An Introduction to Event History Analysis

Oxford Spring School
June 18-20, 2007

Day Two: Regression Models for Survival Data

Figure 1: Various Functions of an Exponential Model with $\lambda = 0.02$

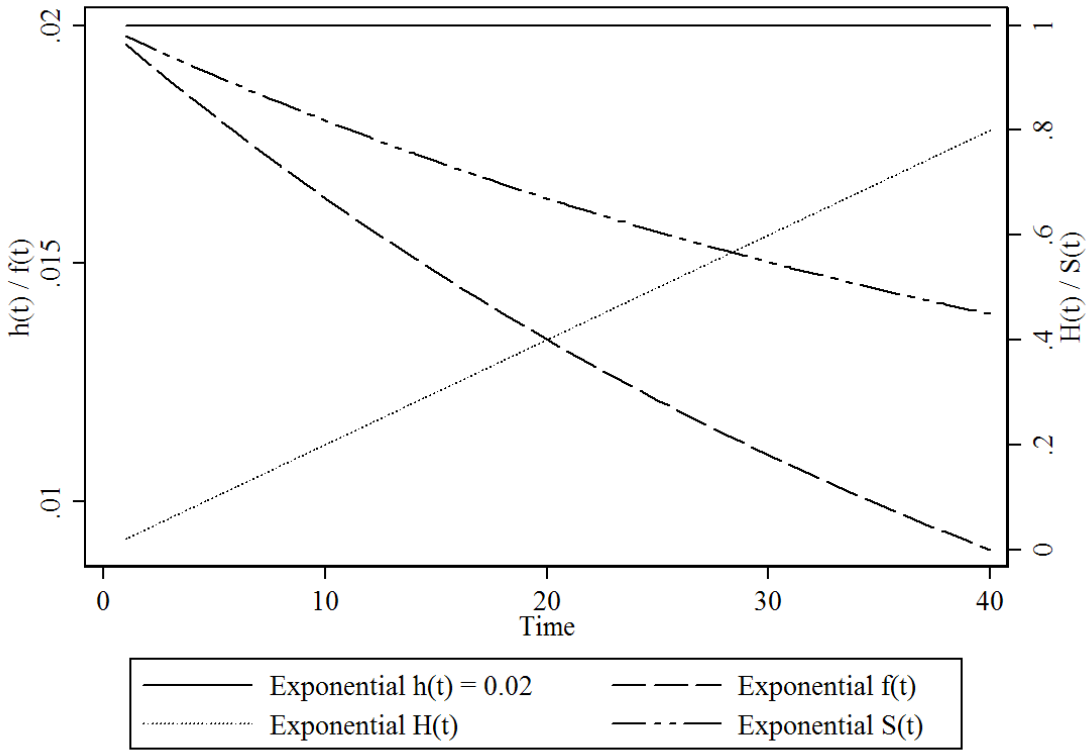


Figure 2: Various Weibull Hazards with $\lambda = 0.02$

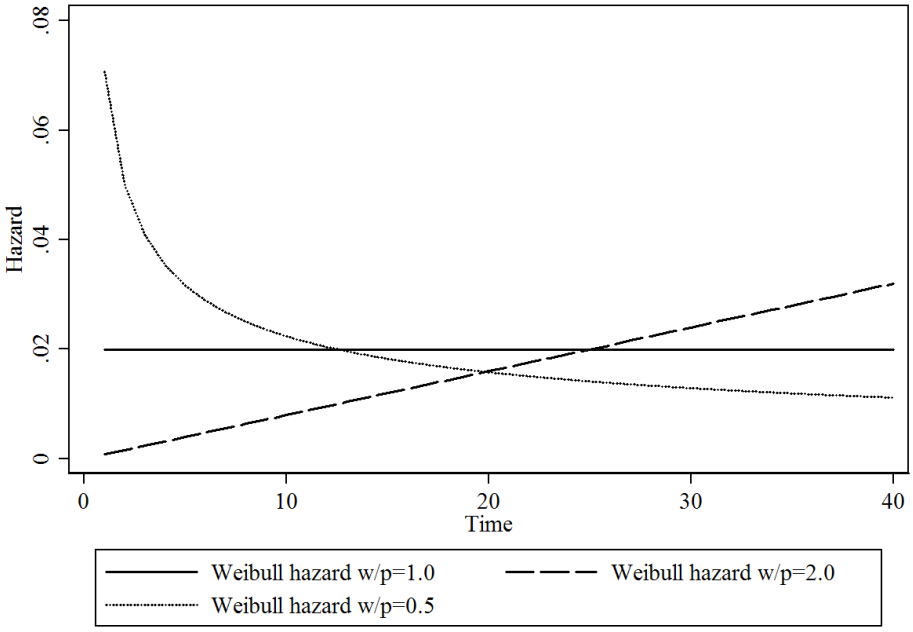


Figure 3: Various Weibull Survival Functions with $\lambda = 0.02$

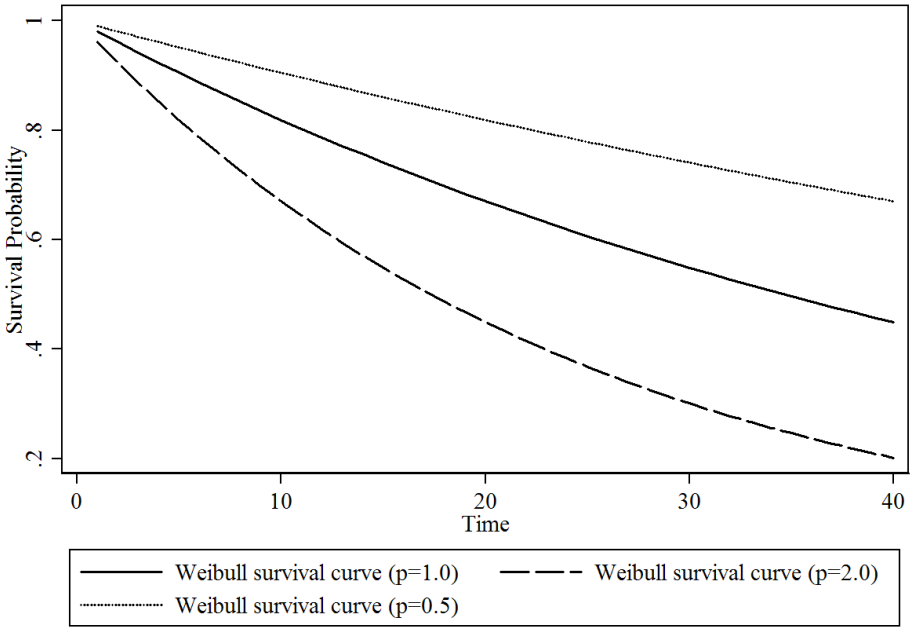


Figure 4: Various Gompertz Hazards with $\lambda = 0.001$

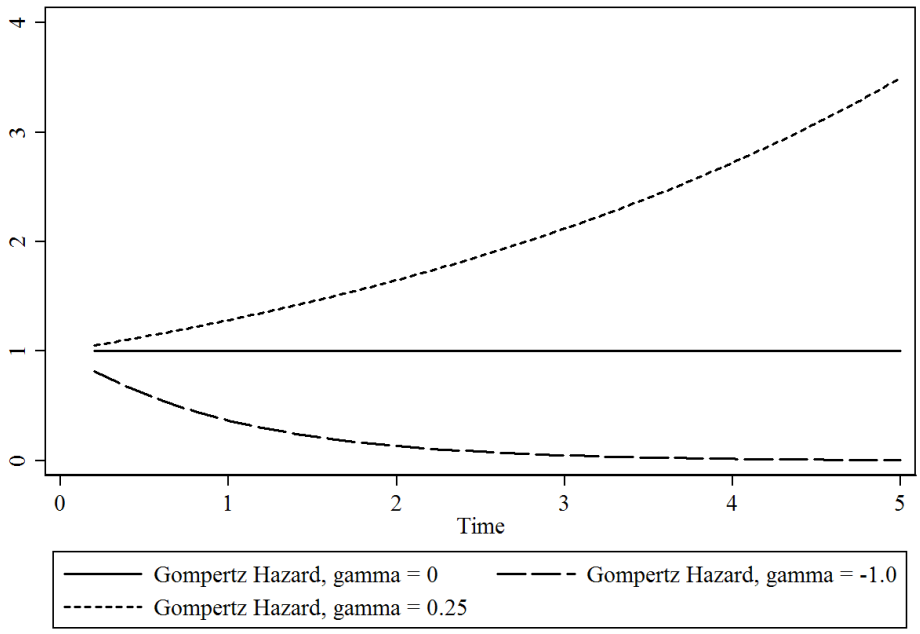
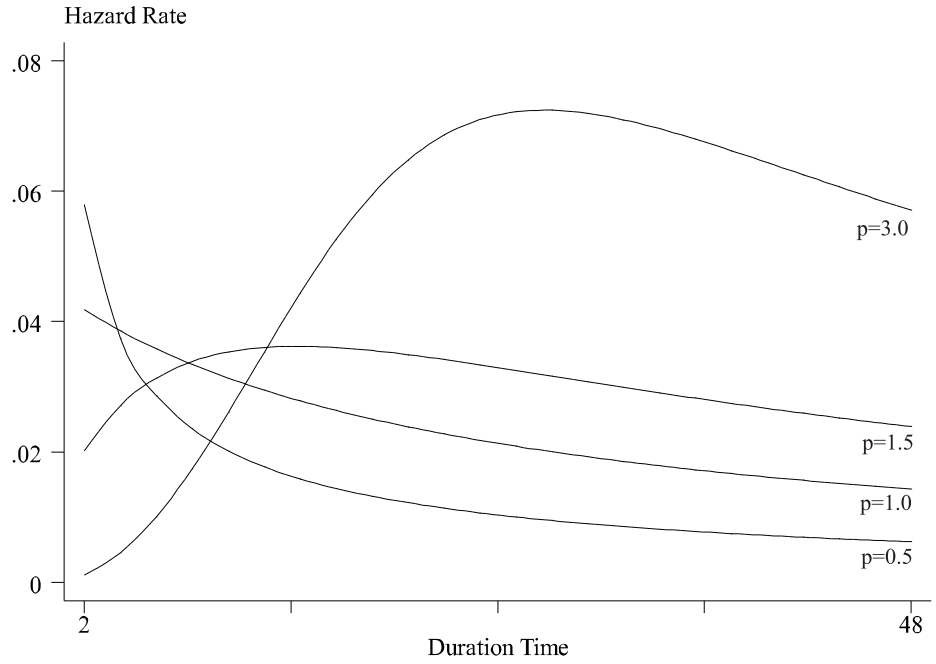


Figure 5: Various Log-Logistic Hazards



Example: Supreme Court Retirements, 1789-1992

```
. summarize justice service retire age pension pagree

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
     justice |      1765    52.13144    29.53513          1        107
     service |      1765    11.74391    8.338646          1         37
      retire |      1765    .0288952    .1675594          0          1
         age |      1765    62.09518    9.647412         32         91
     pension |      1765    .1988669    .3992607          0          1
      pagree |      1765    .6164306    .4863928          0          1

. stdes

         failure _d:  retire
   analysis time _t:  service
                 id:  justice
                                  |-------------- per subject --------------|
Category                   total        mean         min     median        max
------------------------------------------------------------------------------
no. of subjects              107
no. of records              1765    16.49533           2         16         37

(first) entry time                         0           0          0          0
(final) exit time                   16.61682           2         16         37

subjects with gap              0
time on gap if gap             0           .           .          .          .
time at risk                1778    16.61682           2         16         37

failures                      51    .4766355           0          0          1
------------------------------------------------------------------------------

. stvary

         failure _d:  retire
   analysis time _t:  service
                 id:  justice

               subjects for whom the variable is
                                                  never    always   sometimes
    variable |  constant    varying             missing   missing   missing
-------------+-----------------------------------------------------------------
         age |         0        107                 107         0         0
     pension |        60         47                 107         0         0
      pagree |        28         79                 107         0         0
```

Exponential Models, Constant-Only:

Hazard rate form:

```
. streg , nohr dist(exp)

Exponential regression -- log relative-hazard form

No. of subjects =          107                     Number of obs   =      1765
No. of failures =           51
Time at risk    =         1778
                                                   LR chi2(0)      =     -0.00
Log likelihood  =   -100.83092                     Prob > chi2     =         .

------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _cons |  -3.551419    .140028   -25.36   0.000    -3.825869   -3.276969
------------------------------------------------------------------------------
```

AFT form:

```
. streg , time dist(exp)

Exponential regression -- accelerated failure-time form

No. of subjects =          107                     Number of obs   =      1765
No. of failures =           51
Time at risk    =         1778
                                                   LR chi2(0)      =     -0.00
Log likelihood  =   -100.83092                     Prob > chi2     =         .

------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _cons |   3.551419    .140028    25.36   0.000     3.276969    3.825869
------------------------------------------------------------------------------
```

Exponential Models, With Covariates:

```
. streg age pension pagree, nohr dist(exp)

Exponential regression -- log relative-hazard form

No. of subjects =          107                     Number of obs   =      1765
No. of failures =           51
Time at risk    =         1778
                                                   LR chi2(3)      =     44.96
Log likelihood  =   -78.351408                     Prob > chi2     =    0.0000

------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         age |    .041146   .0210568     1.95   0.051    -.0001246    .0824165
     pension |   1.321105   .3870769     3.41   0.001     .5624487    2.079762
      pagree |   .1069193   .2854665     0.37   0.708    -.4525849    .6664234
       _cons |  -6.837742   1.341503    -5.10   0.000    -9.467039   -4.208445
------------------------------------------------------------------------------



. streg age pension pagree, time dist(exp)

Exponential regression -- accelerated failure-time form

No. of subjects =          107                     Number of obs   =      1765
No. of failures =           51
Time at risk    =         1778
                                                   LR chi2(3)      =     44.96
Log likelihood  =   -78.351408                     Prob > chi2     =    0.0000

------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         age |   -.041146   .0210568    -1.95   0.051    -.0824165    .0001246
     pension |  -1.321105   .3870769    -3.41   0.001    -2.079762   -.5624487
      pagree |  -.1069193   .2854665    -0.37   0.708    -.6664234    .4525849
       _cons |   6.837742   1.341503     5.10   0.000     4.208445    9.467039
------------------------------------------------------------------------------
```

Weibull Models, With Covariates:

```
. streg age pension pagree, nohr dist(weib)

Weibull regression -- log relative-hazard form

No. of subjects =          107                     Number of obs   =      1765
No. of failures =           51
Time at risk    =         1778
                                                    LR chi2(3)      =     26.79
Log likelihood  =   -78.350319                      Prob > chi2     =    0.0000
------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         age |   .0405689   .0244068     1.66   0.096    -.0072675    .0884052
     pension |   1.317683   .3935936     3.35   0.001     .5462542    2.089113
      pagree |   .1084476   .2872933     0.38   0.706    -.4546368    .6715321
       _cons |   -6.83356   1.344091    -5.08   0.000     -9.46793    -4.19919
-------------+----------------------------------------------------------------
       /ln_p |   .0103713   .2216177     0.05   0.963    -.4239915     .444734
-------------+----------------------------------------------------------------
           p |   1.010425   .2239281                      .6544294    1.560075
         1/p |   .9896823   .2193312                      .6409947    1.528049
------------------------------------------------------------------------------


. streg age pension pagree, time dist(weib)

Weibull regression -- accelerated failure-time form

No. of subjects =          107                     Number of obs   =      1765
No. of failures =           51
Time at risk    =         1778
                                                    LR chi2(3)      =     26.79
Log likelihood  =   -78.350319                      Prob > chi2     =    0.0000
------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         age |  -.0401503   .0296687    -1.35   0.176    -.0982999    .0179993
     pension |  -1.304088   .5264274    -2.48   0.013    -2.335867   -.2723093
      pagree |  -.1073287   .2826184    -0.38   0.704    -.6612506    .4465932
       _cons |   6.763054     2.0678     3.27   0.001     2.710241    10.81587
-------------+----------------------------------------------------------------
       /ln_p |   .0103713   .2216177     0.05   0.963    -.4239915     .444734
-------------+----------------------------------------------------------------
           p |   1.010425   .2239281                      .6544294    1.560075
         1/p |   .9896823   .2193312                      .6409947    1.528049
------------------------------------------------------------------------------
```

Gompertz Model:

```
. streg age pension pagree, nohr dist(gompertz)

Gompertz regression -- log relative-hazard form

No. of subjects =          107                     Number of obs   =      1765
No. of failures =           51
Time at risk    =         1778
                                                    LR chi2(3)      =     26.31
Log likelihood  =   -78.342685                      Prob > chi2     =    0.0000

------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         age |   .0430369   .0255498     1.68   0.092    -.0070398    .0931136
     pension |   1.329599   .3932018     3.38   0.001     .5589376     2.10026
      pagree |   .1049069   .2859234     0.37   0.714    -.4554928    .6653065
       _cons |  -6.920901   1.487491    -4.65   0.000     -9.83633   -4.005471
-------------+----------------------------------------------------------------
       gamma |  -.0031625   .0239883    -0.13   0.895    -.0501787    .0438538
------------------------------------------------------------------------------
```

Log-Logistic and Log-Normal Models:

```
. streg age pension pagree, dist(loglog)

Log-logistic regression -- accelerated failure-time form

No. of subjects =          107                     Number of obs   =      1765
No. of failures =           51
Time at risk    =         1778
                                                   LR chi2(3)      =     19.36
Log likelihood  =   -84.359393                     Prob > chi2     =    0.0002
------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         age |   .0142307   .0220574     0.65   0.519     -.029001    .0574624
     pension |  -2.846252   3.764288    -0.76   0.450    -10.22412    4.531617
      pagree |   .0806037   .4969815     0.16   0.871    -.8934623     1.05467
       _cons |   2.770183   1.381703     2.00   0.045     .0620944    5.478271
-------------+----------------------------------------------------------------
     /ln_gam |    -.38227   .2162617    -1.77   0.077    -.8061351     .041595
-------------+----------------------------------------------------------------
       gamma |   .6823108   .1475577                      .4465807    1.042472
------------------------------------------------------------------------------


. streg age pension pagree, dist(lognorm)

Log-normal regression -- accelerated failure-time form

No. of subjects =          107                     Number of obs   =      1765
No. of failures =           51
Time at risk    =         1778
                                                   LR chi2(3)      =     26.77
Log likelihood  =    -81.42114                     Prob > chi2     =    0.0000
------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         age |  -.0124893    .029725    -0.42   0.674    -.0707492    .0457705
     pension |  -3.598691   1.642479    -2.19   0.028    -6.817891    -.379491
      pagree |   .0354144   .4266008     0.08   0.934    -.8007078    .8715367
       _cons |   4.632599   1.873923     2.47   0.013     .9597768    8.305422
-------------+----------------------------------------------------------------
     /ln_sig |   .3819538   .2020201     1.89   0.059    -.0139983     .777906
-------------+----------------------------------------------------------------
       sigma |   1.465144   .2959887                      .9860992    2.176909
------------------------------------------------------------------------------
```

Brooks (2005): The Politics of Pension Privatisation

Summary Statistics:

```
. stdes

        failure _d:  fail
  analysis time _t:  end
                id:  id
                                |-------------- per subject --------------|
Category                  total        mean         min     median        max
------------------------------------------------------------------------------
no. of subjects              59
no. of records              896    15.18644           2         19         20

(first) entry time                 3.254237           0          0         12
(final) exit time                  18.44068           2         20         20

subjects with gap             0
time on gap if gap            0           .           .          .          .
time at risk                896    15.18644           2         19         20

failures                     18    .3050847           0          0          1
------------------------------------------------------------------------------
```

```
. su _d _t peerprivat LatinAm EEurCentAs LatAmxPeer EECAxPeer worldbank trade
infdi age65 parties fhouse partdem deficit mcap gdpcap lngdp

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
          _d |       896    .0200893    .1403841          0          1
          _t |       896    10.82478    5.757821          1         20
  peerprivat |       884    9.910966    10.44404          0   42.10526
     LatinAm |       896    .3772321    .4849645          0          1
  EEurCentAs |       896    .1383929    .3455047          0          1
-------------+--------------------------------------------------------
  LatAmxPeer |       884    4.393904    9.233826          0   42.10526
   EECAxPeer |       884    .8908371    4.501443          0      31.25
   worldbank |       885    .0729091    .4845149      -7.25       3.75
       trade |       876    67.37009    38.91518   11.54567   238.7001
       infdi |       857    1.577509    2.092835  -1.223001   20.43747
-------------+--------------------------------------------------------
       age65 |       896     9.73256    4.683838   2.501285   17.86749
     parties |       878      3.4309    1.808586          0      16.25
      fhouse |       894    1.977629    1.374684          1          7
     partdem |       877    6.388198    5.722833          0      48.75
     deficit |       896   -3.571239    4.210995  -35.56053   8.988749
-------------+--------------------------------------------------------
        mcap |       896    15.54599    34.78511          0   541.7224
      gdpcap |       863    10092.12     7369.03    1396.16   42769.14
       lngdp |       885    24.59823    1.974726   20.73322   29.84477
```

Parametric Models

```
. streg peerprivat LatinAm EEurCentAs LatAmxPeer EECAxPeer worldbank trade
infdi age65 parties fhouse partdem deficit mcap gdpcap lngdp, nohr dist(exp)

Exponential regression -- log relative-hazard form

No. of subjects =           58                     Number of obs   =       803
No. of failures =           18
Time at risk    =          803
                                                   LR chi2(16)     =     48.72
Log likelihood  =    -15.21816                     Prob > chi2     =    0.0000
------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  peerprivat |   .0036511   .0714422     0.05   0.959     -.136373    .1436752
     LatinAm |   -.495087   1.789928    -0.28   0.782    -4.003282    3.013108
  EEurCentAs |   1.586211   1.418809     1.12   0.264    -1.194604    4.367026
  LatAmxPeer |   .1220979   .0844656     1.45   0.148    -.0434516    .2876474
   EECAxPeer |   .0608916    .081445     0.75   0.455    -.0987377    .2205209
 (control variables omitted)
------------------------------------------------------------------------------
```

```
. streg peerprivat LatinAm EEurCentAs LatAmxPeer EECAxPeer worldbank trade infdi
age65 parties fhouse partdem deficit mcap gdpcap lngdp, nohr dist(weibull)

Weibull regression -- log relative-hazard form

No. of subjects =           58                     Number of obs   =       803
No. of failures =           18
Time at risk    =          803
                                                   LR chi2(16)     =     43.42
Log likelihood  =   -13.319909                     Prob > chi2     =    0.0002
------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  peerprivat |  -.0510898   .0781423    -0.65   0.513     -.204246    .1020664
     LatinAm |  -.9050964   1.827672    -0.50   0.620    -4.487269    2.677076
  EEurCentAs |   .3484389   1.628047     0.21   0.831    -2.842475    3.539353
  LatAmxPeer |   .1565934   .0882266     1.77   0.076    -.0163276    .3295145
   EECAxPeer |   .1042015   .0865724     1.20   0.229    -.0654773    .2738802
 (control variables omitted)
-------------+----------------------------------------------------------------
       /ln_p |   .6882986    .293876     2.34   0.019     .1123122    1.264285
-------------+----------------------------------------------------------------
           p |   1.990326   .5849091                      1.118862     3.54056
         1/p |   .5024302   .1476522                      .2824412    .8937652
------------------------------------------------------------------------------
```

```
. streg peerprivat LatinAm EEurCentAs LatAmxPeer EECAxPeer worldbank trade infdi
age65 parties fhouse partdem deficit mcap gdpcap lngdp, dist(logn)

Log-normal regression -- accelerated failure-time form

No. of subjects =           58                     Number of obs   =       803
No. of failures =           18
Time at risk    =          803
                                                   LR chi2(16)     =     43.74
Log likelihood  =   -15.223621                     Prob > chi2     =    0.0002
------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  peerprivat |   .0348855   .0260819     1.34   0.181     -.016234     .086005
     LatinAm |   .8293546   .7696259     1.08   0.281    -.6790845    2.337794
  EEurCentAs |   .6412098   .6137123     1.04   0.296    -.5616441    1.844064
  LatAmxPeer |  -.0679468   .0375044    -1.81   0.070     -.141454    .0055605
   EECAxPeer |  -.0733809   .0466923    -1.57   0.116    -.1648961    .0181343
 (control variables omitted)
-------------+----------------------------------------------------------------
     /ln_sig |  -.7035232   .3330094    -2.11   0.035     -1.35621   -.0508367
-------------+----------------------------------------------------------------
       sigma |   .4948388    .164786                      .2576354    .9504338
------------------------------------------------------------------------------

. streg peerprivat LatinAm EEurCentAs LatAmxPeer EECAxPeer worldbank trade infdi
age65 parties fhouse partdem deficit mcap gdpcap lngdp, dist(loglog)

Log-logistic regression -- accelerated failure-time form

No. of subjects =           58                     Number of obs   =       803
No. of failures =           18
Time at risk    =          803
                                                   LR chi2(16)     =     42.49
Log likelihood  =   -14.309971                     Prob > chi2     =    0.0003
------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  peerprivat |   .0346197   .0263019     1.32   0.188    -.0169311    .0861706
     LatinAm |    .438246   .6020244     0.73   0.467    -.7417002    1.618192
  EEurCentAs |   .9684151   .6942763     1.39   0.163    -.3923416    2.329172
  LatAmxPeer |  -.0574358   .0311272    -1.85   0.065    -.1184441    .0035725
   EECAxPeer |  -.1731516   .0915367    -1.89   0.059    -.3525602    .0062571
 (control variables omitted)
-------------+----------------------------------------------------------------
     /ln_gam |  -1.385553   .3013105    -4.60   0.000     -1.97611    -.794995
-------------+----------------------------------------------------------------
       gamma |   .2501855   .0753835                      .1386073    .4515835
------------------------------------------------------------------------------
```

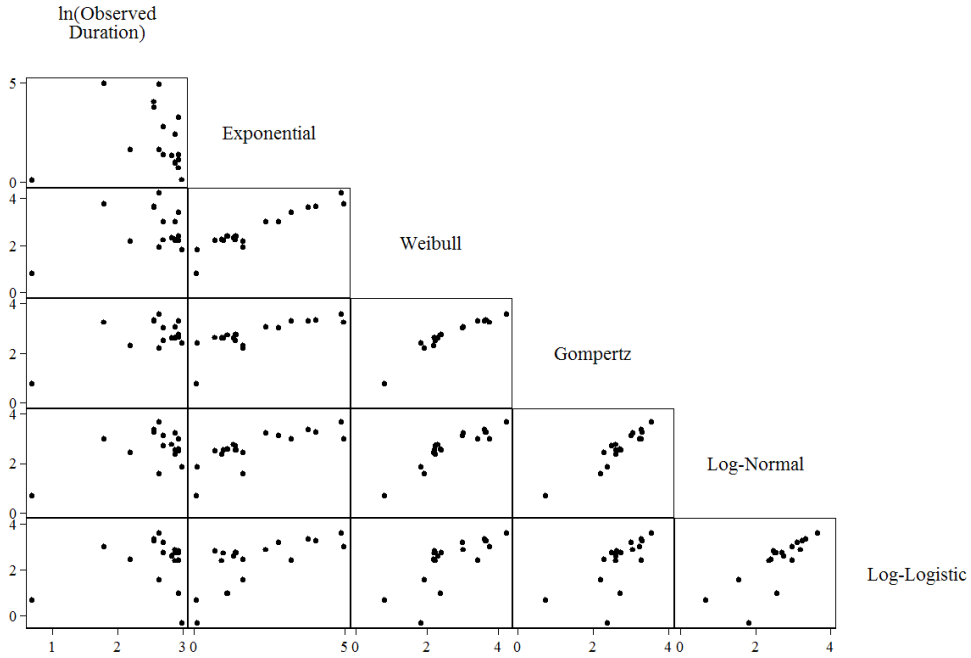
```
. streg peerprivat LatinAm EEurCentAs LatAmxPeer EECAxPeer worldbank trade infdi
age65 parties fhouse partdem deficit mcap gdpcap lngdp, nohr dist(gompertz)

Gompertz regression -- log relative-hazard form

No. of subjects =           58                     Number of obs   =       803
No. of failures =           18
Time at risk    =          803
                                                   LR chi2(16)     =     39.38
Log likelihood  =   -14.058911                     Prob > chi2     =    0.0010
------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  peerprivat |  -.0945198   .0970719    -0.97   0.330    -.2847771    .0957375
     LatinAm |   -1.31783   1.878998    -0.70   0.483    -5.000598    2.364938
  EEurCentAs |  -.5073125   1.982736    -0.26   0.798    -4.393404    3.378779
  LatAmxPeer |   .1794368   .0955893     1.88   0.060    -.0079148    .3667884
   EECAxPeer |   .1353885   .0968469     1.40   0.162     -.054428    .3252049
 (control variables omitted)
-------------+----------------------------------------------------------------
       gamma |   .1749681   .1149338     1.52   0.128    -.0502981    .4002343
------------------------------------------------------------------------------

. streg peerprivat LatinAm EEurCentAs LatAmxPeer EECAxPeer worldbank trade infdi
age65 parties fhouse partdem deficit mcap gdpcap lngdp, dist(gamma)

Fitting constant-only model:

Iteration 0:   log likelihood = -66.490766  (not concave)
Iteration 1:   log likelihood = -40.072025
.
.
.
Iteration 12:  log likelihood = -34.544303

Fitting full model:

Iteration 0:   log likelihood = -34.544303  (not concave)
Iteration 1:   log likelihood = -30.529341  (not concave)
Iteration 2:   log likelihood = -27.222987  (not concave)
Iteration 3:   log likelihood = -25.569054  (not concave)
.
.
.
Iteration 24:  log likelihood = -16.376731  (not concave)
Iteration 25:  log likelihood = -16.254939  (not concave)
discontinuous region encountered
cannot compute an improvement
r(430);
```

AIC & BIC

Table 1: ln$L$, AIC, and BIC for Five Parametric Models

Model	ln$L$	AIC	BIC
Exponential	-15.218	64.436	144.14
Weibull	-13.320	62.640	147.03
Gompertz	-14.059	64.118	148.51
Log-Normal	-15.224	66.447	150.84
Log-Logistic	-14.310	64.620	149.01

Fitted Values




```
. corr ln_duration lnThat_E lnThat_W lnThat_G lnThat_LN lnThat_LL if fail==1
(obs=18)

             | ln_dur~n lnThat_E lnThat_W lnThat_G lnThat~N lnThat~L
-------------+------------------------------------------------------
 ln_duration |   1.0000
    lnThat_E |  -0.0361   1.0000
    lnThat_W |   0.2647   0.9398   1.0000
    lnThat_G |   0.5873   0.7656   0.9294   1.0000
   lnThat_LN |   0.4870   0.7522   0.9067   0.9423   1.0000
   lnThat_LL |   0.1837   0.6758   0.7095   0.6644   0.7868   1.0000
```

Hazard Ratios

```
. streg peerprivat LatinAm EEurCentAs LatAmxPeer EECAxPeer worldbank trade infdi
age65 parties fhouse partdem deficit mcap gdpcap lngdp, dist(weibull)

Weibull regression -- log relative-hazard form

No. of subjects =           58                     Number of obs   =       803
No. of failures =           18
Time at risk    =          803
                                                   LR chi2(16)     =     43.42
Log likelihood  =   -13.319909                     Prob > chi2     =    0.0002

------------------------------------------------------------------------------
          _t | Haz. Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  peerprivat |   .9501933   .0742503    -0.65   0.513     .8152618    1.107457
     LatinAm |   .4045029   .7392988    -0.50   0.620     .0112513    14.54251
  EEurCentAs |   1.416854   2.306705     0.21   0.831     .0582813    34.44461
  LatAmxPeer |    1.16952   .1031828     1.77   0.076     .9838049    1.390293
   EECAxPeer |   1.109824   .0960801     1.20   0.229     .9366203    1.315057
   worldbank |   .6006042   .2568022    -1.19   0.233      .259799    1.388479
       trade |   .9690452   .0153703    -1.98   0.047     .9393833    .9996437
       infdi |   1.217814   .1259195     1.91   0.057     .9944172    1.491398
       age65 |   1.354827   .1825433     2.25   0.024     1.040391    1.764294
     parties |   1.762772    .553122     1.81   0.071     .9530294    3.260512
      fhouse |   3.716148   1.394028     3.50   0.000     1.781493    7.751787
     partdem |   .6515205   .0855734    -3.26   0.001     .5036488    .8428075
     deficit |   1.238215   .1344362     1.97   0.049     1.000873    1.531839
        mcap |   1.008013    .010827     0.74   0.457     .9870141    1.029458
      gdpcap |    .999944    .000127    -0.44   0.659     .9996952    1.000193
       lngdp |   1.296133   .3975817     0.85   0.398     .7104736    2.364563
-------------+----------------------------------------------------------------
       /ln_p |   .6882986    .293876     2.34   0.019     .1123122    1.264285
-------------+----------------------------------------------------------------
           p |   1.990326   .5849091                      1.118862     3.54056
         1/p |   .5024302   .1476522                      .2824412    .8937652
------------------------------------------------------------------------------
```

Linear Combinations of Parameters:

```
. lincom(peerprivat+LatAmxPeer)

 ( 1)  [_t]peerprivat + [_t]LatAmxPeer = 0

------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .1055036   .0457227     2.31   0.021     .0158887    .1951185
------------------------------------------------------------------------------

. lincom(peerprivat+EECAxPeer)

 ( 1)  [_t]peerprivat + [_t]EECAxPeer = 0

------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .0531117   .0448715     1.18   0.237    -.0348348    .1410581
------------------------------------------------------------------------------
```

Nonlinear Combinations of Parameters:

```
. nlcom(exp(_b[peerprivat]+_b[LatAmxPeer]))

       _nl_1:  exp(_b[peerprivat]+_b[LatAmxPeer])

------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _nl_1 |    1.11127   .0508103    21.87   0.000     1.011684    1.210856
------------------------------------------------------------------------------

. nlcom(exp(_b[peerprivat]+_b[EECAxPeer]))

       _nl_1:  exp(_b[peerprivat]+_b[EECAxPeer])

------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _nl_1 |   1.054547   .0473191    22.29   0.000     .9618037    1.147291
------------------------------------------------------------------------------
```

Predicted Hazard and Survival Curves

Figure 6: Predicted Survival Curve, at $\bar{\mathbf{X}}\hat{\beta}$

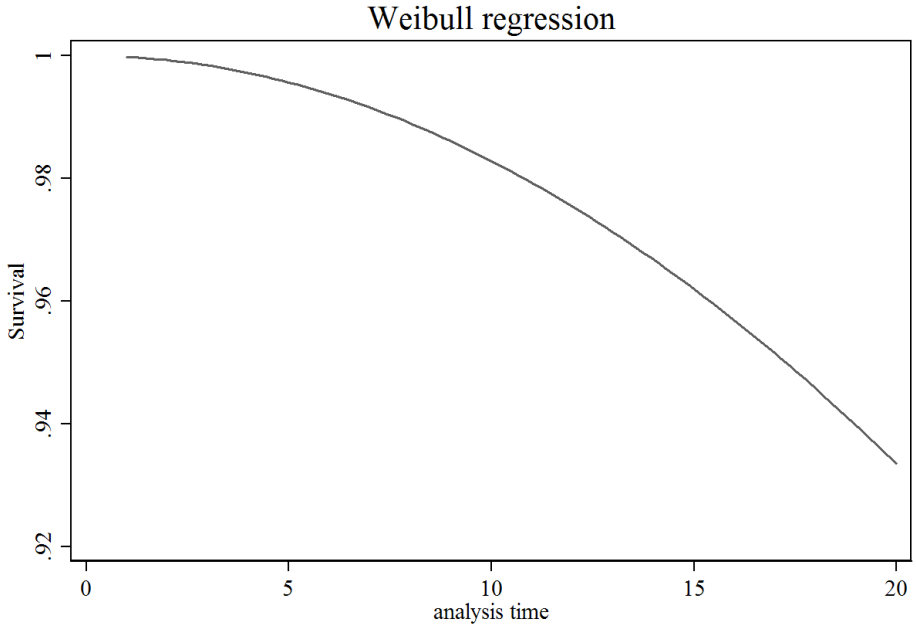


Figure 7: Predicted Hazards for Three Peer Groups, at Group-Specific Means

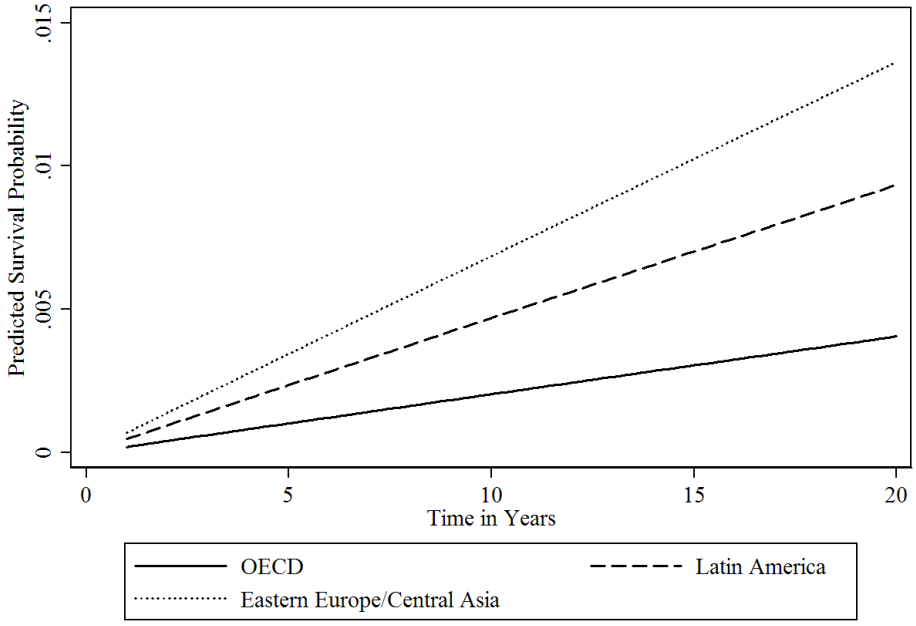


Figure 8: Predicted Survival Curves for Three Peer Groups, at Group-Specific Means

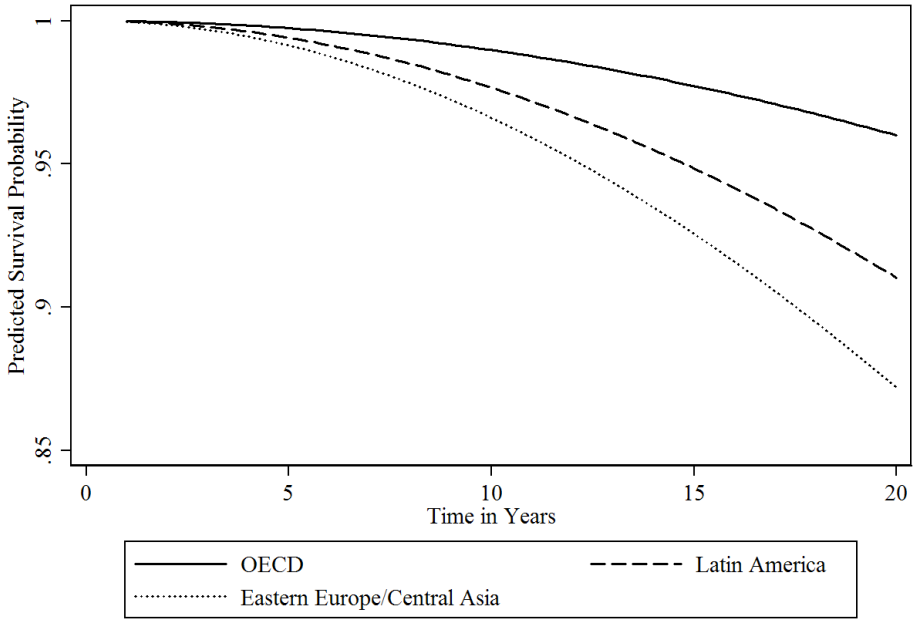
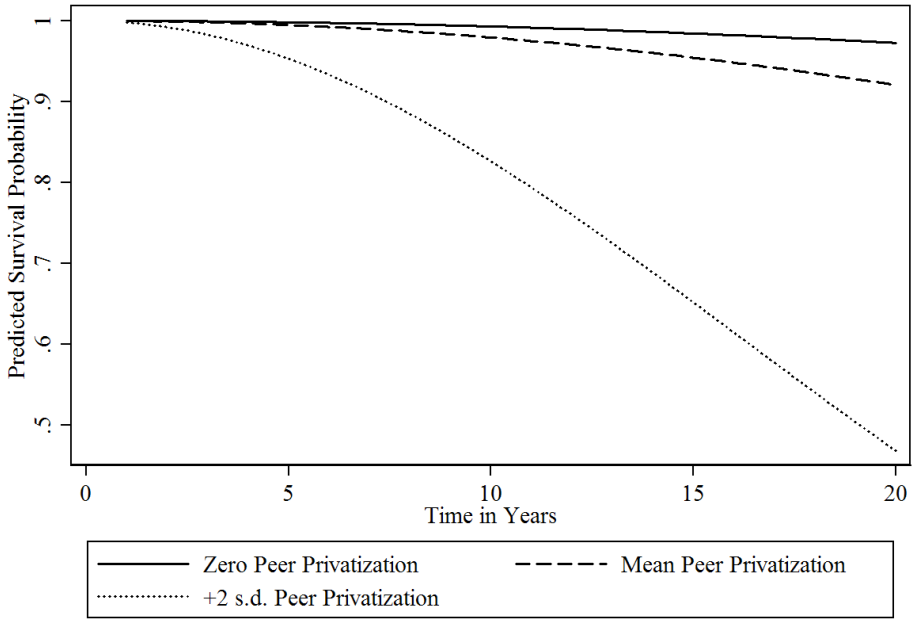


Figure 9: Predicted Survival Curves for Latin American Countries, at Three Levels of *Peer Privatization*



Data: Dyadic Interstate Disputes, 1950-1985

```
. su duration dispute allies contig capratio growth democ trade

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
    duration |     20448    14.18574    8.804608          1         35
     dispute |     20448    .0198063    .1393377          0          1
      allies |     20448    .3563185    .4789226          0          1
      contig |     20448    .3098592    .4624467          0          1
    capratio |     20448    1.667739    4.478851        .01    78.9296
-------------+--------------------------------------------------------
      growth |     20448    .0078229    .0335592     -.2649      .1647
       democ |     20448   -.3437549    .6954232         -1          1
       trade |     20448    .0023101     .008264          0      .1768

. stdes

         failure _d:  dispute
   analysis time _t:  duration
  enter on or after:  time start

                                    |-------------- per subject --------------|
Category                   total        mean         min     median        max
------------------------------------------------------------------------------
no. of subjects            20448
no. of records             20448           1           1          1          1

(first) entry time                   13.18574           0         12         34
(final) exit time                    14.18574           1         13         35

subjects with gap              0
time on gap if gap             0
time at risk               20448           1           1          1          1

failures                     405    .0198063           0          0          1
------------------------------------------------------------------------------
```

Basic Cox Model (Efron Method for Ties):

```
. stcox allies contig capratio growth democ trade, nohr efron bases(basicS)
basehc(basich)

Cox regression -- Efron method for ties

No. of subjects =        20448                     Number of obs   =     20448
No. of failures =          405
Time at risk    =        20448
                                                   LR chi2(6)      =    272.35
Log likelihood  =   -2501.8834                     Prob > chi2     =    0.0000
------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      allies |  -.4141413   .1107106    -3.74   0.000    -.6311301   -.1971526
      contig |   1.213475    .120933    10.03   0.000     .9764511      1.4505
    capratio |  -.2142166   .0514351    -4.16   0.000    -.3150276   -.1134056
      growth |  -3.227159    1.22786    -2.63   0.009    -5.633721   -.8205979
       democ |  -.4394706   .0997931    -4.40   0.000    -.6350616   -.2438797
       trade |  -13.16247   10.32656    -1.27   0.202    -33.40216    7.077214
------------------------------------------------------------------------------
```

Hazard Ratios

```
. stcox

Cox regression -- Efron method for ties

No. of subjects =        20448                     Number of obs   =     20448
No. of failures =          405
Time at risk    =        20448
                                                   LR chi2(6)      =    272.35
Log likelihood  =   -2501.8834                     Prob > chi2     =    0.0000
------------------------------------------------------------------------------
          _t | Haz. Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      allies |   .6609075   .0731695    -3.74   0.000     .5319903    .8210654
      contig |    3.36516   .4069588    10.03   0.000     2.655017    4.265245
    capratio |   .8071736   .0415171    -4.16   0.000     .7297688    .8927885
      growth |     .03967   .0487092    -2.63   0.009     .0035752    .4401684
       democ |   .6443774   .0643044    -4.40   0.000     .5299029    .7835819
       trade |   1.92e-06   .0000198    -1.27   0.202     3.12e-15    1184.663
------------------------------------------------------------------------------
```

An Illustration of the Effect of "Ties"

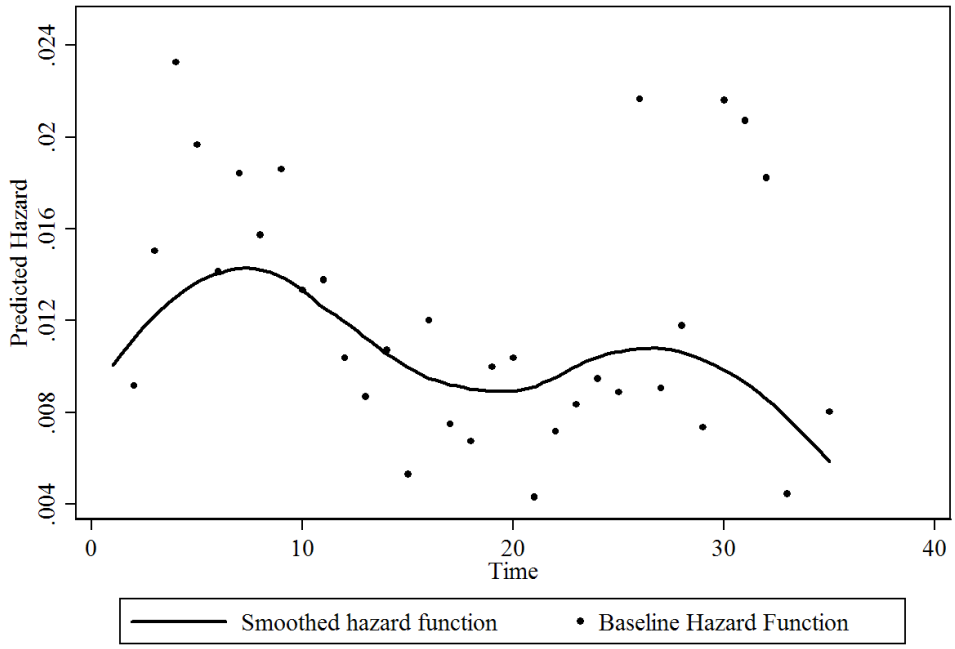
```
. stcox allies contig capratio growth democ trade, nohr

Cox regression -- Breslow method for ties

No. of subjects =        20448                     Number of obs   =     20448
No. of failures =          405
Time at risk    =        20448
                                                   LR chi2(6)      =    264.75
Log likelihood  =   -2510.7156                     Prob > chi2     =    0.0000
------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      allies |  -.4005594    .110695    -3.62   0.000    -.6175176   -.1836013
      contig |   1.193988   .1208723     9.88   0.000     .9570829    1.430894
    capratio |  -.2109814   .0511536    -4.12   0.000    -.3112405   -.1107223
      growth |  -3.126839   1.227503    -2.55   0.011    -5.532701   -.7209763
       democ |   -.434744   .0999085    -4.35   0.000    -.6305612   -.2389269
       trade |  -13.06191   10.28504    -1.27   0.204    -33.22023    7.096406
------------------------------------------------------------------------------

. stset untied_duration, fail(dispute) en(untied_start)
<output omitted>

. stcox allies contig capratio growth democ trade, nohr

Cox regression -- no ties

No. of subjects =        20448                     Number of obs   =     20448
No. of failures =          405
Time at risk    =  20449.21692
                                                   LR chi2(6)      =    269.77
Log likelihood  =   -2501.1676                     Prob > chi2     =    0.0000
------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      allies |  -.4219632   .1107677    -3.81   0.000    -.6390639   -.2048625
      contig |   1.222924   .1209401    10.11   0.000     .9858857    1.459962
    capratio |  -.2068422   .0509056    -4.06   0.000    -.3066153   -.1070691
      growth |  -3.500547   1.234624    -2.84   0.005    -5.920365   -1.080729
       democ |   -.430965   .1003055    -4.30   0.000    -.6275602   -.2343697
       trade |  -14.49323   10.52374    -1.38   0.168    -35.11939    6.132917
------------------------------------------------------------------------------
```

"Exact" Methods for Ties

```
. stcox allies contig capratio growth democ trade, nohr exactp

Cox regression -- exact partial likelihood

No. of subjects =        20448                     Number of obs   =     20448
No. of failures =          405
Time at risk    =        20448
                                                   LR chi2(6)      =    272.57
Log likelihood  =   -1726.7658                     Prob > chi2     =    0.0000
------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      allies |  -.4204018     .11343    -3.71   0.000    -.6427206    -.198083
      contig |   1.237777   .1228533    10.08   0.000     .9969887    1.478565
    capratio |  -.2151302   .0516297    -4.17   0.000    -.3163226   -.1139379
      growth |    -3.3322   1.267388    -2.63   0.009    -5.816235   -.8481654
       democ |  -.4475007   .1012385    -4.42   0.000    -.6459244    -.249077
       trade |  -13.55219   10.43382    -1.30   0.194    -34.00211    6.897731
------------------------------------------------------------------------------


. stcox allies contig capratio growth democ trade, nohr exactm

Cox regression -- exact marginal likelihood

No. of subjects =        20448                     Number of obs   =     20448
No. of failures =          405
Time at risk    =        20448
                                                   LR chi2(6)      =    272.54
Log likelihood  =   -1726.9865                     Prob > chi2     =    0.0000
------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      allies |  -.4146707   .1107262    -3.75   0.000    -.6316901   -.1976514
      contig |   1.213951   .1209406    10.04   0.000     .9769113     1.45099
    capratio |  -.2143322   .0514458    -4.17   0.000     -.315164   -.1135003
      growth |  -3.232832   1.228313    -2.63   0.008    -5.640281   -.8253836
       democ |  -.4396288   .0997959    -4.41   0.000    -.6352251   -.2440325
       trade |  -13.15716   10.32803    -1.27   0.203    -33.39971    7.085402
------------------------------------------------------------------------------
```

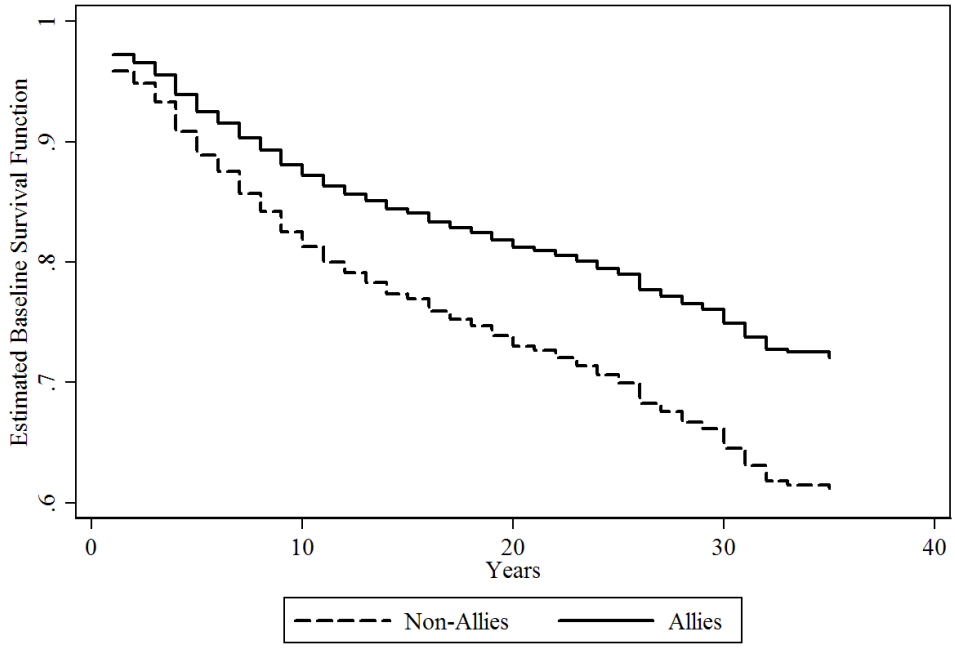
Plotting the Baseline Hazard

Figure 10: Predicted Survival Curves for *Allies*=0 and *Allies*=1



Comparing Predicted Survival Curves

Figure 11: Predicted Survival Curves for *Allies*=0 and *Allies*=1



Robust/Sandwich Variance Estimates

```
. stcox allies contig capratio growth democ trade, nohr efron robust

Cox regression -- Efron method for ties

No. of subjects      =        20448                 Number of obs   =     20448
No. of failures      =          405
Time at risk         =        20448
                                                    Wald chi2(6)    =    203.10
Log pseudolikelihood =   -2501.8834                 Prob > chi2     =    0.0000
------------------------------------------------------------------------------
             |               Robust
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      allies |  -.4141413   .1133494    -3.65   0.000    -.6363021   -.1919805
      contig |   1.213475   .1266108     9.58   0.000     .9653229    1.461628
    capratio |  -.2142166   .0632447    -3.39   0.001    -.3381738   -.0902593
      growth |  -3.227159   1.301138    -2.48   0.013    -5.777344   -.6769749
       democ |  -.4394706   .0951549    -4.62   0.000    -.6259708   -.2529705
       trade |  -13.16247   11.40692    -1.15   0.249    -35.51963    9.194679
------------------------------------------------------------------------------


. stcox allies contig capratio growth democ trade, nohr efron robust cluster(dyadid)

Cox regression -- Efron method for ties

No. of subjects      =        20448                 Number of obs   =     20448
No. of failures      =          405
Time at risk         =        20448
                                                    Wald chi2(6)    =     92.92
Log pseudolikelihood =   -2501.8834                 Prob > chi2     =    0.0000
                              (Std. Err. adjusted for 827 clusters in dyadid)
------------------------------------------------------------------------------
             |               Robust
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      allies |  -.4141413   .1704406    -2.43   0.015    -.7481988   -.0800839
      contig |   1.213475   .1782591     6.81   0.000      .864094    1.562857
    capratio |  -.2142166    .081796    -2.62   0.009    -.3745337   -.0538994
      growth |  -3.227159   1.317689    -2.45   0.014    -5.809782   -.6445371
       democ |  -.4394706   .1231521    -3.57   0.000    -.6808444   -.1980969
       trade |  -13.16247   13.82712    -0.95   0.341    -40.26313    13.93818
------------------------------------------------------------------------------
```

Some R Examples

Model Estimation:

```
> robustCox<-coxph(Surv(start, duration, dispute)~allies +
contig + capratio + growth + democ + trade, data=Day5OR,
na.action=na.exclude, method="efron", robust=TRUE)

> summary(robustCox)
Call:
coxph(formula = Surv(start, duration, dispute) ~ allies + contig +
    capratio + growth + democ + trade, data = Day5OR, na.action = na.exclude,
    method = "efron", robust = TRUE)

  n= 20448
            coef exp(coef) se(coef) robust se     z       p
allies    -0.414  6.61e-01   0.1107    0.1133 -3.65 2.6e-04
contig     1.213  3.37e+00   0.1209    0.1266  9.58 0.0e+00
capratio  -0.214  8.07e-01   0.0514    0.0632 -3.39 7.1e-04
growth    -3.227  3.97e-02   1.2279    1.3011 -2.48 1.3e-02
democ     -0.439  6.44e-01   0.0998    0.0952 -4.62 3.9e-06
trade    -13.162  1.92e-06  10.3266   11.4066 -1.15 2.5e-01

         exp(coef) exp(-coef) lower .95 upper .95
allies    6.61e-01   1.51e+00  5.29e-01     0.825
contig    3.37e+00   2.97e-01  2.63e+00     4.313
capratio  8.07e-01   1.24e+00  7.13e-01     0.914
growth    3.97e-02   2.52e+01  3.10e-03     0.508
democ     6.44e-01   1.55e+00  5.35e-01     0.776
trade     1.92e-06   5.20e+05  3.75e-16  9839.225

Rsquare= 0.013   (max possible= 0.227 )
Likelihood ratio test= 272  on 6 df,   p=0
Wald test            = 203  on 6 df,   p=0
Score (logrank) test = 262  on 6 df,   p=0,   Robust = 221  p=0

  (Note: the likelihood ratio and score tests assume independence of
     observations within a cluster, the Wald and robust score tests do not).
```

Robust/Sandwich Variance Estimates:

```
> clusterCox<-coxph(Surv(start, duration, dispute)~allies + contig + capratio + growth +
democ + trade + cluster(dyadid), data=Day5OR, na.action=na.exclude, method="efron")

> summary(clusterCox)
Call:
coxph(formula = Surv(start, duration, dispute) ~ allies + contig +
    capratio + growth + democ + trade + cluster(dyadid), data = Day5OR,
    na.action = na.exclude, method = "efron")

  n= 20448
            coef exp(coef) se(coef) robust se      z       p
allies    -0.414  6.61e-01   0.1107    0.1703 -2.431 1.5e-02
contig     1.213  3.37e+00   0.1209    0.1782  6.811 9.7e-12
capratio  -0.214  8.07e-01   0.0514    0.0817 -2.620 8.8e-03
growth    -3.227  3.97e-02   1.2279    1.3169 -2.451 1.4e-02
democ     -0.439  6.44e-01   0.0998    0.1231 -3.571 3.6e-04
trade    -13.162  1.92e-06  10.3266   13.8188 -0.953 3.4e-01

         exp(coef) exp(-coef) lower .95 upper .95
allies    6.61e-01   1.51e+00  4.73e-01  9.23e-01
contig    3.37e+00   2.97e-01  2.37e+00  4.77e+00
capratio  8.07e-01   1.24e+00  6.88e-01  9.47e-01
growth    3.97e-02   2.52e+01  3.00e-03  5.24e-01
democ     6.44e-01   1.55e+00  5.06e-01  8.20e-01
trade     1.92e-06   5.20e+05  3.32e-18  1.11e+06

Rsquare= 0.013   (max possible= 0.227 )
Likelihood ratio test= 272  on 6 df,   p=0
Wald test            = 93  on 6 df,   p=0
Score (logrank) test = 262  on 6 df,   p=0,   Robust = 78.2  p=8.33e-15

  (Note: the likelihood ratio and score tests assume independence of
     observations within a cluster, the Wald and robust score tests do not).
```

Plotting Predicted Mean Survival:

```
> plot(survfit(robustCox), ylim=c(.6,1), xlab='Years', ylab='Mean Estimated
  Survival Probability', lwd=3, cex.lab=1.2)
```

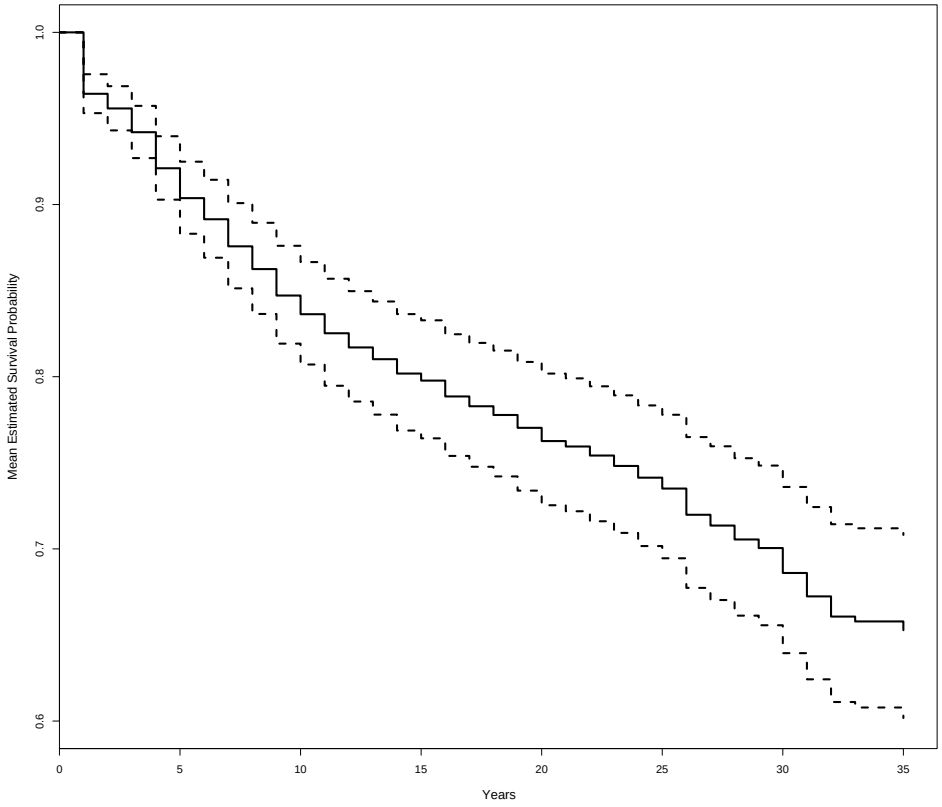
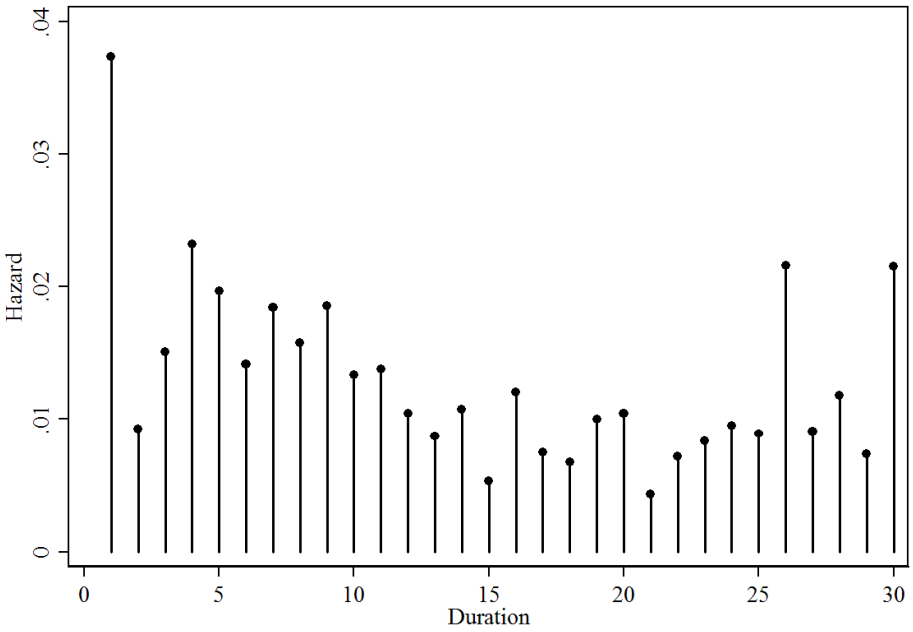


Figure 12: A Discrete Hazard Function



A Few Logit Analyses

```
. logit dispute allies contig capratio growth democ trade

Logistic regression                                     Number of obs   =      20448
                                                        LR chi2(6)      =     284.79
                                                        Prob > chi2     =     0.0000
Log likelihood = -1846.8783                             Pseudo R2       =     0.0716
------------------------------------------------------------------------------
     dispute |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      allies |  -.4796863   .1127463    -4.25   0.000    -.7006649   -.2587076
      contig |   1.353576   .1209052    11.20   0.000     1.116606    1.590546
    capratio |  -.1961988   .0501055    -3.92   0.000    -.2944037   -.0979938
      growth |   -3.42753   1.251813    -2.74   0.006    -5.881038   -.9740222
       democ |  -.4011976   .1006345    -3.99   0.000    -.5984376   -.2039576
       trade |  -21.07611   11.30396    -1.86   0.062    -43.23146    1.079242
       _cons |  -4.326677   .1145089   -37.78   0.000     -4.55111   -4.102243
------------------------------------------------------------------------------
```

```
. logit dispute allies contig capratio growth democ trade duration

Logistic regression                                     Number of obs   =      20448
                                                        LR chi2(7)      =     315.04
                                                        Prob > chi2     =     0.0000
Log likelihood = -1831.7544                             Pseudo R2       =     0.0792
------------------------------------------------------------------------------
     dispute |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      allies |  -.4372892   .1133989    -3.86   0.000    -.6595469   -.2150315
      contig |   1.237468   .1231841    10.05   0.000     .9960314    1.478904
    capratio |  -.2221353   .0522061    -4.25   0.000    -.3244573   -.1198133
      growth |  -3.906579    1.24168    -3.15   0.002    -6.340227    -1.47293
       democ |  -.3897999   .0993313    -3.92   0.000    -.5844857   -.1951141
       trade |  -12.52205    10.5063    -1.19   0.233    -33.11402    8.069913
    duration |  -.0348606   .0064981    -5.36   0.000    -.0475967   -.0221245
       _cons |  -3.831356   .1422191   -26.94   0.000    -4.110101   -3.552612
------------------------------------------------------------------------------

. logit dispute allies contig capratio growth democ trade duration durationsq
duration3 duration4

Logistic regression                                     Number of obs   =      20448
                                                        LR chi2(10)     =     335.03
                                                        Prob > chi2     =     0.0000
Log likelihood = -1821.7585                             Pseudo R2       =     0.0842
------------------------------------------------------------------------------
     dispute |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      allies |  -.4264649   .1133056    -3.76   0.000    -.6485398   -.2043899
      contig |   1.236488   .1228581    10.06   0.000     .9956904    1.477285
    capratio |  -.2164406   .0516908    -4.19   0.000    -.3177528   -.1151285
      growth |  -3.662032   1.258202    -2.91   0.004    -6.128062   -1.196002
       democ |  -.4367741   .1010708    -4.32   0.000    -.6348692    -.238679
       trade |  -13.32134   10.45781    -1.27   0.203    -33.81826    7.175589
    duration |   .0125515   .0967292     0.13   0.897    -.1770342    .2021372
  durationsq |  -.0154883   .0122938    -1.26   0.208    -.0395837     .008607
   duration3 |   .0008897   .0005698     1.56   0.118    -.0002271    .0020065
   duration4 |  -.0000137   8.63e-06    -1.59   0.112    -.0000306    3.21e-06
       _cons |  -3.712094     .24111   -15.40   0.000    -4.184661   -3.239527
------------------------------------------------------------------------------

. testparm durat*

 ( 1)  duration = 0
 ( 2)  durationsq = 0
 ( 3)  duration3 = 0
 ( 4)  duration4 = 0

           chi2(  4) =   51.06
         Prob > chi2 =    0.0000
```

```
. xi i.duration
i.duration        _Iduration_1-35     (naturally coded; _Iduration_1 omitted)

. logit dispute allies contig capratio growth democ trade _Iduration_2 - _Iduration_33
_Iduration_35

Logistic regression                                     Number of obs   =      20448
                                                        LR chi2(39)     =     375.92
                                                        Prob > chi2     =     0.0000
Log likelihood = -1801.3137                             Pseudo R2       =     0.0945
------------------------------------------------------------------------------
     dispute |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      allies |  -.4314486   .1134293    -3.80   0.000    -.6537659   -.2091313
      contig |    1.26358   .1225534    10.31   0.000      1.02338    1.503781
    capratio |  -.2093872   .0510959    -4.10   0.000    -.3095332   -.1092411
      growth |  -3.404787   1.275106    -2.67   0.008    -5.903948   -.9056258
       democ |  -.4634443   .1017302    -4.56   0.000    -.6628319   -.2640567
       trade |  -14.78303   10.54518    -1.40   0.161    -35.45121    5.885155
_Iduration_2 |  -1.319414   .3285792    -4.02   0.000    -1.963417   -.6754108
<output omitted>
_Iduratio~33 |  -2.029241   1.016382    -2.00   0.046    -4.021313   -.0371691
_Iduratio~35 |  -1.418437   1.020086    -1.39   0.164    -3.417769    .5808961
       _cons |  -3.401713    .180382   -18.86   0.000    -3.755255   -3.048171
------------------------------------------------------------------------------

. testparm _I*

 ( 1)  _Iduration_2 = 0
 ( 2)  _Iduration_3 = 0
.
.
.
<output omitted>
.
.
.
 (32)  _Iduration_33 = 0
 (33)  _Iduration_35 = 0

           chi2( 33) =   89.06
         Prob > chi2 =    0.0000
```

Figure 13: Predicted Mean Hazards, Discrete-Time (Logit) Models

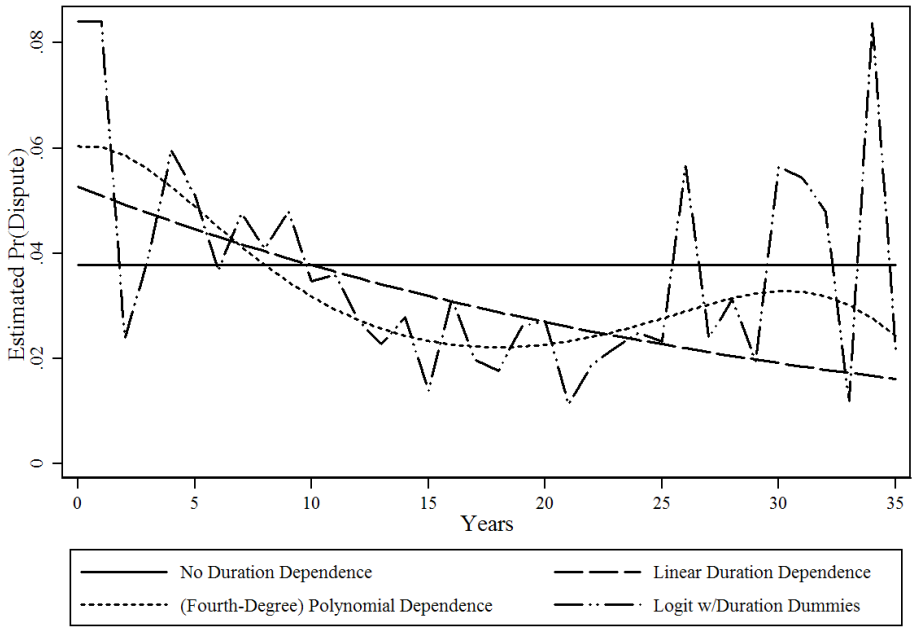
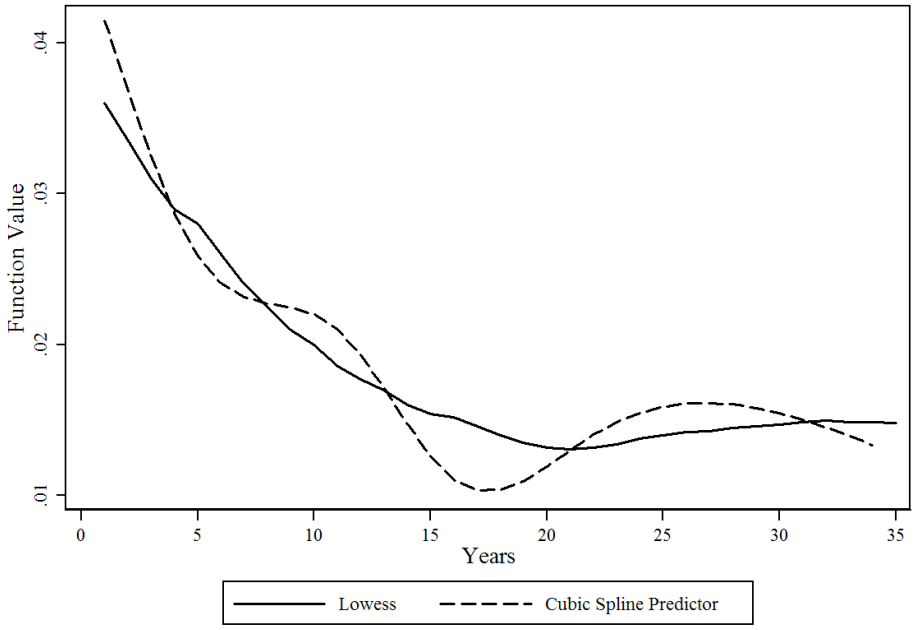


Figure 14: Lowess and Cubic Spline Functions of `dispute` on `duration`



```
. lowess dispute duration, adjust nograph gen(lowessDur)

. logit dispute allies contig capratio growth democ trade lowessDur

Logistic regression                                     Number of obs   =      20448
                                                        LR chi2(7)      =     333.04
                                                        Prob > chi2     =     0.0000
Log likelihood = -1822.7544                             Pseudo R2       =     0.0837
------------------------------------------------------------------------------
     dispute |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      allies |  -.4213745   .1133634    -3.72   0.000    -.6435626   -.1991864
      contig |   1.222782   .1226094     9.97   0.000     .9824719    1.463092
    capratio |   -.221008   .0519247    -4.26   0.000    -.3227787   -.1192374
      growth |  -3.618861   1.241322    -2.92   0.004    -6.051808   -1.185915
       democ |  -.4240152   .0998594    -4.25   0.000     -.619736   -.2282944
       trade |   -12.2739   10.33369    -1.19   0.235    -32.52757    7.979765
   lowessDur |   46.89038   6.577867     7.13   0.000       33.998    59.78277
       _cons |  -5.282134   .1825519   -28.93   0.000    -5.639929   -4.924339
------------------------------------------------------------------------------


. spline dispute duration, n(4) gen(newspline) nograph

. logit dispute allies contig capratio growth democ trade newspline

Logistic regression                                     Number of obs   =      20448
                                                        LR chi2(7)      =     334.15
                                                        Prob > chi2     =     0.0000
Log likelihood = -1822.1979                             Pseudo R2       =     0.0840
------------------------------------------------------------------------------
     dispute |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      allies |  -.4205267   .1133223    -3.71   0.000    -.6426344    -.198419
      contig |   1.230388   .1223423    10.06   0.000     .9906017    1.470175
    capratio |  -.2181174   .0516733    -4.22   0.000    -.3193953   -.1168395
      growth |  -3.423613   1.239825    -2.76   0.006    -5.853625   -.9936014
       democ |  -.4302531   .1000463    -4.30   0.000    -.6263402   -.2341661
       trade |   -12.9469   10.39186    -1.25   0.213    -33.31458    7.420777
   newspline |   39.65726   5.464181     7.26   0.000     28.94766    50.36686
       _cons |  -5.147013   .1666201   -30.89   0.000    -5.473583   -4.820444
------------------------------------------------------------------------------
```

```
. rc_spline duration, nk(4)
 number of knots = 4
 value of knot 1 = 2
 value of knot 2 = 9
 value of knot 3 = 18
 value of knot 4 = 30


. logit dispute allies contig capratio growth democ trade _Sduration1 _Sduration2
_Sduration3

Logistic regression                                     Number of obs   =      20448
                                                        LR chi2(9)      =     334.50
                                                        Prob > chi2     =     0.0000
Log likelihood = -1822.0226                             Pseudo R2       =     0.0841
------------------------------------------------------------------------------
     dispute |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      allies |  -.4271112   .1133278    -3.77   0.000    -.6492297   -.2049927
      contig |   1.235308   .1228487    10.06   0.000     .9945287    1.476087
    capratio |  -.2168885   .0516832    -4.20   0.000    -.3181858   -.1155913
      growth |   -3.68127   1.256232    -2.93   0.003     -6.14344     -1.2191
       democ |   -.442577   .1011338    -4.38   0.000    -.6407955   -.2443584
       trade |  -12.98309   10.39775    -1.25   0.212     -33.3623    7.396126
 _Sduration1 |  -.0675975    .027676    -2.44   0.015    -.1218415   -.0133535
 _Sduration2 |  -.0280649   .1328698    -0.21   0.833    -.2884848    .2323551
 _Sduration3 |   .2396889   .3030326     0.79   0.429    -.3542441    .8336218
       _cons |  -3.628666   .1792857   -20.24   0.000     -3.98006   -3.277273
------------------------------------------------------------------------------


. testparm _S*

 ( 1)  _Sduration1 = 0
 ( 2)  _Sduration2 = 0
 ( 3)  _Sduration3 = 0

           chi2(  3) =   49.91
         Prob > chi2 =    0.0000
```

Figure 15: Mean Predicted Hazards, Lowess and Cubic Spline Models

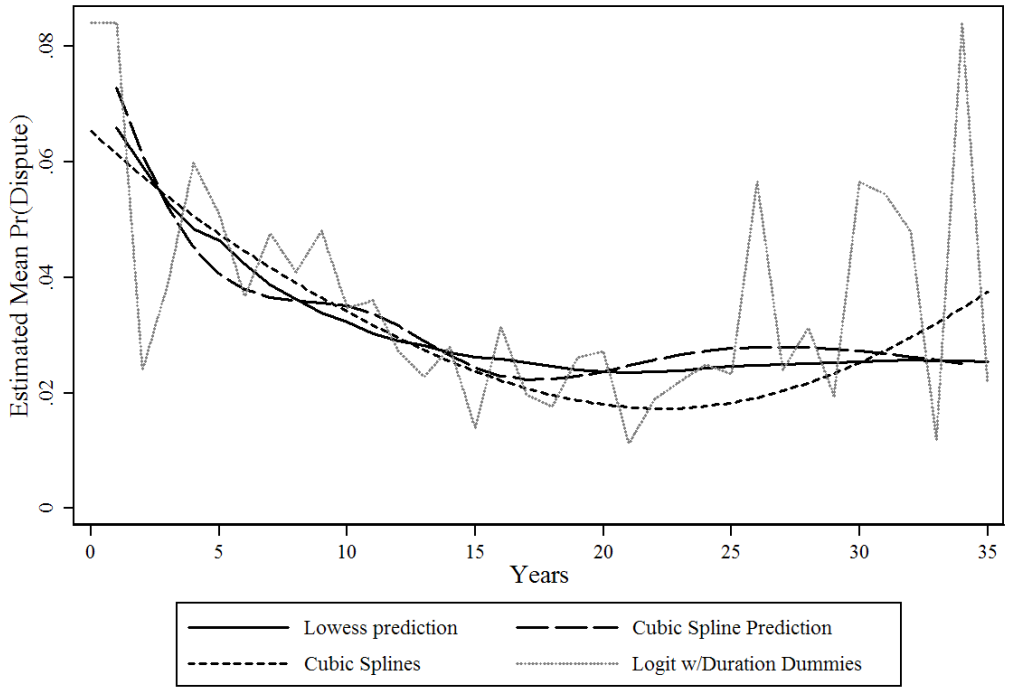


Table 2: AIC and BIC Values, Discrete-Time (Logit) Models

Model	ln$L$	d.f.	AIC	BIC
No Dependence / "Flat"	-1846.88	7	3707.8	3763.2
Linear	-1831.75	8	3679.5	3742.9
Polynomial	-1821.76	11	3665.5	3752.7
"Duration Dummies"	-1801.31	40	3682.6	3999.7
Lowess	-1822.75	8	3661.5	3724.9
Cubic Spline (linear predictor)	-1822.20	8	3660.4	3723.8
Cubic Splines	-1822.02	10	3664.0	3743.3

Cox/Poisson Equivalence

```
. stcox allies contig capratio growth democ trade, nohr

Cox regression -- Breslow method for ties

No. of subjects =        20448                     Number of obs   =     20448
No. of failures =          405
Time at risk    =        20448
                                                   LR chi2(6)      =    264.75
Log likelihood  =   -2510.7156                     Prob > chi2     =    0.0000
------------------------------------------------------------------------------
          _t |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      allies |  -.4005594    .110695    -3.62   0.000    -.6175176   -.1836013
      contig |   1.193988   .1208723     9.88   0.000     .9570829    1.430894
    capratio |  -.2109814   .0511536    -4.12   0.000    -.3112405   -.1107223
      growth |  -3.126839   1.227503    -2.55   0.011    -5.532701   -.7209763
       democ |   -.434744   .0999085    -4.35   0.000    -.6305612   -.2389269
       trade |  -13.06191   10.28504    -1.27   0.204    -33.22023    7.096406
------------------------------------------------------------------------------

. xi: poisson dispute allies contig capratio growth democ trade i.duration

i.duration        _Iduration_1-35     (naturally coded; _Iduration_1 omitted)

Poisson regression                                 Number of obs   =      20448
                                                   LR chi2(40)     =     377.70
                                                   Prob > chi2     =     0.0000
Log likelihood = -1804.4594                        Pseudo R2       =     0.0947
------------------------------------------------------------------------------
     dispute |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      allies |  -.4005639   .1106933    -3.62   0.000    -.6175188    -.183609
      contig |   1.193975   .1208705     9.88   0.000     .9570728    1.430877
    capratio |  -.2109975   .0511552    -4.12   0.000    -.3112598   -.1107352
      growth |  -3.126931   1.227476    -2.55   0.011     -5.53274   -.7211224
       democ |  -.4347376   .0999067    -4.35   0.000    -.6305512    -.238924
       trade |  -13.06209   10.28493    -1.27   0.204    -33.22018    7.095995
_Iduration_2 |  -1.368926   .3219423    -4.25   0.000    -1.999921   -.7379303
_Iduration_3 |  -.8832507   .2705674    -3.26   0.001    -1.413553   -.3529484
<output omitted>
_Iduratio~34 |  -14.68867   608.7769    -0.02   0.981     -1207.87    1178.492
_Iduratio~35 |  -1.496368   1.012187    -1.48   0.139    -3.480219    .4874817
       _cons |  -3.325521   .1775939   -18.73   0.000    -3.673598   -2.977443
------------------------------------------------------------------------------
```