Environmental Disasters and Electoral Cycle: An Empirical Analysis on Floods and Landslides in Italy*

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Abstract

The aim of this paper is to provide an empirical analysis of the potential drivers of regulators' behaviour in the presence of a potential natural disaster. Specifically, we focus our attention on floods and landslides, and select building permits as our measure of regulatory stringency.

We first build a simplified theoretical framework based on political agency modelling, in order to derive theoretical results and testable implications. The empirical analysis is undertaken by relying on a unique dataset covering Italy in the period 1995-2013 and containing information on soil sealing, building permits and natural disasters (floods and landslides), together with data on elections, at a provincial level.

Our main conclusions imply that a bad history in terms of disasters decreases building permits, suggesting that such a unfavourable past strengthens the relevance of "green" voters. On the other hand, the relevance of the construction sector increases the number of building permits issued. Finally, the closeness to elections appears to increase the number of building permits, indirectly suggesting a stronger reactivity of "brown" voters, linked to the construction sector or not affected by environmental disasters.

Keywords: Catastrophic events, Land use, Uncertainty, Environmental Policy, Risk, Natural Disaster.
JEL Classification: H11, Q54, Q58.

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1 Introduction

In the last sixty years, soil sealing and soil exploitation have rapidly increased in Italy and in Europe, as shown in the CORINE Land Cover dataset provided by the European Environmental Agency[1]. Along with the increase in soil sealing, also the number of floods and landslides has increased dramatically.

On the basis of these considerations, the drivers of soil exploitation decisions, potentially triggering environmental disasters, are a relevant issue for economic research. Our work specifically focuses, on the potential role of the electoral cycle, lobbies and socio-demographic features in the willingness of local policy authorities to grant building permits. In so doing, we will also assess how those permits react to past extreme events, in order to gain a better understanding of whether past experiences matter.

The rationale behind our work is that floods or landslides can only partially be deemed as "natural" exogenous events; rather, they result from the combination of a natural hazard and a human system that is exposed to it, and suffer from damage and perturbations (Hallegatte, 2014). In this respect, our work is closely related to this definition of natural disaster that is, above all, a social and human event (World Bank, 2010).

Our contribution is both theoretical and empirical. From a theoretical point of view, we adopt a political agency framework, close to Besley and Burgess (2002) and List and Sturm (2006), where an incumbent politician chooses the degree of soil exploitation, as measured by the number of granted building permits. In so doing, we account for specific interest groups, such as actors involved in the construction sector, as well as past extreme events and the role of elections in land allocation decisions. Our theoretical framework allows us to derive testable implications, that are then scrutinized empirically. To this end, we construct a unique dataset covering Italy in the period 1995-2013 and containing information on soil sealing, building permits and natural disasters

[1] http://land.copernicus.eu/pan-european/corine-land-cover

(floods and landslides), together with data on elections, at a provincial level. Italy is a compelling case study, given the relevance of floods and landslides, partly triggered by environmentally harmful land exploitation.

Our main conclusions suggest that past disasters play a role in driving the "demand" for building permits; on the other hand, building permit intensive sectors, such as construction, have an opposite impact. Interestingly, citizens have a relatively short memory; the impact of past disasters disappears after two to three years. Also, electoral competition only affects the number of issued permits in provinces where the history of disasters is bad, driving the numbers down.

There is extensive literature on geology about the causal link between soil sealing, land instability and extreme events such as floods and landslides (e.g. Guzzetti et al., 2005, Haase and Nuissl, 2007). In our theoretical model, we assume that both politicians and citizens are aware of this link, at least in general terms. Moreover, we also assume that any agent is aware of the existence both of the benefits and risks of land exploitation: benefits are linked to the fact that soil sealing allows a more profitable use of the territory, allowing individuals to consume some material wealth; risks are due to the fact that any additional square metres of soil sealed increases the probability of a flood or landslide.

The empirical evidence on the link between natural disasters and agents' behaviour is scant. Among the very few contributions, Miao and Popp (2014) focus on the relation between natural extreme events (e.g. floods, droughts, or earthquakes) and the number of patents released in the affected regions, finding a positive relationship. Modica et al. (2016)'s paper studies how the housing market responded to the earthquake of 2012, in the Italian region of Emilia Romagna, providing evidence of an overreaction of prices; through a similar approach, Bin et al. (2008) study the effects of flood hazard on the housing market. Deng et al. (2015) focus on the impact of the 2008 Wenchuan earthquake in China, finding evidence of increases in the difference in prices between low and high floor apartments, but this "*fear spread*" is shown to vanish over time (i.e. after two to

three years). Finally, Anbarci et al. (2005) link the earthquake fatalities with income per capita and the level of inequality. Using cross country data on 269 major earthquakes that occurred between 1960 and 2002 worldwide, they assert that: *"policies designed to improve per capita income and reduce inequality can be expected to mitigate, through their impact on the likelihood of collective action, the effects of major quakes*" (Anbarci et al. (2005): page 1931).

None of these papers, however, focuses on the link between exposure to risk of natural disasters, on the one hand, and policy reactions by elected government authorities on the other. This is what we do in this paper. Works that are closest to our own are those of Besley and Burgess (2002) and List and Sturm (2006). Besley and Burgess (2002) use a difference in difference empirical strategy, and highlight the relevance of information and media on government activism. More specifically, they focus on India and find a relation between drought and flood with what they label as "*government responsiveness*", captured through the public food distribution and the calamity relief expenditure; they also detect a positive relation between newspaper circulation and government activism and a negative relation between population density and government activism. List and Sturm (2006) address environmental policy as a secondary policy, so that preferences of "single issue voters" (i.e. "green" and "brown" voters) may matter for electoral reasons and an (incumbent) politician may have incentives to distort her decisions to gain electoral consensus. Clearly, this incentive is stronger the closer the elections are.

We adopt a simplified single issue voters setting, as in List and Sturm (2006). Examples of these voters in our paper are citizens living close to a densely built and resilience-damaged land, on the one hand, and the workers employed in local construction companies, on the other. Also, we adopt a framework close to Besley and Burgess (2002) and complement their work by considering the impact of past natural disasters over time and by explicitly addressing the role of economic structure (i.e. the relevance

of building permit intensive sectors).

The structure of the paper is as follows. Section 2 presents the basic structure of the theoretical model and the testable implications. Section 3 presents the empirical framework, the estimation strategy and a description of the data. Section 4 outlines and comments on the main empirical results. Finally, the last section provides some concluding remarks.

2 Theoretical Framework

2.1 The Model

We deal with a political agency model which is a simplified version of Besley and Burgess (2002). We therefore focus on the choices of an opportunistic incumbent politician, whose aim is to maximize the likelihood of being re-elected. In the latter case, she obtains a net benefit (e.g. an "ego rent") equal to λ.

The choice variable of the incumbent politician is the number of building permits issued, labelled as p. The incumbent politician faces a cost from issuing those permits $c(p)$, which is decreasing and convex, i.e. $c'(.) < 0$ and $c''(.) > 0$, and satisfies $lim_{p \to 0} c(p) = \infty$. The idea behind the assumptions is that not issuing a requested building permit has a cost, and issuing no permit is prohibitively costly. Also, we assume that there is a maximum level of building permits, labelled as p_m and constrained, for example, by the features of the territory under scrutiny.

Two kinds of voters can be identified: a share of voters' η chooses whether to vote for the incumbent depending on her behaviour in terms of environmentally relevant decisions (in our setting, issued building permits p), and the remaining voters $(1 - \eta)$ vote for or against the incumbent politician for ideological reasons.

The impact of an increase in p is not directly observable by the incumbent. Indeed, this response is different if the voters are "green" or "brown". The share of green and

brown voters is not directly observable by the incumbent politician (and it is not directly observable by any agent). It is credible to assume, however, that a worse experience of past disasters is positively correlated with the share of green voters, the idea behind this assumption being that citizens react to extreme events requiring more careful decisions from politicians. On the other hand, we can also expect that a bigger share of employment in the construction sector is positively correlated with the share of brown voters. The incumbent politician is therefore assumed to form her beliefs concerning the share of voters on the basis of this information and, as in List and Sturm (2006), to distort the decision on the number of issued permits accordingly.

We identify green voters as non ideological voters that have experienced natural disasters in the past (label the number and harshness of past disasters as d) and are less keen to accept an increase in p the worse their experience, i.e. the larger is d. On the other hand, brown voters have a close interest in sectors that rely on building permits (e.g. the construction sector) and are more likely to have a position in favour of increases in building permits. We label the share of these sectors in the economy as s.

The share of green voters favouring the incumbent is summed up in a function $\gamma(d, p)$ where $\gamma_d > 0$, i.e. more green voters are present if the number of disasters experienced is larger, $\gamma_p < 0$, i.e. green voters react to an increase in the number of permits by decreasing their support for the incumbent politician, and $\gamma_{dp} < 0$, so that the worse is the disaster history of the territory, the more green voters will decrease their support to the incumbent politician as a reaction to an increase in the number of building permits. On the other hand, the share of brown voters favouring the incumbent is summed up in a function $\beta(s, p)$, where $\beta_s > 0$, i.e. the number of brown voters increases with the relevance of sectors that rely on building permits, $\beta_p > 0$, i.e. brown voters increase their support to the incumbent if the number of permits increases, and $\beta_{sp} > 0$, so that the marginal support linked to increases in p increases with the relevance of related sectors, s. As a result, the function describing support to the incumbent politician from non

ideological voters can be summed up as follows:

$$\theta(d, s, p) = \gamma(d, p) + \beta(s, p).$$

Clearly, $\theta(.)$ increases with s and decreases with d. The impact of an increase in p is instead ambiguous, as $\frac{\partial \theta(.)}{\partial p} = \gamma_p + \beta_p$ is positive if $|\gamma_p| > \beta_p$, i.e. if green voters react to increases in p less than brown voters, and negative otherwise.

Turning to ideological voters, we assume that a share v of them votes in favour of the incumbent. Also, this share is distributed as a continuous uniform random variable, with density function $f(.)$ which is positive and constant[2]. Finally, we label the turnout rate of non ideological voters as σ. This can be interpreted as a measure of electoral competition.

The share of all voters in favour of the incumbent politician is therefore given by $\sigma\eta\theta(.) + (1-\eta)v$; the resulting probability that the incumbent is indeed re-elected is[3]:

$$\pi(d, s, p, \sigma, \eta) = prob\left(\sigma\eta\theta(.) + (1-\eta)v > \frac{1}{2}\right),$$

which may be rewritten as:

$$\pi(d, s, p, \sigma, \eta) = 1 - F\left(\frac{1}{2(1-\eta)} - \frac{\sigma\eta\theta(.)}{(1-\eta)}\right). \tag{1}$$

The incumbent politician chooses the number of issued permits p to maximize the net expected benefits from re-election (i.e. the probability from (1) times the "ego rent" λ) *minus* the cost of (not) issuing permits:

[2]This assumption indeed implies a loss of generality, but greatly simplifies our analysis. Furthermore, it is compatible with existing contributions on political agency (Besley and Burgess, 2002) and (List and Sturm, 2006).

[3]Notice that as, among others, in List and Sturm (2006), we are assuming that majority voting takes place.

$$\Phi(.) = \pi(d, s, p, \sigma, \gamma)\lambda - c\,(p) \tag{2}$$

Differentiating (2) with respect to p we get

$$\frac{\partial \Phi(.)}{\partial p} = \frac{f\,(.)\,\sigma\eta}{(1-\eta)}\frac{\partial \theta\,(.)}{\partial p} - \frac{\partial c\,(.)}{\partial p} \tag{3}$$

Clearly, when $\frac{\partial \theta(.)}{\partial p} > 0$, then the expression in $\frac{\partial \Phi(.)}{\partial p}$ is always positive, and we have a corner solution such that the number of permits is set at the maximum (exogenous) level $p = p_m$. On the other hand, when $\frac{\partial \theta(.)}{\partial p} < 0$, then first order conditions require: $\frac{\partial \Phi(.)}{\partial p} = 0$[4]. The resulting comparative statics imply:

$$\frac{\partial p}{\partial d} = -\frac{\frac{f(.)\sigma\eta}{(1-\eta)}\gamma_{pd}}{\left(\frac{f(.)\sigma\eta}{(1-\eta)}\gamma_{pp} - \frac{\partial^2 c}{\partial p^2}\right)} < 0;$$

and

$$\frac{\partial p}{\partial s} = -\frac{\frac{f(.)\sigma\eta}{(1-\eta)}\beta_{ps}}{\left(\frac{f(.)\sigma\eta}{(1-\eta)}\gamma_{pp} - \frac{\partial^2 c}{\partial p^2}\right)} > 0.$$

These two conditions show that the equilibrium level of building permits decreases (increases) with the number of disasters (the relevance of sectors depending on the number of issued building permits). This is reasonable, as an increase in d decreases, ceteris paribus, the willingness of the incumbent politician to issue permits, to avoid the related loss of consent. In contrast, an increase in s implies stronger support from "permits intensive" sectors, increasing the incentives of the incumbent politician to issue permits.

Turning to our electoral competition parameter, we can conclude that:

$$\frac{dp}{d\sigma} = -\frac{\frac{f(.)\eta}{(1-\eta)}\frac{\partial \theta(.)}{\partial p}}{\left(\frac{f(.)\sigma\eta}{(1-\eta)}\gamma_{pp} - \frac{\partial^2 c}{\partial p^2}\right)} < 0$$

[4]We assume second order conditions for an interior maximum to hold, namely $\left(\frac{f(.)\sigma\eta}{(1-\eta)}\gamma_{pp} - \frac{\partial^2 c}{\partial p^2}\right) < 0$.

as in this case $\frac{\partial \theta(.)}{\partial p} < 0$. In other words, in the corner solution where $p = p_m$ electoral competition does not affect the number of issued permits. On the other hand, when an interior solution exists (i.e. when the green voters are sufficiently "strong") then an increase in electoral competition leads the incumbent politician to reduce the equilibrium number of permits, fearing a loss of consensus from the green voters.

The political equilibrium obtained and the comparative statics lead directly to three testable implications:

Testable implication 1. *The number of building permits increases with the share of employment in the construction sector.*

Testable implication 2. *The number of building permits issued in a given year decreases if the territory has suffered floods and/or landslides in previous years.*

Testable implication 3. *The number of building permits issued decreases with the degree of electoral competition in territories where the risk of disasters is larger.*

3 Empirical Framework

3.1 The Model

We provide empirical tests for our theoretical predictions using data on 96 Italian provinces (NUTS3) over the period 1995-2013, in order to analyse the politicians' responses to voters lobbies. We use data on city council elections taking place in municipalities in each province. We chose municipality-level elections as building permits are granted at municipality level according to Italian legislation; we consider the share of population voting for municipal elections in each year for each province.

Using building permits as our dependent variable, the regressors are selected to indirectly describe the expectations of the incumbent politician regarding the distribution of voters between green and brown voters. Our empirical model is the following:

$$
\begin{aligned}
\log(Build\_permits_{it}) &= \alpha_i + \beta_1 Share\_empl\_constr_{i,t-1} + \beta_2 Disasters^{0,1}_{i,t/t-2} + \\
&+ \beta_3 \log(Crime\_corrupt\_pc_{r,t-1}) + \beta_4 \log(Empl_{i,t-1}) + \\
&+ \beta_5 \log(GDP\_pc_{r,t-1}) + \beta_6 Share\_elect\_year_{i,t} + \\
&+ X_i' \delta_t + \tau_t + \varepsilon_{it} \qquad (4)
\end{aligned}
$$

where:

- $\log(Build\_permits_{it})$ is the logarithm of building permits granted in year t and in province i;
- α_i is the province fixed effect that captures unobservable time-invariant province features;
- $Share\_empl\_constr_{i,t-1}$ is the share of employment in the construction sector (in $t-1$) which, according to our theoretical model, is expected to lead to being positively correlated to the number of building permits; this is our proxy of "brown" voters, in light of the *"interest group"* (Grossman and Helpman, 1994) literature: a greater share of employment in the construction sector corresponds to a sort of "brown" interest group requesting more building permits *"in order to translate their potential productivity into hard economic reality"* (Esteban and Ray (2006): page 274).
- $Disasters^{0,1}_{i,t-1/t-3}$ is a dummy of floods and landslides with fatalities between year $t-2$ and year t which, according to our theoretical model, is expected to be negatively correlated with building permits[5]; We therefore capture the share of "green" voters through the past flood and landslides that have occurred in the

[5]Notice that, coherently with Bin et al. (2008), we also tried to understand how the "memory" of natural disasters persists (or disappears) over time. To this end, we tried to perform the same estimates using larger than 3 years lags for the *Disasters* variable, obtaining not significant results. Results are available from the authors upon request.

province;

- $Share\_elect\_year_{i,t}$ is a variable that measures the share of population interested by municipal election in province i in t; we cannot provide a straightforward sign for the correlation of this variable with the number of issued building permits.
- Additionally, we include specific variables related to illegal behaviour and to the general condition of provincial economies, namely
  - $\log(Crime\_corrupt\_pc_{r,t-1})$ is the logarithm of the number of incriminations (per capita) for crime against public administration per capita at regional level (r, NUTS2);
  - $\log(Empl_{i,t-1})$ is the logarithm of total employment in the province (in $t-1$);
  - $GDP\_pc_{r,t-1}$ is per capita GDP at the regional level (NUTS2); GDP per capita and employment are included to obtain information regarding the civil pressure on municipalities to release building permits.

Finally, X_i' is a set of time-invariant province-specific variables whose effect is allowed to differ over time[6] , while τ_t are year dummies; τ_t captures some state variables such as the average of rainfalls and the local soil sealing.

We have to account for a possible problem of endogeneity. Indeed, employment in the construction sector may suffer from a reverse causality issue as a consequence of the tight relationship between the amount of building permits and the dimension of the construction sector. We account for this potential bias by adopting an instrumental variable approach. Our selected IV is the share of bad debts. This is an indicator of demand shock in the real estate market, because a credit shock is expected to affect the liquidity of final consumers of the construction housing industry (and so the hiring and employment in the same sector) without affecting the number of building permits directly. In response to a bad demand shock, the construction sector would in turn

[6]These include macro-region dummies (NUTS1) and average rainfall in the province. These variables account for region-specific shocks and for the occurrence of region-specific extreme events or extreme events that hit areas that are systematically more exposed to risk due to their average rainfall.

reduce the amount of requests for building permits. We expect, therefore, the exclusion restriction to be satisfied: the instrumental variable affects the dependent variable, but only through its impact on the potentially endogenous variable and without having a direct effect on building permits.

3.2 Data

Data about the number of floods and landslides experienced in Italy are provided by IRPI-CNR based in Perugia, Italy. In particular, the data we use refer to the total number of floods and landslides with fatalities that occurred in each province in Italy. Data about building permits (in metres cubed), GDP per capita (NUTS2), crimes related to corruption per capita (NUTS2) and population are retrieved from public statistics released by the National Statistical Institute (ISTAT). Information on average rainfall (time-invariant) is taken from Ente CRA, Italian Institute for Agricultural Research. Data on employment (total and by sector) is retrieved from the ASIA (Archivio Statistico delle Imprese Attive) database (ISTAT). Data on the state of local soil sealing (time-invariant) was taken from a 2012 Report provided by the Italian National Institute for Environmental Protection and Research (ISPRA), and show the percentage of soil sealing in any Italian province. Information about election years for the city councils of each municipality in each province come from the repository of the Ministero dell'Interno. Table 1 summarizes the variables used and the data sources.

[Table 1 about here]

4 Results

As a first step we evaluate the trends in our variable of interest, i.e the number of granted building permits, for provinces with different attributes. Figure 1 groups together information about natural disasters, average building permits per capita and share of people

subject to elections. The trend of building permits per capita quickly decreases after 2007 due to the macroeconomic crisis. Moreover, figure 1 suggests the existence of a correlation between the trend of the election index and building permits granted. Election index is a variable capturing the share of the population voting in municipal elections in each province. As shown in the figure, before the crisis peaks in the election index trend correspond to peaks in building permits per capita; after the crisis, peaks in the election index are coupled with a slower falling of building permits per capita. Both these behaviours can be rationalised by accounting that, close to the election day, it is easier to attract brown voters with respect to green ones, as environmental policy needs time to be implemented. As a result, at election time, the number of building permits released increases by about 6-7%.

[Figure 1 about here]

As a preliminary step to evaluate how green and brown voters affect building permits, we report the trends in average permits per capita with high or low importance of green and brown lobbies. We compare provinces with disasters in the period 1995-2000 with provinces with no disasters in the same period (Figure 2), concluding that the issued permits are lower in provinces with no disasters before 2000 and that, according to Bin et al. (2008), the difference vanishes over time. Similarly, we split the sample of provinces into two sub-samples according to the share of employees in the construction sector in 1999 using the median value as the threshold to distinguish among high and share of employment. Figure 3 shows these two trends. Even though there is not a large difference, observing the trend of the plain curve, it decreases less than the dotted one. In fact, provinces featuring high employment in the construction sector lose almost 16% less building permits than provinces with a low corresponding share. We also adopt, as an additional proxy of green voters' share, the average involvement in pro-environment NGOs in Italian regions and, more specifically, namely Legambiente, one of the most

relevant for which data are available. We show how it is related to different trends in building permits in Figure 4. It clearly emerges that there appears to be a difference among provinces with high and low involvement in Legambiente. Finally, it is also interesting to see whether the trends in the granting of building permits are different across regions with different objective exposure to natural disasters; in fact, observing Figure 5, we can derive similar considerations as those from Figure 3.

[Figures 2, 3, 4 and 5 about here]

Altogether, descriptive evidence seems to go in the direction of confirming our theoretical findings. A high share of employees in the construction sector and a low share of people living in high-risk areas are linked with a quicker decrease in issued permits over time, while a larger share of people enrolled in Legambiente NGO implies a quicker decrease in building permits over time. Moreover, we also have a preliminary flavour of the role of the proximity to election day (Figure 1) on the incumbent politician's behaviour. On the other hand, the evidence concerning the role of past disasters is clear only up to 2010, after which it becomes mixed, due to the "short memory" which results from Figure 2.

To rigorously and empirically validate this descriptive evidence, we now turn to the discussion of results stemming from the econometric model described in the previous section. As a first step, we evaluate the role played by the main drivers of building permits (Table 2). We report both simple fixed effect models (columns 1, 3, 5) and IV-FE models (columns 2, 4, 6) where the share of employees in the construction section is properly instrumented.

[Table 2 about here]

Results already suggest that testable implications 1 and 2 are not rejected: a larger share of employment in the construction sector, by increasing the number of brown voters, leads to an increase in the number of building permits granted. On the other hand, a

larger number of catastrophic events in the recent past (i.e. a potentially larger share of green voters) negatively affects the number of building permits granted. Another interesting result is concerned with the possible relevance of illegal behaviour and potential corruption in explaining the number of building permits. This is linked to the possibility that permits are granted as a consequence of bribes, which we expect to happen more often where illegal behaviour is more diffused; as already suggested in the data description, this is measured by the number of crimes against public administration. Indeed, Table 2 shows that a larger number of permits is issued when illegal behaviour is more significant.

Results are consistent across different specifications. Indeed, moving from the simplest specification (columns 1 and 2) to the one that also accounts for total employment and GDP per capita (i.e. our preferred specification) does not influence the results. Not however, that when we account for factors that are tightly connected to the likelihood of suffering a natural disaster, namely when we interact year dummies with average rainfalls and soil sealing, the significance of the "past disasters" variable disappears (columns 5 and 6 in Table 2).

Overall, the sign and statistical significance of the variable that measures the relevance of the construction sector also remain robust when we account for possible endogeneity. The main difference between the FE and FE-IV models is that accounting for the endogeneity of the variable results in a greater magnitude of the estimated effect.

[Table 3 about here]

As a second step, and coherently with theoretical analysis, we also consider the role played by the electoral cycle in explaining the number of building permits. We do this by investigating the role played by the share of population subject to municipal elections in each province in a given year. Results in the first column of Table 3 show that building permits increase with the share of population subject to municipal elections.

This seems to run counter to our third testable hypothesis, suggesting that brown voters react more than green voters as elections draw closer. Also in this case we have to account for potential endogeneity biases, linked to the variable "share of population in municipalities subject to election": for instance, corruption (not directly observable) tends to "blow up" the number of building permits granted; at the same time, the probability that a city council is subject to anticipated elections is correlated with the presence of corruption or mismanagement. Thus, in order to avoid an omitted variable bias we use as an instrument the share of population that should be subject to municipal elections according to the "regular" electoral cycle (i.e. at the natural end of the term of office, every five years in Italy). Adopting an IV approach does not change results is confirmed (second column in Table 3).

[Table 4 about here]

As a final step in our empirical analysis we explicitly evaluate whether specific attributes of provinces influence the amount of building permits granted by municipalities in the election year. The idea is that the likelihood of politicians using the building permit lever to satisfy the requests of the brown lobby depend on: i) the objective risk of incurring in a natural disaster; ii) the strength of the green lobby.[7] As a first step, we interact the election year variable with a variable that measures the share of population living in areas with high, medium and low risk of flood.[8] Results suggest that politicians are somewhat more prudent in areas with high objective risks than in other areas, with a relatively lower number of building permits granted in provinces with high risk and, to a lesser extent, medium risk, than in risk-free areas during election years. When it comes to evaluating the role of the green lobby, whose relevance is measured with the

[7] To saturate the model, we also include in the regressions interaction terms with either the objective risk or green lobby variables and year dummies to account for potentially different trends for provinces that systematically differ in these dimensions.

[8] High risk means that the return period of a flood is between 20 and 50 years; medium risk between 100 and 200 years; low risk areas have little probability of a flood.

share of the population who is members of Legambiente, we observe a negative but not statistically significant interaction term.

5 Concluding remarks

Our paper provides food for thought on the links between politicians' incentives, natural disasters and voters' attitude towards environmental problems. Our simple theoretical model, based on Besley and Burgess (2002) and List and Sturm (2006) highlights potential trade-offs between a prudent policy (i.e. limiting building permits) that attracts "green voters" and a more risky policy (i.e. granting more building permits) that increases the risk of experiencing a natural disaster but also favours "brown voters".

Our empirical investigation, based on a panel of Italian provinces, does not reject our main testable implications: a more relevant construction sector in local employment, provides incentives for politicians to use the lever of granting more building permits (and incurring the risk of causing a natural disaster) to attract votes from "brown" voters. On the other hand, past natural disasters, that are likely to increase the share of "green" voters, result in a reduction in building permits. We also show that a more prudent behaviour in issuing building permits is coupled with a larger "objective" risk related to the observed repetition of catastrophic events. Finally, brown voters seem to react more to electoral competition; in this respect, empirical results seem to run counter to our theoretical model's conclusions.

Table 1: Variables used and sources

Dependent Variable	**Source**:
Building permits	ISTAT, National Statistical Institute
Independent Variables	
Number of Floods and Landslides with Fatalities	IRPI, Research Institute for Geo-Hydrological Protection
Percentage of soil sealing on 2012	ISPRA, National Institute for Env Protection and Research
Population Density	ISTAT, National Statistical Institute
Total employment	ISTAT, National Statistical Institute: Banca dati ASIA
Employment in Construction Sector	ISTAT, National Statistical Institute: Banca dati ASIA
Employment in Industry Sector	ISTAT, National Statistical Institute: Banca dati ASIA
Number of incriminations for corruption	ISTAT, National Statistical Institute
Average annual rainfall	Ente CRA
Regional (NUTS2) GDP	ISTAT, National Statistical Institute
Share of pop interested by municipal elections in the prov	Ministero dell'Interno
Share of population in risk-exposed areas	ISPRA, Italian Environment Agency
Percentage of population member of Legambiente	Legambiente
Instrumental Variable	
Share of unpaid debts	Bank of Italy
Other details	
Number of Provinces	96
Estimation sample time series	2001-2012

Figure 1: Trends in variables of interest

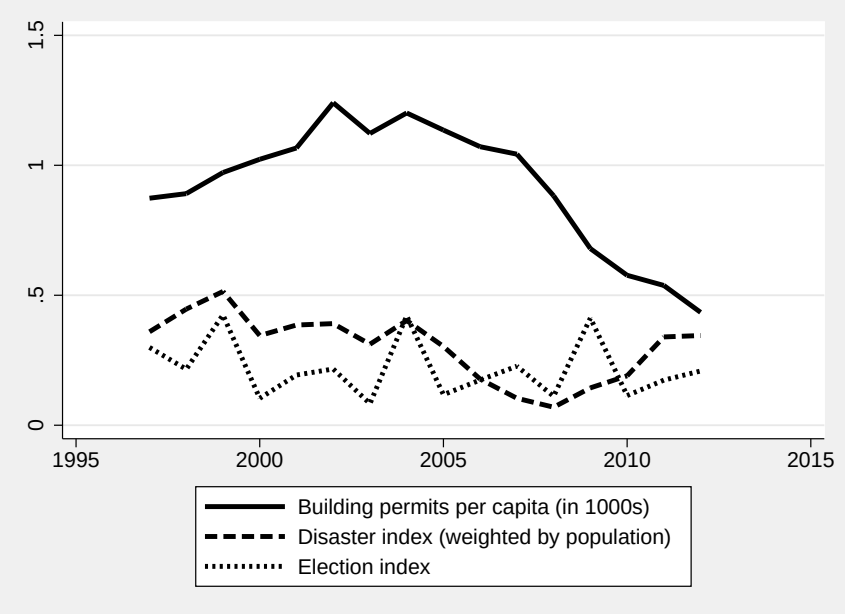

Figure 2: Trends in building permits per capita split by provinces with (or without) disasters before 2000

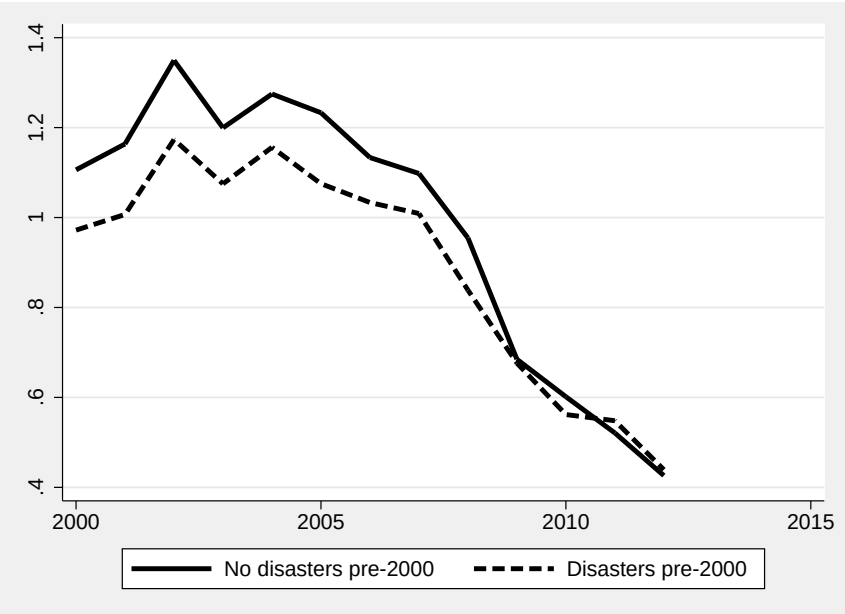

Figure 3: Trends in building permits per capita split by provinces with high (above median, 1999) or low (below median, 1999) share of employment in the construction sector

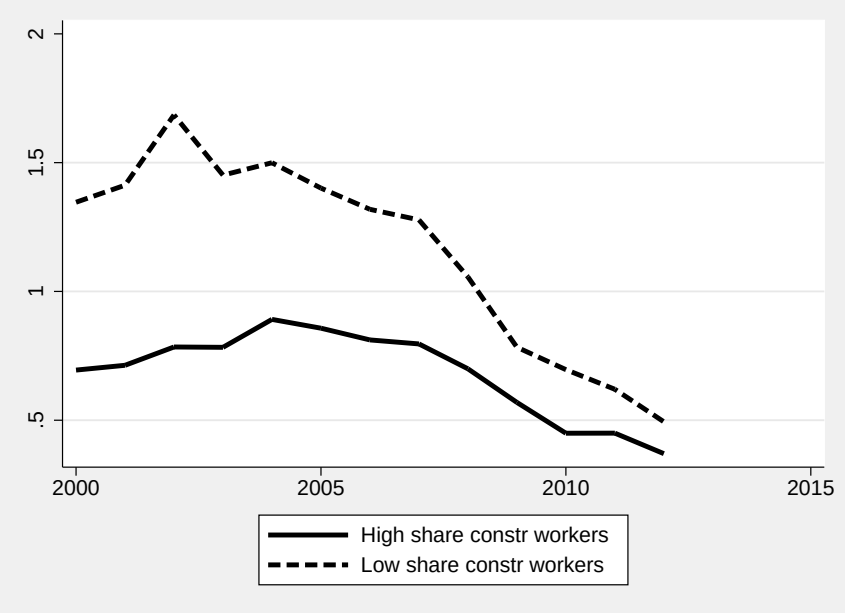

Figure 4: Trends in building permits per capita split by provinces with high (above median, 2005) or low (below median, 2005) percentage of people that are members of Legambiente

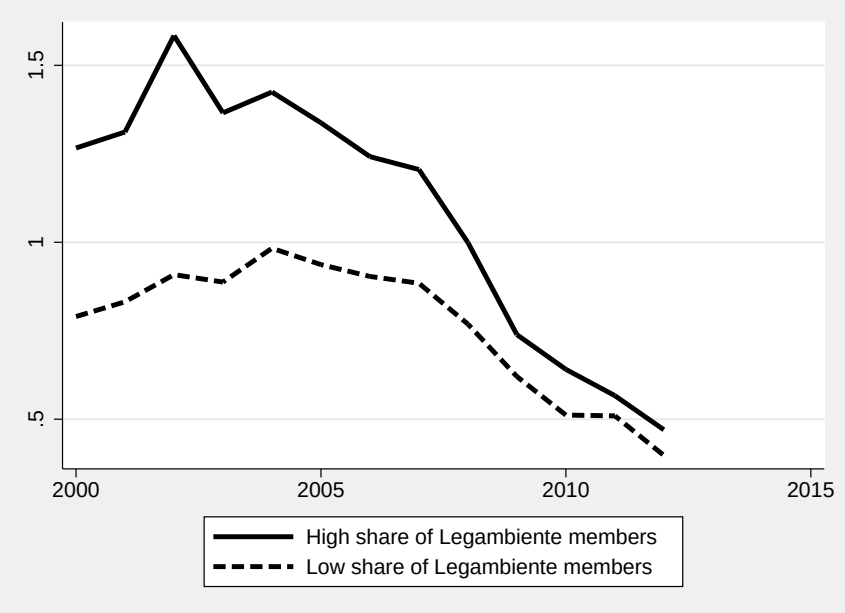

Figure 5: Trends in building permits per capita split by provinces with high (above median) or low (below median) share of people living in 'high-risk' areas

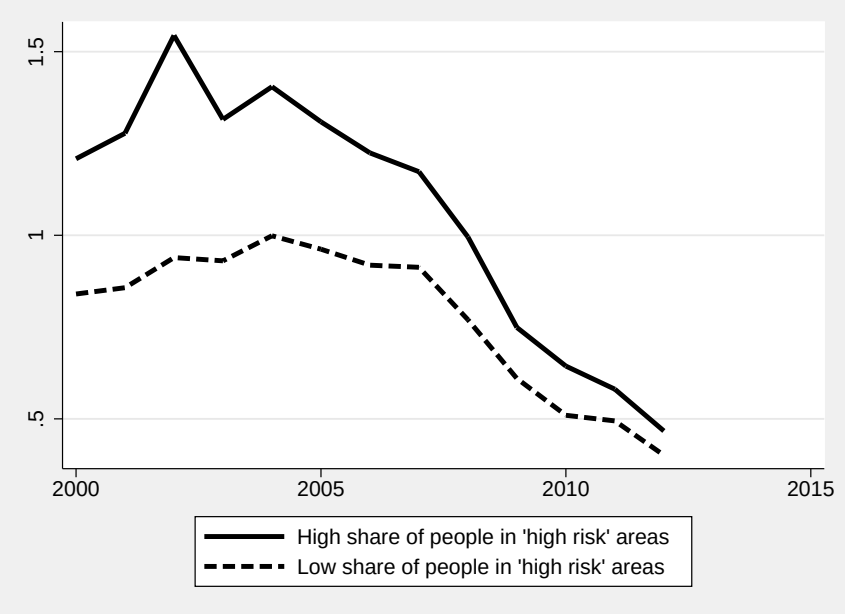

Table 2: Drivers of building permits

	(1) FE	(2) FE-IV	(3) FE	(4) FE-IV	(5) FE	(6) FE-IV
Disasters in the last 3 years	-0.0515**	-0.0506**	-0.0530**	-0.0529**	-0.0313	-0.0192
	(0.0245)	(0.0235)	(0.0266)	(0.0233)	(0.0217)	(0.0243)
Share of empl in construction (t-1)	2.784***	7.602**	2.386**	6.930**	1.986*	7.540**
	(0.802)	(3.461)	(0.909)	(3.022)	(0.991)	(3.575)
log(crime corrupt per capita in NUTS2, t-1)	0.0324**	0.0349*	0.0309**	0.0320*	0.0598***	0.0619***
	(0.0155)	(0.0198)	(0.0151)	(0.0187)	(0.0168)	(0.0194)
log(tot employment, t-1)			-0.0109	0.120	0.116	0.530*
			(0.185)	(0.229)	(0.169)	(0.291)
log(GDP per capita in NUTS2, t-1)			1.350***	0.756	0.578	0.599
			(0.401)	(0.835)	(0.611)	(0.571)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year-NUTS1 dummies	No	No	No	No	Yes	Yes
Year dummies x average rainfalls	No	No	No	No	Yes	Yes
Year dummies x average soil sealing	No	No	No	No	Yes	Yes
F test excluded IV		27.09		27.54		17.87
R sq	0.761	0.732	0.767	0.742	0.808	0.778
N	1149	1149	1149	1149	1149	1149

Dependent variable: log of the number of granted building permits. FE model weighted by average population in NUTS3. Standard errors clustered by NUTS2 region in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. IV for Share of employment in the construction sector in t-1: share of unpaid debts in NUTS3 in t-1 and t-2.

Table 3: Drivers of building permits including elections

	Elections exogenous	Elections endogenous
Disasters in the last 3 years	-0.0527**	-0.0528**
	(0.0229)	(0.0229)
Share of empl in construction (t-1)	6.945**	6.943**
	(2.991)	(2.997)
log(crime corrupt per capita in NUTS2, t-1)	0.0324*	0.0323*
	(0.0187)	(0.0187)
log(tot employment, t-1)	0.124	0.123
	(0.226)	(0.227)
log(GDP per capita in NUTS2, t-1)	0.762	0.761
	(0.833)	(0.833)
Share of pop in municipalities in elect year	0.0714**	0.0594**
	(0.0288)	(0.0257)
Year dummies	Yes	Yes
F test excluded IV	27.59	18.38
R sq	0.743	0.743
N	1149	1149

Dependent variable: log of the number of granted building permits. FE model weighted by average population in NUTS3. Standard errors clustered by NUTS2 region in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. IV for Share of employment in the construction sector in t-1: share of unpaid debts in NUTS3 in t-1 and t-2; IV for election: share of population in municipalities in the 'natural' end of mandate.

Table 4: Role of objective risk and 'green orientation'

	(1)	(2)	(3)	(4)
Share of empl in construction (t-1)	6.871**	6.634**	6.486**	6.760**
	(3.177)	(3.122)	(2.881)	(3.022)
log(tot employment, t-1)	0.137	0.139	0.122	0.146
	(0.231)	(0.235)	(0.246)	(0.228)
log(GDP per capita in NUTS2, t-1)	0.677	0.611	0.801	0.735
	(0.889)	(0.901)	(0.808)	(0.875)
Disasters in the last 3 years	-0.0518**	-0.0517**	-0.0522**	-0.0515**
	(0.0219)	(0.0217)	(0.0216)	(0.0216)
log(crime corrupt per capita in NUTS2, t-1)	0.0358**	0.0393**	0.0392**	0.0314*
	(0.0176)	(0.0192)	(0.0162)	(0.0182)
Share of pop in municipalities in elect year	0.0926***	0.0937***	0.0774**	0.0807
	(0.0326)	(0.0322)	(0.0362)	(0.0928)
Share of pop in municipalities in elect year x share of pop in 'high-risk' areas	-0.824*			
	(0.454)			
Share of pop in municipalities in elect year x share of pop in 'medium-risk' areas		-0.216*		
		(0.130)		
Share of pop in municipalities in elect year x share of pop in 'low-risk' areas			-0.0458	
			(0.0903)	
Share of pop in municipalities in elect year x share of population in 'Legambiente'				-0.0729
				(0.539)
Year dummies x 'high risk'	Yes	No	No	No
Year dummies x 'medium risk'	No	Yes	No	No
Year dummies x 'low risk'	No	No	Yes	No
Year dummies x 'share in Legambiente'	No	No	No	Yes
F test excluded IV	28.25	26.96	27.41	26.51
R sq	0.748	0.753	0.756	0.751
N	1149	1149	1149	1149

Dependent variable: log of the number of granted building permits. FE model weighted by average population in NUTS3. Standard errors clustered by NUTS2 region in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. IV for Share of employment in the construction sector in t-1: share of unpaid debts in NUTS3 in t-1 and t-2.

References

[1] Anbarci, Nejat, Monica Escaleras, and Charles A. Register (2005): "Earthquake fatalities: the interaction of nature and political economy", *Journal of Public Economics*, Vol. 89, pp. 1907–1933. Available at: http://www.sciencedirect.com/science/article/pii/S0047272704001525.

[2] Besley, Timothy and Robin Burgess (2002): "The Political Economy of Government Responsiveness: Theory and Evidence from India", *The Quarterly Journal of Economics*, Vol. 117, No. 4, pp. 1415–1451. Available at: http://qje.oxfordjournals.org/content/117/4/1415.full.pdf+html.

[3] Bin, Okmyung, Jamie B. Kruse, and Craig E. Landry (2008): "Flood Hazards, Insurance Rates, and Amenities: Evidence from the Coastal Housing Market", *The Journal of Risk and Insurance*, Vol. 75, No. 1, pp. 63–82. Available at: http://onlinelibrary.wiley.com/doi/10.1111/j.1539-6975.2007.00248.x/full.

[4] Carrera, L., G. Standardi, E. E. Koks, L. Feyen, L. Mysiak, J. C. J. H. Aerts, and F. Bosello (2015): "Economics of flood risk in Italy under current and future climate", *Annual Conference of the European Association of Environmental and Resource Economists*. Available at: http://www.webmeets.com/files/papers/eaere/2015/1029/Carrera%20et%20al_EAERE.pdf.

[5] Deng, Guoying, Li Gan, and Manuel A. Hernandez (2015): "Do natural disasters cause an excessive fear of heights? Evidence from Wenchuan earthquake", *Journal of Urban Economics*, Vol. 90, pp. 79–89. Available at: http://www.sciencedirect.com/science/article/pii/S0094119015000662.

[6] Esteban, Joan and Debraj Ray (2006): "Inequality, Lobbying, and Resource Allocation", *The America Economic Review*, Vol. 96, No. 1, pp. 257–279. Available

at: https://www.aeaweb.org/articles?id=10.1257/000282806776157533&within%5Btitle%5D=on&within%5Babstract%5D=on&within%5Bauthor%5D=on&journal=1&q=esteban&from=j.

[7] Ferraz, Claudio and Frederico Finan (2011): "Electoral Accountability and Corruption: Evidence from the Audits of Local Governments", *American Economic Review*, Vol. 101, No. 4, pp. 1274–1311. Available at: http://www.aeaweb.org/articles?id=10.1257/aer.101.4.1274, DOI: http://dx.doi.org/10.1257/aer.101.4.1274.

[8] Feyen, L., D. Rutger, K. Bodis, P. Salamon, and J. I. Barredo (2012): "Fluvial flood risk in Europe in present and future climates", *Climatic Change*, No. 112, pp. 47–62. Available at: http://link.springer.com/article/10.1007%2Fs10584-011-0339-7.

[9] Grossman, Gene M. and Elhanan Helpman (1994): "Protection for Sale", *The American Economic Review*, Vol. 84, No. 4, pp. 833–850. Available at: https://www.jstor.org/stable/2118033?seq=1#page_scan_tab_contents.

[10] Guzzetti, F., P. Reichenbach, M. Cardinali, M. Galli, and F. Ardizzone (2005): "Probabilistic landslide hazard assessment at the basin scale", *Geomorphology*, No. 72, pp. 272–299. Available at: http://www.sciencedirect.com/science/article/pii/S0169555X05001911.

[11] Haase, D. and H. Nuissl (2007): "Does urban sprawl drive change in the water balance and policy? The case of Leipzig (Germany) 1870-2003", *Landscape and Urban Planning*, No. 80, pp. 1–13. Available at: http://link.springer.com/article/10.1007%2Fs10584-011-0339-7.

[12] Hallegatte, S. (2014): "An Exploration of the link between Development, Eco-

nomic Growth, and Natural Risk", *World Development Report*. Available at: http://elibrary.worldbank.org/doi/abs/10.1596/1813-9450-6216.

[13] Kellenberg, D. K. and A. M. Mobarak (2011): "The Economics of Natural Disasters", *Annual Rev. Resour. Econ.*, Vol. 3, pp. 297–312. Available at: http://www.annualreviews.org/doi/pdf/10.1146/annurev-resource-073009-104211.

[14] Koks, E. E., B. Jongman, T. G. Husby, and W. J. W. Botzen (2015): "Combining hazard, exposure and social vulnerability to provide lessons for flood risk management", *environmental science & policy*, No. 47, pp. 42–52. Available at: http://www.sciencedirect.com/science/article/pii/S1462901114002056.

[15] List, John A. and Daniel M. Sturm (2006): "How Elections Matter: Theory and Evidence from Environmental Policy", *Quarterly Journal of Economics*. Available at: http://qje.oxfordjournals.org/content/121/4/1249.full.pdf+html.

[16] Miao, Q. and D. Popp (2014): "Necessity as the mother of invention: Innovative responses to natural disasters", *Journal of Environmental Economics and Management*, No. 68, pp. 280–295. Available at: http://www.sciencedirect.com/science/article/pii/S0095069614000357.

[17] Modica, Marco, Roberto Zoboli, Fabrizio Meroni, Vera Pessina, Thea Squarcina, and Marco Locati (2016): "Housing Market Response to 2012 Northen Italy Earthquake: The role of house quality and changing risk perception", *Seeds-Sustainability WP Series*, No. 4. Available at: http://www.sustainability-seeds.org/papers/RePec/srt/wpaper/0416.pdf.

[18] Pistocchi, A., C. Calzolari, F. Malucelli, and F. Ungaro (2015): "Soil sealing and flood risks in the plains of Emilia-Romagna, Italy", *Jour-*

nal of Hydrology: Regional Studies, Vol. 4, pp. 398–409. Available at: http://www.sciencedirect.com/science/article/pii/S2214581815000841.

[19] Scalenghe, R. and F. Ajmone Marsan (2009): "The anthropogenic sealing of soil in urban areas", *Landscape and Urban Planning*, No. 90, pp. 1–10. Available at: http://www.sciencedirect.com/science/article/pii/S0169204608001710.

[20] World Bank (2010): "Natural hazards unnatural disasters. The economics of effective prevention",Technical report.