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Research article

Local politics and land take: Using remote sensing data to analyse land-use changes in Sweden

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1. Introduction

Harold Lasswell famously wrote that politics is the study of who gets what, when and how (Lasswell, 1936). One of the most contested areas of local government activity, land-use policies have been described as powerful instruments to protect environmentally sensitive areas and promote open space, urban infill, transit-oriented systems and higher-density housing, all of which contribute to urban sustainability (Portney, 2013). However, land-use policies are themselves the product of local political institutions and the interactions between local actors in their institutional context. These exchanges generate winners and losers and shape landscapes in ways likely to affect the fight against climate change and the promotion of sustainable development.

Prior studies have rarely examined the influences of partisanship and political competition on land-use changes across municipalities and over time, in which the variation in the degree of political control can be modelled. Combining land-use spatial data with economic and political variables, we explore the extent to which partisanship and political competition influence the intensity of land-use changes in Swedish municipalities while controlling for local employment patterns, demographic characteristics of the municipality, and historical patterns of urbanisation intensity. This country case is investigated to ascertain the extent to which marketplaces for public goods reflect the interplay between these factors. The Swedish case contrasts with other cases analysed using a similar approach. Deslatte et al. (2022) focused on Poland, a country which underwent significant institutional changes in land uses in the post-socialist period and is characterised by a much more dynamic land-use market as a result of investments helped by EU cohesion funds and the absence of a strict land-use planning system covering the entire country. Tavares (2022) applied a similar approach to Portugal, a country where land-use changes are occurring at a fast pace, partly driven by the "sustainability paradox" generated by residential and tourism development closer to environmentally sensitive areas (Lubell et al., 2009), partly by land conversion to agricultural intensive activities, such as wine and olive production. In contrast with these two cases, Sweden exhibits a mature land-use market characterised by stable and predictable institutions, which, in theory, should be much less permeable to the biased influence of employment patterns and constituencies in decision-making processes. Thus, the Swedish case presents a *least likely case* to test the political market framework arguments, one where an unbalanced effect of pro-growth versus pro-conservation groups is less likely to occur.

Land-use conflicts in Sweden commonly relate to issues such as mining (Fjellborg et al., 2022), forestry (Ahlström et al., 2022), and the exploitation of green spaces for residential purposes in urban areas (e.g., Svenska Dagbladet, 2008-12-12). Examples of widely debated conflicts include mining activities in areas populated by Indigenous people (Persson et al., 2017) and protests against planning new apartment buildings in green surroundings to residential district suburbs (e.g., SVT, 2019-03-24).

What factors influence land-use change dynamics in Sweden? In particular, what role have governmental institutions and political actors played in changes towards more intensive land uses? We apply a political market framework to examine how land-use changes in Sweden are shaped by local partisanship and political competition on the supply side while controlling for employment patterns in a community on the demand side, demographic characteristics, and historical changes. Political markets where the ideology of decision-makers aligns with constituency preferences will experience less conflict over land-use choices and more extreme outcomes (either pro-growth or pro-conservation), whereas opposition between local officials and demand expectation patterns will display less balanced outcomes. The political market framework has been applied to the study of environmental policies (Keohane et al., 1998), land-use management decisions (Feiock

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et al., 2008; Lubell et al., 2009), and transparency of local governments (Tavares & da Cruz, 2020). Our work extends the political market framework to land-use changes in the Swedish context. The study employs remote sensing imagery to detect actual changes in land uses by comparing both across municipalities and over time.

Prior research has employed remote sensing imagery to investigate land-use/land cover changes (LUCC) at multiple levels. Xu et al. (2002) used remote sensing data to trace LUCC at the regional and local levels in the Yellow River Delta in China. They found that vegetation cover expanded and crop yields rose over a period of two decades. Overmars and Verburg (2005) studied the behavioural and structural factors affecting the choice of land-use crop types, including corn, wet rice and banana, at the watershed level in the Philippines. The authors found that slope, ethnicity, accessibility and place of birth were the primary drivers of crop choice. Liu et al. (2005) conducted a similar study in China and found that cropland loss in Eastern China was driven by a combination of factors, including "increased development to attract foreign capital and technologies, changes in industry structure, rapid urbanisation, decrease in farming net income and rapid economic growth stimulated by convenient transportation systems" (p.2231). Other studies have investigated the factors affecting LUCC but have failed to explore the potential of remote sensing data to examine changes in land use (Skog, 2018) and the role played by political actors in this process.

Our research extends these empirical studies in several ways. First, we investigate the determinants of LUCC by using an index to assess the magnitude and intensity of the changes. Second, contrary to Chanel et al. (2014), who use remote sensing to explore the determinants of farmland preservation in a single region in France, we extend the groundbreaking work by Deslatte et al. (2022) and investigate land-use dynamics in all municipalities in an entire country. Third, the use of satellite imagery allows a focus on actual policy outcomes rather than simply on the adoption or implementation of land-use policies, which is a clear advantage for linking the driving factors to their impacts. Finally, the political market framework explicitly includes political competition and partisanship as sources of supply and community economic and demographic characteristics in the local political system as factors to be considered when explaining LUCC.

The article is organised as follows. After this introduction, we present the political market as the theoretical framework of this study. The section discusses the role played by political competition, partisanship and local employment patterns in the market for developable land (Keohane et al., 1998; Lubell et al., 2005, 2009). The hypotheses derived from the framework and grounded in the literature are included in the third section. The fourth section provides the context of the study by describing the land-use management system in Sweden and shows some evidence illustrating the major land-use changes during the period under analysis (2006–2018). Next, we present the data and methods employed in the empirical analysis conducted in section six. Section seven discusses the findings and policy implications of the results and the last section concludes.

1.1. Political market framework

This research uses the political market framework to investigate the determinants of land-use changes in Sweden. The political market metaphor has been used in the public choice literature since the 1990s. In the standard account of the framework, the legislators act as brokers between opposing groups pro- or against environmental legislation, and the process generates an equilibrium outcome (a policy instrument), which may entail winners and losers, depending on how competitive this political market is (Keohane et al., 1998). The extension of this framework to land-use policies argues that local elected officials act as suppliers of land-use regulation, producing an outcome that balances the interplay between pro-development or antigrowth pressure groups (Lubell et al., 2005). These exchanges are contingent on the policy-makers' preferences and operate against an institutional backdrop likely to facilitate some interests and hinder others.

The equilibrium level in the political market is the product of the aggregate demand for developable land and the aggregate supply by local elected officials (Keohane et al., 1998). On the one hand, the level of aggregate demand is shaped by the sum of individual demands of each constituency group, their members' preferences, and the group's capacity for organising collective action. The divergence in preferences between groups over land for development purposes and the (dis)proportionate weight of each group in the overall market is likely to determine whether the equilibrium level is balanced, pro-growth or pro-conservation. Markets, where competition between constituency groups is present, are more likely to display balanced outcomes, whereas markets, where one group holds a monopoly position, will exhibit lopsided outcomes. On the other hand, the aggregate supply is the sum of each individual local decision maker's supply function. Each supply function is determined by the ideological costs, the electoral costs in terms of the constituents' preferences, and the opportunity costs of time faced by each local official. Levels of developable land approaching an individual decision maker's ideological preference and congruent with the preferences of her constituents entail lower supply costs than levels which depart from these preferences. To further complicate matters, local government systems are characterised by a diverse set of institutions, which vary between countries and sometimes even within the same country (Schaap et al., 2009). A system can be categorised as strong mayor if executive-level institutions are dominant in decision-making processes and the monitoring role played by the municipal council is negligible or strong council when the deliberative body has the primacy and the mayor holds a largely ceremonial role (Heinelt and Hlepas, 2006). Thus, depending on the prevailing local level institutions, the aggregate supply of developable land can be (primarily) a function of the combination of individual executive-level officials' supply functions or individual councillors' supply functions (Tavares, 2023).

According to the political market framework, local political institutions moderate private actors' demands and public officials' willingness to supply the desired land-use policies (Lubell et al., 2005; Feiock et al., 2008). Opposing constituencies seek to influence land-use policy decisions. However, their actions are constrained by the institutions operating at the local level that filter these political demands and provide opportunities for collective action to bring about policy changes (Clingermayer and Feiock, 2001). Because local political institutions mediate growth demands, they influence the distributive effects of development decisions for specific constituencies. Political institutions amplify or diminish development demands in part because they establish alternative decision roles for appointed and political actors in local governments (Carr, 2015). Thus, even if institutions do not have direct consequences themselves, they mediate the relationships between preferences and outcomes (Ostrom, 1986).

Research conducted in Florida by Lubell et al. (2005) and in Maine by Levesque et al. (2017) suggests that the political market model is more accurate in explaining the adoption of sustainability policies than the public choice, interest group, and institutional models implemented separately. However, a research gap still exists regarding how local political institutions affect land use in varying institutional contexts. The Swedish case provides a stark contrast to studies in the U.S. context, not only because it operates under a unitary system of political organisation that contrasts with the federal one in the U.S. but also because, unlike local governments in the U.S. Swedish municipalities operate under a common institutional and legal framework. Sweden is traditionally characterised by a consensual democracy (Erlingsson et al., 2022; Lewin, 1998) and a much less polarised political system, where corporatist institutional arrangements and negotiated solutions can serve to mitigate tensions between pro-growth and pro-conservation interests (Pontusson, 1991; Rothstein, 1988). We, therefore, expect land use to be less dependent on local political institutions in the Swedish case. These contextual features make Sweden an interesting, *least likely case* to test elements of the political market framework, one where the interplay between supply and demand is less likely to be filtered by the effect of particular locally created institutions.

1.2. Political market hypotheses

Unlike many other policy areas, which typically benefit the community as a whole, land-use decisions and regulations are likely to generate winners and losers among existing groups in each community. Earlier research applying these arguments to land-use policy recognised that institutions as rules of the game shape the incentives of elected officials to advance benefits to some groups at the expense of others (Denzau and Weingast, 1982; Clingermayer, 1993, 2004; see Tavares, 2023 for a review). However, what happens when political institutions are largely invariant across municipalities, elected officials are less constrained by institutions and political ideology, and local citizens are freer to interact and influence land-use decisions?

Veto players are political actors who have the ability to stop a change from the status quo (Tsebelis, 2002). Land-use changes towards more intensive uses represent changes to the status quo that communities, where pro-conservation preferences prevail, will attempt to avoid. Moreover, gridlock and incremental change are also more likely when the preferences regarding land-use management are highly polarised or heterogeneous because each group's attempt to promote more intensive uses will face strong opposition by other individuals with the power to block the approval of land-use changes (De Benedictis-Kessner et al., 2023).

In contrast, the absence of veto players capable of opposing pro-development employment patterns facilitates changes towards more intensive uses. Accordingly, under political majorities at the local level, land-use changes tend to reflect the ideological preferences of local officials, who are less constrained by constituency preferences and are better able to implement their vision for the community (Feiock et al., 2008; Delattre et al., 2015; Hortas-Rico and Gómez-Antonio, 2020). More importantly, if decision-makers are pro-growth and the local socio-economic circumstances also tend to favour pro-development policies, changes towards more intensive uses are more likely. Conversely, pro-development pressures will face stronger hurdles if local officials favour conservation and slow-growth values. Consistent with these ideas, Delattre et al. (2015) found that the absence of political competition in local governments in France allows elected officials to pursue policies further away from the median voter's preference. Chanel et al. (2014) analysed farmland preservation in Southeastern France and found that stronger majorities increase the ability of the municipal council to resist pressures to develop. Based on these findings, we propose.

Hypothesis 1. (H1): Land-use changes towards more intensive uses are more likely under low electoral competition.

When making policy decisions, elected officials are expected to behave consistently with their ideology and political preferences and in anticipation of reciprocal political support for providing favourable policies to selected constituency groups. All else equal, pro-development land uses are more likely to be promoted by centre-right partisan mayors than by their centre-left counterparts (Solé-Ollé and Viladecans-Marsal, 2013), who in turn tend to support their voter preferences for post-materialist values associated with environmental conservation and antigrowth policies (Chanel et al., 2014). Furthermore, a strong presence of the Green Party at the local level is likely to exacerbate pro-conservation tendencies and curb the amount of land made available for development (Coyle, 1994; Edelman, 2020). While the Green Party does not hold any mayorship in Sweden, it often lends support for coalitions with the Social Democratic party, and places demands for pro-environmental policies as a condition for supporting a Social Democratic mayor.[1] These arguments suggest the following hypotheses.

Hypothesis 2. (H2): Land-use changes towards more intensive uses are more likely in municipalities run by center-right partisan mayors than by their center-left counterparts.

Hypothesis 3. (H3): Land-use changes towards more intensive uses are less likely in municipalities with larger support for the Green Party.

Economic activity tends to be strongly dependent upon more intensive local land uses. Key actors representing the main economic interests of a community, such as construction and real estate developers, farmers, tourism firms, and mining companies, play a decisive role in land-use outcomes. Research shows that these economic activities vary across communities within and between countries (Falkowski, 2018; Deslatte et al., 2022). Empirical research in Poland indicates that a larger proportion of farmers present in local councils reduces the rate of exit of small farmers from the community (Falkowski, 2018). Similarly, Deslatte et al. (2022) find that farmer representation in Polish municipal councils weakens or nullifies the effects of more powerful mayors and likely reduces the rate of land-use changes towards more intensive uses. In Portugal, communities where tourism is an integral part of the local economy are more subject to land-use pressures by these economic interests (Deslatte et al., 2018a) and evidence suggests that wine and olive farmers heavily influence land-use choices in many communities (Tavares, 2022).

According to the political market framework, pro-conservation political parties and constituency groups can effectively stop some development from going forward because the costs resulting from bargaining, negotiation, and litigation make some projects less financially viable. Elected officials may seek to speed up or delay development approval as a mechanism to solicit campaign contributions or other forms of political support from organized interest groups (Deslatte et al., 2018). Mayors or council members may seek to slow growth in localities in which credit claiming for such activities is likely to assist in re-election, or where support for environmental interests can result in maximizing political contributions (Hawkins, 2014; Levesque et al., 2017). Green Party vote share has been associated with limits to new housing development in California (Kahn, 2011) and a 5.6 % decrease in the issuance of building permits in Bavaria, Germany (Hufschmidt, 2023). Thus, we expect the positive association between construction/real estate employment and more intensive land uses to be moderated by the vote share for the Green Party. We therefore hypothesize that.

Hypothesis 4. (H4): The interaction between construction/real estate employment patterns and support for the Green Party will result in less intensive land uses in municipalities in communities where the Green Party has more support.

The relationship between mining activities and the presence of Green Party representation in local communities is under investigation in many contexts. The approval of anti-fracking ordinances among New York Municipalities has been positively linked to Green Party vote share (Dokshin, 2016). Likewise, mining is a highly politicised issue in Sweden. Mining activities are commonly criticised due to concerns of negative environmental effects and the fact that they neglect Sami land rights (e.g. Haikola and Anshelm, 2016; Anshelm and Haikola, 2018). Among the established parties, this resistance is most prevalent in the Green Party, which takes a clear stance against all forms of mining activities in their current and previous Party manifestos. The Green Party has a history of opposing mining activities and has put pressure on its senior coalition partner, the Social Democratic Party, which is more

[1] In Sweden, there are no directly elected mayors. The equivalent is the chairman of the municipal board, who is elected by the council.

supportive of mining, to reconsider its stance on several occasions (e.g. Haikola et al., 2018; Wilson and Allard, 2023). Against this background, we anticipate that the Green Party will play a mediating role in mitigating the impact of the mining industry on local socio-ecological systems, drawing on their track record of consistently opposing both new developments and the intensification of existing mining projects, both at the national and local levels (Haikola et al., 2018; Zachrisson and Lindahl, 2019; Wilson and Allard, 2023). We therefore expect that.

Hypothesis 5. (H5): The interaction between mining employment and support for the Green Party will result in less intensive land use in mining municipalities in communities with more support.

1.3. *Contextualisation*

In the Swedish context, we expect intensive land use in municipalities where a mining industry is present. Mining resources are nonrenewable, and once extracted, they cannot be replenished, and the land where these activities take place is difficult to redeploy for other uses (Limpitlaw et al., 2005; Maczkowiack et al., 2012). Hence, mining is frequently associated with land degradation and pollution, including soil contamination due to hazardous wastes (Durden et al., 1991). However, because mining interests tend to be powerful demanders and enjoy monopoly positions in more rural communities where this type of activity occurs, they likely contribute to a faster pace in land conversion.

In the market for developable land, the most easily recognised pro-growth coalition comprises developers, land speculators, builders, real estate agents, and mortgage financiers (Pacione, 2013). These actors from the development industry are often regarded as playing an increasingly active role in the political process (Leffers, 2018; Leffers and Wekerle, 2020), motivated by reducing the costs and delays of development processes and increasing the returns on their investments (Tavares, 2023). When the development industry represents a significant share of local employment, faster land conversion tends to occur, though this may be limited by the amount of artificial land already present in the community. In communities highly dependent on construction and real estate investments for local employment, the approval times for building permits and final projects tend to decrease (Deslatte et al., 2018), and the rate of land conversion for development purposes increases (Hortas-Rico and Gómez-Antonio, 2020). However, because local governments in Sweden are not dependent on property taxes to increase their revenues, there is less of an economic incentive for local governments to convert land from rural to urban uses, contrary to what happens elsewhere (Hortas-Rico and Gómez-Antonio, 2020). This also supports the idea of Sweden as a more stringent and 'least likely case' to observe this expected positive effect between construction/real estate employment patterns and changes in land uses.

Consistent with these two sets of arguments, we control our models for the presence of the construction and mining industries. Beyond that, we also account for other 'usual suspects' in land use dynamics. Farming (Falkowski, 2018; Deslatte et al., 2022), tourism enterprises (de Bruin and Roex, 1994; Przybyła and Kulczyk-Dynowska, 2018), and forestry have all been associated with changes in land uses in other countries.

Agricultural organised interests and environmental protection supporters are often at odds with each other, so reaching a change-inducing consensus might be even more challenging (Kerselaers et al., 2013). In Europe, conflicts over LUCC have expanded beyond the traditional development versus environmental conservation divide. Some authors suggest that stakeholders are now making functional claims along the lines of an "agriculture versus nature versus urban development" triangle (Henle et al., 2008; Kerselaers et al., 2013), and others have even added a fourth major set of interests related to tourism (de Bruin and Roex, 1994; Przybyła and Kulczyk-Dynowska, 2018), confirming the complex dynamics associated with land-use development, the 'sustainability paradox' set forth by Lubell et al. (2009) on the basis on the research in the US. They argue that development tends to take place closer to environmental amenities to attract more affluent citizens. Thus, the focus on environmental conservation areas may make them more appealing for development, resulting in land conversion that degrades the resource the initial policy was intended to protect. This paradox manifests not only in new housing for the wealthy but also in the expansion of the tourism industry (Wang and Liu, 2013; Hjalager, 2020).

Forestry is the economic activity concerned with creating, managing, planting, using, conserving and repairing forests and woodlands (Society of American Foresters, 2008). The sustainable use of forests requires management practices that prevent the degradation of the resource in order to guarantee sustainable economic returns. Thus, professional foresters wishing to secure these returns will oppose land conversion to more intensive uses, including agriculture, tourism and urbanisation. Given the dependence of these employment patterns that Swedish communities tend to experience, the analysis conducted below accounts for these dynamics by including a set of controls for the variation of these employment patterns across localities.

The assignment of spatial planning to the local level of government is a key assumption in this research. The degree of local government's power to influence land uses varies across countries, but when this function is delegated to the local level, it means that decision-making regarding the long-term physical development of the municipality rests primarily or exclusively with the local government. Formally, in Sweden, the municipalities possess a "planning monopoly", which means they have the power to plan what, where and when should be built while respecting the national legal frameworks (Koglin and Petersson, 2017).

The Swedish spatial planning system consists of three levels: national, regional (21 regions) and local (290 municipalities). The national government is responsible for the legislative framework that defines the system of land-use planning and provides the guidelines that municipalities and counties have to follow when designing their plans. The national level has two main policy instruments – the Planning and Building Act and the Environmental Code – to affect the decisions of regional and local authorities. The Planning and Building Act regulates the planning process and coordinates regional and local activities. The Act was introduced in 1987, and it was the most important reform in the past decades. When that Act was approved, the responsibility for land-use planning was transferred to the municipalities. All local policies regarding land uses or buildings contained in municipal urban plans have to follow the regulations defined by The Planning and Building Act (Pahl-Weber et al., 2009). The Environmental Code constitutes an 'umbrella' for the Planning and Building Act as well as for other special laws. The main aim of the Environmental Code is to promote sustainable development. It protects the land of special importance for land-use planning and contains planning guidelines for certain large geographical areas, including parts of the Swedish coastline and the mountains (Pahl-Weber et al., 2009).

The Swedish planning system awards substantial power over land-use planning to the local level. Municipalities are responsible for land and water management planning (Ruotsalainen, 2004) and involve different sectors during the urban planning process, including housing, streets, water, energy, and schools (Pahl-Weber et al., 2009). Swedish municipalities have three main responsibilities related to the use of land. First, they are responsible for local planning, preparing Comprehensive Plans and Detailed Plans, and issuing building permits based on those plans and other essential regulations. Second, they are responsible for the provision of housing through public housing companies, which provide a significant share of all rental accommodation in Sweden. Lastly, they provide the technical infrastructure that is required to develop land, such as roads and water and sewage disposal networks (OECD, 2017).

Municipalities are in charge of the instruments for land-use planning: comprehensive municipal plans and detailed development plans. No land use change can occur if it is not based on a municipal plan. Individual owners cannot build on their land unless the building development aligns with the municipal plans. Furthermore, many municipalities have substantial land holdings. This gives them an important tool to shape land use in their territories (OECD, 2017).

Comprehensive municipal plans are mandatory, cover the entire municipality, and contain the basic principles that affect decisions about the use of land and water areas. While the plans are legally required, they do not contain any legally binding provisions for landowners. Instead, they include strategic objectives for the development of municipalities and, consequently, constitute the primary tool for strategic planning. Detailed Development Plans are binding and cover only part of the municipality. They are the statutory instruments that regulate land use at the municipal level. They establish the duties and rights of private owners. These are protected during an implementation period that can vary between 5 and 15 years (OECD, 2017).

Citizens are engaged in preparing local planning instruments and participating in the decision-making process. The municipalities follow detailed rules on public participation, giving citizens opportunities to comment on the plans, both at the draft stage and on the final proposal, which lasts between four and ten weeks. This is followed by a public hearing where objections and comments in support are discussed (Koglin and Pettersson, 2017).

Traditionally, land-use policy was a Social Democratic Party issue in Sweden. The Party has been pro-working class and welfare state but also very accommodating regarding industrial development and job opportunities. These policies are still strong in some municipalities run by the Social Democrats, but things have changed with the entry and increased influence of the Green Party during the last decades. The Social Democrats are now often in coalition with the Green Party and have been forced to promote more pro-environmental policies as a compromise, especially at the national level. These have sometimes led to tensions between the national and municipal levels within the Social Democratic Party. Thus, centre-left coalitions tend to be more pro-development locally when the Green Party has low support but not otherwise.

The empirical analysis below reflects these and other tendencies in attempting to identify the factors influencing land changes towards more intensive uses in Swedish municipalities.

1.4. Data and methods

The following analysis concentrates on land-use changes in Swedish municipalities in the period 2012–2018. We include changes in the period 2006–2012 as a lagged explanatory variable. The dataset comprises data for the dependent variable tracking land-use changes and sociodemographic, political and environmental data for each municipality. Spatial data on land-use changes were obtained from the CORINE Land Cover (CLC) database and calculated for administrative units based on border shapes data defined with *ArcGIS v 10.3 advanced* to generate the proportion of particular land-use changes in each municipality. According to metadata of the CLC database, land characteristics are delineated and classified on satellite images with better than 100 m positional accuracy and with 5 ha (ha) minimum mapping unit into the standardised Land Cover nomenclature (see appendix A for details on CLC categories). 5 ha is the standard resolution provided by the CLC database, and it has been used frequently in previous research (Cieślak et al., 2017; Leśniewiska-Napierała et al., 2019; Iváncsics and Kovács, 2021). Hence, this operationalisation ensures that our results are comparable with prior studies. A more substantial reason to use this resolution is that it maintains a balance between relatively high resolution while excluding marginal changes (for instance, based on minor border adjustments) that would create unnecessary noise in our dependent variable.

For comparison purposes, the smallest municipality in Sweden (Sundbyberg municipality) has an area of 877 ha, and the median area of Swedish municipalities is 73,300 ha. Thus, the size of the changes featured in the CLC database is small and detailed enough to accurately measure land-use changes in Swedish municipalities for the purposes of our analyses.

1.4.1. Dependent variable

The dependent variable is a Land Use Change Index (LUCI) for each municipality, which is the size of the area with changed land use towards more intensive use in the years 2012–2018 related to the total size of the municipality (i.e., m^2 changed per km^2). The LUCI was computed as follows.

a) a change towards a more intensive use was identified if an area's land use has changed from any class towards one of the classes on an upper level of classification: for example, from agricultural areas to artificial surfaces (1 class up) or from forests and semi-natural areas to artificial surfaces (2 classes up). The analysis does not consider how much higher in the classification the area is assigned after the change, but only that the change is towards a more intensive use;
b) the size of the total changed area within the municipality is the sum of the changed fragments;
c) each observation of the dependent variable is the ratio between the area changed towards more intensive uses and the municipality's total area.

Our choice to focus only on more intensive land uses is consistent with the operationalisation in previous research (e.g. Deslatte et al., 2022) and motivated by the fact that a vast majority of land-use changes are towards more intensive uses (see Appendix B). In the Swedish case, more intensive uses account for 79 per cent of all changes during the period 2012–2018. Hence, cases of less intensive use are of much smaller significance. Moreover, excluding cases of less intensive uses has the upside of avoiding potential discontinuity problems and ambiguous estimations. Changes towards more and less intensive land uses are arguably based on very different political and institutional logic. Interpretations of model estimations with a dependent variable that accounts for both more and less intensive land uses would, therefore, be less clear in comparison to estimations that consider one type of change at a time.

Figs. 1 and 2 display the spatial distribution of the LUCI in two periods, 2012–2018 and 2006–2012, respectively. Darker colours indicate municipalities that have experienced more intensive land-use changes. Two major patterns emerge: more intensive land uses appear in the southern part of the country, in and around the largest cities in Sweden, and in the northeast part of the country. In general, these changes have resulted from the conversion of forests and semi-natural areas into artificial surfaces and, in particular, from forests (code 3.1 in CORINE Land Cover classification) to mine, dump and construction sites (code 1.3 in CLC). A full description of these changes is included in Appendix B, along with all CLC codes in Appendix A.

1.4.2. Independent variables

The key theoretical variables used to test the hypotheses are derived from the political market framework and include political variables (supply side) and interaction between chosen supply side and contextual (demand side) variables. Table 1A presents variable descriptions and sources, whereas Table 2A depicts the descriptive statistics for all variables included in the empirical analysis. Both tables are included in Appendix C.

First, we include a number of variables related to the supply-side of the political market. In order to assess H1, which predicts more intensive land uses in municipalities are associated with low electoral competition, we employ the margin of victory in each election measured as the difference in percentage points between the first-place party/coalition and the second-place party/coalition in the 2014 municipal election. H2 is tested using a set of three dichotomous variables under the heading

[2] The models were estimated in Stata using the spregress command.

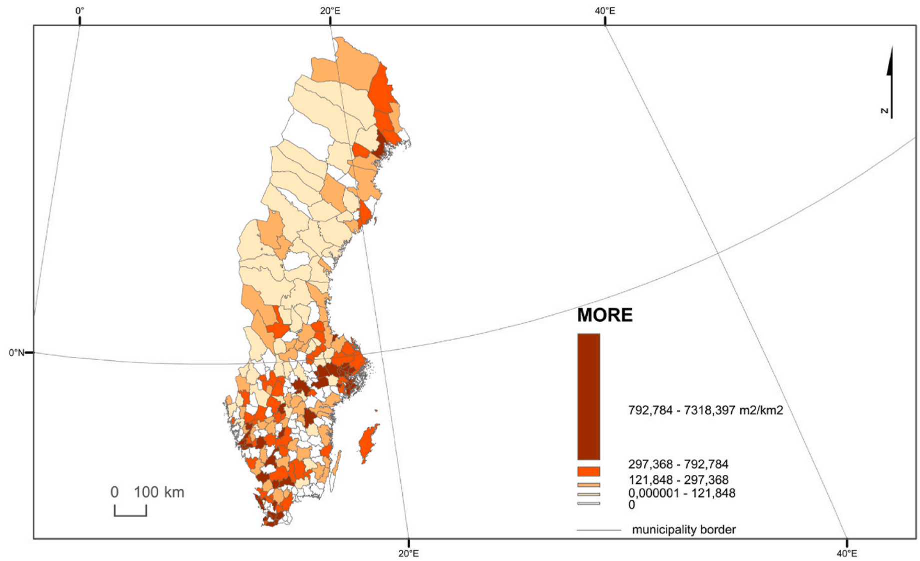

Fig. 1. Spatial distribution of L land use change index 2012–2018 (with municipal borders) in Sweden. Map made by Izabela Karsznia.

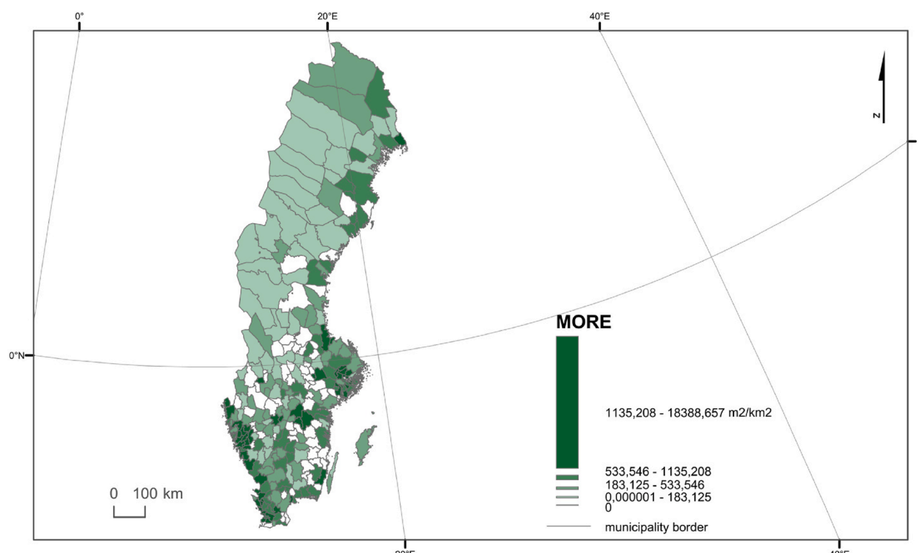

Fig. 2. Spatial distribution of land use change index 2006–2012 (with municipal borders) in Sweden. Map made by Izabela Karsznia.

'ruling coalition' that assess whether the political orientation of the ruling coalition at the municipal level affects land-use policies. Each dichotomous variable identifies left coalitions, bloc exceeding coalitions and other coalitions. Right coalitions are the omitted (base) category. H3 concerns the strength of Green Party representation in the political system. This hypothesis is tested by examining the share of valid votes cast for the Green Party in the 2014 municipal election. A negative coefficient is expected, indicating that support for the Green Party is associated with lower land-use changes towards more intensive uses.

Second, two variables capture the dominant employment patterns in Swedish municipalities in relation to local politics and land use changes. The presence of construction and real estate employment is proxied by taking the combined sum of the share of the population (aged 16+) employed by the construction industry and the real estate industry in 2012. The variable is used to assess H4 regarding the influence of construction activities and its interaction with environmental partisanship on the intensity of land uses in Swedish municipalities. The presence of the mining industry is measured by a dichotomous variable, taking the value 1 for municipalities with commercial activities related to the mining industry during 2012–2018. This variable is employed to assess H5 regarding the influence that an active mining industry has on land-use in Swedish municipalities while interacting with environmental partisanship.

In addition to the main independent variables described above, we include several control variables. The presence of the forest industry is proxied by the proportion of area occupied by forest in the municipality. Employment in the local tourist industry is measured by the share of the population (aged 16+) employed by hotels and restaurants in 2012. The average value in Swedish crowns (SEK/hectare) of productive forest value is included as a control for the opportunity costs of land conversion. Higher productive forest value is a proxy for forest scarcity, thus indicating that unexploited land is scarce and the demand for land that can be converted to more intensive use is high. Efforts to stop or slow growth sometimes pit high and low socioeconomic status (SES) populations against each other. The negative association between low SES minority populations and growth management is not new in the literature (Pendall, 2000; Lubell et al., 2005). In addition, Levesque et al. (2017) employ income as a proxy for administrative capacity, suggesting that communities with higher SES are also more likely to engage in land-use regulation to prevent development. Based on these arguments regarding the SES of municipalities, we expect that jurisdictions with higher per capita personal income will be less supportive of pro-development decisions. We also control for population size and population density. Urban and densely populated municipalities are expected to experience a higher demand for new residential areas. However, the relative changes in land-use exploitation may also be minor in urban municipalities since those municipalities may face scarcity of unexploited land. Lastly, values of the LUCI for the previous period (2006–2012) are included.

1.4.3. Empirical model

Previous research has uncovered the presence of spillover effects with regard to land use changes (e.g. Deslatte et al., 2022). If the intensity of land use increases in a given municipality, it is also likely to increase in its neighboring municipalities. The reason for this is that growth dynamics such as urbanization and population growth are a regional rather than a local phenomenon. If land use pressure is high in a given location, it will also increase the attractiveness of other areas at commuting distance.

To account for potential spillover effects, our analysis employs spatial models to address spatial and temporal dependence across municipalities and over time.[2] To test the validity of a spatial setup we first estimated a simple OLS model, including the dependent variable and all the independent variables.[3] Based on this result, we ran a Moran test to assess whether spatial dependence is present in the data. The results of the test show a statistically significant value indicating spatial dependence and suggesting that a spatial error model should be used to correct for spatial dependence (Anselin, 2005). We use the first order contiguity matrix to address spatial dependence on land-use changes in neighboring municipalities. This setup assumes that spatial lags only exist between municipalities that share borders.

Choosing the most adequate spatial setup is far from straightforward and, analytically, it is challenging to make distinctions between different types of spatial dependence. Our strategy is therefore to present results from different types of models to ensure that our results are not driven by model selection. Hence, we estimate and present results from both Spatial Error Models (SEM) and Spatial Durbin Error Models (SDEM).

The SEM model captures spatial dependence by incorporating a spatially structured error term (see Rüttenauer, 2022). This means that any unobserved factors affecting the dependent variable in one municipality are assumed to be spatially correlated with those in neighboring municipalities. Mathematically, this is modelled through a spatial autoregressive process applied to the error term, typically represented as:

$$y = X\beta + \varepsilon \quad (1)$$

$$\varepsilon = \lambda W\varepsilon + u \quad (2)$$

In this formula, y represents the dependent variable. X is the matrix of independent variables, and β is the vector of coefficients. ϵ denotes the spatially autocorrelated error term, while W is the spatial weights matrix. λ is the spatial autoregressive parameter, and u represents the independent error term.

The SDEM model extends the SEM framework by allowing spatial dependence to affect both the independent variables and the error term (see Rüttenauer, 2022). This means that changes in an independent variable in one municipality may influence the dependent variable in its neighboring municipalities. The SDEM specification introduces spatial lags for the independent variables, expressed as:

$$Y = X\beta + WX\theta + \epsilon \quad (3)$$

$$\epsilon = \lambda W\epsilon + u \quad (4)$$

In this formula, y is the dependent variable. X represents the matrix of independent variables, and β is the vector of coefficients. WX refers to the spatially lagged independent variables, and θ captures their coefficients. ϵ is the spatially autocorrelated error term, while W denotes the spatial weights matrix. λ is the spatial autoregressive parameter, and u is the independent error term.

As shown in the next section, the main results from these specifications were essentially the same. Thus, our results are consistent over different model assumptions. In addition, we conducted Wald *a posteriori* tests comparing OLS to the spatial models SEM and SDEM. The Wald tests values were significant, demonstrating added value of the spatial models.

1.5. Findings

Results from the spatial error models are presented in Table 1. Model 1 is an SEM without any interaction term between the independent variables and includes spatial lags of the dependent variable and the error term. The spatial lag is significant for the dependent variable but

Table 1
Results for spatial error models.

	Model 1	Model 2	Model 3
	No interaction	Construction interaction	Mining interaction
Margin of victory 2014	−0.008*** (0.003)	−0.007*** (0.003)	−0.007*** (0.003)
Left coalition	0.146** (0.063)	0.127** (0.063)	0.137** (0.062)
Bloc exceding coalition	0.066 (0.055)	0.063 (0.054)	0.066 (0.054)
Other coalition	−0.072 (0.365)	−0.058 (0.362)	−0.072 (0.357)
Vote share Green Party	−0.020* (0.011)	0.069* (0.036)	−0.011 (0.011)
Mining	0.876*** (0.104)	0.872*** (0.103)	1.470*** (0.199)
Vote share Green Party X Mining	–	–	−0.111*** (0.032)
Construction	−0.941 (1.033)	3.830* (2.083)	−0.972 (1.012)
Vote share Green Party X Construction	–	−0.902**	–
(ln) Productive forest value	−0.134*** (0.050)	−0.121** (0.049)	−0.133*** (0.049)
Forest	−0.142 (0.098)	−0.114 (0.098)	−0.122 (0.096)
Hotels	1.606 (1.785)	1.755 (1.765)	1.183 (1.753)
(ln) Population size	0.156*** (0.032)	0.148*** (0.031)	0.163*** (0.031)
Population density	−0.0001 (0.00005)	0.00015*** (0.00005)	−0.0001 (0.00005)
Mean income	0.030 (0 0.089)	0.037 (0.088)	0.007 (0.088)
Land Use Change Index 2006–2012	0.127*** (0.028)	0.117*** (0.028)	0.124*** (0.027)
Constant	0.159 (0.627)	−0.385 (0.652)	0.086 (0.615)
Spatial lag dependent variable	0.607*** (0.111)	0.629*** (0.108)	0.586*** (0.108)
Spatial lag error term	−0.268 (0.186)	−0.318* (0.177)	−0.269 (0.183)
Observations	290	290	290
Nagelkerke pseudo-R-squared	0.553	0.467	0.574
Wald Test (df = 1)	32.08***	35.00***	31.10 ***

Notes: Unstandardized coefficients; clustered standard errors within parentheses. Significance: *p < 0.10; **p < 0.05; ***p < 0.01.

[3] We performed a variance inflation factor (VIF) test on the OLS model to ensure that our results were not influenced by multicollinearity. All VIF values were below the commonly accepted threshold of 10. Hence, our results are not affected by multicollinearity.

non-significant for the error term, as shown by the coefficients at the bottom of the column. Model 1 indicates that land use is highly path-dependent. The coefficient for the lagged dependent variable (LUCI, 2006–2012) is positive and highly significant, suggesting that municipalities with more intensive land-use changes in the previous period (2006–2012) display a similar tendency in the current period (2012–2018). Moreover, municipalities with a larger population also tend to experience more intense land-use changes.

The results also reveal that land use in Sweden depends on political factors. Against the expectations expressed in H1, the pressure for intense land use seems to be lower in municipalities where the margin of victory in local elections is higher since the coefficient for 'Margin of victory 2014' is negative and significant. These findings suggest that lower competition leads to less intensive land-use changes and that land-use politics in Sweden is inherently different from other countries where this hypothesis was tested previously (see Solé-Ollé and Viladecans-Marsal, 2012 for Spain and Deslatte et al., 2022 for Poland). In contrast with other countries, most local governments in Sweden are run by coalition governments, making accountability more diffuse but, at the same time, requiring more consensual decision-making. Thus, while appearing more competitive when assessed by the margin of victory, this system based on consensual democracy is actually more likely to accommodate economic activities that entail more intensive land uses. In addition, contrary to Spain and Poland, where land-use markets are highly dynamic, either due to construction and real estate booms and/or to regulatory uncertainty, in Sweden, a stable regulatory framework, which combined with the lessons from the 1990s property crash, may contribute to reduced development pressures.[4]

Model 1 also examines the effect of the political variables. The coefficient for the Green Party is negative and weakly significant at the 10 per cent level, providing weak support to H3. In addition, land use is significantly higher in municipalities ruled by a left coalition compared to a right coalition (the reference category). These results contradict H2 and may seem surprising at first, given that left coalitions in Sweden often include the Green Party, profiled on environmental protectionism and in opposition to major exploitation of natural resources. However, the result is understandable given that the Social Democratic Party, which is the leading party in almost all such coalitions, often takes a positive view of mining as a means for achieving rural development and creating industrial jobs (Zachrisson and Lindahl, 2019; Wilson and Allard, 2023). For instance, towards the end of 2021, the Social Democratic minister of Enterprise and Innovation claimed that his party "loves mines" and "hope to open new mines and give approval to several more mines" (Aftonbladet, 2021).

The coefficient for construction is negative and fails to reach statistical significance, not surprisingly, given the mining industry's role in Sweden, mining explains a lot of the variation in land-use changes. None of the remaining control variables that serve as proxies for employment patterns (forest and tourism) display statistically significant coefficients.[5]

Model 2 in Table 1 presents results for the SEM with an additional interaction term between the election support for the Green Party and the share of the local population employed in construction and real estate. The coefficient for this interaction is negative and significant. Moreover, the sign of the effect goes in line with H4 as well as our theoretical expectations; the pressure from the development industry on land exploitation seems to decrease when the Green Party has a higher vote share in the municipality. However, a look at Fig. 3, which illustrates the interaction effect between these two variables for the values of

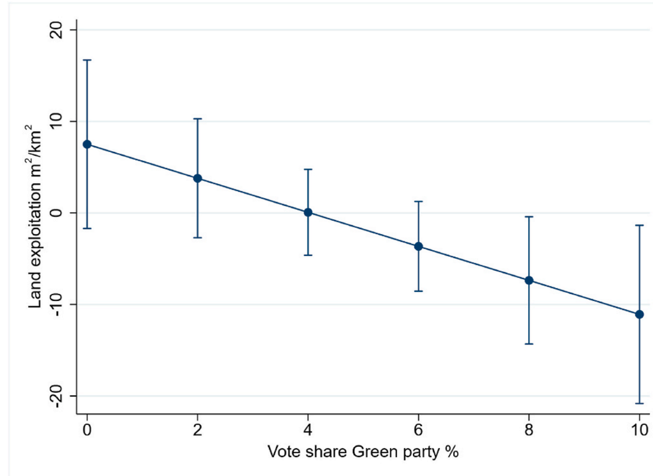

Fig. 3. Marginal effect of share of population employed in the construction industry on land exploitation expressed as m^2/km^2 for various levels of support for the Green Party. The estimation of marginal effects is based on Model 2 in Table 1.

the Green Party commonly found in our dataset (0–10), reveals that this conclusion is premature. Despite a clear interaction effect, the marginal effect of employment in construction on land use is non-significant when the vote share for the Green Party is within the most common interval 0–6. Moreover, the effect is only slightly significant for the interval 8–10. We can thus conclude that the statistical significance of the interaction term between the Green Party and Construction is irrelevant, given that it is insignificant for most of the relevant range of the interacting variable.

Model 3 in Table 1 presents results for the SEM with an interaction term between the election support for the Green Party and the presence of the mining industry in the municipality. The interaction between municipalities with the mining industry and support for the Green Party reveals that the presence of the Green Party in the local council moderates more intensive land uses that are generally associated with mining. The coefficient for this interaction is negative and highly significant. The strength of this relationship is illustrated in Fig. 4. The figure shows the predicted land exploitation at different levels of green vote share for

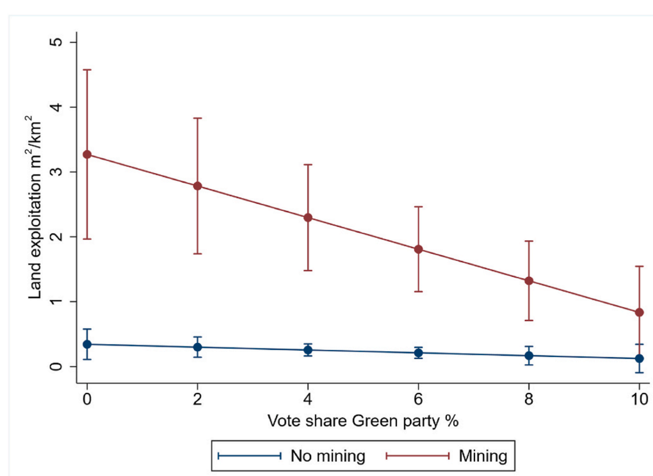

Fig. 4. Linear predictions of land exploitation at different levels of green vote share for mining and no mining municipalities. Green party on land exploitation expressed as m^2/km^2. The linear prediction is separated between municipalities without mining (blue) and with mining (red). The estimation is based on Model 3 in Table 1.

[4] https://www.reuters.com/markets/europe/how-ghost-1990s-property-crash-returned-haunt-sweden-2023-07-28/.

[5] Additional interaction effects for *forest*vote share for the Green Party* and *tourism*vote share for the Green Party* were tested but not included in the final version of the manuscript due to non-significant effects.

municipalities with mining (red) and without mining (blue). The vote share for the Green party is of little importance for the intensity of land uses in municipalities without mining. However, there is a strong negative correlation between land-use and the vote share for the Green party in mining municipalities. Hence, we find support for H5; a higher share of votes for the Green party is associated with smaller exploitation of land in mining municipalities.

This result makes sense, given that the Green Party generally opposes new mining projects and the intensification of land-use in existing mining projects, both at the national and the local level. For instance, in 2021, a coalition government between the Social Democratic Party and the Green Party at the national level experienced much stress regarding a debated application for the opening of the Kallak iron ore mine in Norrbotten County. The Green Party staunchly opposed the issuance of this permit, driven by a concern for the adverse environmental repercussions and the exploitation of land traditionally inhabited by the Indigenous Sami community. In stark contrast, the Social Democratic Party voiced apprehensions about the economic fallout associated with denying mining rights. They viewed it through the lens of national interest, emphasising the significance of tapping into valuable mineral deposits (Wilson and Allard, 2023). Moreover, our research does not capture the cause-effect relationship. Our results may indicate that the popularity of the Green Party in mining municipalities with lower rates of land use change comes from a combination of dynamic factors - the moment of the development of the mining industry or the scale of external effects experienced by residents. We can assume a scenario in which the Green Party's popularity with minor spatial development changes indicates that this party has stopped investments. However, it can also indicate the popularity of this party in municipalities where residents have experienced far-reaching negative effects of the mining industry and, at the same time, feel a decrease in economic benefits resulting from the depletion of fossil deposits. Determining which scenario is being implemented in Sweden requires additional research; we say that the popularity of the Green Party relates to the lower intensity of land use change in municipalities with the mining industry.

Models 4–6 in Table 2 are SDEMs with the same independent and control variables as Models 1–3 but with the additional inclusion of spatial lags of the independent variables. The results are generally consistent with Models 1–3 regarding the coefficients' sign and significance. The margin of victory, left coalition, population size and mining are all estimated to impact changes in land-use. Most spatial lags of the independent variables are insignificant, but two results justify a closer look. First, mining displays a negative and highly statistically significant coefficient. This suggests that higher mining pressures on land-use in neighboring municipalities are associated with lower land-use pressures in a municipality. Second, productive forest land is negatively associated with land conversion for more intensive uses in the municipality, but the coefficient for the spatial lag is positive. The combination of both findings has two important implications. On the one hand, municipalities with higher productive forest value are less likely to engage in more intensive land uses, suggesting that the scarcity associated with higher value prevents rapid conversion and signals a concern with sustainability. On the other hand, municipalities that have higher productive forest value are more likely to have neighbours that convert land to more intensive uses at a higher rate, indicating a spillover effect.

In sum, our results indicate that past land-use changes, the mining industry, local political competition, and partisanship emerge as major explanatory factors for more intensive land uses in Sweden. Moreover, the impact of the mining industry seems to be moderated by the presence of the Green Party at the local level. Finally, left-leaning coalitions may also be a factor that affects land use, but the support for this potential finding is weaker compared to the other results.

Table 2
Results for Spatial Durbin Error models.

	Model 4	Model 5	Model 6
	No interaction	Construction interaction	Mining interaction
Margin of victory 2014	−0.006** (0.003)	−0.006** (0.003)	−0.005** (0.003)
Left coalition	0.147** (0.065)	0.138** (0.064)	0.125** (0.063)
Bloc exceding coalition	0.043 (0.055)	0.052 (0.055)	0.040 (0.054)
Other coalition	0.111 (0.346)	0.059 (0.342)	0.072 (0.344)
Vote share Green Party	−0.017 (0.011)	0.072** (0.036)	−0.006 (0.011)
Mining	0.826*** (0.102)	0.838*** (0.101)	1.488 (0.195)
Vote share Green Party X Mining	–	–	−0.124*** (0.031)
Construction	0.645 (1.283)	5.119** (0.348)	0.558 (1.251)
Vote share Green Party X Construction	–	−0.893** (0.348)	
(ln) Productive forest value	−0.224*** (0.056)	−0.234*** (0.059)	−0.204*** (0.057)
Forest	−0.00085 (0.180508)	−0.027 (0.178)	0.015 (0.201)
Hotels	1.900 (1.826)	1.394 (1.829)	1.344 (1.785)
(ln) Population size	0.214*** (0.035)	0.203*** (0.035)	0.227*** (0.034)
Population density	−0.000086 (0.000074)	−0.00013* (0.000076)	−0.00010 (0.00007)
Mean income	0.108 (0.102)	0.101 (0.100)	0.042 (0.101)
Land Use Change Index 2006–2012	0.075*** (0.026)	0.067*** (0.025)	0.067** (0.026)
Constant	0.156 (0.604)	−0.012 (0.660)	0.034 (0.026)
Lags of independent variables			
Margin of victory 2014	0.002 (0.006)	−0.002 (0.006)	0.007 (0.006)
Left coalition	−0.103 (0.165)	−0.074 (0.164)	0.0008 (0.006)
Bloc exceding coalition	0.203 (0.156)	0.179 (0.152)	0.225 (0.154)
Other coalition	−0.261 (1.049)	−0.063 (1.016)	−1.436 (1.101
Vote share Green Party	−0.006 (0.026)	−0.123 (0.08)	−0.016 (0.026)
Mining	−1.005*** (0.297)	−1.049*** (0.284)	−0.418 (0.681)
Vote share green party X Mining	–	–	−0.089 (0.108)
Construction	−0.499 (2.116)	−6.503 (4.348)	−0.363 (2.094)
Vote share Green Party X Construction	–	1.183 (0.780)	
(ln) Productive forest value	0.295*** (0.073)	0.336*** (0.076)	0.263*** (0.073)
Forest	−0.009 (0.265)	0.035 (0.257)	−0.034 (0.262)
Hotels	−3.268 (4.366)	−1.495 (4.285)	−3.215 (5.053)
(ln) Population size	−0.354*** (0.085)	−0.344*** (0.082)	−0.359*** (0.084)
Population density	0.00020 (0.00016)	0.00026 (0.00016)	0.00016 (0.00016)
Mean income	0.068 (0.238)	0.052 (0.231)	0.255 (0.241)
Spatial lag dependent variable	1.326*** (0.149)	1.375*** (0.133)	1.254*** (0.153)
Spatial lag error term	−1.020*** (0.233)	−1.129*** (0.218)	−0.908*** (0.237)
Observations	290	290	290
Nagelkerke pseudo-R-squared	0.063	0.065	0.012
Wald Test (df = 1)	117.30***	148.55***	110.30***

Notes: Unstandardized coefficients; clustered standard errors within parentheses. Significance: *p < 0.10; **p < 0.05; ***p < 0.01.

1.6. Discussion

In this study, we employed a political market framework to analyse land-use dynamics at the local level in Sweden. The country represents a 'least likely case' to apply this framework, given its long tradition of consensual democracy, stable political institutions and absence of reliance on property taxes as a major source of local revenue. In Sweden, electoral competition at the local level is high, both between elections (party alternation) and within elections (fewer cases of single-party dominance). Together with its corporatist tradition, this context favours more balanced policy outcomes in response to constituencies. Consequently, the empirical test was less likely to deliver statistically significant results for local competition, partisanship and dominant economic activity over land uses.

Contrary to our initial expectations, in municipalities with a higher degree of political stability – indicated by larger margins of victory in local elections – there is a lower tendency for changes towards more intensive land uses. This finding is even more surprising compared to prior empirical studies. In Poland, a larger number of changes was identified in municipalities where the margin of electoral win of the mayor was larger (Deslatte et al., 2022). Likewise, empirical research in Spain also reveals a similar phenomenon: "both left-wing and right-wing local governments develop more land as local elections become less competitive" (Solé-Ollé and Viladecans-Marsal, 2012, 2013, p. 51). Several distinct features of the Swedish political system can probably explain this divergence. First, Swedish municipalities predominantly operate through coalition governments, making decision-making more consensus-based than the strong mayor systems common in Spain and Poland. When multiple parties must cooperate to govern, policy outcomes tend to reflect negotiated positions rather than single-party preferences. Second, Sweden's political culture emphasizes consensus-building and compromise (Erlingsson et al., 2022), which differs markedly from Southern and Eastern Europe's more adversarial political systems. This institutional context means that seemingly more competitive elections (measured by smaller victory margins) may indicate a more stable, consensus-oriented governing environment accommodating economic development interests. Third, unlike Spain and Poland, Swedish municipalities do not heavily depend on property taxes for revenue. This reduces the fiscal motivation to approve intensive land development that often drives decision-making in other contexts, making the relationship between political competition and land use less direct. Lastly, Sweden's mature and predictable land-use regulatory framework, combined with lessons learned from the 1990s property crash, may contribute to more moderate development pressures regardless of electoral margins. This contrasts with Spain and Poland's more dynamic land markets during their respective study periods.

Consistently with the expectations of the political market framework, employment patterns still play an important role in land conversion in Swedish municipalities, but their presence is less prominent than in other countries. Unlike other contexts, where construction and real estate interests (Lubell et al., 2005; Deslatte et al., 2018) or agricultural activities (Deslatte et al., 2022) are key to land conversion, in Sweden, it is the presence of mining activities in a municipality that plays a central role in land-use changes towards more intensive uses. Nevertheless, we also find that political partisanship can mitigate the effect of employment patterns, particularly since a stronger presence of the Green Party moderates the impact of mining activities in the land conversion process. This result alone justifies the use of the political market framework advocated in this work and confirms its explanatory power in the Swedish case. In contrast, the importance of local employment in construction and real estate appears less relevant than in other countries, most likely because local governments in Sweden do not rely on property taxes as a revenue source. In southern European countries like Spain and Portugal, local budgets heavily rely on property taxes. This represents a significant economic incentive to issue more building permits and convert land to residential and commercial uses, not only to improve local economic development, but also to enhance the financial status of each municipality.

The usefulness of analysing land-use changes with path dependence in mind is confirmed by the importance of the variable describing the continuity of land-use changes over time, both in this study and in the study conducted in Poland (Deslatte et al., 2022). The lagged dependent variable has a high explanatory power for the phenomenon under analysis, thus confirming the high institutional stickiness in land-use processes. Beyond the time lag, the analysis also supports the idea of a spatial lag, i.e., the intensity of land-use changes in a municipality is affected by land-use processes in neighboring municipalities.

2. Conclusions

Our analysis reveals that Sweden's political market for land use is shaped by distinct institutional features that differentiate it from previous empirical studies in other contexts. The negative relationship between electoral competition and land-use changes reflects Sweden's consensus-based governance system, where coalition-building and negotiation are paramount. This finding suggests that political institutions play a crucial role in mediating development pressures, but their effects vary significantly based on the broader institutional context.

The role of mining activities in driving land-use changes, moderated by Green Party representation, demonstrates how economic interests can be effectively balanced through political mechanisms. This interaction provides important insights for designing governance systems that can accommodate both development needs and environmental concerns. The success of environmental parties in moderating intensive land uses suggests that formal representation of environmental interests in decision-making processes can help achieve more sustainable outcomes.

Based on our findings, we propose several concrete management recommendations for policymakers and planners. First, in contexts where mining activities significantly drive land-use changes, we recommend implementing a two-tier approval system. Local governments can establish specialized committees that include both industry representatives and environmental stakeholders, particularly in municipalities where mining interests are strong. These committees should conduct mandatory sustainability impact assessments before major land-use changes are approved. The success of Green Party involvement in moderating mining-related land use in Sweden suggests that institutionalizing environmental perspectives in the decision-making process can help balance development pressures with conservation goals.

Second, our findings highlight the importance of coalition-building in land-use governance. Municipalities should consider adopting formal consultation mechanisms that ensure diverse stakeholder participation in land-use decisions, regardless of their political system. This could include mandatory public hearings, stakeholder advisory boards, and formal consultation periods for major land-use changes. While our research focused on Sweden's consensual democracy, these mechanisms can be adapted to different political environments by adjusting the degree of binding authority given to stakeholder input. For instance, in more majoritarian systems, these consultative bodies could have mandatory review powers while leaving final decisions to elected officials. This approach allows for the benefits of consensus-building while respecting different institutional contexts.

These recommendations can be tailored to local conditions by adjusting the composition of oversight committees, consultation requirements, and implementation timelines based on local institutional capacity and political circumstances. The key is to institutionalize balanced stakeholder participation while maintaining sufficient flexibility to accommodate different political and economic environments.

One important limitation of this study relates to the measurement of some employment pattern variables. Assessing the strength of mining interests in a municipality with a dichotomous variable is far from ideal since the monetary value or the number of employees involved in this economic activity would be much better proxy measures of the local impact of this type of employment. Unfortunately, confidentiality issues are involved, which prevent such information from being used in the analysis. Similarly, while the proportion of forest land in a municipality is a good proxy for the economic importance of forestry, the monetary value or the number of employees associated with forestry, which are unavailable, would have been even better measures. If these measures or other equivalents become available for future research, examining the mechanisms behind our findings in more detail would be beneficial.

For future research, examining the mechanisms behind these relationships would be beneficial, particularly regarding how different institutional arrangements affect the balance between development and conservation interests. Studies comparing outcomes across different governance systems could provide valuable insights into how political markets for land use operate under varying institutional conditions. Such research would help refine our understanding of how to design effective land-use governance systems that promote sustainable development while respecting local political and economic contexts.

While this study relied on established land-use databases, we acknowledge the potential advantages of incorporating remote sensing technology for high-resolution monitoring of land-use changes. Future research could also leverage a combination of remote sensing data and geographic information system (GIS) methods to capture more detailed spatial patterns and regional dynamics. This approach would facilitate more granular analyses and provide deeper insights into the spatial interactions and spillover effects examined in this study.

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CRediT authorship contribution statement

Emanuel Wittberg: Writing – original draft, Visualization, Validation, Software, Methodology, Formal analysis, Data curation. **António Fernando Tavares:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Katarzyna Szmigiel-Rawska:** Writing – review & editing, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Legend for CORINE land cover classification

1. Artificial surfaces
    - 1.1. Urban fabric
        - 1.1.1. Continuous urban fabric
        - 1.1.2. Discontinuous urban fabric
    - 1.2. Industrial, commercial and transport units
        - 1.2.1. Industrial or commercial units
        - 1.2.2. Road and rail networks and associated land
        - 1.2.3. Port areas
        - 1.2.4. Airports
    - 1.3. Mine, dump and construction sites
        - 1.3.1. Mineral extraction sites
        - 1.3.2. Dump sites
        - 1.3.3. Construction sites
    - 1.4. Artificial, non-agricultural vegetated areas
        - 1.4.1. Green urban areas
        - 1.4.2. Sport and leisure facilities
2. Agricultural areas
    - 2.1. Arable land
        - 2.1.1. Non-irrigated arable land
        - 2.1.2. Permanently irrigated land
        - 2.1.3. Rice fields
    - 2.2. Permanent crops
        - 2.2.1. Vineyards
        - 2.2.2. Fruit trees and berry plantations
        - 2.2.3. Olive groves
    - 2.3. Pastures
        - 2.3.1. Pastures
    - 2.4. Heterogeneous agricultural areas
        - 2.4.1. Annual crops associated with permanent crops
        - 2.4.2. Complex cultivation patterns
        - 2.4.3. Land principally occupied by agriculture, with significant areas of natural vegetation
        - 2.4.4. Agro-forestry areas
3. Forests and semi natural areas
    - 3.1. Forests
        - 3.1.1. Broad-leaved forest
        - 3.1.2. Coniferous forest
        - 3.1.3. Mixed forest
    - 3.2. Scrub and/or herbaceous vegetation associations
        - 3.2.1. Natural grasslands
        - 3.2.2. Moors and heathland
        - 3.2.3. Sclerophyllous vegetation
        - 3.2.4. Transitional woodland-shrub
    - 3.3. Open spaces with little or no vegetation
        - 3.3.1. Beaches, dunes, sands
        - 3.3.2. Bare rocks
        - 3.3.3. Sparsely vegetated areas
        - 3.3.4. Burnt areas
        - 3.3.5. Glaciers and perpetual snow
4. Wetlands
    - 4.1. Inland wetlands
        - 4.1.1. Inland marshes
        - 4.1.2. Peat bogs
    - 4.2. Maritime wetlands
        - 4.2.1. Salt marshes
        - 4.2.2. Salines
        - 4.2.3. Intertidal flats
5. Water bodies
    - 5.1. Inland waters
        - 5.1.1. Water courses
        - 5.1.2. Water bodies
    - 5.2. Marine waters
        - 5.2.1. Coastal lagoons
        - 5.2.2. Estuaries
        - 5.2.3. Sea and ocean

Of the two periods analysed in Sweden, 2006–2012 is characterized by more dynamic land-use changes. There are 48 % fewer changes in 2012–2018 than in 2006–2012 at the second and first CLC. In both periods, changes towards more intensive land uses are more common than changes towards less intensive land uses. In 2006–2012, the disproportion is smaller – 79 % of all changes are towards more intensive uses, and 21 % are towards less intensive uses, whereas in 2012–2018, the percentages are 87 % and 13 %, respectively. In sum, the observed trend between these two periods is fewer land-use changes in 2012–2018 with greater changes towards more intensive uses in both periods.

Appendix BDescription of land-use changes in Sweden.

	2006-2012		**2012-2018**	
Area of changes at the second level of CLC classification, m^2 Mean for Sweden; m^2/km^2	33 822 581 467 75 112		17 519 129 024 38 906	
Area of changes at the first level of CLC classification, m^2 Mean for Sweden; m^2/km^2	208 480 963 463		108 396 906 241	
	less intensive use	**more intensive use**	**less intensive use**	**more intensive use**
Area of changes at the first level of CLC classification, m^2	44 039 443	164 441 519	14 547 679	93 849 227
Characteristics of the most common changes at the first level of classification, in % of the area which changed (more than 1% of all changes, covering 99% of all changes 2006-2012, 99% 2012-2018)	1®2 10,6% 1®3 5,6% 2®3 3,1% 2®5 1,6%	3®1 45,0% 2®1 20,6% 3®2 6,1% 4®3 4,5% 4®1 1,7%	2®3 5,5% 1®2 3,7% 3®4 2,7% 1®3 1,2%	3®1 53,83% 2®1 14,49% 3®2 7,72% 4®3 7,23% 4®1 3,15%
Characteristics of the most common changes at the second level of classification, in % of the area which changed (more than 1% of all changes, covering 90% of all changes 2006-2012; 89% 2012-2018; without changes within the same 1st level class)	1.3®3.1 – 7,3% 1.3®3.2 – 3,3% 2.1®3.2 – 2,9% 3.1®4.1 – 2,8% 2.4®3.2 – 1,7% 1.3®2.1 – 1,2%	3.1®1.3 – 21,8% 3.1®1.2 – 8,6% 3.1®1.1 – 7,3% 2.1®1.1 – 6,0% 4.1®3.2 – 4,4% 2.1®1.3 – 4,4% 2.1®1.4 – 3,9% 2.1®1.2 – 3,5% 3.2®1.3 – 3,1% 3.1®2.1 – 2,5% 3.2®1.2 – 1,5% 4.1®1.3 – 1,4% 3.1®1.4 – 1,4% 3.2®2.3 – 1,3%	1.3®2.1 – 3,0% 2.4®3.2 – 2,7% 3.1®4.1 – 2,2% 2.1®3.2 – 1,8%	3.1®1.3 – 30,4% 3.1®1.2 – 6,7% 4.1®3.2 – 6,4% 3.1®1.1 – 6,3% 3.2®1.3 – 6,1% 2.1®1.2 – 4,3% 2.1®1.1 – 3,6% 3.1®2.1 – 3,1% 2.1®1.3 – 3,1% 4.1®1.3 – 3,1% 3.1®2.4 – 2,6% 3.2®1.2 – 2,4% 2.1®1.4 – 1,1%
	decrease	**increase**	**decrease**	**increase**
The classes of the largest changes, net value (more than 1% of change)	32 68,30% 31 31,20%	31 68,4% 32 31,0%	31 53,3% 32 46,3%	32 52,4% 31 46,2%

Considering changes on the second level within one category at the first level of classification, the most common changes are the same for both periods – towards less intensive use: from 3.1. – forests to 3.2. scrub and/or herbaceous vegetation associations, and towards more intensive use: conversely from 3.2. scrub and/or herbaceous vegetation associations to 3.1. – forests. Nevertheless, the categories of changes are the same, the area and ratio of changes significantly differ between the two periods. In 2006–2012, 68,3 % (23 100 km^2) of all changes are towards new forest (from 3.2. to 3.1.), whereas in 2012–2018, this value decreases to 46,2 % (8097 km^2). In 2006–2012, deforestation (from 3.1. to 3.2.) is 30,9 % (10,466 km^2) of all changes, and in 2012–2018 this value increases to 52 % (9160 km^2).

In sum, the different share of observed changes is more balanced in 2012–2018 – nearly the same percentage of forest disappeared and appeared, while in 2006–2012 more forest appeared (68,2 %) than disappeared (30,9 %). It is worth underscoring that changes within the same category at the first level of CLC, which are not included in the dependent variable because they are changes within the same category, account for 33,614 km^2 in 2006–2012 and in 2012–2018 for 17,410 km^2.

Considering changes at the second level, but only outside the same category at the first level of classification, anthropopressure is observed in both periods. Changes towards more intensive use are primarily from 3.1 – forest to 1.3 – mine, dump and construction sites, 1.2. – industrial, commercial and transport units and 1.1. – urban fabric. In 2006–2012, these changes account for 57 % of the total of more intensive changes and in 2012–2018 for 62 %. In both periods, the greater increase besides the 3rd class of CLC is class 1.3. The second most significant, more intensive changes are from 2.1. – arable land to all subcategories of class 1 – artificial surfaces. In 2006–2012, the main changes towards less intensive uses are from 1.3. – mine, dump and construction sites to 3.1. – forest and 3.2. – scrub and/or herbaceous vegetation associations; in 2012–2018, from 1.3. – mine, dump and construction sites to 2.1. – arable land, and from 2.4. – heterogeneous agricultural areas to 3.2. – scrub and/or herbaceous vegetation associations.

Hence, in this context, the reasonable empirical strategy is to consider only the land-use changes towards more intensive use, similarly as studies in Poland and Portugal

Appendix C

Table 1A
Variable descriptions and sources

Variable	Description	Source
Dependent variable		
LUCI 2012-18	area of the municipality transformed towards more intensive use, m^2/km^2, 2012–2018	European Environmental Agency. Copernicus Land Monitoring Service
Political variables		
Margin of victory (H1)	Difference in percentage between the first-place party/coalition and the second-place party/coalition in the 2014 municipal elections	National Electoral Commission
Ruling coalition (H2)	Ideology of the ruling coalition. Three dichotomous variables were included in the models for left, bloc exceeding and other coalitions. The omitted category is right coalitions.	The Swedish Association of Local Authorities and Regions and Quality of Government Institute
Vote share Green Party (H3)	% of valid votes cast for the Green Party in the 2014 election	Statistics Sweden and Quality of Government Institute
Employment pattern variables		
Construction (H3&H4)	% of gainfully employed 16+ in construction industry and real estate companies in all gainfully employed 16+ (industrial classification used), 2012.	Statistics Sweden
Mining (H3&H5)	A dummy variable taking the value 1 for each municipality that has active mining companies during the period 2012–2018	Own creation, based on Statistics Sweden
Tourism	% of gainfully employed 16+ in hotels and restaurants in all gainfully employed 16+ (industrial classification used), 2012.	Statistics Sweden
Forest	Proportion of area occupied by forest in the municipality, 2012	European Environmental Agency. Copernicus Land Monitoring Service
Control variables		
LUCI 2006-12	area of the municipality transformed towards more intensive use, m^2/km^2, 2006–2012	European Environmental Agency. Copernicus Land Monitoring Service
(ln) Productive forest value	Natural logarithm of the average assessed value in Swedish crowns (SEK)/hectare in 2015. The information is based on data from the Tax Assessment Register collected by the Swedish Tax Agency. The tax assessment value corresponds to 75 percent of the probable market value of the land. Unfortunately, the variable productive forest value has missing values for two municipalities (Lomma and Solna). We imputed these missing values by the average productive forest value of all neighboring municipalities.	Swedish Tax Agency
Mean income	Mean earned income for persons registered in the national population register during the whole year [100,000 SEK]	Statistics Sweden
(ln) Population size	Natural logarithm of municipal population in 2015	Statistics Sweden
Population density	The municipal population in 2015 divided by the municipal area.	Statistics Sweden

Table 2A
Descriptive statistics.

	Mean	Standard deviation	Min	Max
Land Use Change Index 2012–2018	0.324	0.552	0.000	4.510
Land Use Change Index 2006–2012	0.567	0.952	0.000	8.256
Margin of victory 2014	14.527	9.804	0.1	44.8
Left coalition	0.341	0.475	0	1
Bloc exceding coalition	0.348	0.477	0	1
Other coalition	0.003	0.059	0	1
Vote share Green party	5.354	2.788	0.300	14.300
Construction	0.096	0.021	0.048	0.173
Mining	0.055	0.229	0.000	1.000
Tourism	0.027	0.013	0.010	0.143
Forest	0.617	0.236	0.000	0.919
Productive forest value	48,958	19,776	4416	109,545
Mean income	2.600	0.336	2.098	4.939
Population size	32,951	67,112	2421	881,235
Population density	141.04	495.69	0.2	4708.2
Observations	**290**			

Notes: Productive forest value and population size were taken in natural logarithm before estimation.

Data availability

Data will be made available on request.

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