

A HAZARD RATE ANALYSIS OF MIRANT'S GENERATING PLANT OUTAGES IN CALIFORNIA

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STATA Data

The analysis of failure times and outage durations utilizes a STATA database on individual Mirant plants distilled from primary sources. The resulting STATA database describes chronological data of daily plant operations from January 1994 to June 2001.¹ The STATA files include programs to estimate the regression equations and aggregate statistics. The STATA databases include the following information on plant operations and outages:

- The type of outage, including reserve, maintenance, unplanned, and overhauls (there has been some re-categorization and aggregation of plant outages when outages occur in short succession);
- The day, hour and minute of the start and end of outages;
- Energy generation during each day, or portion of a day when outages occur;
- Unit capacity; and

¹ Observations are for full days, except when the plant undergoes some type of outage. In this case, the daily observation represents the portion of the day leading up to the outage and the portion of the day after the plant has gone back on-line.

- Variables on calendar days, number of previous outages and other statistics generated for use in the regression analyses.

The individual variables include

Variable	Description
plant	Plant name
unit	Unit number
time	Date of observation
gen_mwh	Energy generation (mwh) for each observation
t_real	Chronological real time minutes since 1/1/1994
gen_mwh_temp ¹	Energy generation (mwh) for each observation (Same as gen_mwh)
out_dat ¹	Identifier for beginning or end of outage (including reserve shutdowns and overhauls)
online_wo_gen ¹	Indicates periods with no generation but not identified as an outage in the outage data. These periods are treated as reserves shutdowns for time-on-line calculations.
rs_unid ¹	Duration in minutes of periods with no generation and no outage identification.
rs_unid_temp ¹	Duration in minutes of period with no generation and no outage identification.
cap	Nominal Unit Capacity (mw)
mwh_sum ¹	Cumulative mwh since 1/1/1994
event_start	Date and time of outage start
event_end	Date and time of outage end
point ¹	Identifier for begining or end of outage – includes reserve shutdowns and overhauls
event_type	Type of outage: MO = maintenance outage PO = overhaul RS = reserve shutdown U1, U2, U3 = forced outage
year	Year
hour_start	Hour of outage start
min_start	Minute of outage start
date_start	Date of outage start
hour_end	Hour of outage end
min_end	Minute of outage end
date_end	Date of outage end
descrip	Outage description

type	Outage Type 0 = overhaul 1 = maintenance outage 2 = forced outage 3 = reserve shutdown
unit_1	Unit dummy
unit_2	Unit dummy
unit_3	Unit dummy
unit_4	Unit dummy
unit_5	Unit dummy
unit_6	Unit dummy
unit_7	Unit dummy
unit_8	Unit dummy
unit_9	Unit dummy
unit_10	Unit dummy
unit_pl	Plant ID
crisis	Crisis dummy
first_rec	First observation for unit
rs ¹	Identifies outages (includes reserve shutdowns and overhauls)
t_rs_sum ¹	Cumulative off-line minutes since 1/1/1994
t_ev	Chronological on-line minutes since 1/1/1994
over_in ¹	Indicates if overhaul has previously occurred
pre_over ¹	No previous overhaul date dummy
unit_1_pre	No previous overhaul date dummy
unit_2_pre	No previous overhaul date dummy
unit_3_pre	No previous overhaul date dummy
unit_4_pre	No previous overhaul date dummy
unit_5_pre	No previous overhaul date dummy
unit_6_pre	No previous overhaul date dummy
unit_7_pre	No previous overhaul date dummy
unit_8_pre	No previous overhaul date dummy
unit_9_pre	No previous overhaul date dummy
unit_10_pre	No previous overhaul date dummy
t_over ²	On-line minutes since last overhaul
mwh_over ¹	Generation since last overhaul, scaled to capacity (= mwh generation / capacity)
t_last	On-line minutes since last outage

mwh_last ¹	Generation since last outage, scaled to capacity (= mwh generation / capacity)
num_prev_U ²	Number of forced outage since last overhaul
num_prev_MO ²	Number of maintenance outages since last overhaul
t	On-line minutes since last outage
t_r ²	Minutes (real time) since last outage
gwh_last_r ²	Average Utilization since last outage = mwh since last outage / (capacity * time since last outage)
gwh_over_last_r ²	Average Utilization from last overhaul to beginning of last outage or overhaul = mwh since last overhaul / (capacity * time since last overhaul)
gwh_last_r_ns	Average Utilization from last outage = mwh since last outage / (60 * capacity * time since last outage)
gwh_over_last_r_ns	Average Utilization since last overhaul to beginning of last outage or overhaul = mwh since last overhaul / (60 * capacity * time since last overhaul)
t_over_ns	On-line minutes since last overhaul
t_r_ns	Minutes (real time) since last outage
id_mark ¹	Identifier of plant unique event leading to outage
rs_temp ¹	Temporary variable
_st	Identifies whether observation is to be used in the analysis (set by Stata using stset command)
_d	Identifies unforced or maintenance outages (i.e., unit failure) for survival analysis (set by Stata using stset command)
_t0	Time at the start of the observation (set by Stata using stset command)
_t	Time at the end of the observation (set by Stata using stset command)

¹ These are intermediate variables created in the process of constructing the set of variables used in the regression analysis and are not themselves used in these regressions. The definitions provided are as accurate as possible given the nature of the process of constructing the dataset. We caution against use of these variables, since they are intended as intermediate steps in a process rather than final variables.

² Data has been normalized so that the mean equals (approximately) 1.

STATA Program Files

H_OUTAGE: Base case regressions for alternative time to failure models.
H_DURATION: Base case regressions for alternative time to failure models.
H_MEAN_BOOT: Bootstrap of outage rates evaluated at means
H_MUTIL_BOOT: Bootstrap of dynamic integration for outage rates