

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

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Abstract

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 MFI's more vulnerable to tail-probability aggregate shocks, with higher leverage, lower paid staff, lower economic rents, and more extensive liabilities limiting 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.

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1 Introduction

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 to microfinance credit can mitigate the impact of environmental shocks on income and consumption (Dercon 2002; Khandker, 2007; Becchetti and Castriota 2011; Goodspeed 2015), 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 (Miamiian et al. 2005). MFI's 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 dataset constructed by Goodspeed (2015), 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 pre-famine 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 pre-famine 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 pre-famine gross profit margins per loan were generally no more likely to survive long-term than less profitable funds, but higher pre-famine 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 pre-famine 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 pre-famine 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 pre-famine 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 pre-famine 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 pre-famine balance sheet metrics cannot be explained by pre-famine differences in available micro-level social and economic variables.

These findings suggest that MFI's 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 2 provides a historical summary of the Irish Loan Funds and the Great Famine of Ireland. Section 3 develops a theoretical model for analyzing the effects of an aggregate shock on credit supply in a relationship lending

context. Sections 4 and 5 detail data construction and the empirical framework, while Section 6 presents the results. Section 7 concludes.

2 Historical Background

2.1 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-18th century into the early 20th 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

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.

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 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. 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 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.⁴

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

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 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.

“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.”⁵

Funds were operated by paid clerks, and predominantly funded by interest-earning deposits (Hollis and Sweetman 1998). 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 pre-famine 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.

2.2 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 oomycete *Phytophthora infestans*.⁶ The disease, commonly known as “late blight,” as the effects do not

⁵ Consider also: “I. K. applies for the sum of £1 to buy a pig; he states he has sufficient food for his family, but that the offal of his house is going to loss because he has no pig to consume it; he receives the £1 with which he purchases the pig, that which was heretofore going to loss supports it, the animal increases in value according to the ordinary calculation a shilling a-week.—if this increased value was available every week, then he might pay the instalment, and at the end of twenty weeks he would have paid the money borrowed and have the pig ‘to the good;’ but as the increased value of the pig is not available every week, he pays one shilling a-week out of his wages, and at the end of twenty weeks he has paid off the loan, and is in possession of a pig worth at least forty shillings” (Piesse 1841).

⁶ 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).

become apparent until relatively late in the growing season, rots the tubers of infected potatoes.⁷ 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 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.⁸

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 1847.⁹ 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). 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

⁷ 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.

⁸ *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).

⁹ 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).

following year, 58 funds had to wind 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.¹⁰

3 Theoretical Framework

A central challenge confronting MFI’s, particularly in developing contexts, is the high degree of asymmetric information concerning the creditworthiness of potential borrowers. The problem is especially acute for MFI’s, 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).¹¹ Following Petersen and Rajan (1995) and Berg and Schrader (2012), I therefore frame the Loan Fund model in the context of relationship lending.

For simplicity, I assume a risk-neutral world. The number of households is normalized to 1, with each household holding different initial amounts of capital, k_n . The distribution of capital across households is described by the cumulative distribution function $G(k)$, so that the aggregate volume of household capital is $K = \int_0^\infty G(k)dk$.¹² At the start of period $t = 0$, households apply to an MFI lender for a loan so as to invest an amount $I_0 > k_n$ in a project that pays out Y_0 at the end of the period if the borrower is a “good” entrepreneur, and 0 otherwise. At the start of $t = 1$, good

¹⁰ 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.

¹¹ 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.

¹² In other words, $G(k)$ is the fraction of households with assets less than k . The fraction N of households requiring external financing is thus equal to $G(I)$, meaning total loan demand is $L = \int_0^I G(I)I - G(k)dk$.

entrepreneurs will then be able to borrow $I_1 > Y_0 + k_n$ to invest in a second project paying out Y_1 at the end of $t = 1$.

I assume that at the start of $t = 0$, only prospective borrowers know whether they are good or bad entrepreneurs; MFI lenders know only that a fraction θ_n of borrowers are good entrepreneurs who will repay their loan in full, with interest, at the end of the first period and return for another loan to invest in the second period. θ_n is thus the ex ante credit quality of borrowers. At the start of $t = 0$, the lender therefore offers a standard debt contract with an interest rate of r . But at the end of $t = 0$, the lender becomes fully informed of the type of borrower it is dealing with, and can therefore charge returning borrowers a safe rent $R < r$.

The lender's problem is then to determine the optimal interest rate r^* that satisfies:

$$\theta r(I_0 - k_n) + \theta R(I_1 - k_n - Y_0) - (1 - \theta)(I_0 - k_n) \geq 0$$

Borrowers, meanwhile, will only take out a loan if the net return is positive, meaning:

$$Y_0 + Y_1 - I_0 - I_1 - r(I_0 - k_n) - R(I_1 - k_n - Y_0) \geq 0$$

The MFI thus faces a trade-off—raising r 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. From these positive net income constraints, it is then easy to derive the optimal interest rate (r^*) and lowest credit quality (θ^*) at which the MFI is able to lend without making losses:

$$r^* = \frac{Y_0 + Y_1 - I_0 - I_1 - (1 - \theta)(I_0 - k_n) - (1 - \theta)R(I_1 - k_n - Y_0)}{(1 - \theta)(I_0 - k_n)}$$

$$\theta^* = \frac{(1 + r)(I_0 - k_n) + R(I_1 - k_n - Y_0) - (Y_0 + Y_1 - I_0 - I_1)}{(1 + r)(I_0 - k_n) + R(I_1 - k_n - Y_0)}$$

Supposing an aggregate income shock occurs before prospective borrowers apply for loans in $t = 0$, there are three channels through which lending may be affected. The first is the direct impact on household capital assets, k_n . In a subsistence economy such as 1840s Ireland, this would largely comprise drawdowns of stocks of seed potatoes, grain stores, and/or liquidation of livestock assets

and durable goods. The second channel consists of the indirect losses of lower revenues at the end of $t = 0$ (i.e. Y_0), implying smaller flows of intermediate goods for production in period $t = 1$, while the third channel consists of the macroeconomic effects of lower investment returns in later periods (Y_1). In the context of 1840s Ireland, indirect losses would likely consist primarily of lower year-end stores of fodder and seed, while macroeconomic losses would consist of lower revenues owing to a decline in aggregate income. Since investment projects with negative net present values will not be undertaken, I assume that the effects of the shock on Δk_n , ΔY_0 , and ΔY_1 are not so large as to render projects unprofitable.¹³

Proposition 1: *After an adverse aggregate shock, the fraction of loan applicants receiving a loan will decrease.*

Proof: An aggregate income shock will result in a decline in k_n , Y_0 , and/or Y_1 . Taking derivatives of θ^* with respect to k_n , Y_0 , and Y_1 , I find that, given the assumptions that some portion of first- and second-period investment must be financed by borrowing (i.e. $I_0 > k_n$ and $I_1 > Y_0 + k_n$) and that investment returns are non-negative (i.e. $Y_0 > I_0$, $Y_1 > I_1$), then $\partial \theta^* / \partial Y_0$, $\partial \theta^* / \partial Y_1$, and $\partial \theta^* / \partial k_n$ are all strictly negative. A decline in k_n , Y_0 , and/or Y_1 will thus correspond to an increase in minimum credit quality, θ^* .

Proposition 2: *After an adverse aggregate shock, the rate of interest on loans will decline if the market power of the lender is sufficiently large.*

Proof: It is straightforward to show that, given the assumption that some portion of first-period investment must be financed by borrowing (i.e. that $I_0 > k_n$), $\partial r^* / \partial Y_0$ and $\partial r^* / \partial Y_1$ are strictly positive, meaning a decline in first- and/or second-period investment returns, Y_0 and Y_1 , will lower the optimal rate of interest. However, the optimal interest rate will only decrease with a decline in

¹³ See Appendix A2 for derivation of the following propositions. Goodspeed (2015) 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 non-tradeable 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.

initial capital if the value of repeat business with good entrepreneurs is sufficiently high; otherwise, a decline in k_n will increase r^* . That is, $\partial r^* / \partial k_n > 0$ if and only if $R > \frac{I_0 + I_1 - Y_0 - Y_1}{(1-\theta)(I_0 + Y_0 - I_1)}$. This implies that the greater the MFI's market power—and thus the higher the second-period rents the MFI can earn from repeat business with good entrepreneurs—the more likely an adverse shock to initial wealth may lower interest rates, as greater market power and lower starting capital means the lender can earn more on larger loans in the second period. Since $\partial r^* / \partial Y_0$ and $\partial r^* / \partial Y_1$ are strictly positive but the sign of $\partial r^* / \partial k_n$ is ambiguous, an adverse income shock may raise, lower, or have no effect on interest rates, depending on the market power of the lender and the relative magnitudes of the shocks to k_n , Y_0 , and/or Y_1 .

Proposition 3: *After an adverse aggregate shock, loan demand will increase.*

Proof: Assuming the magnitude of the shock to investment returns is not so large as to render projects unprofitable, (i.e. $Y_0 - \Delta Y_0 > I_0$ and $Y_1 - \Delta Y_1 > I_1$), the adverse shock to household capital, Δk_n , and first-period revenue, ΔY_0 , will have the effect of shifting the distribution function $G(k)$ leftward, such that for more entrepreneurs will it now hold that $k_n < I_0$ and $Y_0 + k_n < I_1$. Thus, not only will households that already required external financing now have need of additional credit, but also households that previously were able to entirely self-finance investment projects will now require external financing.¹⁴ The net effect on average loan size is therefore ambiguous, since while existing borrowers will require larger loan amounts, the entrance of new borrowers previously able to finance investment projects from their own funds may lower the average loan size.

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

¹⁴ Berg and Schrader (2012) find an increase in MFI loan demand following volcanic eruptions in Ecuador.

Funds. Moreover, donations to funds in worse affected districts declined by an average of 23% more during the famine than donations to funds in less affected districts. The consequently higher reserve requirements to meet potential liquidity shortfalls would have effectively raised the cost of capital for affected funds. If we therefore allow the risk neutral risk-adjusted rate of interest charged to borrowers to include a liquidity discount, λ , we find that $\partial r^* / \partial \lambda < 0$ and $\partial \theta^* / \partial \lambda > 0$, meaning an increase in the cost of capital will raise the minimum credit quality, θ^* , and lower the optimal interest rate, r^* . The theoretical model outlined here therefore strongly predicts that an adverse aggregate shock will result in tighter credit standards, with higher quality, repeat borrowers able to borrow at lower rates of interest.

4 Data Construction

This paper utilizes original data from numerous archival sources. Since previous studies of the Irish Famine have lacked indicators of micro-variation in blight, and have thus relied on *ex post* excess mortality—which is itself an outcome variable—following Goodspeed (2015) I instead construct an index of blight severity at the baronial level using constabulary reports from the Distress 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 or high impact, corresponding to moderate or severe blight infection. In the case of quantitative reports, I define a low or moderate impact barony as a barony with less than one-half of its potato crop infected by blight.¹⁵ High or severe impact baronies experienced crop infection rates in excess of one half. For baronies with only qualitative reports, I use language ranging from “very good,” “trifling,” and “partially infected” to “considerably infected” or “very much infected” to designate low impact baronies; and “generally very bad,” “extensively infected,” and “very extensively infected” to designate high impact baronies.¹⁶ Reports issued at the larger administrative unit of Poor Law union (PLU) I assign to baronies according to the location of the reporting official. 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.

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

¹⁵ 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 surviving reports in the Relief Commission papers for these baronies. Numerous official Irish records were lost in June 1922, during the Irish Civil War, when the Public Record Office was destroyed by fire.

¹⁶ 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. In addition, in robustness checks, Goodspeed (2015) includes 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, and finds that it does not. Goodspeed (2015) also demonstrates that blight severity was uncorrelated with pre-famine baronial characteristics that may have been correlated with differential fund performance during and after the famine.

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.¹⁷ This is corroborated by Goodspeed (2015), who finds a strong correlation between blight severity in 1845-46 and potato yields during the severe blight-induced harvest failure of 1879.¹⁸

Data on lending activity by the Irish Loan Funds is from the annual reports of the Commissioners of the Loan Fund Board of Ireland. Pre-famine 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.

5 Empirical Framework

Following Hornbeck (2012) and Goodspeed (2015), 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 pre-famine management and financial metrics, in the same county and Poor Law Union and with similar pre-famine 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

¹⁷ 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.

¹⁸ It is also consistent with Cousens (1960, 1962, 1964).

was active in 1844 but not in year t . 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 a binary variable for high blight infection at the baronial level (B_b^{high}), pre-famine baronial characteristics (X_b), county (α_c), PLU (α_u), and barony (α_b) fixed effects, and an error term (ε_{it}):

$$S_{it} = \beta_t B_b^{high} + \theta_t X_b + \alpha_c + \alpha_u + \alpha_b + \varepsilon_{it} \quad (1)$$

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.¹⁹ This difference is then regressed on a binary variable for high blight infection at the baronial level (B_b^{high}), pre-famine baronial characteristics (X_b), county (α_c), PLU (α_u), and barony (α_b) fixed effects, and an error term (ε_{it}):

$$Y_{it} - Y_{ipre} = \beta_t B_b^{high} + \theta_t X_b + \alpha_c + \alpha_u + \alpha_b + \varepsilon_{it} \quad (2)$$

In order to evaluate the effects of particular fund management practices, in section 6.2 I estimate an expanded Eq. 1, adding a vector of average annual pre-famine Loan Fund financial metrics, L_i .²⁰ Further, each of these metrics is fully interacted with high blight:

$$S_{it} = \beta_{1t} B_b^{high} + \beta_{2t} L_i + \beta_{3t} L_i \cdot B_b^{high} + \theta_t X_b + \alpha_c + \alpha_u + \alpha_b + \varepsilon_{it} \quad (3)$$

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

¹⁹ For two time periods, first-difference and fixed effects estimators are numerically equivalent. As with the fixed-effect method, first-differencing eliminates time-invariant baronial characteristics and thereby yields consistent and unbiased estimators. Differencing is more efficient when the untransformed error term more closely follows a random walk. Clustering corrects for any possible serial correlation in the errors.

²⁰ 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 non-staff, non-capital 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.

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 a binary variable for high blight infection at the baronial level (B_b^{high}), a vector of the relevant average annual pre-famine Loan Fund financial metrics (L_i), pre-famine baronial characteristics (X_b), county (α_c), PLU (α_u), and barony (α_b) fixed effects, and an error term (ε_i). Each of the included fund metrics is also interacted with high blight at the baronial level, to allow fund financials to have had different effects where blight infection was more severe:

$$Y_{ifam} - Y_{ipre} = \beta_1 B_b^{high} + \beta_2 L_i + \beta_3 L_i \cdot B_b^{high} + \theta X_b + \alpha_c + \alpha_u + \alpha_b + \varepsilon_i \quad (4)$$

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 Eqs. (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 1841.²¹ 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 pre-famine levels of potato dependence to experience systematically different changes after 1845. Additionally, blight severity is interacted with the 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.²²

²¹ In the 1841 *Census of Ireland*, fourth-class houses are defined as “all mud cabins having only one room.”

²² 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.

Along these observable dimensions, in Eqs. (1) and (2), funds differentially afflicted by blight are allowed to experience systematically different changes after 1845. The identification assumption is that, controlling for county, PLU, and barony fixed effects, funds in baronies with different blight infection rates but similar pre-famine characteristics would have had the same survival probabilities after 1845 if not for blight. In Eqs. (3) and (4), funds with different pre-famine 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 county, PLU, and barony fixed effects, funds in baronies with similar pre-famine 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 pre-famine management and financials.

The coefficient β_{3t} in Eq. (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, etc., compared to the difference in survival probabilities between funds in high-infection and low-infection baronies when there was less leverage, lower salaries, etc., controlling for all other pre-famine baronial and fund characteristics and county, PLU, and barony fixed effects. This allows for pre-famine 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_3 in Eq. (3) 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, etc. versus if they had been less levered, been paying lower salaries, etc. This allows for pre-famine 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 pre-famine 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 6.3 I also regress these fund variables on available pre-famine baronial-level social and economic indicators to test for systematic differences in pre-famine financials.

Several additional estimation details are worth noting. First, Eqs. (1) and (3) are estimated using a linear probability model (LPM). To correct for 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, the sample is balanced in each regression, meaning every included barony has data in every analyzed time period. Fourth, outcome years analyzed are selected so as to estimate average effects during and immediately after the famine. Fifth, 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 (2011), Berg and Schrader (2012), and Goodspeed (2015) have demonstrated that demand for microfinance credit generally increases in the event of an adverse environmental shock, with Goodspeed (2015) 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.

6 Results

6.1 Estimated effects of blight severity

Results of estimating Eqs. (1) and (2) are reported in Table 2. 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 14.2-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 16.2 percentage

points lower for funds located in baronies suffering severe blight infection in 1845-46, compared to funds located in less infected baronies. Compared to funds in less-infected baronies, funds located in severely infected baronies had a non-statistically significant 7.3-percentage point lower probability of surviving to 1856, five years after the end of the famine.

Estimated coefficients reported in columns (2) - (8) of Table 2 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 £4,560 (15.8%) more than funds in less infected baronies, and extended 1,060 fewer loans. On the liabilities side, by 1848, funds in severely infected baronies had lost £954 (11.6%) more of their capital, relative to funds in less infected baronies, and 5 more depositors. By the end of the famine, in 1852, relative to funds in less infected baronies, funds in severely infected baronies had reduced lending by £4,923 and the number of loans by 1,115, and had lost £1,266 more of their capital and 7 more depositors.

Estimated coefficients reported in column (6) indicate that, for funds in worse 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 less affected baronies.²³ By 1848, average annualized interest charged by funds in worse infected baronies was 660 basis points lower than average interest on loans extended by funds in less infected baronies, with the relative differential dissipating after 1852. Estimated coefficients reported in column (7) of Table 2 also show a relative decline in the ratio of delinquency fines to total lending by funds in worse affected baronies. By 1848, the ratio of fines to total lending was 540 basis points lower for funds in severely infected baronies than for funds in less infected baronies. Results presented in column (8) reveal that the volume of bad debts also decreased relatively for funds in worse affected baronies during the famine; by 1848, funds in worse affected baronies had decreased the amount of bad debts on their books by £23, relative to funds in less affected baronies.

²³ Unfortunately, annual reports do not report average interest rates, but instead total interest income, which includes application and surety screening fees. To compute average rates, I therefore divide total interest income by total lending.

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.

6.2 Estimated effects of fund management

Results from estimating Eq. (3) are presented in Table 3. Each (a) column of Table 3 reports estimated β_{2t} 's, the main effect of the indicated pre-famine Loan Fund management or financial metric on the predicted probability of fund survival, while each (b) column reports estimated β_{3t} 's, the interaction effect of pre-famine Loan Fund metrics where blight infection was 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 pre-famine 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 (1a,b) through (3a,b) indicate that while higher pre-famine leverage ratios were generally associated with 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 columns (3a) and (3b) reveal that by 1848, the main effect of a 100% increase in the average pre-famine leverage ratio (for example, from 4:1 to 5:1) was a non-statistically significant 10.4-percentage point higher predicted probability of institutional survival, whereas in baronies suffering more

severely from blight, a 100% increase in average pre-famine leverage was associated with a 20.4-percentage point lower predicted probability of survival.

Estimated coefficients reported in columns (1a,b) through (3a,b) 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 1.1 percentage points through 1847. However, estimated coefficients reported in columns (2b) and (3b) 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 0.5-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.

Pre-famine 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.²⁴ Average pre-famine expense ratios were generally a strong short-run predictor of institutional survivability—funds with a 1-percentage point higher expense ratio had a 12.679-percentage point lower probability of surviving through 1846 than funds with a lower expense ratio—but differences in pre-famine expense ratios appear to have had no net differential effect on the predicted probability of fund survival where blight infection was severe.²⁵ Higher expense ratios may even 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 14.092-percentage point higher probability of surviving through 1847 than funds

²⁴ 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.

²⁵ Expense ratio refers to the ratio of non-staff operating costs, excluding cost of capital, to total lending.

in severely infected baronies with a lower expense ratio—though the estimated effect appears to have dissipated by 1848.

Estimated coefficients reported in columns (4a,b) and (5a,b) show the effects of pre-famine 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 pre-famine leverage was generally associated with a 25.6-percentage point higher predicted probability of survival—for funds in severely infected baronies the net effect of a 100% increase in leverage was a 5.9-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 pre-famine 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 pre-famine staff salary was a 1.4-percentage point lower predicted probability of survival through 1852, funds in severely infected baronies paying £1 more in average employee salaries had a net 1.3-percentage point higher probability of survival through 1852 than funds in severely infected baronies paying £1 less.

Estimated coefficients reported in column (4a) also indicate that ministers were generally less competent fund managers. Funds with a minister as manager before the famine had a 23.4-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 more 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 non-clergy managers. Estimated coefficients reported in columns (5a,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 more severe the net effect of a £1 increase in average pre-famine loan size was a 14.963 higher predicted probability of institutional survival through 1856.

Results presented in columns (4a,b) and (5a,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 and 1856, 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 and a net 0.70-percentage point lower probability of surviving through 1856.

Estimated coefficients for the interaction effects of different pre-famine fund metrics and more severe blight infection on Loan Fund activity during the famine— β_3 's in Eq. (4)—are presented in Table 4. Estimated coefficients reported in column (1) indicate that funds in worse affected baronies with higher pre-famine 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 worse affected 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 26.894 loans per year. Estimated coefficients reported in column (2) reveal that while funds in worse affected baronies with higher pre-famine leverage ratios, average salaries, and expense ratios did not experience differential changes in average loan size during the famine, funds in worse affected baronies with higher pre-famine gross margins and more depositors did. Specifically, funds in severely infected baronies with an average pre-famine gross margin per loan higher by 100 basis points relatively reduced the average size of a loan during the famine years by £0.88 (17 s. 7d.), while funds in severely infected baronies with an additional depositor before the famine relatively increased average loan size during the famine by £0.03 (7d.).

Results presented in column (3) of Table 4 reveal that funds in severely infected baronies with an average pre-famine 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 214.6 basis points. Funds in worse affected baronies that were more levered before the famine likewise relatively reduced average interest rates—a 100% increase in average pre-famine leverage was associated with a 180-basis point relative decline in the discount rate for funds in severely infected baronies. Estimated coefficients reported in column (4) indicate that funds in worse affected baronies with higher pre-famine gross margins per loan and average salaries also relatively reduced the ratio of fines to total lending during the famine. For funds in severely infected baronies, a 100-basis point increase in average pre-famine gross profit margin was associated with a 286.1-basis point relative reduction in the average fines rate during the famine, while a £1 increase in average pre-famine employee salary was associated with a 10-basis point relative reduction in the average fines rate during the famine. Funds in worse affected baronies with more depositors, however, experienced relative increases in the ratio of fines to total lending during the famine; an additional depositor before the famine 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 4 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 pre-famine gross profit margin per loan higher by 100 basis points relatively reduced their average annual volume of bad debts by £1,091.36. In contrast, funds in worse affected 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 4 suggest that different pre-famine 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 20-basis point relative increase in average expense ratio during the famine. In contrast, funds with higher non-wage 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 2.734-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 pre-famine leverage was associated with a 20-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 82.6-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 152.8-basis point relative increase in average margin per loan during the famine.

However, results reported in column (8) of Table 4 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 pre-famine leverage ratio was associated with a 40-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 pre-famine 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 127.9 basis points, respectively, during the famine.

Overall, the results presented in Tables 3 and 4 suggest that differences in pre-famine 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 pre-famine 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 per-unit basis, they did relatively reduce the average size of their loans. Moreover, during the famine, funds that had been more profitable on a per-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 per-unit basis during the famine.

6.3 Robustness Checks

Because it is a strong identifying assumption that average pre-famine 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 5. 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 pre-famine profit margins, male literacy was associated with lower margins. An additional Loan Fund in the same barony lowered average pre-famine 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 pre-famine 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 pre-famine 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 pre-famine social and 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 pre-famine leverage ratios were actually lower where the share of housing rated fourth was higher, but higher where overall population was greater. Other indicators appear to have been unassociated with differences in pre-famine leverage ratios.

In sum, results presented in Table 5 do not reveal any systematic variation in average pre-famine 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

pre-famine 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 pre-famine 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.

7 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 pre-famine 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 pre-famine margins were strong positive predictors of institutional survival where blight infection was worse.

Differences in pre-famine 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 pre-famine 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 pre-famine 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 (2014), who finds that while access to Loan Fund credit had significant effects on relative accumulations of buffer livestock during the Great Famine by mid-sized 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 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 pre-famine 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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A1: 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*.

A2: Mathematical Appendix

Taking derivatives of θ^* with respect to k_n , Y_0 , and Y_1 yields:

$$\frac{\partial \theta^*}{\partial Y_0} = \frac{R(I_0 + k_n - Y_1) - (1+r)(I_0 - k_n)}{[(1+r)(I_0 - k_n) + R(I_1 - k_n - Y_0)]^2}$$

$$\frac{\partial \theta^*}{\partial Y_1} = \frac{-1}{(1+r)(I_0 - k_n) + R(I_1 - k_n - Y_0)}$$

$$\frac{\partial \theta^*}{\partial k_n} = \frac{(1+r+R)(I_0 + I_1 - Y_0 - Y_1)}{[(1+r)(I_0 - k_n) + R(I_1 - k_n - Y_0)]^2}$$

Assuming some portion of first-and second- period investment must be financed by borrowing (i.e. $I_0 > k_n$ and $I_1 > k_n + Y_0$) and that investment returns are non-negative (i.e. $Y_0 > I_0$, $Y_1 > I_1$), these are all strictly negative.

Taking derivatives of r^* with respect to k_n , Y_0 , and Y_1 yields:

$$\frac{\partial r^*}{\partial Y_0} = \frac{1 + R - \theta R}{(1 - \theta)(I_0 - k_n)}$$

$$\frac{\partial r^*}{\partial Y_1} = \frac{1}{(1 - \theta)(I_0 - k_n)}$$

$$\frac{\partial r^*}{\partial k_n} = \frac{(1 - \theta)R(I_0 + Y_0 - I_1) + Y_0 + Y_1 - I_0 - I_1}{(1 - \theta)(I_0 - k_n)^2}$$

Again with the assumption that some portion of first-period investment must be financed by borrowing ($I_0 > k_n$), $\partial r^* / \partial Y_0$ and $\partial r^* / \partial Y_1$ are strictly positive. Since $(1 - \theta)(I_0 - k_n)^2$ is always positive, the sign of $\partial r^* / \partial k_n$ is determined by the numerator. If $R > \frac{I_0 + I_1 - Y_0 - Y_1}{(1 - \theta)(I_0 + Y_0 - I_1)}$, the numerator of $\partial r^* / \partial k_n$ is positive, meaning r^* is increasing in k_n . But if $R < \frac{I_0 + I_1 - Y_0 - Y_1}{(1 - \theta)(I_0 + Y_0 - I_1)}$, then r^* is decreasing in k_n (i.e. $\partial r^* / \partial k_n < 0$).

If we then allow for the lender's cost of funds to vary, on account of higher liquidity requirements, the risk neutral risk-adjusted rate on loans must therefore exceed its liquidity discount, λ . The lending constraint thus becomes

$$\theta(r - \lambda)(I_0 - k_n) + \theta(R - \lambda)(I_1 - k_n - Y_0) - (1 - \theta)(I_0 - k_n) \geq 0$$

Solving for r^* and θ^* and taking derivatives with respect to λ , we find that

$$\frac{\partial r^*}{\partial \lambda} = \frac{\theta[(I_0 - k_n) + (I_1 - k_n - Y_0)]}{-(1 - \theta)(I_0 - k_n)}$$

$$\frac{\partial \theta^*}{\partial \lambda} = \frac{[(I_0 - k_n) + (I_1 - k_n - Y_0)][(1 + r)(I_0 - k_n) + R(I_1 - k_n - Y_0) + I_0 + I_1 - Y_0 - Y_1]}{[(1 + r - \lambda)(I_0 - k_n) + (R - \lambda)(I_1 - k_n - Y_0)]^2}$$

Again assuming some portion of first-and second- period investment must be financed by borrowing (i.e. $I_0 > k_n$ and $I_1 > k_n + Y_0$), $\partial r^* / \partial \lambda$ is strictly negative. Since the denominator of $\partial \theta^* / \partial \lambda$ is always positive, the sign is determined by the numerator. Since $I_0 > k_n$ and $I_1 > k_n + Y_0$, the numerator will be positive if

$$Y_0 + Y_1 - (I_0 - k_n) > I_0 + I_1 + r(I_0 - k_n) + R(I_1 - k_n - Y_0)$$

Provided the shock to Y_0 and Y_1 not so large and negative as to render projects unprofitable, this inequality will hold, as otherwise households would not borrow.

Table 1: Summary Statistics

	Mean	Std. Dev.	Min	Max
	(1)	(2)	(3)	(4)
<i>Panel A: 1841-1844</i>				
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
<i>Panel B: 1846-1852</i>				
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.

Table 2: Estimated Loan Fund Survival Probability and Changes in Financial Metrics by Blight Severity

	Survival	Lending	Loans	Capital	Depositors	Interest	Fines Ratio	Bad Debts
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1846	0.033 (0.04)	-1950.421 (1353.44)	-226.961 (321.08)	-134.43 (350.10)	-1.842 (2.29)	-0.093 (0.09)	-0.035 (0.06)	-16.528* (8.45)
1847	0.029 (0.07)	-4560.419** (1963.00)	-1059.784** (502.50)	-658.059 (399.69)	-4.046* (2.27)	-0.005 (0.02)	-0.023 (0.03)	-18.249* (9.75)
1848	-0.142* (0.09)	-4261.169** (2086.75)	-1093.227** (532.89)	-953.940* (518.61)	-5.047** (2.53)	-0.066* (0.04)	-0.054** (0.02)	-23.026** (9.06)
1852	-0.162** (0.08)	-4923.199* (2724.28)	-1115.067* (667.99)	-1265.608* (664.42)	-7.423** (3.03)	-0.016 (0.03)	-0.061*** (0.02)	-20.638* (11.76)
1856	-0.073 (0.08)	-2333.454 (2851.32)	-774.917 (710.46)	-637.284 (739.10)	-6.192** (3.00)	0.003 (0.03)	-0.045 (0.02)	-21.042* (11.10)
N	191	191	191	191	191	191	191	191
R2	0.188	0.133	0.175	0.190	0.183	0.493	0.135	0.180

Notes: Column (1) reports LPM estimates of Loan Fund survival by blight severity (see 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 barony-, PLU-, and county fixed effects. Robust standard errors are reported in parentheses and clustered at the fund level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 3: Estimated Loan Fund Survival Probability by Blight Interacted with pre-Famine Metrics

	1846		1847		1848		1852		1856	
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)	(5a)	(5b)
Leverage Ratio	0.094** (0.05)	-0.008 (0.06)	0.069 (0.05)	-0.100 (0.09)	0.104 (0.08)	-0.204* (0.11)	0.256*** (0.09)	-0.315*** (0.12)	0.220*** (0.08)	-0.269** (0.11)
Ave Salary	-0.009 (0.01)	0.008 (0.01)	-0.011* (0.01)	0.016* (0.01)	-0.011 (0.01)	0.016 (0.01)	-0.014* (0.01)	0.027** (0.01)	-0.015* (0.01)	0.028** (0.01)
Profit Margin per Loan	-0.596 (0.76)	0.269 (1.11)	0.376 (1.47)	2.349 (1.74)	1.983 (1.73)	1.074 (2.17)	-0.866 (1.55)	4.575** (2.08)	-1.066 (1.55)	4.753** (2.08)
Expense Ratio	-12.679** (5.30)	12.024** (6.08)	-9.135 (5.95)	14.092* (8.00)	0.537 (7.49)	1.221 (10.63)	-5.581 (7.00)	11.384 (9.96)	-3.463 (7.28)	9.109 (10.00)
Manager a Minister	-0.102 (0.08)	0.145 (0.10)	-0.084 (0.09)	0.006 (0.14)	0.013 (0.10)	-0.115 (0.16)	-0.234** (0.11)	0.145 (0.14)	-0.153 (0.11)	0.008 (0.14)
Ave Loan Size	-0.071* (0.04)	0.043 (0.05)	-0.016 (0.06)	-0.041 (0.08)	0.021 (0.07)	-0.061 (0.09)	-0.081 (0.09)	0.151 (0.11)	-0.152** (0.08)	0.237** (0.10)
Fines Ratio	-0.986 (2.41)	1.027 (2.38)	-1.065 (2.94)	-0.054 (3.11)	-5.677* (3.32)	4.093 (3.54)	1.068 (3.43)	-2.376 (3.72)	-0.098 (3.27)	-1.379 (3.59)
Bad Debts	0.002 (0.01)	-0.003 (0.01)	0.003 (0.01)	-0.002 (0.01)	-0.001 (0.01)	0.004 (0.01)	-0.007 (0.01)	0.008 (0.01)	-0.008 (0.01)	0.008 (0.01)
Number of Loans	0.078 (0.08)	-0.036 (0.10)	0.058 (0.10)	-0.096 (0.14)	0.022 (0.12)	-0.049 (0.17)	0.015 (0.13)	-0.081 (0.17)	0.03 (0.13)	-0.101 (0.17)
Cost of Capital	-0.516 (2.81)	-4.214 (3.92)	0.111 (5.59)	-0.732 (6.92)	1.911 (5.84)	-1.267 (7.76)	0.827 (5.67)	-3.351 (7.59)	4.253 (5.25)	-7.338 (7.26)
Depositors	0.006 (0.00)	-0.003 (0.00)	0.005 (0.00)	-0.004 (0.01)	0.006 (0.01)	-0.008 (0.01)	0.013** (0.01)	-0.018*** (0.01)	0.013*** (0.01)	-0.020*** (0.01)
N	191		191		191		191		191	
R2	0.279		0.262		0.205		0.227		0.247	

Notes: Column (1a) through (5b) reports LPM estimates of Loan Fund survival by pre-famine Loan Fund metrics, averaged over 1841-44. Each (a) column reports estimated main effects (β_{2t} 's of Eq. (3)), while each (b) column reports estimated interaction effects (β_{3t} '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. Also included are barony, PLU, and county fixed effects. Robust standard errors are reported in parentheses and clustered at the fund level. *** p < 0.01, ** p < 0.05, * p < 0.1

Table 4: Estimated Changes in Loan Fund Activity by Blight Interacted with pre-Famine Metrics

	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	-25947.921 (18265.56)	-88.435** (41.46)	-2.146** (0.97)	-2.861*** (0.67)	-1091.358** (550.60)	0.459 (0.35)	-0.826*** (0.22)	0.396 (0.24)
Leverage Ratio	-134.202 (97.54)	0.04 (0.17)	-0.018* (0.01)	-0.001 (0.00)	-1.537 (1.92)	0.002** (0.00)	-0.002** (0.00)	-0.004*** (0.00)
Ave Salary	-26.894** (11.00)	-0.005 (0.01)	0.000 (0.00)	-0.001* (0.00)	-0.207 (0.37)	0.000 (0.00)	0.000 (0.00)	0.001** (0.00)
Expense Ratio	-14665.604 (28758.03)	-115.766 (70.54)	-2.433 (2.12)	-1.900 (3.15)	-1154.954 (754.09)	-2.734*** (-0.284)	1.528*** (0.49)	1.279*** (0.47)
Depositors	-5.463 (7.41)	0.033*** (0.01)	0.001 (0.00)	0.000** (0.00)	0.663* (0.34)	0.000 (0.00)	0.000 (0.00)	0.000 (0.00)
N	191	191	191	191	191	191	191	191
R2	0.309	0.228	0.37	0.293	0.332	0.213	0.477	0.351

Notes: Columns (1) - (7) report estimated coefficients (β_3 '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 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 blight severity. 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. Also included are barony, PLU, and county fixed effects. Robust standard errors are reported in parentheses and clustered at the fund level. *** p < 0.01, ** p < 0.05, * p < 0.1

Table 5: Robustness Checks

	Profit Margin	Ave Salary	Depositors	Expense Ratio	Leverage
	(1)	(2)	(3)	(4)	(5)
% Fourth-class Housing	0.004 (0.01)	-6.200 (11.45)	9.168 (14.20)	0.001 (0.00)	-1.664* (0.95)
Potato Crop Share	-0.005 (0.00)	-5.687 (3.94)	-9.548 (6.12)	0.001 (0.00)	-0.277 (0.35)
Male Literacy Rate	-0.018* (0.01)	-8.678 (33.69)	-30.968 (43.72)	0.002 (0.00)	-1.354 (2.12)
Female Literacy Rate	0.012* (0.01)	12.055 (24.07)	44.119 (31.87)	-0.001 (0.00)	-0.811 (1.60)
% Families in Agriculture	0.000 (0.00)	0.001 (0.00)	0.000 (0.00)	0.000 (0.00)	0.000 (0.00)
% Families in Manufacturing	0.000 (0.00)	0.005 (0.00)	0.014*** (0.00)	0.000 (0.00)	0.000 (0.00)
% Males in Cloth Industry	0.000 (0.00)	0.000 (0.00)	-0.004 (0.00)	0.000 (0.00)	0.000 (0.00)
% Females in Cloth Industry	0.000 (0.00)	-0.002** (0.00)	-0.003* (0.00)	0.000 (0.00)	0.000 (0.00)
Baronial Valuation	0.000 (0.00)	-0.000** (0.00)	0.000 (0.00)	0.000 (0.00)	0.000 (0.00)
Valuation per Capita	0.000 (0.00)	0.005 (0.21)	-0.338 (0.24)	0.000 (0.00)	0.003 (0.01)
Population Density	0.000* (0.00)	0.23 (0.46)	0.167 (0.76)	0.000 (0.00)	0.006 (0.06)
Total Population	0.000 (0.00)	0.000 (0.00)	0.000 (0.00)	0.000 (0.00)	0.000** (0.00)
Number of Funds in Barony	-0.001* (0.00)	-0.956 (0.61)	0.581 (1.08)	0.000 (0.00)	-0.056 (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 barony, PLU, and fixed effects. Robust standard errors are reported in parentheses and clustered at the fund level. *** p < 0.01, ** p < 0.05, * p < 0.10