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ENVIRONMENTAL ZONING AND URBAN DEVELOPMENT: NATURAL REGIONAL PARKS IN FRANCE - ENVIRONMENT WORKING PAPER No. 110

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FOREWORD

This report has been authored by Julien Salanié (Université Jean Monnet, Saint-Etienne) and Thomas Coisnon (Agrocampus Ouest, Angers). The authors are grateful to delegates to the Working Party on Integrating Environmental and Economic Policies for helpful comments on earlier drafts of this paper. From the OECD the authors would also like to thank Walid Oueslati, Paolo Veneri, Alexandros Dimitropoulos and Ioannis Tikoudis for comments on previous versions of the paper, and Natasha Cline-Thomas and Katjusha Boffa for editorial assistance. The authors are responsible for any remaining omissions or errors. Work on this paper was conducted under the overall responsibility of Shardul Agrawala, Head of the OECD Environment and Economy Integration Division.

ABSTRACT

This study provides an empirical analysis of the effects of environmental zoning on urban development. It focuses on the case of Natural Regional Parks (NRPs) in France. Of the environmental zoning instruments used in France, NRPs extend over the widest physical area. The analysis uses a quasi-experimental empirical approach (difference-in-differences) to evaluate the effects of NRPs on urban development at the municipality level. Three potential side-effects of NRPs on urban development in the regulated area are investigated. First, the long-term effects of environmental zoning on housing and population flows are analysed using French National Census data in the period from 1968-2011. Second, annual data on building permits granted in the period from 2003-2012 are used to estimate the short-term effects of NRPs on housing supply. Finally, the effects of NRPs on land-use in the regulated area using high-resolution geospatial data are evaluated. The results of the empirical analysis reveal that NRPs have had heterogeneous effects on urban development in regulated areas. Compared to development in neighbouring areas, some NRPs have discouraged urban development in the regulated area, in line with their intended objectives. However, in other cases NRPs have actually favoured urban development. In most cases, however, the policy had no significant effect on urban development within the regulated area.

Keywords: Environmental zoning, Urban development, Natural regional parks, France

JEL classification: R14, Q24, Q26

TABLE OF CONTENTS

Tables

Figures

EXECUTIVE SUMMARY

Among the broad range of land-use regulatory instruments, environmental zoning generally serves various purposes, such as achieving the conservation of natural areas, protecting the associated ecosystem services and contributing to the conservation of cultural heritage. In 2014, the World Database for Protected Areas included more than 200 000 sites covering over 32 million km² of land and marine areas.

The literature has highlighted the potential side-effects of land-use regulations on housing markets, but little attention has been paid to the specific case of environmental zoning policies. This study focuses on the case of Natural Regional Parks (NRPs) in France and provides an empirical analysis of their effects on urban development. Of the environmental zoning instruments used in France, NRPs extend over the widest physical area. NRPs are designated by the national government for 12-year periods. The aim of an NRP is to support social and economic development within the designated territory, while at the same time preserving its natural and cultural heritage. In accordance with this ambition, NRPs include provisions to contain urban sprawl. The very first NRP was established in the late 1960s.

The analysis uses a quasi-experimental empirical approach (difference-in-differences) to evaluate the effects of NRPs on urban development at the municipality level. Three potential side-effects of NRPs on urban development in the regulated area are investigated. First, the long-term effects of environmental zoning on housing and population flows are analysed using French National Census data. Second, the short-term effects of NRPs on housing supply are estimated using annual data on building permits granted in the period 2003-2012. Finally, the effects of NRPs on land use in the regulated area are evaluated using high-resolution geospatial data from the Corine Land Cover database.

The results of the empirical analysis reveal that NRPs have had heterogeneous effects on urban development in regulated areas. The analysis of long-term census data shows that 27% of the NRPs have significantly limited housing development and population growth in comparison with neighbouring areas. In other NRPs, urban development has been favoured in view of encouraging touristic development. In most cases, however, the policy had no significant effect on urban development within the regulated area. The spatial heterogeneity of results is also observed in the short-term analysis of building permit data. The analysis of geospatial data investigates the effect of the NRP on plot development probabilities. While the majority of NRPs do not have a clear effect on plot development, in two cases, plots inside the NRP are over 1% less likely to be developed in the observed periods than plots outside of it.

The large variation in the estimates can probably be explained by distinct economic mechanisms affecting housing supply and demand. First, the establishment of an NRP naturally entails legal constraints on development opportunities. Aiming to protect designated natural areas, NRPs include provisions which limit the extent of urbanisation. Although these provisions may be effective in controlling urban development, they may lead to significant increases in housing prices. On the other hand, NRPs protect natural landscapes and secure the provision of recreational amenities in the long term, having, thus, a positive effect on housing demand and on tourism. This increase in demand is likely to increase urban development. The protection of environmental and recreational amenities by NRPs may also have spill-over effects in terms of increased development in unregulated neighbouring areas. The net effect of the establishment of an NRP on urban development depends, thus, on the interaction of these two mechanisms.

The findings of this report highlight the importance of a number of elements of the decision-making process preceding the implementation of environmental zoning. In particular, clear specification of the objectives of the zoning policy, efficient governance and collective arrangements to ensure the resilience of the designated territory, and a legal framework preventing conflicts with other local zoning policies are key for the environmental effectiveness of this regulatory instrument.

1. INTRODUCTION

Environmental zoning is one of the main instruments used to protect ecologically sensitive areas from urban development and other types of potentially harmful human activity. The International Union for Conservation of Nature (IUCN) classifies protected areas into six broad categories, accounting for their scale, scope and governance.[1] The most stringent regulatory provisions within this classification apply to *strict nature reserves* (category Ia) where human activity is strictly controlled. The level of stringency of areas classified under other IUCN classes, such as *protected areas and landscapes* (categories V and VI), is much laxer. In general, in these areas human activities and nature are largely interconnected, but specific environmental measures to ensure the sustainability of the area are implemented.

In 2014, the World Database for Protected Areas[2] counted a total of more than 200,000 protected areas, covering more than 32 million km² of land and marine area. This represented over 15% of the world's terrestrial and inland water areas (Juffe-Bignoli et al., 2014). This coverage was mostly achieved through an exponential growth in the number of protected areas after World War II. Following Chape et al. (2005), there were less than 10 000 protected sites in 1960 covering an area of less than 2 million km². In 1950, protected areas in Europe consisted of 2 900 sites covering 18 300 km².[3] In 1980, almost 17 000 sites covered 250 000 km². In 2014, protected areas included 96 500 sites covering 1 150 000 km². In Canada, the cumulative area of protected areas was 200 000 km² in 1950 and is more than a million km² in 2011.[4]

In most of these protected areas, land-use is, to some extent, controlled. Land development for residential, commercial or industrial purposes may be completely forbidden in nature reserves. Controls are laxer in more flexible protected areas, including designated areas for land development, requirements for environmental impact assessments before development, for example via specific building codes. The definition of environmental zoning used in this study is consistent with the IUCN classification of protected areas. Environmental zoning is defined as a spatially-explicit policy aiming to protect the environment in a given area. This policy may include a number of land-use regulatory instruments to fulfil its objectives. While land-use regulations have been extensively studied, little attention has been paid to environmental zoning in the literature.[5]

[1] The full categorisation can be found online at: *www.iucn.org/theme/protected-areas/about/categories.*

A shortened version of this categorisation is available in Appendix A.

[2] The World Database for Protected Areas can be downloaded from: *www.protectedplanet.net/*.

[3] Over 39 European countries, see: *www.eea.europa.eu/data-and-maps/indicators/nationally-designated-protected-areas#tab-latest-figures-and-vizualizations*.

[4] Environment Canada - Canadian Protected Areas - Status Report 2006-2011, available online: *http://ec.gc.ca/ap-pa/default.asp?lang=En&n=8EF4F871-1&printfullpage=true#TOClink*.

[5] It has been shown that land-use regulations have strong influence on the supply of housing, and thus its price (Pollakowski and Wachter, 1990; Mayer and Sommerville, 2000a and 2000b; Quigley and Raphael, 2004 and 2005; Glaeser and Ward, 2009; Kok et al., 2014), its location and pattern of development (Quigley and Swoboda, 2007; Ihlanfeldt, 2007; Cheshire and Vermeulen, 2009), the timing of development (Mayer and Sommerville, 2000a; Cunningham, 2007), and social segregation (Levine, 1999). Land-use regulations may also potentially have non-negligible distributional effects (Quigley and Swoboda, 2007; Cheshire and Vermeulen, 2009). They have received much attention in economics, a literature that has been thoroughly reviewed recently by Schill (2005), Quigley and Rosenthal (2005), McLaughlin (2012) and Gyourko and Molloy (2014).

Empirical literature advocated already from the late 1970s (Dowall, 1979) that environmental regulations, and environmental zoning in particular, can have side-effects on the housing market. Supply and demand analysis, indeed, suggests that environmental zoning may have strong price effects. On the supply side, environmental regulation may limit the area available for development or raise building costs, shifting the supply curve to the left.[6] On the demand side, if the protected area generates a positive amenity to residents, it will shift the demand curve to the right. As a result of the changes in supply and demand, housing prices will increase. Braconi (1996) argues that housing supply restrictions based on environmental reasons were to a large extent responsible for the rise of housing prices in the U.S. after the 1960s.[7] Frech and Lafferty (1984) and Parsons (1992) show that regulations to protect coastal areas in California and Maryland respectively, significantly increased property prices. Beaton (1991) shows that the enforcement of pine forest protection in New Jersey increased housing prices. Spalatro and Provencher (2001) also find a significant effect of minimum frontage regulations on lakefront properties in Wisconsin. However, other studies conclude that the effects on prices are insignificant or even negative. For instance, Shilling et al. (1991) find that critical areas designation, coastal zones and wetlands management areas have no impact on supply or demand in a study of the housing market in 37 U.S. States. Guttery (2004) finds that the compliance costs related to wetland regulations in Louisiana have strong negative effects on housing prices.

Similarly, the impact of environmental zoning on the quantity of housing units depends on the relative shifts of housing supply and demand and the relative elasticity of the two curves (see Exhibit 5 in Kiel, 2005, for an illustration). Dempsey and Plantinga (2013) evaluate the impact of Urban Growth Boundaries (UGBs) on development containment in 17 cities in Oregon. They find a significant impact of UGBs in only 12 cases and most significant effects being small in magnitude. Focusing on Portland’s UGB, Grout et al. (2011) find that it has a significant effect in some areas, but not across the designated area. Overall, authors show that the effects of such policies are highly variable (Netusil, 2005; Sims and Schuetz, 2009; Jaeger et al., 2012). Shilling et al. (1991) and Netusil (2005) emphasise that the demand effect is ambiguous, because environmental regulations may also lower the development opportunities of existing plots and increase user costs (e.g. increased compliance costs). If such negative effects are larger than the positive amenity effect, it is possible that demand will shift downwards. Netusil (2005) concludes that the mitigated effects of environmental zoning policies depend on the type of environmental zoning, its location and neighbourhood characteristics.

Quigley and Swoboda (2007) provide a theoretical analysis of the enforcement of a protected area in general equilibrium. Their analysis provides insights regarding the impacts of environmental zoning on urban development patterns. First, housing rents increase outside the area due to both effects – lower supply and amenities – described above. Development densities are also higher in non-protected areas. The zoning policy may cause additional development on previously undeveloped land, potentially increasing the total developed area in the city. Moreover, the environmental zoning policy has distributional effects, increasing the property values and amenity of homeowners outside the regulated area while driving up the rents of current renters. These effects depend on the location of the protected area and are stronger as the protected area gets closer to the city centre. In a spatial context with mobile households, the distributional effects of land-use regulation may indeed be strong, as also suggested by the works of Bento et al. (2006) on several anti-sprawl policies and Coisnon et al. (2014) on agri-environmental policies. Wu and Plantinga (2003) and Wu (2006) also emphasise the role of amenities provided by a protected area, on the pattern of development and social segregation.

[6] The supply effect may be even stronger when the regulation includes mechanisms such as building height restrictions.

[7] However, Evans (1996) argued for the opposite in an answer to Braconi.

The importance of local characteristics to understand the effects of land-use and environmental regulations has been highlighted in the literature. In most OECD countries, and more generally in most developed countries, land-use policy is decentralised at least to some degree (Silva and Acheampong, 2015). There may be national guidelines, but local governments have at least some control over the regulatory toolbox offered to their residents. In a decentralised state, residents may have, through their elected representatives, a strong influence over the stringency and design of land-use regulations. Gyourko et al. (2008) elaborate on the results of an extensive survey on land-use regulations at the community level in the United States.[8] This study shows that there is large variation in the stringency of land-use regulations across the US. Empirical evidence also suggests that environmental zoning may be influenced by homeowners' special interests (Fischel, 1989; Bates and Santerre, 1994).[9]

The strictest environmental zoning (nature reserves and full conservation areas) is less likely to serve strategic goals because they generally follow national guidelines and are selected on the national level, on the basis of the importance of the ecological heritage to safeguard. Yet, most flexible and decentralised categories of protected areas, such as IUCN's categories IV, V and VI, involve high degrees of human-nature interactions and a high heterogeneity of stringency in protection measures. These three categories account for two thirds of protected areas worldwide.[10] In OECD countries, they represented 57% of total protected areas in 2004 (OECD, 2005). Despite their importance, they have received little attention in the empirical literature.

This paper estimates the effects of protected areas on urban development within regulated areas. The analyses focus on Natural Regional Parks (hereafter NRPs) in France. This environmental zoning regulation was created in the late 1960s in France and has been increasingly used in various settings to protect environmental and cultural heritage. These regional parks now cover 15% of the French territory and represent the main environmental zoning policy (in terms of total area covered) used in France. They fall in category V of IUCN classification, an environmental zoning category widespread in many OECD countries, representing more than half of total protected areas in Korea, Austria, Belgium, Czech Republic, Denmark, France, Germany, Hungary, Iceland, Luxembourg, Portugal, Slovak Republic, and Switzerland (OECD, 2005).[11] In addition to their spatial extent, NRPs are interesting because they are supported by 12-year contracts between local authorities and the government.[12] They are multi-purpose and multi-jurisdictional environmental zoning instruments. The paper first analyses the long-term effects on urban development, measured by changes in population and the housing stock. It then investigates short-term effects on housing flows and housing composition. For the latter, it focuses on the impact of NRPs on individual vs. collective housing. To this end, it uses panel data on population, housing stock and building permits at the most disaggregated administrative level in France: the municipality. The paper also investigates the effects of NRPs on urban development at a finer resolution. The results of the analyses reveal that NRPs have heterogeneous effects, which can be related to the heterogeneity of their designs.

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[8] They also synthesise this information into an index: the Wharton Residential Land Use Regulatory Index (WRLRUI).

[9] The role of homeowners in the shaping of land-use regulations has been uncovered in several empirical works (Dehring et al., 2008; Holian, 2011; Hilber and Robert-Nicoud, 2013; McGregor and Spicer, 2015)

[10] Authors' calculation based on the World Protected Areas database. Categories IV, V and VI sum up to 18.6 million km² while overall protected categorised protected areas sum up to 25.2 million km². Note that most of the protected areas notified in the database are not categorised.

[11] A description of IUCN management categories can be found at: *www.eea.europa.eu/themes/biodiversity/protected-areas/facts-and-figures/IUCN-management-categories*.

[12] Initially 10 years.

The remainder of the paper is organised as follows. Section 2 presents National Regional Parks, their importance and how they are designated. The third section describes the empirical methodology used to estimate the different effects of NRPs on urban development. The fourth section presents the data and the empirical results. The last section concludes and discusses possible implications for the design of environmental zoning policies.

2. NATURAL REGIONAL PARKS IN FRANCE

NRPs were created in France by governmental decree in 1967.[13] An NRP is a label granted by the national government to a consortium of municipalities who make such a request. Each municipality in the consortium can decide to put under classification its whole territory or just part of it. Classification by the government is granted on the basis of the importance of cultural and natural heritage in the territory, its relevance for tourism and quality of life and the need to protect it. Only territories effectively selected by the government have the right to use the label Natural Regional Park. In addition to justifying the natural and cultural interest of the territory, municipalities also have to propose a clear delimitation of the park, including planned use and objectives for each zoned area within the NRP. The label NRP is granted for 12 years. After this period, the municipalities have to make a new request for classification which is evaluated with respect to the achievement of the objectives stipulated in the previous period. The NRP convention specifies environmental protection objectives and the means and funding to achieve them and is established between the government and the municipalities. The NRP is financed by the municipalities, the government and local authorities.

NRPs are not the only environmental zoning instrument used in France. Instruments can be classified in two broad categories (Perrin-Gaillard and Duron, 2000). The first category, knowledge zoning, is intended to make the inventory of flora and fauna in designated areas. Areas where this instrument is implemented have no regulatory purpose and are exclusively designated on scientific grounds. These areas provide valuable information to local authorities about the evolution of species richness in their jurisdiction. The second category is related to intervention zoning which has an environmental regulation component. Small areas are identified regarding local nature protection issues and risks. Such areas may be concealed in local land-use planning, in accordance with local policy makers. This designates, at the municipality level, which lots could or could not be developed. On a larger scale, there is planification zoning which establishes large environmental goals over large territories (e.g. river basin schemes, etc.) decided by Regions or on the national level. Local planning tools, such as local intervention zoning, have to comply with these territorial zoning goals. Finally, there is contractual zoning, which is a non-mandatory tool, in which local authorities propose to contract with the government for the protection of a part of their territory. They encompass Natura 2000 sites, which result from the enforcement of the so called “Birds Directive” and “Habitats Directive” voted by the European Commission[14], and NRPs.

Since 1967, the number of NRPs in France and the area they cover has been steadily increasing (see also Figure 1). Not accounting for overseas territories, there are currently 49 NRPs, covering about 7 million hectares (i.e. 15% of the French national territory).[15] Every region in continental France is covered by at least one NRP (Figure 2). Currently, 4 100 municipalities out of 36 000 are engaged in an

[13] Decree 67-158 of March 1st 1967 establishing Natural Regional Parks, Journal Officiel de la République Française of March 2nd 1967, page 2131.

[14] Directive 2009/147/EC and Directive 92/43/EEC of the European Parliament and of the Council.

[15] Refer to Appendix B for an historical overview of NRPs creation in France.

NRP, covering 3.5 million inhabitants. The overall annual funding for NRPs in France is EUR135 million, an average of EUR 2.8 million per NRP. This funding is mostly provided by regional and local authorities. Regions and Departments ensure 67% of the NRPs funding, conventioned municipalities 19%, and the national government funds 18%. NRPs are heterogeneous in size. The number of municipalities can range from 3 (*Camargue* NRP) to 187 (*Ballon des Vosges* NRP). Areas covered by NRP range from 51 000 hectares (*Les Alpilles* NRP) to 189 000 hectares (*Volcans d'Auvergne* NRP). While 11 000 inhabitants live in the *Camargue* NRP, the *Loire-Anjou-Touraine* NRP is home to 200 600 inhabitants. In terms of governance, NRPs are locally managed by a syndicate or an association including local authorities and the municipalities covered by the NRP.

Each NRP is different from the other. Its objectives for 12 years are stated in the park's convention. Since 1967, all convention renewal procedures have been successful, with the exception of the *Marais Poitevin* NRP which has been rebutted, as it did not succeed in achieving objectives related to the protection of wetlands. Created in 1979, the *Marais Poitevin* NRP was declassified in 1996, and reclassified in 2014.

Each NRP convention stipulates the objectives and action plan during the 12 years of the convention. These action plans cover measures for the protection and promotion of natural and cultural heritage, the development of tourism and the control of urban development. However, NRP conventions, until very recently, provided guidelines with no regulatory power. As noted by Jegouzo (2014), NRPs were originally designed as mediation tools to develop collective territorial projects. The increase in environmental concerns through the 1970s and 80s ended up with the "Landscape Law"[16] establishing the enforceability of NRPs conventions and their priority over local regulatory zoning in 1993. Nevertheless, the existence of collective regulatory zoning[17], established by several municipalities, on a perimeter that rarely coincided with NRPs, rendered this enforceability problematic. As noted by Jegouzo (*ibid.*), an NRP convention was legally given priority over local regulatory zoning in the absence of a collective regulatory zoning only. Jegouzo (*ibid.*) notes that this point and the unclear delimitations of the enforceability of NRPs conventions created legal holes which limited the scope of NRPs as instruments to restrain urban development and organise land-use. The legislators, aware of those issues, modified the law in 2014. The 2014 "ALUR Law"[18] stipulated that collective regulatory zoning had to account for NRPs conventions, even if their perimeters where not coinciding.

Hence, and despite their original ambition, the potential impact of NRPs on urban development is ambiguous. Their lack of clear legal power may well have limited their effect on urban development. However, as mediation tools, they may also have reached some degree of restraint. Also, being locally decided, NRPs may well be very heterogeneous in both their scope and ambition.[19] The following section describes the methodology used to estimate the impacts of NRPs on urban development.

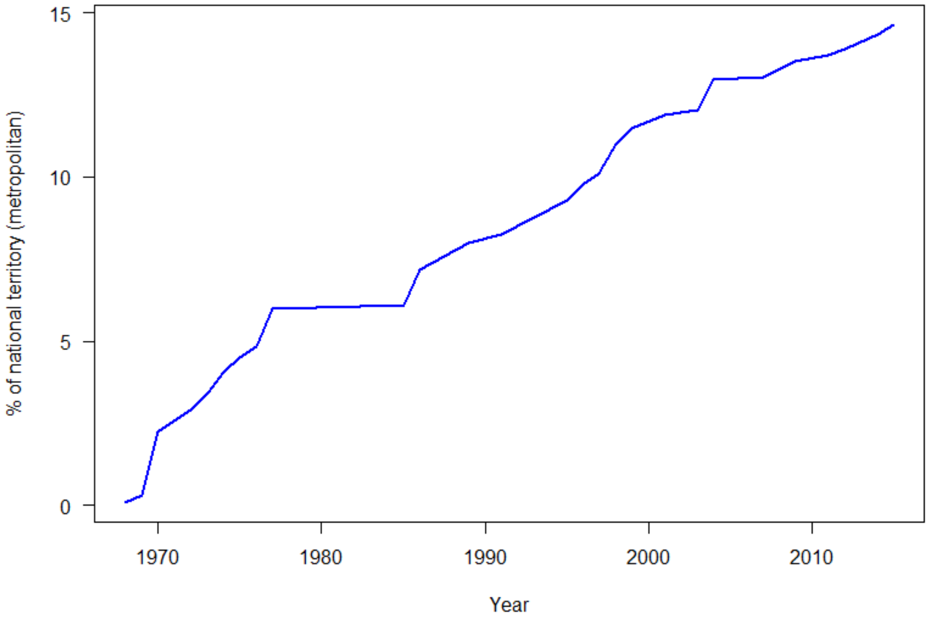
[16] Law 93-24 of January 8th 1993 on protection and valuation of landscapes.

[17] In France, each municipality establishes its local regulatory zoning (called "Plan Local d'Urbanisme", which translates to "Local Urbanism Plan") delimitating areas to be developed and areas to be set aside from development. Municipalities are encouraged to establish these regulatory zoning collectively (so called "SCoT – Schéma de Cohérence Territorial" which translates to "Territorial Coherency Schemes"). In some cases, collective regulatory zoning is mandatory (near the coast, etc.).

[18] Law 2014-366 of March 24th 2014 on accessibility to housing and renovated urbanism.

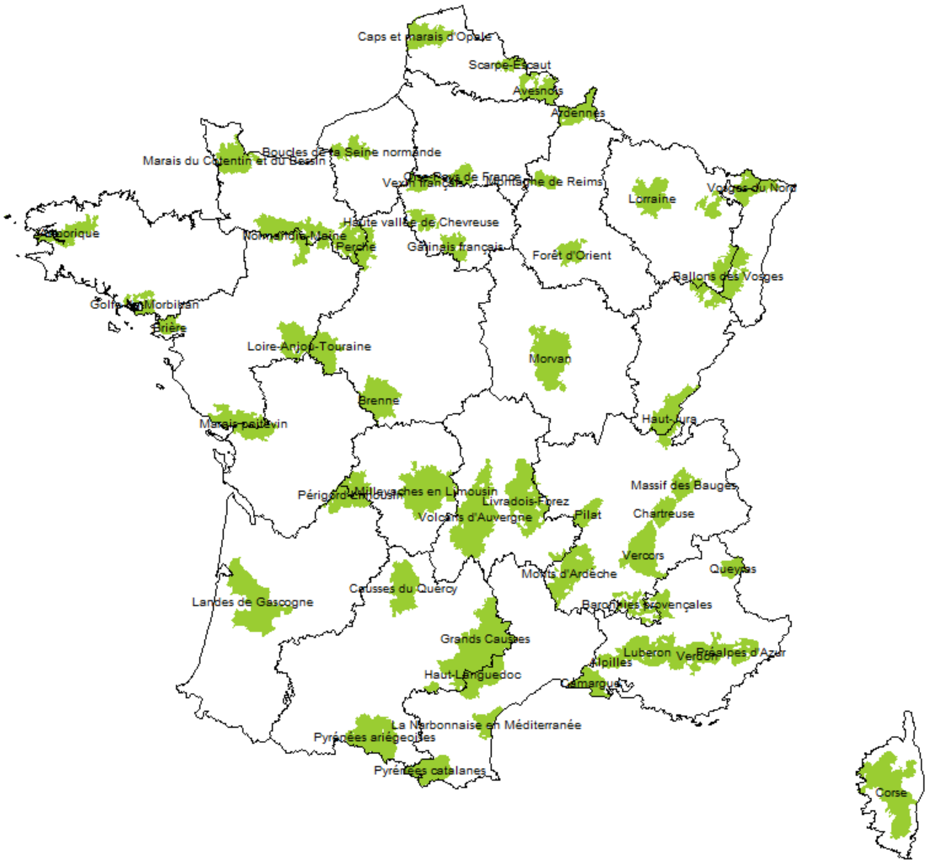
[19] Gerbaux and Paillet (2000) describe the case of the Vercors NRP and the difficulties to reach a consensus over a coordinated action of all member municipalities.

Figure 1. NRPs' share of national territory since 1967



Source: Federation of Natural Regional Parks of France data

Figure 2. Location of the 49 NRPs in metropolitan France



Source: Authors' own elaboration

Note: Municipality borders plotted using the GEOFLA® 2015 database from the National Institute for Geographic and Forestry Information

3. EMPIRICAL FRAMEWORK

To evaluate the effects of NRPs on urban development, the study uses a difference-in-differences method (for reviews see Blundell and Dias, 2002 and 2009; Ravaillon, 2007; Todd, 2007). The aim is to uncover the causal effects of NRPs on the housing stock. A major issue here is that NRPs have not been randomly assigned to municipalities. This may raise concerns about a reverse causality problem. When choosing to belong to an NRP, a municipality self-selects on the basis of unobserved costs and benefits related to the NRP, creating an endogeneity issue[20]. Municipalities inside and outside NRPs cannot be safely compared in a straightforward way. The identification strategy followed here relies on the use of fixed-effects[21] panel data models.

[20] There is endogeneity when an observed variable (here the municipalities belonging to the NRP) is not fully independent from other variables of the system.

[21] A fixed-effects model refers to a statistical model where individual effects are treated as non-random constants. It allows taking account of non-observed specificities of each individual (here the municipalities).

The set-up of the econometric model is outlined in equation [1]. Y_{it} denotes a measure of urban development (e.g. housing units) at time t in municipality i. $PARK_{it}$ is a dummy variable, taking the value 0 for municipalities outside the NRP (the control group), 0 for municipalities inside the NRP before its creation and 1 for these municipalities after its creation. Thus, the coefficient β estimates the effect of belonging to an NRP on Y_{it}. A regression of Y_{it} on $PARK_{it}$ yields biased estimates of β when the unobserved ϵ_{it} are correlated with $PARK_{it}$. Making use of the panel structure of the data allows recovering an unbiased estimate of β.

$$Y_{it} = \alpha_i + \lambda_t + \gamma \times t + \beta \times PARK_{it} + \epsilon_{it} \quad [1]$$

Equation [1] includes α_i, a municipality fixed effect controlling for the municipality fixed (i.e. time-invariant) characteristics that might affect self-selection such as the presence of fixed amenities (lake, mountains), infrastructure built before the establishment of the NRP, etc… The time fixed-effect, λ_t, captures unobserved variations in the economic environment that may affect Y_{it} for all municipalities. For example, it captures variations in interest rates, building costs or national building regulations that may affect urban development in all municipalities. Trend *t* captures any global time trend in Y_{it}.

Parameter β is of primary interest as it reveals the treatment effect of being inside an NRP under 3 identifying assumptions. The first assumption made is that fixed effects correctly capture self-selection (strict exogeneity assumption). Participation is not due to time-varying unobserved changes in municipality characteristics. This assumption is not too strong here because the process of NRP creation and validation by the government is long and the area of the NRP is delimitated well before its creation. Moreover, despite several periods of NRP renewal, the municipality composition of NRPs is remarkably stable over time with very few new entrants or leavers.

The second assumption made is that if the participating municipalities had not chosen to belong to an NRP, they would have evolved like those outside the NRP (common trend assumption). This is a more important assumption here because municipalities inside the NRP are contiguous. It is, thus, possible that there are unobserved shocks affecting particularly this group of municipalities, or those outside of the NRP. That would imply that municipalities within NRPs have different trends than those outside. This assumption can be relaxed with several periods of data like the ones used here.

The final assumption made is that of the absence of spill-over effects of NRPs on neighbouring areas. However, spill-overs may exist due to the functioning of housing markets (see also Quigley and Swoboda, 2007). Urban development may be higher in municipalities neighbouring an NRP if the NRP effectively controls urban development inside its limits and creates valuable amenities. As a result, the measure of the NRP effect (β) would be inflated by these spillovers. The interpretation of β provided later in the text accounts for this. Moreover, additional robustness tests are taken to deal with spillovers.

Equation [1] can be estimated using Ordinary Least Squares (OLS). To alleviate autocorrelation issues (Papke, 1994), the first-difference version presented in [2] can be estimated by OLS instead.

$$\Delta Y_{it} = \Delta\lambda_t + \gamma + \beta \times \Delta PARK_{it} + \Delta\epsilon_{it}, \quad [2]$$

where *Δ* denotes the difference between the value of the variable in period *t+1* and its value in period *t*, e.g. $\Delta Y_{it} = Y_{it+1} - Y_{it}$.

With several periods, it is possible to relax the common trend assumption by estimating a model with municipality-specific trends (Papke, 1994). This model is presented in equation [3]. In contrast to equation [1], the coefficient of the trend variable in equation [3] is allowed to differ between municipalities (note subscript *i* after parameter γ in equation [3]),. A closer look at equation [3] reveals that the estimation will indeed lead to individual specific linear trends $\alpha_i + \gamma_i t$. This model can also be estimated in first-difference as in equation [4] by OLS. The model with individual specific trends is formulated as follows:

$$Y_{it} = \alpha_i + \lambda_t + \gamma_i \times t + \beta \times PARK_{it} + \epsilon_{it}. \qquad [3]$$

Transforming equation [3] in first-differences, the model becomes:

$$\Delta Y_{it} = \Delta\lambda_t + \gamma_i + \beta \times \Delta PARK_{it} + \Delta\epsilon_{it}. \qquad [4]$$

Several checks of the common trend assumption in the data showed that it was violated in the majority of NRPs, as they had different Y_{it} trends before the enforcement of the NRP. [22] The estimates of β reported next are thus based on the individual specific trend model described in equation [4], unless stated otherwise. Following Bertrand et al. (2004), all reported standard errors are clustered at the observation level (*i.e.* the municipality or the cluster; see also section 4.3).

To further increase comparability between municipalities inside and outside NRPs, the analysis is limited to municipalities contained within a buffer along the frontier of each NRP. The sensitivity of results to the buffer size is tested against the use of three buffers: 5 km, 10 km and 20 km. By limiting the sample of municipalities to those directly in the vicinity of an NRP border, the likelihood that unobserved shocks may affect both groups similarly is increased. As some NRPs are adjacent, or close to each other (see Figure 2), observations falling inside the buffer of another NRP are excluded from the analysis.

4. DATA & RESULTS

The approach described above is applied to three datasets. First, census data between 1968 and 2011 on housing units, municipal population and the housing stock by type are used to estimate the long-term effects of NRPs on urban development. In continuation, the short-term effects of NRPs on housing permits are estimated using yearly data for the period 2003-2012. Finally, the impact of NRPs on the probability to convert undeveloped land plots to urban fabric is analysed using geospatial data for the period 1990-2006. Small adjustments made to the methodology presented in the preceding section to deal with these fine-scale data are described in section 4.3.

4.1. Long-term effects of NRPs on urban development

The empirical model is first applied to National Census data, whose periodicity allows the estimation of the effects of a wide range of NRPs on urban development; from the early creation of the *Armorique*

[22] Results available from the authors upon request.

NRP in 1969 to the more recent *Ardennes* NRP in 2011[23]. The INSEE (French National Institute of Statistics and Economic Studies) Census data provides the number of housing units and inhabitants at the municipality level on regular intervals over the period 1968-2011. Different types of housing units are provided in the database. Principal housing corresponds to housing occupied by a household on a regular and daily basis. Holiday housing designates both occasional occupancy and touristic use. Finally, vacant housing is defined as any type of unoccupied housing (other than touristic). Figure 3 represents the variation in the number of total housing units in each French municipality between 1975 and 2011. Housing units have mainly increased along the Atlantic coast, in the south-eastern part of France and on the edge of major French cities. NRPs seem to be characterised by a lower increase in total housing units. However, some of them are located close to dynamic areas. The first set of regressions aims at comparing municipalities within the jurisdiction of NRPs with a control group including neighbouring municipalities outside of the regulated area.

The effects of being inside an NRP are measured in terms of demographics and quantity of housing units. Table 1 reports the estimates of β from equation [4] for all 44 NRPs created between 1969 and 2011, with different buffers and for each housing type. As expected, results vary considerably across NRPs. Twelve of the 44 NRPs show no significant variation of population or housing units of any type due to the implementation of environmental zoning, meaning that demographic and urbanisation patterns have not been significantly different for municipalities within and outside the NRP. All other NRPs present significant effects following different trends. This highlights the antagonism of two distinct economic mechanisms. First, the implementation of the NRP may induce a positive effect in terms of urbanisation. This can be explained by the provision of additional environmental amenities which are valued positively by households when making their residential location choice. This amenity effect is reinforced by the expectation that the natural area will be protected in the long term; hence the natural environment will be maintained. Furthermore, the cultural aspect is not to be neglected, as households may identify themselves as part of a culturally and historically important area. Hence, the positive effect of NRPs on urban development mainly stems from increased demand for residential lots. However, this mechanism may be compensated by a negative effect of the implementation of the NRP on urbanisation patterns, due to legal constraints specified in the park's convention, specific contract agreements or unsteady protection inducing uncertainty in developers' expectations. This negative effect is often consistent with the environmental issues addressed by NRPs.

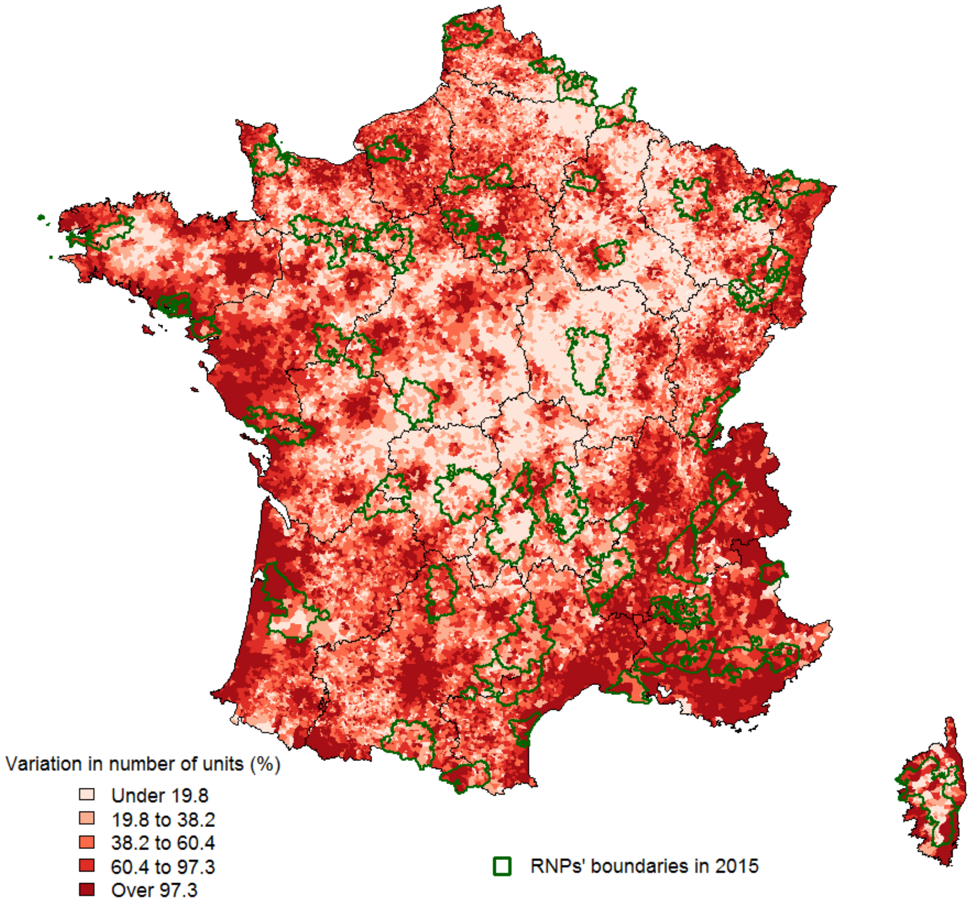
Indeed, 12 NRPs show a significant negative effect on housing units or population, implying that the implementation of the environmental zoning jurisdiction has significantly decreased the number of housing units – and sometimes inhabitants – within the area, compared to the neighbouring control group. This has particularly been the case for the *Pyrénées Ariègeoises*, *Verdon*, *Massif des Bauges* and *Lorraine* NRPs, and to a lesser extent for, *Pyrénées Catalanes*, *Forêt d'Orient*, *Loire Anjou Touraine, Landes de Gascogne* and *Boucles de la Seine Normande* NRPs.

While having a negative effect on total housing units and population, some NRPs simultaneously have a positive effect on holiday housing units. This highlights the importance of NRPs in territorial attractiveness through tourism and landscape and leisure externalities. Even though the number of principal housing units and inhabitants decreases, the number of holiday and occasional housing units is significantly higher after the implementation of the NRP. This is clearly the case for the *Monts d'Ardèche* and *Armorique* NRPs, both of them characterised by strong tourism dynamics. Note that the *Avesnois, Vosges du Nord* and *Lubéron* NRPs also exhibit a positive effect on holiday housing units, without, however, significant effects on other variables.

[23] Five of the 49 NRPs are excluded from the analysis presented here as they were either created before or after the examined period (1968-2011): *Scarpe-Escaut* (1968), *Préalpes d'Azur* (2012), *Marais Poitevin* (2014), *Golfe du Morbihan* (2014) and *Baronnies Provençales* (2015).

The territorial attractiveness induced by the implementation of the Natural Park can also go beyond the touristic aspect, and encourage households to reside within the NRP. A significant positive effect of the environmental zoning on population and/or housing units is observed for the *Alpilles*, *Périgord-Limousin*, *Haut-Jura*, *Grands-Causses* and *Causses du Quercy* NRPs. It is interesting to note that in *Vexin Français* and *Gâtinais Français* NRPs, a significant positive effect of the zoning policy on the population is accompanied by a negative effect on the number of unoccupied housing units, which may be due to the attractiveness of the area, combined with its proximity to central Paris.

Figure 3. Variation in number of housing units per municipality between 1975 and 2011



Source: Authors' elaboration using INSEE National Census data from 1975 and 2011

Note: Municipality borders plotted using the GEOFLA® 2015 database from the National Institute for Geographic and Forestry Information

Table 1. First-difference panel data estimates of population and housing units – period 1968-2011

The number of observations for each dataset is specified in Appendix D

	TOTAL HOUSING UNITS			POPULATION			HOLIDAY H. UNITS			PRINCIPAL H. UNITS			VACANT H. UNITS		
	5km	10km	20km	5km	10km	20km	5km	10km	20km	5km	10km	20km	5km	10km	20km
ALPILLES															
	-18.30	18.77	78.54	11.64	77.53	**234.14***	-2.99	-2.23	**-33.09 .**	-0.78	79.31	**148.88 .**	-16.10	-56.73	-22.39
	(85.66)	(72.47)	(58.53)	(279.73)	(193.33)	**(114.50)**	(15.08)	(10.63)	**(18.95)**	(116.54)	(125.52)	**(87.89)**	(52.15)	(63.26)	(33.49)
ARDENNES															
	24.30	21.71	10.04	42.39	**35.70 .**	23.55	**-3.53***	**-2.58***	-0.51	35.50	29.34	9.12	0.92	4.64	4.79
	(23.56)	(15.57)	(8.61)	(34.27)	**(21.16)**	(11.77)	**(1.61)**	**(1.27)**	(2.11)	(39.40)	(25.73)	(12.59)	(9.20)	(6.75)	(4.82)
PYR. ARIEGEOISES															
	-7.13 .	**-9.13****	**-9.06*****	-16.89	-12.24	-7.81	-3.73	**-6.88****	**-7.99****	-14.30	-3.08	-1.08	-3.04	0.41	-0.81
	(4.10)	**(3.25)**	**(2.71)**	(10.83)	(7.61)	(5.32)	(2.80)	**(2.67)**	**(2.54)**	(8.69)	(3.11)	(2.44)	(3.25)	(3.61)	(3.32)
PYR. CATALANES															
	-1.28	-3.47	-7.57	-19.15	-10.63	-13.24	13.19	8.29	4.03	**-9.74 .**	-5.56	-5.06	-7.09	-8.27	-8.58
	(14.61)	(12.74)	(12.00)	(16.21)	(10.46)	(8.15)	(15.79)	(14.06)	(13.26)	**(5.73)**	(4.17)	(3.64)	(10.64)	(7.57)	(6.69)
OISE PAYS DE FRANCE															
	17.16	**44.13***	61.55	92.93	87.20	**-607.32 .**	-1.41	1.89	26.94	16.14	19.67	**-144.40***	1.01	25.44	**181.65***
	(20.52)	**(21.79)**	(39.51)	(83.06)	(77.87)	**(351.46)**	(3.10)	(2.97)	(18.38)	(25.33)	(23.01)	**(67.98)**	(15.97)	(16.90)	**(79.36)**
MILLEVACHES EN LIMOUSIN	3.75	0.88	2.08	4.95	-4.37	5.84	1.10	0.73	1.11	3.54	-1.01	-0.24	-0.79	1.41	1.43
	(4.62)	(3.34)	(3.31)	(10.06)	(10.05)	(8.24)	(3.58)	(2.91)	(2.74)	(3.26)	(3.27)	(2.59)	(3.46)	(3.15)	(2.54)
NARBONNAISE EN MEDITERRANEE	-141.56	-153.43	-105.47	205.35	129.46	75.97	-195.29	-188.51	-119.95	76.40	62.40	31.66	-20.90	-25.94	-18.29
	(126.62)	(120.17)	(100.73)	(134.37)	(153.20)	(120.70)	(126.06)	(117.59)	(99.26)	(54.55)	(58.20)	(46.65)	(60.42)	(55.56)	(41.69)
MONTS D'ARDECHE															
	-4.17	**-10.07 .**	-8.45	**-19.47 .**	**-27.96***	-15.31	**8.24 .**	4.88	4.64	**-11.51***	**-12.67****	**-15.37****	-2.82	-4.11	0.71
	(6.21)	**(5.94)**	(5.41)	**(11.74)**	**(11.10)**	(10.95)	**(4.91)**	(4.82)	(3.96)	**(4.77)**	**(4.31)**	**(5.36)**	(4.68)	(4.05)	(3.97)

*Clustered standard errors at the municipality level in parenthesis. In bold: ***, ** and * denote significance at 1, 5 and 10% respectively.*

	TOTAL HOUSING UNITS			POPULATION			HOLIDAY H. UNITS			PRINCIPAL H. UNITS			VACANT H. UNITS		
	5km	10km	20km	5km	10km	20km	5km	10km	20km	5km	10km	20km	5km	10km	20km
FORET D'ORIENT															
	-17.09*	-27.33	-16.75	-23.11	-69.55	-36.70	2.46	1.11	0.26	-16.78	-29.45	-15.29	**-11.44***	**-9.99****	**-6.29****
	(10.07)	(19.18)	(11.47)	(27.95)	(58.74)	(36.67)	(2.41)	(1.51)	(1.07)	(10.88)	(22.93)	(12.83)	**(6.55)**	**(4.94)**	**(2.82)**
VOSGES DU NORD															
	6.83	6.31	3.32	9.77	5.61	-4.09	**3.29****	**3.09****	**2.76****	2.44	3.70	1.25	2.72	1.06	1.23
	(6.41)	(4.56)	(3.63)	(13.75)	(11.22)	(10.00)	**(1.35)**	**(1.22)**	**(1.22)**	(7.75)	(5.64)	(4.28)	(5.83)	(3.94)	(2.67)
VOLCANS															
D'AUVERGNE	7.06	4.11	4.22	16.72	1.00	-0.15	-15.00	-8.82	-3.21	10.97	4.44	1.66	13.19	9.45	6.54
	(20.80)	(14.52)	(9.52)	(59.30)	(38.40)	(24.19)	(11.68)	(8.96)	(6.44)	(20.99)	(13.40)	(8.58)	(11.63)	(7.91)	(5.41)
VEXIN FRANCAIS															
	-11.04	-9.81	-10.90	**178.45****	**125.86****	**104.65****	2.16	3.75	**12.27*****	8.79	8.56	25.28	**-22.26****	**-22.80*****	**-51.36*****
	(20.66)	(14.77)	(19.64)	**(84.96)**	**(57.44)**	**(50.28)**	(3.22)	(2.36)	**(3.69)**	(24.64)	(18.25)	(20.36)	**(10.14)**	**(7.50)**	**(13.47)**
VERDON															
	-1.17	-8.54	**-20.76***	**-38.53***	**-54.04****	-32.85	-0.58	3.33	-1.83	-7.16	**-20.30****	**-25.32*****	4.63	4.30	0.52
	(15.04)	(13.21)	**(12.15)**	**(19.89)**	**(21.78)**	(20.60)	(12.02)	(10.16)	(8.56)	(8.34)	**(9.21)**	**(9.41)**	(10.49)	(8.32)	(7.73)
VERCORS															
	-17.50	-6.03	9.77	-164.48	-51.97	16.91	-5.34	-6.73	-5.45	-78.74	-36.74	-5.86	66.79	37.05	23.12
	(46.00)	(33.47)	(22.01)	(206.66)	(134.82)	(87.29)	(6.94)	(6.11)	(5.14)	(85.25)	(54.69)	(32.73)	(58.11)	(34.82)	(21.17)
QUEYRAS															
	-83.24	-7.21	-31.83	44.04	64.14	39.46	-95.02	-29.84	-58.38	10.63	17.47	5.87	-2.21	8.25	26.02
	(142.05)	(72.92)	(58.08)	(44.29)	(49.84)	(45.14)	(124.92)	(63.38)	(52.67)	(12.70)	(15.05)	(13.42)	(27.71)	(21.48)	(24.30)
PILAT															
	87.15	94.38	75.77	61.58	69.70	146.29	17.92	19.64	15.98	31.55	32.61	33.91	41.70	45.46	28.79
	(111.06)	(109.49)	(117.21)	(192.62)	(182.58)	(343.89)	(13.77)	(13.30)	(13.40)	(54.62)	(52.13)	(81.02)	(52.05)	(51.62)	(55.01)
PERIGORD-LIMOUSIN															
	1.52	-10.02	-3.43	**21.29***	**21.47****	**23.33****	-6.26	0.98	-1.33	-0.32	-20.23	-9.88	**9.03****	**9.41****	**8.11****
	(6.52)	(14.49)	(8.81)	**(12.18)**	**(10.50)**	**(9.78)**	(4.63)	(6.93)	(4.83)	(4.03)	(21.71)	(11.79)	**(4.50)**	**(4.21)**	**(3.50)**

*Clustered standard errors at the municipality level in parenthesis. In bold: ***, ** and * denote significance at 1, 5 and 10% respectively.*

	TOTAL HOUSING UNITS			POPULATION			HOLIDAY H. UNITS			PRINCIPAL H. UNITS			VACANT H. UNITS		
	5km	10km	20km	5km	10km	20km	5km	10km	20km	5km	10km	20km	5km	10km	20km
PERCHE															
	1.08	2.39	**3.59***	5.28	2.08	0.36	-1.49	0.25	0.95	1.16	-0.35	-0.41	1.71	2.90	**3.29****
	(2.75)	(2.53)	**(2.17)**	(7.34)	(6.54)	(5.41)	(1.91)	(1.68)	(1.46)	(2.20)	(2.20)	(1.82)	(2.27)	(1.85)	**(1.61)**
MORVAN															
	-2.00	-4.85	-5.82	-7.34	-26.47	-27.91	-1.47	-0.71	-0.43	0.81	-3.04	-4.36	-0.80	-0.92	-1.14
	(12.16)	(9.88)	(8.65)	(32.87)	(29.99)	(25.70)	(4.33)	(3.64)	(3.41)	(10.25)	(8.63)	(7.61)	(4.35)	(3.58)	(3.07)
MONTAGNES DE REIMS															
	9.67	1.07	3.28	54.40	12.94	10.25	-6.44	-4.61	**-3.94****	20.63	5.54	5.59	6.41	4.19	4.38
	(12.50)	(9.59)	(5.54)	(80.63)	(53.93)	(26.62)	(6.22)	(3.92)	**(1.98)**	(23.93)	(15.76)	(7.91)	(4.86)	(3.65)	(3.42)
MASSIF DES BAUGES															
	-41.25*	**-31.35***	-8.01	4.02	-6.61	7.47	18.89	10.10	13.11	**-44.83****	**-30.68****	-12.93	-22.55	-14.14	**-9.63***
	(24.16)	**(16.52)**	(11.50)	(38.57)	(28.05)	(20.40)	(24.33)	(15.90)	(9.91)	**(21.05)**	**(14.35)**	(9.70)	(14.00)	(9.22)	**(5.81)**
MARAIS DU COTENTIN															
ET DU BESSIN	-4.87	-4.26	-1.41	19.22	**17.23***	**24.98*****	**-7.53***	**-6.37***	**-5.82***	2.90	0.26	4.11	0.30	2.24	1.22
	(6.10)	(4.70)	(4.50)	(15.15)	**(10.42)**	**(9.36)**	**(3.99)**	**(3.44)**	**(3.11)**	(4.95)	(3.49)	(3.46)	(2.08)	(2.08)	(1.66)
NORMANDIE-MAINE															
	-11.20	-4.59	-6.97	-51.84	-27.45	-25.56	-1.23	-1.01	**-2.17****	-18.12	-9.31	-8.01	6.07	4.36	2.11
	(9.48)	(6.72)	(8.52)	(31.62)	(21.93)	(24.43)	(1.01)	(0.88)	**(1.04)**	(11.98)	(8.26)	(8.82)	(4.23)	(3.54)	(2.95)
LOIRE-ANJOU-															
TOURAINE	-40.97	**-53.83***	**-34.13***	-40.88	-43.53	-20.65	-0.48	8.46	3.69	-34.45	-47.32	-27.39	-7.07	-17.86	-11.75
	(32.97)	**(32.62)**	**(18.95)**	(64.16)	(47.33)	(29.43)	(3.88)	(10.24)	(6.02)	(35.07)	(33.16)	(19.20)	(7.85)	(14.20)	(9.33)
LUBERON															
	14.62	13.73	2.44	-8.75	30.21	-51.14	28.86	**32.40***	22.15	-9.34	-25.12	-28.52	-9.62	3.50	5.87
	(24.99)	(28.27)	(21.87)	(77.24)	(84.16)	(74.79)	(18.77)	**(17.70)**	(14.55)	(18.47)	(42.44)	(28.47)	(21.34)	(18.14)	(14.24)
LIVRADOIS-FOREZ															
	-0.25	2.50	-4.48	0.98	39.73	18.83	-1.27	-1.10	-3.00	-0.88	10.99	6.69	1.98	-7.00	-7.82
	(6.44)	(7.11)	(5.84)	(9.79)	(46.16)	(27.42)	(2.98)	(2.49)	(2.41)	(3.52)	(12.88)	(7.88)	(5.37)	(8.68)	(6.46)

*Clustered standard errors at the municipality level in parenthesis. In bold: ***, ** and * denote significance at 1, 5 and 10% respectively.*

	TOTAL HOUSING UNITS			POPULATION			HOLIDAY H. UNITS			PRINCIPAL H. UNITS			VACANT H. UNITS		
	5km	10km	20km	5km	10km	20km	5km	10km	20km	5km	10km	20km	5km	10km	20km
LANDES DE GASCOGNE															
	-19.45	-42.41	-20.72	-122.90	**-226.27***	-64.88	4.21	15.73	14.16	-29.70	**-63.58***	-8.24	0.52	-3.84	-29.29
	(30.27)	(35.58)	(43.40)	(90.71)	**(125.07)**	(185.57)	(14.43)	(13.52)	(8.68)	(30.02)	**(37.95)**	(72.33)	(6.65)	(5.96)	(19.14)
HAUTE VALLEE DE															
LA CHEVREUSE	16.06	11.31	16.80	-24.21	13.39	-8.90	-5.19	**-10.06***	-101.37	-17.82	1.44	101.94	**25.74*****	**13.50***	22.34
	(46.08)	(30.40)	(26.13)	(161.59)	(100.59)	(120.66)	(5.19)	**(5.35)**	(77.15)	(42.90)	(27.82)	(70.17)	**(9.51)**	**(7.36)**	(15.86)
HAUT-LANGUEDOC															
	-4.53	4.88	-2.48	-55.94	-9.59	-19.90	0.14	-0.07	-3.13	-5.19	7.43	-1.27	-1.42	-2.39	0.65
	(16.82)	(10.16)	(10.94)	(55.13)	(33.25)	(28.27)	(2.82)	(2.67)	(4.23)	(15.84)	(9.87)	(12.20)	(5.37)	(4.07)	(4.42)
HAUT-JURA															
	17.17	**15.50***	**20.82****	12.16	23.83	**28.81****	9.67	9.51	**11.25****	7.52	10.64	**14.82****	1.47	-3.69	-3.90
	(10.77)	**(8.83)**	**(8.68)**	(20.73)	(14.99)	**(13.59)**	(6.85)	(5.93)	**(5.63)**	(9.33)	(6.66)	**(5.85)**	(5.99)	(5.97)	(5.74)
GRANDS CAUSSES															
	-12.71	-4.36	-0.89	-6.51	6.94	**17.82***	-8.48	-2.88	2.40	-1.78	2.79	1.04	-4.33	-4.68	-4.18
	(8.66)	(7.65)	(5.79)	(9.47)	(10.97)	**(10.80)**	(7.35)	(6.15)	(5.00)	(3.50)	(3.90)	(2.90)	(4.09)	(4.64)	(3.82)
GATINAIS FRANCAIS															
	-15.16	-12.45	-2.74	101.86	**115.80****	**144.57*****	6.35	2.84	0.01	13.98	17.70	**23.52***	**-35.55***	**-32.42****	**-29.61*****
	(17.67)	(13.10)	(13.86)	(65.95)	**(52.14)**	**(49.43)**	(5.35)	(3.87)	(2.79)	(21.96)	(17.46)	**(14.02)**	**(19.59)**	**(13.07)**	**(8.41)**
BOUCLES DE LA															
SEINE NORMANDE	**-53.65****	**-49.99***	-20.08	-125.32	-123.74	-35.75	-1.29	-2.03	-1.91	-48.81	-51.45	-21.54	-12.15	**-9.14***	-3.60
	(25.02)	**(30.17)**	(15.46)	(87.04)	(88.83)	(45.46)	(1.63)	(1.49)	(1.19)	(29.73)	(33.97)	(17.93)	(7.91)	**(5.49)**	(3.29)
BRENNE															
	2.86	8.06	5.60	**31.70****	21.50	16.51	3.41	3.25	0.81	5.22	0.78	2.29	-6.18	3.82	2.32
	(4.33)	(5.47)	(3.80)	**(13.04)**	(16.02)	(14.45)	(8.37)	(5.86)	(4.05)	(3.47)	(3.90)	(3.05)	(8.50)	(9.15)	(5.22)
BRIERE															
	175.01	156.01	151.75	430.87	437.66	453.60	38.52	26.83	19.21	118.34	109.11	115.89	18.15	20.08	16.68
	(140.41)	(137.10)	(135.89)	(429.96)	(426.47)	(424.02)	(31.36)	(23.61)	(20.96)	(134.48)	(133.18)	(132.40)	(22.67)	(21.52)	(21.19)

*Clustered standard errors at the municipality level in parenthesis. In bold: ***, ** and * denote significance at 1, 5 and 10% respectively.*

	TOTAL HOUSING UNITS			POPULATION			HOLIDAY H. UNITS			PRINCIPAL H. UNITS			VACANT H. UNITS		
	5km	10km	20km	5km	10km	20km	5km	10km	20km	5km	10km	20km	5km	10km	20km
BALLONS DES VOSGES															
	-0.85	1.89	3.53	**31.68****	**41.75****	**39.20*****	**-6.00*****	**-7.24*****	**-6.61*****	7.93	**14.15****	**12.46*****	0.50	1.15	2.81
	(6.34)	(5.94)	(4.80)	**(14.45)**	**(17.16)**	**(12.15)**	**(2.11)**	**(2.67)**	**(2.07)**	(6.03)	**(6.36)**	**(4.58)**	(3.57)	(3.75)	(3.10)
CAUSSES DU QUERCY															
	2.37	5.60	**6.20****	**16.58***	**16.96****	**20.43*****	0.37	1.83	-0.12	-3.35	-3.22	-0.33	5.47	**7.75****	**7.18*****
	(4.53)	(3.91)	**(3.16)**	**(8.74)**	**(7.08)**	**(6.51)**	(3.44)	(2.75)	(2.32)	(4.76)	(3.19)	(2.11)	(4.04)	**(3.31)**	**(2.44)**
CORSE															
	7.83	-12.37	-8.00	-3.89	-24.70	-15.76	4.49	-0.69	-0.38	2.71	-39.12	-25.42	5.05	-8.81	-9.54
	(10.51)	(28.01)	(25.87)	(20.52)	(24.68)	(23.97)	(8.78)	(11.12)	(10.65)	(17.57)	(47.95)	(41.21)	(12.93)	(16.89)	(15.65)
ARMORIQUE															
	-102.10	-64.25	-28.06	-361.19	**-298.40***	**-197.91****	**19.67****	**18.27****	**15.71***	-95.65	-65.57	-33.39	-37.97	-23.18	-12.68
	(110.53)	(61.64)	(33.51)	(308.54)	**(173.74)**	**(95.40)**	**(9.86)**	**(8.84)**	**(8.45)**	(93.30)	(51.06)	(26.76)	(32.67)	(18.09)	(9.99)
CAMARGUE															
	268.78	-173.23	-96.79	**1906.24***	-56.17	65.04	-227.47	-81.10	-78.03	**604.52****	153.95	101.70	-108.28	**-246.08****	**-122.31*****
	(363.34)	(282.73)	(123.80)	**(943.41)**	(884.19)	(406.53)	(164.92)	(87.25)	(45.14)	**(239.49)**	(217.62)	(106.55)	(120.76)	**(110.27)**	**(46.16)**
AVESNOIS															
	15.40	-5.85	-8.54	29.20	-11.44	-15.02	**3.21****	**2.51***	2.10	7.28	-18.63	-10.80	8.56	7.78	-2.28
	(10.90)	(16.71)	(10.28)	(27.66)	(39.73)	(25.36)	**(1.49)**	**(1.35)**	(1.62)	(8.01)	(24.02)	(14.31)	(9.13)	(9.61)	(7.43)
CAP ET MARAIS D'OPALE															
	-4.12	-4.43	-4.54	19.04	11.84	27.55	-15.89	-10.89	-14.99	17.07	13.62	**16.41***	-4.04	-5.65	-4.11
	(16.61)	(11.42)	(11.39)	(39.93)	(28.19)	(23.43)	(13.83)	(9.32)	(9.80)	(18.65)	(13.58)	**(9.92)**	(9.14)	(6.70)	(5.44)
LORRAINE															
	-18.13*	**-16.92****	**-17.36****	**-45.00****	-33.93	**-55.29****	0.75	-1.60	-0.53	**-32.06****	-21.67	**-28.04****	-7.38	-8.82	-4.39
	(10.80)	**(7.98)**	**(7.43)**	**(20.12)**	(34.90)	**(26.94)**	(1.47)	(1.68)	(1.10)	**(14.20)**	(17.19)	**(14.14)**	(7.00)	(6.87)	(3.73)
CHARTREUSE															
	-87.77	-58.67	-23.17	-93.62	-64.79	-23.06	21.89	6.53	6.38	-102.98	-62.01	-26.73	-10.59	-5.97	-4.42
	(58.01)	(35.84)	(21.08)	(110.48)	(73.49)	(46.28)	(17.84)	(11.57)	(13.26)	(72.32)	(44.41)	(25.30)	(7.52)	(5.43)	(6.73)

*Clustered standard errors at the municipality level in parenthesis. In bold: ***, ** and * denote significance at 1, 5 and 10% respectively.*

4.2. Short-term effects of NRPs on housing flows and housing composition

To assess the effects of NRPs on housing flows, annual data on building permits at the municipality level from the French Ministry of Housing (MLETR) are used. These data cover the period 2003-2012 and distinguish between 4 types of housing: individual houses, grouped housing, collective housing and residences. Permits for individual houses are provided to a particular household. Grouped housing refers to developments involving several individual houses raised in a given land plot. Collective housing permits concern the construction of multi-family housing, i.e. buildings with several lodgings. Finally, residences are buildings with collective services targeted to specific groups such as students, elderly people, tourists, etc.

This section provides estimates of the effects of NRPs on the number of building permits granted (in total and by type of housing) within the regulated area. These estimates are labelled "short-term" in the sense that they measure the effect of the NRP during the first years of the NRP, before any NRP renewal. By estimating separate regressions for each NRP and each housing type, it is also possible to see if, in some NRPs, the environmental zoning changes housing composition towards denser and more collective housing, as suggested by the NRP conventions. Over the time frame 2003-2012, 5 NRPs were created: *Pyrénées Catalanes* (2004), *Alpilles* (2007), *Pyrénées Ariègeoises* (2009), *Ardennes* (2010) and *Préalpes d'Azur* (2012). Table 2 reports the estimates of β from equation [4] for these NRPs,[24] for different buffers and housing types. Appendix C presents the average housing flows for municipalities inside and outside these NRPs.

First, most of the estimates are statistically insignificant indicating that NRPs generally have no effects on housing flows in total or by housing type. While the lack of any effect for the *Ardennes* and *Préalpes d'Azur* NRPs could be attributed to the fact that they were created later, this is not the case for the *Pyrénées Catalanes* NRP. However, in that case there is only one period of observation before the creation of the NRP.

[24] The estimation of model [2] (i.e. assuming common trends) leads to identical conclusions and the parameters are of very similar magnitude.

Table 2. First-difference panel data estimates of new building permits – period 2003-2012

	TOTAL			INDIVIDUAL			GROUPED			COLLECTIVE			RESIDENCES		
	5km	10km	20km	5km	10km	20km	5km	10km	20km	5km	10km	20km	5km	10km	20km
ALPILLES															
	17.400	-8.811	-0.618	3.508	4.545	2.722	-8.174	**-13.936***	-9.168	5.319	-13.753	-1.626	16.746	14.333	7.454
	(25.494)	(21.111)	(15.631)	(4.725)	(3.356)	(2.310)	(9.570)	**(8.085)**	(5.052)	(14.951)	(14.865)	(13.297)	(13.860)	(9.678)	(5.913)
ARDENNES															
	0.371	-1.081	-0.057	0.291	-0.217	-0.199	-0.559	-0.354	0.711	0.632	-0.515	-0.574	0.006	0.006	0.005
	(1.507)	(1.521)	(1.324)	(0.482)	(0.483)	(0.348)	(1.374)	(0.889)	(0.910)	(1.819)	(1.317)	(0.794)	(0.007)	(0.006)	(0.005)
PREALPES D'AZUR															
	6.002	-5.590	-3.198	-0.050	0.246	0.480	-0.830	0.568	1.920	12.932	-2.472	-3.285	-6.050	-3.932	-2.313
	(14.935)	(13.158)	(10.854)	(0.894)	(0.741)	(0.592)	(1.908)	(1.442)	(1.671)	(22.582)	(16.867)	(11.956)	(9.570)	(6.043)	(3.772)
PYR. ARIEGEOISES															
	-1.364	-1.311	-1.078	**-1.027***	**-1.165****	**-0.892*****	-0.469	-0.580	-0.058	-0.423	-0.496	-0.595	0.555	0.931	0.466
	(0.972)	(1.026)	(0.766)	**(0.562)**	**(0.456)**	**(0.321)**	(0.419)	(0.404)	(0.504)	(0.504)	(0.338)	(0.237)	(0.565)	(0.710)	(0.349)
PYR. CATALANES															
	4.115	2.408	0.065	1.200	0.654	0.353	0.669	0.702	0.116	-2.098	-2.074	-2.369	4.344	3.125	1.964
	(12.452)	(10.556)	(10.066)	(0.936)	(0.803)	(0.993)	(2.589)	(2.243)	(2.259)	(10.145)	(8.794)	(8.538)	(4.532)	(3.609)	(3.212)

Dependent variable: Number of building authorised. Clustered standard errors at the municipality level in parenthesis. In bold: significance at the 10% level. ***, ** and * denote significance at 1, 5 and 10% respectively.

The estimates for the *Alpilles* and *Pyrénées Ariégeoises* NRPs confirm this result. Neither in *Les Alpilles* nor in the *Pyrénées Ariégeoises* did the creation of the NRP affect total housing permits. In *Les Alpilles* however, the creation of the NRP appear to have slowed the development of grouped housing by roughly 10 units per year. This effect is weak though, since it is not significant when considering other buffers. The only consistent effect is found in the *Pyrénées Arièegeoises* where the creation of the NRP has slowed down the granting of housing permits by one unit per year, which represents a 50% decrease for the average municipality inside this NRP.

Overall, NRPs seem to have little measurable short-term impacts on urban development. No significant variation in housing permits inside NRPs has been found. Although all NRPs included in the analysis are engaged, through their convention, to contain and restrain urban development, neither the total supply of permits nor their composition by type of housing are consistently affected by NRPs. In particular, no shift towards denser housing (i.e. from individual and grouped housing towards more collective housing) seems to have occurred. The authors believe that potential spill-overs are limited here due to two elements. First, the time period under scrutiny (the first few years after NRPs creation) is short and the displacement of housing may be limited over that time-span. Second, parameters are consistent across the examined buffers.

4.3. Effects of NRPs on plots development [25]

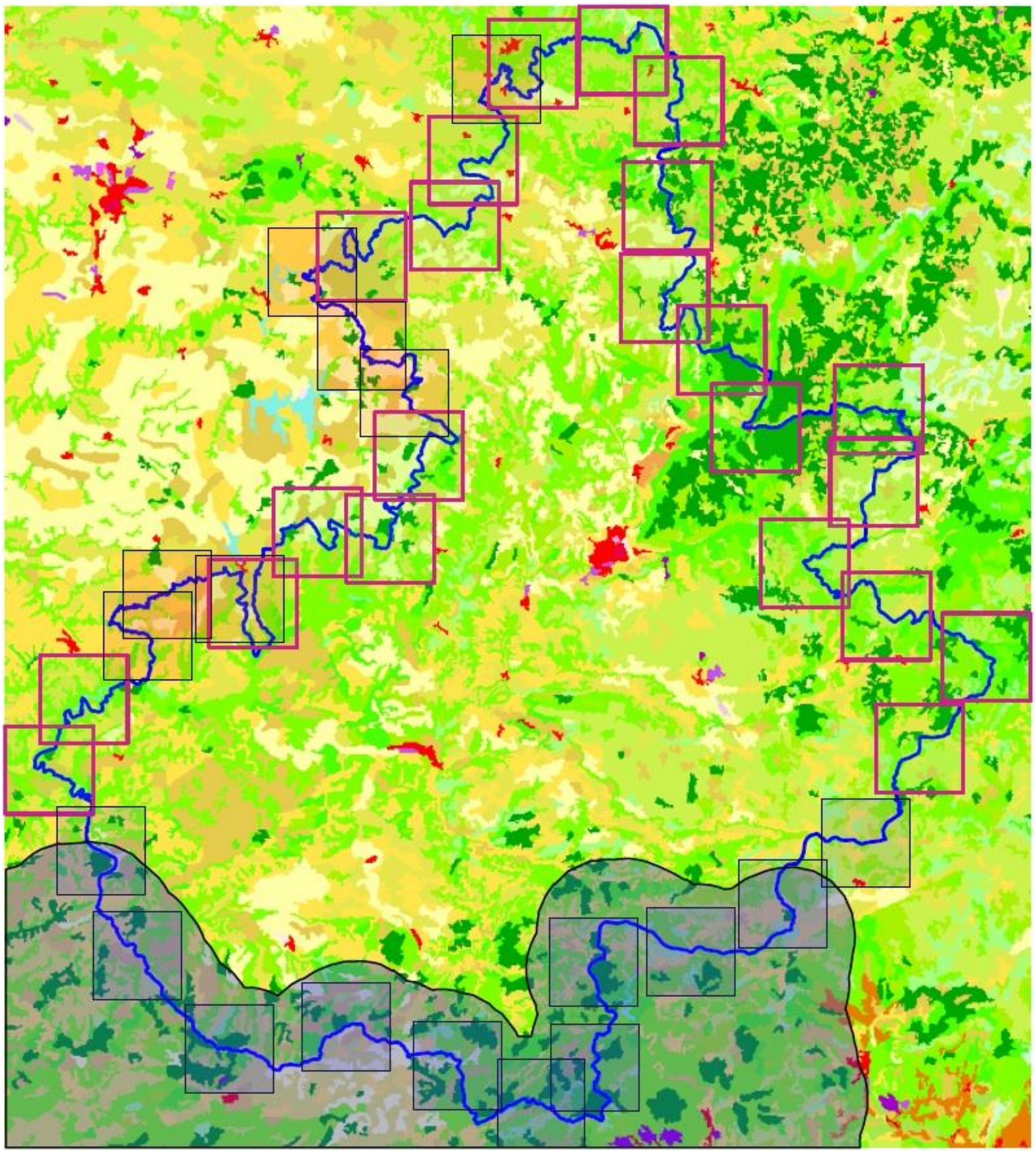
All NRPs have an objective of limiting urban development, in particular to protect agricultural activities and forestry and to avoid the development of impervious areas. In these areas, these activities contribute to natural and cultural heritage. The analyses conducted thus far are aggregated at the municipality level. The analysis presented in this section makes use of fine-resolution land-use data available in Corine Land Cover. Corine Land Cover is a European geographical information system, detailing land-use in 44 categories on a 25 m × 25 m raster with a classification precision of 5 hectares (CGDD, 2009).[26] Data are available for 1990, 2000 and 2006.

The approach used to identify the impact of NRPs on plot development is similar to the one used by Dempsey and Plantinga (2013). The authors create blocks (5 km × 5 km) around the NRP borders created between 1990 and 2006 as illustrated in Figure 4 for the *Grands Causses* NRP.

[25] Plots are not to be conceived here as cadastral land plots, but as pixels identified on the Corine Land Cover grid.

[26] Raster cells are classified in a land-use when an overall uniform land-use patch exceeds 5 hectares (see CGDD (2009) for details).

Figure 4. Blocks created along the Grands Causses NRP border



Source: Authors' elaboration based on data from the Corine Land Cover database and French Ministry of the Environment, Energy and the Sea

Notes: NRP border in blue. The squares are the sampling blocks. Thin black borders identify blocks that were not retained in the analysis. Purple border blocks constitute the sampling scheme. The shaded area is located within the 10 km buffer of another NRP (here Haut-Languedoc) and discarded from the sampling scheme.

As illustrated in Figure 4, blocks located within a 10 km buffer of any other NRP are discarded.[27] Each block is centred on the NRP border and thus contains approximately half pixels inside and half outside the NRP. For each plot i in block c and time $t \in \{1990,2000,2006\}$ Y_{ict} is a dummy taking the value of 1 if the plot is developed and the value of zero otherwise. To assess the impact of the NRP on plot development, the linear probability model[28] in equation [5] is estimated:

$$Y_{ict} = \alpha_c + \lambda_t + \theta_{ct} + \beta \times PARK_{ict} + \epsilon_{ict}, \qquad [5]$$

[27] Overlapping blocks are also discarded when the overlap exceeds 30%. Designing exactly contiguous and non-overlapping blocks has no impact on the results presented.

[28] As noted by Wooldridge (2010, p. 564), for example, the linear probability model is a good substitute to a logit or probit approach when the model is saturated (as in this case) due to its ease of interpretation.

where α_c is a block-specific fixed-effect, λ_t a time fixed-effect, θ_{ct} a block-year fixed-effect and $PARK_{ict}$ a dummy taking value 1 for plots inside the NRP at time *t* and 0 otherwise. The effect of the NRP is given by β. Variable α_c captures all block-specific and time-invariant unobservable elements affecting plots development Y_{ict} such as the proximity to a city, an industrial area or a major road. Implicitly, it is assumed that all plots within a block are affected similarly by these unobserved factors, a reasonable assumption because the blocks are of small size.[29] Time fixed-effects, λ_t, are defined as in equations [1] to [4]. Block-year fixed-effects θ_{ct} capture all time-varying unobservable factors affecting identically the plots within each block. By allowing block-specific trends, the model controls for local changes affecting plot development within each block, like for example, the creation of a new road or a commercial centre.

As in the previous models, unbiased identification of β requires several assumptions. First, the model assumes strict exogeneity. After controlling for block-specific fixed-effects, there are no unobservable factors affecting the probability of being inside or outside the NRP. The model also makes a common trend assumption at the block level. It is assumed that each plot inside the NRP would evolve like any plot outside the NRP within this block. Because within each block there are approximately[30] 40 000 plots, no plot-specific fixed-effects are added in the model. However, as in Dempsey and Plantinga (2013), plot-level controls X_i are added to the model. This specification can be formulated as follows.

$$Y_{ict} = \alpha_c + \lambda_t + \theta_{ct} + \beta \times PARK_{ict} + \boldsymbol{\delta}'\mathbf{X}_i + \epsilon_{ict}. \qquad [6]$$

Vector $\mathbf{X}_i$ contains the slope and squared slope of the plots measured from the numeric terrain model[31] provided by the French National Institute of Geography. This numeric terrain model is a 25 m × 25 m raster with altimetry precision of less than 5 m. It also contains the initial land-use in 1990 as described by the 44 categories of the Corine Land Cover nomenclature. Parameters in vector **δ** are to be estimated.Table 3 reports the estimates of β from models [5] and [6] for the 15 NRPs created between 1990 and 2006. Standard errors are clustered at the block level to control for heteroskedasticity and spatial correlation.

Amongst the 15 NRPs considered, most estimated coefficients are negative. However, they are only significant for 4 NRPs: *Vexin Français*, *Perche*, *Oise-Pays-de-France* and *Millevaches-en-Limousin*. The magnitude of the estimated coefficients is similar between the two specifications. The estimated coefficients directly read as the effect of the NRP on plots development probabilities. For *Vexin Français*, plots inside the NRP are 1.1% less probable to be developed on the observed periods than plots outside. For *Oise-Pays-de-France*, this amounts to 1.4%. For the *Millevaches-en-Limousin* and *Perche* NRPs, the effect is statistically significant, but very modest, below 0.2%. Dempsey and Plantinga (2013) find a significant negative effect of urban growth boundaries (UGBs) in Oregon in 12 out of 17 cases (cities) analysed. The magnitude of this policy instrument (i.e. UGB) on the probability of development of a plot is in the range of 2.6% to 31.2%. Considering that UGBs are directly targeted towards containing urban development, it is not surprising to see that NRPs, which are multipurpose and multijurisdictional, have significantly lower effects than UGBs.

[29] The estimations have been done with several blocks sizes (1 km and 2 km) yielding to similar results.

[30] All undevelopable plots classified as water bodies (lake, rivers, flooded areas, seas and oceans) in Corine Land Cover are excluded from the analysis. Hence, the number of plots within each block is always lower than 40 000.

[31] BD Alti (Institut National de Géographie).

Table 3. Linear probability model of plots development – period 1990-2006

NRP	Model [5]	Model [6]	NRP	Model [5]	Model [6]
Vexin	**-0.0109***	**-0.0108***	Cotentin	-0.0010	-0.0009
	(0.0064)	**(0.0064)**		(0.0014)	(0.0014)
Verdon	0.0032	0.0032	Loire	-0.0030	-0.0030
	(0.0030)	(0.0030)		(0.0032)	(0.0032)
Pyr. Catalanes	0.0008	0.0008	Gâtinais	0.0014	0.0014
	(0.0020)	(0.0020)		(0.0040)	(0.0040)
Périgord	-0.0009	-0.0009	Quercy	-0.0007	-0.0007
	(0.0014)	(0.0014)		(0.0018)	(0.0018)
Perche	**-0.0016***	**-0.0016***	Avesnois	-0.0003	-0.0003
	(0.0009)	**(0.0009)**		(0.0003)	(0.0003)
Oise	**-0.0143*****	**-0.0144*****	Ardèche	0.0004	0.0004
	(0.0068)	**(0.0066)**		(0.0007)	(0.0007)
Narbonnaise	-0.0128	-0.0128	Chartreuse	-0.0058	-0.0056
	(0.0103)	(0.0105)		(0.0069)	(0.0070)
Millevaches	**-0.0012****	**-0.0007****			
	(0.0012)	**(0.0007)**			

Dependent variable: Plot development (dummy). Clustered standard errors at the block level in parenthesis. In bold: significance at the 10% level. ***, ** and * denote significance at 1, 5 and 10% respectively.

5. DISCUSSION AND CONCLUDING REMARKS

Environmental zoning is used to protect natural and ecological heritage from different human and natural pressures. In an urbanising world, environmental zoning is more and more frequently used to limit the negative environmental impacts of urban development. However, the impacts of zoning may be complex and sometimes contradictory. First, environmental zoning that adds costs, or eventually puts limits to development, may increase the social cost of housing provision. Although this may be effective in controlling urban development, it may strongly increase prices. By protecting the environment, environmental zoning creates amenities which increase demand, attract development and push housing prices up. They may also have side-effects by contributing to urban development in neighbouring, unregulated, areas. Natural Regional Parks (NRPs) created in the late 1960s in France are particularly interesting in this regard, as they are multi-purpose and multi-jurisdictional environmental zoning instruments.

The results of the analysis reveal that NRPs have limited impacts on long-term urban development as measured by growth in housing units or population. Similarly, their short-term effects on building permits are not significant and no empirical evidence is found that NRPs would direct growth towards denser housing structure within the regulated areas. Finally, no substantial effect is found on plot development which suggests that NRPs have generally been unsuccessful in preventing the conversion of undeveloped land to urban area. Beyond the French case, it is a recurrent finding in the literature that environmental zoning and urban growth management measures have ambiguous effects. The results presented in this paper are thus in line with the findings of earlier literature.

However, the model could be improved in several ways. In its current form, the model relies on the assumption that there are no spill-over effects. The reason for making this assumption is that trying to take spill-over effects into account in this particular case, could lead to under- or over-estimated results, depending on the type of effects. As the majority of the results found in this study are statistically insignificant, the authors think that this is not a crucial assumption. It should nevertheless be checked by using a second different control group that would not have been affected by NRPs' spill-overs.

Despite the variability of results, this work raises several questions regarding the design of environmental zoning policies and the characteristics that may influence the extent of effects on urban development. First, the specificities of natural parks' conventions may vary depending on local issues, partly explaining the heterogeneity of results. The authors suspect that the semantics used in the convention play an important role when defining the goals and strategic issues of the targeted territory. The frequent co-existence of environmental protection goals and the ambition of cultural and/or touristic dynamics may send out confusing political signals. Policymakers should therefore ensure that these goals are clarified. The case of the *Marais Poitevin* NRP, which was declassified in 1996 for failing in achieving its wetlands protection goals, is certainly a relevant example, being a major French touristic site. A specific analysis of NRP conventions to classify their ambitions regarding their several dimensions would help to explain the variability in results. It would also help to identify failure and success factors in the design of these conventions.

The diversity of social, economic and environmental issues within a regulated area also raises the question of governance and respective local roles. The results of this study suggest that the more complex the territory is, the more uncertain the effects are. For instance, significant estimates of the effects of an NRP on total number of housing units seem more likely to be negative for smaller NRPs, and when only one region is involved. Furthermore, NRPs with significant effects on total housing units are also those for which at least 80% of municipalities are fully comprised in the regulated area, as opposed to partial zoning of the municipality's surface (see Appendix E for results estimates depending on NRPs' characteristics). Ensuring an efficient governance and communication between the various local stakeholders may therefore be key to higher resilience within these territories and the accomplishment of defined goals.

In terms of design, Natural Regional Parks share a lot with Marine Protected Areas (MPAs). Under the IUCN classification most of them fall within categories IV to VI. (UNEP-WCMC, 2008; Day et al., 2012) and are designed to pursue both ecological and human objectives.[32] It has been largely acknowledged that MPAs have highly heterogeneous fates. In a survey of more than 1,300 MPAs worldwide, Kelleher et al. (1995) show that less than a third of MPAs disclose achieving their management objectives. The abundant literature on MPAs and collective-action for conservation in general, especially regarding their environmental and economic efficiency, yields ideas on what should be improved in NRPs to enable them reach their goals. First, as noted by Sanchirico et al. (2002), MPAs design should mirror each policy goal with a specific tool. This proposal echoes Tinbergen's rule for macroeconomic policy (Tinbergen, 1952). For NRPs, in general, the set of objectives is rather broadly defined and the actions to be taken are not very precise. Although NRPs may lack enforcement power, defining such goals and tools should certainly bring in more coherence and help NRPs achieve their complex goals.

A wide stream of this literature emphasises the key role of institutions in the efficiency of collective action. Ostrom (2002) synthesises the institutional key factors leading to the success of self-

[32] See *www.protectplanetocean.org/collections/introduction/introbox/mpas/introduction-item.html*.

governing associations, such as MPAs or NRPs, to 7 points.[33] These points relate to: (i) well-defined boundaries, (ii) congruence (i.e. costs borne by individuals are related to their benefits), (iii) collective-choice arrangement (i.e. stakeholders can influence the rules), (iv) liability of those who monitor and enforce rules, (v) a system of graduated sanctions, (vi) a conflict-resolution mechanism and (vii) autonomy (i.e. the ability of stakeholders to design their own institutions). Ostrom (2005) underlines that the effects of the size of the protected area and the heterogeneity of appropriators on the outcomes of the protected area are unclear. There is a need to evaluate NRPs on these important elements to know how they could be improved. Evaluation guidelines have been developed for MPAs (Pomeroy et al., 2005; Leverington et al., 2008) and could probably inspire an evaluation methodology for NRPs.

Finally, the obvious spatial dimension of environmental zoning exposes it to possible conflicts with other local policies. As mentioned earlier, stated goals of a natural park may be conflictual to specific stakeholders' interests, but they may also be contradictory or at least mitigated by other policies such as local urban planning instruments or other environmental measures. In this case, NRPs for which more than half of the surface is also subject to Natura 2000 regulation, do not exhibit significant results (see Appendix E). The multiplication and superposition of environmental and land regulation measures, in addition to the natural park itself, may actually hide its benefits. In 1993, the Law on Landscape Protection established the enforceability of NRP conventions with priority over local regulatory zoning. However, as noted by Jegouzo (2014) there were a number of legal holes that perhaps made this law less effective than desired. For example, an NRP convention was not given priority over local collectively decided regulatory zoning. The legislator was well aware of those issues and tried to improve the position of NRPs as urban containment devices. In 2014, the Law for Access to Housing and a Renewed Urbanism (ALUR Law) marked a profound change. It made collective regulatory zoning mandatory and established a coherence principle which stated that they should comply with existing pertinent zoning such as NRPs. It will be interesting to measure, in the future, the impact of this change.

[33] See Table 1, p. 1331, in Ostrom (2002) for more details.

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APPENDIX A. EXCERPT FROM THE IUCN CATEGORISATION OF PROTECTED AREAS

Category	Comment
Ia: Strict Nature Reserve	Strictly protected areas set aside to protect biodiversity [. . .], where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values
Ib: Wilderness Area	Protected areas are usually large unmodified or slightly modified areas,[. . .], which are protected and managed so as to preserve their natural condition
II: National Park	Protected areas are large natural or near natural areas set aside to protect large-scale ecological processes, [. . .], which also provide a foundation for environmentally and culturally compatible, spiritual, scientific, educational, recreational, and visitor opportunities
III: Natural Monument or Feature	Protected areas are set aside to protect a specific natural monument [. . .]. They are generally quite small protected areas and often have high visitor value
IV: Habitat/Species Management Area	Protected areas aim to protect particular species or habitats and management reflects this priority. [. . .] regular, active interventions to address the requirements of particular species or to maintain habitats, but this is not a requirement of the category
V: Protected Landscape/ Seascape	Protected area where the interaction of people and nature over time has produced an area of distinct character with significant, ecological, biological, cultural and scenic value and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values
VI: Protected area with sustainable use of natural resources	Protected areas conserve ecosystems and habitats together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in a natural condition, [. . .] nature conservation is seen as one of the main aims of the area

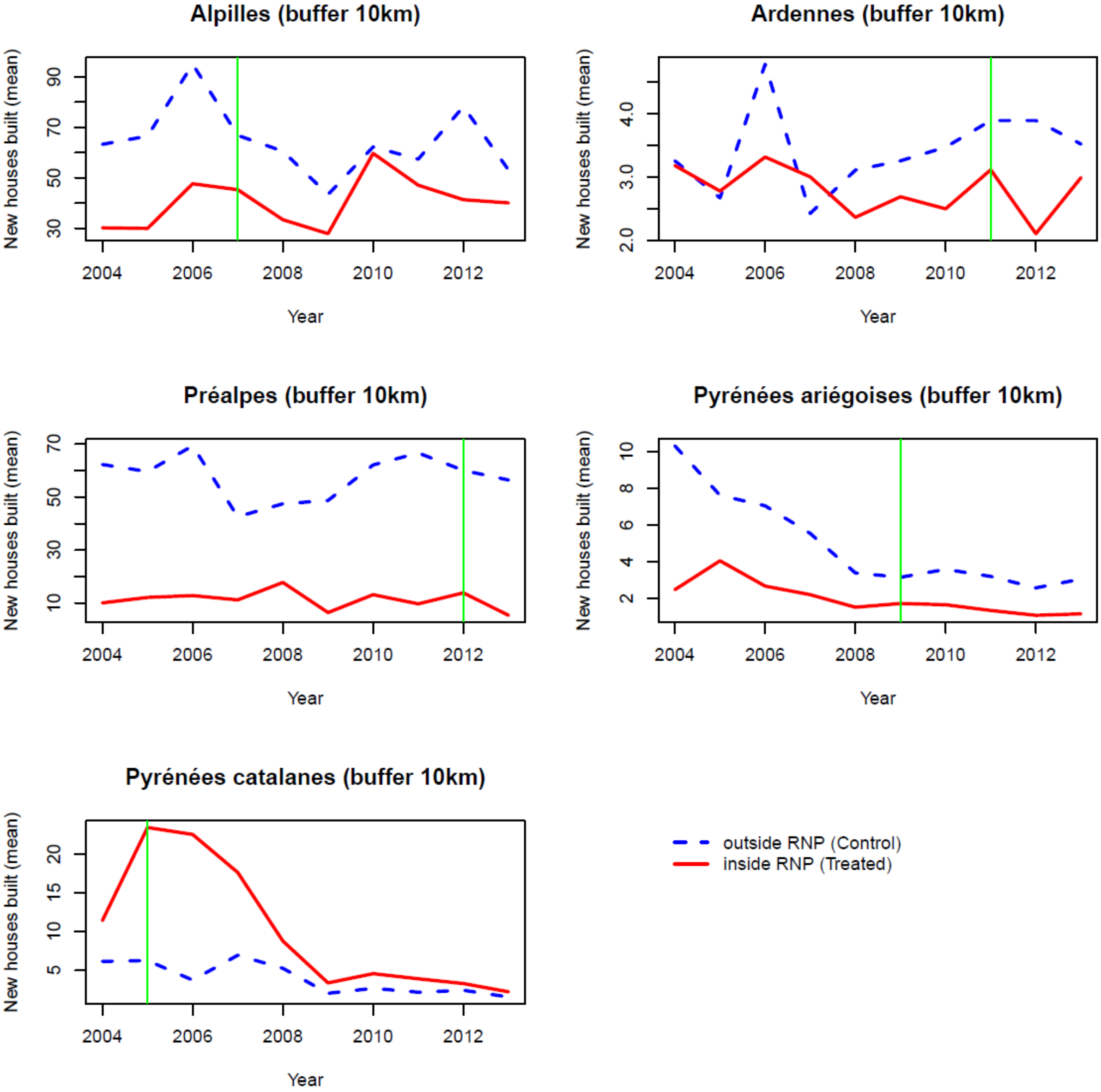
APPENDIX B. LIST OF NATURAL REGIONAL PARKS IN FRANCE

NRP	Municipalities	Area (km²)	Inhabitants	Year created
Scarpe-Escaut	55	48 500	190 000	1968
Armorique	44	126 000	65 500	1969
Brière	20	54 800	82 000	1970
Camargue	3	101 000	11 000	1970
Forêt d'Orient	57	82 000	23 400	1970
Landes de Gascogne	51	336 100	78 100	1970
Morvan	117	285 000	71 000	1970
Vercors	85	206 000	53 000	1970
Corse	145	350 500	26 700	1972
Haut-Languedoc	109	284 300	67 200	1973
Boucles de la Seine Normande	72	80 500	60 300	1974
Lorraine	183	210 000	76 000	1974
Pilat	47	70 000	50 000	1974
Normandie-Maine	164	234 000	91 000	1975
Montagne de Reims	68	53 300	34 000	1976
Vosges du Nord	111	130 000	86 000	1976
Luberon	77	185 000	171 500	1977
Queyras	10	57 400	3 000	1977
Volcans d'Auvergne	150	389 000	90 000	1977
Haute-Vallée de Chevreuse	51	63 300	115 000	1985
Caps et Marais d'Opale	154	136 500	200 000	1986
Haut-Jura	118	178 000	82 000	1986
Livradois-Forez	158	284 800	103 000	1986
Ballons des Vosges	187	264 500	238 000	1989
Brenne	51	183 000	33 800	1989
Marais du Cotentin et du Bessin	150	146 700	74 000	1991
Chartreuse	60	76 700	50 000	1995
Grands Causses	97	328 500	68 300	1995
Massif des Bauges	65	85 600	56 500	1995
Vexin français	99	71 100	98 400	1995
Loire-Anjou-Touraine	141	270 900	200 600	1996
Verdon	46	180 000	22 000	1997
Avesnois	131	125 000	131 000	1998
Perche	126	194 000	77 000	1998
Périgord-Limousin	78	185 500	50 000	1998
Causses du Quercy	102	183 000	30 000	1999
Gâtinais français	69	76 600	70 000	1999
Millevaches en Limousin	113	314 000	38 300	2000
Oise - Pays de France	59	60 000	110 000	2000
Monts d'Ardèche	145	228 000	76 650	2001

APPENDIX B. LIST OF NATURAL REGIONAL PARKS IN FRANCE (CONTINUED)

NRP	Municipalities	Area (km²)	Inhabitants	Year created
Narbonnaise en méditerrannée	21	70 000	35 000	2003
Pyrénées catalanes	66	139 500	22 700	2004
Pyrénées Ariégeoises	142	246 500	43 500	2005
Alpilles	16	51 000	68 000	2007
Préalpes d'Azur	45	89 000	31 300	2008
Golfe du Morbihan	30	64 100	110 000	2010
Marais Poitevin	93	197 300	195 000	2010
Ardennes	91	117 200	76 000	2011
Baronnies provençales	76	156 000	31 200	2015

APPENDIX C. 2003-2012 PANELS OF HOUSING FLOWS INSIDE AND OUTSIDE NRPS (10 KM BUFFER)



APPENDIX D. NUMBER OF OBSERVATIONS FOR EACH DATASET FROM NATIONAL CENSUS DATA

NRP	N obs (5 km)	N obs (10 km)	N obs (20 km)
Alpilles	43	67	129
Ardennes	118	159	272
Pyrénées ariègeoises	174	241	383
Pyrénées catalanes	73	102	159
Oise-Pays-de-France	150	244	469
Millevaches en Limousin	198	285	446
Narbonnaise en Méditerranée	55	92	177
Monts d’Ardèche	237	320	486
Forêt d’Orient	121	185	307
Vosges du Nord	141	181	263
Volcans d’Auvergne	292	428	645
Vexin français	224	324	597
Verdon	94	131	217
Vercors	165	256	419
Queyras	16	29	45
Pilat	137	205	352
Périgord-Limousin	160	238	384
Perche	219	318	527
Morvan	223	543	223
Montagnes de Reims	110	159	295
Massif des Bauges	164	229	358
Marais du Cotentin et du Bessin	207	291	413
Normandie-Maine	337	461	728
Loire-Anjou-Touraine	270	352	518
Luberon	121	165	252
Livradois-Forez	287	417	635
Landes de Gascogne	109	155	291
Haute Vallée de la Chevreuse	172	276	504
Haut-Languedoc	204	317	521
Haut-Jura	189	279	487
Grands Causses	147	210	337
Gâtinais français	168	251	446
Boucles de la Seine normande	201	303	545
Brenne	112	162	269
Brière	51	73	111
Ballons des Vosges	368	489	730
Causses du Quercy	192	274	425
Corse	88	103	114
Armorique	102	152	257
Camargue	13	28	75
Avesnois	180	242	371
Cap et Marais d’Opale	206	259	374
Lorraine	256	391	671
Chartreuse	156	224	369

APPENDIX E. FIRST-DIFFERENCE PANEL DATA ESTIMATES OF TOTAL HOUSING UNITS DEPENDING ON A SELECTION OF NRPS’ CHARACTERISTICS