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Common-pool resource governance and uneven food security: Regional resilience during the Great Irish Famine, 1845–1852

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Abstract

This paper deals with two principal questions, drawing closely on the experience of Ireland. First, it addresses a deficit in our knowledge of resource governance institutions and land tenure systems as moderators of the impact of famine. We have known for some time of the extent of common-pool resource systems in districts of 19th-century Ireland and wider Europe, but their role in determining levels of ecological risk exposure is less understood. Knowing that both food insecurity and common tenancy were higher in marginal Irish districts, this represents a gap in our understanding of the geographical impact of the Great Irish Famine. Second, although current thinking on common-pool resource governance suggests that such systems were potentially robust to ecological stress, why did this not translate into greater resilience in Ireland? To make sense of this contradiction, we must consider both the local behaviour of ecological stressors and wider context of Irish colonialism. Using local clustering analysis and geographically weighted regression, we see how the impact of key stressors varied geographically. These findings suggest that analyses of the role of common-pool resource governance in conferring ecological resilience must be tempered with a fuller appreciation of geopolitical context.

KEYWORDS

commons, famine, Ireland, nineteenth century, resilience

1 | INTRODUCTION

Why does the Great Irish Famine of 1845–1852 continue to capture popular and academic imagination? Its depiction as the 'last great subsistence crisis in the Western world' invites questions of how such an event could occur in a colony of industrial Britain as it approached the peak of its industrial and imperial power. It defies typical markers of famine recovery, as its population never recovered from an estimated excess mortality of 981,000, or 10–18% loss of total population due to combined mortality and emigration (Boyle & Ó Gráda, 1986, p. 555). Although its sesquicentenary in 1995 saw the emergence of a new wave of writing delving deeper into its proximate causes (Gray, 1995; Kinealy, 1997, 2006; Póirtéir, 1995), these questions are far from resolved. By 2012, a continued state of lively debate saw the publication of a major collection of writing in the *Atlas of the Great Irish Famine*, emphasizing continued interest from geography, economics, history, cultural studies and social science (Crowley, Smyth, & Murphy, 2012).

Debate remains open, however, on the respective role of the British State, the intentionality of its disastrous relief policies, the Malthusian nature of the event, the role of landlordism and the biology of the pathogen itself (Delaney, 2012; Flaherty, 2014; Kelly & Ó Gráda, 2015). Research on the Great Irish Famine informs interpretations of similar events throughout the 19th and 20th centuries. Similar questions on the role of colonialism were asked of the Bengal Famine of 1943, where occupational restructuring under colonial rule set a disastrous context for the catastrophe that followed (Sen, 1981a,b). Also recognized is the modest role Ireland may play in helping us to understand the ecological crises of modern times, such as Fraser's (2006, 2007) work on resilience to climate change and food security. In a similar vein, the literature on common-pool resource systems or 'the commons' has grown, albeit independently of work on the Irish Famine. This work emphasizes the potential role of common-pool systems in conferring ecological robustness and resilience to shock events, by assessing the relative merits of stakeholder-led versus market-based approaches to ecosystem management (Janssen, Anderies, & Ostrom, 2007; Ostrom, 1990, 2009). As such, there are considerable grounds for investigating the Irish case both to clarify the casual factors of regional variation in famine and to inform wider debate on the nature of 'the commons' in global, but especially pan-European context.

This article applies these new insights to an analysis of the role of common-pool resource governance and land tenure as determinants of the uneven geography of the Great Famine's impact. There is good reason for integrating the literatures of the commons with those of famine studies. Several authors have brought classic works on the political economy of the commons back into focus, in the wake of growing attention on alterative governance options to combat climate change. Historical instances of specific common-pool systems have featured heavily in these, as have the processes of formal enclosure that institutionalized private property across the capitalist world (Linebaugh, 2014; Wall, 2014a,b). Renewed attention has also been given to the extent of common-pool resource governance in Ireland during the mid-19th century (Anderson, 2010; Flaherty, 2013, 2014; Slater & Flaherty, 2009). Statistical evidence considered later in this article suggests that such systems of landholding persisted into the 19th century and, in certain districts of Ireland, coexisted and coincided with the period of the Great Famine. In the context of such a catastrophe of enduring global relevance, Ireland provides an ideal testing ground for theories linking institutional composition with resilience to ecological stress and disaster.

As a case study, Ireland also emphasizes the wider pan-European significance of common-pool and non-capitalistic agrarian systems (Anderson, 2010). Several authors have recently drawn our attention to the wider role of common-pool systems, specifically agrarian communes, as stages in the evolution of human social orders from nomadic, to sedentary, feudal and capitalist (Anderson, 2010; Foster & Clark, 2020). Ireland thus has much to teach us about processes and mechanisms of social change, given the complex coexistence of feudal, primitive-communal and putative capitalistic modes of production throughout this time. In this way, theory and history of the commons speak to not only our theories of social evolution but also ongoing processes of capitalist natural resource enclosures. They also inform debate over the solutions we might derive to deal with local adaptations to the hazards of climate change. Finally, by bringing previously under-utilized data to bear on the subject, it clarifies the potential role of common-pool resource governance and land tenure in determining the uneven geography of regional distress rates. It concludes by suggesting how spatial analyses, coupled with such theories of institutional resilience, may enhance our understanding of famine's causal factors in similar contexts.

2 | MODELS AND THE MODELLING OF FAMINE DISTRESS

Since the publication of Amartya Sen's (1981a) seminal work on the causation of famine, subsequent research has deepened our understanding of the factors underpinning instances of global famine (Devereux, 2001, 2007). The current lexicon of human ecology reflects continued interest and growth in resource security studies, where concepts such as robustness, resilience and adaptive capacity now predominate (Cumming, 2011; Flaherty, 2019; Stone-Jovicich, Goldstein, Brown, Plummer, & Olsson, 2018). Although such concepts are useful, there is a risk that—as with the concept of sustainability in recent decades—they lapse into metanarrative, in a manner that obscures their origins as useful 'middle-range' heuristics (Walker et al., 2006). How, then, can these concepts and frameworks of the 'new' approaches to resource studies—those of the commons, complexity or ecological resilience—be incorporated into famine studies, in a way that preserves their explanatory potential?

Sen's (1981a,b) 'entitlements' approach remains one of the most cited in the famine studies literature. According to Sen, lapses in resource security occur through a confluence of 'entitlement collapses', when opportunities for food acquisition through subsistence (direct entitlements), purchase (indirect entitlements) and public welfare (transfer entitlements) simultaneously collapse. In such instances of cumulative entitlement collapses, famine often results. The immediate benefit of this model was its ability to transcend Malthusian arguments focusing on overpopulation as a prime factor, shifting attention instead to the political and social infrastructures underpinning food distribution. Although the entitlements model is criticized for methodological individualism and lack of attention to non-market famine vectors (Devereux, 2001), it has remained markedly resilient.

Central to its appeal amongst sociologists is its ability to address explanations that focus on food supply alone, in favour of those that emphasize the make-up of socially embedded resource systems. In this respect, one crucial deficiency identified by Devereux (2001) is that of the role of different institutionalized forms of resource governance in determining different levels of resource security. Although a methodological individualist approach might be blinded to such overarching institutional forms, evidence on their significance as moderators of resource security is substantial (Anderies, Janssen, & Ostrom, 2004; Costanza, Low, Ostrom, & Wilson, 2001; Flaherty, 2014; Futemma, De Castro, Silva-Forsberg, & Ostrom, 2002; Janssen et al., 2007; Ostrom, 1990, 2009).

Compounding the lack of quantitative analyses of resource inequality—within sociology at least—is an unhelpful methodological divide. Whilst debate continues amongst proponents of complexity theory regarding the validity of strictly regression-based approaches alone (Byrne & Callaghan, 2013), geographers have been developing statistical models to better model spatially varying processes (Brunsdon & Comber, 2015; Brunsdon, Fotheringham, & Charlton, 1996; Fotheringham, Brunsdon, & Charlton, 2003). The potential for mutual benefit here is obvious. As resource security theory moves further from 'global' accounts of macro-level drivers, the capacity of such statistical techniques to corroborate more nuanced mechanisms of famine causation offers a welcome pairing. Equally, the attention given to the role of institutions in these new literatures on the commons and ecological resilience may clarify more pointedly the mechanisms generating effects observed in spatial models.

Such is the objective of this paper. Ireland remains a concerning case in famine studies. It continues to violate one of the standard benchmarks of post-famine recovery with a population level below that of its historical peak in 1841 and remains an area of active debate and research as new datasets and source documents are exploited (Delaney, 2012; Fernihough & Ó Gráda, 2018; Flaherty, 2013, 2014; Kelly & Ó Gráda, 2015; Kinealy, 2001). As we uncover more about the extent of non-capitalistic modes of resource governance in pre-famine Ireland and wider Europe (Anderson, 2010; Slater & Flaherty, 2009), the case of Ireland speaks not only to famine studies but also to the growing literature on *the commons*. Finally, the specific aggregation of data available for this period allows us to apply different statistical techniques for the detection and modelling of spatial heterogeneity, in a manner not typically accounted for in existing quantitative models of famine impact. Before examining these specific issues further, the following sections clarify the conceptual foundations of this analysis.

3 | THINKING GEOGRAPHICALLY: SPATIAL DEPENDENCIES, COMPLEXITY AND RESILIENCE

A resurgence of interest in Waldo Tobler's *first law of geography*, culminating in the publication of a discussion symposium in the *Annals of the Association of American Geographers* in 2004, saw renewed attention offered to a long-standing staple of human geography (Goodchild, 2004; Miller, 2004; Sui, 2004; Tobler, 2004). Tobler's (1970) law, claiming '… everything is related to everything else, but near things are more related than distant things', may be interpreted in several ways. As a theory of spatially varying relationships, it offers a basic defining principle for explanation in human geography: location and distance matter to the character of socio-spatial relationships. As a diagnostic criterion, it formalizes the phenomenon of spatial autocorrelation into a parsimonious methodological principle, where it becomes a condition to be modelled in quantitative geographical analysis (Brunsdon & Comber, 2015). In the *Annals* debate, attempts were made to extend the law beyond its narrowly defined use within spatial modelling, as a means of making sense of *mechanisms* of local dependency, rather than a descriptor of spatial autocorrelation alone. It was here suggested that the literature on complex adaptive systems could contribute (Miller, 2004).

It is worth exploring this possibility further, considering the volume of work in resilience and complexity that has emerged since the *Annals* discussion. The challenge, however, is in reconciling the apparently simplistic idea of 'location' as a sufficient explanation of spatial relationships, with a body of theory that appreciates the complex nature of local spatial interactions. The wider social/ecological complexity literature may here be useful. This literature draws attention to the ways in which apparently simple local interactions can generate complex macro-geographies and emergent patterns, which transcend the properties of the units from which they are generated (Byrne, 1998, 2005; Sawyer, 2005). This does not imply that macro-level patterns can be understood simply by studying the properties of constituent units as per the 'classical systems' paradigm (Skyttner, 2005). Instead, it calls for careful attention to how we conceptualize systems themselves and how we theorize the mechanisms that connect local institutions to higher order geographical patterns. This is as much the work of theory, as measurement and modelling, and is a staple concern of the resilience and complexity approaches.

Complexity theory views social-ecological systems as multilevel entities embedded in specific geographical contexts. It suggests that these complex systems, although composed of multiple interrelated parts, often display 'emergent' properties—consistent patterns that we can detect through measurement. Agrarian systems are one such example. By connecting micro-actions and macro-structures, it offers a powerful account of both the actions of agents that give rise to wider social structures and the emergent properties that constitute our measurements as quantitative analysts. Complexity is complemented by the resilience approach, which gives more concrete form to the multi-causal nature of ecological distress. This approach views resource insecurity not as a product of destabilizing variables such as population growth alone but of patterns of cumulative risk exposure specific to the nature of local ecosystems. This approach works from the unique characteristics of food production systems themselves, to explain the causes of food and resource insecurity in specific contexts (Berkes, Colding, & Folke, 2003; Cumming et al., 2005; Cumming & Collier, 2005; Fraser, 2007; van Apeldoorn, Kok, Sonneveld, & Veldkamp, 2011). Fraser (2006), for example, has suggested that measuring a system's degree of species diversity, biomass volume and connectivity offers a means of operationalizing resilience as a measure of robustness to ecological stress.

Together, these perspectives can contribute to the task of addressing causal mechanisms in analyses of spatially varying association, by broadening the role of theory beyond that of law-like statements. As such, we may better understand mechanisms operating at local levels that give rise to spatial heterogeneity, and the practice of geographical modelling can be brought to closer dialogue with theory in human ecology. If we adopt as a basic principle that our units of analysis, at any given spatial scale, are complex open systems, composed of emergent social, cultural, economic and ecological properties in a state of mutual interconnection (Capra, 2005; Cillers, 2001; Harvey & Reed, 2004), our task is to interpret our models in terms of the interactions of these various dimensions. This can be accomplished by thinking through mechanisms of local dependency, in a manner that incorporates aspects of culture, economy and ecology, and the ways in which they conspire to create unique geographies of local interaction that may then be detected through spatial analysis. In short, whilst not rejecting the presence of stable patterns and structures, we must remain sensitive to local context, and the underlying complexity of interacting agents and social structures, which give rise to geographical patterns. We can operationalize this task more clearly by focusing on the specific properties and dynamics of common-pool resource systems that may mediate local patterns of ecological risk exposure.

4 | COMMON-POOL RESOURCE SYSTEMS AS MODERATORS OF ECOLOGICAL RISK

As the resilience approach is one inherently geared towards understanding the spatially varying effects of different systems of resource governance, a sufficient overview of the properties of the system in question is vital. In the language of resilience, this involves delineating the system's identity, and using this information as a means of inferring the adaptive capacity of the systems institutions, or its ability to respond to disturbances in its environment. This resilience is a function of the institutional robustness of a system (i.e., the integrity or adaptability of its governance institutions, modes of resource management, demography and economy). It also involves examining boundary interactions, or potential constraints placed upon the system from without (i.e., local ecology, climate, land ownership and state administration). Several of these general properties may vary over space. Resilience may thus be provisionally defined as '… the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks' (Walker, 2004, cited in Grimm & Calabrese, 2011, p. 8). It is an invaluable heuristic for addressing shortcomings in structuralist approaches, which tended to search for general rather than case-specific mechanisms that induce disturbance. Examples include the IPAT approach to ecological impact modelling, which emphasizes the role of identical factors such as population and technology across different cases (VanWey, Ostrom, & Meretsky, 2005). The resilience approach therefore helps us reconcile the general properties of common-pool resource systems, with specific mechanisms of local dependency unique to the systems in question.

There is much evidence suggesting that social-ecological systems with robust institutions that are adaptive to economic, political and ecological variability experience heighted resilience to ecological stress (Janssen et al., 2007; Wall, 2014b). This robustness is often explained as a function of cumulative experience and knowledge internalized in institutions, allowing subsequent generations to adapt to variations in local ecological conditions (McMillen et al., 2014). Works such as Ostrom (1990) have similarly observed '… that small-scale governance regimes that incorporate local knowledge, have clear rules that are enforced, and rely on high levels of trust frequently perform well' (Janssen et al., 2007, p. 308). Resource pooling is often a viable option for non-capitalist agricultural systems, in the absence of stocks of capital and as a means of bringing new tracts of land into cultivation through labour pooling. Common-pool systems are especially appropriate when land productivity is low, yield reliability is low, and capital investment is absent and where large territories are involved (Ostrom, 1990, p. 63).

Interest in common-pool resource systems long predates the seminal work of Ostrom (1990). In response to anthropologists of the time, Marx wrote on the status of agrarian communes as a potential evolutionary stage in human social order (Marx, 1983 [1881]; Shaw, 1984). The system has long featured in comparative accounts of field systems and enclosure in wider Europe, such as Romania (Stahl, 1980), Russia (Shanin, 1983) and Germany (Engels, 1882). In several respects, and as discussed further in the following section, the customary legal codes of these communities were markedly similar. Whereas the process of enclosure in Ireland was largely devolved to local lordships and considerably more piecemeal than the English that relied more on formal legislation, these similarities allow us to place the Irish case in comparison with others. Chief amongst these was the manner in which these unique institutional arrangements enabled a characteristic style of cultivation with marked similarities in different locations.

Ecological viability within common-pool agrarian systems was often kept in check by institutions that incentivized collective coordination and responsibility. Such mechanisms included the scattering of an individual's landholding in strips of varying quality, restrictions on numbers of livestock in proportion to an individual's arable holdings and periodic rotation of individual plots amongst commune members. Within English, Swedish and German openfield systems of the 17th and 18th centuries, similar practices of strip dispersal as those later observed in Ireland prevailed, according to which each individuals' holdings (themselves merely usufruct) were scattered in a series of intermixed strips throughout the joint lands of the village. According to Smith (2000), common property regimes such as these resolved several ecological difficulties engendered by the collective action 'problem', which has so occupied rational actor-oriented human ecology (Ostrom, 1990). Crucially, these arrangements permitted combined tillage and grazing, as the size of each individual holding was determined by the number of oxen contributed by each tenant to the community plough team (Goransson, 1961, p. 83). This was otherwise impossible individually owing to land and labour requirements, as the throwing open of common tillage lands to grazing after harvesting served to maximize total grazing area (Janssen et al., 2007). These mechanisms of subdivision and plot scattering thus imposed sanctions on individual resource accumulation and labour hoarding on specific portions of common lands.

4.1 | Common-pool resource governance systems in Ireland

We suggested above that the Irish 'Rundale' system, in particular, and common-pool resource systems, generally, constitute a mode of cultivation different to those of feudal and capitalist societies. On the basis of comparative data, there is little doubt that common tenancy was present across many districts of mid-19th-century Ireland, and even where it was a minority phenomenon, its presence marked it apart as a distinct mode of tenure and governance (McCabe, 1991; McCourt, 1955). The unique nature of common tenancy is well established in both documentary and statistical record, and early colonial administrators were acutely aware of the residual influence of Gaelic legal code in local landholding practices. One of the key acts of Lord-Lieutenant Chichester in 1605 following the accession of James I was to outlaw the practice of partible inheritance known as 'gavelkind'. The highly localized and community-based nature of Irish landholding and kinship was also remarked upon by Sir John Davies in *Of the Lawes of Ireland* (ca. 1610), where he noted that lands were often distributed amongst local *septs* headed by deputed chiefs, with lands periodically redistributed between sept members (Davies, 1610, cited in Kelly, 1997, p. 430).

One school of thought locates the origins of common tenancy in the pre-Gaelic era. It suggests that practices of common holding may have congealed over centuries into stable local identities giving rise to the geographical divisions of *townlands*, which remain in use to this day (Evans, 1939). Local case studies show how individual Rundale settlements were often concentrated within the boundaries of specific townlands (Buchanan, 1958). Despite attempts by local landowners to subvert the system, by the 19th century, survey figures from the appendices of the Devon Commission (1845) show that 59%, 58% and 29% of the lands of Counties Kerry, Mayo and Clare, respectively, were held in common or joint tenancy at the time of recording. Variance between unions within counties was more pronounced still, with 83% of the union of Westport (Co. Mayo), 71% of the union of Scariff (Co. Clare) and 50% of the union of Kenmare (Co. Kerry) recorded as held in common. Local patterns of tenure thus appear important and variable, and the omission of such from cross-sectional models is concerning. The specific characteristics of these areas were also quite distinct from those of wider Irish society at the time. As shown in Table 1, there were differences in the composition of these common-pool systems relative to more individualized settlements.

The presence of the above differences is well noted in the wider literature on the Irish Rundale (Evans, 1971; McCourt, 1955, 1971; O'Sullivan & Downey, 2008). But these regions, in Ireland and beyond, did not exist in

TABLE 1 Composition of common-pool resource systems

Dimension	Common-pool system	Individualized system
Tenure	Joint or partnership	Individual
Property transmission	Partible inheritance	Primogeniture
Settlement morphology	Nucleated	Dispersed
Field system	Openfield (infield–outfield) system with communal share allocation	Enclosed fields, stable boundary demarcation
Local governance	Governance by communal council/headman	Solitary decision making
Legal reckoning	Customary law, usufruct entitlement	Civil/common law, private property
Village structure	Absence of services (public house or church)	Growth of township to include services
Demography	High fertility, high subdivision	Restricted subdivision, high migration, impartible inheritance

isolation from wider national and international contexts. In Ireland, the cultivation methods and governance practices of these areas—and in turn their potential resilience to ecological risk—were filtered through the wider national context of colonialism. The non-capitalistic nature of the Irish rental system to which all tenures were beholden under colonialism is corroborated by the absence of a supply-and-demand price-setting mechanism for Irish rents (Slater & McDonough, 2008). Irish rent was instead determined by the number of intermediary sub-tenancies, as landlords often sub-let their properties extensively to middlemen and land agents. Thus, although Ireland's level of outward trade in agricultural produce lent it the appearance of a putatively capitalistic society, the social relations of production remained rooted in a feudal rental system with highly variable patterns and extents of direct local control.

This system was interspersed with extensive tracts of common-pool resource governance settlements where lands were held and administered in common, a situation that remained in some districts in devolved form into the early 20th century. Because of the overarching feudal rental system, all common-pool regions operated under the auspices of a joint leasehold system geared as much towards rent production, as to subsistence. Rundale thus remained a highly constrained system, according to the specific nature of local colonial land administration. A crucial problem arises from this. An existing body of work on common-pool systems suggests that they may display a particular resilience to ecological stress due to their responsive institutional make-up and intimate local stakeholder knowledge. Why then, as the following analysis outlines, did these areas appear to suffer worst during the peak famine year? Addressing this question may contribute to understanding an important mediating factor in the Great Irish Famine, as well as refining our theories of how common-pool institutions in general respond to ecological stress. Our methodological task is thus to identify regional measures that best capture these degrees of constraint and to formulate an appropriate modelling strategy.

5 | DATA AND METHOD

Some analytical use has been made of statistics on common tenancy, such as Almquist (1977) and Flaherty (2014). Both studies relied on data measured at county level (N = 32), thus limiting scope for multivariate modelling. The following analysis draws on a set of data measuring a range of physical, social, economic and agricultural conditions at poor law union level (N = 130). This level of aggregation is high, relative to studies that have used electoral divisions (Fotheringham, Kelly, & Charlton, 2013, N = 3,436) or civil parishes (Fernihough & Ó Gráda, 2018, N = 2,387). Owing to the importance of the variables *extent of common tenancy*

TABLE 2 Summary statistics

Variable	Mean	SD	Min	Max	Moran's I
Ration uptake (standardized rate of relief ration uptake, 1847)	0	1	−1.44	3.85	.685***
Population density (individuals per acre, 1841)	0.49	0.45	0.14	4.02	.191***
Poor law valuation (£ pounds per acre)	0.87	1.43	0.02	12.82	.298***
Consolidation of holdings (% change in proportion of farms over 30 acres, 1848–1849)	3.06	7.28	−17.06	38	.185***
Uncultivated land (% total cropland uncultivated, 1847)	71.44	12.29	40.72	97.08	.442***
Corn yield (% change in corn yield [kilograms per acre], 1847–1849)	−8.09	19.10	−45.39	75.64	.123***
Total crop area (% change in total crop area, 1847–1849)	1.54	2.27	−3.95	6.74	.182***
Flax cultivation (% area under flax, 1847)	1.14	2.03	0	9.52	.628***
Common tenancy (% lands held in common or joint tenancy)	8.00	15.25	0	83.88	.224***

*$p < .05$; **$p < .01$; ***$p < .001$.

and *ration uptake* in this analysis, our chosen level of aggregation is most appropriate for maximizing the availability of additional variables. Although these variables are not available at lower levels of aggregation, the widespread use of the poor law union at this time allows us to combine data from several additional statistical sources compiled between 1841 and 1849. Summary statistics for all variables are provided in Table 2, and all sources are cited in the data appendix (Appendix A). This analysis draws on the decennial population census, annual agricultural censes, Commission of Inquiry into the Occupation of Land in Ireland (Devon Commission, 1845) and the Reports of the Select Committee on Poor Laws. All relevant calculations are noted, and any applied transformations are noted in the figure titles and regression tables.

The dependent variable is the rate of relief ration uptake, following the approach used by Kinealy (2006) in her appendix indicating areas suffering high levels of distress. Following initial discussion concerning the establishment of a system of rate-based poor relief in pre-famine Ireland, an act of parliament made provision for additional measures as the crisis of famine deepened.[1] The famine relief activities of the *Select Committee on Poor Laws* were subsequently recorded in a series of reports presented to parliament in 1847, and a key set of tables in these reports notes the extent up uptake in emergency relief rations within each union. Owing to increases in the import of food-stuffs throughout this time, a reduction in domestic food prices enabled the commissioners to subsidize outdoor relief in the form of rations issued either gratuitously or at reduced cost according to individual means. These rations consisted of 1 and 1/4 lb of bread (or 1 lb of biscuit or meal), or 1 quart of soup thickened with a portion of meal along with 1/4 ration of bread (see Second Report of the Relief Commissioners …, 1847).

The first table of records concerning the issuing of rations appears in the Second Report of the Relief Commissioners and distinguishes between rations issued gratuitously to the registered destitute and those sold to individuals of limited means at reduced cost (Second Report of the Relief Commissioners …, 1847). Statistics employed in the forthcoming analysis are limited to those concerning the issue of gratuitous rations, which in a majority of unions significantly outnumber those sold at subsidized rates. The data are drawn from six successive reports of 8 May, 5 June, 3 July, 31 July, 28 August and 11 September 1847. The largest number of rations issued on a single date across all reporting periods was selected for inclusion. The rate of ration uptake per head of population was first calculated, before *z*-score standardization.

[1]See *An Act for the Temporary Relief of Destitute Persons in Ireland* (1847).

TABLE 3 Inter-item correlations

	Ration	Population	Valuation	Consolidation	Uncultivated	Corn	Crop	Flax
Population	–.184*							
Valuation	–.200*	.962***						
Consolidation	.226**	–.227*	–.237**					
Uncultivated	.515***	–.331***	–.309***	.085				
Corn	–.175*	–.130	–.137	–.181*	.109			
Crop	–.227**	.112	.058	–.194*	–.062	.006		
Flax	–.340***	–.044	–.100	–.158	–.161	.082	.248**	
Common (log)	.290***	.023	–.021	.161	.266***	–.069	–.038	.100

*p < .05; **p < .01; ***p < .001.

Our key independent variable is the extent of common tenancy, sourced from the statistical tables of the Devon Commission (1845). Appendix 94 of this report records the 'Area of Union in Statute Acres' and 'Total Number of Acres Held in Common or Joint Tenancy' in each union, permitting calculation of a comparable rate. Figures at union level exhibit greater variation than those reported at county level in previous studies such as Almquist (1977), as when aggregated to county level, significant variation is lost owing to differences in the extent of *recorded* communal tenure within individual counties. For example, despite 50% of the lands of the union of Kenmare, Co. Kerry being noted as held in common, the union of Caherciveen—also falling within Co. Kerry—shows none. McCabe (1991) suggests that joint tenancy may have been under-enumerated, owing to the reliance of union clerks on union rate books. As such, any potential errors in the compilation of figures are likely to affect absolute levels within all unions, rather than the variance, which is of primary concern. When corroborated with other estimates of the extent of common tenancy such as McCourt's (1971) clachán distribution map compiled from first edition 6-inch ordnance survey maps (pp. 138–139), we can be confident that these figures are representative of between-union variance in common tenancy. Further details on other variables used in this analysis are available in Appendix A.

Preliminary inspection of the spatial distribution of variables is given by Moran's I and Getis–Ord Gi* plots. Full details of the calculation of both, and spatial lag plots for common tenancy and ration uptake, are provided in Appendix B. The discussion section of this paper draws on these preliminary findings to suggest mechanisms giving rise to these local dependencies. Having established the presence of spatial clustering, we present a geographically weighted multivariate regression model (GWR) of factors contributing to local distress rates. In this specification, independent variables become functions of both a location and its attribute, thus permitting variation in parameters over space (equations from Brunsdon & Comber, 2015, p. 291). The standard regression model (1.1) maintains fixed parameter estimates across the entire set of data. Adding a location represented by coordinates (u_i, v_i) allows coefficients, intercepts and diagnostics to vary as a function of different weighting methods (1.2). These methods typically involve distance-based bandwidths, moving windows or contiguity functions. In effect, this method estimates an iterative series of restricted models using cases falling within a given bandwidth. The distribution of regression parameters (coefficients, residuals and r^2) can then be plotted to assist interpretation of results.

$$z_i = a_0 + X_i + \varepsilon_i, \tag{1.1}$$

$$z_i = a_0(u_i, v_i) + a_1(u_i, v_i)X_i + \varepsilon_i. \tag{1.2}$$

Parameters are estimated through ordinary least squares (OLS), and both fixed and adaptive bandwidths based on Akaike's information criterion (AIC) are provided. These are compared with cross-sectional OLS specifications with standard errors clustered by county. The discussion argues that cross-sectional analyses that discard the potential for spatial effects introduce potential error into their conclusions—substantive and theoretical. Consequently, by examining this local variation, we can better understand how this complex mix of factors can produce geographically uneven distress rates. We interpret these results through resilience theory's emphasis on local adaptive capacity, as a property of social-ecological systems that mediates risk exposure.

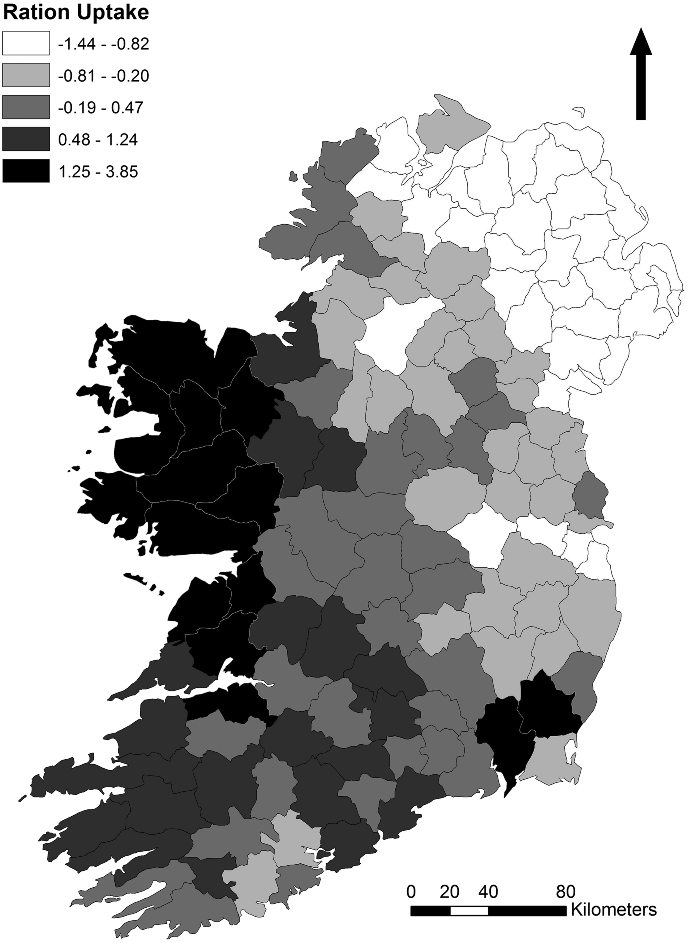
6 | UNDERSTANDING THE LOCAL GEOGRAPHY OF FAMINE

To what extent do these variables show local clustering, and how might we account for this regional variation? Considering the zero-order correlations from Table 3, we see that our outcome variable shows moderate correlation with other predictors. These are intuitively signed, with higher valuation, higher crop yield, greater productive area and greater extents of flax growth associated with reduced ration uptake. The effect of population is counter-intuitive however, and we should expect this to be positively signed, with respect to both ration uptake and common tenancy.[2] The negative sign of population density is likely detecting the effect of urban concentration in areas such as Dublin, Cork, Waterford and Belfast. As such, this is likely detecting the comparative affluence of certain areas particularly within Dublin. It is difficult to detect the impact of population density in Western districts however. Although we may hypothesize that it was substantial, it is more likely to have taken the form of high-density settlement pockets, within otherwise sparse and spacious regions. The presence of large tracts of grazing land, which in turn impacted on the ability of common-pool systems to expand under population pressure, is also likely to have diminished the sensitivity of this measure to smaller, more localized high-density settlement. Similarly, settlement consolidation, the presence of uncultivated land and the extent of common tenancy are associated with higher rates of ration uptake.

Turning to the autocorrelation figures (Moran's I) in Table 2, we find substantive and statistically significant degrees of spatial autocorrelation across all variables (see Appendix B, Figures B.1 and B.2). Ration uptake records a score of .685, the largest of all variables. This is easily accounted for visually as can be seen in Figure 1 showing strong concentration in Western regions. Common tenancy also exhibits a modest degree of spatial autocorrelation, which is likely diminished by the presence of isolated pockets of common tenancy in the southeast and southwest as shown in Figure 2. Those of the southwest—South Kilkenny in particular—represent a different form of commune to that described by the typical criteria of common-pool governance described above. These areas are mostly devolved manorial villages of the three-field system, which acquired their nucleated morphology during Norman occupation, but typically without accompanying communal institutions (Burtchaell, 1988). Inspection of the spatial lag plots of these variables reveals more, with evident linearity in the lag of ration uptake, but a less certain trend in common tenancy (see Figures B.1 and B.2). Finally, Getis–Ord Gi* plots for both variables reveal significant hotspots departing from the global average and clustering along the Western seaboard—particularly in Western Counties Mayo, Clare and Kerry (see Figures B.3 and B.4). Together, these indices provide strong corroboration of the importance of local dependency in the behaviour of variables, with clear patterns emerging between East–West and North–South. In all instances, Western regions associated with the 'small-farm' archetype (Whelan, 2000) display especially strong clustering behaviour.

[2]Studies such as Fernihough and Ó Gráda (2018) have shown that population pressure, when subject to additional controls, shows a correlation with living standards (which we might expect in turn to be a good indicator of potential suffering during the Great Famine). Their analysis of civil parishes is at a higher spatial resolution and considers several local conditions that may have played a mediating role in distress rates, such as proximity to market towns and roads (Fernihough & Ó Gráda, 2018, p. 24).

FIGURE 1 Ration uptake



6.1 | Mechanisms of local dependency

How did these patterns arise, and how might their geographies have influenced spatial inequalities in the impact of famine? More importantly, how might these processes have been influenced by the institutional structures of common-pool governance and colonialism? This is an important precursor to formal modelling, as effects must be grounded in a valid narrative that captures the mechanisms at work. These causal mechanisms are also summarized in Table 4. *Poor law valuation* is a measure closely linked to potential land productivity and profitability. As such, it is closely linked to a range of factors such as regional economic profile, regional archetypes (whether the regions are primarily tillage, pastoral or quasi-subsistence) and local geology (Collins, 2008). Thus, we find a characteristic East–West bias in the distribution of valuation, with a concentration of low valuation in Western unions. This region is characterized by a predominance of small farms of low capital and high labour intensity and with shallow, heavily leached soil (Evans, 1979). High rates of subdivision also diminished the introduction of plant and capital to the labour process. Others have suggested that this regional poverty owed its origins to a hypothesized post-17th-century westerly mass migration of a dispossessed peasantry in the wake of the Cromwellian plantation, for example, evidence for which remains disputed (Braa, 1997). In any event, the combination of economic, social and geological marginality created an immediate need for labour pooling to break in new lands for cultivation, making it conducive to governance by common-pool resource systems.

The geography of *consolidation of holdings* is more intuitive. In the post-Napoleonic period, grain and stock price fluctuation dictated patterns of regional restructuring, as landlords sought to move away from high-density tillage

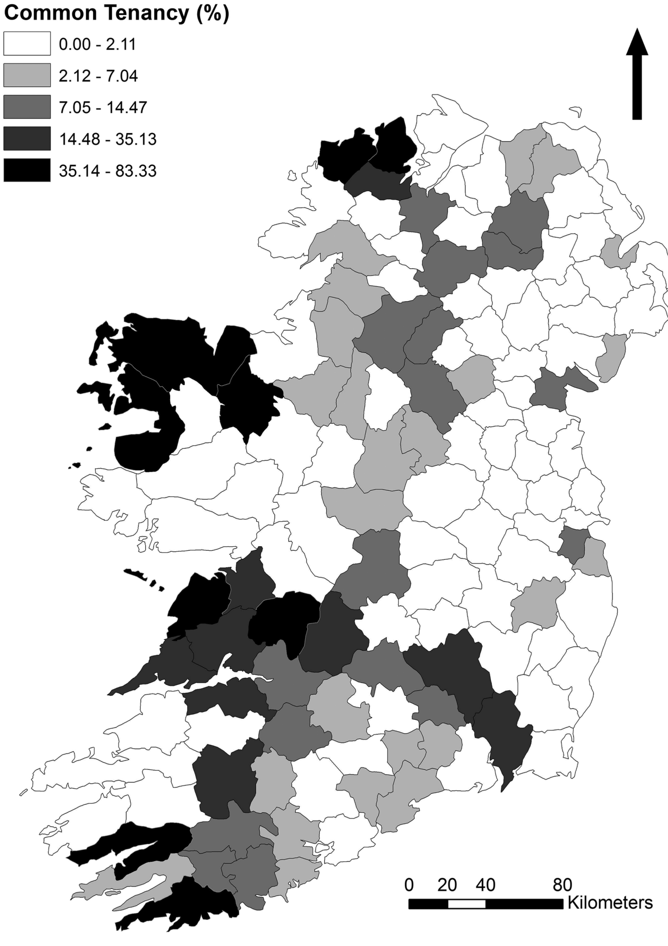


FIGURE 2 Lands held in joint or common tenancy

production towards land-extensive grazing in response to rising stock and wool prices. Local styles of land administration also played a role; hence, we find contradictory mass evictions on the Nixon estates of Donegal, the Mahon estates of Roscommon and the Walsh estates of Mayo, yet investment, improvement and resettlement on the Hill estates of Donegal (Mac Aoidh, 1990; Yager, 1996). The post-Napoleonic years marked a watershed in this respect, insofar as landlord's core channels of profitability shifted from increasing the density of tenant farmers engaged in tillage towards clearing estates to make way for capital-intensive grazing. Approximately 37,286 evictions occurred from 1846 to 1849 (Orser, 2006), placing stress on the capacity of Rundale-dense regions to maintain their essential structures. The result was a spatially uneven pattern of redistribution, with varying degrees of direct local intervention by landowners.

Our four measures of productive activity, *uncultivated land*, *corn yield*, *total crop area* and *flax production*, map well onto the processes described for valuation and consolidation, and these are key factors in accounting for local adaptive capacity. The availability of 'wasteland' conditioned the expansion of the Rundale system on peripheral lands, as the system tended towards demographic expansion through subdivision (Aalen, Whelan, & Stout, 2011). This was facilitated by the expansion of communes onto new marginal lands and, coupled with the retention of gavelkind inheritance practices, was essential to its persistence. This was also an unfortunate precondition of the Great Famine however, as the prolific potato allowed smallholders to settle comparatively smaller plots of land, thus enhancing the concentration of biomass and lowering species diversity in the pre-famine years (Fraser, 2006).

TABLE 4 Mechanisms of local dependency

Variable	Mechanism
Population density	Classic mechanism of Rundale expansion: high fertility, partible inheritance, endogenous expansion and clachan morphology engendered high-density settlement. Density also played a role in the spread of communicable disease. Our data are detecting higher urban densities.
Poor law valuation	Valuation linked closely to productivity and productive capacity of land, and in turn, the profitability of particular activities corresponds with wider economic circumstances such as the relative prices of produce (i.e., grain vs. wool vs. stock).
Consolidation of holdings	Strong regional differences in estate reconfiguration post-Napoleonic war, moderated by price of produce, extent of direct control over estates and labour within settlements.
Uncultivated land	Availability of wasteland, a key contextual variable in the growth of Rundale through both outward reclamation from within and new settlement colonization. Elevation is also important, as such settlements tended to thrive on higher, marginal lands.
Crop yield	Strong patterning of production and yield according to 'regional archetypes', with particularly strong output in certain specialized areas (i.e., the Anglo-Norman Southern-Eastern tillage tract). Yield consistency reflects regional ecological and economic resilience.
Flax production	Regional clustering of linen production in the Ulster linen triangle, in certain districts of West Mayo, with proximity to linen markets, household divisions of labour and availability of labour, a key factor. Linen production reflects a diversity of income streams beyond sole dependence on single crops and is a key factor in settlements resilience to external stress.
Common holding	Settlements constituting Rundale identity (Table 1, 'common-pool system') thrived in marginal land-poor districts, at higher altitudes, and under favourable grain prices where landlords encouraged tillage.
Ration uptake	Together, these factors conspired to lower resilience to distress amongst common-pool and land-poor regions. With the balance of openfield production disrupted, continuing rent obligations, restrictions on expansion, monoculture of dietary potato dependence, low species diversity and disease in turn thrived.

Corn yield and *total crop area* both capture changes in production from 1847 to 1849, the peak years of hardship. Although both exhibit low degrees of spatial autocorrelation, they are key components of regional resilience. These measures also capture longitudinal change, as they capture differences between the annual agricultural censes of 1847 and 1849. It is telling in this regard that both corn yield and crop area are negatively correlated with consolidation and ration uptake (Table 3). These measures capture seasonal yield consistency during the peak famine months, and declines in cultivated space were likely linked to lower labour input and forced land enclosures. Corn yield is of interest as, despite the depiction of Western regions as wholly potato dependent, grains featured prominently in the production process owing to the necessity of rent payments as mentioned above. Thus, whereas potatoes were consumed, or their surplus used as stock fodder, grains were essential to avoid falling into arrears.

The effect of physical restrictions on the ability of settlements to expand, coupled with continuing rent obligations despite the hardship of the peak famine years, meant surrendering an ever-greater proportion of tillage area to non-subsistence crops. This particularly affected peripheral areas, especially common-pool regions, which depended on a delicate balance of tillage and stock for their viability. As such, we find a concentric diminishing of yield from East to West, consistent with the predominance of intensive tillage along the Southern to North-Eastern Anglo-Norman tillage crescent. The pattern is less pronounced for changes in crop area, consistent with its low degree of spatial autocorrelation, although large pockets are found towards West-Connaught and southwesterly towards Limerick and Kerry.

Our outcome and key predictor (*ration uptake* and *common tenancy*) display clearer spatial patterning, visually and diagnostically. Whereas evidence of autocorrelation for common tenancy is low owing to the haphazard intermixing of high–low-density areas, it correlates positively with ration uptake. Figures B.3 and B.4 show results from Getis–Ord hotspot analyses, which reveals clear concentrations in Western counties. Consistent with evidence governing the distribution of flax production in the North, we also find concentrations of lower ration uptake in comparatively affluent northern unions. Discussed further below, these unions were additionally protected by the 'Ulster Custom' that offered greater security of tenure to tenants relative to their southern counterparts (Dowling, 1999).

The included predictors describe well the conditions that facilitated higher densities of Rundale. These included the availability of marginal lands of low productivity, and high volumes of direct producers subsisting on a narrow range of root crops, in a mixed-farming openfield system characterized by extensive subdivision. With the removal of barriers to early family formation, fertility soared amongst rural smallholders, resulting in a near fourfold increase in population from the late 17th to mid-19th centuries (Flaherty, 2013). The Irish Rundale system achieved this through internal subdivision of commune lands, facilitated by the prolific nature of the potato. Such was the pace of fragmentation that by 1841, 45% of all holdings in Ireland were under 5 acres, with higher regional rates such as 64% recorded in Connaught (Connell, 1950, p. 284). This was tolerated in many districts owing to the 'absolute rental regime' that prioritized an ever-increasing number of direct producers as a means of surplus accumulation amongst colonial elites (McDonough & Slater, 2005).

The concept of panarchy from the resilience literature links these factors to diminished adaptive capacity at settlement level and their heightened vulnerability to ecological stress. As connectivity (settlement fragmentation) heightens, coupled with a reduction in species diversity (monoculture) and an increase in biomass, the magnitude of disturbance required to induce systemic collapse becomes ever smaller. Such were the circumstances in Ireland on the eve of the famine; however, models to date have not taken adequate account of the uneven geography of resilience, nor of the potential role of common tenancy. As our diagnostics show, these factors were distributed such that a general model cannot be applied universally to the entire territory. Institutions, particularly those of the Irish common-pool governance, played a crucial role in the construction of this geography, mediating the impact of the specific antagonist—the blight strain that decimated crops over multiple seasons. Our final piece of analysis examines the impact of common tenancy, controlling for these contextual factors.

7 | A GEOGRAPHICALLY WEIGHTED MODEL OF FAMINE DISTRESS

Table 5 displays parallel results from a set of cross-sectional and geographically weighted models and visual diagnostics (residual plots and R^2) in Figures C.1–C.4. Both geographically weighted models offer some improvement on the overall explanatory power of the included variables, with the fixed and adaptive specifications improving the R^2 substantially. Whereas this is also due in part to the inclusion of additional parameters in the GWR specification, the AIC also records a reduction, and this figure is itself adjusted for the complexity of the model, suggesting that the GWR is the preferred specification. Whereas the fixed bandwidth performs marginally better diagnostically, the adaptive is a more intuitive fit with the research problem, as it adjusts the number of neighbours according to our chosen contiguity criteria. Examining the distribution of local R^2 in both fixed and adaptive specifications (Figures C.1 and C.2) shows substantial regional variation in explanatory ability across regions—particularly the north and west, although this may be a function of the large bandwidths excluding influential cases.

In all specifications, the dependent variable (ration uptake) is centred by converting the rate of ration uptake to a z-score, as population and ration counts vary between unions. Regression coefficients may be interpreted as the effect in standard deviation units on ration uptake, of a unit increase in the predictor. The relative impact of different independent variables can be established with reference to the original units of measurement, given in Appendix A. For Model 2, an increase of 1 percentage point in the area under flax is associated with a .15 standard deviation decrease in ration uptake. With geographical weights (Model 5), the effect is a reduction of .09. Across all cross-sectional specifications, coefficients are signed as expected by the preceding discussion. Common holding displays strong positive association with ration uptake, recording one of the strongest effect sizes aside from population density. Care is needed when interpreting these, as a unit increase in the log of common tenancy relative to that of a unit increase in population density means that these are not directly comparable as relative effect sizes.

TABLE 5 Regression output (OLS and geographically weighted)

	OLS (errors clustered by province)			GWR (fixed bandwidth)	GWR (adaptive bandwidth)
Model #	**1**	**2**	**3**	**4**	**5**
Common (log)	.544*	.284*	-	.290* (.073)	.300* (.059)
Population	-	1.54**	1.508**	1.323* (.536)	1.472** (.409)
Valuation	-	−.541**	−.510**	−.477** (.140)	−.511** (.109)
Consolidation	-	.004	.006	.007 (.009)	.008 (.008)
Uncultivated	-	.035**	.031**	.030*** (.009)	.031*** (.010)
Corn yield	-	−.010*	−.009*	−.011** (.003)	−.011** (.002)
Crop area	-	−.064*	−.069*	−.040 (.032)	−.041 (.037)
Flax cultivation	-	−.150***	−.148**	−.096* (.076)	−.091* (.068)
Common (Group 1)	-	-	Reference	-	-
Common (Group 2)	-	-	−.109	-	-
Common (Group 3)	-	-	−.153	-	-
Common (Group 4)	-	-	.694**	-	-
Constant	−0.312	−2.743**	−2.369*	−2.448*** (.540)	−4.235*** (.608)
F	(1, 31) 6.43*	(8, 31) 10.21***	(10, 31) 12.10***	(8, 121) 41.894	(8, 121) 44.482
Adj R^2	.084	.467	.512	.605	.593
AIC	360.476	292.120	280.793	268.379	270.519
Mean VIF	-	4.90	4.31	-	-
Neighbours	-	-	-	-	117
Bandwidth	-	-	-	149 km	-
N	130	130	130	130	130

Note: In the GWR column, coefficient standard deviations are in parentheses.
Abbreviations: AIC, Akaike's information criterion; GWR, geographically weighted regression; OLS, ordinary least squares; VIF, variance inflation factor.
*p < .05; **p < .01; ***p < .001.

This is addressed with Model 3, which decomposes the impact of common tenancy by four distinct groupings. Categorization was performed through *k*-means clustering, with an input condition of four, yielding a set of comparator groups for which Group 4 displayed the highest group mean. The groupings were set using the untransformed common holding variable. Group 4 is here associated strongly and positively with heightened ration uptake (.694 standard deviation of ration uptake), suggesting that these unions were particularly affected. Relative to the ungrouped variable in Models 1–2 and 4–5, it shows the disproportionate impact that higher densities of common tenancy may have produced. To explain this further, we need to look to the additional controls and place them in context. Taking Models 1–3 as an unadjusted baseline, we now focus discussion on the geographically weighted (GWR) specifications in columns 4 and 5. These adjust both the point estimates and standard errors according to the calibrated geographical weights and are thus preferable to the OLS.

Beginning with our controls, whereas the impact of population density is intuitive in terms of the mechanisms outlined above—particularly in high-density common-pool regions—the variable is itself only weakly correlated with common holding, as per Table 3. As such, the positive effect of population is likely due to high-density urban regions into which numbers of destitute flooded during the peak famine years. Rather than marking a departure from the rural norm however, urban areas were themselves sites of vast inequality and high mortality, particularly in high-density tenement districts. Additional stressors of ration uptake include consolidation and uncultivated lands. In line with our discussion of the role of productivity above, consistency of yield (*corn yield*) and productive area (*crop area*) are both associated with lower ration uptake, albeit with a small effect size of .01 and .04 standard deviations of ration uptake, respectively. Corn yield is particularly interesting, as although recorded potato acreages were provided through the agricultural censes, the widespread destruction of crops makes systemic comparison of true yield estimates impossible, whereas turnips are of too small a count to substitute. As corn production is widely distributed across the island, the capacity of regions to maintain output—itself dependent on not only ecological circumstance but also institutional robustness—is a useful resilience indicator.

Of those whose effects can be compared in unit terms, flax cultivation appears to play the greater role in diminishing ration uptake, relative to other land-use variables such as *crop area*, *corn yield* and *consolidation*. Flax cultivation captures not only the comparative resilience of Northern Ulster but also the importance of economic diversification. According to Sen's classic entitlements model, the collapse of indirect entitlements constitutes one of three key sustenance channels in a healthy economy. One avenue towards widening indirect entitlement channels at settlement level is economic diversification, and our results suggest that the diversity of income streams offered by cottage industries engaged in flax production and ‘putting-out’ played a key role in enhancing their resilience to ecological stress. The North–South geography is worth emphasizing, as the presence of ‘Ulster Custom’ has long been viewed as a key factor in the formation of capital in Ulster, relative to stunted industrialization in the South. According to this, Ulster Tenants enjoyed not only comparative fixity of tenure but also rights to compensation for improvements enacted upon repossession of their land (Dowling, 1999; Gray, 2005). Contemporary authors saw the absence of fixity of tenure as a disincentive to investment in fixed improvements such as drainage and boundary setting. This would later form a key part of the mission of the Congested Districts Board in the late 19th century, whose reports reflect a state of overcrowding and underdevelopment in western regions (Breathnach, 2005).

This was not the only disincentive to improvement however, and it is important that these factors be interpreted in their colonial context. Just as the absence of the ‘Ulster Custom’ implicated the formation of capital in southern unions, so too did other stressors affect cultivation practices at local levels. This is key to understanding the likely experience of Rundale-dense areas who faced constraint from several factors. Whereas potato dependence has long been viewed as a proximate cause, many marginal communities, and indeed Rundale communes themselves, operated as mixed economies. As a colony under landlordism, Irish tenants were still required to produce cash crops to meet rent payments, and this often meant eliminating oats from tenant's diets, as oats were consigned to the markets (Slater & Flaherty, 2009). This is but one example of the conditioning effect of landlordism on local ecology and its production of a tendency towards monoculture.

Considering Ireland's rate of population growth in early 19th-century Ireland, which rose 72% from 4,753,000 in 1821 to 8,175,124 in 1841, the capacity of individual settlements to incorporate new members whilst retaining their delicate balance of tillage and grazing was essential—and wasteland played a crucial role in this regard. Villages often grew exponentially, with noted instances of unchecked settlements evolving from a handful of homesteads to over 30 within a single generation (Aalen et al., 2011). In the absence of external constraints, expansion was often limited primarily by local geography and geology, but under colonialism, the calculus of international markets played a dominant role in the annexation of neighbouring lands by landlords for capital-intensive activities. The result was a heightened strain on communes who were now forced to accommodate new members by further subdividing their existing space, or by colonizing parts of their grazing ground for tillage, thus upsetting the balance of pasture and tillage central to the systems' identity. It also forced the expansion of settlements onto ever-more marginal plots, exposing them to an internal 'metabolic rift' of declining fertility (Slater & Flaherty, 2009). The clearest effects of this reduced coping ability were in the progress of disease. Excess mortality during the peak famine period was not attributable to direct starvation alone, and communicable diseases—particularly cholera, dysentery and typhus—played the greatest role in fatalities (Clarkson & Crawford, 2001). We may infer that the high-density settlement associated with Rundale contributed to the rapid spread of disease amongst an already immune-compromised population. These factors also played a significant role in previous disease outbreaks such as the smallpox epidemic of 1739.

Focusing on the interaction of both internal and external factors explains something of the contradiction between the general literature on common-pool resource systems and the specific Irish case. Whereas the classic works in this area suggest a greater potential resilience for systems with localized resource governance (Ostrom, 1990; Wall, 2014a,b), common tenancy is associated with increased ration uptake in both GWR specifications. This does not substantiate a Malthusian reading of the phenomenon either, as although population density and valuation play a role, the explanation of Rundale's diminished resilience, and thus the positive sign of the common coefficient, is through the way in which colonial context conditioned cultivation strategies and adaptive capacities at local levels. In the absence of constraints on outward expansion and internal disruptions in seasonal rotation, it is possible that the system may have offset some of the severe impacts it experienced. This is a cautionary note on the importance of local contextualization and the transplanting of explanations that deal with characteristics of a diffuse 'commons in general'. The system of agrarian collectivism implicated in the 20th-century post-revolutionary Soviet/Ukranian famines traced its origins to the indigenous Russian *Mir* system (Wemheuer, 2014), which bore striking similarities to that of Rundale. Conversely, the communal dining systems of post-revolutionary China that preceded the Great Leap famine of 1959–1961 were imposed from without however (Kung & Lin, 2003). Both produced disastrous consequences under very different circumstances.

8 | CONCLUSION

To fully appreciate the context, emergence and impact of famine, we must consider not only its uneven regional impact but also the moderating role of resource governance systems in generating this uneven distribution. These results map well onto Ostrom's emphasis on the role of institutional adaptive capacity and, in turn, confront several common charges levelled against other meso-level models such as Sen's entitlements model. First, by investigating more fully the structures and institutions that characterized the settlements in question, we are better able to account for the complex channels through which environmental stressors translated into inequalities of impact. The preceding models verify not only the significance of local modes of governance as predictors of distress rates but also their uneven impact across the island. This question of spatial variance has been largely absent from much quantitative work on the impact of famine. Second, in addressing Devereux's (2001) criticism of the methodological individualism of work in famine studies, we might argue that a more reasonable approach is to turn to ecological models such as this, to more fully tease out the role of contextual effects. Methodologically, these results demonstrate the need for sociologists to pay greater attention to geographical variability in their analyses. Rather than 'controlling out' spatial heterogeneity through regional fixed effects, or treating them as confounding factors to be adjusted through standard errors, instead, we should use the descriptive abilities of spatial diagnostics, and the analytical capabilities of weighted modelling, to enhance our understanding of the behaviour of meso-level social structures and institutions.

Most important are the lessons this case study may hold not only for understanding systems of 'primitive communism' in pan-European context but also for common-pool resource systems in general. Repeal of constitutional protections for Mexican village commons sparked the 1994 Chiapas conflict, giving lie to the notion that enclosure was a process limited to the transition from feudalism to capitalism (Linebaugh, 2014). Others have argued that Marx's analysis of the Irish environment under colonialism marked the passage of his ecological thought into more 'concrete' form, thus linking Ireland directly with both classical and modern theories of ecology under capitalism (Foster & Clark, 2020, p. 64). As work continues on the extent to which empirical cases of European commons informed such classical theories of ecology and capital, the connections between historical ecology, commons and the future of climate under capital are becoming ever clearer. The results of this study should be read as both an exercise in empirical clarification and the need to consider capitalist or colonial context when assessing the robustness of resource governance systems. These contexts are key to explaining the experience of ecological disaster, rather than supposed inherent inefficiencies in common-pool systems themselves.

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APPENDIX A: DATA SOURCES

Variable	Source
Ration uptake (standardized rate of relief ration uptake, 1847)	Second Report of the Relief Commissioners ... (1847)
Population density (individuals per acre, 1841)	Census of Ireland (1841)
Poor law valuation (£ pounds per acre)	Almquist (1977)
Consolidation of holdings (% change in proportion of farms over 30 acres, 1848–1849)	Devon Commission (1845)
Uncultivated land (% total cropland uncultivated, 1847)	Returns of Agricultural Produce in Ireland, in the Year, 1847
Corn yield (% change in corn yield [kilograms per acre], 1847–1849)	Returns of Agricultural Produce in Ireland, in the Year, 1847
Total crop area (% change in total crop area, 1847–1849)	Returns of Agricultural Produce in Ireland, in the Year, 1847
Flax cultivation (% area under flax, 1847)	Returns of Agricultural Produce in Ireland, in the Year, 1847
Common tenancy (% lands held in common or joint tenancy)	Devon Commission (1845)

APPENDIX B: UNIVARIATE SPATIAL ANALYSIS

This section details the calculation of Moran's I and the procedure for generating a Getis–Ord Gi* plot. Together, both Moran's I and Getis–Ord Gi* permit closer investigation of the local and global behaviour of particular variables.

B.1 | Moran's I

Moran's I measures the slope of a bivariate plot of a given variable against its *spatial lag* calculated from as the mean of both a unit and its set of defined neighbours. Neighbours are here defined by 'Queen' contiguity, which includes the unit and all proximate units in direct contact with any portion of its boundary. Accordingly, a positive slope indicates close correspondence between the variable and its spatial lag (i.e., its neighbours). In specification, Moran's I is an extension to the standard product–moment correlation, with the addition of a weights matrix capturing dependencies between contiguous regions (Brunsdon & Comber, 2015, p. 230). Variables are centred prior to plotting and calculation. Moran's I for all variables is included in Table 2 in the main text.

The spatial lag plots below (Figures B.1 and B.2) record the correlation of the original variable with its spatial lag. To interpret, a positive correlation such as that indicated below shows that locations with low uptake tend to border locations with low values, and similarly, locations with high values tend to border those with higher values. The *y*-axis is the local mean of the surrounding units of each point. Together with the Moran's I statistic, we observe strong spatial autocorrelation for ration uptake (.685) and weaker for common tenancy (.224).

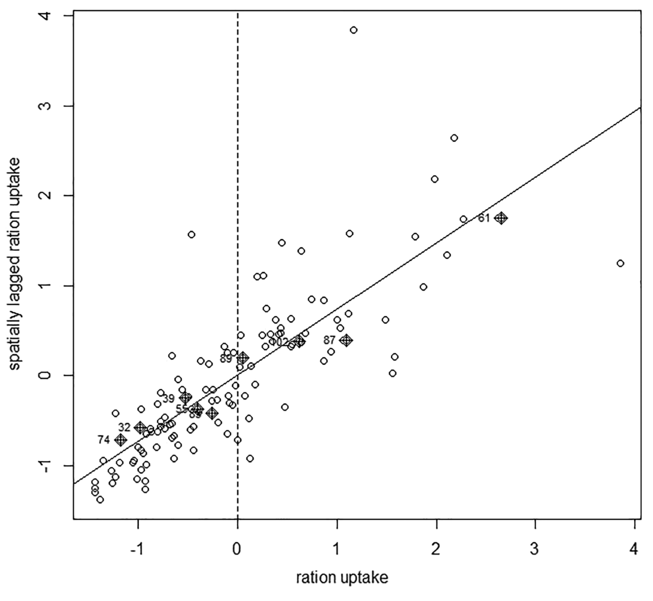

FIGURE B.1 Spatial lag plot, ration uptake

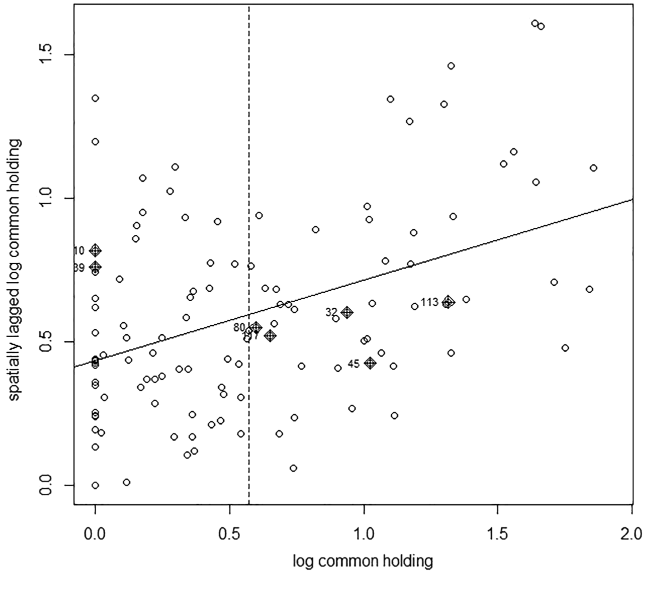

FIGURE B.2 Spatial lag plot, common tenancy

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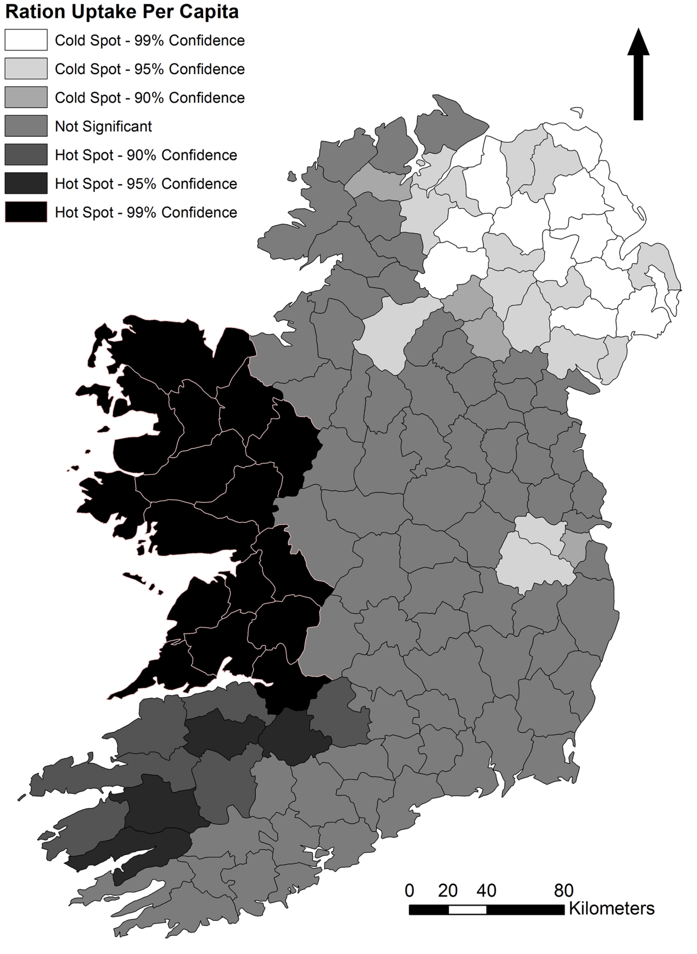

FIGURE B.3 Getis–Ord Gi*, ration uptake

B.2 | Getis–Ord Gi*

Getis–Ord Gi* (Ord & Getis, 1995) compares the local mean of a location and its defined neighbours against the global mean, producing a plot identifying statistically significant instances of high and low clusters. This approach identifies areas that represent a significant departure from the global norm and are useful for gaining a visual appreciation of local clustering behaviour. As with the Moran statistic, we use contiguity definitions of neighbouring rather than fixed bandwidths. The mapping of 'hot and cold' spots uses *Z*-scores to identify clusters of high or low values with a statistically significant departure from the global mean. In order for a location to be deemed statistically significant, not only must its value be substantially high or low, but it should also border locations with similarly high or low scores.

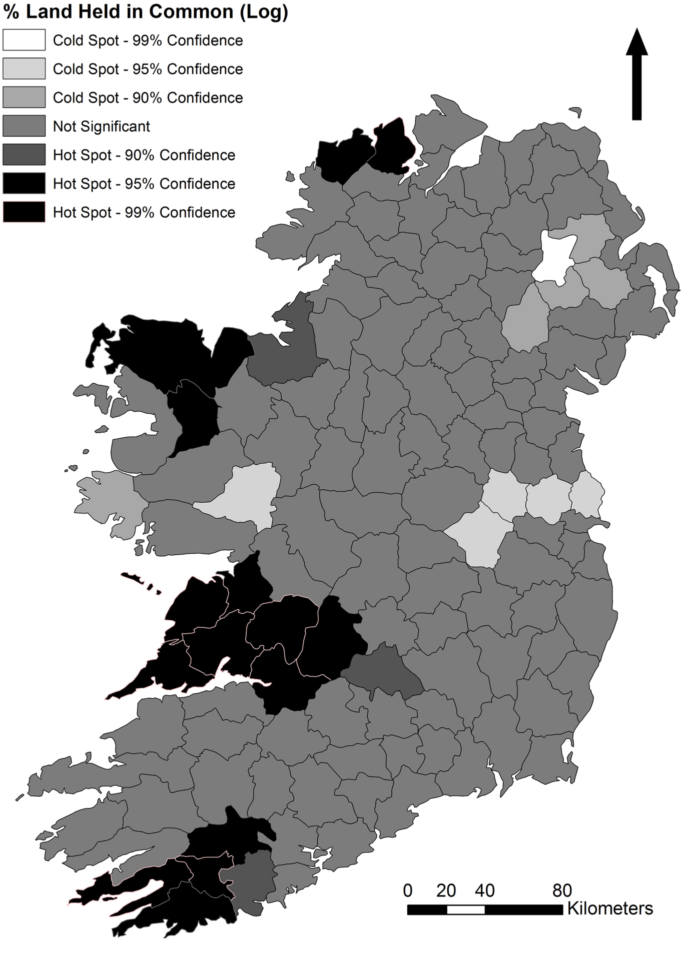

FIGURE B.4 Getis–Ord Gi*, common tenancy

APPENDIX C: MODEL OUTPUT AND DIAGNOSTICS

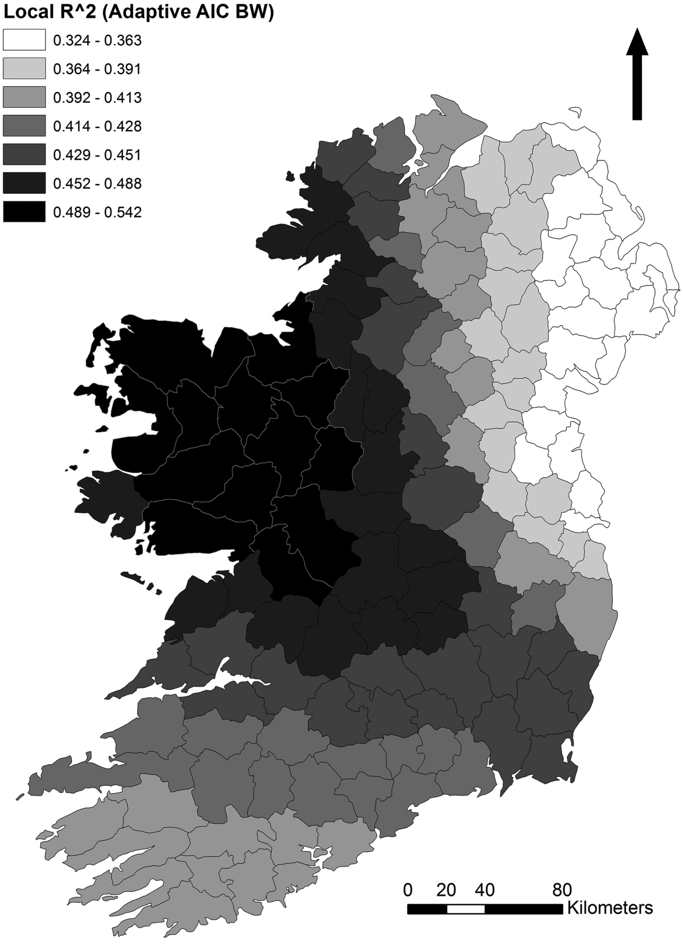

FIGURE C.1 Local R^2 (adaptive). AIC BW, Akaike's information criterion bandwidth

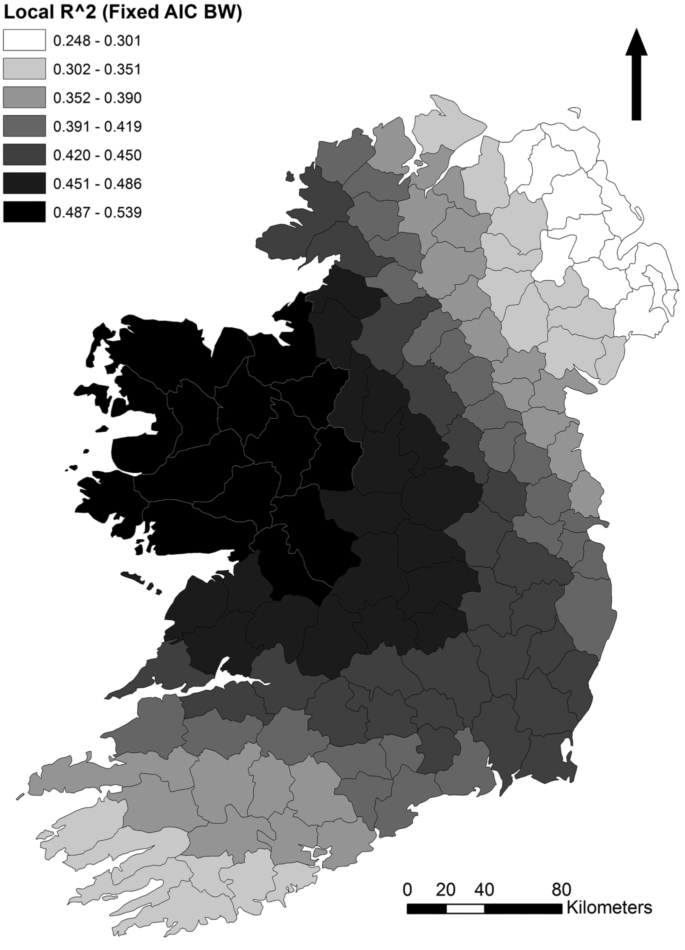

FIGURE C.2 Local R^2 (fixed). AIC BW, Akaike's information criterion bandwidth

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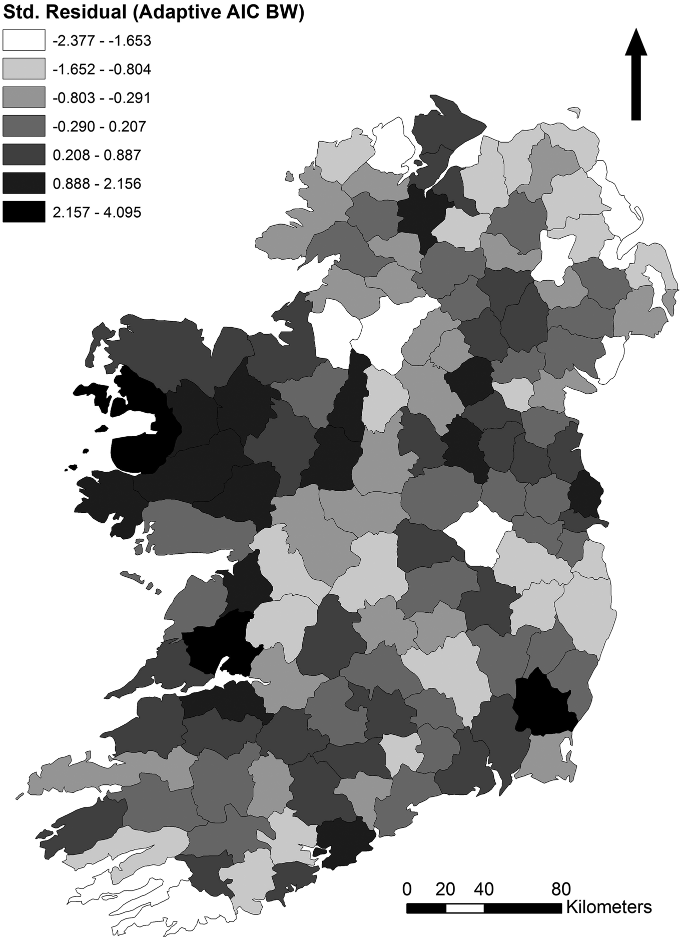

FIGURE C.3 Standardized residuals (adaptive). AIC BW, Akaike's information criterion bandwidth

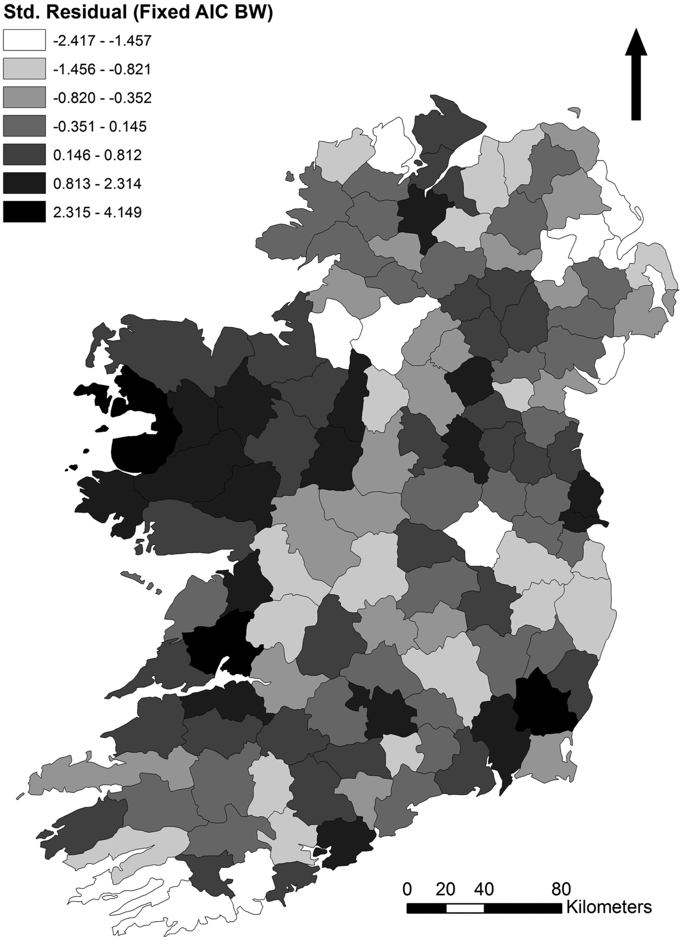

FIGURE C.4 Standardized residuals (fixed). AIC BW, Akaike's information criterion bandwidth