Market Contagion: Evidence from the Panics of 1854 and 1857

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To test a model of contagion—where individuals hear some bad news and communicate it to their acquaintances, who then pass it on, leading to a market panic—requires a knowledge of the information networks of participants, something hitherto unavailable. For two panics in the 1850's this paper examines the behavior of Irish depositors in a New York bank. As recent immigrants, their social network was determined largely by their place of origin in Ireland, and where they lived in New York. During both panics this social network turns out to be the prime determinant of behavior. (*JEL* G21, N21)

The idea of market panics spreading through social contagion—where individuals hear some bad news and communicate it to their acquaintances, who pass it on in turn, leading to a market panic—goes back at least to David Ricardo (1951 p. 68), who attributed the panic leading to the suspension of convertibility in 1797 to "the contagion of the unfounded fears of the timid part of the community." While suggestive evidence for the importance of networks of personal contact in financial markets is provided by the survey data of Robert J. Shiller (1989 Chs. 1–2), Shiller and John Pound (1989), and Ellen Hertz's (1998) fascinating ethnographic study of investor groups in the Shanghai stock boom of 1992, a formal test of market contagion requires not only information on the transactions of individual participants, but also a knowledge of their information networks, something hitherto unavailable for financial markets.[1]

To test the role of social contagion in market panics, this paper looks at the behavior of depositors in a New York bank, the Emigrant Industrial Savings Bank, during two bank runs in the 1850's. We can reconstruct the social networks of these depositors with some confidence because of one fact about them: most were recent immigrants from Ireland.

The classic pattern of migration is that newly arrived immigrants move in near people they knew in their home country.[2] As a recent immigrant, one's social network in the new world is determined in large part by where one came from in the old. We confirm that social networks reflect place of origin by using marriage records from a church located close to the bank. Of Irish couples married there in the 1850's, a majority had come from the same county, and very often the same parish, in Ireland; and frequently inhabited the same tenement in New York. Consequently, if a depositor had emigrated from County Cork in Ireland, we can be quite confident that he knew other depositors from Cork.

After taking account of the individual characteristics of depositors and their account histories, we test how well social-network variables—county of origin and district of residence—distinguish depositors who closed their accounts during each panic from those who stayed with the bank. We use a classification-tree procedure that recursively partitions the set of depositors into increasingly homogeneous groups of panickers and stayers.

The results obtained are striking. While factors such as length of time the account had been open,

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[1] In sociology, the classic study of Bryce Ryan and Neal C. Gross (1943) showed the central role played by influence of neighbors in the diffusion of hybrid seed corn. Josef Lakonishok et al. (1992) and Mark Grinblatt et al. (1995) examine whether institutional investors herd together in buying or selling the same stock, but find limited evidence for this.

[2] Robert Ernst (1994 pp. 40–41); George J. Borjas (1995); Thomas Sowell (1996 pp. 4–9).

years lived in the United States, and size of account have some role in predicting behavior, the most important characteristic that distinguishes panickers from stayers is county of origin in Ireland. Depositors from one set of counties tended to close their accounts in both panics, while otherwise identical individuals from other counties tended to stay with the bank. County of origin also determines, in the more important run, the timing of panicking: different groups of depositors closed their accounts at different times. The importance of county of origin in determining behavior does not diminish the longer the depositor had lived in America, reflecting the well-known failure of these, mostly very poor, immigrants to assimilate into wider New York society.

Bank panics are the product of observable events that are perceived by depositors to contain adverse information about a bank's solvency. They can be the result of a sequence of stochastic withdrawals (Douglas Diamond and Philip Dybvig, 1983), or of asymmetric information between the bank and its depositors about the quality of the bank's assets (V. V. Chari and Ravi Jagannathan, 1988).[3] What matters is that a few depositors decide for some reason that the bank is in trouble and start to pass the news on to their acquaintances.

The rest of the paper is as follows. Section I gives the historical background to the paper, discussing the bank, Irish immigrants in New York, and the panics of 1854 and 1857. Our data are summarized in Section II, and Section III tests the importance of social networks relative to individual characteristics in distinguishing depositors who panicked from those who stayed put. Section IV concludes.

I. Historical Background

A. *Bank*

The Emigrant Industrial Savings Bank (EISB) was one of a score of mutual savings banks set up in New York State before the Civil War. These banks, established to offer high interest and liquidity to the industrious poor, proved extremely popular: in New York City by 1860 there was one savings bank account for every four people (Alan L. Olmstead, 1976 p. 4). For good economic histories of the early savings banks, see Peter L. Payne and Lance E. Davis (1956) on Baltimore, and Olmstead (1976) on New York City.

The EISB was set up on Chambers Street in the Sixth Ward by a group of prominent Irish citizens, acting at the behest of the ubiquitous Bishop John Hughes of New York, in September 1850. Its first depositors were overwhelmingly Irish immigrants and, although it attracted increasing numbers of German immigrants and Irish-Americans, this group still held almost 90 percent of accounts in the late 1850's. By 1860 it had over 10,000 accounts and held over $2 million on deposit, making it a medium-sized savings bank by contemporary standards (Olmstead, 1976 p. 159).

What makes this bank notable is the large amount of background information on individual depositors that it collected, which makes its archive a primary source of information about Irish immigrants to America in the immediate post-Famine period.[4] For example, the bank's first depositor, Bridget White, was the wife of a tailor living on Henry Street in the Seventh Ward. Born near Mountmellick in Queens County, Ireland, she had arrived in New York nine years earlier on the *Fairfield* out of Liverpool. Her father still lived in Ireland, but her mother was dead. She had four brothers (whose names are given), three of them living in the United States, and three sisters.

The patterns of account holding in the bank are discussed in Ó Gráda and Eugene White (1999) and summarized below in Table 3. While some account holders behaved in true Smilesian fashion, making small deposits and allowing them to accumulate, and others made frequent deposits and withdrawals, treating their accounts almost as checking accounts; in most cases, as George Alter et al. (1994) found for the Philadelphia Saving

[3] A useful survey of the causes of panics is given by Charles W. Calomiris and Gary Gorton (1991). Our concern here is with contagion among depositors, rather than the contagion among lenders considered by Guillermo Calvo and Enrique Mendoza (1995), Jeffrey Sachs et al. (1995), and others. The role of bank solvency in propagating panics is examined by Calomiris and Joseph R. Mason (1997).

[4] Our data are taken from Reels 4–5 and 15–20 of the microfilms of the EISB archives in the New York Public Library.

Fund Society in 1850, accounts were relatively large in size, brief in duration, and inactive.

B. *People*

The EISB was located in the greatest concentration of Irish immigrants in North America. New York was the main port of entry into the United States for Irish immigrants and, by the mid-1850's, contained almost as many Irish-born people as Dublin. Like immigrants everywhere, the Irish tended to cluster in neighborhoods of their own. In New York in 1855, Irish immigrants accounted for 28.2 percent of the city's population but made up over two-fifths of the populations of the First, Fourth, and Sixth Wards. Immigrants from different parts of Ireland tended to cluster in distinct enclaves; Monroe Street was known as "Cork Row," in the Fourth Ward the area next to the East River was "a favorable spot for Kerry men and their descendants," and so on (John T. Ridge, 1996 pp. 276–77). The EISB was located in the Sixth Ward next to streets teeming with impoverished immigrants from Counties Kerry and Sligo.

Marriage patterns reflect social networks, and the importance of regional and local networks for Irish immigrants is demonstrated by the marriage records of a Roman Catholic Church located a few hundred yards from the EISB, the Church of the Transfiguration of Our Lord.[5] As Table 1 shows, in the period 1853 to 1860, most Irish couples who married there had come from the same or neighboring county in Ireland. Among men originating from the well-represented counties of Kerry and Sligo, more than two-thirds married women from the same county and, in most cases, from the same corner of the same county. Ten of the 15 grooms from Tuosist parish in Kerry married women from the same parish, and three more women from neighboring parishes. Eleven of the 29 grooms from the parish of Rahamlish in Sligo married women from Rahamlish, and another four married women from a neighboring parish.

Certain Sixth Ward addresses recur in the marriage records. For instance, thirteen men, mostly with different surnames and mostly from County Cork, married out of 22 Mulberry Street in the 1850's. The residence at 31 Baxter Street supplied eight grooms, all from Kerry or neighboring west Cork, and five of them married women giving the same address. Given that in about one marriage in four both bride and groom gave an address in the same tenement demonstrates how narrowly circumscribed by place of origin in Ireland and residence in New York were the social networks of Irish immigrants.

TABLE 1—MARRIAGE PATTERNS OF IRISH IMMIGRANTS, 1853–1860

Birthplace of spouses of Irish-born persons married in Church of the Transfiguration of Our Lord	Percentage	
	Women	Men
Same county	49.4	51.1
Neighboring county	18.0	18.6
Same province	3.9	4.0
Elsewhere in Ireland	21.9	22.6
Outside Ireland	6.8	3.6

Notes: Based on all marriages of occupants of the area bounded by Canal, Baxter, Pearl, and Chatham/Bowery for the period October 1853–November 1860. Sample includes 722 women and 698 men. Thanks to Heather Griggs who supplied the database.

C. *The Panics of 1854 and 1857*

Our purpose is to examine how these immigrants behaved during two bank panics: a small run in 1854, and the major Panic of 1857. The 1854 run began on December 12 with the news that, for the second week running, the Knickerbocker Bank (parent of the Knickerbocker Savings Bank, the only New York savings bank to fail in the antebellum era) had not produced a weekly statement for the New York bankers' clearinghouse (Olmstead, 1976 pp. 142–43). On December 13 several savings banks were forced to pay out freely, and on the following day the Bank of Savings on Chambers Street sent $200,000 of its government paper to Washington for redemption. The news reduced the demand for deposits but, although the city's press was unanimous in denouncing the gullibility of those involved in the run and repeatedly urged that the city's other savings banks were sound, banks continued to experience high rates of account closure until December 30.

[5] These records are discussed in more detail in Ó Gráda (1999 pp. 114–21).

During this period, well over 200 savers in the EISB closed their accounts.

The Panic of 1857 started in New York with news of the failure of the Ohio Life and Trust Company (August 24) and of the loss of a steamer en route to New York with $2 million of uninsured gold bullion (September 17). The crisis quickly spread from the United States to the United Kingdom, where it provoked the suspension of the Banking Act of 1844, and thence to the Continent (Charles Kindleberger, 1978 p. 186). The Panic of 1857 led to a brief but sharp rise in unemployment in New York (Edwin G. Burrows and Michael Wallace, 1999 pp. 845–46) and had a devastating short-term impact on banking systems and stock exchanges: for a recent interpretation of the panic see Calomiris and Larry Schweikart (1991).

New York's savings institutions were far more seriously affected in 1857 than they had been in 1854. Although the press and the financial establishment were dismissive of the fears of the crowds who gathered around banks, the declines in railway stock and state and municipal bonds were such as to threaten the solvency of at least some of the banks (Ó Gráda and White, 1999). For several days thousands of account holders lined up to withdraw most or all of their savings. On October 13 the savings banks invoked a rarely imposed clause in their articles of agreement limiting withdrawals on demand to 10 percent of the outstanding balance, and brought the panic to a close. Between September 28 and October 13, 1857 over 500 EISB savers closed their accounts, nearly two-fifths of them on October 12 and 13 alone.

II. Data and Estimation

We consider the behavior of depositors during the panics of 1854 and 1857. Based on our earlier discussion, we date the 1854 panic as the period December 11 to December 30, and the 1857 panic as the period September 28 to October 13. These two events show clearly as spikes in the monthly series of changes in the number of EISB accounts (closures minus openings) in Figure 1. A depositor is defined as a panicker if he closed his account during these periods. A possible limitation of this definition is that it excludes depositors who removed most of their money while keeping their account

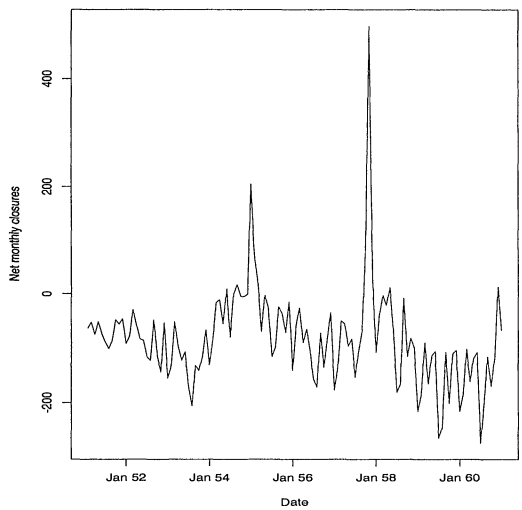

FIGURE 1. CHANGE IN NUMBER OF ACCOUNTS (NET CLOSURES) BY MONTH, 1851–1860

open. However, given the frequency with which depositors closed accounts, and the low time cost of reopening an account, this is probably not important. The relatively short duration of both panics reduces the force of a second limitation, that our "panickers" include some depositors who would have closed their accounts in any case.

For each period, our sample consists of all panickers and a one in ten sample of other depositors who decided not to close their accounts. This led to an initial sample of 598 accounts for 1854, of which 235 were closed during the panic; and 1,035 accounts, including 505 panickers, for 1857. Note that only a small proportion of depositors (6 percent in 1854 and 8.7 percent in 1857) closed their accounts on each occasion.[6]

For each depositor we recorded the date the account was opened, the number of deposits and withdrawals made prior to the panic, and the closing balance of the account (or its balance at the end of the panic, if the account stayed open). As well as this account information, we collected information about the personal details of

[6] The sample size was dictated by the need to calculate individual-account details from handwritten bank ledgers. Varying the proportion of nonpanickers sampled changes the reported sample probabilities of panicking but does not affect the relative significance of explanatory variables.

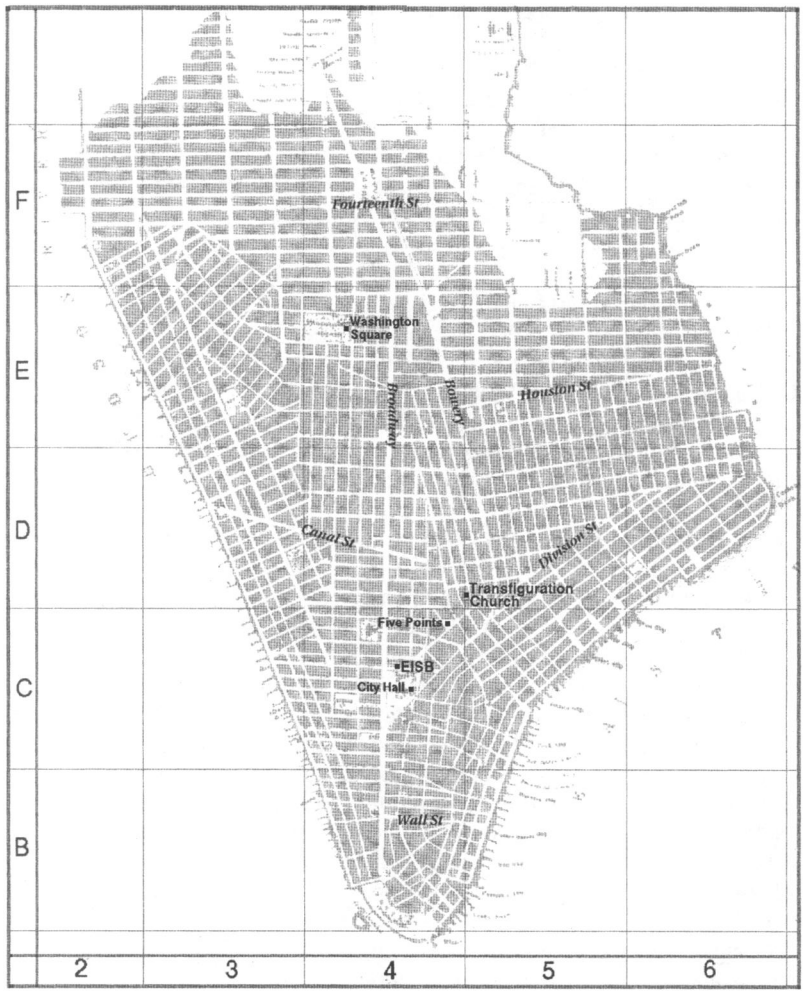

FIGURE 2. MAP OF 1850'S NEW YORK, SHOWING PHELPS'S GRID ASSIGNMENTS

Source: Based on *City of New York,* published by Thomas Cowerthwait & Co. (Philadelphia, 1850).

depositors: their sex, occupation, how long they had been living in the United States, and, most importantly, their social networks.

As the marriage data discussed above demonstrated, the social networks of Irish immigrants reflected two interrelated facts about their lives: where they had come from in Ireland, and where they lived in New York. We have data on both factors: we know the province and county of origin of most Irish depositors, and the street addresses of all depositors.

To convert street addresses into district codes we use the street grid of Humphrey Phelps's "New York City Street and Avenue Guide" in Phelps (1857) (see Figure 2). This assigned the city into grids about 1,000 yards square (approximately 11 north–south blocks by 4 east–west blocks).[7] Streets in row F below 14th Street are grouped together as Downtown, the area between 14th Street and 32nd Street we label Midtown, and the remainder of Manhattan as Uptown. Our

[7] Some longer streets span more than one grid square but are assigned by Phelps to one, so some depositors on these streets will have been assigned to the wrong square.

TABLE 2—DEFINITIONS OF VARIABLES

Panicked	Account closed during panic
Previous deposits	Number of deposits made into account at annualized rate, excluding initial deposit
Previous withdrawals	Number of withdrawals from account prior to panic
Closing balance	Closing balance if panicked, balance at end of panic otherwise
Length open	Number of months the account had been open prior to panic
Years in United States	Number of years the depositor had lived in the United States
Occupation	Occupation: laborer (l), professional (p), or other (o)
Sex	Female or male
District	Depositor's address given by grid coordinate of Phelps's 1857 "New York City Street and Avenue Guide" (3b–6d); otherwise Downtown (dt), Midtown (mt), Uptown (ut), Long Island (li), Brooklyn (bn), Staten Island (si), New Jersey (nj), Upstate (us), or other (oth)
County	Depositor's county of origin in Ireland

Note: Panic is defined as the period from December 11 to December 30 for the 1854 data, and from September 28 to October 13 for the 1857 data.

TABLE 3—SUMMARY STATISTICS FOR STAYERS AND PANICKERS, 1854 AND 1857

	1854		1857	
	Stayers	Panickers	Stayers	Panickers
Previous deposits	2.18	2.61	2.01	2.19
Previous withdrawals	1.33	3.08	1.1	1.45
Closing balance	186.86	124.36	223.36	161.5
Length open	16.05	11.56	23.84	18.34
Years in United States	7.98	5.42	10.61	8.02
Female	31.71	31.61	32.97	43.36
Laborer	44.72	59.59	42.78	52.38
Professional	4.07	1.55	3.81	3.25
Ulster	33.74	16.06	28.33	14.28
Connacht	9.76	17.62	13.90	15.04
Munster	29.67	36.79	27.52	40.35

Note: Entries for numerical variables are means; entries for factors are percentages of accounts.

other districts are Brooklyn, Long Island, Staten Island, New Jersey, Upstate, and other. As well as capturing potential neighborhood effects, this grid allows us to gauge the impact of shoe-leather costs on panicking: depositors living in squares closer to the bank face a lower cost of going to the bank and closing their accounts and may therefore be more likely to panic.[8]

Restricting ourselves to Irish depositors whose county of origin is known, and whose address we could locate, gave us a sample of 439 accounts, including 193 panickers, for 1854; and 766 accounts, including 399 panickers, for 1857. The variables that we use to distinguish between panickers and stayers are defined in Table 2, and summary statistics are presented in Table 3.

There are several notable features about the depositors summarized in Table 3. The first is the high proportion of unskilled workers—laborers, porters, domestic servants—among depositors, composing about half of all accounts; with most of the remainder belonging to clerks and small capitalists. Secondly, most depositors were recent immigrants: over 80 percent had arrived since the start of the Great Famine in 1845. Thirdly, at a time when the average weekly wage of a male laborer was around $5, with a female domestic earning about half that, the average account balance was large: $160 in 1854 and $190 in 1857, with medians of $100 and $115 respectively. Finally, accounts were short lived—the average account had been open for 14 months in 1854 and 21 months in 1857—and comparatively inactive when open, averaging three or four transactions a year.

Comparing panickers with stayers, the major

[8] We are grateful to a referee for this point.

TABLE 4—CHARACTERISTICS OF PANICKERS: LOGISTIC REGRESSION

	1854	1857	1854	1857
Intercept	0.4976	0.5951**	0.5747	0.6118*
	(0.2758)	(0.2178)	(0.3314)	(0.2543)
Previous deposits	0.0139	0.0059	0.0062	−0.0037
	(0.021)	(0.0261)	(0.0208)	(0.0264)
Previous withdrawals	0.0225	0.043	0.0281	0.0389
	(0.0173)	(0.0303)	(0.0182)	(0.0306)
Closing balance	−0.0018*	−0.001*	−0.001*	−0.0008
	(0.0008)	(0.0005)	(0.0008)	(0.0005)
Length open	−0.0324**	−0.0116**	−0.034**	−0.0117**
	(0.0102)	(0.0044)	(0.0105)	(0.0045)
Years in United States	−0.0456*	−0.0459**	−0.04*	−0.0396**
	(0.0201)	(0.0126)	(0.0202)	(0.0128)
Female	−0.1171	0.3581*	−0.1263	0.3627*
	(0.2273)	(0.1618)	(0.2319)	(0.1635)
Laborer	0.452*	0.2565	0.4945*	0.2124
	(0.2133)	(0.1572)	(0.2182)	(0.1591)
Professional	−0.4297	0.299	−0.2398	0.3737
	(0.7098)	(0.4267)	(0.7138)	(0.4303)
Ulster			−0.8247**	−0.6116**
			(0.2951)	(0.219)
Connacht			0.4871	0.025
			(0.338)	(0.2405)
Munster			−0.0295	0.2065
			(0.2617)	(0.1916)
Density	0.0648	0.0882	0.0641	0.0882
Null deviance	602	1061	602	1061
Residual deviance	553	1001	537	987
Percent misclassified	35	39	32	36

Notes: Logistic regression. Dependent variable: Panicked. Standard errors are in parentheses. 439 observations for 1854, 766 for 1857. Density is the mean of the logistic density estimated for each observation, adjusted for the undersampling of stayers: multiplying the coefficient of a numerical variables by this gives the marginal effect of the variable on the probability of panicking. Null deviance and residual deviance are minus twice the log-likelihood (up to a constant) when only the intercept is included, and when all explanatory variables are included respectively. Percent misclassified is the percentage of observations where the predicted value of the dependent variable differs from the actual value.

* Denotes pseudo-t-statistic significant at 5 percent.

** Denotes pseudo-t-statistic significant at 1 percent.

differences are in size of deposit and length of time in America: the larger one's account and the longer one had lived in the United States the less likely one was to panic. Province of origin also mattered, with depositors from Ulster underrepresented among panickers relative to other provinces.

This informal division is supported by logistic regressions for the probability of panicking reported in Table 4. The regression coefficients reflect the behavior of the sample where panickers are overrepresented. If p is the fraction of our sample that panicked, then $p/(10 - 9p)$ is the fraction of the bank's depositors that panicked. To estimate the marginal effect of a numerical variable on the true probability of panicking for an individual at the mean level of the covariates, these coefficients are multiplied by the figure in the row labeled "Density," which is the logistic multiplier times the derivative of the population probability of panicking. The undersampling of stayers implies that this adjustment factor is substantial, in the range 0.06 to 0.08.

In both 1854 and 1857 the probability of panicking declines the longer one had lived in the United States and had been with the bank, the larger one's account balance, and if one came from Ulster. Holding other covariates fixed at their mean values, and again adjusting for the fact that only one in ten stayers were sampled, a depositor from Ulster has a predicted

TABLE 5—ACCOUNTS AND PANICKERS BY COUNTY

County of origin	1854 Accounts	1854 Panickers (percent)	1857 Accounts	1857 Panickers (percent)
Antrim	10	20	8	50
Armagh	15	40	13	31
Carlow	5	0	9	56
Cavan	31	29	39	26
Clare	9	33	22	59
Cork	49	45	84	57
Derry	6	0	12	67
Donegal	16	12	23	17
Down	9	67	8	50
Dublin	21	43	36	56
Fermanagh	4	25	12	58
Galway	24	71	35	57
Kerry	28	50	73	74
Kildare	8	38	11	9
Kilkenny	13	62	29	45
Laois	6	50	18	78
Leitrim	7	43	13	54
Limerick	34	56	51	51
Longford	12	42	21	38
Louth	5	100	15	53
Mayo	8	75	15	67
Meath	11	45	24	67
Monaghan	11	18	22	32
Offaly	6	50	14	50
Roscommon	12	50	29	55
Sligo	7	29	19	37
Tipperary	24	54	32	62
Tyrone	12	25	24	38
Waterford	8	50	14	43
Westmeath	16	44	22	55
Wexford	7	57	16	69
Wicklow	5	20	3	0
Total	439	44	766	52

probability of panicking of 3 percent in 1854 and 5 percent in 1857, only half that of a depositor from Leinster (the omitted province in the regression dummies), whose predicted probabilities are 8 percent and 10 percent respectively. In addition, depositor's occupation is significant for 1854, while sex is significant for 1857.

The importance of networks of personal acquaintance in propagating panics can be seen in the day to day accounts of the bank. During the 1854 run, for instance, we find that John Hayes and John Lane (originally from Cork) and Thomas Murray and Michael Corcoran (from Roscommon), all laborers living at 26 Cherry Street, showed up at the bank on September 14 and closed their accounts.

Table 5 shows that there is a large variation in the likelihood of panicking across different counties of origin. In 1857, for example, while 52 percent of accounts in our sample closed during the panic, only 17 percent of depositors originally from Donegal and 26 percent from Cavan (both Ulster counties) panicked, compared with 67 percent for Meath and 74 percent for Kerry. The hypothesis that these proportions are equal across counties is strongly rejected: the chi-squared statistic is 52.4 for 1854 and 74.6 for 1857, both significant at 1 percent. It can be seen that the same counties tended to produce panickers or stayers in both years: the rank-order correlation between percentage of panickers in both years is 0.55.

Figure 3 maps the likelihood of panicking by

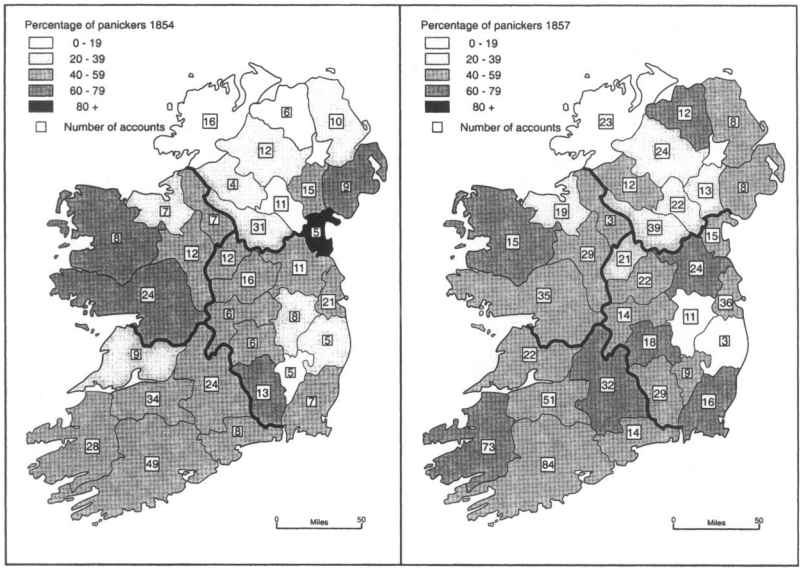

FIGURE 3. NUMBER OF DEPOSITORS AND PERCENTAGE OF PANICKERS BY COUNTY OF ORIGIN IN IRELAND, 1854 AND 1857

Note: Dark lines are boundaries of provinces.

county of origin in Ireland. Neglecting counties with few depositors, it shows not only a strong variation in the probability of panicking, but also that the counties least likely to produce panickers are clustered in the north and northwest of the county.

When county-of-origin dummies were added to the regressions in the first two columns of Table 4, only Galway and Wexford in 1854 were individually significant. However, the county dummies are jointly strongly significant: the chi-squared statistic for the hypothesis that their coefficients are jointly zero is 54 for 1854 and 72 for 1857. Using district-of-residence instead of county-of-origin dummies, districts 4d and 4e were individually significant in 1854, and district 4b in 1857. Testing joint significance of all districts gave a borderline significant chi-squared statistic of 30 for 1854, but a highly significant 43 for 1857. If county of origin is already included, the district-of-residence dummies are jointly insignificant for 1854, but significant at 2 percent for 1857. While these results suggest that social network factors may play an important role in panics, we need a technique that can handle factors with many levels, and possible nonlinear interactions between explanatory variables, more economically than a logistic regression.

III. Social Networks in Panics

To examine the importance of social networks in propagating panics, an elegant and intuitive approach is provided by the classification-tree procedure of L. Breiman et al. (1984).[9] Classification trees use a recursive, binary partitioning procedure to split the data into groups of observations that are as homogeneous as possible in terms of the dependent variable.

The procedure goes through all explanatory variables and tries a split at each level for every numerical variable, and for every combination of levels for each factor. It chooses the split that partitions the data into panickers and stayers with as few misclassifications of individuals as possible. For instance, an account balance of $60 might provide the best split, with depositors holding less than this tending to panic and those with more tending to stay. The procedure is then repeated for

[9] A good introduction to classification trees is given by W. N. Venables and B. D. Ripley (1994 Ch. 13).

each of the two new subgroups of data, with the algorithm again searching through the explanatory variables to find the best partition in each case. For example, among depositors with a balance of less than \$60, district of residence might give the best split, with depositors from districts 4c and 4d tending to panic and those from other districts tending to stay; while for depositors with balances above \$60, length of time in the United States might give the best partition, with those present more than five years being inclined to stay and a majority of those present less than five years panicking. This partitioning process continues until the process runs out of observations.

Splits higher in the tree are more important in terms of distinguishing panickers from stayers than splits lower down. The result is a decision tree that gives a rule for classifying each individual, and states the probability that an individual is misclassified by this rule. A typical decision path might be, for example, that an individual with less than \$60 in the bank, who lived in districts 4c or 4d, and was an unskilled workers is predicted to be a panicker; and of the 12 individuals in the sample that fit this description, 4 are incorrectly classified as panickers.

The 32 levels of the county factor lead to over two billion possible splits that must be evaluated, making the algorithm impossibly slow. We therefore omitted depositors from the four counties with the fewest accounts in each year. This allowed the algorithm used to run in a reasonable time, and reduced the chance of results being distorted by a factor level corresponding to a handful of observations. This gave 420 observations for 1854 and 738 for 1857.

The results of the classification procedure for 1854 and 1857, estimated using the S-Plus package, are presented in Figures 4 and 5. The interpretation of these figures is straightforward. The value at each node, 1 or 0, tells whether the majority of depositors at that node were panickers (1) or stayers (0). The number *a*/*b* below the node gives the number of misclassified observations *a* as a fraction of the total number of observations at the node *b*. Looking at the left-most path of Figure 4, for instance, we can see that of 102 depositors who came from Antrim, Cavan, Clare, Derry, Donegal, Monaghan, Sligo, and Tyrone, only 23 panicked; and of the 7 depositors from these counties who had been with the bank for less than 2.1 months, all but one panicked.

The pattern of results in Figures 4 and 5 is immediate and striking. For both panics, the most important factor that distinguishes panickers from stayers is county of origin. In both 1854 and 1857, depositors from Cavan, Donegal, Monaghan, Tyrone, and Sligo tended to stay while depositors from other counties tended to panic. Among depositors from staying counties, three-quarters stayed with the bank in 1854, and two-thirds in 1857. For these depositors, the length of time with the bank (1854) and the size of their balance (1857) have a secondary effect in reducing the risk of panicking.

Among depositors from other counties, slightly over half those in the sample panicked in 1854 and 60 percent in 1857. In both years, the most important secondary characteristic of panickers is length of time in the United States: of 23 depositors in 1854 who had been there more than 18 years, only 3 panicked; while in 1857 more than two-thirds of depositors who had lived less than 8 years in the United States panicked. After this, the most important characteristic is district of residence for 1854, with depositors from the contiguous blocks 4c, 4d, 4e, and 5d likely to panic (these blocks lie close to the bank, which is located in 4c, suggesting a possible role for shoe-leather costs, although this effect is probably mitigated by the small size of the city at the time); and in 1857 it is number of months with the bank.

These results are highly robust: using any large subset of the data in each year gave rise to the same pattern of partitions.[10] The most important assurance of robustness is the similarity of the trees generated in each year.

The parsimony of the classification tree is apparent. Using only the first two layers of the tree, 63 percent of depositors are correctly classified in 1854, and 65 percent in 1857, and this

[10] A referee raised the possibility that the large number of levels of the county factor could generate a spurious importance for that variable. If depositors are assigned a county at random, county does appear occasionally as high as the second or third split variable in a tree. In this case, however, the generated trees were nonrobust: using different subsets of each year's data generated different patterns of splits by county, and the county partitions were very different for each year. That a large number of levels need not generate classificatory power is shown by the district of residence variable, with 23 levels, which does not appear high in any tree, even when the county variable is omitted.

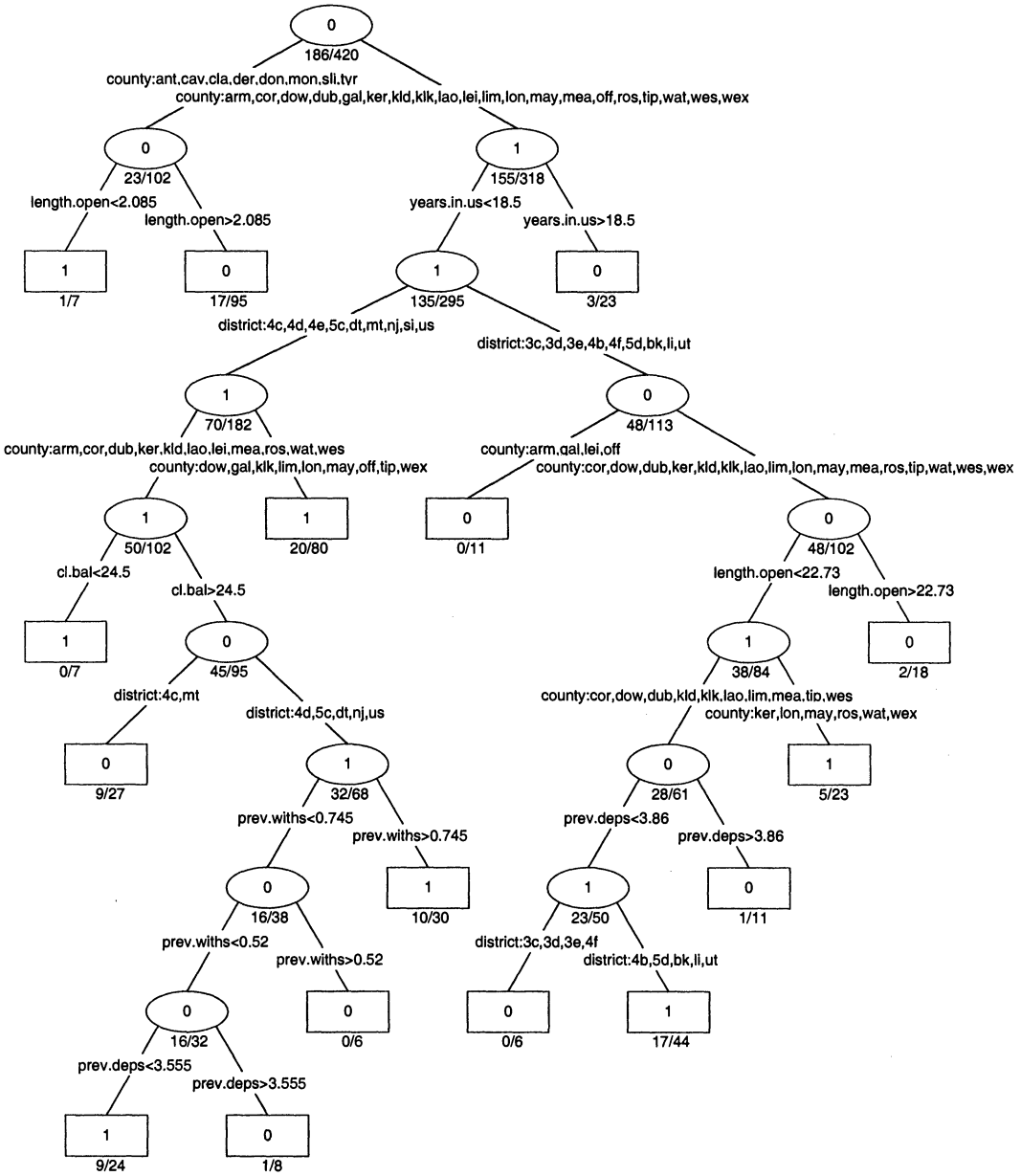

FIGURE 4. CLASSIFICATION TREE, 1854 PANIC

Note: The number in each node denotes whether the majority of depositors there are panickers (1) or stayers (0); the fraction beneath the node denotes the proportion of depositors that are misclassified at the node.

rises to 67 and 68 percent respectively if the next layer of the tree is added. This is similar to the misclassification rates obtained from the logits in Table 4.

Classification trees continue to partition data until they run out of observations, resulting in overfitting. To prune the fitted tree, two approaches are available. The first is to split the data

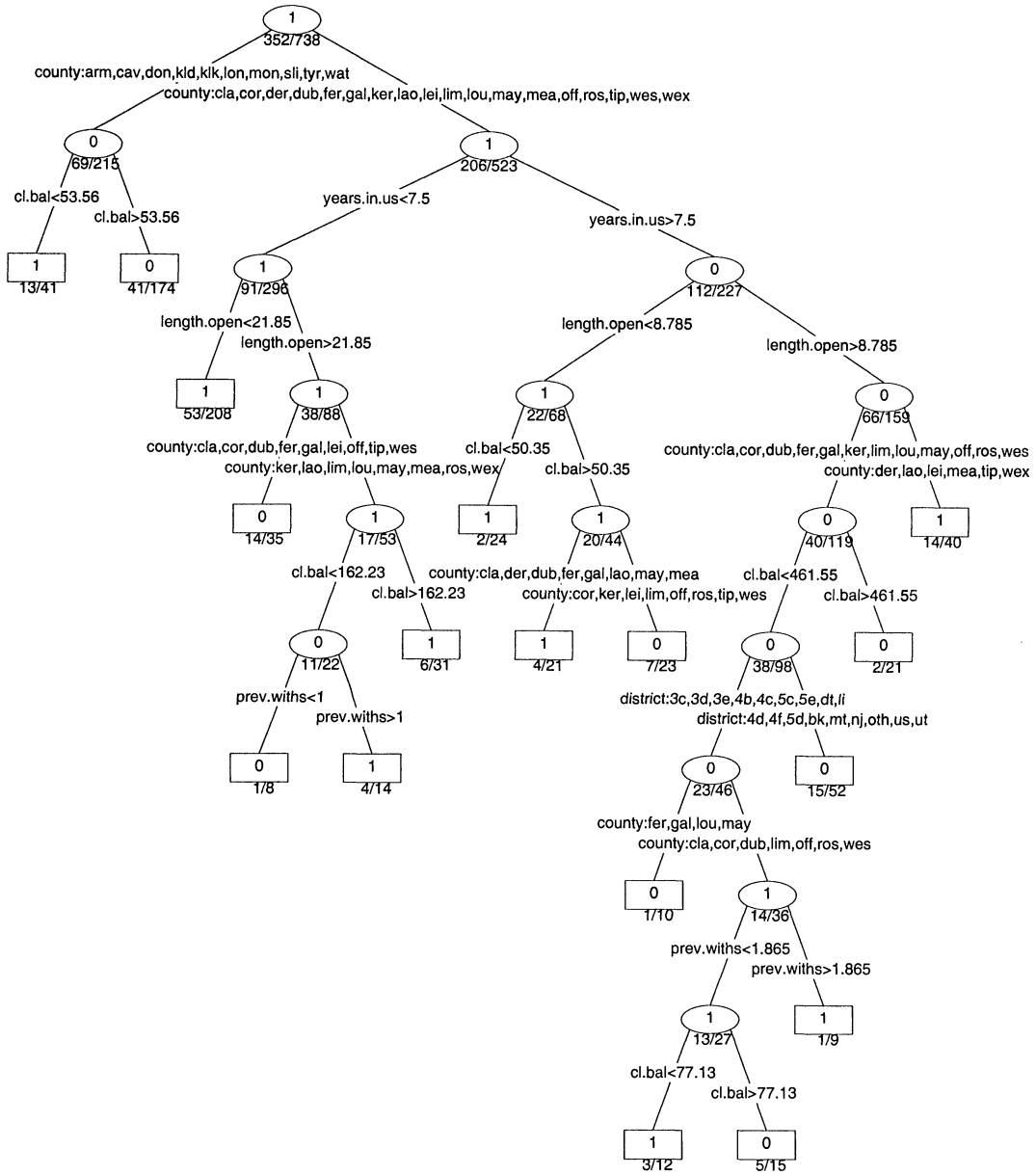

FIGURE 5. CLASSIFICATION TREE, 1857 PANIC

Note: The number in each node denotes whether the majority of depositors there are panickers (1) or stayers (0); the fraction beneath the node denotes the proportion of depositors that are misclassified at the node.

into a training sample, which generates a tree whose classificatory power is then measured on a separate testing sample. Adding extra nodes initially reduces misclassification rate in the second sample until, as overfitted nodes are added, the misclassification rate starts to rise. Alternatively a cross-validation procedure (Breiman et al., 1984 pp. 59–81) can be used where subsets of observations are used in turn to fit the tree, which is then tested on the remaining observations. Both

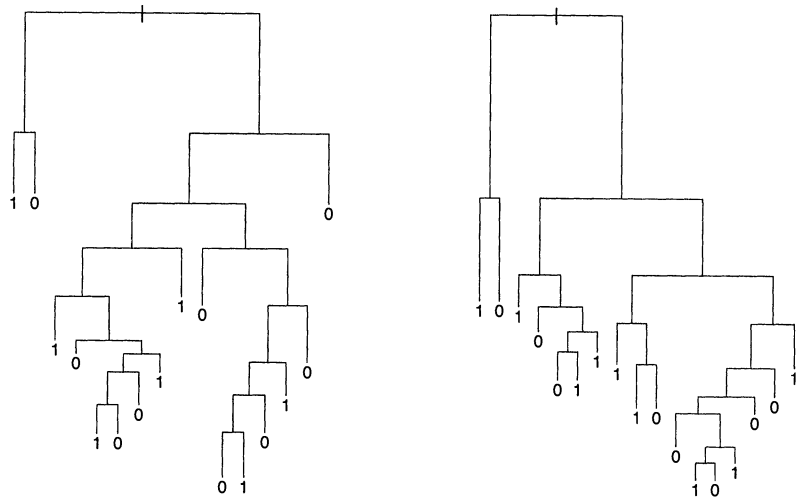

FIGURE 6. SCHEMATIC VERSION OF CLASSIFICATION TREES IN FIGURES 4 (1854, LEFT) AND 5 (1857, RIGHT)

Note: The depth of the branches below each node indicates the relative importance of each split in reducing the misclassification rate.

approaches were tried here and, based on misclassification rates, suggested the trees with approximately 16 terminal nodes that are reported here. These trees have a misclassification rate of 22 percent for 1854 and 25 percent for 1857.

While the relative importance of each split is indicated by its position in the classification tree, it is not evident from Figures 4 and 5 how much each split contributes to the reduction of the misclassification rate. This is shown in Figure 6 where the amount by which each split improves the fit of the tree is proportionate to the length of the branches beneath it. While county of origin is the most important split for both trees, Figure 6 shows that county has much greater classificatory power for the major panic of 1857 compared with the smaller run in 1854.

Given that county of origin is the most important determinant of panicking, does it follow that social networks are influencing individual behavior, or is county of origin merely proxying for some omitted individual characteristic such as education or previous experience with banks? While individual education is likely to be captured by the occupation and bank-balance variables, region of origin may determine the economic sophistication of recent immigrants. In terms of economic development, regions of nineteenth-century Ireland can be ranked Eastern Ulster, Leinster, Munster, and Connacht and Western Ulster. While the importance of the Ulster variable in the logistic regressions in Table 4 might suggest that economic sophistication of Ulster depositors is what deters them from panicking, looking at Table 5 and the classification trees we can see that most Ulster depositors came from poorer western counties rather than the industrialized east. In particular, few depositors from very poor northwestern counties, such as Sligo and Donegal, panicked; while depositors who had come from more prosperous eastern counties, such as Dublin, Meath, and Wexford, showed a strong tendency to panic.

Few of the EISB's depositors are likely to have had previous contact with banks in Ireland, where joint-stock commercial banking relied almost exclusively on a professional and business clientele. While Ireland did have a trustee savings-bank movement dating from 1815, its scale was tiny: only 90,000 depositors out of a population of about 8.5 million on the eve of the Great Famine (1845–1850), compared with nearly 70,000 depositors in New York City alone in 1850 (Olmstead, 1976 pp. 157–61; Ó Gráda, 1994 pp. 138–42). Irish savings banks catered to a disproportionately urban clientele, and the overwhelmingly rural background of Irish emigrants

means that few of those who opened accounts in New York can have previously held accounts in an Irish savings bank. The possibility that some EISB depositors from Dublin and Kerry were acting on recollections of the well-publicized frauds that affected savings banks in Dublin, Tralee, and Killarney in 1848 cannot be ruled out, although arguably such memories would have deterred them from opening an account in the first place (R. D. C. Black, 1960 pp. 152–53; Ó Gráda, 1999 pp. 54, 155–56).

Do social networks affect the timing of panicking? Each of the panics here spanned three weeks. In 1854, 60 percent of panickers left in the first week, 26 percent in the second, and 14 percent in the third week (forgoing a half year's interest payment of 3 percent); while in 1857, 24 percent left in the first week, 37 percent in the second, and 39 percent on the first two days of the third week, before withdrawals were restricted. Using a classification tree to determine what week the account was closed, for 1854, district of residence was the most important determinant of timing, but has a high error rate. For 1857 however, there is a clear difference in timing of closure by county of origin: panickers in the first week tended to be from Clare, Derry, Donegal, Tipperary, and Westmeath; whereas panickers in the third week tended to be from Fermanagh, Kerry, Longford, Meath, and Sligo.

It might be expected that the effect of county of origin on behavior would diminish the longer the depositor had lived in America and formed other ties. To test this we split depositors by years lived in the United States (trying splits at five and eight years) to see if depositors who had been there longer behaved differently from new arrivals. However, for both 1854 and 1857, the two groups behaved the same, with county of origin being the prime determinant of panicking. This failure to assimilate reflects the social isolation of these immigrants: in general, wealthier Irish immigrants left New York rapidly for cities with greater economic opportunities; those remaining were the poorest and least skilled (Joseph P. Ferrie, 1999 pp. 47–50).

IV. Conclusion

To test whether social contagion helps to propagate panics in financial markets we need to identify the informational networks of market participants. In this paper we were able to do this by looking at a distinctive group of depositors: Irish immigrants living in New York in the 1850's. As immigrants, their social networks reflected two interrelated facts about their lives: where they had come from in Ireland and where they lived in New York.

When we examined the behavior of these depositors in the panics of 1854 and 1857, we found that whether an individual panicked or not depended strongly on how long they had lived in America, and how long they had been with the bank. The most important factor in whether they panicked, however, was county of origin. Depositors from one set of counties tended to close their accounts in both panics, while otherwise identical individuals from other counties tended to stay with the bank. Our results show that individual behavior depends not only on private information but on access to the information and opinions of other group members, and raises the possibility that a handful of influential individuals can have a lot of power over group opinion.

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