A Spatial-Temporal Analysis of Corporate Bankruptcies

Why model bankruptcies as point processes? (1)

Figure 1: When companies go bust, creditors receive nearly nothing. Many of these creditors are typically other corporations that were counting on receiving their money back.

Lehman bondholders to receive 17 cents on dollar

By Kevin Dugan August 15, 2014 | 10:20pm

James Giddens, the trustee overseeing the liquidation of the bank's estate.

Reuters

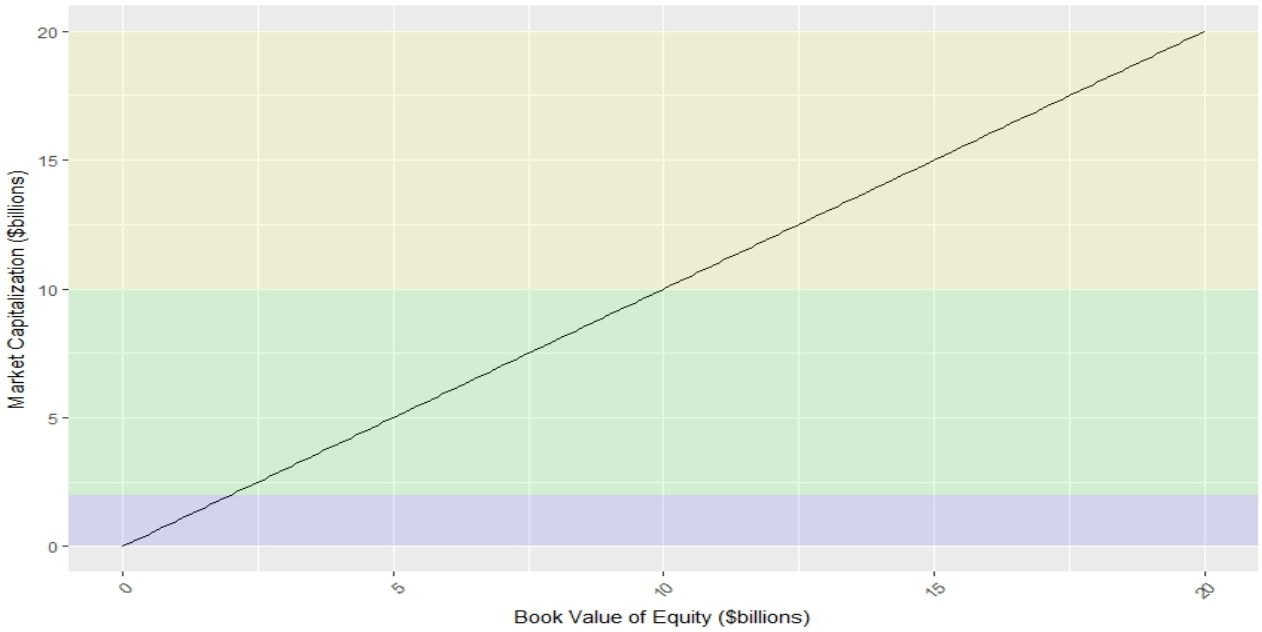
- Contagion effect (clustering in time): Bankruptcies can trigger other bankruptcies, which can trigger more bankruptcies...

Why model bankruptcies as point processes? (2)

- Conditional intensity may be higher in some "asset allocation spatial region" (inhomogeneity). We might want to avoid investing in these "regions", much like we would like to avoid wandering in a crime-prone neighborhood.
- Asset Allocation Space: Market Capitalization x Book Value of Equity
- Market Capitalization : price of one share x number of shares ("market value")
- Book Value of Equity: Assets - Liabilities ("liquidation value")

Spatial Domain

Figure 2: Asset Allocation Space: Yellow - large cap stocks; green - mid cap stocks; blue - small cap stocks. Stocks above 45 degree line - "growth" stocks; stocks below the 45 degree line - "value stocks".



- Market Value > Liquidation value (company is an ongoing concern - low distress risk)
- Market Value < Liquidation value (company may be liquidated - high distress risk)

Data (1)

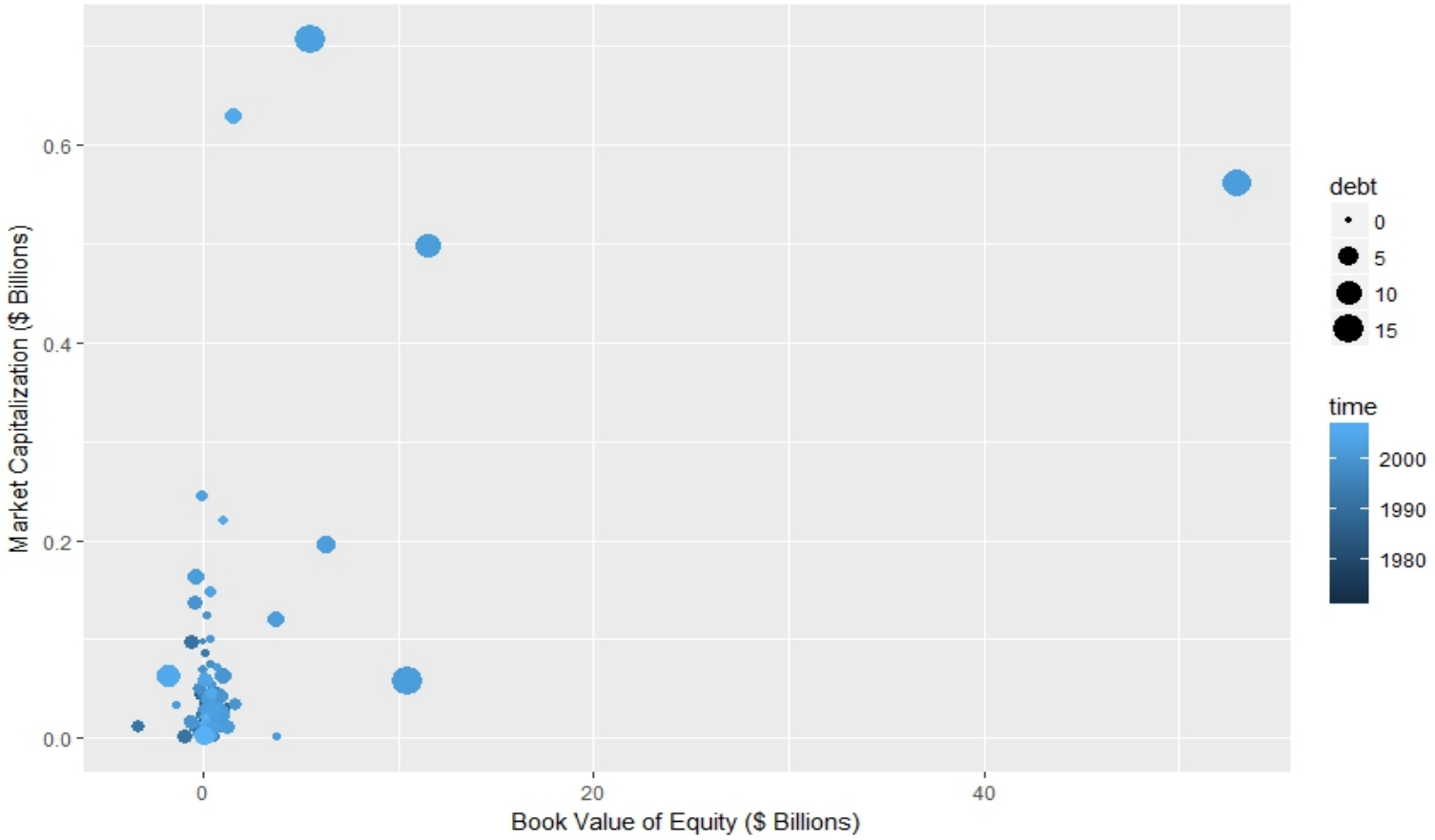
- Time Observation Window: from Jan. 1971 (time 0) to Dec. 2007 (time 1).
- Point pattern represents bankruptcies of publicly-traded firms (traded in the following exchanges: NYSE, Nasdaq and AMEX) in asset allocation space (Book x Market Cap. $= [-\infty, \infty] \times [0, \infty]$) and in time ($t = \times[0, 1]$).
- We have marks: total debt of company that went bankrupt (magnitude).
- Time covariate: return investors demand on risky bonds (BAA-rated) - return investors demand on safe bonds (AAA-rated). We call this covariate the "default spread".

Data (2)

- Share price and number of shares come from CRSP (Center for Research in Security Prices).
- Book value of equity, and debt levels come from Compustat.
- Default spread comes from website of the Board of Governors of the Federal Reserve System.
- Bankruptcy occurrences are from the CRSP database (delisting code = 574).
- n = 456 observations.
- Data definitions are shown in written report.

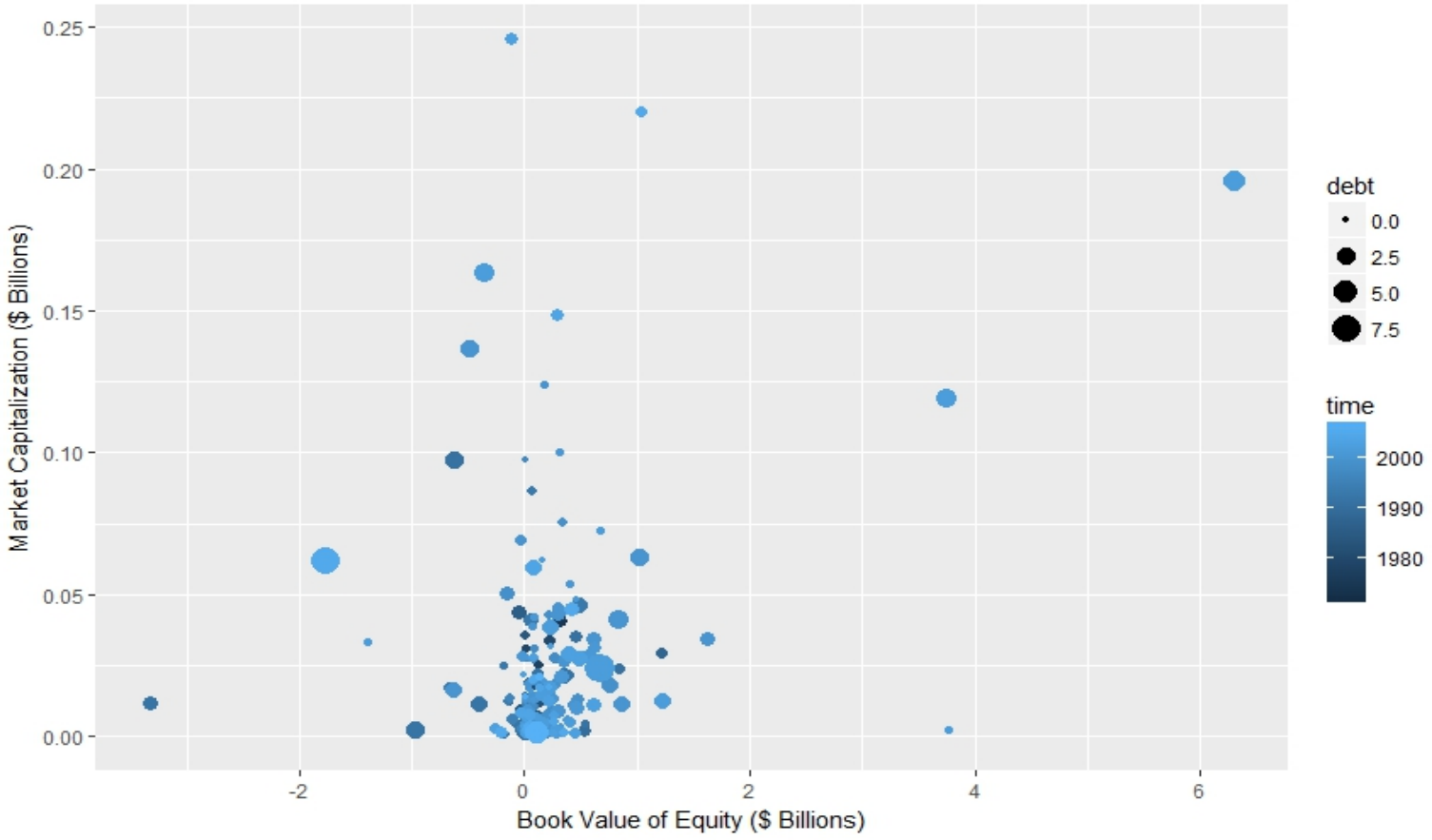
Spatial-Temporal Point Pattern (1)

Figure 3: Bankruptcies in Space-Time: most companies going bankrupt have market values below $ 200 million dollars; and book values below $5 billion.



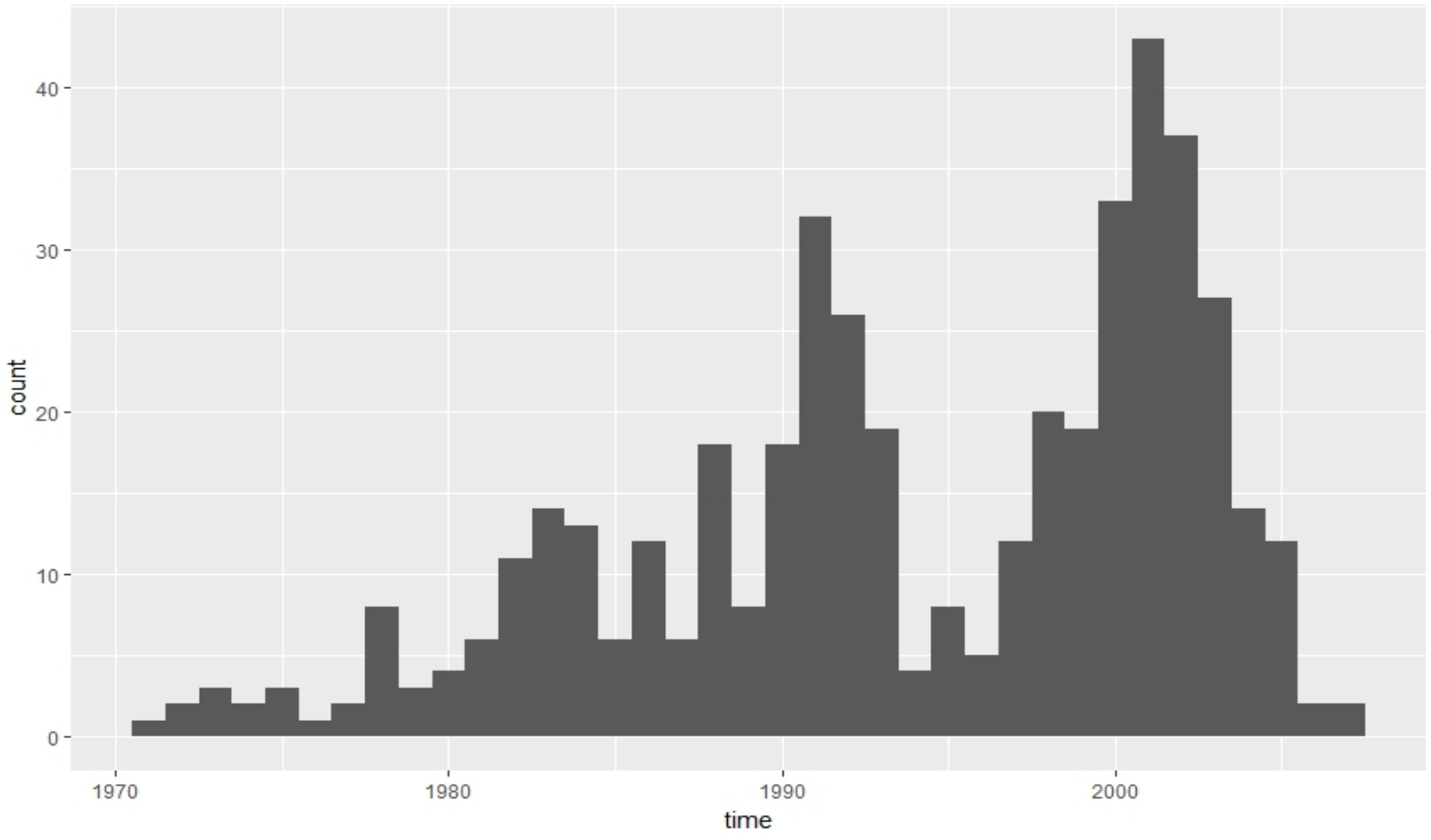
Spatial-Temporal Point Pattern (2)

Figure 4: Bankruptcies in Region with Greatest Activity.



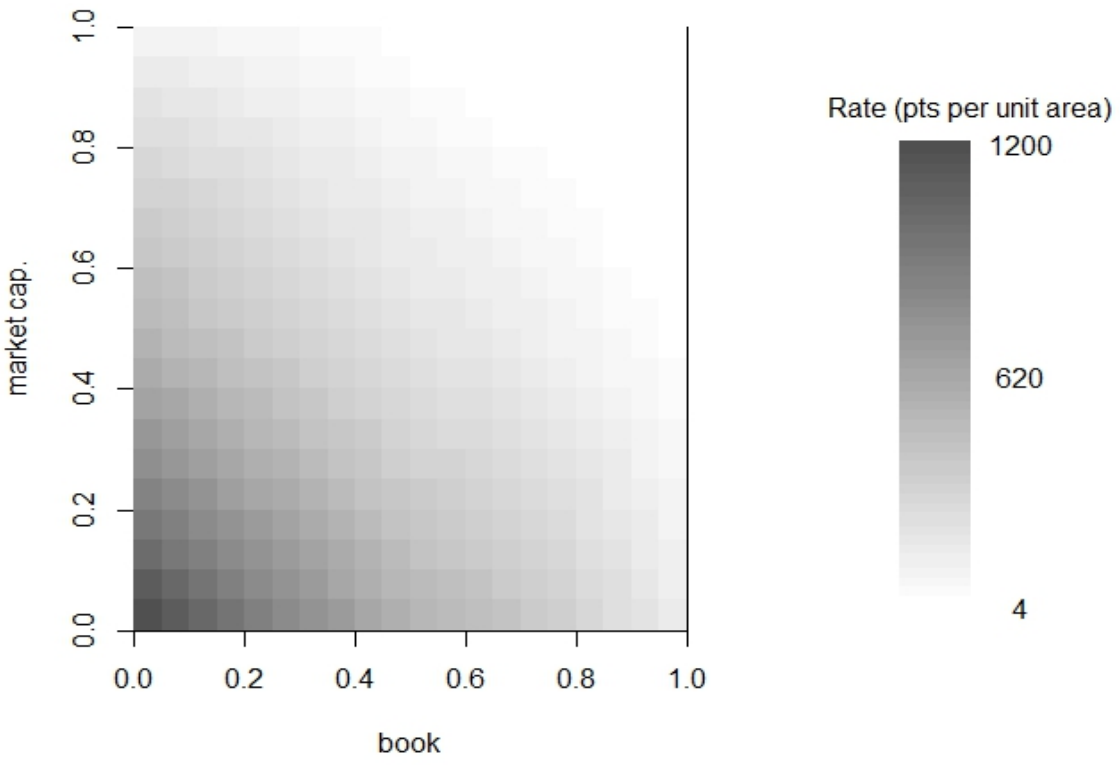
Potential Clustering in Time

Figure 5: Histogram showing corporate bankruptcies: periods of "low" activity are followed by periods of "high" activity.



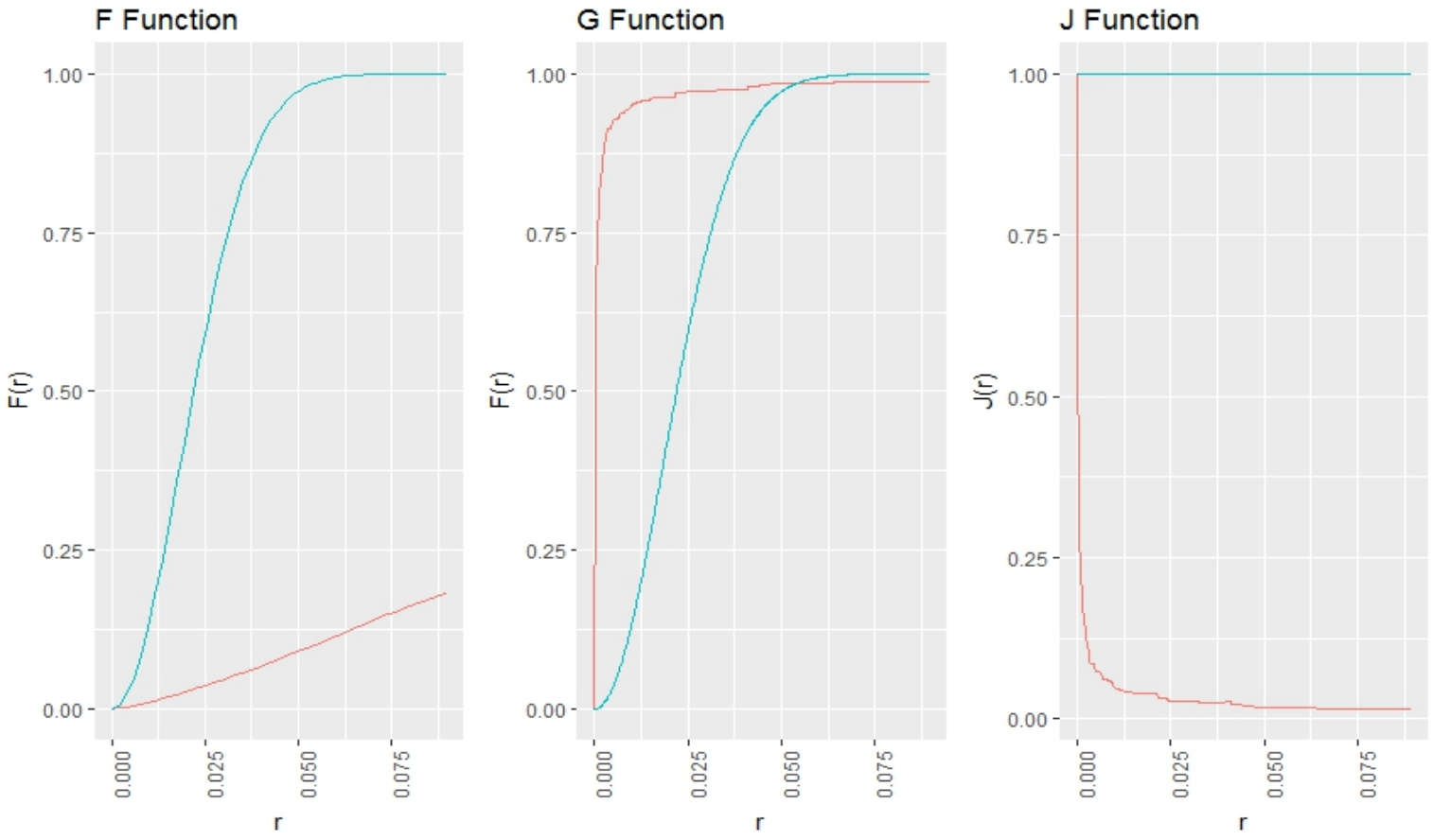
Purely Spatial Analysis (1)

Figure 6: Kernel estimation of the Papangelou intensity: intensity is too small in "active region".



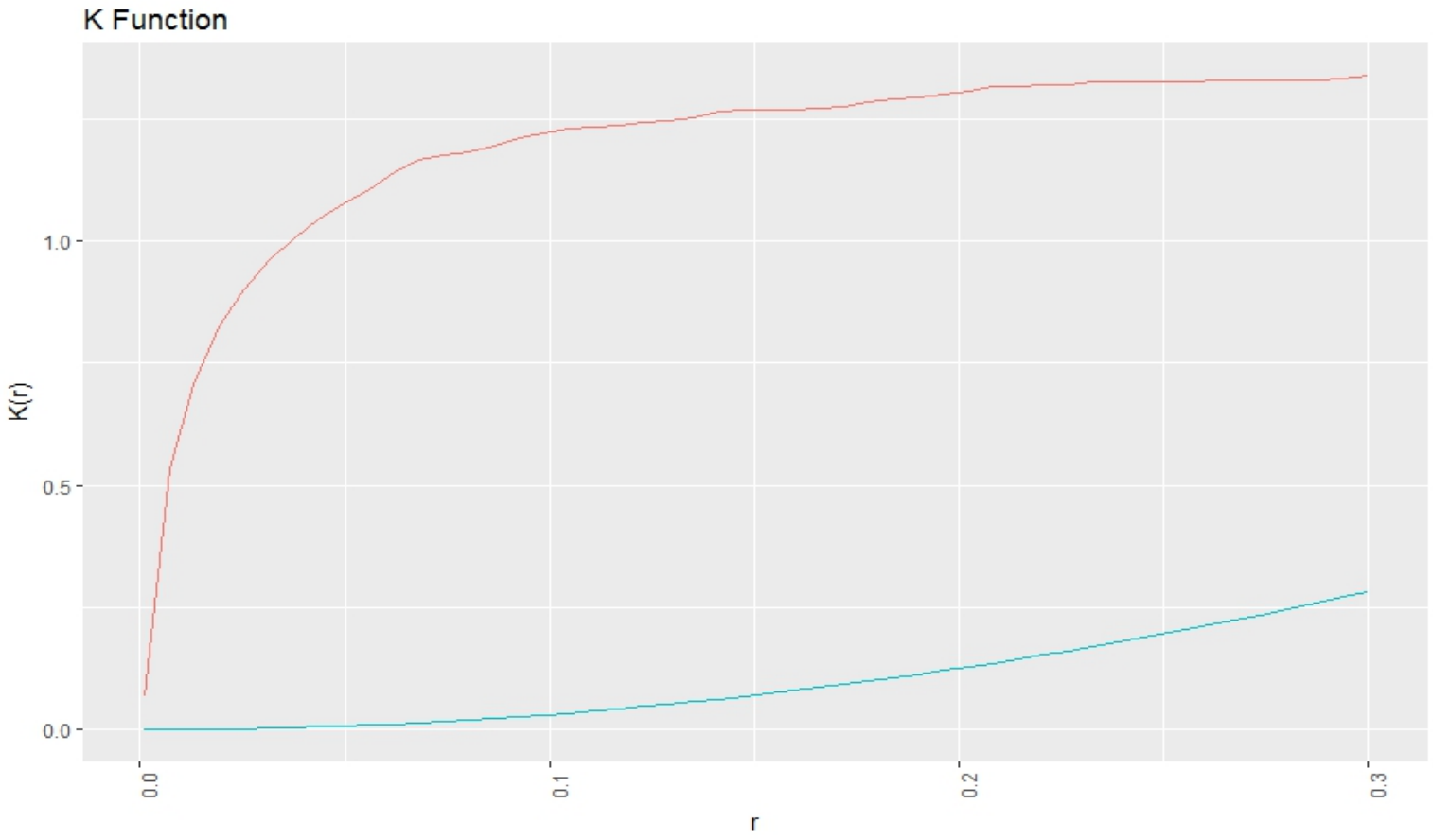
Purely Spatial Analysis (2)

Figure 7: F, G and J functions indicate clustering or inhomogeneity. Data: red line; Poisson: green line.



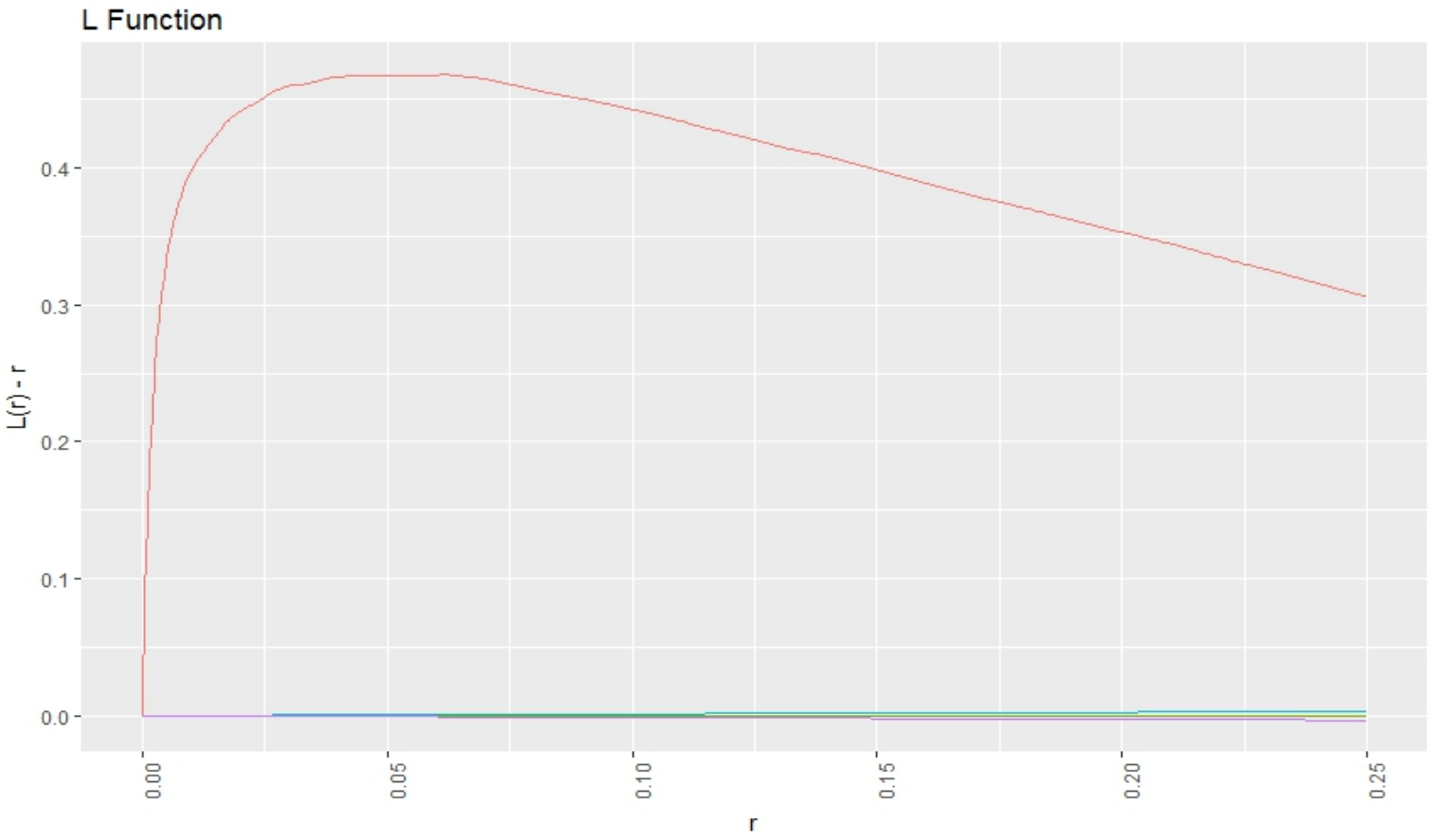
Purely Spatial Analysis (3)

Figure 8: K function also indicates clustering or inhomogeneity. Data: red line; Poisson: green line.



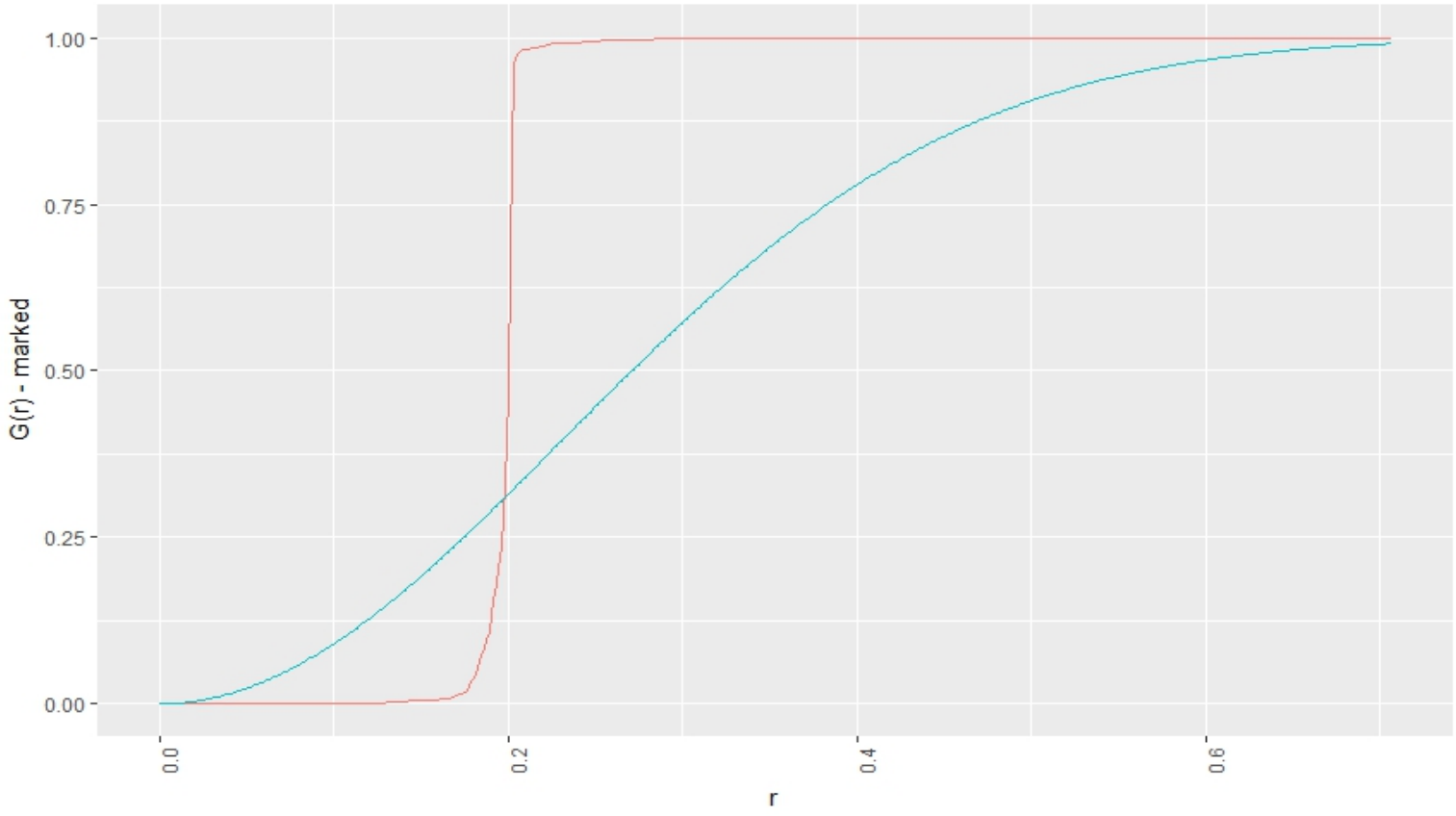
Purely Spatial Analysis (4)

Figure 9: ...and so does the L function. Data: red line.



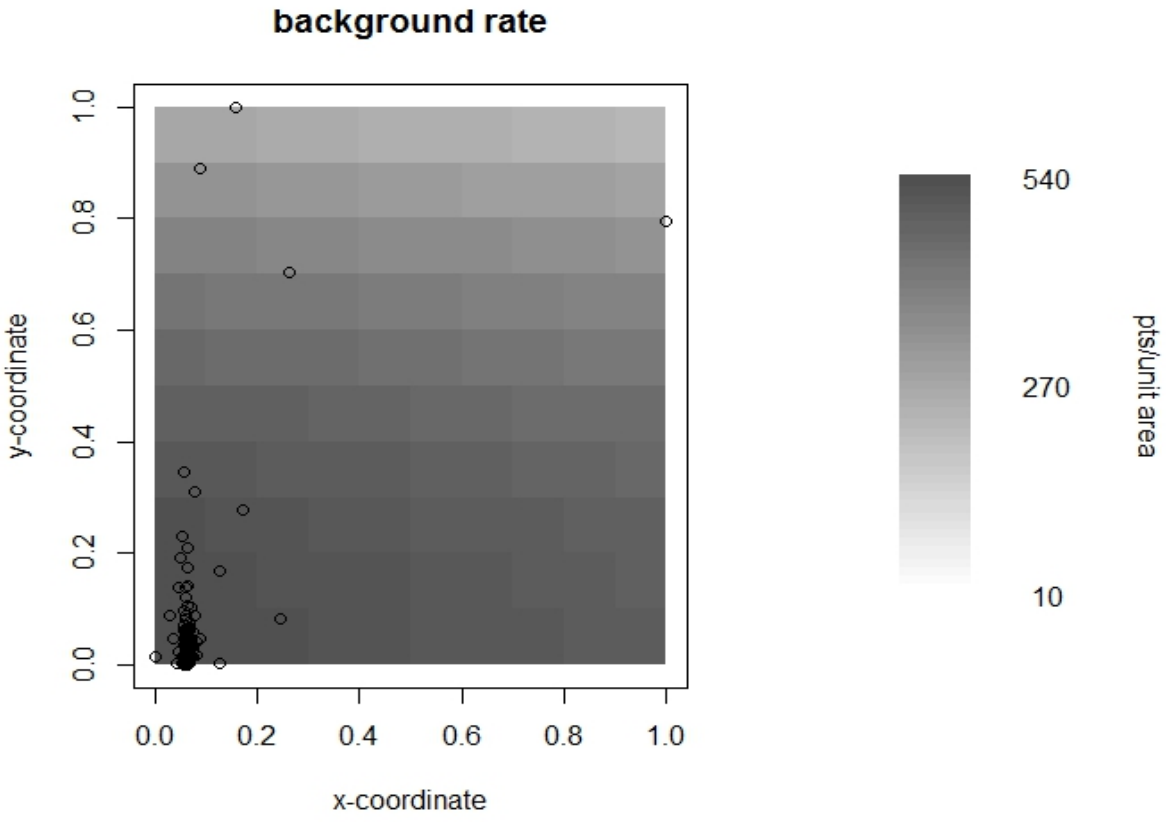
Purely Spatial Analysis (5)

Figure 10: Marked G Function: Probability that a point with $m \leq 0.5$ is within distance r of point with $m \geq 0.8$. Data: Red; Poisson: Green.



Papangelou intensity via pseudo log-likelihood

Figure 11: A simple model can't explain well our data. Model:
$\lambda(x, y) = 539.17 - 50.27x + 50.27y - 341.42xy$; SE = [98.44,1553.06,385.40,1977.14]



ETAS model with covariate

$\lambda(x,y,t) = \mu(x,y,t) + \sum_{\{t'|'t'<t\}} g^*(x,y)g(t-t^{'})h(m')$

Where:

$$\mu(t,x,y) = \bar{\mu} + ax + by + ct + dspread_t$$

And:

$$g(t-t^{'}) = \alpha e^{-\alpha(t-t^{'})},$$

$$h(m^{'}) = Ke^{\beta m^{'}}$$

$$g^*(x,y) = \frac{1_{\{x \leq 0.2, y \leq 0.2)}}{0.2 \times 0.2}$$

Estimation via Max. Likelihood

Table 1: Coefficient estimates and standard errors. The background rate decreases with market cap. and book value, and increases with time. The expected number of first generation aftershocks is $E[h(m)]$, which we estimate to be 0.9753.

$\bar{\mu}$	a	b	c	d	α	β	K
2.052	-11.450	-19.775	18.837	16.667	62.990	0.016	0.975
(60.252)	(24.660)	(24.257)	(38.759)	(39.229)	(8.974)	(0.849)	(0.052)

$\lambda(x, y, t) = \mu(x, y, t) + \sum_{\{t'|'t'<t\}} g^*(x, y)g(t - t^{'})h(m')$

Where:

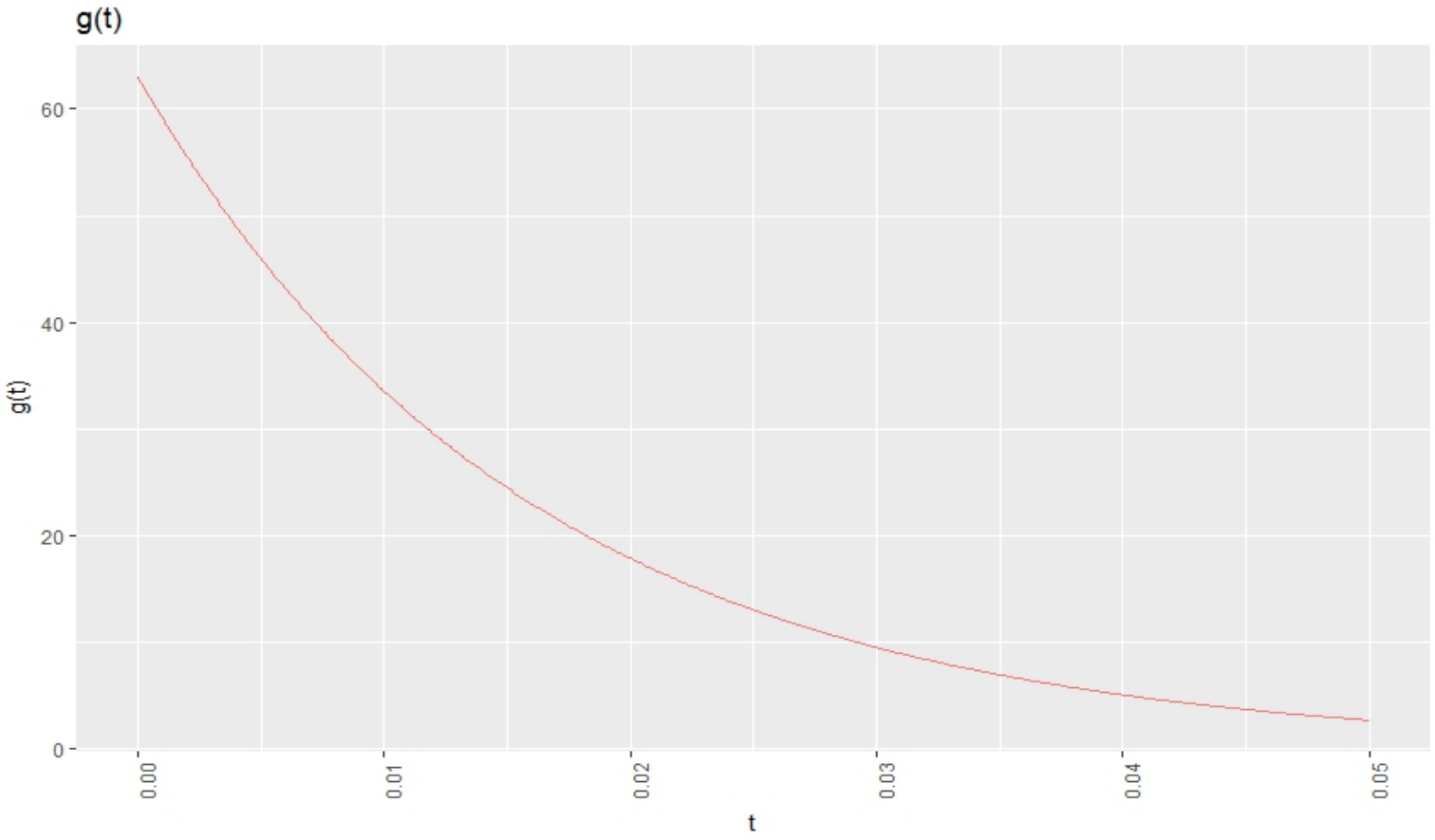
$$\mu(t, x, y) = \bar{\mu} + ax + by + ct + dspread_t$$

And:

$$g(t - t^{'}) = \alpha e^{-\alpha(t-t^{'})},$$
$$h(m^{'}) = Ke^{\beta m^{'}}$$

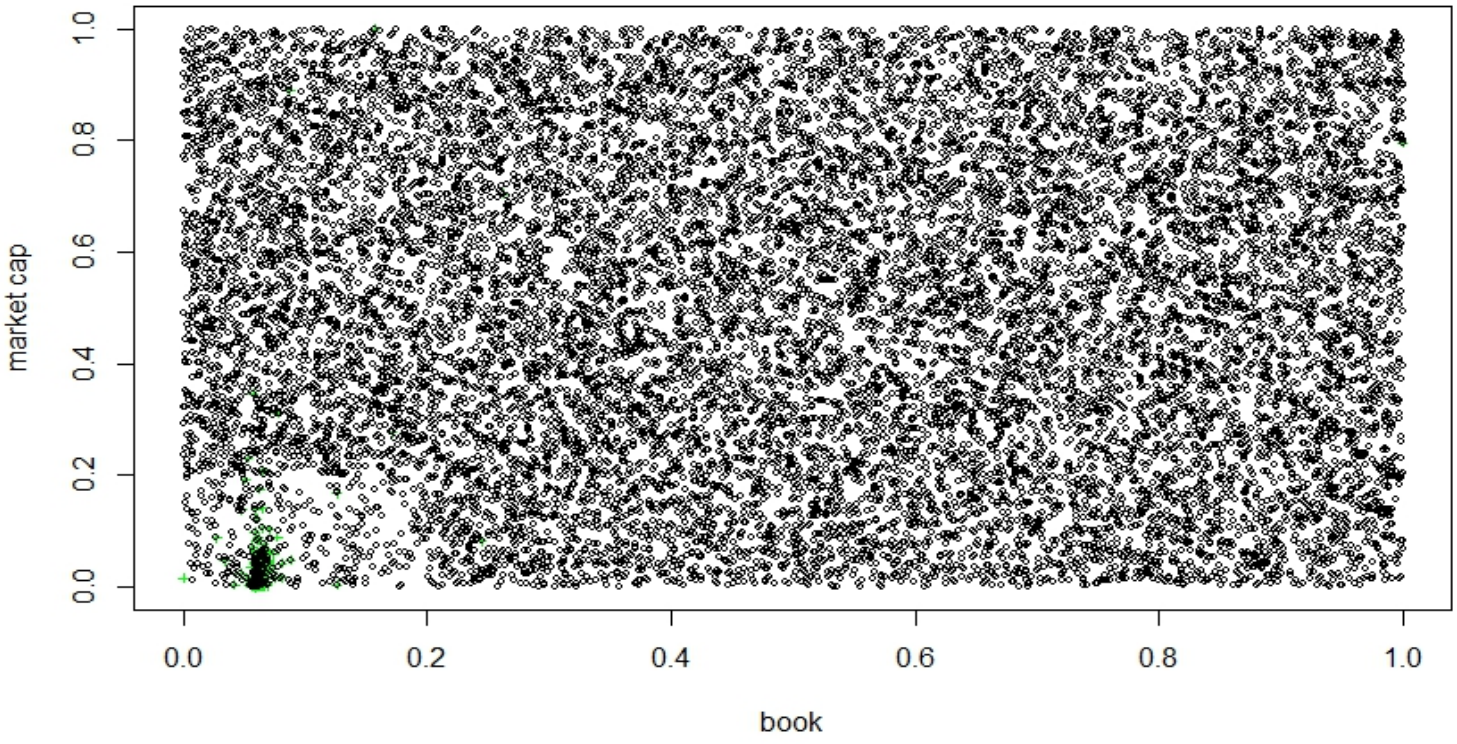
Temporal Triggering - g(t)

Figure 12: Bankruptcies help trigger bankruptcies up to 20 months apart.



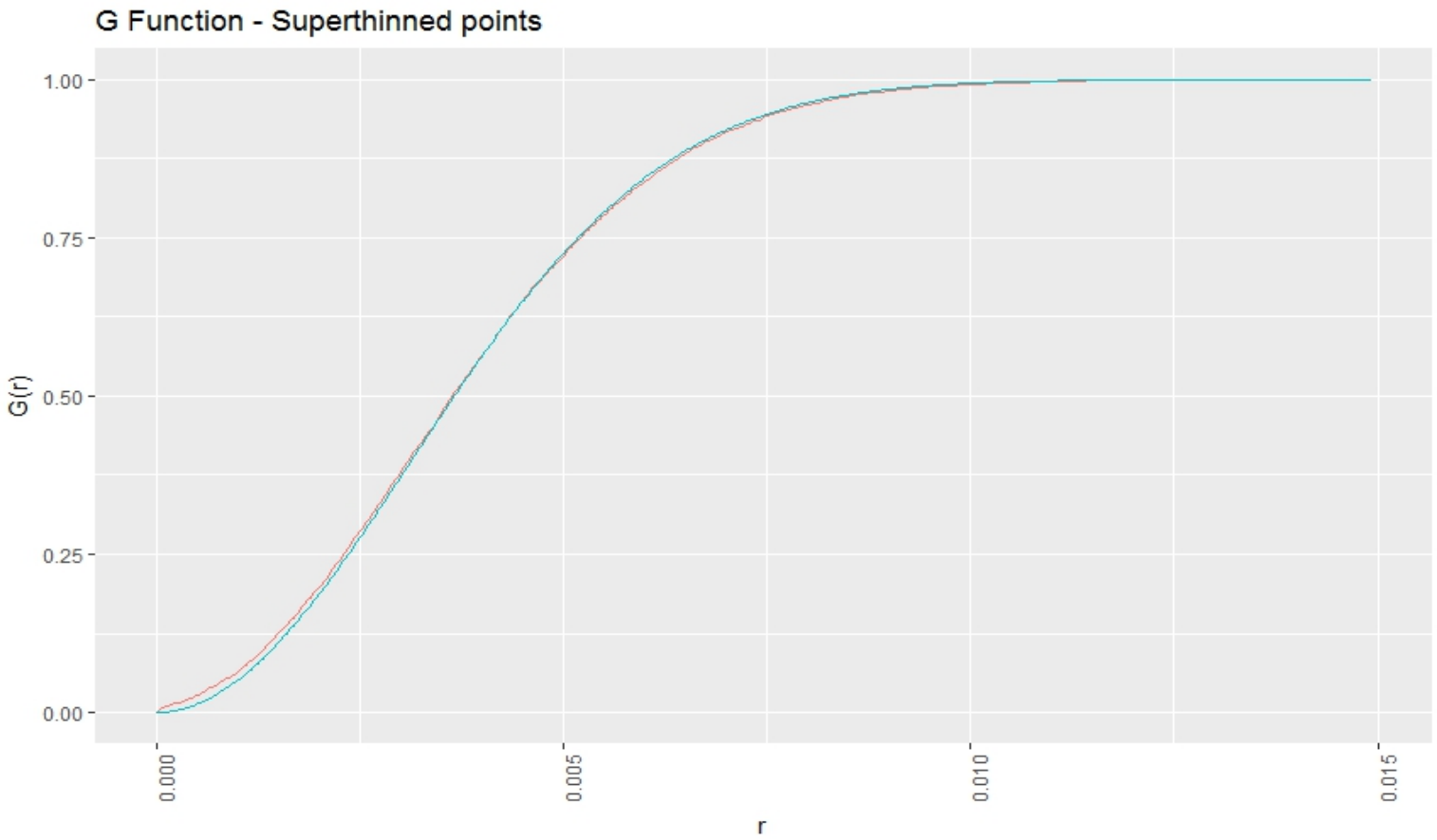
Superthinning

Figure 13: Model "overpredicts" in [0,2]x[0,2].



G Function of Superthinned Points

Figure 14: 75% probability that a point chosen at random has another point within a distance of 0.005 from it. Consistent with what we would get with a Poisson process - Data: Red Line; Poisson: Green Line



Conclusion (1) - Implications

- Investment Implications: Warren Buffet's Strategy
- Policy Implications: Too big to fail? Possible (hardcore) policy: solve $Ke^{\beta m} = 1$; m $= 1.72 \Rightarrow 25.9$ billion dollars.
- Background rate has been is increasing with time(though coefficient is not statistically significant; but note it's diff. to make inferences given SE depends on having max. log likelihood)

Conclusion (2) - Limitations and Extensions

- We don't consider private bankruptcies, or bankruptcies of individuals.
- Other covariates might impact conditional intensity.
- Could define space differently using networks, creating measures of "proximity".
- Having more time, we could estimate spatial triggering non-parametrically.