This paper examines the impact of social cohesion, culture and property rights on the diffusion of two new agricultural technologies in late 19th century Ireland. Endowments and property rights mattered for the diffusion of the cream separator; while social cohesion mattered for the diffusion of cooperative creameries. The cooperative organisational form spread far more rapidly in Protestant Ulster than in the rest of the country, which suggests a potentially important role for culture in explaining its diffusion. However, the evidence indicates that Ulster’s greater propensity to cooperate was more a result of political than of religious factors. In areas with more medium sized farms, political conflict slowed down the diffusion of separators as well as of cooperatives. The structure of property rights and political conflict help explain why Irish agriculture was less successful than Danish agriculture during this period.

I am grateful to the Irish Research Council for the Humanities and Social Sciences for their generous funding, and to University College Dublin’s ISSC for its hospitality. I am also grateful to the following for advice and encouragement: Neal Beck, Liam Brunt, Charles Calomiris, Bruce Campbell, Arnaud Chevalier, Kevin Denny, Terence Dooley, Ed Glaeser, Claudia Goldin, Avner Greif, Tim Guinnane, Colm Harmon, Mike Harrison, Ingrid Henriksen, Mike Kunz, Philip Lane, Peter Lindert, Jim Livesey, Joel Mokyr, Anthony Murphy, Andy Newman, Cormac Ó Gráda, Tim Park, Andrei Shleifer, Javier Silvestre, Ian Walker, Eugene White, Jeffrey Williamson, Rainer Winkelmann, and seminar participants at Bergen, Cambridge, Harvard, the LSE, Northwestern, Oxford, Rutgers, Toulouse, U.C. Davis, U.C.L., Yale, the Dublin Economics Workshop, the conference on ‘Patterns of Danish Development’ held at the University of Copenhagen, and the Third Congress of the European Historical Economics Society, Lisbon. Roberto Perotti and four anonymous referees have made extremely helpful suggestions which have improved the final product immensely. Hampus Wilfors and William Hynes provided able research assistance. The usual disclaimer applies.
Section 1. Introduction

This paper explores the diffusion of two agricultural innovations in late 19th century Ireland. The first was technological: the centrifugal milk separator, which made it possible to extract a greater proportion of the butter fat in milk, and to do so more quickly and hygienically. The second was organizational: the creamery cooperative, in which farmers jointly owned the creamery which processed their milk, and which was held by contemporaries to have important efficiency advantages over the privately owned creamery— a judgement with which economic historians, notably Ingrid Henriksen (1999), have concurred.

Throughout, the paper uses Denmark as a benchmark by which to judge Irish performance, as was the universal practice among Irish agricultural reformers at that time. Separators and cooperatives spread much more quickly in Denmark than in Ireland, despite the fact that both countries were important dairy producers, located in north-west Europe, and selling to the same market (Britain). This paper argues that the slower diffusion in Ireland was not just due to different comparative advantages (for example, related to numbers of dairy cattle, and thus indirectly to variables such as land quality, population and climate), but to a variety of political and social factors as well. It argues that the structure of property rights mattered for the productivity of Irish farmers, and thus for the demand for cream separators; and that a lack of social cohesion and a history of violence and political conflict between different social and ethnic/religious groups hampered the diffusion of the cooperative organisational form.

The paper is thus related to several literatures. First, the findings regarding the structure of property rights in Ireland speak to the theoretical literature on firm ownership (e.g. Grossman and Hart 1986), as well as to the literature on land reform (e.g. Banerjee 2000). Second, the literature on the impact of ethnic divisions and ethnic conflict on economic policies and performance (e.g. Easterly and Levine 1997) finds an echo in this paper’s argument that political divisions between Catholics and Protestants hampered the diffusion of cooperative organisations in Ireland. However, while that literature largely focusses on the impact of ethnic divisions on public policy decisions, this
paper is concerned with the private sector diffusion of technological and organisational innovations. Third, the paper provides evidence related to a growing literature on the economic consequences of social capital, culture and religion. For example, several authors (e.g. Putnam 1993; La Porta et al. 1997) have argued that hierarchical religions, such as Catholicism or Islam, inhibit the development of trust and social capital, which others (e.g. Knack and Keefer 1997, Zak and Knack 2001) claim is beneficial for economic performance. At first sight, the stark contrast between the propensity to cooperate in Protestant Ulster (which, as we shall see, was high) and in the Catholic rest of the island (which, as we shall see, was low) provides strong evidence in favour of this view.

Many of the papers just cited rely on cross-country growth regressions to establish their case. The contribution of this paper is that it provides detailed empirical evidence at a fairly disaggregated level on the economic effects of property rights, cultural and political forces, and other variables, and on the mechanisms which were involved in linking these variables to economic outcomes. The econometric exercises involve Irish rather than Danish data, and the focus is thus on explaining relatively slow diffusion in Ireland rather than rapid diffusion in Denmark. However, a comparative perspective yields benchmarks by which Irish performance can be judged, as well as a range of hypotheses and qualitative evidence that can help make sense of the Irish data.

The next section establishes the superiority of the Danish dairying sector’s performance relative to its Irish counterpart in the late 19th and early 20th centuries. Section 3 asks whether the diffusion of cream separators in Ireland can be explained by differing endowments alone, or whether the structure of property rights and other factors also mattered. It then explores the determinants of the propensity to cooperate; that is, it asks what determined whether creameries were cooperative or not. Section 4 concludes by returning to a comparative perspective, and asking to what extent can the results of the previous section help explain Ireland’s poor performance relative to that of Denmark.

Section 2. Dairying in late 19th century Denmark and Ireland

Late 19th century Denmark and Ireland were both largely agricultural, and both competed for
the lucrative British market for breakfast goods: bacon, eggs, and, especially, butter. It was a
competition which, by common consent, the Danes won hands down.\(^1\) As late as the 1870s, the Irish
dairy industry dwarfed the Danish one, but the 1880s proved a crucial turning point: Irish butter
exports were overtaken by Danish exports in the late 1880s, and were almost two-thirds lower by
1914 (Table 1). Both Ireland and Denmark exported almost all their butter to Britain; Ireland’s share
of the British butter market dropped from over 50 percent in 1860 to only 12 percent in 1910, while
Denmark’s increased from 0.6 percent in 1860 to 37 percent on the eve of World War I \(\text{(ibid.)}\).

Losing market share might not have been so bad, had it indicated that Ireland was moving
into a high-quality niche, and substituting high prices for volume. The reverse was the case. Official
average butter prices in the two countries are available from 1846; in principal these should capture
not only overall movements in butter prices, but changing average qualities as well. According to the
data, Irish prices were well above Danish prices in mid-century, the gap was rapidly eliminated
during the 1870s, and average Danish prices exceeded Irish ones from the early 1880s (Table 1). The
gap averaged 14.8 percent between 1905 and 1914: 14.8 percent of the value of butter production on
the eve of the Great War was equivalent to one percent of Irish national income.\(^2\) About half of this
average price gap was due to Irish butter being inferior to Danish butter, within given product classes;
the remaining half was due to an inferior Irish quality mix.\(^3\)

The basic problem regarding the quality of Irish butter was that not enough of it was
produced in modern creameries. Creamery butter was produced using the new cream separator
technology, invented in Scandinavia in the late 1870s. Prior to the introduction of the separator, milk

---

\(^1\) Crotty (1966) and Lee (1989) among others have compared the two countries during this period.

\(^2\) For the sources of official price data, see the notes to Table 1.

\(^3\) On average, between 1905 and 1914, Danish creamery butter fetched between 6.4 percent (for first
quality butter) and 7.3 percent (for second quality butter) more than Irish creamery butter in Britain;
this presumably reflected quality differences within these product classes (source: *UK Agricultural
Statistics* (various years)). In principle higher transport costs between Britain and Ireland could also
have been to blame for lower average Irish prices, but in fact Anglo-Danish price gaps were higher
than Anglo-Irish ones for most of the period.
had been allowed to sit in containers while the cream rose to the top; the cream was then skimmed off and churned. The separator not only extracted more cream from the milk (leaving 0.1-0.25 percent butter fat in the skim milk, as opposed to a minimum of 0.5-1.0 percent, and more probably 1.0-1.5 percent under the old system);\(^4\) it could efficiently extract fat from milk which had been shaken in transit, and it extracted the cream more quickly and hygienically. Separators were rapidly introduced into Denmark, and the vast majority of butter was being produced using the new methods by 1914. However, as late as 1907 only 37.2 percent of Irish butter was produced in creameries, according to a witness to the 1911 Irish Milk Commission. 50 percent of total output was farmers’ butter, produced on farms using traditional methods; the remaining 12.7 percent was ‘factory butter’, i.e. farmers’ butter which was bought up by factory owners and blended to produce a more uniform consistency. Creamery butter fetched 15 percent more than factory butter, and 16 percent more than farmers’ butter;\(^5\) Irish butter producers were persisting in producing what was clearly regarded as an inferior product.

The quality of Irish butter was also variable, frequently containing more moisture than the 16 percent maximum allowed under British law. In some cases water was deliberately added to the butter by farmers or factories to add to its weight. Thus, while only 11 samples of butter imported into Britain and Ireland from abroad (out of a total of 1875) contained more than 16 percent water in 1905-6 (all 11 were Dutch), and only one sample was found to be so deficient between 1899-1900 and 1904-5, 8.7 percent of salt firkin samples\(^6\) tested in Ireland between May 1902 and December 1905 were found to contain more than 16 percent water (B.P.P. 1906, p. 413). In 1910 an inter-departmental committee found that the salt firkin trade, while small, damaged the reputation of Irish butter; indeed, one merchant asserted in his evidence to the committee “that he had always

\(^4\) Whole milk contains approximately 3.5 percent butter fat; see Jensen (1937, pp. 174-176) from whom this discussion is drawn.

\(^5\) These are average figures for 1905-1914, based on the official data in the Irish *Agricultural Statistics* (various years).

\(^6\) Salt firkin butter was produced by hill farmers who added brine to preserve it.
understood that all Irish butters were exempted from the 16 per cent limit” (B.P.P. 1910, p. 25). More
generally, the committee concluded that a “want of uniformity is the outstanding fault in Irish butter
as an article of merchandise” (B.P.P. 1910, p. 23).

In addition to not producing as much butter using new creamery methods as the Danes, the
Irish were not as rapid in adopting another, organizational innovation: the cooperative creamery.
Employing cream separators was only financially viable when they were processing the milk from a
large number of cows. In the context of early 20th century Denmark, minimum efficient scale has been
estimated as corresponding to the output of roughly 400 cows (Henriksen and Hviid 2004). However,
the average mid-sized Danish farm only possessed between 6 and 14 cows (Henriksen 1999, p. 61).
Farms were also small in Ireland, where 50 percent of agricultural holdings in 1906 were smaller than
15 acres, and 72 percent were smaller than 30 acres in size (Irish Agricultural Statistics 1906). In
order for creameries to be viable, therefore, they had to process the milk output of several farms
(somewhere in the order of 50 in the Danish context). In principle this could be done by privately
owned creameries as well as by cooperatives. However, cooperatives offered several important
advantages over their private counterparts. Indeed, they continue to do so today, as evidenced by the
fact that in 1991, the cooperative market share for dairy products was no less than 81 percent in the
United States (Hansmann 1996, p. 120). There are several reasons why ownership of the creamery by
the farmers supplying it with milk was (and still is) beneficial.

Hansmann (1996) argues that ownership of firms will be assigned in such a way that
minimises “the sum of (1) the costs of market contracting for those classes of patrons that are not
owners and (2) the costs of ownership for the class of patrons who own the firm” (p. 22), where
patrons are defined as all persons who transact with the firm. The theory thus explains the prevalence
of agricultural cooperatives as being due to some combination of (a) high costs of market-based
transactions between agricultural processors and their suppliers and (b) low costs of ownership of
agricultural processors by their suppliers. There are at least two arguments in the literature as to why
such cost considerations might in practice favour dairy cooperatives.
First, for Hansmann (1996, pp. 134-140) the key factor explaining the success of agricultural cooperatives generally is the unusually low costs of ownership by agricultural suppliers. In the context of a late 19th century creamery, its suppliers were all dairy farmers, reliant on their output of milk for the majority of their income. They thus had every incentive to monitor the creamery’s activities closely. Moreover, high transport costs for milk ensured that a creamery’s suppliers lived close to the creamery; for example, in 1898 the average length of milk collection routes for a sample of 206 Danish creameries was less than 3 miles (Henriksen and Hviid 2004). It was thus easy for farmers to monitor the creamery effectively, for example by participating in the governance of a cooperative creamery, electing members to its boards and voting on important issues at general meetings. A high incentive and a high ability to monitor combined to imply low agency costs. The fact that the farmers supplying a creamery were from a small area and were all producers of the same commodity, milk, also meant that they had relatively homogenous interests, which made collective decision-making easier.7

A second argument, which was advanced by the cooperative movement’s 19th century advocates, concerns the costs of market-based transactions between a creamery and its suppliers. The way that creameries worked was that they bought in milk supplies from several farmers; the milk was blended and separated; and butter was manufactured from the resulting cream.8 This butter was then sold by the creamery, for a price that reflected its quality; the price paid to farmers for their milk reflected this butter price realised by the creamery. The basic problem facing creameries was to ensure that the milk which they bought from all their milk suppliers was of high quality (that is to say, had a high butter fat content and was clean); crucially, bad milk from even one or two suppliers could reduce the overall quality of the creamery’s output. This would lower the price of the

---

7 19th century Denmark and Ireland were both notable for the predominance of medium-sized farms, with farms in an area tending to be of similar size. This also made collective decision-making easier: see Legros and Newman (1996), Bannerjee et al. (2001).

8 The technical economies of scale involved in butter-making were such that it would not have been viable for a creamery to separate the milk of an individual farmer, and make butter just with that.
creamery’s butter, and lower the price which the creamery was able to pay suppliers for their milk. In turn, obtaining high quality milk from all their suppliers required that all their suppliers make the necessary investments in equipment (for example, by purchasing steel milk churns, which were more hygienic than wooden churns), time and effort, in order to ensure that their milk was clean and fresh-tasting. Proper feeding of the cattle was also important, since while some fodder crops, such as turnips, gave the milk (and hence the butter) a sour taste, other feedstuffs, such as rapeseed cake, had a good effect on the texture and taste of the butter (Svendsen 1886, p. 112).

Creameries were locked in to particular locations as a result of their large investments in plant and equipment; moreover, they needed a minimum number of milk suppliers in order to be viable as a result of the fixed costs thus occurred. This made it difficult for private creameries to sanction farmers unwilling or unable to produce high-quality milk, since the creameries could not always credibly threaten to turn them away. By turning a farmer away, a creamery might indeed increase the average quality of its milk supplies, and hence of the butter it produced; but this would come at the cost of operating at a lower scale of production, which was damaging for profitability. Creameries could thus be faced with an uncomfortable choice between accepting low quality milk and producing low quality butter; or operating an at insufficient scale. This problem was particularly acute in areas where other creameries were able and willing to accept milk from farmers that had been turned away elsewhere. In this case, not only was the sanction of refusing a farmer’s milk supplies costly to the creamery; it was also costless to the farmer, and thus useless.

Cooperative creameries, by contrast, were owned by the farmers themselves, who were the residual claimants. The statutes of the typical cooperative committed members to (a) supply all their milk not used in the household to the cooperative; (b) do so for a given period, typically the length of the loan raised to finance the construction of the creamery (e.g. 15 years); (c) not adulterate the milk, and observe specific standards in relation to both cleanliness and feeding the cows; (d) share in the profits of the creamery, typically in proportion to the amount of milk delivered in a year; (e) share in
any losses or outstanding debt of the creamery, again according to a pre-specified formula.\textsuperscript{9}

Commitments (a) and (b) guaranteed the creamery sufficient suppliers to cover its fixed costs (a cooperative would not set up until it had sufficient members to begin with, and these commitments meant that it could count on members remaining with the creamery), while commitment (c) guaranteed the creamery an adequate quality of milk supplies. These commitments were backed up in the cooperatives’ regulations with clearly-specified penalties for those farmers in breach of contract (Henriksen and Hviid 2004). Thus, farmers who left the cooperative early (i.e. started selling their milk to anywhere other than the cooperative) would be forced to pay their share of the remaining debt; lose their share of the cooperative’s assets; and (frequently) pay an additional fine to the creamery. Farmers who adulterated their milk, or failed to supply clean milk, faced substantial fines, while the cooperative gave itself the right (but did not place itself under the obligation) to expel such members, which again would involve forcing them to pay their share of the gross debt of the creamery, and stripping them of their share of the cooperative’s assets. These financial penalties were very substantial. For example, in one case in 1889 a farmer who had delivered poor quality milk was fined a (not atypical) sum of Kr. 382.43 (Henriksen and Hviid 2004), which compares with an annual agricultural wage of Kr. 400 in 1890 (Ølgaard 1976, p. 34).

The net result of these contracts was that farmers were effectively locked into an exclusivity arrangement with their creamery. In such a situation, they became as dependent on the creamery as it was on them, and the incentives which they faced to supply the creamery with adequate amounts of clean milk were greatly enhanced. First, as co-owners of the creamery, they had a direct financial stake in its profitability. This would not be the case for farmers supplying a private creamery. According to a witness to the 1910 Departmental Committee on the Irish Butter Industry, in the case of private creameries “(t)here is... no community of interest between the owner and the suppliers. The seeds of friction are always there, and the imposition by the proprietor, of regulations which are

\textsuperscript{9} The discussion refers to the classic cooperative creamery, as found in Denmark. See Henriksen and Hviid (2004)
accepted as a matter of course in a co-operative creamery, at once leads to dissatisfaction and to reduced milk supply (B.P.P. 1910, p. 476).” Second, if they failed in their supply commitments they would face serious financial penalties, and in particular run the risk of losing their assets (on top of being forced to pay back their share of the remaining debt). Again, these very heavy sanctions were not available to private creameries. Third, if their actions threatened the financial viability of the creamery, and thus threatened the financial interests of the creameries’ owners – that is to say, their neighbours – they risked facing a variety of social sanctions. Farmers who owned the creamery would have a greater incentive to monitor their neighbours and, if necessary, impose sanctions upon them, than would farmers who simply supplied a privately-owned creamery. And fourth, if they were excluded from the cooperative, not only did this mean a substantial and immediate financial penalty; it also meant not being able to supply their local creamery in the future. If there were no other creamery within easy reach, or if the closest creamery was also a cooperative (in which case it would not buy his milk, since he was not a member, and could not become one), then the defaulting farmer would find himself unable to sell his output in the future, which might mean being forced out of business altogether.

The first three sets of incentives operated for all cooperative creameries, regardless of the nature of neighbouring creameries. However, the last consideration suggests that cooperatives’ already considerable power to sanction their members, and thus to ensure themselves adequate, high-quality milk supplies, was even stronger when neighbouring creameries were cooperative as well. Exclusion might still be a costly option for a cooperative creamery, but in such an environment it would be catastrophic for the defaulting farmer. Consider the following extract from the evidence of Harald Faber, a Danish Government Commissioner, to a British Government Committee investigating

---

10 According to an official UK report on Danish agriculture, “(a) member of a Danish Co-operative Society, deliberately violating the rules, would certainly have a very uncomfortable time of it in his district. Every one feels that the creamery or the slaughtery has been organised to develop the people's industry, and that with its success or failure the welfare of the people must stand or fall” (D.A.T.I.I. 1904, pp. 78-9).
the butter industry:

Have you never had any difficulty in Denmark with certain farmers sending dirty milk to the creameries? — Yes, but the creameries deal with that themselves. — How do they deal with that? — They refuse it; send it back. — Is there no likelihood of their going to any other creamery with it? — No. They could not do that. — Why could they not do that? — In the first place these creameries are co-operative creameries; the farmer is under an obligation to send his milk to that creamery. — And will that creamery absolutely refuse to take milk from a farmer unless he is associated with the creamery? — They don’t take milk from anybody but members. — It never happens that they take milk from anybody outside? — Not in a co-operative creamery. It could not be done. — Have you any proprietary dairies? — Yes, a couple of hundred. — Would they be inclined to take it? — That is the reason we have not so many. They cannot so well refuse. ¹¹

Not only did proximity to other cooperatives make a cooperative’s incentive structure more effective; it was clearly easier to tie one’s hands and not admit milk from non-members when your neighbours also committed themselves to not accepting milk from your members. The logic suggests that an initial shift towards cooperatives might have a snowball effect, increasing the desirability of having cooperatives elsewhere. All this is consistent with the very rapid transition to the cooperative organizational form in Denmark between 1888 and 1894.

The Danish experience suggests that cooperatives provided the superior institutional form, since they conclusively displaced their private competitors which had earlier been dominant. In 1888 there were 388 cooperative creameries and 468 private creameries in Denmark: cooperatives thus accounted for a minority (45 percent) of the total. However, by 1894 the situation had completely changed. There were then 907 cooperative creameries, and just 215 private creameries: cooperatives now accounted for 81 percent of the total, a proportion which was to remain roughly constant until the Great War, and which is strikingly similar to the share of cooperatives in US dairy output today. ¹²

Not only did cooperatives overtake private creameries in terms of overall numbers; many private creameries opted to become cooperative themselves (Henriksen 1999). This is important, since it


shows that the prior existence of private creameries was not an insuperable obstacle to the development of the cooperative creamery movement.

There is also indirect evidence that cooperative creameries were more efficient in Ireland. As will be seen later, creameries were far more likely to be cooperative in Ulster than in the rest of the island; and Ulster creameries were more efficient than creameries elsewhere. In the year ended 30 September 1904 (the last year for which data are available), Ulster creameries produced 3.83 cwt. of butter per 1000 gallons of milk delivered, as opposed to 3.54 in the rest of the country. This was despite the fact that Ulster creameries were smaller than creameries elsewhere: they received on average 127,846 gallons of milk per annum, as opposed to 247,168 in the rest of the island; and employed 3.1 workers on average, as opposed to a figure of 7.9 elsewhere.\textsuperscript{13} Their superior productivity was not due to any exploitation of economies of scale, therefore; above all, it indicated a superior milk quality.

The first Danish cooperative was established in 1882, although proprietary creameries had already been in existence for some years. The number of Danish cooperatives increased dramatically over the next decade; by 1914 there were almost 1200 in the country, of which over a half had been established by 1890 (Table 1). Diffusion was almost complete by the turn of the century. Irish cooperatives started later (in 1889), their numbers jumped from 1896 (70) to 1903 (356) and continued to increase up to the War, at which stage there were 445 in existence.\textsuperscript{14} Thus diffusion in Ireland was slower, and the innovation was never as widespread, as a glance at the maps of Ireland and Denmark early this century will confirm (Ó Gráda 1977, p. 290; Bjørn 1988, p. 373). Ireland’s cooperative performance looks even weaker when set against the two countries’ milch cow herds (the Irish herd was substantially larger throughout this period); by 1888 there was almost one cooperative per 2000 milch cows in Denmark, and there was almost one cooperative per thousand milch cows by the turn of the century; in Ireland, there was only slightly more than one cooperative per 4000 milch

\textsuperscript{13} Irish Agricultural Statistics, 1904.

\textsuperscript{14} IAOS Annual Reports (various years).
cows by 1914. This four to one advantage in favour of Denmark can be roughly decomposed as follows: there were slightly more than twice as many creameries per cow in Denmark as in Ireland; and the share of creameries which were cooperative was roughly twice as high in Denmark as in Ireland (just over 80 percent, as opposed to 39 percent in Ireland in 1906).

What can explain these contrasting performances?

Section 3. The causes of creamery diffusion in Ireland: hypotheses and evidence

Why did cream separators and cooperatives diffuse more slowly in Ireland than in Denmark? It is helpful to consider each question separately, since cream separators could be (and were) owned by both private creameries and cooperatives.

3.A. The diffusion of separators

A key factor determining the diffusion of cream separators was of course the availability of local milk supplies. Without milk to process, there was no need for such a technology; the milk supplies needed to be local, since fresh milk was costly to transport. What determined local milk supplies? The most obvious variable is obviously the number of milch cows. A second is the human population in the area, since people drank liquid milk, and thus reduced the supply of milk available for butter-making, *ceteris paribus*. A third variable, stressed by Cormac Ó Gráda (1977), is the density of cows in an area. He argued that it was rational for Irish farmers not to adopt cooperative creameries as enthusiastically as their Danish counterparts, since they faced an economic environment that was different in one crucial respect: Ireland had almost twice as many acres per cow as did Denmark. Creameries needed a minimum milk supply to cover their fixed costs; if there were not enough cows within easy reach, a creamery would not be viable. Ó Gráda found that the number

---

15 These statistics, as well as those in the following paragraph, are based on Henriksen (*ibid.*), Jensen (1937, p. 393), IAOS *Annual Reports* (various years), Irish *Agricultural Statistics* (various years) and CSO (1997, pp. 282-3).
of cooperative creameries in each county or poor law union in 1913 was well explained statistically by cow density, milch cow numbers and population. In areas such as Limerick, which most resembled Denmark, creameries (both private and cooperative) were widely diffused; they had “spread as far as was viable in the Irish context by the 1910’s” (p. 299).

Another factor determining the supply of milk in an area was the productivity of the individual farmer, which was reflected in the milk yields which he obtained from his cattle, and the butter fat content of the milk. An important tradition in the Irish historiography has debated whether farmer productivity might have been related to the Irish system of land tenure. Irish agricultural land had traditionally been owned by landlords, who let it out to tenant farmers. However, the landlords played no role in running their tenants’ farms. Not only did tenant farmers and their families do all the work on their farms (by the late 19th century, labour on the farms was carried out by the farmers themselves, since landless agricultural labourers effectively vanished as a class in the decades following the Famine: see Fitzpatrick 1980); key decisions about how to run their farms, as well as key investment decisions, were taken by the farmers on the ground rather than by the landlords. Indeed, the landlords often lived in Britain rather than Ireland, invested little (Ó Gráda 1975), and were for the most part content merely to collect their rent from farmers who farmed the same holding all their lives, and passed it on to their children. The traditional view among Irish commentators held that this landlord-tenant system discouraged investment in agriculture: not only did absentee landlords not invest, but tenants feared that if they themselves invested, any benefit they derived would be appropriated by landlords raising their rent. If this argument is correct, then owner occupancy of farms should have been positively related to economic performance; in terms of Grossman and Hart (1986), owner occupancy represented an allocation of ownership rights that minimized ex ante investment distortions (or at least lowered them substantially relative to the

---

16 The key variable for Ó Gráda is cow density; he also included the number of cows in his regressions since if you take two hypothetical counties with identical cow densities, there should be more milk, and more creameries, in the larger county with the larger milk herd.
As it happens, this hypothesis can be tested with the available data. Prior to the Wyndham Act, British government land reform policies had not led to any great transfer of ownership toward tenant farmers. However, that piece of legislation massively subsidised such transfers (see Guinnane and Miller 1997 for details). Landlords were encouraged to sell their estates to the government via cash bonuses and other incentives; tenants were encouraged to buy their farms from the government by a provision which stated that their annual payments would be 10 to 30 percent lower than their existing rents. This meant that all tenants faced an irresistible incentive to buy. Predictably, tenants everywhere immediately tried to buy out their holdings; the resulting transfers of ownership were limited only by the willingness of landlords to sell, and that depended on their own financial and personal circumstances rather than on any pressure from tenants. 17 The Wyndham Act thus gave rise to a massive transfer of ownership of family farms away from absentee landlords and towards farming families; moreover, this transfer of ownership was essentially exogenous to the farmers themselves. By 1906, the year for which there are data, the share of tenant farmers owning their own property ranged from 15.4 percent in County Louth to 52.5 percent in County Londonderry. The prediction of the traditional argument regarding Irish landlord-tenant relations is thus that in counties with higher levels of owner occupancy, farm productivity was higher, and milk supplies (and therefore the demand for cream separators) was higher, ceteris paribus, than in counties where the transfer of ownership from landlord to tenant was less advanced. 18

Thus far the discussion has emphasized the supply of milk, and thus the demand for cream separators. But what about their cost? Cream separators required investment, not just in the separator itself, but in the steam engines required to power them, and in the buildings required to house them. Some contemporary observers (and in particular the promoters of the cooperative credit movement)

---

17 See for example the case of Lord Granard, in Dooley (2001).

18 In the discussion that follows, the term ‘farmer’ is used throughout to refer to tenant farmers, or owner occupiers. It does not refer to landlords.
argued that Irish financial institutions were conservative lenders, and that would-be borrowers found it difficult to obtain funds, particularly in the more underdeveloped parts of the country. On the other hand, bank archives reveal substantial lending to farmers and creameries (Ó Gráda 1994), and cooperative creamery records reveal substantial borrowing from banks and other financial institutions. Despite such evidence, I will test the ‘financial underdevelopment hypothesis’ by including the number of bank branches per county, per 100,000 of population, in regressions explaining the diffusion of cream separators.

There are three other variables that might also have mattered a priori for the diffusion of cream separators. The first is literacy: Schultz (1983, p.189) argues that education was crucial for Danish innovation; while Griliches (1963) documents the links between education and agricultural productivity in the 20th century U.S. The second is farm size, and in particular the share of very small farms. These are likely to have been less efficient than other farms; in addition, a greater proportion of the milk produced on such farms would have been consumed on the farm (given that a farming family would have consumed roughly the same amount of milk, regardless of whether they worked a small or a large farm), leaving less for the creameries. The regressions will thus include the share of farms less than 5 acres in size. Finally, there were topographical and land quality differences between the four Irish provinces that traditionally implied different agricultural specialisations and productivities. Poverty-stricken Connaught in the west had generally poor land, and was the least prosperous province. While there were also several poor areas along the western seaboard of Munster, this southern province contained many of Ireland’s most prosperous dairying areas, in particular the so-called Golden Vale, whose fertile land implied high milk yields. The land in Leinster was relatively good, but cattle farmers there tended (relatively speaking) to specialize in beef rather than dairying. Ulster was the most prosperous province, but this was primarily based on its industry rather on its agriculture; indeed, the land in Ulster was not particularly fertile, and the climate there was slightly harsher than it was further south. The expectation is thus that a Munster dummy variable would have a significant and positive effect on the diffusion of cream separators.
3.B. The determinants of cooperation

The next question to be considered is what determined the diffusion of the cooperative organizational form in Ireland; in other words, what were the determinants of the propensity to cooperate?

A first hypothesis is that the propensity to cooperate may have been determined by efficiency considerations, and in particular by the distribution of landholdings. Where there were fewer, bigger farmers in an area, private creameries might have been more viable, in that bigger farms were likely to be more efficient and produce higher quality milk. The incentive effects of cooperation might thus not have been required, or at least as badly required.\(^\text{19}\) On the other hand, the collective action problems involved in setting up a cooperative might have been more difficult to overcome in areas with many very small landholdings, for well-known reasons having to do with the ability to resolve collective action problems (Olson 1965). Cooperatives might therefore be observed more often in areas with predominantly medium-sized landholdings, and this is a testable proposition since there exist data on the size distribution of landholdings.\(^\text{20}\)

The next two hypotheses, by contrast, involve non-economic factors. The first is motivated by the recent literature on religion and social capital, and focusses on trust. Cooperation required, almost by definition, a large amount of trust within a community. Farmers would only be willing to place their economic welfare in each others’ hands if they trusted each other to do a professional job, both in running the cooperative and in adopting sound farming practices (since one farmer’s bad practices implied costs for everyone). La Porta et al. (1997) report empirical evidence that trust today is strongly and negatively related to Catholicism. If trust was indeed important in setting up a

\(^{19}\) The argument is not that farms above 30 acres were large enough to supply the entire milk requirements of a creamery; virtually no Irish farms were large enough to do so at this time. The argument is simply that larger farms were more likely to be efficient and produce good milk, even in the absence of the sanctions for poor producers defined by the network of contracts which constituted a cooperative creamery.

\(^{20}\) I am indebted to an anonymous referee for this suggestion.
cooperative, and if the finding of La Porta et al. also applied to the late 19th and early 20th centuries, then cooperation may have been more difficult to sustain in Catholic areas than in Protestant areas. The obvious test of this is to see if the propensity to cooperate was related to the proportion of Roman Catholics in an area.\textsuperscript{21}

Another factor that may have had an impact on the propensity to cooperate is religious and political strife, connected with the Land Wars of the 1870s and 1880s, as well as with the so-called ‘National Question.’ The Land Wars concerned the attempts by (largely Catholic) tenant farmers to expropriate their (almost exclusively Protestant) landlords; and while as has been seen the end result of this process (owner occupancy) may have been good for incentives and productivity, the conflict itself kept alive inter-communal divisions. In particular, the late 1870s and early 1880s saw a series of boycotts, rent strikes and violence against both property and persons. Such land-related violence had long died away by the early 20th century; however, it brought about a bitterness in inter-communal relationships which proved enduring. Moreover, divisions between Catholics and Protestants flared to life again in the decade or so before World War I, as Catholics demanded Irish independence, or Home Rule, and Protestants – both the workers and farmers of Ulster, but also the landlords of the south – demanded the continuation of the Union with Britain. \textit{A priori} it seems likely that the debate about Irish Home Rule damaged social cohesion, making collective action more difficult.

\textsuperscript{21} Some care has to be taken in implementing such a test econometrically, however, since another factor which might make horizontal cooperation easier is religious homogeneity. This suggests that the impact on the propensity to cooperate of raising the proportion of Catholics in a county might depend on whether the county in question had a Protestant or a Catholic majority. Imagine for the sake of argument that Catholicism was indeed negatively related to the propensity to cooperate, but that religious homogeneity was positively related to trust and cooperation. In that case, raising the proportion of Catholics in a majority Protestant county would have two effects, working in the same direction: it would make the county more Catholic, and less homogenous. However, an increase in the Catholic share in a majority Catholic county would make the county more Catholic but also more homogenous, and these two effects might have opposite impacts on the propensity to cooperate. The econometric analysis thus allows the Catholic share of the population to have different effects in majority Protestant and majority Catholic counties. I am grateful to an anonymous referee for this suggestion.
Indeed this was quite clearly so as far as the cooperative movement was concerned, since many Nationalists were suspicious of the Irish Agricultural Organisation Society (IAOS, the main Irish cooperative organization), on the grounds that, as an interdenominational body, its leaders were as likely to be Protestants and/or Unionists as they were to be Catholic Nationalists. The Irish cooperative movement differed from its Danish counterpart in that it was a ‘top down’ movement, set up initially by patriotic aristocratic (and therefore Protestant) reformers such as Horace Plunkett, rather than by farmers on the ground. The IAOS went to some trouble to include Catholics in leadership positions, it defined itself as interdenominational and a-political, it refused to take a position on divisive issues such as the Home Rule question, and at the local level many Catholics were obviously involved in its activities. Nevertheless, between 1894 and 1915, 21 out of the 49 people to have served as committee members of the IAOS were landlords (King 1996, p. 73).

This was enough for some Nationalists to condemn the movement as a landlord plot. For example, on one occasion R.A. Anderson, an organizer with the IAOS, was prevented from addressing a local meeting on the subject of cooperation, when a local solicitor discovered that the cooperative movement was apolitical and non-denominational. The solicitor informed Anderson that cooperation “would not suit Rathkeale. “Rathkeale,” said he pompously, “is a Nationalist town--Nationalist to the backbone-- and every pound of butter made in this Creamery must be made on nationalist principles, or it shan’t be made at all.” This sentiment was applauded loudly and the proceedings terminated” (Plunkett 1982, pp. 190-91). More generally, attacks on the IAOS by

---

22 Plunkett had taken a seat in Parliament in 1892 as a unionist candidate for south Dublin; and while he was always a moderate (and indeed converted to the Home Rule cause in 1911), his 1904 book Ireland in the New Century, with its attacks on the influence of the Roman Catholic Church and the tactics of the Nationalist party, its advocacy of the union and its comments on the defects of the Irish personality, alienated many nationalists. Plunkett was appointed to the Irish Senate in 1922, the first year of Irish independence. The following year his house was burnt down by Republicans, Plunkett resigned his Senate seat, and the founder of the Irish cooperative movement emigrated to England, where he spent the rest of his life.

23 Smith-Gordon and Staples (1917, pp. 46-47) suggest another explanation for the Nationalist Party’s ‘frank opposition’ to the IAOS, namely a fear that rural reforms might bring prosperity to the country-side and thus undercut the demand for Home Rule.
Nationalist newspapers like the *Skibereen Eagle* were commonplace (Smith-Gordon and Staples 1917).

The stress in the Irish literature on the divisive effects of the Land Wars and the ‘National Question’ is mirrored by an emphasis in the Danish literature on the importance of social cohesion. For Charles Kindleberger (1951) this was the decisive factor in Denmark’s success:

...co-operation in Denmark flourished, because of the social cohesion which enabled the farmers to create the necessary institutions, when the occasion demanded economies of scale in marketing along with labor-intensive production. The prevalence of freeholds bespeaks equality of status, which makes communication freer in all directions. Education increases the quantity and quality of communication. Together with a high degree of communication, a closely held set of values, and internal social mobility – all of which are interrelated – Denmark had social cohesion. It was this factor which enabled her to create institutions needed to take advantage of an economic opportunity. (Kindleberger 1951, p. 45)

Similarly, Henriksen (1999, p. 60) has argued that Danish farmers’ “ability to identify with one another” was crucial for cooperation in that country; could it be that political and religious divisions undermined that ability in Ireland? This hypothesis will be tested by looking at the relationship between *inter-communal divisions*, associated with the Land Wars, and the diffusion of creameries. The measures used refer to the extent of vertical conflict between landlords and tenants; the argument is that such conflict exacerbated tensions between Catholics and Protestants generally, and heightened Nationalist suspicion of the inter-denominational cooperative movement, thus reducing the propensity to cooperate.

3.C. Econometric evidence

Summarising the above discussion, the hypotheses to be tested are as follows:

(1) The diffusion of creameries reflected efficiency considerations— that is, endowments (cow numbers and density, population, literacy, and the favourable land endowment in Munster) and institutions (the local availability of capital, the share of small farms, and the structure of property rights— i.e. the share of owner occupancy).
(2) The propensity to cooperate depended on a mix of efficiency considerations (related to the size distribution of farms) and cultural and political factors (related to Catholicism, and inter-communal tensions, respectively).

In order to test the hypotheses outlined above, I collected data on the number of creameries in each of the 32 Irish counties in 1906. 1906 was chosen since it is the only year for which data are available on both private and cooperative creameries, as well as on owner-occupancy. (An appendix gives data sources and descriptive statistics.) I also collected county-level data on the number of milch cows in 1906 (expressed in thousands); cow density in 1906, defined as milch cows per 1000 acres; population size in 1901 (expressed in thousands); the percentage of farms which were owner-occupied in 1906; the illiteracy rate in 1901; the share of Roman Catholics in the total population in 1901; the size distribution of landholdings in 1906; and the number of bank branches per 100,000 of population in 1906.24

Finally, I collected data on the number of ‘agrarian outrages’ (i.e. crimes against persons or property) per 10,000 of population, at the height of the Land Wars (1880-82). To be sure, this was a long time before 1906, but the dates were chosen since 1880-82 is when the bulk of Land War-related crime occurred. The question is whether regions which had a history of such violence were different from those that did not; in particular, the hypothesis to be tested is that where landlord-tenant (and hence inter-communal) tensions were historically higher, resistance to the inter-denominational IAOS was greater, and the propensity to cooperate was lower.

The strategy is to first run a series of regressions explaining the number of cream separators in each county (i.e. the number of creameries, both cooperative and private). Having done that, I will

24 The population variables were collected for 1901 since there was a population census in 1901 (as well as in 1911). I also ran the regressions using 1906 values for these variables, which were generated by interpolation between 1901 and 1911; not surprisingly, the results were unaffected. I have presented here the results using 1901 data since these are ‘real’ data, in contrast to the interpolated data which are merely informed speculation. A data appendix gives the sources for all variables.
explore the determinants of the share of these creameries that was cooperative. That is, I consider separately the diffusion of the new cream separator, and of the new cooperative organisational form.

Concerning the diffusion of cream separators, if Ó Gráda (1977) is right then the only variables that should matter are the number of milch cows, cow density, and population. Milch cow numbers and cow density should be positively related to creamery numbers, while population should have a negative effect. Equation (1) tests these predictions, by regressing total creamery numbers on milch cow numbers (in thousands), population, and milch cows per 1000 acres. The three variables all have the signs predicted by theory, and are highly statistically significant. Cow density is the key variable in Ó Gráda’s analysis and this remains strongly positive throughout; however, the other two variables lose statistical significance once enough other control variables have been added (equations 3 and 4). The impact of cow density is large: increasing the number of cows per 1000 acres by one standard deviation (28.3) relative to its mean value of 72.7 increases the expected number of creameries per county by 8.76, relative to an expected value of 6.56 when all right hand side variables are set equal to their mean values.

However, cow density is not the beginning and end of the story. Column (2) introduces the share of owner-occupied farms into the specification, and the result is a striking confirmation of the argument that owner-occupancy was better for productivity than traditional landlord-tenant arrangements. The coefficient on owner-occupancy is positive and strongly statistically significant; moreover, it is also economically significant. Increasing the share of owner-occupied farms by one standard deviation (9.2) relative to its mean value (29.6) would lead to the expected number of

---

25 A count specification is used because of the nature of the dependent variable, which takes on low integer values for most counties, and is equal to zero in the others. A negative binomial specification is preferred to a Poisson specification, since when Poisson models are estimated goodness of fit chi-squared tests show that the data are not Poisson distributed; correspondingly, when negative binomial regressions are estimated, LR tests indicate that the overdispersion parameter \( \alpha \) is greater than zero. I use the standard NB2 model with mean \( \mu \) and variance \( \mu (1 + \alpha \mu) \) (described in Cameron and Trivedi 1998, pp. 71-2, and implemented via the nbreg command in Stata 8) to model overdispersion.

26 Here and elsewhere results are calculated using CLARIFY (Tomz et al. 2001), as described in King et al. (2000), and use the specification in equation (3).
creameries per county increasing by 5.46, relative to an expected value of 6.56 when all right hand side variables are set equal to their mean values.

These are big effects. The results vindicate not only traditional nationalist critiques of the Irish landlord-tenant system, but the predictions of Grossman and Hart (1986) and the associated literature on vertical integration.\footnote{In principle one might worry about tenants and owner occupiers differing in some unobservable way that accounted for the difference in productivity between the two groups, but this was not a factor in this instance. As explained above, the provisions of the Wyndham Act implied that tenants everywhere wished to become owner occupiers; whether they had in fact become so by 1906 depended solely on their landlords, and there was nothing that tenants could do, or did do, to speed up the process. By the first decade of the 20th century, violent confrontations between landlords and tenants, rent strikes, boycotts and other such tactics had become a thing of the past.} Property rights mattered for the productivity of Irish agriculture, and owner occupancy was beneficial: this is the first major finding of this paper.

Equation (3) introduces the other variables that section 3.A suggested should matter for the diffusion of cream separators. Bank branch density is positively and significantly related to diffusion, which is a somewhat revisionist finding in the light of Ó Gráda’s (1994) view that access to capital was not an obstacle to development in rural Ireland. By contrast, these results suggest that there were more creameries, other things being equal, where there was a greater density of banks. The effect is not as large as the effect for owner occupancy; increasing the number of bank branches per 100,000 of population by one standard deviation (4.75) relative to its mean value (17.4) increases the expected number of creameries per county by 2.7, relative to an expected value of 6.56 when all right hand side variables are set equal to their mean values. The coefficient loses statistical significance at conventional levels in some other specifications (equations 5 through 7); nevertheless it remains positive (and roughly the same size) throughout.

Illiteracy does not appear to be related to diffusion (and indeed, while it is statistically insignificant it has the ‘wrong’ sign in regressions 3 through 6). The other control variables perform better: the share of small farms (i.e. less than 5 acres in size) is, as expected, negatively related to diffusion. Increasing the share of small farms by one standard deviation (10.5) relative to its mean...
value of 26.3 reduces the expected value of the number of creameries per county by 4.2, relative to an expected value of 6.56 when all right hand side variables are set equal to their mean values. Again as expected, the Munster dummy variable is positive and strongly statistically significant.\footnote{28}

The results thus show that cream separator diffusion is well explained by ‘objective’ economic factors: endowments (cow density and provincial topography) and institutions (the share of small farms, the structure of property rights, and bank density). By contrast, \textit{a priori} reasoning suggested a potential role for political and cultural factors in explaining the diffusion of the cooperative organisational form. Do such variables also explain the diffusion of cream separators (\textit{a priori} reasoning suggests not)? Equation (4) tests this possibility by including the variables that should matter for the propensity to cooperate. The specification includes not just the share of medium sized farms (which is an objective economic factor that might be expected to influence the propensity to cooperate on efficiency grounds); it also includes the share of Catholics in the population, and agrarian outrages. Not only are all these variables unrelated to the diffusion of cream separators; including them in the specification leaves the previous results unaffected.

Finally, one possible objection to Ó Gráda’s argument that cow density was the crucial factor explaining separator diffusion in Ireland is the possibility that cow density might be endogenous (and in particular, that an increase in creamery activity in an area might lead to a corresponding rise in the local herd). Although Ó Gráda’s argument is not the focus of this paper,\footnote{29} columns (5) and (6) replicate the specifications of columns (3) and (4), but replace cow numbers and cow density in 1906 with cow numbers and cow density in 1871. Milch cow numbers in 1871 were clearly exogenous to the number of cream separators in 1906, and indeed in any other year, since cream separators had not yet been invented in 1871 (they were invented in 1878). As can be seen, the results are qualitatively identical to those obtained earlier (with the coefficients on cow numbers becoming larger, and those

\footnote{28} The omitted province in these regressions is Connaught.

\footnote{29} Indeed, my main purpose is to show that endowments alone cannot explain the diffusion of creameries and cooperatives; therefore anything that weakens his argument strengthens mine.
on cow density becoming smaller—the only difference is that the banking coefficient now becomes statistically insignificant); this is hardly surprising, given that regions which had specialised in dairying in the past continued to do so after the advent of the separator.  Of greater interest to this paper is the fact that the coefficients on owner occupancy are larger under these alternative specifications.

In summary, the diffusion of cream separators seems to be well explained by ‘objective’ economic factors: cow density, the share of small farms, the structure of property rights, and the density of banking services, with an additional role for Munster’s fertile land endowment.

What about the diffusion of the cooperative organisational form? In order to explore this, I look at the correlates of the share of creameries in a county that were cooperative. There were no creameries at all in eight counties, so there are only 24 observations to work with. This makes multiple regression analysis difficult, but the data are sufficiently striking that several conclusions can nonetheless be drawn from them.

The big cultural and political divide within Ireland was, and remains, the divide between the northern province of Ulster and the rest of the island. Ulster was predominantly Protestant and Unionist, and six of the nine Ulster counties remain part of the United Kingdom today. There were Protestant majorities in these six counties in 1901; in the other three Ulster counties (Cavan, Donegal and Monaghan) Protestants accounted for between 27 and 36 percent of the population, a not insubstantial proportion. The other three provinces (Leinster, Connaught and Munster) were overwhelmingly Catholic, and favoured Home Rule.

There were 154 creameries in Ulster in 1906, of which 126, or 81.8 percent, were cooperatives. In the rest of the island, there were 563 creameries, of which just 156, or 27.7 percent, were cooperatives. This is striking confirmation of the hypothesis that political and/or cultural factors were related to the choice of whether or not creameries should become cooperative: efficiency

30 Henriksen (1999) tries to instrument for cow density in the Danish context and finds that doing this makes no difference to her results.
considerations alone cannot possibly explain this discrepancy between the organisational choices of Ulstermen and farmers elsewhere in Ireland. Creameries in Protestant Ulster were overwhelmingly cooperative. Indeed, the proportion of cooperatives in Ulster in 1906 (just over 80 percent) was virtually identical to that in Denmark during the same period, or in the United States today. Creameries in the rest of Ireland, on the other hand, were overwhelmingly private.

What were the mechanisms at work that led to this difference between the propensity to cooperate in Ulster and elsewhere? The fact that the propensity to cooperate was so much higher in Protestant Ulster than in the rest of the country is certainly consistent with Putnam (1993) and La Porta et al. (1997), who argue that hierarchical religions such as Catholicism inhibit the development of trust. If trust was essential for the establishment of cooperatives, which seems plausible, then a purely cultural explanation for the slow diffusion of cooperatives in Ireland seems promising. On the other hand, the data are also consistent with the alternative (but not necessarily mutually exclusive) hypothesis that Nationalist antipathy to the IAOS blocked the spread of cooperation in southern Ireland, and thus with the argument that social and political divisions within Ireland were a deterrent to cooperation.

The difficulty in explaining why the propensity to cooperate was so much higher in Ulster than in the rest of the country is that Catholicism and landlord-tenant conflict were highly correlated with each other, and took on values more favourable to cooperation in Ulster than elsewhere. Ulster was not only more Protestant than the rest of the country, but had experienced less landlord-tenant strife during the Land Wars, and was Unionist rather than Nationalist. There were 7.6 agrarian outrages per 10,000 population during 1880-82 in the average Ulster county, as opposed to the 28.3 per 10,000 population recorded elsewhere in Ireland. Similarly, medium sized farms were more common in Ulster (where they accounted for 57.8 percent of holdings) than elsewhere (where they accounted for just 43.7 percent of holdings).

Table 3 thus runs a series of OLS regressions explaining the propensity to cooperate (i.e. the share of creameries that were cooperative) in each county. Columns (1) through (3) regress the share
of cooperatives on Catholicism, the share of medium-sized farms, and agrarian violence respectively. As discussed earlier (see footnote 21), the share of Catholics in the population is entered separately for majority Catholic and majority Protestant counties. The results are as predicted by the discussion in Section 3.B: the propensity to cooperate is positively related to the share of medium-sized farms, and negatively related to Catholicism (although the coefficient is statistically insignificant in Protestant-majority counties) and Land War violence. Of greater interest, however, are columns (4) and (5), which enter these variables jointly in the specification. As can be seen from the results, the coefficient on the share of medium-sized farms remains positive and statistically significant throughout, while that on agrarian outrages remains negative and statistically significant throughout. The coefficients on these two variables are economically as well as statistically significant. For example, the coefficients in equation (5) imply that raising the share of medium-sized farms by one standard deviation (15.5) increases the share of creameries in a county that are cooperative by 16.7 percentage points. The impact of landlord-tenant conflict is even greater: raising the number of agrarian outrages per 10,000 of population by one standard deviation (15.2) reduces the cooperative share in a county by an impressive 27.9 percentage points. In contrast, the effect of Catholicism vanishes once these other variables have been controlled for. Column (5) includes an Ulster dummy variable, which is statistically insignificant (and actually negative). It appears that a higher share of medium-sized farms and a relatively benign history of landlord-tenant relations can fully explain Ulster’s greater propensity to cooperate. More precisely, the 54.1 percentage point difference in the propensity to cooperate between Ulster and the rest of the island can be decomposed as follows (using the coefficients from regression 4, and the average values for Ulster and elsewhere reported earlier): 36.1 percentage points, or 66.8 percent, was due to the lower level of Land War violence in Ulster; 14.2 percentage points, or 26.4 percent, was due to a higher share of medium sized farms; and 3.8 percentage points, or 7 percent, was due to other factors.31

31 It should be noted that the farm size distribution in Ireland was remarkably stable during the late 19th and early 20th centuries – for example, the share of farms between 5 and 30 acres in all farms
The findings regarding Catholicism are striking. At first sight, the contrast between Ulster and the rest of the country seems like an obvious example of the impact of religion on economic behaviour. However, in the Irish context religious differences were also differences in national identity, with Protestants (on the whole) feeling British and Catholics (on the whole) feeling Irish. The results suggest that it was the ethnic and religious divide within Ireland that was crucial for the slow spread of cooperation outside Ulster, not the cultural characteristics of Catholicism *per se*. It was this divide which led to tensions between Catholic tenant farmers and Protestant landlords being so virulent at the time of the Land Wars; and these tensions persisted even after the Land Wars themselves had been resolved by the British Government. In turn, tension between the two communities (which by the early 20th century had to do more with the question of Irish independence than with the land question) made it more difficult for the cooperative movement to progress, and this effect was strongest in areas where the history of tension was highest. Such areas were all outside Ulster.

A lack of social cohesion thus impeded the diffusion of the cooperative organisational form in Ireland. This is the second key finding of the paper. Moreover, this lack of social cohesion might have impeded the diffusion of cream separators in areas where the cooperative organisational form was potentially most useful; that is to say, in areas with medium-sized farms. Column (7) in Table 2 explores the diffusion of separators outside Ulster; it uses the baseline specification in column (3), but adds an interaction term between the number of agrarian outrages in a county and the share of medium-sized farms there.\(^3\) The coefficient is negative and statistically significant at the 10 percent level. The coefficient implies that increasing the size of this interaction term by one standard deviation (810.0) relative to its mean value (1023.7) reduces the expected number of creameries by larger than one acre was 57.0 percent in 1870, 56.9 percent in 1880, 56.4 percent in 1890, 56.0 percent in 1900, and 56.0 percent in 1906 (C.S.O. 1997, p. 285; *Agricultural Statistics* 1906). It would not be plausible, therefore, to argue that the share of medium-sized farms in Table 3 is endogenous to the diffusion of cream separators or cooperative creameries.

\(^3\) I am indebted to an anonymous referee for this suggestion.
0.9, relative to an expected value of 2.8 when all right hand side variables are set equal to their mean values: that is to say, by roughly a third. The results suggest that in areas with particularly high shares of medium-sized farms, a history of inter-communal tension did not just retard the spread of cooperatives, but was an obstacle to the spread of the new cream separator technology as well.

Section 4. Conclusion

This paper has shown that there were very different forces at work explaining the introduction of the new cream separator technology into Ireland, on the one hand, and the cooperative organisational form on the other. Cream separators diffused where there were lots of cows per acre, just as Ó Gráda (1977) suggested. However, this paper has also shown that the structure of property rights in Ireland held back progress there. Diffusion was slower where farmers still rented their land from absentee landlords, consistent both with nationalist claims and with the theoretical literature on vertical integration.

On the other hand, the diffusion of the cooperative organisational form seems to be strongly linked to non-economic, and in particular to political factors. The propensity to cooperate was much less pronounced in Catholic areas than in Protestant ones, but this was more a result of inter-communal conflict than of any inherent disadvantages of Catholic culture per se. Importantly, in areas where medium-sized farms were particularly important, such conflict reduced the spread not just of cooperation, but of the cream separator technology as well.

It seems that Denmark benefited from several advantages that Ireland did not enjoy during this period. As regards the diffusion of cream separators, Denmark enjoyed a higher cow density: 133.2 cows per thousand acres, as opposed to 71.7 cows per thousand acres in Ireland.33 As regards land ownership, peasant proprietorship in Denmark was given a boost by the government during the ‘period of reform’ from 1784-1807, and the transition to that institution proceeded throughout the

nineteenth century. Already by 1835 there were 41,695 peasant proprietors in Denmark, as opposed to 24,795 tenant farmers, and by the early 20th century Danish farmers were essentially all owner-occupiers. According to Wade (1981, p. 56), the Danish “freehold form had the effect of avoiding the problem of who owned improvements made to increase livestock operations that tenant farmers faced in Great Britain in the 19th century.” Both a high cow density, and peasant proprietorship, help explain why separators spread more rapidly in Denmark than in Ireland.

As for the more rapid diffusion of cooperatives in Denmark, Denmark was an extremely homogenous, Protestant country. There was no conflict over who should own the land; nor was there any ethnic conflict, or conflict over where national boundaries should lie (all such controversies became redundant following the loss of Schleswig-Holstein, with its large German population, to Prussia in 1864). The results suggest that the homogeneity of Danish society in particular helped to explain the success of cooperation there. Interestingly, one Danish county, Hjørring in northern Jutland, had fewer cooperative creameries (and consumer cooperatives) than the national average; it turns out that ideological attitudes in the county, particularly in eastern Hjørring, were different than in the rest of the country. Relative to the rest of the country, more people there voted for the conservative party, as opposed to the liberal peasants’ party; and more adhered to the Church of Denmark’s evangelical branch, as opposed to mainstream Lutheranism (Henriksen 1999, pp. 71-72). This is consistent with arguments that social cohesion in the rest of Denmark was a major factor in the success of the cooperative movement there.

---

References


B.P.P. (1906), Report from the Select Committee on Butter Trade, British Parliamentary Papers, Vol. VII.


IAOS (various years), Annual Reports of the Irish Agricultural Organisation Society, Ltd. (Dublin).


Rumpf, E. and A.C. Hepburn (1977), Nationalism and Socialism in Twentieth-Century Ireland (Liverpool: Liverpool University Press).


Svendsen, A. (1886), Fodringslæren Særligt med Hensyn til Kvægets Fodring (København: Rasmussen & Olsens Bogtrykkeri).


Table 1. Butter exports, prices and cooperatives, 1850-1914

<table>
<thead>
<tr>
<th>Year</th>
<th>Exports, 1000 tons</th>
<th>Share of British imports</th>
<th>Official prices, s. per cwt.</th>
<th>Number of coops</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Denmark</td>
<td>Ireland</td>
<td>Denmark</td>
<td>Ireland</td>
</tr>
<tr>
<td>1850</td>
<td>2</td>
<td>28</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>1860</td>
<td>2</td>
<td>37</td>
<td>0.6</td>
<td>46.6</td>
</tr>
<tr>
<td>1870</td>
<td>7</td>
<td>37</td>
<td>6.8</td>
<td>38.3</td>
</tr>
<tr>
<td>1881</td>
<td>12</td>
<td>34</td>
<td>10.3</td>
<td>24.5</td>
</tr>
<tr>
<td>1885</td>
<td>18</td>
<td>32</td>
<td>12.5</td>
<td>20.7</td>
</tr>
<tr>
<td>1890</td>
<td>43</td>
<td>29</td>
<td>31.7</td>
<td>22.0</td>
</tr>
<tr>
<td>1895</td>
<td>52</td>
<td>34</td>
<td>33.2</td>
<td>19.3</td>
</tr>
<tr>
<td>1900</td>
<td>61</td>
<td>35</td>
<td>36.6</td>
<td>16.8</td>
</tr>
<tr>
<td>1905</td>
<td>80</td>
<td>29</td>
<td>34.5</td>
<td>12.1</td>
</tr>
<tr>
<td>1910</td>
<td>89</td>
<td>30</td>
<td>35.2</td>
<td>11.9</td>
</tr>
<tr>
<td>1914</td>
<td>95</td>
<td>36</td>
<td>37.2</td>
<td>15.2</td>
</tr>
</tbody>
</table>

Sources: Exports: Johansen (1985, pp. 199-201), Solar (1989-90, pp. 159-60); Shares of British market: Solar (*ibid.*); Nüchel Thomsen and Thomas (1966, p. 152); Ó Gráda (1977, p. 206); Prices: Danish *Statistiske Meddelelser* (various issues), Irish *Agricultural Statistics* (various years); Cooperative numbers: Danish figures kindly supplied by Ingrid Henriksen; IAOS Annual Reports (various years).

Notes: n/a = not available. `*`: obtained by interpolation between figures for 1894 and 1896. Shares of British butter imports are calculated assuming that all Irish exports went to Britain, and that all UK imports were consumed in Britain. Before 1887 the UK import statistics include substantial margarine imports, mostly from Holland; thus Ireland accounted for over 50 percent of British butter imports in 1860.
Table 2. Negative binomial regressions: the diffusion of separators, 1906
(dependent variable: total number of creameries)

<table>
<thead>
<tr>
<th>Sample</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milch cows</td>
<td>0.02854***</td>
<td>0.03275***</td>
<td>0.00632</td>
<td>0.01254</td>
<td>0.01498</td>
<td>[0.00695]</td>
<td>[0.00786]</td>
</tr>
<tr>
<td>Milch cows per 1000 acres</td>
<td>0.04050***</td>
<td>0.02653**</td>
<td>0.02925***</td>
<td>0.02696***</td>
<td>0.01802*</td>
<td>[0.01080]</td>
<td>[0.01066]</td>
</tr>
<tr>
<td>Milch cows (1871)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milch cows per 1000 acres (1871)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population (thousands)</td>
<td>-0.00612***</td>
<td>-0.00570***</td>
<td>0.00124</td>
<td>-0.00118</td>
<td>0.00131</td>
<td>-0.0005</td>
<td>-0.00511</td>
</tr>
<tr>
<td>Share of owner-occupied farms</td>
<td>0.05173***</td>
<td>0.06544***</td>
<td>0.06644***</td>
<td>0.06716***</td>
<td>0.07379***</td>
<td>0.14770***</td>
<td></td>
</tr>
<tr>
<td>Bank branches per 100,000 population</td>
<td>0.06741*</td>
<td>0.07223*</td>
<td>0.06231</td>
<td>0.0476</td>
<td>0.04828</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illiteracy rate</td>
<td>0.04074</td>
<td>0.05117</td>
<td>0.02012</td>
<td>0.00727</td>
<td>-0.01923</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share of farms less than 5 acres</td>
<td>-0.10063***</td>
<td>-0.12260***</td>
<td>-0.08389***</td>
<td>-0.08037***</td>
<td>-0.13058*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Munster</td>
<td>1.88868***</td>
<td>2.18613**</td>
<td>1.94824**</td>
<td>2.06409**</td>
<td>2.05025***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ulster</td>
<td>-0.3852</td>
<td>-1.17323</td>
<td>-0.41004</td>
<td>-0.59011</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leinster</td>
<td>0.63584</td>
<td>0.76769</td>
<td>0.29756</td>
<td>0.26064</td>
<td>-0.5483</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Catholic share (Catholic-majority counties)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.02757</td>
<td>-0.00714</td>
</tr>
<tr>
<td>Catholic share (Protestant-majority counties)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>[0.03225]</td>
<td>[0.02841]</td>
</tr>
<tr>
<td>Share of farms between 5 and 30 acres</td>
<td>-0.0001</td>
<td>0.00754</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agrarian outrages per 10,000 population</td>
<td>-0.01883</td>
<td>-0.0177</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outrages*share of farms between 5 &amp; 30 acres</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.00054*</td>
</tr>
<tr>
<td>Constant</td>
<td>-1.24562</td>
<td>-2.07975**</td>
<td>-2.25384*</td>
<td>0.72335</td>
<td>-1.9341</td>
<td>-1.01051</td>
<td>[0.65708]</td>
</tr>
<tr>
<td>Observations</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>23</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-10.11</td>
<td>-97.37</td>
<td>-87.82</td>
<td>-86.82</td>
<td>-89.81</td>
<td>-88.75</td>
<td>-48.49</td>
</tr>
<tr>
<td>Pseudo-R-Squared</td>
<td>0.17</td>
<td>0.28</td>
<td>0.28</td>
<td>0.29</td>
<td>0.26</td>
<td>0.27</td>
<td>0.41</td>
</tr>
</tbody>
</table>

Robust standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.
Table 3. Determinants of the cooperative share (OLS regressions)

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catholic share (Catholic-majority counties)</td>
<td>-1.11996*</td>
<td>0.29245</td>
<td>0.17718</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.58385]</td>
<td>[0.51941]</td>
<td>[0.54230]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Catholic share (Protestant-majority counties)</td>
<td>-1.67783</td>
<td>-0.06437</td>
<td>-0.16709</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[1.02926]</td>
<td>[0.78696]</td>
<td>[0.82039]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share of farms between 5 and 30 acres</td>
<td>1.16665***</td>
<td>1.00755***</td>
<td>1.07552***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.34998]</td>
<td>[0.32879]</td>
<td>[0.36212]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agrarian outrages per 10,000 population</td>
<td>-1.37903***</td>
<td>-1.74519***</td>
<td>-1.83437***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.30574]</td>
<td>[0.48101]</td>
<td>[0.59691]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outrages (Catholic-majority counties)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outrages (Protestant-majority counties)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ulster</td>
<td></td>
<td></td>
<td></td>
<td>-9.23225</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>[16.72119]</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>144.87703***</td>
<td>2.64341</td>
<td>90.45397***</td>
<td>31.7565</td>
<td>41.89787</td>
</tr>
<tr>
<td></td>
<td>[46.49843]</td>
<td>[19.72621]</td>
<td>[8.05361]</td>
<td>[44.32109]</td>
<td>[49.34650]</td>
</tr>
<tr>
<td>Observations</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.22</td>
<td>0.33</td>
<td>0.4</td>
<td>0.65</td>
<td>0.65</td>
</tr>
</tbody>
</table>

Robust standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.
Data Appendix.


Private creameries per county. Source: Agricultural Statistics, Ireland, 1907.

Number of milch cows per county. Source: as above.

Milch cows per thousand acres. Source: as above.

(Data on the above two variables are also available in C.S.O. (1997), from which the data on cow numbers in 1871 were taken.)

Share of farms less than 5 acres, between 5 and 30 acres, and above 30 acres. Source: as above.

Owner-occupied farms, as a percentage of total farm numbers. Source: as above.

Population (in thousands). Source: Census of Ireland (1901).

Share of Roman Catholics in population. Source: as above.

Illiteracy rate. Source: as above.

Outrages per 10,000 of population in 1880-82: Rumpf and Hepburn (1977, p. 52).

Bank branches per county: Thom’s Directory of Ireland, 1906, pp. 1072-1081. The directory listed bank branches by company and town; county-level data were generated by summing over banks, and matching towns to counties.

Appendix Table 1. Summary statistics, county data 1906

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Std. Dev.</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperatives</td>
<td>8.8</td>
<td>4.5</td>
<td>10.2</td>
<td>0.0</td>
<td>37.0</td>
</tr>
<tr>
<td>Private creameries</td>
<td>13.6</td>
<td>1.0</td>
<td>28.1</td>
<td>0.0</td>
<td>108.0</td>
</tr>
<tr>
<td>Milch cows (thousands)</td>
<td>46.8</td>
<td>38.1</td>
<td>37.2</td>
<td>10.5</td>
<td>192.0</td>
</tr>
<tr>
<td>Milch cows per 1000 acres</td>
<td>72.7</td>
<td>75.6</td>
<td>28.3</td>
<td>29.6</td>
<td>155.3</td>
</tr>
<tr>
<td>Milch cows in 1871 (thousands)</td>
<td>48.3</td>
<td>42.0</td>
<td>35.8</td>
<td>9.0</td>
<td>182.0</td>
</tr>
<tr>
<td>Milch cows per 1000 acres in 1871</td>
<td>76.6</td>
<td>78.7</td>
<td>30.4</td>
<td>28.6</td>
<td>147.6</td>
</tr>
<tr>
<td>Population (thousands)</td>
<td>147.0</td>
<td>111.8</td>
<td>109.8</td>
<td>40.9</td>
<td>471.2</td>
</tr>
<tr>
<td>Share of owner-occupied farms</td>
<td>29.6</td>
<td>30.7</td>
<td>9.2</td>
<td>15.4</td>
<td>52.5</td>
</tr>
<tr>
<td>Bank branches per 100,000 population</td>
<td>17.4</td>
<td>17.1</td>
<td>4.8</td>
<td>9.1</td>
<td>27.1</td>
</tr>
<tr>
<td>Illiteracy rate</td>
<td>14.0</td>
<td>13.2</td>
<td>4.6</td>
<td>7.3</td>
<td>26.0</td>
</tr>
<tr>
<td>Catholic share</td>
<td>74.0</td>
<td>81.5</td>
<td>18.3</td>
<td>26.6</td>
<td>89.6</td>
</tr>
<tr>
<td>Share of farms less than 5 acres</td>
<td>26.3</td>
<td>26.2</td>
<td>10.5</td>
<td>11.6</td>
<td>55.3</td>
</tr>
<tr>
<td>Share of farms between 5 and 30 acres</td>
<td>46.1</td>
<td>43.4</td>
<td>15.5</td>
<td>25.2</td>
<td>70.6</td>
</tr>
<tr>
<td>Share of farms above 30 acres</td>
<td>27.6</td>
<td>28.4</td>
<td>9.6</td>
<td>10.5</td>
<td>45.9</td>
</tr>
<tr>
<td>Agrarian outrages per 10,000 population</td>
<td>22.5</td>
<td>19.5</td>
<td>15.2</td>
<td>2.0</td>
<td>52.0</td>
</tr>
</tbody>
</table>