	.062***	(.016)	.19***	(.048)	.32***	(.082)
Lower secondary	-.098***	(.027)	-.3***	(.085)	-.51***	(.14)
Upper secondary	-.14***	(.029)	-.42***	(.089)	-.68***	(.15)
Degree	-.18***	(.033)	-.53***	(.1)	-.86***	(.17)
Specialization	-.19***	(.045)	-.55***	(.14)	-.92***	(.23)
Age	-.00051	(.0008)	-.0011	(.0024)	-.002	(.004)
Duration >5 & ≤ 10	.052*	(.027)	.15*	(.08)	.25*	(.13)
Duration >10 & ≤ 20	.059**	(.026)	.16**	(.076)	.27**	(.13)
Duration >20 & ≤ 50	.002	(.027)	.0045	(.08)	.0082	(.13)
Duration >50	.032	(.042)	.11	(.13)	.17	(.22)
Unemployed	-.016	(.043)	-.044	(.14)	-.084	(.23)
Retirement	-.016	(.023)	-.049	(.07)	-.072	(.12)
Inactive	-.04	(.043)	-.099	(.13)	-.14	(.22)
Income from build.s (ln)	-.044***	(.0027)	-.17***	(.014)	-.3***	(.025)
Taxable income (ln)	-.0065**	(.0029)	-.027***	(.01)	-.043**	(.017)
Food consumption (ln)	-.008	(.017)	-.018	(.049)	-.031	(.081)
Non-durable, non-food cons. (ln)	-.03**	(.015)	-.088**	(.044)	-.15**	(.073)
Center	-.033	(.025)	-.13*	(.075)	-.21*	(.13)
North East	-.064***	(.024)	-.22***	(.072)	-.35***	(.12)
North West	-.11***	(.024)	-.35***	(.072)	-.58***	(.12)
Cons	35*	(19)	95*	(55)	156*	(91)
Number of observations	3986		3986		3986	
Percent correctly predicted			68.51%		68.41%	
Log-likelihood value	-		-2307.3		-2305.81	
Pseudo R-squared	0.1964		0.1664		0.1650	

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Standard errors in ( ), *(resp. ** and ***) significant at 10% level (resp. 5% and 1%).

Table A.6: **Fiscal and economic additionality**

Dependent variable: SILC renovation				
Independent Variable	Multinomial Probit (MLE)		Multinomial Logit (MLE)	
0 = No Renovation = Base category				
1 = Renovation without enjoy tax credit				
Trend	.05**	(.02)	.061**	(.029)
Policy	**-.14***	**(.08)**	**-.29****	**(.11)**
After 2010	-.51***	(.12)	-.71***	(.18)
2000 - 2009	-.25**	(.12)	-.31*	(.18)
1990 - 1999	-.023	(.12)	-.0051	(.17)
1980 - 1989	.22**	(.11)	.33**	(.16)
1970 - 1979	.22**	(.1)	.32**	(.15)
1960 - 1969	.21**	(.1)	.31**	(.16)
1950 - 1959	.27**	(.11)	.4**	(.16)
1900 - 1949	.15	(.11)	.23	(.16)
Before 1900	.2*	(.12)	.3*	(.18)
Well finished dw	-.81**	(.36)	-1.1**	(.44)
Economic dw	-.75**	(.36)	-.99**	(.44)
Cheap dw	-.8**	(.36)	-1.1**	(.45)
Ultra cheap dw	-.87**	(.42)	-1.2**	(.54)
Rural dw	-.61	(.38)	-.79*	(.48)
Detached house	-1***	(.36)	-1.3***	(.45)
Villas	-12***	(.38)	-14***	(.56)
Castles	-11***	(.4)	-13***	(1.1)
Semi detached	.024	(.05)	.022	(.073)
Flat in building with < 10 dw	.12**	(.051)	.13*	(.075)
Flat in building with ≥ 10 dw	.37***	(.05)	.44***	(.072)
Lower secondary	-.07	(.059)	-.12	(.085)

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Upper secondary	-.00065	(.063)	-.04	(.091)
Degree	-.074	(.075)	-.16	(.11)
Specialization	-.1	(.11)	-.23	(.17)
Age	.0019	(.0017)	.0031	(.0025)
Duration	-.004***	(.0015)	-.0058***	(.0021)
Unemployed	-.012	(.11)	-.024	(.16)
Retirement	.046	(.054)	.053	(.079)
Inactive	-.013	(.087)	-.036	(.13)
Ability to keep home warm	-.11**	(.054)	-.17**	(.077)
Subjective rent (ln)	.096**	(.048)	.11	(.072)
Total housing cost (ln)	.47***	(.036)	.67***	(.052)
Income from build.s (ln)	.011	(.0074)	.0053	(.011)
Taxable income (ln)	.012**	(.0059)	.015*	(.0086)
Non-durable, non-food cons. (ln)	-.036	(.031)	-.061	(.046)
Centre	.071	(.053)	.11	(.079)
North East	.21***	(.053)	.27***	(.078)
North West	.15***	(.055)	.17**	(.08)
Cons	-105**	(41)	-129**	(59)
2 = Renovation with tax credit				
Trend	.13***	(.023)	.2***	(.034)
Policy	**1*** **	**(.087)**	**1.3*** **	**(.12)**
After 2010	-.64***	(.13)	-.93***	(.2)
2000 - 2009	-.63***	(.13)	-.91***	(.19)
1990 - 1999	-.17	(.12)	-.26	(.18)
1980 - 1989	.049	(.11)	.039	(.16)
1970 - 1979	.15	(.11)	.18	(.16)
1960 - 1969	.16	(.11)	.18	(.16)
1950 - 1959	.13	(.12)	.11	(.17)
1900 - 1949	.015	(.12)	-.04	(.18)

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Before 1900	.015	(.13)	-.009	(.19)
Well finished dw	.18	(.59)	.49	(.84)
Economic dw	.24	(.59)	.57	(.84)
Cheap dw	.15	(.59)	.41	(.85)
Ultra cheap dw	.038	(.66)	.27	(.96)
Rural dw	-.14	(.61)	-.0025	(.89)
Detached house	-.023	(.59)	.21	(.85)
Villas	-11***	(.62)	-13***	(.95)
Castles	-7.9***	(.62)	-8.8***	(1.3)
Semi detached	.081	(.061)	.14	(.093)
Flat in building with < 10 dw	.46***	(.06)	.7***	(.09)
Flat in building with ≥ 10 dw	.93***	(.055)	1.3***	(.082)
Lower secondary	.22***	(.073)	.35***	(.11)
Upper secondary	.42***	(.075)	.63***	(.11)
Degree	.47***	(.085)	.7***	(.12)
Specialization	.51***	(.11)	.75***	(.16)
Age	.00088	(.0019)	.00099	(.0026)
Duration	-.0011	(.0016)	-.00048	(.0022)
Unemployed	.061	(.12)	.13	(.17)
Retirement	.11*	(.056)	.15*	(.079)
Inactive	.16	(.1)	.22	(.15)
Ability to keep home warm	.19***	(.07)	.3***	(.11)
Subjective rent (ln)	.39***	(.051)	.57***	(.072)
Total housing cost (ln)	.22***	(.041)	.27***	(.059)
Income from build.s (ln)	.15***	(.0086)	.21***	(.012)
Taxable income (ln)	.046***	(.0088)	.072***	(.014)
Non-durable, non-food cons. (ln)	.06*	(.033)	.088*	(.047)
Centre	.17***	(.062)	.25***	(.093)
North East	.46***	(.059)	.68***	(.088)

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North West	.53***	(.06)	.77***	(.088)
Cons	-267***	(47)	-406***	(68)
Number of observations	23236		23236	
Log-likelihood value	-11974.5		-11980.1	
Pseudo R-squared			0.1065	

Standard errors in ( ), *(resp. ** and ***) significant at 10% level (resp. 5% and 1%).