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Environmental Shocks and Sustainability in Microfinance: Evidence from the Great Famine of Ireland

Tyler Beck Goodspeed

I study the effects of a major environmental shock on microfinance lending by analyzing the Irish Loan Funds during the Great Famine of Ireland. I find that funds in districts worse affected by blight experienced higher failure rates and greater credit retrenchment and flight-to-quality than funds in less affected districts. Though greater leverage was generally associated with a higher predicted probability of institutional survival, the reverse was true where blight infection was more severe, and though more profitable funds were generally no more likely to survive, higher pre-famine margins were positive predictors of institutional survival where blight infection was worse. Results further indicate that the primary mechanisms by which pre-famine balance sheet metrics influenced survival probabilities were differential balance sheet contraction and flight-to-quality during the famine. The results of this study, therefore, suggest that optimal lending models in ordinary circumstances may render microfinance institutions (MFIs) more vulnerable to tail-probability aggregate shocks, with higher leverage, lower paid staff, lower economic rents, and more extensive liabilities limiting the scope for credit retrenchment and flight-to-quality. Results further indicate that one cost of MFI resilience to adverse environmental change is substantially reduced outreach to borrowers of lower credit quality. JEL codes: G2, N00, O1, Q1, Q5.

A major potential challenge confronting microfinance lenders, cooperatives, and credit-granting NGOs is that they may be ill-equipped to absorb the kinds of large covariate shocks typical of agricultural loan portfolios (Binswanger and Rosenzweig 1986; Braverman and Guasch 1986; Rosenzweig 1988; Shoji 2010; Kurosaki and Khan 2012). While recent research has demonstrated that access

Tyler Beck Goodspeed is a Junior Research Fellow in Economics at the University of Oxford; his email address is tyler.goodspeed@economics.ox.ac.uk. The author thanks Richard Hornbeck, Cormac Ó Gráda, Joel Mokyr, Benjamin Friedman, Nathan Nunn, Liam Kennedy, Peter Solar, Sean Barrett, Emma Rothschild, John Turner, Andrew Foster, two anonymous referees at the *World Bank Economic Review*, and seminar participants at LSE, MIT, Harvard, Oxford, Queens University Belfast, University of Southern Denmark, and the Royal Economic Society for detailed comments and suggestions. The author would also like to thank Aidan Hollis and Arthur Sweetman for generously sharing their data on the Irish Loan Funds.

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to microfinance credit can mitigate the impact of environmental shocks on income and consumption (Dercon 2002; Khandker 2007; Becchetti and Castriota 2008; Goodspeed 2016a, 2016b), the ability of microfinance lenders to cope with large-scale aggregate shocks involving high spatial correlation in income effects and default risk remains understudied. This is a significant gap in the extensive microfinance literature—which has tended to focus on welfare effects and optimal models of sustainability under ordinary lending circumstances—because the concentration of borrowers and depositors in contiguous geographic locales and identical crop portfolios can generate considerable covariate risk for microfinance institutions, for example following adverse environmental change (Miamidian et al. 2005). MFIs may, therefore, be most vulnerable where and when they are most needed (Berg and Schrader 2012). History offers a unique opportunity to observe such rare events, and to analyze differential MFI outcomes and adjustment strategies, over both the short and long runs, in order to identify how sustainable lending models may vary depending on the macro context.

Following Hollis and Sweetman (2004) and utilizing a new data set constructed by Goodspeed (2016a, 2016b), this paper thus analyzes the effects of a major adverse environmental shock, the Great Irish Famine of 1845 to 1852, on the Irish Loan Funds—independently-run microfinance organizations operating throughout Ireland from the mid-eighteenth to early-twentieth centuries. I find that compared to funds operating in less infected districts, funds in districts worse affected by blight in 1845 and 1846 not only had lower predicted probabilities of survival and experienced greater declines in lending, capital, and depositors, but also experienced larger declines in average interest rates, penalty fines on loans, and bad debts. Borrowing costs for qualifying borrowers, therefore, fell as funds in worse affected districts contracted lending and significantly raised credit standards.

I further find that prefamine balance sheet metrics were important predictors of institutional survival during the famine, though certain metrics that were generally associated with higher (lower) survival probabilities were associated with lower (higher) survival probabilities where the severity of the environmental shock was greater. Specifically, while greater leverage, lower average staff salaries, and more depositors were generally associated with higher predicted probabilities of institutional survival, the reverse was true where blight infection was more severe. Conversely, though a higher average prefamine unit cost of credit intermediation was generally associated with a lower predicted survival probability, in the face of severe blight infection funds with higher expenses as a percentage of total lending before the famine were more likely to survive the first two years of blight.

Funds with higher prefamine gross profit margins per loan were generally no more likely to survive long-term than less profitable funds, but higher prefamine margins were positive predictors of institutional survival where blight infection was worse. While ministers were generally less competent fund managers—funds

managed by ministers had a significantly lower predicted probability of survival—ministers were statistically no more or less competent than non-clergy managers where the magnitude of the environmental shock was greater. Differences in average prefamine loan size, bad debts, fines ratio, number of loans, and cost of capital do not appear to have had differential effects on predicted survival probabilities during and immediately after the famine, either generally or particularly where blight infection was more severe.

I additionally find that differences in prefamine balance sheet metrics were associated with differential institutional responses to the adverse shock. Specifically, relative to funds with lower average gross profit margins per loan before the famine, funds in worse affected districts with higher prefamine margins relatively reduced average loan size, interest rates, fines ratios, and bad debts during the famine, implying a relative increase in average credit quality among approved borrowers. Similarly, funds in worse affected districts with higher staff salaries before the famine relatively reduced their average annual number of loans and fines ratios during the famine. Moreover, while funds with higher prefamine profit margins experienced relative declines in average margin per loan, there was no difference in their average, non-differenced level of profit margin per loan during the famine. In contrast, funds in worse affected districts with more depositors before the famine experienced relative increases in average loan size, fines ratios, and bad debts during the famine, while funds in worse affected districts that had been more highly levered before the famine experienced a relative rise in the unit cost of credit intermediation and relative decline in profitability, resulting in lower average margins per loan during the famine. In robustness checks, I find that differences in prefamine balance sheet metrics cannot be explained by prefamine differences in available micro-level social and economic variables.

These findings suggest that MFIs that had been earning higher rents before the famine had more scope to contract credit and raise lending standards in response to an adverse spatially correlated shock, while still remaining profitable. Better compensated staffs seem to have been more effective at restricting credit to higher quality borrowers. In contrast, funds that had been relying more heavily on leverage appear to have been more severely affected by balance sheet contraction during the famine, with more levered funds experiencing relative increases in the unit cost of credit intermediation and relative decreases in average profit margin per loan, resulting in lower average margins during the famine. Funds with more depositors, meanwhile, seem to have been less able to contract their lending portfolios and raise average credit standards. These results imply that MFI sustainability in the face of a major covariate shock such as a natural disaster may depend critically on an ability to rapidly scale down lending, reduce average loan size, and significantly raise lending standards, and, therefore, that though microfinance may help to mitigate the effects of such shocks on borrowers of higher credit quality, it is not a viable mitigant for more vulnerable borrowers.

The organization of the remainder of this paper is as follows. Section 1 provides a historical summary of the Irish Loan Funds and the Great Famine of Ireland. Section 2 outlines a theoretical model for analyzing the effects of an aggregate shock on credit supply in a relationship lending context. Sections 3 and 4 detail data construction and the empirical framework, while section 5 presents the results. Section 6 concludes.

I. HISTORICAL BACKGROUND

The Irish Loan Funds

On the eve of the Great Famine, Ireland's was an undercapitalized subsistence economy heavily dependent upon a single staple crop. By 1845, median farm size in many Irish districts had declined to such levels that the potato was the only crop with sufficient yield and nutritional and caloric content to support an average-sized family for twelve months (Mokyr 1985; Bourke 1993; Ó Gráda 1995, 1999).[1] On the eve of the famine, the potato thus accounted for approximately 60% of the Irish food supply, with nearly 40% of Irish depending almost exclusively on the potato for subsistence (Bourke 1993). While average annual per capita income was an estimated £10, with those at the 67th percentile earning £4.30 or less, no conventional bank in Ireland was in the business of extending loans in amounts smaller than £10. Indeed, before 1845 just two Irish joint-stock savings banks—the Agricultural and Commercial Bank and the Provident Bank—had ventured into the business of extending loans below £10; both had failed by 1845.

Important providers of credit to Ireland's rural poor, therefore, were the Irish Loan Funds—privately run microfinance funds operating throughout Ireland from the mid-eighteenth century into the early twentieth century. Originally conceived by Irish essayist and satirist Jonathan Swift in the early 1700s, the first Loan Fund was established as a quasi-charitable enterprise by the Musical Society of Dublin, which for a brief time thereafter operated a branch system of musical loan societies. By the early 1840s, however, the Loan Funds were a diverse set, including private pawnbrokers and Mont-de-Piétés that had reorganized and registered as Loan Funds, and with no operating connection to the original Dublin society (McLaughlin 2009). On the eve of the famine, there were thus 300 independent Loan Funds active in more than half of Ireland's

1. Despite high potato dependency, however, revisionist quantitative work by Mokyr (1985) and Ó Gráda (1995, 1999) challenges conventional claims that the pre-famine Irish economy was balanced on a Malthusian knife-edge. Mokyr and Ó Gráda find that, owing partly to the high caloric and nutritional content of the potato, mean height and estimated daily caloric intake were in fact higher in pre-famine Ireland than in most other Western European countries.

323 baronies, extending almost 500,000 loans a year to approximately 300,000 borrowers.[2]

Like more contemporary microfinance models, the Irish Loan Fund model was predicated on extending small, short-term loans with frequent payments, secured by two cosignatories in lieu of collateral. The average fund made 1,750 loans a year, with a mean loan size of approximately £3 and a fixed maximum of £10. The standard term was 20 weeks, with mandatory weekly payments, enforced by penalty fines. Cosignatories, who were not allowed to borrow themselves or cosign another loan so long as they were bound by cosignature to an outstanding loan, could be pursued in the event of default, with 2s. deducted from the pay of staff members who failed to initiate legal proceedings against delinquent cosignatories to a defaulted loan (Piesse 1841).[3,4] Interest was standardized to 4d. in the pound per week, or 8% per annum, though additional fees for filing application cards and promissory notes, and for screening sureties, could raise effective rates to 9%–12%, with penalties for late payments adding a further 1%–5% on an annualized basis.[5]

Lending was explicitly intended for low-income, rural borrowers, with small farmers, cottiers, and agricultural laborers comprising the majority of loan recipients. Approximately 20% of borrowers were women. From 1838, funds were overseen by a central board, the Loan Fund Board, that standardized rules and accounting practices. The board also issued annual reports, which include illustrative examples of Loan Fund lending. The 1841 report mentions a borrower who "holds a small mountain farm; got a loan, and laid out 4*l*. on flax, which enabled him to set his four girls at work, spinning; with their help, he paid the instalments, and was 4*l*. better at the end; bought a cow for that sum, which is now worth 6*l*.; has at present three cows, and says he is so well off that he may give up borrowing" (*Third Annual Report of the Loan Fund Board*, 1841). The same report describes "A.B., formerly a day labourer, and frequently assisted by a kind neighbour in the maintenance of his family, has, by means of the Loan Fund, raised himself to independence, and is now possessed of a cow, a pony, and a good cart, with a small patch of land, which he farms to good purpose."

2. Assuming an average family size of five, this implies Loan Funds were annually extending loans to roughly 20% of Irish households, though in some counties the figure was closer to 30–40% (Hollis and Sweetman 1998, 2004).

3. Legally, Loan Funds enjoyed priority over other creditors (McLaughlin 2009).

4. Charles A. J. Piesse was a British civil servant at Dublin House and Secretary of the Loan Fund Board of Ireland. His publication, *Sketch of the Loan Fund System in Ireland and Instructions for the Formation of a New Society*, was intended not just as a guide for the establishment of Loan Fund societies, but also to encourage establishment. The publication therefore likely overstates the degree of uniformity and regulatory consistency within the Loan Fund system.

5. Interest was originally set at 6d. in the pound, or 12% on an annualized basis, though was lowered to 4d. in the pound in 1843.

Funds were operated by paid clerks, and predominantly funded by interest-earning deposits (Hollis and Sweetman 1998).[6] A standard 5% annual rate on deposits (reduced from 6% in 1843)—nearly twice the rate typically offered by conventional joint-stock banks—allowed the Loan Funds to attract considerable depositor interest. The majority of depositors, however, in contrast to borrowers, were large depositors, with a mean prefamine deposit size of £46. Piesse (1841) notes that most depositors held deposits of £50 or more, an observation confirmed by McLaughlin (2009), who finds that 44% of depositors in 1840 held £50 or more, with a further 20% holding between £10 and £20. Loan Fund debtors and creditors were, therefore, for the most part drawn from non-overlapping economic sectors and income strata. Nonetheless, Ó Gráda (1999, 2008) finds that the general equilibrium effects of the famine on the deposit base of Irish financial institutions was substantial, as lower aggregate demand and the need for higher nutritional efficiency wages for farm laborers imposed severe negative income shocks on middle- and upper-income depositors, forcing many to withdraw funds from savings institutions.

The Great Famine and the Irish Loan Funds

The Great Famine of Ireland was among the most devastating of all time, claiming, through starvation and disease, some one million of Ireland's eight million inhabitants, and forcing a further one million to emigrate. Its proximate cause was the arrival in Ireland, in autumn 1845, of the oomycte *Phytoflora infestans*.[7] The disease, commonly known as "late blight," as the effects do not become apparent until relatively late in the growing season, rots the tubers of infected potatoes.[8] Spores germinate on the leaves of potato plants, spreading to host tubers when temperatures rise above 10° C (50° F) and humidity over 75%–80% for two or more days. By the time dark blotches on leaf tips and plant stems reveal

6. Some funds also received charitable donations. In the empirical analysis below, however, I do not incorporate gifts directly because they do not appear as a line item in the annual reports of the Loan Fund Board, nor do they appear as residuals in the balance/loss column, which leads me to conclude that they were not a substantial component of revenue. However, gifts are reflected in the average cost of capital (as gifts were interest free, they would have lowered the average cost of capital), which means I do implicitly control for variation in gifts.

7. Most likely originating in the central Mexican highlands, *P. infestans* traveled to Ireland via West Flanders, where in 1843 the provincial government funded importation of new potato varieties from the Americas. By late summer 1845, the fungus had spread throughout Flanders and neighboring regions in the Netherlands, northwestern France, lower Rhineland, Channel Islands, and southern England (Donnelly 2001). On 6 September, press reports announced the first observations of potato disease in Ireland (*Dublin Evening Press* 1845). Since the potato was at the time primarily a subsistence crop, rapidly reproducing spores were typically spread by wind, traveling up to fifty miles a week (Koepsell and Pscheidt 1994).

8. Blight can also affect tomatoes, but tomatoes were rarely grown in pre-famine Ireland, and no mention is made in the historical literature of the effect of blight on negligible tomato cultivation in Ireland.

the presence of blight, infection is already terminal, and the plant will quickly decay. Entire fields can thus be destroyed in a matter of days.[9]

Though the relatively late arrival of blight in Ireland allowed roughly 60%–70% of 1845's above-average potato crop to survive, in 1846, after an unusually damp spring and summer, potato crop failure was catastrophic, with an estimated three quarters of the island's harvest lost to blight (Ó Gráda 1999). Yields recovered somewhat in 1847, but the devastation of 1846 had left seed potatoes in scarce supply, which resulted in "Black '47" turning out to be the most deadly of the famine years. Moreover, after two years of potato crop failure, many Irish farmers had already been compelled to sell or consume their scant livestock holdings, which meant stocks of pigs and poultry—traditional buffers against adverse harvest fluctuations—were exhausted by 1847.[10] While blight would reassert itself in 1848 and with less intensity in 1849 and, in isolated cases, 1850–52, the winter of 1846–47 marked the worst of the disaster. By 1851 the outbreak had essentially run its course.

Given their low-income, agrarian clientele, many Loan Funds struggled during the famine years, ostensibly as repeated crop failures led to higher default rates (Hollis and Sweetman 2004). McLaughlin also notes that though most depositors were not directly affected by the failure of the potato crop, some withdrew their savings out of concern for the solvency of any institution lending to low-income debtors (McLaughlin 2009), while Ó Gráda (1999, 2008) argues that the macroeconomic effects of the famine adversely impacted incomes of middle-class depositors, resulting in substantial withdrawals from Irish savings institutions. Of the 300 funds operating in 1843, only 123 remained by 1852, while the average amount circulated per fund fell from £6,197 in 1845 to £2,438 in 1847. The following year, 58 funds wound up. Nonetheless, many funds remained active throughout the famine years, and many of those that survived eventually recovered and returned to profitability. Even during the worst years of 1846 and 1847, Loan Funds managed to extend 459,360 and 223,465 loans, providing, respectively, £1,712,638 and £834,855 of credit to Ireland's rural poor.[11]

9. *P. infestans* spores winter on tubers of the previous year's crop that have been left in the ground as seed or in cull piles. Attempts at early harvest of an infected crop are likely to be in vain, as infected tubers will deteriorate quickly in storage. *P.infestans* remains difficult to manage even today. Genetic engineering of resistant varieties, proper field hygiene, and use of fungicides are common tools for preventing or combating blight, but continually evolving resistance remains a challenge (Zwankhuizen, Govers, and Zadoks 1998).

10. Given that successive crop failures were rare before 1845, many farmers expanded potato plantings in 1846, confident of the improbability of back-to-back failure. Livestock were rarely consumed directly, but rather sold as pork, eggs, and butter, with the proceeds used to buy cheaper food substitutes (Ó Gráda 1995, 1999).

11. In the first two years of the famine, Loan Funds extended an average of 2,375 and 3,297 loans in baronies with a mean pre-famine population of 30,876. In 1849, Loan Funds still extended an average of 1,886 loans per fund. Cumulatively during the famine years, Loan Funds extended one loan for nearly every two men, women, and children of the 1841 population in those baronies, with a mean loan size of £3.56.

It is also important to note that the Loan Funds suffered from several institutional flaws, which may have rendered them more vulnerable to adverse shocks such as the famine. Though the annual reports of the Loan Fund Board indicate that a handful of funds operated jointly with associated Mont-de-Piétés, in general the Loan Fund system was highly decentralized, and exhibited considerable heterogeneity in the quality and consistency of management. Therefore, not only were the Loan Funds severely limited in their ability to absorb shocks through asset- and liability-side geographic diversification and private or public insurance, but many funds also suffered from severe corruption and rent-seeking on the part of managers and clerks (Hollis and Sweetman 2001; McLaughlin 2009).[12] McLaughlin (2009) further finds that ministers may have been less effective managers during the famine than non-clergy not, as Hollis and Sweetman (2004) surmise, due to a more lenient approach to delinquent borrowers, but rather to laxer monitoring of their own staff.

II. CONCEPTUAL FRAMEWORK

A central challenge confronting MFIs, particularly in developing contexts, is the high degree of asymmetric information concerning the creditworthiness of potential borrowers. The problem is especially acute for MFIs, such as the Irish Loan Funds, that extend loans on zero collateral. Like more contemporary lenders in the business of lending to potentially high-risk borrowers, many Loan Funds therefore relied on relationship-based lending to overcome informational asymmetry, accumulating "soft" information on borrower creditworthiness through weekly repayment records and repeat lending (Piesse 1841; Petersen and Rajan 1994; Berger and Udell 1995, 2002; Cole 1998; Chakravarty and Scott 1999; Cole, Goldberg, and White 2004; Chakravarty and Yilmazer 2009; and McLaughlin 2009).[13]

Following Petersen and Rajan (1994) and Berg and Schrader (2012), the conceptual framework underpinning the empirical analysis here is therefore a standard multi-period relationship lending model in which MFIs learn through lending whether given borrowers are "good" or "bad" entrepreneurs.[14] "Good" entrepreneurs can then borrow again to finance investment projects in subsequent periods, with the MFI lender earning a safe rent owing to their acquisition of soft information on borrower creditworthiness in the initial period. As borrowers will only accept the terms of a loan if the net return is positive, the lender's problem is thus to determine the optimal interest rate and minimum *ex ante*

12. Though Besley (1995) observes that higher-tier agency problems remain an issue with more contemporary MFI's as well.

13. McLaughlin (2009) cites the account book of the Knockmourne Loan Fund, where the number of borrowers was approximately 20% of the number of loans extended, implying many borrowers were repeat clients.

14. The model is fully developed in Goodspeed (2015).

credit quality at which they can lend without incurring losses. The MFI, in other words, faces a trade-off—raising the interest rate on a standard loan yields higher revenue in the first period but lowers the rents it could earn in the second by reducing the viability of investment projects potentially undertaken by good entrepreneurs.

An aggregate income shock occurring before prospective borrowers apply for loans will then affect MFI lending through its direct impact on household capital assets, indirect losses of lower revenues at the end of the first period, and the macroeconomic effects of lower investment returns in later periods. In a subsistence economy such as 1840s Ireland, the initial direct effect would largely comprise drawdowns of stocks of seed potatoes, grain stores, and/or liquidation of livestock assets and durable goods, while the second and third channels would likely consist primarily of lower year-end stores of fodder and seed, and lower revenues owing to a decline in aggregate income, respectively.[15,16]

Evaluating how the optimal rate of interest rate and minimum ex ante credit quality change as household capital assets, flows of intermediate goods, and revenues in later periods vary as a result of an adverse shock, the simple model sketched above then yields the relatively straightforward predictions that an adverse aggregate shock will result in greater loan demand but tighter credit standards, with higher quality, repeat borrowers able to borrow at lower rates of interest.

III. Data Construction

This paper utilizes original data from numerous archival sources. Since previous studies of the Irish Famine have lacked indicators of microvariation in blight and have thus relied on *ex post* excess mortality—which is itself an outcome variable—following Goodspeed (2016a, 2016b) I instead construct an index of blight severity at the baronial level using constabulary reports from the Distress

15. I assume that these effects are not so large as to render projects unprofitable. Goodspeed (2016a, 2016b) finds that farms in severely infected districts with a Loan Fund relatively increased investments in alternative agricultural activities during the famine, particularly through the acquisition of traditional buffer stocks of poultry and swine, but also through conversion of land to other tillage crops. Most of these investments consisted of substitutions away from the potato, a highly nontradeable good, to more tradeable goods for export. The evidence therefore strongly suggests that returns to alternative agricultural investments remained large and positive throughout the famine.

16. An additional channel through which an adverse aggregate shock might affect lending is a decline in MFI liquidity. While Piesse (1841) and McLaughlin (2009) note that the majority of Loan Fund depositors held deposits of £10 or more, and thus were less likely to be directly affected by the failure of the potato crop, McLaughlin (2009) also finds that many depositors withdrew their savings during the famine out of concern that rising default rates would threaten the solvency of particular Loan Funds. The consequently higher reserve requirements to meet potential liquidity shortfalls would have effectively raised the cost of capital for affected funds. If I therefore allow the rate of interest charged to borrowers to include a liquidity discount, I find that an increase in the cost of capital will raise the minimum credit quality and lower the optimal interest rate. See Goodspeed (2015) for derivation.

Papers of the Parliamentary Relief Commission. The Relief Commission was established by the British government in November 1845, in response to the failure of the potato crop in Ireland, in order to advise the government concerning the extent of potato loss and distress in Ireland, to oversee the storage and distribution of emergency Indian corn and meal, and to administer the activities of local relief committees. In practice, though, the commission had little real authority beyond coordinating the collection of data. To discharge its duties, the commission regularly solicited reports from local officials regarding the state of the potato crop, extent of blight infection, and the condition of the local populace. Reports and incoming letters were received from local constables, coast guard officials, lieutenants of counties, resident magistrates, and Poor Law guardians.

To assess the level of local blight severity, I rely on reports received between November 1845 and August 1846, when the commission was disbanded, with most reports received in July/August 1846. Based on these reports, I designate each barony as low, medium, or high impact, corresponding to moderate, considerable, or severe blight infection.[17] In the case of quantitative reports, I define a low or moderate impact barony as a barony with less than one-third of its potato crop infected by blight. Medium or considerable impact baronies are baronies with a one-third to two-thirds infection rate, and high or severe impact baronies experienced crop infection rates in excess of two-thirds. For baronies with only qualitative reports, I use language such as "very good," "trifling," and "partially infected" to designate low-impact baronies; "considerably infected" or "very much infected" to designate medium-impact baronies; and "generally very bad," "extensively infected," and "very extensively infected" to designate high-impact baronies.[18] Altogether, I am thus able to assign a blight severity designation to 255 of the 323 baronies in Ireland on the eve of the famine, representing all four Irish provinces, all 32 counties, and 105 of 163 Poor Law unions. Several baronies were split or merged after 1851. For those that split, I sum statistics for the successor baronies to preserve continuity. For those that merged, I sum statistics for the predecessor baronies. The main sample is therefore a panel of these 255 baronies from 1841 to 1856.[19]

17. A barony is an Irish administrative unit, used mainly for cadastral purposes. In increasing order of size, Irish administrative units proceed from townland to civil parish to barony to PLU to county to province. Many baronies are absent from the sample because there were no reports in the Relief Commission papers for these baronies.

18. The majority of reports consist of both qualitative and quantitative assessments of blight severity. To ensure equivalent coding of qualitative and quantitative reports, I rely on these mixed reports to link particular vocabulary with corresponding quantitative accounts. For example, "extensively" and "generally" were universally associated with estimated crop infection rates in excess of 75%, whereas "considerably" and "very much" or "quite" were typically associated with infection rates near 50%. Nonetheless, in table 2, below, I include a categorical variable for whether a report was qualitative, quantitative, or both to test for whether the type of report explains variation in blight index scores. It does not.

19. For a map of the geographic distribution of low, medium, and high blight infection, as well as nonreportage, see Goodspeed (2016a, 2016b).

It is important to note that by the time the blight had run its course in 1851, virtually no part of Ireland had been completely spared, and even baronies designated as low impact experienced significant blight infection. Furthermore, my index of blight severity solely measures blight severity in 1845 and 1846 in observed baronies. Baronies designated as low impact may subsequently have been severely impacted as the blight spread throughout the island. However, *P. infestans* thrives in moist, temperate, and humid conditions, hence why the unusually wet summer of 1846 was exceptionally favorable to blight (Bourke 1965b). Consequently, regions whose typical climatic conditions, particularly in late summer, were especially hospitable to blight faced permanently higher probabilities of severe outbreaks. Thus, insofar as variation in blight severity in 1845–46 reflected variation in climatic hospitability to blight, observations of blight severity in 1845–46 will reflect subsequent variation in the intensity of infection.[20] This is corroborated by Goodspeed (2016a, 2016b), who finds a strong correlation between blight severity in 1845-46 and potato yields during the severe blight-induced harvest failure of 1879.[21]

Data on lending activity by the Irish Loan Funds are from the annual reports of the Commissioners of the Loan Fund Board of Ireland, a sample page from which is presented as figure 1. Prefamine baronial valuations are from the 1845 *Appendix to the Minutes of Evidence taken before Her Majesty's Commissioners of Inquiry into the State of the Law and Practice in Respect to the Occupation of Land in Ireland*. All other baronial and county data were assembled using the decennial *Census of Ireland* (1821–1841) and *Returns of Agricultural Produce in Ireland* (1847–1856). Summary statistics for all in-sample funds are reported in table 1.

Though there is no historical evidence that the incidence of blight severity, reporting to the Relief Commission, or location of Loan Funds was correlated with nonfixed baronial characteristics that were also correlated with famine outcomes, to test these identifying assumptions I regress blight severity, nonreportage to the Relief Commission, Loan Fund presence, and average annual Loan Fund lending during the first five years of the famine (1845–50) on prefamine baronial characteristics, with results presented in table 2.[22,23] To test whether my blight severity index maps onto late-summer climatic conditions hospitable to

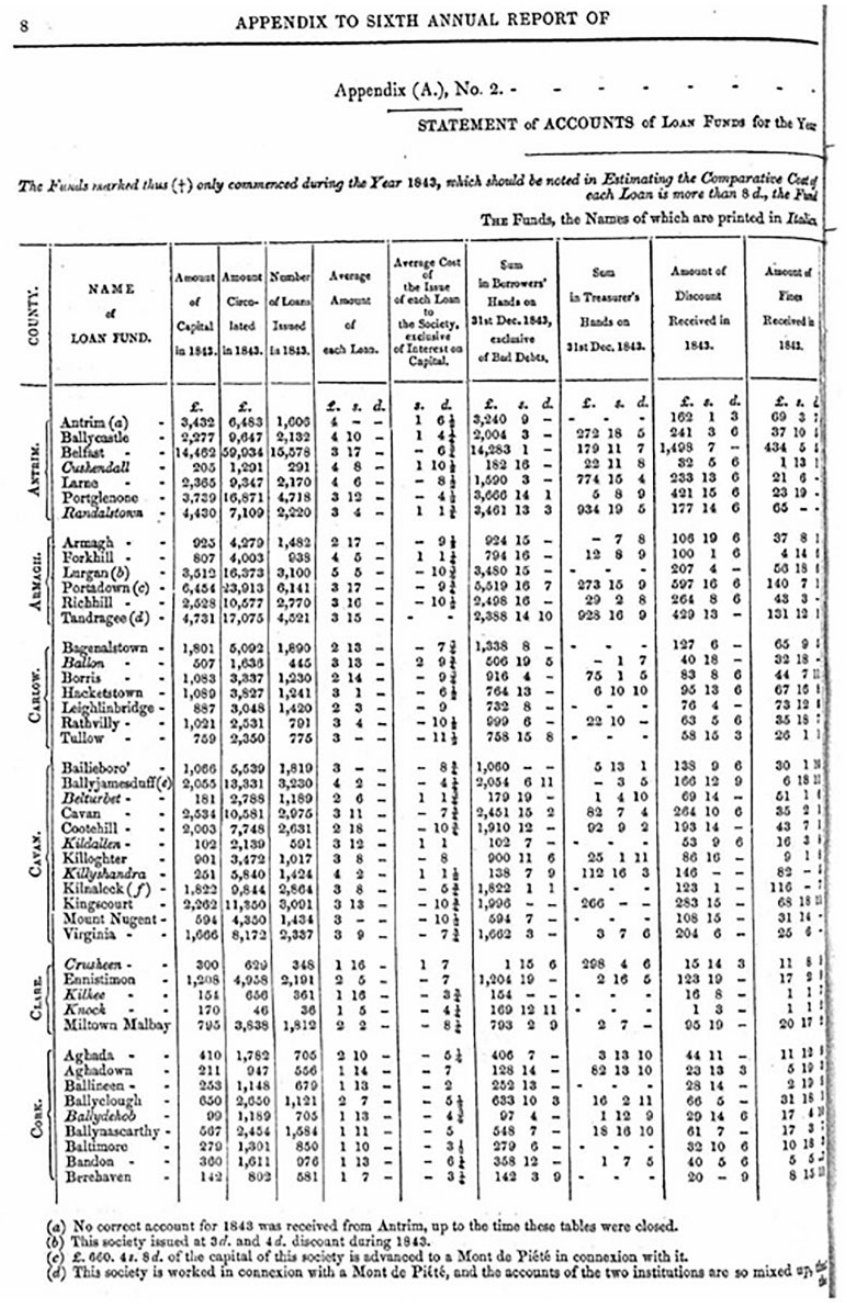
20. More severe blight infection in 1845 and 1846 further suggests a larger aggregate shock at least through 1847, as it implies a more intense deficit of end-of-season seed potatoes, food stores, and animal feed.

21. It is also consistent with Cousens (1960, 1962, 1964).

22. I include a Herfindahl index of religious diversity in 1861, the first year for which data on religious affiliation is available, as a proxy for social capital. The variable is thus $R = \sum_{i=1}^{N} p_i^2$, where p_i is the proportion of all religious affiliates belonging to denomination i and N is the number of religious denominations.

23. Moreover, though the possible correlation of Loan Fund presence with other, unobservable baronial characteristics may affect external validity, it should not affect internal validity, as I am comparing average differences in famine outcomes among baronies with a Loan Fund only.

FIGURE 1. Sample Page from the Appendix to the 1843 Annual Report of the Loan Fund Board of Ireland.



8 APPENDIX TO SIXTH ANNUAL REPORT OF

Appendix (A.), No. 2. - - - - - - - - .

STATEMENT of ACCOUNTS of LOAN FUNDS for the Yea

The Funds marked thus (†) only commenced during the Year 1843, which should be noted in Estimating the Comparative Cost of each Loan is more than 8 d., the Fund

THE Funds, the Names of which are printed in *Italic*

COUNTY.	NAME of LOAN FUND.	Amount of Capital in 1843.	Amount Circulated in 1843.	Number of Loans Issued in 1843.	Average Amount of each Loan.	Average Cost of the Issue of each Loan to the Society, exclusive of Interest on Capital.	Sum in Borrowers' Hands on 31st Dec. 1843, exclusive of Bad Debts.	Sum in Treasurer's Hands on 31st Dec. 1843.	Amount of Discount Received in 1843.	Amount of Fines Received in 1843.
		£.	£.		£. s. d.	s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.
ANTRIM.	Antrim (a)	3,432	6,483	1,006	4 – –	1 6½	3,240 9 –	- - -	162 1 3	69 3 7
	Ballycastle	2,277	9,647	2,132	4 10 –	1 4½	2,004 3 –	272 18 5	241 3 6	37 10 4
	Belfast	14,462	59,934	15,578	3 17 –	– 6	14,283 1 –	179 11 7	1,498 7 –	434 5 4
	Cushendall	205	1,291	291	4 8 –	1 10	182 16 –	22 11 8	32 5 6	1 13 1
	Larne	2,365	9,347	2,170	4 6 –	– 8	1,590 3 –	774 15 4	233 13 6	21 6 –
	Portglenone	3,739	16,871	4,718	3 12 –	– 4	3,666 14 1	5 8 9	421 15 6	23 19 –
	Randalstown	4,430	7,109	2,220	3 4 –	1 1	3,461 13 3	934 19 5	177 14 6	65 – –
ARMAGH.	Armagh	925	4,279	1,482	2 17 –	– 9½	924 15 –	– 7 8	106 19 6	37 8 1
	Forkhill	807	4,003	938	4 5 –	1 1½	794 16 –	12 8 9	100 1 6	4 14 6
	Largan (b)	3,512	16,373	3,100	5 5 –	– 10	3,480 15 –	- - -	207 4 –	50 18 6
	Portadown (c)	6,454	23,913	6,141	3 17 –	– 9	5,519 16 7	273 15 9	597 16 6	140 7 1
	Richhill	2,528	10,577	2,770	3 16 –	– 10½	2,498 16 –	29 2 8	264 8 6	43 3 –
	Tandragee (d)	4,731	17,075	4,521	3 15 –	- -	2,388 14 10	928 16 9	429 13 –	131 12 1
CARLOW.	Bagenalstown	1,801	5,092	1,890	2 13 –	– 7	1,338 8 –	- - -	127 6 –	65 9 4
	Ballon	507	1,636	445	3 13 –	2 9	506 19 5	– 1 7	40 18 –	32 18 –
	Borris	1,083	3,337	1,230	2 14 –	– 9	916 4 –	75 1 5	83 8 6	44 7 11
	Hacketstown	1,089	3,827	1,241	3 1 –	– 6	764 13 –	6 10 10	95 13 6	67 16 1
	Leighlinbridge	887	3,048	1,420	2 3 –	– 9	732 8 –	- - -	76 4 –	73 12 1
	Rathvilly	1,021	2,531	791	3 4 –	– 10½	999 6 –	22 10 –	63 5 6	35 18 7
	Tullow	759	2,350	775	3 – –	– 11½	758 15 8	- - -	58 15 3	26 1 1
CAVAN.	Bailieboro'	1,066	5,539	1,819	3 – –	– 8	1,060 – –	5 13 1	138 9 6	30 1 10
	Ballyjamesduff (e)	2,055	13,331	3,230	4 2 –	– 4	2,054 6 11	– 3 5	166 12 9	6 18 11
	Belturbet	181	2,788	1,189	2 6 –	1 1	179 19 –	1 4 10	69 14 –	51 1 6
	Cavan	2,534	10,581	2,975	3 11 –	– 7	2,451 15 2	82 7 4	264 10 6	35 2 1
	Cootehill	2,003	7,748	2,631	2 18 –	– 10	1,910 12 –	92 9 2	193 14 –	43 7 1
	Kildallen	102	2,139	591	3 12 –	1 1	102 7 –	- - -	53 9 6	16 3 6
	Killoghter	901	3,472	1,017	3 8 –	– 8	900 11 6	25 1 11	86 16 –	9 1 6
	Killyshandra	261	5,840	1,424	4 2 –	1 1	138 7 9	112 16 3	146 – –	82 – 4
	Kilnaleck (f)	1,822	9,844	2,864	3 8 –	– 5	1,822 1 1	- - -	123 1 –	116 – 7
	Kingscourt	2,262	11,350	3,001	3 13 –	– 10	1,996 – –	266 – –	283 15 –	68 18 11
	Mount Nugent	594	4,350	1,434	3 – –	– 10	594 7 –	- - -	108 15 –	31 14 –
	Virginia	1,066	8,172	2,337	3 9 –	– 7	1,062 3 –	3 7 6	204 6 –	25 6 –
CLARE.	*Crusheen*	300	629	348	1 16 –	1 7	1 15 6	298 4 6	15 14 3	11 8 1
	Ennistimon	1,208	4,958	2,191	2 5 –	– 7	1,204 19 –	2 16 5	123 19 –	17 2 1
	Kilkee	154	656	361	1 16 –	– 3	154 – –	- - -	16 8 –	1 1 1
	Knock	170	46	36	1 5 –	– 4	169 12 11	- - -	1 3 –	1 1 1
	Miltown Malbay	795	3,838	1,812	2 2 –	– 8	793 2 9	2 7 –	95 19 –	20 17 2
CORK.	Aghada	410	1,782	705	2 10 –	– 5	406 7 –	3 13 10	44 11 –	11 12 1
	Aghadown	211	947	556	1 14 –	– 7	128 14 –	82 13 10	23 13 3	5 19 2
	Ballineen	253	1,148	679	1 13 –	– 2	252 13 –	- - -	28 14 –	2 12 1
	Ballyclough	650	2,650	1,121	2 7 –	– 5	633 10 3	16 2 11	66 5 –	31 18 1
	Ballydehob	99	1,189	705	1 13 –	– 4	97 4 –	1 12 9	29 14 6	17 4 10
	Ballynascarthy	567	2,454	1,584	1 11 –	– 5	548 7 –	18 16 10	61 7 –	17 3 1
	Baltimore	279	1,301	850	1 10 –	– 3	279 6 –	- - -	32 10 6	10 18 1
	Bandon	360	1,611	976	1 13 –	– 6	358 12 –	1 7 5	40 5 6	5 5 1
	Berehaven	142	802	581	1 7 –	– 3	142 3 9	- - -	20 – 9	8 15 11

(a) No correct account for 1843 was received from Antrim, up to the time these tables were closed.
(b) This society issued at 3*d*. and 4*d*. discount during 1843.
(c) £. 660. 4*s*. 8*d*. of the capital of this society is advanced to a Mont de Piété in connexion with it.
(d) This society is worked in connexion with a Mont de Piété, and the accounts of the two institutions are so mixed up

TABLE 1. Summary Statistics

	Mean	Std. Dev.	Min	Max
	(1)	(2)	(3)	(4)
Panel A: 1841-1844				
Number of Loans	1754.246	1752.177	89.000	17211.000
Total Lending Volume	6076.330	6736.067	141.500	59407.000
Leverage Ratio	4.044	1.073	0.776	12.889
Average Interest Rate	0.115	0.063	0.037	0.601
Fines Ratio	0.032	0.031	0.000	0.344
Loan Size	3.247	1.052	1.000	6.927
Bad Debts	6.234	18.394	−25.000	154.250
Average Salary	17.135	12.031	0.000	70.875
Expense Ratio	0.002	0.002	−0.001	0.020
Cost of Capital	0.041	0.016	0.000	0.090
No. of Depositors	23.715	26.189	0.000	175.400
Profit Margin per Loan	0.060	0.051	−0.194	0.247
Manager a Minister	0.406	0.492	0.000	1.000
Panel B: 1846-1852				
Severe Blight	0.518	0.501	0.000	1.000
Fund Survive 1852	0.515	0.501	0.000	1.000
Number of Loans	1454.968	1472.827	54.000	15466.000
Total Lending Volume	5393.321	5589.421	141.500	50334.670
Leverage Ratio	2.179	6.164	0.428	80.607
Average Interest Rate	0.098	0.089	0.021	1.148
Fines Ratio	0.030	0.038	0.001	0.444
Loan Size	2.631	1.812	0.000	6.547
Bad Debts	3.319	21.178	−26.667	263.000
Average Salary	8.325	5.163	0.733	28.500
Expense Ratio	0.002	0.004	−0.002	0.050
Cost of Capital	0.026	0.085	0.000	1.107
No. of Depositors	20.134	21.335	0.000	185.000
Profit Margin per Loan	−0.017	0.128	−0.882	0.179
N		239		

Notes: Each row reports the mean, standard deviation, minimum, and maximum values for the indicated variable for all in-sample funds. Loan Fund financial metrics are annual averages for the 1841-44 (pre-blight) and 1846-1852 (famine) periods. Average leverage ratio is total lending divided by capital. Average salary is the total wage bill divided by the number of employees. Gross profit margin per loan is gross revenue minus total expenses, divided by the number of loans. Expense ratio is total expenses, less wages and capital costs, divided by total lending. Cost of capital is interest payments divided by capital. Fines ratio is total fines collected divided by total lending. Interest rates are calculated by dividing total interest income (including application and surety screening fees) by total lending.

blight, I also regress blight severity on local average July air and soil temperature and humidity.[24] Finally, to test for coding consistency, I include a categorical variable for whether the blight report was qualitative, quantitative, or both.

OLS-estimated coefficients presented in column 1 of table 2 indicate that prefamine baronial characteristics are poor predictors of blight severity; none of

24. For climate data, I use contemporary averages from Met Éireann, the Irish National Meteorological Service.

TABLE 2. Estimated Blight Severity, Loan Fund Presence, and Loan Fund Lending, by Pre-Famine Characteristics

	Blight Severity	Non-Reporting	Loan Fund	Lending
	(1)	(2)	(3)	(4)
Valuation	0.000*	−0.000	0.000	−0.005
	(0.00)	(0.00)	(0.00)	(0.01)
Literacy Rate	0.205	0.077	−0.384	4310.535
	(0.40)	(0.45)	(0.45)	(3052.03)
Religious Diversity	−0.336	−0.033	−0.954	−2517.238
	(0.73)	(0.56)	(0.64)	(4329.04)
Population Density	0.006	0.009	0.005	454.565***
	(0.02)	(0.03)	(0.02)	(139.81)
Fourth-Class Housing	−0.046	0.116	−0.423	−1301.827
	(0.41)	(0.42)	(0.35)	(2379.84)
Potato Crop Share	15.689	36.031	0.647	6188.983
	(46.73)	(49.78)	(0.90)	(6149.65)
Mean July Air Temp (C°)	0.311*			
	(0.16)			
Mean July Soil Temp (C°)	0.149			
	(0.16)			
Mean July Humidity (%)	0.028*			
	(0.02)			
Relief Commission Report				
Qualitative v. Quantitative	0.049			
	(0.10)			
Both v. Quantitative	−0.133			
	(0.10)			
N	191	242	191	191
R2	0.142	0.033	0.138	0.331

Notes: Each column reports OLS estimated coefficients for differences in blight severity, Relief Commission non-reporting, Loan Fund presence, and average annual Loan Fund lending from 1845 to 1850 by pre-famine baronial characteristics. Standard errors are reported in parentheses. ***p < 0.01, **p < 0.05, *p < 0.10.

the estimated coefficients are statistically significant, and the fit is poor.[25] Estimated coefficients on the potato crop share of total crop acreage and fourth-class housing indicate that officials were no more likely to report severe blight infection where potato dependence was higher and poverty greater. The estimated coefficient on baronial valuation is statistically significant, though it is small in size and significant only at the 10% level. While mean July soil temperature is not a statistically significant predictor of blight severity, the estimated coefficients for mean air temperature and humidity are positive and statistically significant, consistent with slightly warmer, more humid late-summer atmospheric conditions being more hospitable to spore germination. Whether a report was qualitative, quantitative, or both does not appear to have had an effect on assessed

25. In the *Census of Ireland*, fourth-class houses are defined as "all mud cabins having only one room."

blight severity. Similarly, OLS-estimated coefficients reported in column 2 of table 2 indicate that prefamine characteristics are poor predictors of whether a report exists in the Relief Commission papers for a given barony; none of the estimated coefficients in column 2 are statistically significant, and the fit is poor.[26]

Finally, estimated coefficients presented in columns 3 and 4 of table 2 indicate that prefamine characteristics are also poor predictors of the presence of at least one active Loan Fund and average annual Loan Fund lending during the famine years. None of the estimated coefficients in column 3 are statistically significant, and the fit is again poor. In column 4, higher prefamine population density, which Mokyr (1985) and Ó Gráda (1997) use as a proxy for poverty, is positively associated with the volume of Loan Fund lending, though the remaining variables are not correlated with differential microcredit supply during the famine. Notably, social capital, as proxied by a Herfindahl index of religious diversity, appears to have had no statistically significant effect either on Loan Fund presence or the scale of Loan Fund lending during the famine.

IV. Empirical Framework

Following Hornbeck (2012) and Goodspeed (2016a, 2016b), the empirical analysis is based on estimating average changes in the probability of Loan Fund survival and Loan Fund activity, first, for funds operating in baronies more severely infected by blight relative to funds in less severely infected baronies and, second, for funds in more severely infected baronies with different prefamine management and financial metrics, in the same county and Poor Law Union and with similar prefamine characteristics.

I define fund survival, S_{it}, for fund i in year t as a binary variable assuming a value of 1 if fund i extended loans in both 1844, the last year before the arrival of blight, and in year t; and 0 if fund i was active in 1844 but not in year t.[27] To estimate average changes in the probability of fund survival by blight severity, each survival outcome S_{it} for fund i in year t is regressed on binary variables for medium and high blight infection at the baronial level (B_b^{med} and B_b^{high}), prefamine baronial characteristics ($\boldsymbol{X}_b$), the number of Loan Funds operating in the same barony b as fund i in year t (N_{bt}), a binary variable for whether fund i

26. The dependent variable is a binary variable equal to 1 if a report for barony i exists in the Relief Commission papers, and a 0 otherwise.

27. Funds which did not submit reports in any given year are noted in the annual reports of the Loan Fund Board as having failed to report. When a fund failed to report by the filing deadline in a given year, the Board substituted the preceding year's figures. In my analysis, I accept the Board's figures for any one year, but categorize funds which failed to report for two or more successive years, and funds reporting the same figures for more than two successive years, as having failed. For the period of analysis, there are three such cases.

pooled accounts with another society in year t (φ_{it}),[28] barony (α_b) fixed effects, and an error term (ϵ_{it}):

$$S_{it} = \beta_{1t} {B_b}^{med} + \beta_{2t} {B_b}^{high} + \boldsymbol{X}_b' \delta + N_{bt} + \varphi_{it} + \alpha_b + \epsilon_{it} \quad (1)$$

To evaluate the effect of blight severity on average changes in Loan Fund lending, number of loans, capital, number of depositors, average interest rate, ratio of fines to total lending, and bad debts, each outcome, Y_{it}, for fund i in year t is differenced from its 1841–44 average, Y_{ipre}. Differencing allows us to control for unobservable fund characteristics that vary across funds but are fixed over time. This difference is then regressed on binary variables for medium and high blight infection at the baronial level (${B_b}^{med}$and ${B_b}^{high}$), prefamine baronial characteristics ($\boldsymbol{X}_b$), the number of funds operating in the same barony b as fund i in year t (N_{bt}), a binary variable for whether fund i pooled accounts with another society in year t (φ_{it}), barony (α_b) fixed effects, and an error term (ϵ_{it}):

$$Y_{it} - Y_{ipre} = \beta_{1t} {B_b}^{med} + \beta_{2t} {B_b}^{high} + \boldsymbol{X}_b' \delta + \gamma_t N_{bt} + \varphi_{it} + \alpha_b + \epsilon_{it} \quad (2)$$

In order to evaluate the effects of particular fund management practices, in section 5 I estimate an expanded equation 1, adding a vector of average annual pre-famine Loan Fund financial metrics, L_i.[29] Further, each of these metrics is fully interacted with medium and high blight:

28. The annual reports of the Loan Fund Board note that some funds operated so intimately with associated Mont-de-Piétés that their accounts were reported jointly. In all regressions I therefore include as an independent binary variable whether or not a given fund operated jointly with another Loan Fund, Mont-de-Piété, or other credit institution in a given year, as noted in the Loan Fund Board reports. I include this variable to help attenuate the potential positive bias of the omitted factor that most Loan Funds were unable to smooth shocks on either the asset or liabilities side of their balance sheets.

29. Included metrics are average annual pre-famine leverage ratio (total lending divided by capital), average annual pre-famine salary per employee (total wage bill divided by number of employees), average annual pre-famine gross profit margin per loan (gross revenue minus total expenses, divided by number of loans), average annual pre-famine nonstaff, noncapital expense ratio (total expenses, less wages and capital costs, divided by total lending), average annual pre-famine loan size, average annual pre-famine cost of capital (interest payments divided by capital), average annual pre-famine fines ratio (total fines divided by total lending), average annual pre-famine volume of bad debts, average annual pre-famine number of loans, and whether the manager was a minister. I also include as a three-way interaction medium (and high) blight multiplied by average salary by profit margin. This allows for the fact that funds operating in locales with similar levels of blight infection and pre-famine profit margins may have experienced systematically different survival probabilities and balance sheet changes where higher margins were associated with higher salaries. In other words, the three-way interaction allows for funds paying higher average salaries to experience differential effects of blight if those salaries were associated with higher profitability (consistent with an efficiency wages interpretation of higher salaries) versus lower profitability (consistent with a corruption interpretation, in which profits are absorbed by higher salaries).

$$S_{it} = \beta_{1t} B_b{}^{med} + \beta_{2t} B_b{}^{high} + \beta_{3t} L_i \; + \beta_{4t} L_i \times B_b{}^{med} + \beta_{5t} L_i \times B_b{}^{high} + \boldsymbol{X}_b{}' \delta + N_{bt} + \varphi_{it} + \alpha_b + \epsilon_{it} \quad (3)$$

Finally, to further examine the mechanisms through which various fund metrics that were associated with higher/lower predicted probabilities of survival where blight infection was more severe may have affected institutional resilience, I estimate their effects on average changes in the mean annual number of loans, loan size, interest rate, ratio of fines to total lending, bad debts, expense ratio, and gross profit margin per loan during the famine. Each outcome, Y_{ifam}, for fund i, averaged over the duration of the famine, is differenced from its 1841–44 average, Y_{ipre}. This difference is then regressed on binary variables for medium and high blight infection at the baronial level ($B_b{}^{med}$and $B_b{}^{high}$), a vector of the relevant average annual pre-famine Loan Fund financial metrics (L_i), prefamine baronial characteristics ($\boldsymbol{X}_b$), the average number of Loan Funds operating in the same barony b as fund i during the famine (N_b), a binary variable for whether fund i pooled accounts with another society during the famine (φ_i), barony (α_b) fixed effects, and an error term (ϵ_i). Each of the included fund metrics is also interacted with medium and high blight at the baronial level, to allow fund financials to have had different effects where blight infection was more severe:

$$Y_{ifam} - Y_{ipre} = \beta_1 B_b{}^{med} + \beta_2 B_b{}^{high} + \beta_3 L_i \; + \beta_4 L_i \times B_b{}^{med} + \beta_5 L_i \times B_b{}^{high} + \boldsymbol{X}_b{}' \delta + N_b + \varphi_i + \alpha_b + \epsilon_i \quad (4)$$

In addition, for average gross profit margin per loan, I also estimate the effects of pre-famine metrics on non-differenced famine levels, Y_{ifam}.

For non-fixed but observable fund characteristics, the included controls in equations (1) through (4) are baronial valuations completed by 1845, area in 1841, adult male and female literacy rates (reading, writing, or both) in 1841, the potato crop share of total acreage under tillage in 1844, the fraction of housing stock rated fourth-class in the 1841 census, pre-1845 valuation per capita, population density in 1841, the 1841 share of families at the county level drawing income from agricultural work, and the county-level number of males and females employed in the cloth industry in 1841.[30] In the absence of income or wealth statistics, these variables are included as proxies for local economic development and poverty. Acreage under potato crop as a share of total tillage acreage in 1844 is included to allow funds operating in locales similarly impacted by blight but with different prefamine levels of potato dependence to experience systematically different changes after 1845. Additionally, blight severity is

30. In the 1841 *Census of Ireland*, fourth-class houses are defined as "all mud cabins having only one room."

interacted with fourth-class housing share, to allow for blight to have had more or less of an effect on Loan Fund outcomes where initial poverty was greater.[31]

Along these observable dimensions, in equations (1) and (2), funds differentially afflicted by blight are allowed to experience systematically different changes after 1845. The identification assumption is that, controlling for barony fixed effects, funds in baronies with different blight infection rates but similar prefamine characteristics would have had the same survival probabilities after 1845 if not for blight. In equations (3) and (4), funds with different prefamine financial metrics are likewise allowed to experience systematically different survival probabilities and changes in lending activity and balance sheet metrics after 1845. The identification assumption is that, controlling for barony fixed effects, funds in baronies with similar prefamine characteristics and the same level of blight infection would have had the same survival probabilities and changes in lending activity after 1845 if not for differences in prefamine management and financials.

The coefficient β_{5t} in equation (3) reports whether funds in baronies suffering from severe blight infection in 1845 and 1846 were more or less likely to survive than funds in baronies with moderate blight infection if there was a history of more leverage, higher salaries, and so forth, compared to the difference in survival probabilities between funds in high-infection and low-infection baronies when there was less leverage, lower salaries, and so forth, controlling for all other prefamine baronial and fund characteristics and barony fixed effects. This allows for prefamine fund management and financials to have had more or less of an effect on the probability of institutional survival where blight infection was greater. Similarly, the coefficient β_5 in equation (4) reports whether funds in baronies suffering from severe blight infection in 1845 and 1846 experienced differential changes in average lending and balance sheet metrics during the famine if they had been more highly levered, been paying higher salaries, and so forth, versus if they had been less levered, been paying lower salaries, and so forth. This allows for prefamine fund management and financials to have had more or less of an effect on average changes in lending activity and balance sheet metrics where blight infection was greater. Because it is a strong identifying assumption that average prefamine financial metrics were not correlated with other non-fixed baronial characteristics that may have been correlated with differential fund performance during the famine, as a robustness check, in section 5 I also regress these fund variables on available prefamine baronial-level social and economic indicators to test for systematic differences in prefamine financials.

Several additional estimation details are worth noting. First, equations (1) and (3) are estimated using a linear probability model (LPM).[32] To correct for

31. Though the main sample of blight severity includes 255 observations, the number of observations for all regressions is less than 255. This owes to the fact that not all baronies in my blight sample had a Loan Fund, and because funds missing pre-famine observations of included outcome and control variables are automatically excluded.

32. The linear probability model permits an easier interpretation of estimated coefficients than in alternative specifications. In addition, coefficients in a linear model directly measure marginal effects for the probability that an outcome occurs. The simpler specification is also employed because with few time

heteroskedasticity, I therefore take robust standard errors (Angrist and Pischke 2008). Second, standard errors are clustered at the fund level to adjust for within-fund correlation over time. Third, outcome years analyzed are selected so as to estimate average effects during and immediately after the famine. Fourth, available historical data does not allow me to identify the extent to which observed average changes in lending and interest rates are due to supply- or demand-side factors. However, since Dercon (2002), Becchetti and Castriota (2008), Berg and Schrader (2012), and Goodspeed (2016a, 2016b) have demonstrated that demand for microfinance credit generally increases in the event of an adverse environmental shock, with Goodspeed (2016a, 2016b) finding a particularly strong effect of access to microfinance on accumulations of buffer livestock during the famine, observed average changes reported here should be interpreted as providing a lower bound for the magnitude of the effect of natural disasters on MFI credit supply.

V. Results

Estimated Effects Of Blight Severity

Results of estimating equations (1) and (2) are reported in table 3. Column 1 reports LPM-estimated coefficients for the effect of blight severity on the probability of fund survival through the indicated year. Results show that funds in baronies experiencing severe blight infection in 1845 and 1846 had a 24.1-percentage point lower predicted probability of surviving the first three years of the famine. By 1852, the predicted probability of survival was a large and statistically significant 34.8 percentage points lower for funds located in baronies suffering high blight infection in 1845–46, compared to funds located in low infection baronies.

Estimated coefficients reported in columns (2)–(8) of table 3 show that blight also had a significant effect on Loan Fund balance sheets. By the third year of the blight, in 1847, funds located in severely infected baronies had reduced total annual lending volume by £4,688 more than funds in less infected baronies, and extended 1,103 fewer loans. On the liabilities side, by 1848, funds in severely infected baronies had lost £1,171 more of their capital, relative to funds in low infection baronies, and 12 more depositors. By the end of the famine, in 1852, relative to funds in moderately infected baronies, funds in severely infected

points (the famine years) and long-duration intervals, a robust method like OLS is preferable to iterative procedures such as logistic regression or instantaneous hazard models. However, since F is a binary discrete variable, the variance is not homoscedastic, but varies with the values of the independent variables. Formally, if ρ_i is the probability of failure and $\boldsymbol{X}_i$ a vector of independent variables ($\rho_i = \Pr(F_i = 1 \mid \boldsymbol{X}_i)$), then the LPM is $\rho_i(\boldsymbol{X}) = \beta\boldsymbol{X}_i + \epsilon_i$. As F_i is a binary discrete variable, ϵ_i can only take two values, $\epsilon_i = (1 - \beta\boldsymbol{X}_i) \mid F_i = 1$, and $\epsilon_i = -\beta\boldsymbol{X}_i \mid F_i = 0$. By definition, since $E(\epsilon_i) \mid \boldsymbol{X}_i = 0$, we have $\sigma_i^2 = E[(\epsilon_i - E(\epsilon_i))^2 \mid \boldsymbol{X}_i] = E(\epsilon_i^2) = \rho_i(1 - \beta\boldsymbol{X}_i)^2 + (1 - \rho_i)(-\beta\boldsymbol{X}_i)^2 = \beta\boldsymbol{X}_i(1 - \beta\boldsymbol{X}_i)^2$, which varies with i, thus establishing the heteroscedasticity of the residuals ϵ_i. To correct for this consequent heteroscedasticity, I compute robust standard errors.

TABLE 3. Estimated Loan Fund Survival Probability and Changes in Financial Metrics, High vs. Low Blight

	Fund Survival	Lending	Loans	Capital	Depositors	Interest	Fines Ratio	Bad Debts
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1846	−0.103	−2243.144**	−373.686	−240.94	−2.274	−0.049	0.063	−19.596**
	−0.15	(1097.99)	(331.37)	(309.85)	(2.08)	(0.04)	(0.06)	(8.93)
1847	−0.025	−4688.478**	−1102.733**	−715.435*	−3.659*	−0.025	−0.023	−20.654**
	(0.15)	(1843.06)	(533.36)	(400.07)	(2.20)	(0.02)	(0.03)	(10.39)
1848	−0.241*	−4522.917**	−1123.025**	−1170.667**	−11.805*	−0.089*	−0.071*	−25.658***
	(0.14)	(2034.86)	(552.31)	(520.53)	(6.40)	(0.05)	(0.04)	(9.55)
1852	−0.348**	−4873.925*	−1044.567*	−1226.031*	−16.093*	−0.057***	−0.059**	−23.704**
	(0.14)	(2767.47)	(608.80)	(634.19)	(9.33)	(0.02)	(0.03)	(11.51)
N	191	191	191	191	191	191	191	191
R2	0.190	0.169	0.183	0.182	0.136	0.219	0.114	0.186

Notes: Column (1) reports LPM estimates of Loan Fund survival by high vs. low blight severity (β_{2t}'s in Eq. (1) in the text). Columns (2) - (8) report estimated coefficients for differences in average changes in total lending, number of loans, capital, number of depositors, interest rate, ratio of fines to total lending, and bad debts by blight severity (see Eq. (2) in the text). Included control variables for all regressions are (at the baronial level) the share of 1841 housing stock rated fourth class, the 1844 potato crop share of total tillage acreage, male and female literacy rates in 1841, pre-famine valuation and valuation per capita, area, total population and population density in 1841, and (at the county level) the fractions of families drawing a majority of income from agriculture and manufacturing, and the county-level numbers of men and women engaged in the cloth industry. Blight severity is additionally interacted with fourth-class housing. Also included are the number of funds in the barony, a binary variable for whether the fund pooled accounts with another society, and barony fixed effects. Robust standard errors are reported in parentheses and clustered at the baronial level.
***p < 0.01, **p < 0.05, *p < 0.10.

baronies had reduced lending by £4,874 and the number of loans by 1,044, and had lost £1,226 more of their capital and 16 more depositors.

Estimated coefficients reported in column (6) indicate that, for funds in severely affected baronies, average interest rates (including application and surety screening fees) on loans declined, relative to average interest rates on loans extended by funds in moderately affected baronies.[33] By 1848, average annualized interest charged by funds in worse infected baronies was 890 basis points lower than average interest on loans extended by funds in low infection baronies, with the relative differential persisting through 1852. Estimated coefficients reported in column (7) of table 3 also show a relative decline in the ratio of delinquency fines to total lending by funds in high blight baronies. By 1848, the ratio of fines to total lending was 710 basis points lower for funds in severely infected baronies than for funds in low infection baronies. Results presented in column (8) reveal that the volume of bad debts also decreased relatively for funds in severely affected baronies during the famine; by 1848, funds in high blight baronies had decreased the amount of bad debts on their books by £26, relative to funds in low blight baronies.

These results suggest that in the short and medium runs, funds located in baronies experiencing greater blight infection responded primarily by balance sheet contraction. Moreover, the relative decline in bad debts and the ratio of fines to lending implies that funds in worse affected baronies significantly raised credit standards, while the observed relative decline in interest income indicates that funds in worse affected baronies were also collecting less in interest and application and surety screening fees as a percentage of lending, which suggests that borrowing costs for repeat and/or high-credit quality borrowers actually fell.

Estimated Effects Of Fund Management

Results from estimating equation (3) are presented in table 4. Each column in panel A of table 4 reports estimated β_{3t}'s, the main effect of the indicated prefamine Loan Fund management or financial metric on the predicted probability of fund survival, while each column in panel B reports estimated β_{5t}'s, the interaction effect of prefamine Loan Fund metrics where blight infection was high (severe) on the predicted probability of fund survival. I report both main and interaction effects of Loan Fund management and financial metrics because results indicate that different prefamine Loan Fund metrics had in some cases quite different effects on the probability of fund survival where blight infection was more severe.

Estimated coefficients reported in columns (1) through (3), panels A and B indicate that while higher prefamine leverage ratios were generally associated with

33. Unfortunately, reports do not report average interest rates, but instead total interest income, which includes application and surety screening fees. To compute average rates, I divide total interest income by total lending.

TABLE 4. Estimated Loan Fund Survival Probability by Pre-Famine Metrics Interacted with High Blight

	1846	1847	1848	1852
	(1)	(2)	(3)	(4)
Panel A: Main Effects				
Leverage Ratio	0.092**	0.067	0.099	0.257***
	(0.05)	(0.05)	(0.08)	(0.09)
Ave Salary	−0.009	−0.014*	−0.015*	−0.019*
	(0.01)	(0.01)	(0.01)	(0.01)
Profit Margin per Loan	−0.853	−0.186	1.086	−1.641
	(0.95)	(1.67)	(1.85)	(1.76)
Expense Ratio	−12.638**	−9.491	0.044	−6.336
	(5.34)	(6.02)	(7.53)	(7.05)
Manager a Minister	−0.051	−0.039	−0.031	−0.189*
	(0.08)	(0.10)	(0.11)	(0.11)
Ave Loan Size	−0.062	−0.013	−0.032	−0.091**
	(0.04)	(0.06)	(0.07)	(0.05)
Fines Ratio	−0.961	−1.024	−5.510*	0.963
	(2.36)	(2.79)	(3.31)	(3.41)
Bad Debts	0.002	0.002	−0.002	−0.007
	(0.01)	(0.01)	(0.01)	(0.01)
Number of Loans	0.066	0.041	−0.002	−0.006
	(0.08)	(0.10)	(0.13)	(0.13)
Cost of Capital	−0.666	0.068	1.761	0.986
	(2.71)	(5.71)	(6.05)	(5.70)
Depositors	0.006*	0.006	0.007	0.013**
	(0.00)	(0.00)	(0.01)	(0.01)
Panel B: Interactive Effects				
Leverage Ratio	−0.004	−0.096	−0.193*	−0.317***
	(0.06)	(0.08)	(0.11)	(0.12)
Ave Salary	0.007	0.016*	0.016*	0.029***
	(0.01)	(0.01)	(0.01)	(0.01)
Profit Margin per Loan	0.287	2.43	1.257	4.617**
	(1.09)	(1.76)	(2.19)	(2.08)
Expense Ratio	11.883*	14.789*	2.478	12.452
	(6.22)	(7.90)	(10.54)	(9.98)
Manager a Minister	0.056	−0.022	−0.116	0.120
	(0.09)	(0.15)	(0.17)	(0.16)
Ave Loan Size	0.034	0.047	0.077	0.155**
	(0.05)	(0.08)	(0.09)	(0.07)
Fines Ratio	1.16	−0.073	4.022	−2.44
	(2.34)	(2.97)	(3.53)	(3.67)
Bad Debts	−0.002	−0.002	0.005	0.008
	(0.01)	(0.01)	(0.01)	(0.01)
Number of Loans	−0.035	−0.097	−0.055	−0.076
	(0.10)	(0.13)	(0.16)	(0.17)
Cost of Capital	−3.561	0.197	0.459	−2.612
	(3.93)	(7.00)	(7.80)	(7.46)
Depositors	−0.004	−0.004	−0.008	−0.018***

(Continued)

TABLE 4. *Continued*

	1846	1847	1848	1852
	(0.00)	(0.01)	(0.01)	(0.01)
N	191	191	191	191
R2	0.273	0.263	0.203	0.231

Notes: Columns (1) through (4) report LPM estimates of Loan Fund survival by pre-famine Loan Fund metrics, averaged over 1841-44. Each column in Panel A reports estimated main effects (β_{4t}'s of Eq. (3)), while each Panel B column reports estimated interaction effects (β_{5t}'s of Eq. (3)). Included control variables for all regressions are (at the baronial level) the share of 1841 housing stock rated fourth class, the 1844 potato crop share of total tillage acreage, male and female literacy rates in 1841, pre-famine valuation and valuation per capita, area, total population and population density in 1841, and (at the county level) the fractions of families drawing a majority of income from agriculture and manufacturing, and the county-level numbers of men and women engaged in the cloth industry. Blight severity is additionally interacted with fourth-class housing. Also included are the number of funds in the barony, a binary variable for whether the fund pooled accounts with another society, and barony fixed effects. Robust standard errors are reported in parentheses and clustered at the baronial level.
***p < 0.01, **p < 0.05, *p < 0.10.

a higher predicted probability of surviving the first three years of the famine, greater leverage had a significant negative effect on the predicted probability of fund survival where blight infection was more severe. Estimated coefficients reported in column (3), panels A and B reveal that by 1848, the main effect of a 100% increase in the average prefamine leverage ratio (for example, from 4:1 to 5:1) was a non-statistically significant 9.9-percentage point higher predicted probability of institutional survival, whereas in baronies suffering from severe blight infection, a 100% increase in average pre-famine leverage was associated with a 19.3-percentage point lower predicted probability of survival.

Estimated coefficients reported in columns (1) through (3), panel A also reveal that the main effect of higher average staff salaries was a lower predicted probability of institutional survival during the famine, with a £1 increase in average employee salary lowering the predicted probability of survival by 1.4 percentage points through 1847. However, estimated coefficients reported in columns (2) and (3), panel B reveal that higher average salaries had a net positive effect on the probability of fund survival where blight infection was more severe; funds in severely infected baronies paying £1 more in average employee salaries before the famine had a net 0.2-percentage point greater probability of survival through 1847 than funds in severely infected baronies paying less. While higher salaries were therefore generally associated with a lower survival probability, in the presence of a major covariate shock higher staff remuneration was associated with a higher probability of survival.

Prefamine differences in fund scale, gross profit margin per loan, average loan size, fines ratio, cost of capital, bad debts, and whether or not the fund manager was a minister do not appear to have had differential effects on survivability during the first three, and most acute, years of famine.[34] Average prefamine expense

ratios were generally a strong short-run predictor of institutional survivability—funds with a 1-percentage point higher expense ratio had a 12.638-percentage point lower probability of surviving through 1846 than funds with a lower expense ratio—but differences in prefamine expense ratios appear to have had no net differential effect on the predicted probability of fund survival where blight infection was severe.[35] Higher expense ratios may have been associated with a net positive effect on the predicted probability of survival through 1847 where blight infection was worse—funds in severely infected baronies with a 1-percentage point higher expense ratio had a 14.789-percentage point higher probability of surviving through 1847 than funds in severely infected baronies with a lower expense ratio—though the estimated effect appears to have dissipated by 1848.

Estimated coefficients reported in columns (4) and (5), panels A and B show the effects of prefamine financials on the predicted probability of surviving through the end of the famine and beyond, through 1856. Results again indicate that management practices that were generally positively (negatively) associated with fund survival were in several instances negatively (positively) associated with survival in the presence of severe blight infection. While higher leverage generally had a positive effect on the predicted probability of surviving through 1852—a 100% increase in average prefamine leverage was generally associated with a 25.7-percentage point higher predicted probability of survival—for funds in severely infected baronies the net effect of a 100% increase in leverage was a 6.0-percentage point lower predicted probability of survival. In contrast, whereas the main effect of higher average employee salaries before the arrival of blight was a lower predicted probability of surviving through 1852, higher prefamine salaries had a positive effect on the probability of institutional survival where blight infection was more severe. While the main effect of a £1 increase in average prefamine staff salary was a 1.9-percentage point lower predicted probability of survival through 1852, funds in severely infected baronies paying £1 more in average employee salaries had a net 1.0-percentage point higher probability of survival through 1852 than funds in severely infected baronies paying £1 less.

The estimated coefficient reported in column (4), panel A also indicates that ministers were generally less competent fund managers. Funds with a minister as manager before the famine had a 18.9-percentage point lower probability of surviving through 1852 than funds with a non-clergy manager. Having a minister as manager, however, appears to have had no additional statistically significant differential effect on the probability of survival where blight infection was severe, which suggests that while ministers were generally less competent fund managers, they were no more or less capable of handling a major adverse shock than

34. Fund scale is proxied by the average annual number of loans extended. Fines ratio refers to the ratio of fines collected to total lending. Unfortunately, available data does not distinguish whether variation in the rate of pre-famine fine collection was due to differences in actual delinquency rates, or rather to differences in the intensity of fine collection.

35. Expense ratio refers to the ratio of nonstaff operating costs, excluding cost of capital, to total lending.

nonclergy managers. Estimated coefficients reported in column (5), panels A and B also suggest that, over the long term, while larger loans were generally associated with a lower predicted probability of survival, where blight infection had been severe the net effect of a £1 increase in average prefamine loan size was a 6.4-percentage point higher predicted probability of institutional survival through 1852.

Results presented in columns (4) and (5), panels A and B indicate that while a larger depositor base was generally associated with a higher predicted probability of institutional survival through the end of the famine, the reverse was true where blight infection was more severe. While an additional depositor before the famine was generally associated with a 1.3-percentage point higher probability of surviving through 1852, for funds located in severely infected baronies one more depositor was associated with a net 0.50-percentage point lower predicted probability of institutional survival through 1852.

Estimated coefficients for the interaction effects of different prefamine fund metrics and severe (high) blight infection on Loan Fund activity during the famine—β_5's in equation (4)—are presented in table 5. Estimated coefficients reported in column (1) indicate that funds in severely affected baronies with higher prefamine gross profit margins per loan, leverage ratios, expense ratios, and more depositors did not experience systematically different changes in the average annual number of loans extended during the famine. Funds in high blight baronies that had been paying £1 more in average staff salaries before the famine, however, relatively reduced the average number of loans extended during the famine by an additional 27.100 loans per year. Estimated coefficients reported in column (2) reveal that while funds in worse affected baronies with higher pre-famine leverage ratios and average salaries did not experience differential changes in average loan size during the famine, funds in severely affected baronies with higher pre-famine gross margins and more depositors did. Specifically, funds in severely infected baronies with an average prefamine gross margin per loan higher by 100 basis points relatively reduced the average size of a loan during the famine years by £0.89 (17 s. 10d.), while funds in severely infected baronies with an additional depositor before the famine relatively increased average loan size during the famine by £0.03 (8d.).

Results presented in column (3) of table 5 reveal that funds in severely infected baronies with an average prefamine gross profit margin per loan higher by 100 basis points also relatively reduced the average rate of interest on loans, including application and surety fees, by an additional 230.4 basis points. Estimated coefficients reported in column (4) indicate that funds in severely infected baronies with higher prefamine gross margins per loan and average salaries also relatively reduced the ratio of fines to total lending during the famine. For funds in high blight baronies, a 100-basis point increase in average pre-famine gross profit margin was associated with a 295.0-basis point relative reduction in the average fines rate during the famine, while a £1 increase in average prefamine employee salary was associated with a 10-basis point relative reduction in the

TABLE 5. Estimated Changes in Loan Fund Activity by Pre-Famine Metrics Interacted with High Blight

	Loans	Loan Size	Interest Rate	Fines Ratio	Bad Debts	Expense Ratio	Margin per Loan	Margin per Loan (Level)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Margin per Loan	−26211.072	−89.143**	−2.304**	−2.950***	−1089.684**	0.093	−0.848***	0.373
	(19797.04)	(42.22)	(1.01)	(0.73)	(541.43)	(0.14)	(0.20)	(0.26)
Leverage Ratio	−129.222	0.033	−0.017	−0.001	9.943*	0.001*	−0.001*	−0.003***
	(98.01)	(0.19)	(0.01)	(0.00)	(5.80)	(0.00)	(0.00)	(0.00)
Ave Salary	−27.100***	−0.006	0.000	−0.001*	−0.195	0.000	0.000*	0.001**
	(10.31)	(0.01)	(0.00)	(0.00)	(0.37)	(0.00)	(0.00)	(0.00)
Expense Ratio	−14623.982	−107.290*	−2.538	−1.84	−1181.023	−2.739***	1.717***	1.319***
	(29257.17)	(63.68)	(2.05)	(3.44)	(748.05)	(0.29)	(0.42)	(0.45)
Depositors	−5.804	0.033***	0.001	0.000*	−0.660*	0.000	0.000	0.000
	(7.81)	(0.01)	(0.00)	(0.00)	(0.36)	(0.00)	(0.00)	(0.00)
N	191	191	191	191	191	191	191	191
R2	0.313	0.283	0.386	0.307	0.341	0.220	0.521	0.365

Notes: Columns (1) - (7) report estimated coefficients (β_5's of Eq. (4) in the text) for differences in mean changes in the average annual number of loans, loan size, interest rate, ratio of fines to total lending, bad debts, expense ratio, and gross profit margin per loan during the famine by pre-famine average annual Loan Fund metrics interacted with high blight severity. Column (8) reports estimated coefficients for differences in the average level of gross profit margin per loan during the famine by pre-famine average annual Loan Fund metrics interacted with high blight. Included control variables for all regressions are (at the baronial level) the share of 1841 housing stock rated fourth class, the 1844 potato crop share of total tillage acreage, male and female literacy rates in 1841, pre-famine valuation and valuation per capita, area, total population and population density in 1841, and (at the county level) the fractions of families drawing a majority of income from agriculture and manufacturing, and the county-level numbers of men and women engaged in the cloth industry. Blight severity is additionally interacted with fourth-class housing. Also included are the number of funds in the barony, a binary variable for whether the fund pooled accounts with another society, and barony fixed effects. Robust standard errors are reported in parentheses and clustered at the baronial level.
***p < 0.01, **p < 0.05, *p < 0.10.

average fines rate during the famine. Funds in high blight baronies with more depositors, however, experienced relative increases in the ratio of fines to total lending during the famine; an additional prefamine depositor was associated with a 4-basis point relative increase in the average fines rate during the famine.

Estimated coefficients reported in column (5) of table 5 indicate that funds in severely infected baronies with higher margins on loans before the famine also relatively reduced the volume of outstanding debts. Funds in severely infected baronies with an average prefamine gross profit margin per loan higher by 100 basis points relatively reduced their average annual volume of bad debts by £10.90. In contrast, funds in high blight baronies with more depositors experienced relative increases in the volume of bad debts during the famine; an additional depositor before the famine was associated with a £0.66 (13s. 3 d.) relative increase in the average annual volume of bad debts during the famine.

Estimated coefficients reported in column (6)–(8) of table 5 suggest that different prefamine fund financials had significant effects on differential changes in the cost of credit intermediation and profitability during the famine. Funds that had been more highly levered before the famine experienced a relative increase in the ratio of non-wage operating expenses to total lending during the famine, with a 100% increase in average pre-famine leverage associated with a 10-basis point relative increase in average expense ratio during the famine. In contrast, funds with higher nonwage expense ratios before the famine experienced a relative decline in average expense ratio during the famine. A 1-percentage point higher pre-famine expense ratio was associated with a 2.739-percentage point relative decrease in average expense ratio during the famine.

Both more levered funds, and more profitable funds, also experienced relative declines in the average gross profit margin per loan. A 100% increase in average prefamine leverage was associated with a 10-basis point relative decline in the average margin per loan during the famine, while a 100-basis point increase in average pre-famine gross profit margin per loan was associated with an 84.8-basis point relative decline in average margin per loan. Funds with higher expense ratios before the famine, though, experienced relative increases in the average gross margin per loan during the famine. Funds with a 1-percentage point higher expense ratio before the famine experienced a 171.7-basis point relative increase in average margin per loan during the famine.

However, results reported in column (8) of table 5 suggest that while funds with higher gross margins per loan before the famine experienced relative declines in the average margin per loan during the famine, there was no difference in their average, non-differenced level of gross profit margin per loan during the famine. Average margin per loan for funds that had been more highly levered, though, was lower during the famine. A 100% increase in average prefamine leverage ratio was associated with a 30-basis point lower average gross margin per loan during the famine. In contrast, funds with higher average staff salaries and higher average non-wage expense ratios before the famine were relatively more profitable during the famine. A £1 increase in average prefamine employee salary

and a 100-basis point increase in the average pre-famine expense ratio were associated with average gross profit margins per loan higher by 10 and 137.9 basis points, respectively, during the famine.

Overall, the results presented in tables 4 and 5 suggest that differences in prefamine fund management and financials played a significant role in determining the probability of surviving the adverse shock of the Great Famine. In particular, while funds with higher gross profit margins per loan and higher paid staff before the famine were more likely to survive the severe environmental shock, funds that had been more highly levered and funds with more depositors before the famine were less likely to survive the shock. Results further suggest that the primary mechanisms by which prefamine financials influenced the probability of institutional survival were balance sheet contraction and an elevation of credit standards, and that funds with higher gross margins per loan and funds with more highly remunerated staff before the famine were more successful in effecting this retrenchment, while more levered funds and funds with more depositors were less successful.

Specifically, results reveal that though funds in worse affected districts with a higher average gross margin per loan before the famine did not reduce the average number of loans extended per year during the famine by any more or less than funds that had been less profitable on a unit basis, they did relatively reduce the average size of their loans. Moreover, during the famine, funds that had been more profitable on a unit basis relatively reduced the average interest rate charged on loans, the average ratio of delinquent fines to total lending, and the average volume of bad debts, implying a relative increase in average credit quality among approved borrowers. Similarly, funds in severely infected districts with more highly remunerated staff relatively reduced the average number of loans extended during the famine and experienced a relative decline in average fines ratios.

In contrast, funds in worse affected districts with more depositors before the famine experienced relative increases in average loan size, fines ratios, and bad debts during the famine, which indicates a relative decline in average credit quality compared to funds with fewer depositors. While funds in worse affected districts that had been more highly levered before the famine do not appear to have experienced systematically different changes in lending or average credit quality during the famine, they did suffer a relative rise in the unit cost of credit intermediation, and a relative decline in unit profitability. Funds in worse affected districts with higher average expense ratios before the famine, meanwhile, appear to have been able to relatively reduce their average expense ratios during the famine and thus experienced smaller relative declines in average gross profit margin per loan. However, funds in severely infected baronies with higher average pre-famine expense ratios had no higher probability of surviving beyond 1847, which indicates that cost cutting was an effective adjustment mechanism only in the short run.

These findings suggest that Loan Funds that had been earning higher rents before the famine had more scope to contract credit and raise lending standards in response to an adverse aggregate shock, while still remaining profitable. Better compensated staffs similarly seem to have been more effective at restricting credit to higher quality borrowers. In contrast, funds that had been relying more heavily on leverage before the famine appear to have been more severely affected by balance sheet contraction during the famine. Though more levered funds contracted lending by no more or less than less levered funds, they experienced relative increases in the unit cost of credit intermediation and relative decreases in average margin per loan, resulting in lower average margins on a unit basis during the famine.

Robustness Checks

Because it is a strong identifying assumption that average prefamine gross profit margins, employee salaries, numbers of depositors, expense ratios, and leverage were not correlated with other non-fixed baronial characteristics that may have been correlated with differential fund performance during the famine, I also regress these fund variables on available pre-famine social and economic indicators. Results are reported in table 6. Estimated coefficients reveal that differences in poverty levels (as proxied by the fraction of all occupied housing stock rated fourth class), potato dependence, wealth (as proxied by baronial valuation and valuation per capita), county-level fractions of households deriving the majority of income from agriculture and manufacturing, and county-level numbers employed in the cloth industry do not explain observed differences in pre-famine gross profit margin per loan. Greater population density was associated with higher profit margins, though the estimated effect is small in absolute terms and significant only at the 10% level. While female literacy was associated with higher average prefamine profit margins, male literacy was associated with lower margins. An additional Loan Fund in the same barony lowered average prefamine gross profit margin per loan by 10 basis points, which suggests that higher margins may indeed have owed to greater market power. Again, however, the estimated effect is significant only at the 10% level, and the overall fit of the model is poor, with an R^2 of just 0.038.

Baronial valuation and the county-level number of females engaged in the cloth industry were associated with lower average prefamine staff salaries, while fourth-class housing, potato dependence, literacy, county-level fractions of households deriving the majority of income from agriculture or manufacturing, the county-level number of males in the cloth industry, total population, and population density appear to have had no effect on differences in average prefamine employee salaries. Funds in baronies in counties with a larger fraction of households deriving the majority of their income from manufacturing activity had more depositors, though county-level female employment in the cloth industry was associated with fewer depositors. Available prefamine social and

TABLE 6. Robustness Checks

	Profit Margin	Ave Salary	Depositors	Expense Ratio	Leverage
	(1)	(2)	(3)	(4)	(5)
% Fourth-class Housing	0.004	−6.200	9.168	0.001	−1.664*
	(0.01)	(11.45)	(14.20)	(0.00)	(0.95)
Potato Crop Share	−0.005	−5.687	−9.548	0.001	−0.277
	(0.00)	(3.94)	(6.12)	(0.00)	(0.35)
Male Literacy Rate	−0.018*	−8.678	−30.968	0.002	−1.354
	(0.01)	(33.69)	(43.72)	(0.00)	(2.12)
Female Literacy Rate	0.012*	12.055	44.119	−0.001	−0.811
	(0.01)	(24.07)	(31.87)	(0.00)	(1.60)
% Families in Agriculture	0.000	0.001	0.000	0.000	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
% Families in Manufacturing	0.000	0.005	0.014***	0.000	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
% Males in Cloth Industry	0.000	0.000	−0.004	0.000	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
% Females in Cloth Industry	0.000	−0.002**	−0.003*	0.000	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Baronial Valuation	0.000	−0.000**	0.000	0.000	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Valuation per Capita	0.000	0.005	−0.338	0.000	0.003
	(0.00)	(0.21)	(0.24)	(0.00)	(0.01)
Population Density	0.000*	0.23	0.167	0.000	0.006
	(0.00)	(0.46)	(0.76)	(0.00)	(0.06)
Total Population	0.000	0.000	0.000	0.000	0.000**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Number of Funds in Barony	−0.001*	−0.956	0.581	0.000	−0.056
	(0.00)	(0.61)	(1.08)	(0.00)	(0.06)
N	191	191	191	191	191
R2	0.038	0.245	0.180	0.165	0.167

Notes: Each column reports estimated coefficients for average pre-famine levels of gross profit margin per loan, average staff salary, number of depositors, expense ratio, and leverage ratio by pre-famine baronial and county-level characteristics. Also included are baronial area and fixed effects. Robust standard errors are reported in parentheses and clustered at the baronial level.
***p < 0.01, **p < 0.05, *p < 0.10.

economic indicators appear to have had no effect on differences in average pre-famine fund expense ratios, as reported in column (4). Estimated coefficients reported in column (5) reveal that average prefamine leverage ratios were actually lower where the share of housing rated fourth class was higher, but higher where overall population was greater. Other indicators appear to have been unassociated with differences in prefamine leverage ratios.

In sum, results presented in table 6 do not reveal any systematic variation in average prefamine gross profit margins per loan, employee salaries, numbers of depositors, expense ratios, and leverage ratios that would be consistent with those variables being correlated with unobservable, non-fixed baronial characteristics that may in turn have been correlated with differential fund performance

and balance sheet changes during the famine. Differences in average profit margins, which were positive predictors of fund survival where blight infection was more severe, did not vary with differences in prefamine levels of poverty or potato dependence. Average staff salaries, which were also positive predictors of fund survival where blight infection was more severe, were in fact lower where baronial valuation was higher, while the number of depositors, which was a negative predictor of survival where the environmental shock was worse, was actually greater in baronies with more families earning the majority of their income from manufacturing. Finally, average prefamine leverage, which was also a negative predictor of survival where the severity of blight infection was worse, was in fact lower where the poverty level was higher.

VI. Conclusion

I find that a large environmental shock can have significant adverse effects on MFI sustainability, resulting in lower institutional survival probabilities, large declines in lending, capital levels, and numbers of depositors, as well as substantial flight-to-quality in lending portfolios. During the Great Famine, borrowing costs for qualifying borrowers in worse affected districts therefore actually fell as funds in these districts contracted lending and significantly raised credit standards. I further find that prefamine balance sheet data were important predictors of MFI survival during the famine, though certain metrics that were generally associated with higher (lower) survival probabilities were associated with lower (higher) survival probabilities where the magnitude of the environmental shock was greater. While greater leverage, lower average staff salaries, and more depositors were generally associated with higher predicted probabilities of institutional survival, the reverse was true where blight infection was more severe. Conversely, though funds with higher gross profit margins per loan before the famine were generally no more likely to succeed over the long run than less profitable funds, higher prefamine margins were strong positive predictors of institutional survival where blight infection was worse.

Differences in prefamine balance sheet metrics were also associated with differential institutional responses to the adverse shock. Relative to funds with lower average gross profit margins per loan before the famine, funds in worse affected districts with higher prefamine margins relatively reduced average loan size, interest rates, fines ratios, and bad debts during the famine, indicating a relative increase in average credit quality among approved borrowers. Funds in worse affected districts with more highly remunerated staff before the famine similarly relatively reduced their mean annual number of loans and fines ratios during the famine. However, though funds with higher prefamine margins experienced relative declines in average margin per loan, there was no relative difference in their average, non-differenced level of profit margin per loan during the famine. In contrast, funds in severely infected districts with

more depositors before the famine experienced relative increases in average loan size, fines ratios, and bad debts during the famine, while funds in worse affected districts that had been more highly levered before the famine experienced a relative rise in the average unit cost of credit intermediation and relative decline in profitability, resulting in a lower average gross profit margin per loan during the famine.

This study therefore not only reaffirms the tension between sustainability and outreach in microfinance but also reveals that optimal MFI lending models under ordinary circumstances may impede adjustment to a major aggregate shock. Specifically, results show that MFI sustainability in the face of a major spatially correlated shock depends critically on an ability to rapidly scale down lending, reduce average loan size, and significantly raise lending standards and therefore that though microfinance may mitigate the effects of such shocks on borrowers of higher credit quality, it is not a viable mitigant for more vulnerable, marginal borrowers. This is consistent with Goodspeed (2016b), who finds that while access to Loan Fund credit had significant effects on relative accumulations of buffer livestock during the Great Famine by midsized farms of 5 to 15 acres, it had limited effects on relative changes in livestock holdings by farms of fewer than 5 acres.

Moreover, whereas a broader depositor base was ordinarily advantageous to institutional sustainability, the additional liability of more depositors appears to have limited funds' capacity to contract lending portfolios and raise average credit standards in response to adverse shock. Similarly, though greater leverage was generally a strong positive predictor of long-run MFI survival, where the magnitude of the environmental shock was greater funds that had been more highly levered were less able to an effect balance sheet contraction while remaining profitable. In contrast, Loan Funds that had been earning higher rents before the famine appear to have had more scope to contract lending and raise credit standards while still remaining profitable. Meanwhile, higher paid staff, though ordinarily a long-run institutional liability, were more effective in restricting credit to higher quality borrowers in response to worse blight infection.

The Great Famine of Ireland was a rare event that allows for an analysis of differential MFI outcomes and adjustment strategies to a major aggregate shock, over both the short and long runs. Further research is needed, however, to better understand the causes of variation in prefamine MFI balance sheets and to evaluate the potential private and social welfare costs under ordinary conditions of greater institutional resilience to rare adverse environmental events.

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Appendix 1: Data Sources

Blight Severity: Blight severity in 1845–46 is obtained from the famine Relief Commission Papers, 1845–1847. RFLC3/2, Incoming Letters: Baronial Sub-series. The National Archives of Ireland, Dublin Ireland. Observations made at the civil parish, township, or PLU level are assigned to their corresponding baronies.

Demographics: Population data, including the share of families receiving income from agricultural work and the number of men and women employed in the cloth industry, are from the decennial *Census of Ireland*, 1841.

Loan Funds: Data on Loan Fund activity are from the annual reports of the Loan Fund Board of Ireland, 1843–1856, compiled by Aidan Hollis and Arthur Sweetman (see Hollis and Sweetman 1998, 2001, 2004).

Agricultural Data: Potato crop acreages for 1844–1846 are from tabulated constabulary returns in the Public Record Office of Ireland assembled by Austin Bourke (see Bourke 1960, 1965c).

Other Control Variables: Adult literacy and third- and fourth-class housing share at the baronial level and barony area in statute acres are taken from the 1841 *Census of Ireland*. Pre-Famine baronial and are from partial returns from Griffith's *Valuation of Ireland* and Her Majesty's Poor Law Commissioners, as presented in the 1845 *Appendix to the Minutes of Evidence taken before Her Majesty's Commissioners of Inquiry into the State of the Law and Practice in Respect to the Occupation of Land in Ireland*.