

A Land 'of Milk and Butter': The Role of Elites for the Economic Development of Denmark

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Abstract: We explore the role of historical elites for development and in particular for the spread of cooperative creameries in Denmark after 1882, which is often cited as a major factor behind that country's rapid economic catch-up. We demonstrate empirically that the location of early proto-modern dairies, so-called *hollænderier*, introduced onto traditional landed estates by German-speaking elites from the Duchies of Schleswig and Holstein in the eighteenth century, can explain the location of cooperative creameries in 1890, more than a century later, after controlling for other relevant determinants of cooperation. We interpret this as evidence that areas close to a *hollænderi* witnessed a gradual spread of modern ideas from the estates to the peasantry. Moreover, we identify a causal relationship by utilizing the nature of the spread of *hollænderier* around Denmark, and the distance to the first *hollænderi*. These results are supported by evidence from a wealth of contemporary sources.

Keywords: Institutions, technology, cooperatives, dairying.

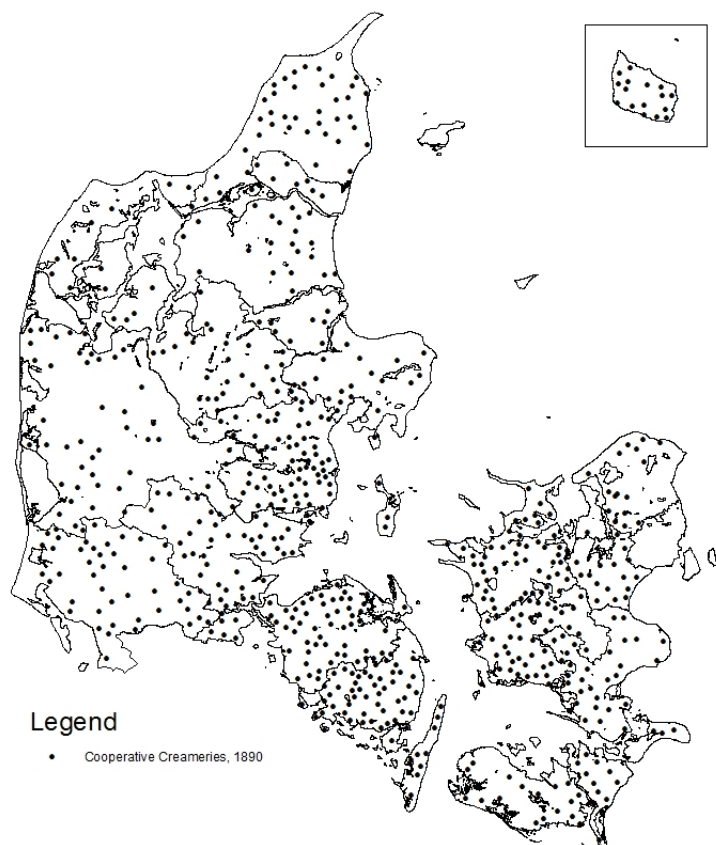
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1. Introduction

A substantial literature in economics examines the impact of elites on the growth trajectories of societies across time and space via several different channels. While, the impact on economic and political institutions is well-established, the role of elites for knowledge diffusion is not as well understood. In this paper, we shed new light on how elites may foster growth through the knowledge diffusion channel. We focus on a specific example centered on the Kingdom of Denmark, and the emergence of a modern dairy industry based on a new technology, the automatic cream separator, and an institution, the cooperative creamery, which propelled the country towards prosperity in the last decades of the nineteenth century (for a brief account, see Henriksen 1993). An important point surrounding this development is the rapidity with which it happened: after the foundation of the first cooperative creamery in 1882, within a decade the whole country was covered, as shown in figure 1.

Figure 1: Location of Cooperative Creameries in 1890



Source: Own work, based on Bjørn (1988).

What allowed this institution to spread so rapidly within the space of a few years? Usually this is considered a turning point in Danish history. By contrast, we argue that it was rather the end result of a long period of agricultural enlightenment, as a modern scientific form of agriculture spread into and throughout the country, propelled initially by a group of elites on traditional landed estates.

In the present paper, we demonstrate this econometrically by showing that the pattern of adoption in Denmark follows the introduction of proto-modern dairies, *hollænderier*, by agricultural elites on estate farms more than a century earlier. In the Duchies of Schleswig and Holstein, ruled by the King of Denmark in personal union, an intensified crop rotation system with an important dairy component was developed on the large manorial estates known as *Koppelwirtschaft* in German, or *kobbelbrug* in Danish. It became the dominant field system in the Duchies in the 1700s, and included unprecedentedly large herds of milch cows and the invention of an innovative new centralized system of butter production, the *hollænderi*, with unparalleled standards of hygiene and equipment. These innovations – collectively known as the ‘Holstein System’ when the crop-rotation was combined with the dairy unit – came relatively late to Denmark, but when they did they gradually transformed Danish agriculture. We show in a narrative account how the specific organizational and technological innovation of estate dairy production came to Denmark in the 1760s and quickly increased in importance, although this adoption was unequal across the country, and led to an uneven spread of emulation by common farmers in the following decades, a common pattern for the diffusion of innovations in early modern societies, as highlighted by Mokyr (2009) for the British ‘agricultural enlightenment’. The main alternative use of the same resources, cattle-fattening, within the production system of *Koppelwirtschaft*, was still discussed and seen as viable in the run-up to the spread of dairy cooperatives. Subsequent scientific debate led to further advances, including accurate bookkeeping, better breeds of cows, and better feed. Agricultural societies, schools, and journals were established. More generally, it became firmly established that Denmark’s comparative advantage lay in dairying, and butter production in particular. As we will discuss, and summarize below, we have previously (Lampe and Sharp forthcoming) established a narrative account – based on substantial use of primary archival and other sources – of how this innovation spread and trickled down to the peasantry through general and specific education, research, diffusion of examples of best practice and the establishment of channels of marketing.

While our results show that that the pre-existence of specialized estate dairies in and from the 1780s are positively correlated with the cooperatives one hundred years later, this does not take into account the endogeneity of the location estate dairies. We therefore rely on the pattern of diffusion of *Koppelwirtschaft* with dairy units from the original place of introduction as an instrumental variable so as to estimate the causal effect on the establishment of cooperatives. We also demonstrate empirically that areas with more *hollænderier*

developed greater cow densities, which in previous research (Henriksen 1999) have been described as the most important determinant of the presence of cooperatives. Our use of distance as an instrument follows studies on the spread of ideas such as Dittmar (2011) on the diffusion of the printing press and Becker and Woessmann (2009) and Akçomak et al. (2016) on the spread of religious practices that favor literacy.

The present paper is also closely connected to recent studies that show the long-run impact of the adoption of agriculture (Olsson and Hibbs 2005; Putterman 2008; Comin et al 2010, Cook 2014a) and major productivity improving implements like the (heavy mouldboard) plough (Andersen et al 2016). While our research is concerned with the diffusion of ideas, technology and specialization that facilitated the establishment of cooperatives, and not directly with the effects of cooperatives themselves, it still complements the emerging literature on the effects of new crops on productivity, population and economic growth, and political stability (e.g. Nunn and Qian 2011, Cook 2014a, Cook 2014b, Dall et al 2014, Chen and Kung 2012, Jia 2014, Bustos et al 2016). We further provide a new explanation for the rise of dairy cooperatives in Denmark. These are the paradigmatic case for success of cooperation in development and also one of the most salient cases of organization of agricultural producers of a specific good, i.e. milk, to be converted into butter. Finally, our work connects to literatures such as the role of immigration for technology and knowledge transfer, the significance of local knowledge spillovers from large to small firms, and to ‘new new’ trade theory, which suggests that firms that export are more productive, and that more productive firms export more.

We thus demonstrate and quantify in a formal econometric framework what we have previously only suggested qualitatively: that the reason for the extremely rapid spread of cooperative creameries in Denmark between 1882 and 1890 can be attributed to the spread of innovations from Schleswig and Holstein over the preceding century. The cooperatives thus benefited from the prior accumulation of knowledge, with the only innovation needed in order for the peasants to benefit being the invention of the automatic cream separator, which allowed for the centralized separation of milk from small peasant herds. After this invention was introduced in the late 1870s, the whole country was rapidly overrun by the cooperative wave, and their historical forerunners, the *hollænderier*, were all but forgotten. This work establishes their rightful place as the starting point of the Danish agricultural revolution, which was to change Denmark forever.

The following section provides a brief review of the relevant literature. Section 3 describes *Koppelwirtschaft* and *hollænderi* as they emerged in Schleswig and Holstein, and considers their spread into and throughout Denmark. Section 4 provides an empirical analysis of the impact of this spread for the emergence of the cooperatives more than a century later. Section 5 concludes.

2. Literature review

In the present section, we highlight our contribution to the existing literature by considering previous work on elites and the rise of the dairy movement in Denmark.

Literature on elites

A long running theme in growth and development is how elites influence the long run economic trajectories of societies (Amsden, DiCaprio and Robinson 2012). It is undeniable that elites exert disproportionate influence on how institutions are designed and factor endowments are used, but it is less well known how their actions feed into the development process. For the case of agricultural elites, the existing literature has provided conflicting views on the role of large landowners in economic development. On the one hand, the concentration of agricultural resources in the hands of large landowners and accompanying high levels of land inequality are often seen as an impediment to development. Engerman and Sokoloff (2002) stress the interaction between factor endowments and the resulting impact of land inequality and how higher land inequality leads to agricultural elites who favor slavery and extractive institutions, which produces poor economic outcomes, see also Acemoglu, Johnson and Robinson (2001) and Bannerje and Iyer (2005). Galor, Moav and Vollrath (2009), Baten and Juif (2014) and Cinnirella and Hornung (2016) demonstrate that high land inequality causes elites to block investment in human capital. Others have stressed that high land inequality limits the scope for agricultural cooperation both through lower social capital (Fernández 2014) and through direct crowding-out (Henriksen 1999). On the other hand, in contexts in which property rights are poorly defined, large landowners can ‘shelter’ dependent peasants from extractive state institutions (Dell 2010) and effectively lobby for better provision of collective goods and infrastructure than politically weak peasant communities (Dell 2010, Dell 2012).¹ As mentioned, we stress that agricultural elites may spread knowledge, which then subsequently aids development in the agricultural sector. In other words, our work suggests that agricultural elites may also be knowledge elites, who facilitate later development. Recent work by Squicciarini and Voigtländer (2016) demonstrates that knowledge elites played a significant role in the industrialization of France by e.g. running businesses themselves or exchanging knowledge entrepreneurs. By contrast, our work emphasizes the importance of knowledge spill-overs and agricultural enlightenment (Mokyr 2009, ch. 9). Our work also shares

¹ In Denmark, during the nineteenth century, the property rights of peasant farmers became increasingly more secure through enclosure and formation of inheritable property. Hence we do not believe – and find no evidence – that estates *per se* should have had a necessary facilitating function for the establishment of cooperatives. On the other hand, while large landowners in Denmark might have been interested in blocking education and other rights for peasants between the 1780s and the 1880s, as evidenced by the short-lived second serfdom in the late eighteenth century, effectively, the centralization and professionalization of government and the Constitution of 1849 reduced the scope for such action. However, since long-term effects of elite blockage might have persistent outcomes, we control for the share of land under the direct control of estates (demesnes).

some similarities with Hornung's (2014) work on high-skilled immigration of Huguenots into Prussia. He shows that this led to higher productivity in the textile sector and interprets this as evidence of an effect of diffusion of technology. We focus on agricultural elites and their impact on the part of the agricultural sector that led to an economy-wide take-off.

Literature on the rise of the dairy cooperatives

The existing literature (basically Henriksen 1999, inspired by Ó Gráda 1977) on the rise of dairy cooperatives in Denmark, has attributed the rapid diffusion of the cooperative dairy movement in Denmark mostly to pre-existing cow densities. In other country-commodity specific studies, scale of production prior to the introduction of cooperatives has also been highlighted, apart from other product-specific factors and access to transport networks. Recent internationally comparative studies (Fernández 2014) have highlighted the importance of social capital (or trust) proxied by a variety of variables, especially low land inequality and (protestant) religion. While religion and social fractionalization have proven to be important in other countries, this arguably could not explain the adoption pattern within Denmark given the extremely homogenous population. We do, however, control for the presence of estates, to disentangle the specialization and technology effect of estate-dairies from the potential political and social consequences of the presence of estates – although the progressive Danish constitution of 1849 should have mitigated the effect of any prior coercion by 1890.

3. The evolution of modern dairying and its spread to Denmark

In this section, we provide the argument that we set out to test. We first explore the origin of the Holstein system. We next describe how the system spread into and across Denmark. As will become clear in Section 4, we will apply our knowledge of the spread across Denmark to identify the causal effect of early elites on the spread of cooperative creameries. We finally discuss how the spread of proto-modern dairying eventually produced the spread of cooperative.

Origin of the Holstein System and Koppelwirtschaft

The Holstein System and *Koppelwirtschaft* more generally was a 'collective invention' by estate owners and their administrators in sixteenth-century Holstein and Schleswig, the German-speaking part of the Danish monarchy, in order to overcome the fundamental problem of intensified organic agriculture, i.e. how to sustain production and yields in the long run by obtaining sufficient fertilizer from animal husbandry. This challenge was met in different parts of Europe in different ways, especially in modern-day Belgium, Northern France, the Netherlands and Britain, where 'convertible husbandry' systems developed (Mokyr 2009, p. 173; Jones 2016). The Holstein

model consisted of changing the traditional three-field rotation with outlying pasture areas into an eleven-field rotation, thus alternating the use of individual fields between pasture and grain cultivation over eleven years.² This way, extensively used grazing areas (pastures) were included in the crop rotation by changing the traditional design of fields and the crop rotation itself in a way that allowed for sustained grain yields and sufficient fodder for the animals, normally in the form of summer pasture and winter hay – all this at the same time as production surpluses were exported from rural areas in order to sustain growing urban populations. This system was relatively more focused on animal production than alternative systems, in part because soils were particularly suited for fertile grasslands in Holstein and Schleswig, which in the sixteenth-century had focused on oxen fattening and horse breeding. In part, the evolution of *Koppelwirtschaft* in the seventeenth and eighteenth century seems to be the reaction of estate owners to an improvement in the relative prices of dairy products versus grain and oxen (Porskrog Rasmussen 2010a, p. 180), which led to intensified collaboration with available specialized immigrants from the Netherlands and their descendants so as to develop a strong dairy sector (Porskrog Rasmussen 2003, p. 447). Since these specialists originated from Holland, the tenants involved in dairying became known as *hollænder* (and their dairies as *hollænderier*), even if they were not of Dutch descent.³

Koppelwirtschaft was introduced in the *demesne* farming of large manors, and not in peasant agriculture, because these were the most commercially oriented agricultural units, the most likely to be able to sustain the considerable capital investments and labor efforts (via *corvée* or hired labor), and also the ones with the largest freedom to act under the institutional framework of the time. Many manors were managed by relatively professional staff (Porskrog Rasmussen 2010a, p. 182), and dairying became a professionalized subset of *demesne* farming activities, in which specialist *hollænder* managed specialized dairy equipment under a regime of well-specified dairy lease contracts (Drejer 1925-33, p. 181-2; Iversen 1992, p. 76-77; Porskrog Rasmussen 1987, pp. 63-65 and Lampe and Sharp forthcoming). *Hollændere* were normally a couple, with the woman in charge of dairy production and the man supervising the feeding of the cows and the transportation of raw materials and produce to and from the dairy (Hansen 2006). Moreover, the Holstein system implied a proto-modern dairy with a centralized production facility for separation of cream from milk and production of butter much like the cooperative creameries a century later.⁴ Under the Holstein system, many estates in Holstein and

² For more details on alternative systems see Lampe and Sharp (forthcoming) and the references provided there.

³ Bieleman (1996) gives an account of the sophisticated dairy sector in the Lower Countries during the Dutch 'Golden Age'.

⁴ The *hollænderi* would also have practical independent rooms, a strong focus on hygiene, cows milked at particular times (and milked dry), control of the temperature of the cream, so it could be skimmed and churned at the right time, and care would be exerted at all times from milking to packaging

Schleswig came to have very large herds of several hundred cows, even exceeding herd sizes in Holland (Porskrog Rasmussen 2010a, pp. 181-2).

Within Holstein, Schleswig, and subsequently Denmark,⁵ the Holstein system thus led to a model of production with advances on the estates in different parts of agriculture and thus the opening of a gap in quality between estate-produced and peasant producers emerged in the extent to which produce was regularly marketed (Lampe and Sharp 2015a) and in terms of grain yields, butter quality, etc. (Bjørn 1988, p. 159; see also Lampe and Sharp 2014, 2015b). In the Kingdom of Denmark itself, from the Middle Ages until the seventeenth century, estates as well as peasant farms typically only had as many cows as they needed to feed the household, and more sophisticated dairy products were imported from Holland (Appel and Bredkjær 1924-33, pp. 279-80).⁶ Even for the latter half of the 1700s, authors often highlight the low proportion of cows (and bulls) relative to horses in the use of pasture in Denmark. Hertel (1920, 149-51) for example, estimates the cattle to horse ratio at only 1.4:1 in the 1770s⁷, much less than the 4:1 in 1914.

Introduction into Denmark

An important prerequisite to the introduction of the Holstein System was the redistribution of land throughout the eighteenth century. In the 1600s Denmark consisted of a large number of Crown Estates, under the direct administration of the monarch, smaller estates owned by the nobility, as well as many medium sized subordinate farms belonging to estates (Porskrog Rasmussen 2003, p. 8). From the 1600s and into the 1700s, the bad finances of the crown, largely as a result of continuous wars against Sweden until 1721, meant that monarchs were forced to sell off more and more land, until by the 1740s almost all the crown estates were privatized (Frandsen 2005, p. 58, 74-76), with a final touch of privatizations in around 1770. At the same time, the introduction of absolutism in Denmark in 1660 had weakened the privileges of the traditional nobility and opened up the possibility of estate ownership to non-nobles (Lampe and Sharp forthcoming, Linvald 1912). This situation encouraged discussions, also in the government, on how to introduce reforms and a general modernization of agriculture (Jensen 1998, p. 37-8; Feldbæk 1988, p. 19).

⁵ *Koppelwirtschaft* and *hollænderier* also spread to the east to Mecklenburg in the eighteenth century, but relatively little research is available on this, apart from Schröder-Lembke (1978, 65-67), who portrays the troubled figure of Mecklenburg *Koppelwirtschaft* pioneer Joachim Friedrich von der Lühse and his Panzow estate. See also Jones (2016, 95-97)

⁶ The word *hollænderi* entered the Danish language apparently from the eighteenth century with the spread of *Koppelwirtschaft* into Denmark (Drejer 1925-33, p. 138). Some prior examples of larger dairy units, managed by *hollænder* from Holstein or the Netherlands have been mentioned in the literature, but with little sustained impact (Drejer 1925-33, pp. 140-143; Skrubbeltrang 1978, p. 120; Frandsen 2005, pp. 46-47, 146).

⁷ When, however, cattle pests had done much to reduce cattle stocks.

The introduction of *Koppelwirtschaft* was to be the result of this debate, although most saw it simply as a means to increase grain yields. This is best illustrated by a famous quote by Adam Gottlob Moltke, effectively prime minister from 1746 to 1766 and generally credited with introducing *Koppelwirtschaft* into Denmark (Jensen 1998, p. 92), from a plan devised in 1746 for King Frederik V: 'Agriculture in these lands seems to be still very backward. I keep myself assured that, if the soil here would be worked as is custom in other countries, especially in Holstein, the land could yield twice as much as it has produced hitherto.' (quoted from Porskrog Rasmussen 2010b, p. 9 and note 1). In the context of his ascent to Lord Chamberlain for Frederik V in 1746, Moltke also received the large estate of Bregentved in Southern Zealand, and up to 1751 bought four more nearby estates: Turebyholm, Juellinge, Tryggevælden and Alslev (Porskrog Rasmussen 2010b, p. 11).⁸ In 1759, he came, under fortuitous circumstances, to own the estate of Niendorf near Lübeck in Holstein, on which *Koppelwirtschaft* was firmly established. He sold it two years later with a large profit (Porskrog Rasmussen 2010b, p. 19-21) and took the former leaseholder of Niendorf, Johann Matthias Völckers, to his estates on Zealand to become his administrator and agricultural reorganizer there. Völckers started on the newly established farm of Stenkelstrup (later named Sofiendal after Moltke's second wife) to implement an exact copy of Holstein *Koppelwirtschaft* with the layout of the eleven fields, the original crop rotation and a *hollænderi*, and finished this in 1766. He then continued to reform Moltke's estates of Alslev, Turebyholm and the Bregentved main estate up to 1767 and Juellinge in the early 1770s. Most of Moltke's reorganized estates were then, as before, leased in auctions to interested leaseholders, including Völckers himself (Jensen 1998, p. 49-51, Porskrog Rasmussen 2010b). In reports he wrote for the king in the 1780s to highlight his role as a reformer, Moltke claimed that the value of his lease contracts in 1787 had increased by more than 200 percent since the introduction of *Koppelwirtschaft* in comparison to the 1740s, although modern research has qualified this somewhat since estate leases had generally increased over the period (Porskrog Rasmussen 2010b, p. 26-7). There is, however, no doubt that Moltke's reorganization increased the capitalized value of his estates. Moltke was imitated by his neighbors. For example, the Løvenborg estate was reorganized in 1767 with Völckers as expert, and the Gisselfeld estate, adjacent to Bregentved, in 1768 (Porskrog Rasmussen 2010b, 27; Jensen 1998, 52). In 1769 the estate of the Vemmetofte Jomfruekloster was reorganized, with Völckers as consultant to its administrator (Linvald 1905-08, p. 250; Prange 1971, p. 552). Gradually Moltke's example was followed in other parts of Denmark.⁹

⁸ During the next decades, Moltke would own estates in all parts of Denmark as well as in Schleswig and Holstein and become the largest landowner in the Monarchy (see the map in Porskrog Rasmussen 2010b, p. 14). His cultivation reforms in Denmark were centered mostly on the aforementioned estates on Zealand and the ones he bought between 1763-5 on Fyn.

⁹ In the late 1760s, he and Völckers also developed a version of *Koppelwirtschaft* for the villages dependent on his estates which respected traditional common land rights (*fællesskab*) (Porskrog Rasmussen 2010b, 30-35). It did, however, not spread as fast and widely as its estate demesne counterpart.

Over the subsequent decades, despite a general economic and agricultural crisis as a consequence of the Napoleonic Wars and state bankruptcy, *Koppelwirtschaft* continued to spread across Denmark, and by the 1840s, the transformation of Denmark was already well underway. The German travel writer Johann Georg Kohl observed that the Holstein System had spread throughout the country, even to Northern Jutland, where he noted that many farms had switched from oxen-raising to dairying. He was impressed by the scientific nature of this progress, and noted that important articles on dairying from the Duchies were reprinted all over Denmark. In conclusion, he stated his belief that Denmark would eventually converge on the Duchies, and that they would finally integrate completely with the Kingdom to become a land ‘not of milk and honey, but of milk and butter’ (Kohl 1846, pp. 58-60). Other foreigners, even from the UK, marveled at the scale of the operations, such as the British writer, Samuel Laing, who wondered at the ‘regularity, arrangement, cleanliness and the vast scale of all the operations [which] give the impression rather of a great manufactory of butter and cheese than of a farm’ (Laing 1852, p. 124).

The spread of knowledge and cooperative creameries

In the next section, we demonstrate empirically that the estate creameries had a trickle-down effect on the peasantry, consistent with the historical narrative. In a forthcoming book,¹⁰ Lampe and Sharp provide a detailed account of the chain of events and the developments which connect the two end points of the reduced form analysis presented in this paper: the establishment of the elite-owned estate creameries in the late eighteenth century, and the emergence of the peasant-owned cooperative creameries from 1882. Thus, in other work, we describe in detail the developments which were initiated by the elites since the establishment of the Holstein System, and document the links that emerged between the estates and the peasantry. Next, we provide a concise, self-contained summary.

A program of agricultural reforms went alongside the spread of the Holstein System in the late eighteenth century, with the end result that for example serfdom (or ‘adscription’) was abolished and land enclosures were put in place, firmly establishing private property rights in the countryside. The completion of these reforms by the first years of the nineteenth century coincided however with the Napoleonic Wars, which were particularly devastating for Denmark. Copenhagen was almost completely destroyed in a British bombardment in 1807, and the Danish fleet was captured, and in the terms of the peace Denmark lost Norway to Sweden in 1814. The Danish state went bankrupt, and a profound period of uncertainty followed, although a second wave of elites (again, often from Holstein and Schleswig) began to establish themselves in Denmark from the 1820s, and built

¹⁰ In part based on previously published articles: Henriksen, Lampe and Sharp (2011, 2012), Lampe and Sharp (2014, 2015a)

on the reforms of the eighteenth century. Of particular importance was the early introduction of an ‘enlightened’ approach to dairying and agriculture more generally, involving accurate measuring and recordkeeping, combined with sophisticated bookkeeping and accounting. This allowed first of all for a scientific and experimental approach to agriculture, answering questions such as how best to feed and breed cows. Second, accounting allowed for a better idea of profitability, allowing for profit-maximizing behavior and for example the discovery that specialization in dairying was the best strategy. Lively debates on methodology and the implications of the findings made played out in the Danish agricultural press in particular from the mid-nineteenth century. We argue that the knowledge built up in this process laid the foundation for the rapid spread of smallholder dairying later on, in particular because – apart from the example of specialization – it was increasingly taught through specialized agricultural schooling and apprenticeship programs.

The Danish estates owners were also joined from the second half of the nineteenth century by a new set of elites, merchants, who established the marketing channels necessary for taking advantage of markets abroad, especially in industrializing Britain, and how they encouraged quality improvements to obtain more marketable produce. This was in part by encouraging medium-sized farms and smallholders outside the realm of the estates to centralize production, initially through a model of privately owned community creameries, which then evolved into and were spread by the dairy cooperatives from 1882, thus introducing the *hollænderi* to a wider set of producers.

Just prior to the emergence of the cooperatives, so-called community creameries, allowing for the centralized production of butter produced using milk from local peasants, were promoted in the 1860s by merchants and the agricultural societies in order to increase the quality of peasant produce and make it fit for export (McLaughlin and Sharp 2015). However, the key problem was that peasant producers owned just a few cows, and their milk production could not easily be transported to a central production facility. This was solved with the invention of the automatic cream separator in the late 1870s, which was able to separate the cream from transported milk using centrifugal force. The cream separator thus finally allowed peasants to enjoy the benefits of centralized production and marketing pioneered by the *hollænderier* more than a century before, this time in the form of cooperative creameries. They did not enjoy an easy start, however. The first cooperative creameries in southwestern Jutland met with great skepticism from the agricultural establishment, that is, estate owners. Thus, the chairman of the dairy committee of the United Jutland Agricultural Associations (and member of the board of the Royal Agricultural Society of Denmark) commissioned an instructor from the agricultural college of Ladelundgaard to travel around eighteen of them in order to demonstrate their inferiority compared to the privately-owned community creameries which he had previously reported on (Petersen 1885; Henriksen 1999).

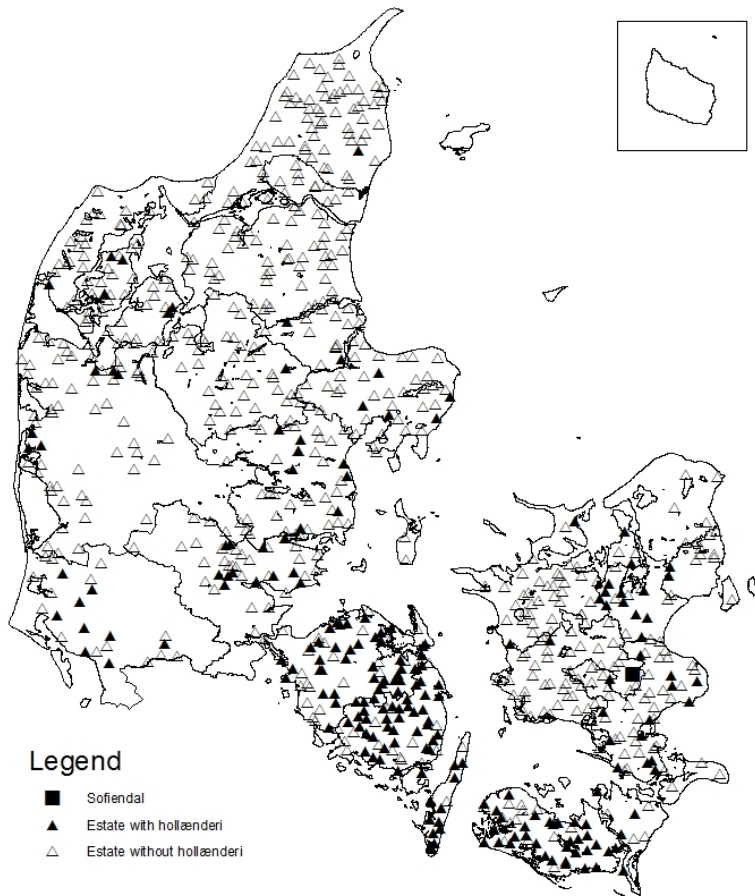
Although his report reached the opposite conclusion to that which its commissioners had hoped for, there can be little doubt that the estates themselves were not promoting the cooperative form as such.

4. Persistency and the spread of the cooperatives

To test for the influence of the elites on the location of cooperative creameries, we examine whether grid cells which were closer to estates with *hollænderier* were more likely to have cooperative creameries nearby.

Our main proxy for the spillovers from elites to peasants is the variable *elite 1782*, constructed in the spirit of Harris' (1954) 'market potential' measure as the sum of the (tax assessed land quality adjusted) sizes of all estates with *hollænderier* weighted by their distance to the grid cell. The idea is that the influence of the elites increases with the estate size, but decreases with distance. In other words the closer and larger the estates, the more influence they had in terms of knowledge spillovers. When assessing the relationship in this way, however, one needs to bear in mind that any surviving *hollænderier* on estates would have been competitors to the first cooperatives (see Henriksen 1999).

Figure 3: Location of *hollænderier* among all estates in 1782



Source: Own work based on Andersen (1963), Christensen (1886-91) and Roholt (2012).

The estates with *hollænderier* are given in figure 3, together with all other estates in 1782.¹¹ To measure the extent to which a grid cell is exposed to dairies, we construct a ‘market potential’ measure for dairies in a similar fashion and construct the variable *cooperative creamery intensity* as the sum of cooperative creameries weighted by the inverse distance from the grid cell to the cooperative.

Table 1 provides a brief description of the variables included in the regressions below, as well as some summary statistics. Apart from *cooperative creamery intensity* and *elites 1782*, we have also constructed several other variables, which might also contribute to explaining the location of cooperatives in 1890. The first is distance to the first cooperative creamery as the cooperatives might have spread from there. Second we control for the share of a grid cell that is occupied by estate demesnes (with or without *hollænderier*) and the proximity of estates to capture the general effect of the presence of large landowners on peasant cooperation, which might be negative or positive, following the different results in the literature discussed above. Next we add controls for

¹¹ Unfortunately we have no way of knowing which estate creameries survived until 1882/1890, but as noted above, the agricultural establishment was initially hostile to the peasant cooperatives.

ideas in the half century leading up to the spread of the cooperative creameries in the form of proximity to a number of late innovators and to folk high schools. One might further argue that *hollænderier* did not actually cause the cooperatives to emerge, but were established in areas with dairy know-how and cows prior to the introduction of *Koppelwirtschaft*. We have a number of controls for this including grass field system in the 17th century, historical butter production, clover cultivation in 1805 and barley suitability¹², which captures the main alternate use of the land.¹³ First, Frandsen (1983) reports information on the prevalence of field-grass-systems in agriculture in the 1680s at the time of the large land quality (and use) assessment for a new land-based taxation system – this might be positively related to dairying, but it might more likely proxy for the use of cattle-raising. Second, Frandsen (1983) also gives more direct information on dairying, that is, the amount of in-kind rent payments in butter made by peasants in 1662 per unit of land.¹⁴ Although this says little about demesne production of butter on estates, it might be positively related to the later establishment of cooperatives if there is a persistency in dairying patterns (which *hollænderier* might just have taken advantage of). Third, as clover was an important part of *Koppelwirtschaft* and the whole Holstein system, we control for the share cultivated with clover in 1805. Finally, we add distance to the coast as a simple measure for openness to new ideas and technologies as well as market access given that the cooperatives were heavily export oriented. To further control for market access we add distance to Copenhagen, parish level population density, and proximity to market towns, distance to the rail road in 1890, and distance to the Ox Road.

<< Table 1 around here >>

Table 2 presents our baseline OLS results with results from estimating the following regression equation:

$$\text{Cooperative creamery}_i = \alpha + \beta \text{elites1782}_i + \mathbf{X}'_i \boldsymbol{\beta} + \epsilon_i. \quad (1)$$

where i is a grid cell, *Cooperative creamery* is cooperative creamery intensity, *elites1782* is our proxy for the influence of the elite on cell i as explained above, \mathbf{X}_i is a vector of control variables described above, $\boldsymbol{\beta}$ is the associated coefficients and ϵ_i is the error term. The standard errors are corrected for clustering at the parish

¹² Measured by present day potential yields of rain-fed barley, from FAOs GAEZ database (2002). As shown by Andersen et al. (2016) present day potential barley yields correlates strongly with the level of barley tenant payments under the feudal system in 1662.

¹³ It might also potentially capture its availability as fodder. Under *Koppelwirtschaft* dairying and grain production can be considered to be complements, but the cooperatives also imported grain and concentrates from overseas.

¹⁴ This information was collected by the government for several commodity-payments (see two notes up) to construct a proxy for land productivity as a basis of immediate taxation before the actual land survey was carried out.

level. We also compute and report Conley standard errors to account for potential spatial autocorrelation not captured with dependence within the parish. In most specifications, \mathbf{X}_i contains region fixed effects.

<< Table 2 around here >>

In all specifications in Table 2, *elites1782* have a positive and significant effect on the likelihood that the grid cell was exposed to cooperative creameries nearby. To interpret the importance of the results we look at how many standard deviations the cooperative creamery variable increases by a one standard deviation increase in the *elites1782* variable. For instance the estimate in column two of table 2 implies that an increase of one standard deviation in the elite influence increases the likelihood for a grid cell to be exposed to cooperative creameries by $(0.0171 \cdot 70,81) = 1.21$, or 60 percent of a standard deviation in the cooperative creamery intensity. Hence, this indicates that the effect of the elites seems not only to be statistically, but also economically, significant. The results also produce some interesting findings for the control variables. Being closer to the first cooperative creamery seems to have made the emergence of cooperatives more likely as one might expect, all else equal. Having estates nearby also increases the emergence of cooperatives but naturally not if the location is *on* an estate demesne. Further, ideas in the half century leading up to the cooperative movement seems to have had a positive impact on the location of cooperatives but the estimate on cooperatives remains almost unchanged. Including controls for dairy know-how in column 6 also doesn't change the size of the effect of the *elites1782* whereas the estimate is cut in half in column 7 when we add numerous market access controls in the full specification.

Despite the extensive set of controls, there might be a concern that omitted variables determine both the location of *hollænderier* and the cooperatives. We propose an instrumental variable identification strategy, where we instrument *elites1782* by the distance to Moltke's estate, Sofiendal, where the first *hollænderi* was established. This is consistent with our story that the *hollænderier* spread through Denmark inspired by Moltke (and his administrator, Völckers) as well as the historical literature cited above. Hence, we estimate the following instrumental variables model

$$Cooperative\ creamery_i = \alpha + \beta elites1782_i + \mathbf{X}'_i \boldsymbol{\beta} + \epsilon_i. \quad (2)$$

$$elites1782_i = \theta + \gamma DistanceSofiendal_i + \mathbf{X}'_i \boldsymbol{\gamma} + \mu_i. \quad (3)$$

where we include the great circle distance¹⁵ to Sofiendal in our first stage (3) as our excluded instrument in (2).

In Table 3 we present the results of our first stage, controlling for the same variables as above. We notice that the coefficient on the distance to Sofiendal is always negative and strongly significant and as shown at the bottom of Table 4, the F-test of the instrument relevance is always above 10, which is the usual rule of thumb for checking for weak instruments. We also notice, among other things, that *hollænderier* are established in places nearer estates in general but away from the estates with the late innovators. Higher suitability for barley production increases the likelihood of *hollænderier* as do places further away from the coast and closer to the historical Ox Road. Importantly, the inclusion of various control variables does not change the significance of the relation between the location of the *hollænderier* and Sofiendal.

<< Table 3 around here >>

The second stage, presented in table 4, confirms the picture in table 2 above, though now the coefficient for the *elites1782* variable is larger and more stable as control variables are added. Thus, when we rely on the plausibly, exogenous component of *elites1782*, we obtain large and significant effects that can be interpreted as the causal impact of the traditional landed elites and the spread of knowledge on the emergence of the cooperative creamery movement.

<< Table 4 around here >>

If the *hollænderier* had a persistent effect for a century before the first cooperatives, we would expect that this meant a gradual spread of the ideas used on the estates to the wider peasant population. That this might have happened is not beyond the realms of possibility, considering the traditional links between the estates and the surrounding peasantry, and our reading of the contemporary literature. We can quantify this by considering the increase in the number of milch cows around the country in the intervening period. In 1760 there were 270,000 milch cows in Denmark, increasing to 335,000 in 1774, and 450,000 in 1810 (Drejer 1962, p. 22, Jensen 1998). In

¹⁵ We have estimate all models using cost distances instead of great circle distances. Results are very similar in terms of significance and magnitude.

1837 we have parish level data from the first (surviving) animal census, which put the total level at 578,000 in 1837. In 1861, there were 756,834 milch cows in the animal census. By 1881, the year before the first cooperative creamery was founded, there were 898,790. If we are to believe the persistency story, the local density of cows should have remained fairly constant before 1882. In fact, the correlation between the density in 1837 and 1861 and 1881 is around 0.9. It then remains to demonstrate that the location of the *hollænderier* also explains the pattern we observe in the cow densities. To do this, we employ the same empirical strategy as above, but with the cow densities in 1837 at the parish level as the outcome variable. Again, the relationship is very strong and robust – a greater influence from the elites implies greater cow densities.¹⁶ This result is consistent with the work of Henriksen (1999), who shows that the share of cows supplying a coop correlated with cow density, and implies that the peasantry was also turning to dairying in areas close to *hollænderier*.

5. Conclusion

We have demonstrated that the reason for the extremely rapid spread of cooperative creameries in Denmark between 1882 and 1890 can be attributed to the spread of innovations from Schleswig and Holstein over the preceding century. We have described based on the contemporary literature how these innovations spread throughout the country, and trickled-down to farmers beyond the large estates. Moreover, we have demonstrated empirically that areas with more *hollænderier* developed greater cow densities, revealing the spread of dairying around the country, and that the initial wave of cooperation was in areas which had been so treated. On a less optimistic note, however, it should also be remembered that the process as a whole took well over a century. The institutions, technology, schools, etc. did not appear overnight, or within the first decade of cooperation. Farmers would not have known that their comparative advantage lay in dairying in the 1880s, and they would not even have had the cow densities for this to be the case, if the *hollænderier* had never existed. This has implications for understanding the reason why the attempt to transfer Danish-style cooperatives to other countries, such as Ireland in the 1890s (see e.g. Henriksen et al 2015) and Iceland around the turn of the twentieth century (Jónsson 2012), as well as to developing countries more recently were relative failures. For more than a century elites were initiating a whole package of reforms which eventually allowed the cooperatives to prosper. There has been a tendency to see cooperation as the solution to agricultural poverty, but this work suggests that this must be in combination with other reforms, which elites are probably better placed to implement than the peasants themselves.

¹⁶ The results are available on request.

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Table 1: Summary statistics and variable descriptions

	N	Mean	SD	Min	Max	Description
Cooperative creamery intensity, 1890	38,370	8.22	2.00	3.17	14.05	Inverse distance weighted sum of cooperative creameries, 1890 (mp)
Elites 1782	38,370	132.23	70.81	42.20	580.35	Inverse distance weighted sum of hollænderi estate hartkorn, 1782 (mp)
Distance Sofiendal	38,370	161.40	77.52	0.41	288.54	Distance from grid cell to the estate Sofiendal (km)
Distance first cooperative creamery	38,370	131.05	74.89	0.46	421.33	Distance from grid cell to the first cooperative creamery in Hjedding (km)
Estate (mp)	38,370	10.10	1.95	2.64	16.07	Inverse distance weighted sum of estates, 1770 (mp)
Demesne share	38,370	0.12	0.28	0.00	1.00	Share of grid cell area owned by an estate (with or without a hollænderi), 1680s
Late innovators (mp)	38,370	0.11	0.08	0.04	2.14	Inverse distance weighted sum of 'late innovator estates' (mp)
Folk high school (mp), 1890	38,370	0.75	0.24	0.26	3.55	Inverse distance weighted sum of folk high schools, 1890 (mp)
Butter production, 1662	38,370	1.18	4.89	0.00	73.21	Butter payments in 1662 - barrels per km2 land in the grid cell
Clover share, 1805	38,370	0.18	0.36	0.00	1.00	Share of grid cell area cultivated with clover, 1805
Barley suitability	38,370	57.02	17.53	0.00	92.50	Barley suitability from GAEZ, FAO (2002)
Field-grass-system, 1682	38,370	0.55	0.50	0.00	1.00	=1 if field-grass-system in 1682
Distance coast	38,370	9.45	9.46	0.00	48.67	Distance from grid cell to the nearest coast (km)
Distance Copenhagen	38,370	178.39	73.68	0.55	297.14	Distance from grid cell to Copenhagen (km)
Population density, 1787	38,010	21.58	96.17	0.00	7920.25	Parish population density in 1787
Market town	38,370	0.90	0.20	0.47	3.15	Inverse distance weighted sum of market towns (mp)
Distance rail, 1890	38,370	10.37	20.15	0.00	177.31	Distance from grid cell to the nearest rail road, 1890 (km)
Distance Ox Road	38,370	64.81	67.49	0.00	368.30	Distance from grid cell to the nearest Ox Road (km)

Table 2: Main results (OLS)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Dependent variable: Cooperative creamery intensity in 1890						
Elites 1782	0.01743*** (0.00064) [0.00316]	0.01710*** (0.00112) [0.00260]	0.01624*** (0.00112) [0.00272]	0.00632*** (0.00095) [0.00293]	0.00525*** (0.00093) [0.00268]	0.00513*** (0.00092) [0.00267]	0.00241*** (0.00083) [0.00236]
Distance first cooperative creamery			-0.01589*** (0.00166)	-0.01280*** (0.00147)	-0.01308*** (0.00126)	-0.01054*** (0.00125)	-0.01573*** (0.00111)
Estate (mp)				0.43413*** (0.02262)	0.36220*** (0.02100)	0.36262*** (0.01983)	0.29976*** (0.01882)
Demesne share				-0.10676*** (0.02699)	-0.09797*** (0.02545)	-0.08305*** (0.02381)	-0.04564** (0.02043)
Late innovators (mp)					1.29763*** (0.33280)	0.91156*** (0.28776)	0.72050*** (0.23924)
Folk high school (mp), before 1890					0.87820*** (0.09600)	0.75634*** (0.09450)	0.41609*** (0.08185)
Butter production, 1662						0.00094 (0.00080)	0.00060 (0.00073)
Clover share, 1805						0.06737* (0.03573)	0.02896 (0.03100)
Barley suitability						0.00318*** (0.00102)	0.00575*** (0.00088)
Field-grass-system, 1682						-0.42063*** (0.06131)	-0.39772*** (0.05059)
Distance coast						0.02807*** (0.00262)	0.01493*** (0.00242)
Distance Copenhagen							-0.01806*** (0.00113)
Population density, 1787							-0.00043*** (0.00007)
Market town							0.12355* (0.07501)
Distance rail, 1890							-0.01794*** (0.00238)
Distance Ox Road							-0.01167*** (0.00132)
Constant	5.91323*** (0.08849)	3.33979*** (0.06521)	9.82393*** (0.69005)	7.81674*** (0.62537)	7.40101*** (0.54376)	6.14022*** (0.55348)	18.50807*** (0.88332)
FE (Region)	No	Yes	Yes	Yes	Yes	Yes	Yes
N	38370	38370	38370	38370	38370	38370	38010
Adj R ²	0.382	0.805	0.822	0.858	0.873	0.885	0.904

Parish level clustered standard errors in parentheses, Conley standard errors correcting for spatial autocorrelation within 50 km in squared brackets, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3: IV first stage, Main results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Dependent variable: Elites 1782						
Distance Sofiendal	-0.657*** (0.016)	-0.647*** (0.037)	-0.666*** (0.038)	-0.420*** (0.029)	-0.416*** (0.033)	-0.468*** (0.031)	-0.732*** (0.113)
Distance first cooperative creamery			-0.197*** (0.042)	-0.052 (0.032)	-0.046 (0.032)	-0.153*** (0.032)	-0.103*** (0.038)
Estate (mp)				12.155*** (0.667)	12.222*** (0.673)	12.189*** (0.625)	11.956*** (0.697)
Demesne share				3.174*** (0.751)	3.254*** (0.749)	2.773*** (0.746)	3.061*** (0.740)
Late innovators (mp)					-23.999*** (7.500)	-21.946*** (7.503)	-22.029*** (7.559)
Folk high school (mp), 1890					2.075 (1.970)	0.660 (1.861)	2.154 (1.811)
Butter production, 1662						0.015 (0.024)	0.013 (0.024)
Clover share, 1805						0.246 (1.005)	-0.152 (1.019)
Barley suitability						0.124*** (0.025)	0.087*** (0.026)
Field-grass-system, 1682						-9.389*** (1.390)	-8.947*** (1.401)
Distance coast						-0.425*** (0.055)	-0.352*** (0.061)
Distance Copenhagen							0.311*** (0.116)
Population density, 1787							-0.004* (0.002)
Market town							-1.072 (2.420)
Distance rail, 1890							-0.067 (0.078)
Distance Ox Road							0.087** (0.039)
Constant	238.346*** (3.502)	166.443*** (6.925)	249.798*** (17.634)	110.552*** (13.663)	106.215*** (14.426)	152.657*** (14.959)	114.916*** (29.147)
FE (Region)	No	Yes	Yes	Yes	Yes	Yes	Yes
N	38370	38370	38370	38370	38370	38370	38010

Parish level clustered standard errors in parentheses, * p < 0.1, ** p < 0.05, *** p < 0.01

Table 4: IV second stage, Main results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Dependent variable: Cooperative creamery intensity in 1890						
Elites 1782	0.01958*** (0.00082) [0.00450]	0.05041*** (0.00299) [0.00942]	0.05201*** (0.00275) [0.00835]	0.06321*** (0.00510) [0.01448]	0.05663*** (0.00495) [0.01307]	0.04549*** (0.00366) [0.00967]	0.05159*** (0.00801) [0.01798]
Distance first cooperative creamery			-0.01100*** (0.00202)	-0.01316*** (0.00217)	-0.01363*** (0.00193)	-0.00812*** (0.00179)	-0.00432 (0.00276)
Estate (mp)				-0.37146*** (0.08233)	-0.33337*** (0.07670)	-0.19071*** (0.05843)	-0.34507*** (0.10747)
Demesne share				-0.23783*** (0.05703)	-0.22409*** (0.05150)	-0.15978*** (0.04253)	-0.17433*** (0.05285)
Late innovators (mp)					2.19435*** (0.54342)	1.64798*** (0.45000)	1.87281*** (0.53222)
Folk high school (mp), 1890					0.40531*** (0.10505)	0.44980*** (0.08846)	0.38922*** (0.09511)
Butter production, 1662						-0.00037 (0.00131)	-0.00049 (0.00141)
Clover share, 1805						-0.00118 (0.05561)	-0.00559 (0.06097)
Barley suitability						-0.00143 (0.00137)	-0.00030 (0.00178)
Field-grass-system, 1682						0.10094 (0.08925)	0.13559 (0.12174)
Distance coast						0.03460*** (0.00318)	0.03458*** (0.00551)
Distance Copenhagen							0.00132 (0.00382)
Population density, 1787							0.00002 (0.00012)
Market town							0.03088 (0.14447)
Distance rail, 1890							-0.01505*** (0.00441)
Distance Ox Road							-0.01449*** (0.00234)
Constant	5.62888*** (0.10533)	1.84466*** (0.14107)	6.23412*** (0.88117)	7.68077*** (0.89465)	7.63903*** (0.80079)	5.46665*** (0.73217)	11.34358*** (2.17806)
FE (Region)	No	Yes	Yes	Yes	Yes	Yes	Yes
N	38370	38370	38370	38370	38370	38370	38010
F	566.032	624.665	571.234	420.216	455.311	552.261	281.251
First stage F	1795.176	312.670	301.853	203.028	163.902	228.733	42.229

Parish level clustered standard errors in parentheses, Conley standard errors correcting for spatial autocorrelation within 50 km in squared brackets, * p < 0.1, ** p < 0.05, *** p < 0.01