CEEPR **Center for Energy and Environmental Policy Research**

Capacity Factor Risk At Nuclear Power Plants

by
Yangbo Du and John E. Parsons

10-016 November 2010

A Joint Center of the Department of Economics, MIT Energy Initiative, and Sloan School of Management

CAPACITY FACTOR RISK AT NUCLEAR POWER PLANTS

Yangbo Du[*] *and John E. Parsons*[**]

November 2010

We develop a model of the dynamic structure of capacity factor risk. It incorporates the risk that the capacity factor may vary widely from year-to-year, and also the risk that the reactor may be permanently shutdown prior to the end of its anticipated useful life. We then fit the parameters of the model to the IAEA's PRIS dataset of historical capacity factors on reactors across the globe. The estimated capacity factor risk is greatest in the first year of operation. It then quickly declines over the next couple of years, after which it is approximately constant. Whether risk is constant or increasing in later years depends significantly on the probability of a premature permanent shutdown of the reactor. Because these should be very rare events, the probability is difficult to estimate reliably from the small historical sample of observations. Our base case is parameterized with a conservatively low probability of a premature permanent shutdown which yields the approximately constant variance. Our model, combined with the global historical dataset, also yields relatively low estimates for the expected level of the capacity factor through the life of the plant. Our base case estimate is approximately 74%. Focusing on alternative subsets of the data raises the estimated mean capacity factor marginally, but not significantly, unless the sample chosen is restricted to selected countries over select years. This emphasizes the need for judgment in exploiting the historical data to project future probabilities.

[*] Center for Energy and Environmental Policy Research, MIT, E19-411, 77 Massachusetts Ave., Cambridge, MA 02139 USA, E-mail: yangbodu@mit.edu

[**] Corresponding author: MIT Sloan School of Management, MIT Center for Energy and Environmental Policy Research, and the MIT Joint Program on the Science and Policy of Global Change, MIT, E19-411, 77 Massachusetts Ave., Cambridge, MA 02139 USA, E-mail: jparsons@mit.edu

1. INTRODUCTION

One of the critical risks facing an investor in a nuclear power plant is uncertainty about the plant's realized capacity factor. Realized capacity factors show great variation. Although the typical investor's cash flow model of a proposed plant shows a projected capacity factor of 85% or more, many reactors have problems achieving this target. Oftentimes the shortfall is quite large. According to the Power Reactor Information System (PRIS) database maintained by the International Atomic Energy Agency (IAEA), the realized capacity factor is less than 50% in more than 10% of all reactor years in their database. In one of the countries with the largest nuclear power programs, Japan, the three most recently constructed plants have been marked by major operational problems that have kept their lifetime capacity factors at 63%, 77% and 34%. Several other units in Japan were recently shutdown for over two years due to an earthquake. The average capacity factor in Japan for 2007-2009, the most recent period for which data are available, lies at 61%. In the US, performance was extremely poor in the 1970s and 1980s. For example, in 1985 the overall capacity factor for nuclear power plants in the US was 58%. Individual reactor performance varied widely. Subsequently, capacity factors in the US have climbed markedly, so that the average is now slightly above 90%.

How should capacity factor risk impact the valuation of a prospective new build power plant? Few economic analyses address this question explicitly. The standard discounted cash flow model simply applies a single risk-adjusted discount rate to the aggregate cash flow line, discounting successive year's cash flows by the compounded discount rate. Although not widely appreciated, this simple model embodies a very restrictive implicit assumption about the dynamic structure of risk at the level of the aggregate cash flow: that is, the risk or variance of the cash flow grows linearly with time. This structure is consistent with the risk being well described as a geometric Brownian motion, but is not consistent with many other dynamic risk structures. Capacity factor risk is unlikely to be well described by a geometric Brownian motion. Uncertainty on the capacity factor parameter will almost certainly not grow linearly with time. But what is the dynamic structure of capacity factor risk? Answering this question is a prerequisite to turning to more advanced valuation techniques, such as a real options model or similar tools.[1]

In this paper we provide a fully specified model of the dynamic structure of capacity factor risk. We then fit the parameters of the model to the IAEA's PRIS dataset of historical capacity factors on reactors across the globe.

We find that capacity factor risk is greatest in the first year of operation, declining quickly in the next couple of years. In later years, regardless of parameterization, capacity factor risk never again rises to the level attained in the early years. Whether risk is constant or slightly increasing in later years depends significantly on the probability of a premature permanent shutdown of the reactor.

In fitting our model, we also obtain estimates on the expected *level* of the capacity factor through the life of the plant. Our estimates are very low relative to the 85% or higher figures commonly employed in investor cash flow models. We examine various subsets of the data to account for possible factors that could bias our numbers to a low

---

[1] An example of the application of these more sophisticated techniques appears in Rothwell (2006), which is an application of the real options technique to the valuation of a new nuclear build. However, Rothwell continues to rely upon the Brownian motion assumption although certain key risk factors—such as the capacity factor and the electricity price—clearly do not fit this assumption. Another example of these more sophisticated techniques appears in Samis (2009). He focuses on the structure of electricity price risk, which is not assumed to follow an unmodified Brownian motion, but is mean reverting instead.

level. These do argue for a slight upward adjustment in the expected level of the capacity factor through the life of the plant, but the adjustments are small and the final estimate remains well short of the 85% mark, unless the sample chosen is restricted to selected countries over select years.

There is a large literature analyzing the determinants of the capacity factor. Joskow and Rozanski (1979) estimate a significant learning curve for the operator, with the expected capacity factor increasing significantly in the first years of operation. They also document some learning by the manufacturer as successive plants of the same design are produced. They document some difference in the learning curve by reactor design, but essentially no difference across countries. Finally, they noted that the larger reactor designs had lower capacity factors. Easterling (1982) estimates that the learning effect on capacity factors is greatest during the first five years of operation. The variability of capacity factors is highest in the first year. He notes that different designs have different mean capacity factors, and that there are persistent differences in the individual unit capacity factors that could possibly represent any number of other factors. Krautmann and Solow (1988) find that the age of the unit, its vintage, the size of the unit, and the past year's capacity factor are all significant determinants of the expected capacity factor. Rothwell (1990) refines the observation of the capacity factor by organizing the data according to the frequency for refueling, which need not be annual, the frequency used in most analyses. He also decomposes the capacity factor into the service factor—i.e., whether the unit is available or has been taken down for refueling or for repair—and the capacity utilization when operating. Finally, he segments the dataset by manufacturer. The results for age are very mixed across manufacturers, and so he argues it should not be used to estimate the expected capacity factor. Similarly, the results for size seem to relate to specific designs and not to size generally.[2] Krautmann and Solow (1992) show that improvements in the expected capacity factor with the age of the unit appear to have exhausted themselves in the period following the Three Mile Island accident, and that the units of at least one design were on the declining side of the age-performance curve. Lester and McCabe (1993) find a learning curve effect in the first three years of a units operation, and then document the differential learning curves for units operated at the same site, as well as the role of experience by design, by company and for the industry as a whole. Sturm (1993) identifies declining performance with age for countries in the former Soviet Union and Eastern Europe, especially attributable to the years immediately following the political transformations of the late 1980s and early 1990s. This is in contrast to the improving performance with age in the West at the same time, and even with identical reactor designs. Noting the significant improvements in the capacity factors among US nuclear power plants, Rothwell (2000) provides an updated estimate of the expected capacity factors by design type, manufacturer and size of the unit. Rothwell (2006) updates this for one cohort. Koomey and Hultman (2007) also note the significant improvement in the mean capacity factor at US units.

Our contribution to this literature is our focus on the variability in the capacity factor and the risk structure through time.

---

[2] There is related work on factors that one might expect to enter as a determinant of the capacity factor. For example, Roberts and Burwell (1981) estimate the learning curve in licensee events reports and how this is impacted by placing new reactors at the same site as existing reactors. A lower number of events may lead to an increased capacity factor, although the authors did not report on capacity factors. David Maude-Griffin and Rothwell (1996) document how the hazard rate for an unplanned outage declined after the Three-Mile-Island reactor incident and the ensuing regulatory policy changes. Sturm (1994) also evaluates the time between forced outages, and finds significant country differences. Within country no differences by design generation or date of construction are identifiable.

A portion of the previous literature touches on the variability in the capacity factor, including the random process of unplanned shutdowns and the decision to permanently shutdown a reactor. Rothwell (2007) incorporates a measure of the volatility in the capacity factor into his valuation model. It appears that volatility is estimated as if the factor were generated by a Brownian motion. Sturm (1995) estimates nuclear power production at a plant as a controlled stochastic process. The technology defines certain tradeoffs facing plant managers, and these managers make choices in operating the plant to optimize an objective function. This yields an estimated stochastic process for unplanned outages and plant capacity when operating. Given the complexity of the problem, the data used for estimating the model is chosen from a narrow time window likely to reflect a stable technology and objective function. Rothwell and Rust (1995) estimate a similar type of model in order to estimate the endogenous decision to permanently shutdown a plant. Rothwell (2000) also estimates the differential likelihood of different US plants being permanently shutdown as the regulatory environment shifts.

Our paper does not report the volatility or likelihood of a shutdown estimated from an optimization problem. We model the capacity factor risk structure as if the capacity factor were an exogenous variable.

2. THE DATA

The IAEA's PRIS database reports a variety of data on individual reactors throughout the world, including annual performance data.[3] Table 1 shows some summary

[3] Although the data is available on-line, the mode of access currently makes it inconvenient to acquire a complete overview of the data. Upon request, the IAEA provided us the data in a convenient spreadsheet form, and we have posted that on our website together with this paper so that others can easily access the same data. See: web.mit.edu/ceepr/www/publications/workingpapers.html

information on the PRIS data. As of year-end 2008, the database included information on 535 reactors that had operated for some subset of years since 1969. Of these, 428 were in OECD countries, while 107 were in non-OECD countries. For calendar year 1969 the database includes information on only a single operating reactor. This number grows quickly to a maximum of 444 operating reactors included in the database in 2005. Obviously, early in the database the reactors included are young: the median age of operating reactors is less or equal to 5 years through 1978, growing to 10 years in 1990, and reaching 25 years in 2008.[4]

PRIS reports a variety of data on a reactor's operating performance, including the portion of time the reactor was on-line, the total energy generated, the energy lost due to planned outages, the energy lost due to unplanned outages and the energy lost due to external factors. PRIS also reports a reference level of energy generation, which is a measure of the nameplate capacity of the unit. These variables can be combined to calculate a number of different versions of a capacity factor. Discrepancies between the different versions tend to occur because they each reflect differently events in which the plant's potential generating capacity differs from its reference power rating due to factors outside the control of the plant operator. These factors include but are not limited to ambient temperature, which affects the plant's thermal efficiency, and periods of low electricity demand that do not result in complete utilization of a plant's electricity output. Higher generating potential arises during periods of colder temperatures relative to that of the plant's nameplate capacity, which increases the plant's heat sink capacity and in turn

[4] Although the PRIS database of capacity factors is relatively comprehensive, it turns out that the capacity factors for a few reactors are missing. We did not investigate or try to resolve these few missing observations.

its power output. Therefore output may be greater than capacity. Examples of this are widespread among units reporting high capacity factors, notably in South Korea where at least one reactor operated at above 100 percent nameplate capacity for every year since 1993 except for 1995 and 2007. One version of a capacity factor will reflect this, recording a capacity factor above 100%, while another version will adjust the baseline capacity to reflect the higher potential and record a capacity factor of 100%. Conversely, in a country like France where nuclear capacity exceeds base-load demand, inevitably some units are forced to follow load and cut generate below capacity although the plant is fully available. One version of a capacity factor will reflect this lower generation, while another version will adjust the baseline capacity to reflect the external constraint. In France in 2008, where nuclear power supplies over three-quarters of electricity output, the average capacity factor as measured by one version, the Load Factor, was a full two percentage points below the average capacity factor as measured by another version, the Energy Availability Factor — 75.9 percent versus 77.9 percent respectively.

To formalize this discussion, we provide the definitions of various elements in the calculation of capacity factors, and the formulas for different versions of capacity factors. These are the definitions as provided by the IAEA's PRIS dataset:

- T – Reference period – time from beginning of period, first electrical production (for units in power ascension), or start of commercial operation (for units in commercial operation), whichever comes last, to the end of the period or final shutdown, whichever comes first
- t – On-line hours – hours of operation (breakers closed to the station bus) during the reference period
- OF – Operating factor (%) = $t/T\times100$
- RUP – Reference unit power (MW) – Maximum electrical power output maintained during prolonged operation at reference ambient conditions,
- REG – Reference energy generation (MWh) = $RUP\times T$

- EG – Energy generated – net electric energy output after subtracting station load (electric energy drawn by the power station's components)
- LF – Load factor (%) = EG/REG×100
- PEL – Planned energy loss – energy not produced during the reference period due to planned outages (foreseen at least four months in advance) during refueling and other operations and maintenance activities
- PUF – Planned Unavailability Factor = PEL/REG
- UEL – Unplanned energy loss – energy not produced during the reference period due to unplanned outages (foreseen less than four months in advance) internal to the plant
- UUF – Unplanned Unavailability Factor = UEL/REG
- UCF – Unit capability factor (%) = (REG – PEL – UEL)/REG×100
- XEL – External energy loss – any energy loss due to causes external to the plant
- XUF – External Unavailability Factor = XEL/REG
- EAF – Energy availability factor (%) = (REG – PEL – UEL – XEL)/REG×100

To illustrate how the different versions of capacity factors reflect the specific situation of different units, Table 2 shows the data for four different reactors as reported in 2007. Column E shows the Genkai 4 Unit in Japan. It operated 100% of the time, so that its Operating Factor was 100%. However, its Load Factor was 101.5%. This is because the Energy Generated was more than its Reference Energy Generation, i.e. the ambient conditions in that year produced an actual capacity greater than the nameplate or reference capacity. Its Energy Availability Factor was 100%. This demonstrates the difference between the LF and the EAF. The LF reflects actual energy produced as against a reference or nameplate capacity, although the actual capacity may be higher or lower than the reference. In contrast, the EAF is normalized by whatever is the actual capacity of production. Therefore the EAF cannot be greater than 100%. Column F shows the Sequoyah 1 Unit in the United States. This unit operated 87.5% of the time, with 12.5% of the time down for planned outages. When it was operating, it must have been operating at full capacity since the EAF equals the OF. The LF is lower than the EAF, which must be because actual capacity across the hours of planned operation was less than the reference capacity. Column D shows the Wolsong 4 Unit in Korea. This unit operated 93.1% of the time. However, the EAF is only at 92.8%, so during some portion of the time it was operating it must have done so at slightly less than full capacity. Most of the time it was not operating was for planned outages, although a small portion was for unplanned outages. Column C shows the Cattenom 1 Unit in France. In addition to the planned and unplanned outages, there is a portion of its generation capacity that is unutilized, 1.5%, because of external factors. This is likely due to the need in France to operate some units in a load following mode, i.e. to not take the full capacity of the unit even when it is made available to the system. Therefore, the UCF is higher than the EAF.

In our analysis below we focus exclusively on the variable called "Load Factor" (LF), so for the remainder of this paper the reader should treat the term Load Factor as synonymous with capacity factor. Table 3 shows how the median Load Factor has evolved over time, growing from the 60% range in the early 1970s to approximately 85% in the 2000s. The standard deviation of the annual Load Factors has not changed very much over time, fluctuating modestly around 22% throughout the life of the database.

Importantly, the database includes the time series of performance data on reactors that have since been permanently shutdown. There are 98 reactors in the database that had been permanently shutdown as of 2008. Table 1 shows the annual number of shutdown reactors, together with the cumulative number of shutdown reactors through time. The large majority of these shutdowns occurred because the reactor has reached the end of its useful life, or has become technologically outdated, or because economic factors no longer make it worth operating. A few of these shutdowns occur because of accidents or other operational problems. The database provides some information on these reasons, although it is useful to have more detail on each case.[5] We will return later to examine more carefully the issue of reactors that are both temporarily and permanently shutdown.

3. A STOCHASTIC MODEL OF THE CAPACITY FACTOR

Denote a nuclear power plant's capacity factor in year t as F_t. Denote by T the number of years in the normal economic life of the plant—for example, the normal economic life may be 40 or 60 years. Then the profile of the capacity factor over the life of the plant, $t=1,\ldots T$, is, $F_1,\ldots,F_T$. We assume that in each year, the capacity factor can take on only the integer values from 0% to 100%. In addition, we assume that the plant may permanently shut-down, despite not having yet reached the end of its normal economic life, i.e., despite the fact that $t\leq T$. We call this a premature permanent shutdown. Once a plant is permanently shutdown, it cannot be restarted, so there is a difference between a capacity factor of 0% and the state of being permanently shutdown.

We model the evolution of the capacity factor over the life of the plant as a stochastic process. This allows us to reflect correlation between the capacity factors

---

[5] The IAEA provides separate information on permanently shutdown reactors. This shows a total of 123 permanently shutdown reactors. Of these, 7 were shutdown prior to 1969, and so would not be included in our dataset. That leaves 116 reactors that were permanently shutdown and that would appear in our dataset. Of these, 2 were shutdown in 2009, and so we do not treat them as shutdown as of 2008 when our data ends. That leaves 114 reactors that were permanently shutdown as of 2008 and that would appear in our dataset. We can only identify 99 of these, leaving 15 unaccounted for. These are reactors for which no capacity factor data appeared in the PRIS database. Omitted these will underestimate the probability of shutdown.

across years. For example, a plant currently operating at 50% capacity factor may be more likely to operate at 50% in the next year than is a plant currently operating at 95%. We initially assume that the probability distribution for the capacity factor at t is conditioned only on the capacity factor at t-1, and so is independent of the age of the plant. Obviously, one could make a case that the distribution might vary according to the reactor's age, and we will revisit this possibility later in the paper.

Let i be the capacity factor in year t-1 and j be the capacity factor in year t, $i,j \in \{0\%,1\%,\ldots,100\%\} \cup \{\text{“shutdown”}\}$. Define $\pi_{i,j}$ as the probability that the capacity factor in year t equals j, given that the capacity factor in year t-1 equals i. That is, $\pi_{i,j}$ is the probability of transitioning from i to j. Denote by Π the 102×102 transition matrix with elements $\pi_{i,j}$, $i,j \in \{0\%,1\%,\ldots,100\%\} \cup \{\text{“shutdown”}\}$. We assume the probability $\pi_{i,j}$ is a mixture of two distributions: the probability of a permanent shutdown, and, given no permanent shutdown, the probability of transitioning from one integer capacity factor value to another. Define θ_i as the probability that the plant is permanently shutdown in year t, given that the capacity factor in year t-1 equals i. Define $\phi_{i,j}$ as the probability that the capacity factor in year t equals j, given that the plant is not permanently shutdown in year t, and that the capacity factor in year t-1 equals i. Then the probability that the capacity factor in year t equals j, given that the capacity factor in year t-1 equals i, is

$$\pi_{i,j} = \begin{cases} \varphi_{i,j}\left(1-\theta_i\right) & \mathit{for}\ i,j \in \{0\%,1\%,\ldots 99\%,100\} \\ \theta_i & \mathit{for}\ i \in \{0\%,1\%,\ldots 99\%,100\},\ j = \mathit{shutdown} \end{cases} .$$

For t=1, the first year of operation following the start-up, there is no prior year capacity factor, and so we must define the first year's probability distribution separately. We denote this distribution as $\pi_{start,j}$. It is similarly composed as a mixture of two distributions, and we label these elements as θ_{start} and $\phi_{start,j}$. We denote by Φ the full 102×101 conditional transition matrix with elements $\phi_{i,j}$, $i \in \{\text{“start”}\} \cup \{0\%,1\%,\ldots,100\%\}$, $j \in \{0\%,1\%,\ldots,100\%\}$. We denote by Θ the 102×1 matrix of shutdown probabilities, θ_i, $i \in \{\text{“start”}\} \cup \{0\%,1\%,\ldots,100\%\}$.

In order to capture the volatility of the capacity factor transitions, and to impose some regularity on the structure of the elements of the conditional transition probability matrix, Φ, we assume that $\phi_{i,j}$ is a Beta-binomial distribution with n=100 and parameters $\alpha(F_{\mathrm{i}})$ and $\beta(F_{\mathrm{i}})$. When we estimate α and β, we will make some regularity assumptions on how the parameters may vary with the capacity factor, $i \in \{0\%,1\%,\ldots,100\%\}$.

This simple structure enables us to calculate a time profile of stochastic capacity factors for a new build nuclear power plant. Define $p_{t,j}$ as the unconditional probability that the capacity factor in year t equals j. Denote by P the T×102 matrix with elements $p_{t,j}$, t=1,…T, $j \in \{0\%,1\%,\ldots,100\%\} \cup \{\text{“shutdown”}\}$. The first row of P is the first year's probability distribution, $p_{1,j}=\pi_{start,j}$. We can derive the successive rows by successive matrix multiplication using Π:

$$p_{t,*} = p_{t-1,*}\,\Pi\,,$$

where $p_{t,*}$ is the t^{th} row of P, with 1×102 elements, $p_{t\text{-}1,*}$ is the previous row of P, with 1×102 elements, and Π is the 102×102 transition matrix.

4. ESTIMATION FROM THE RAW DATA

We organize the sample data into a transition matrix by populating the elements of the matrix with a simple count of the observed transitions. Reactor-by-reactor, we simply count the number of year-to-year transitions from capacity factor *i* to capacity factor *j*, and sum across all reactors. In the PRIS database, capacity factors are reported to the 12th decimal place. In doing our count, we round down to the nearest integer. Therefore, the row denoted by 90 percent includes all capacity factors from 90 percent up to, but strictly less than 91 percent. An exception to this rule applies for reactors operating above 100 percent capacity factor, which are classed in the 100 percent level regardless of the margin the actual power generation exceeds the reference power generation. Count values in each row are then normalized to a sum of one by dividing each row entry by the sum of the count values for the row. We call this the sample conditional probability matrix, Φ^{sample}. Table 4 shows an extract of this sample conditional transition matrix constructed using the complete capacity factor data available from PRIS through 2008. Figure 1 is a graphical display of the matrix.

We use this sample to estimate the underlying probability distribution. Table 5 shows the conditional sample mean capacity factor in year *t*, given each capacity factor in year *t*-1, $\overline{\varphi}_i^{sample} = \sum_{j=0}^{100} j\ \varphi_{i,j}^{sample}$, $i \in \{0\%, 1\%, \ldots, 100\%\}$. These values are also plotted in Figure 2. Clearly the conditional expected capacity factor in year *t* is increasing as a function of the capacity factor in year *t*-1. Table 5 also shows the sample variance of the capacity factor in year *t*, given each capacity factor in year *t*-1, $\sum_{j=0}^{100} \left(j - \overline{\varphi}_i^{sample}\right)^2 \varphi_{i,j}^{sample}$, and these values are also plotted in Figure 3. The variance of the capacity factor in year *t* is a declining function of the capacity factor in year *t*-1. This indicates a tendency for reactors already performing at a high capacity factor to maintain such performance with relatively low variability. Reactors performing at lower capacity factors at any given year tended to exhibit more variable performance the following year. This characteristic is also apparent in Figures 2 and 3.

From these sample conditional means and variances we estimated the underlying distribution means and variances by regressing the log of the sample mean and the log of the sample variance onto the initial capacity factor. Table 6 reports the results of this OLS regression with robust standard errors. Table 5 shows the fitted moments at each capacity factor using the parameter estimates from the regression in Table 6. From these fitted moments we generate the distribution parameters alpha and beta using the method-of-moments.[6] Table 5 reports the resulting alpha and beta parameters at each initial capacity factor. Figure 4 illustrates the results by displaying three probability distributions associated with three different initial capacity factors. Each distribution describes the probability of the capacity factor in year *t* given its respective capacity factor in year *t*-1, as marked. The pattern described above—in which reactors already performing at a high capacity factor tend to maintain such performance, while reactors performing at lower capacity factors at any given year tend to exhibit more-variable performance the following year—is reflected in the resulting conditional implied Beta distributions.

In order to recover the conditional probability distribution at the start-up, we follow a similar procedure. However, since we only have one distribution to calculate,

---

[6] The implied parameters of the distribution, α and β, are solved for using the fitted mean, μ, and the fitted variance, σ^2, and the two equations: $\mu = \alpha/(\alpha+\beta)$ and $\sigma^2 = \alpha\beta/\left((\alpha+\beta)^2(\alpha+\beta+1)\right)$.

there is no need to impose any regularity across different starting capacity factors, and so we skip the OLS step. Instead, we directly apply the method of moments to the sample conditional mean, $\overline{\varphi}_{start}^{sample} = \sum_{j=0}^{100} j\ \varphi_{start,j}^{sample}$, and sample conditional variance, $\sum_{j=0}^{100} \left(j - \overline{\varphi}_{start}^{sample}\right)^2 \varphi_{sttart,j}^{sample}$. The results are included at the bottom of Table 5.

We estimate the probability of a premature permanent shutdown starting with the sample distribution, Θ^{sample}. The sample permanent shutdown probability is determined by counting the number of premature permanent shutdowns for each given load factor range and then dividing by the total count of transitions for that particular load factor range. We then constructed a smoothed, fitted set of probabilities via heteroscedacity-robust ordinary least squares regression of natural logs of raw probability figures against load factor in year n-1. The exponential best-fit curve was then scaled so that the sum of all fitted values equaled the sum of the sample values.[7] The results are shown in Table 7.

Having constructed our estimated conditional probability matrix, Φ, and the probability of a permanent shutdown, Θ, it is straightforward to calculate the transition matrix, Π , and then the unconditional probability matrix, P. From this matrix, we can calculate the mean load factor in each year of operation, and the variance. These are shown in Table 8. We can also calculate a mean and variance conditional on the reactor still being in operation, i.e., not permanently shutdown. These are also shown in Table 8.

7 The unconditional probability of a permanent shutdown is determined by the interaction between the conditional transition matrix which determines the probability of arriving at any load factor in year t-1, and this conditional probability of shutdown. Therefore, unfortunately, this scaling does not necessarily assure that the resulting unconditional probability of a shutdown matches the sample frequency. We have not estimated the discrepancy in our estimations.

We can see from Table 8 that the conditional variance is 9.4% in the first year and asymptotes quickly to 3.8%. The unconditional variance also is 9.4% in the first year. It declines quickly in the next few years. Ultimately, the unconditional variance begins to gradually rise with the year of operation, although it never reaches as high as it was in the first year. This risk profile is the main result of this paper. It is graphed in Figure 5. The difference between the conditional and the unconditional variance—the fact that the unconditional variance does not asymptote, but rather begins to rise with the year of operation—is due to the increasing cumulative probability of being permanently shutdown in the later years of scheduled operation. We will see that this basic pattern in both the conditional and unconditional volatility holds for all variations of the estimation pursued later in the paper. Only the specific values change. The pattern follows from the model of risk that we have imposed on the data.

Table 8 also shows that for the raw sample, the conditional mean capacity factor is 52% in year 1. It quickly increases and asymptotes to 73%, which it has approximately reached by year 6 of operation. The unconditional mean capacity factor is 52% in the first year after start-up. The unconditional mean capacity factor also rises gradually over the first few years of operation, reaching a peak at approximately 70%. However, it gradually falls again to 52% by year 60 of operation. The gradual drop reflects the accreting cumulative probability of a permanent shutdown. The increasing mean of the conditional probability distribution in the first few years reflects the fact that the conditional transition probability at start-up has a relatively low mean, below the steady-state conditional distribution to which it must rise. This happens to produce the same empirical observation as one would get with an explicit learning curve.

5. ANALYSIS AND REESTIMATION

The previous section utilized the raw PRIS data. There are several objections that must be made to this naïve calculation.

First, the PRIS database includes several different types of reactors. The vast majority—402 of the 535 reactors, or 75%—belong to either the boiling light water reactor (BWR) or to the pressurized light water reactor (PWR) categories that currently dominate the commercial reactor industry. The database also includes less popular commercial designs such as the 53 pressurized heavy water reactors (including the Canadian CANDUs), and designs no longer built for commercial purposes, such as the 42 gas cooled, graphite moderated reactors (widely used in the UK among other places) or the 21 light water cooled, graphite moderated reactors (which includes the shutdown Chernobyl reactors and cousins elsewhere in the territory of the former Soviet Union). Being comprehensive, the database also includes unusual and experimental designs, including 4 high temperature reactors, 4 heavy water moderated reactors, and 1 steam generating heavy water moderated, light water cooled reactor. There are 8 fast reactors, a very different type of reactor that has primarily been constructed on an experimental or a demonstration basis. Does it make sense to mix the results from these different types of reactors? Even within the two most popular categories, BWR and PWR, there are different designs, and one could argue that the transition matrix is likely to vary across individual reactor designs. In addition, the database includes a number of small, experimental or demonstration reactors, and the operating experience of these will not be comparable to that of commercial scale reactors. Lumping everything together in a single matrix muddies the picture.

Second, the database includes reactors managed in very different types of institutional settings. Just to illustrate, Table 3 breaks down the mean capacity factor by reactors operated in OECD countries and reactors operated in non-OECD countries, and there is clearly a marked difference between these two settings. Even across OECD countries, one expects to observe different capacity factors in response to the specific context. For example, France's heavy reliance on nuclear power for a very large fraction of its total electricity requirements necessarily means that some of its reactors must "load follow"—i.e. vary their output as electricity use varies through the day, week or season. They simply cannot all operate at a high capacity. In other countries, where nuclear reactors represent a smaller fraction of the total generating capacity, this constraint is not binding. Therefore, one might expect to observe a very different transition matrix for reactors operated in France, and this would not be informative about the expected capacity factor for a reactor being built elsewhere.

Third, the database covers a long window of time during which significant changes occurred in reactor operations and management. We have already noted the obvious trend in the median capacity factor apparent in Table 3. This trend may reflect a number of different things, including changes in reactor design that make them more reliable and easier to maintain, as well as improved management practices. For example, in the United States, the number of days required to reload fuel fell from 104 in 1990 to 38 in 2008. This contributed significantly to raising capacity factors in the US. Given changes such as this, to what extent is the historical data informative about future expectations for a new reactor's capacity factor?

Fourth, lumping all of the reactor years together into a single matrix ignores any life-cycle pattern that may apply to the operation of a specific reactor. For example, the literature suggests that there may be a learning curve during at least the early years of a reactor's operation. Although our results happen to mimic a key outcome of a learning curve, this is not the same thing as explicitly incorporating how the transition matrix varies with the age of the reactor. We can reorganize the PRIS data to show capacity factors by vintage, i.e., by the year of operation of the reactor. There we see a trend towards higher capacity factor as operating experience at the reactor increases.

The life-cycle perspective is also important as the reactor ages and reaches the end of its anticipated useful life. Sooner or later, it will not make economic sense to invest additional money to maintain an old reactor. In the raw database, this will show up as a permanent shutdown. But clearly there is a difference between the events that precipitate permanently shutting down a 40-year old reactor as scheduled, and the events that precipitate permanently shutting down a 5-year old reactor. We should not lump both events in the same matrix entry.

Fifth, and finally, there is some discrepancy between how we are modeling the capacity factor and the data recorded in the PRIS database. In a financial analysis of a new reactor build, we would like an estimate of an exogenous capacity factor variable. This could then be combined together with estimates of the other inputs to the analysis, such as a forecast of the electricity price, construction and operating costs, and so on, to yield an assessment of the value of a new reactor. We could then determine how the risk profiles of the various inputs combine together to generate a risk profile for the cash flow and value of the reactor. What we observe in the PRIS database, however, is not a purely exogenous variable. It is, in part, an outcome of the very valuation decision being made. This is most obvious in the case of permanent shutdowns, as was mentioned above.[8]

We address these five issues as follows. First, we focus our analysis on a subset of reactors. We limit ourselves to the broad classes of BWR, PWR and PHWR designs. We choose not to make any finer categorization so as to retain all of the information in the combined dataset. We also excluded all reactors with capacity less than 300 MW since most of these are either experimental or demonstration projects and not commercial reactors. This leaves us with a total of 426 reactors.

Second, we categorize shutdowns in a manner that reflects our objective of modeling an exogenous capacity factor variable—i.e. only premature permanent shutdowns. Table 9a lists all reactors in our base case sample that are reported by the PRIS database to have been permanently shutdown prior to 12/312008. We sort this list into 2 mutually exclusive categories. One is involuntary shutdowns. This is the count that we use to construct our premature permanent shutdown probability. The second is voluntary shutdowns. These are excluded from the count that we use to construct our permanent shutdown probability. The sort is done as follows. All shutdowns that occur after the 35th year of operation are excluded from the "exogenous" shutdown category on the basis that the plant is approximately at the end of its originally intended useful life. We then reference the "reasons" for shutdown listed in the IAEA database. Categories 1-3 and 5-7 are counted as voluntary shutdowns and excluded from our count of premature permanent shutdowns. Categories 4 and 8-10 are counted as involuntary shutdowns and

---

[8] As we mentioned in the introduction, a few studies attempt to address this distinction explicitly, at least with respect to certain specific variables. These include Sturm (1995), Rothwell and Rust (1995) and Rothwell (2000).

included in our count of premature permanent shutdowns. In some cases multiple reasons are given: whenever at least one reason falls in the involuntary category, the reactor is categorized as involuntarily shutdown and added to our premature permanent shutdown count. At the conclusion of this step we are left with 13 reactors in our base case sample that were involuntarily shutdown and that enter into our count as premature permanent shutdowns.

Table 9b lists all reactors in our base case sample that are reported by the PRIS database to have experienced an extended period of dormancy, i.e., 4 or more years with no commercial production. These are reactors that are shutdown for an extended period of time, but continue on the IAEA's list as still licensed for operation. In 11 cases identified in the table we treat these reactors as having been permanently shutdown at the start of the dormancy period. According to our algorithm stated above, these shutdowns are treated as voluntary and therefore do not add to the permanent shutdown count. If the reactor was extensively rebuilt prior to restart of operation or if the reactor enters final shutdown during its dormancy, the later years of zero production are not used in the counts creating our conditional transition matrix. In four cases identified in the table, after substantive reinvestment and new construction, the reactor is re-started, and we treat this as an entirely new reactor.

We believe this methodology is likely to underestimate the sample frequency of premature permanent shutdowns caused by exogenous factors, at least as a financial investor considering the value of constructing a new reactor is likely to view it. Several of the shutdowns that are categorized as voluntary could easily be categorized as involuntary, once again from the perspective of the financial investor: for example, the shutdown of the Browns Ferry reactors in the US, the shutdown of the Armenia reactor, and the shutdown of the Barsebäck reactor in Switzerland, to name a few. And some reactors that began construction but were never completed or that never generated power commercially—such as the Shoreham plant in the US—never make it into the dataset and so do not add to the count of permanent shutdowns.

Because even a small number of permanent shutdowns has a large impact on the unconditional expected capacity factor, and because of the subjective element involved in assessing the relevance of the small sample of permanent shutdowns for future operation, the correct estimation of the probability of a permanent shutdown going forward is likely a very contentious issue in valuation of a new nuclear power plant. The algorithm chosen here results in a much smaller count of prematurely permanently shutdown reactors than in the raw dataset. This has a major effect on the unconditional expected capacity factor and on the unconditional volatility of the capacity factor, as we shall see below. This emphasizes the necessity of applying careful judgment in estimating this probability using historical data.

After taking these two steps, we have what we call our complete "base case" data. We use this data to reproduce the transition matrix calculations and we report those results below.

We then do 3 subsidiary analyses. First, we produce transition matrix calculations broken down by bloc—OECD vs. non-OECD. Second, we produce transition matrix calculations broken down by reactor age. We group the reactors years into the first 5 years of operation and the remaining years. Third, and finally, we produce transition matrix calculations broken down by epoch—before and after 2000. These three analyses are not statistically independent of one another. For example, non-OECD reactor year observations are more heavily concentrated in the post-2000 data set. The post-2000 data set contains a different profile of observations at the different age in a reactor's life as compared to the pre-2000 data set. These 3 analyses do not generate statistical tests of the differences, but merely identify the size of the differences one finds in the data set. Obviously, finer breakdowns lead to even sharper distinctions. To illustrate, we report results for the post-2000 data for three specific countries: the US, France and Japan.

Base Case Results

Table 10 shows the estimation of the parameters of the conditional probability distributions for the conditional transition matrix, Φ, using the base case data. Table 11 shows the estimation of the probabilities of permanent shutdown, Θ. Table 12 shows the mean and variance from the unconditional transition matrix, P, through the life of the reactor.

From Table 12, we see that the conditional variance is 9.5% in the first year of operation. It quickly asymptotes to 3%. The unconditional variance is also 9.5% in the first year. It then falls to 2.9%. Unlike in the raw data case, there is no discernable increase in the unconditional volatility. This is due to the low probability of a permanent shutdown in our base case.

We also see from Table 12 that conditional mean capacity factor starts at 53.5% and quickly increases to the asymptote of 74.5%. The uncondititional mean capacity factor starts out at 53.5%. It quickly climbs towards its peak of just over 74%. The peak is reached in year 7. After this the unconditional probability declines, but only very gradually, so that the expected capacity factor is only slightly below 73% at the end of 40 years and just below 72% at the end of 60 years.

Bloc results

The base case dataset is further divided into an OECD dataset and a non-OECD dataset. There are 428 OECD reactors and only 107 non-OECD reactors in the raw PRIS database, and 353 OECD reactors (360 counting the rehabilitated units) and only 72 non-OECD reactors in the base case database. Tables 13-15 show the results for the OECD, while Tables 16-18 show the results for the non-OECD. Comparing the unconditional mean capacity factors calculated from the P matrices reported in Tables 15 and 18 we see that the mean capacity factor in OECD reactors is higher than non-OECD reactors. For example, at year 10 the OECD mean capacity factor is 75.2% versus 64.8% in the non-OECD. This is a result of differences in both the conditional probability matrix, Φ, and the probability of permanent shutdowns, Θ. Some of the differences in the conditional probability matrix can be summarized in the steady-state mean conditional capacity factors reported in Tables 15 and 18. The steady-state mean conditional capacity factor in OECD reactors is higher than non-OECD reactors, 75.3% versus 69.2%. The probability of a shutdown is lower among OECD reactors than among non-OECD reactors.

Interestingly, a comparison of Tables 15 and 18 reveals that the variance of the capacity factor is greater when constructed from the OECD reactor data than when constructed from the non-OECD reactor data. For example, in the second year of operation, the unconditional variance in the OECD capacity factor is 5.2% versus 3.5% for the non-OECD capacity factor. The variance of the steady-state conditional distribution for the OECD capacity factor is 3% versus 1.9% for the non-OECD capacity factor.

Epoch results

The base case dataset is divided into transitions occurring pre- and post-2000. Transitions from 1999 into 2000 are assigned to the post-2000 dataset. Tables 19-21 show the results constructed using the pre-2000 experience, while Tables 22-24 show the results constructed using the post-2000 experience. Comparing the unconditional mean capacity factors calculated from the P matrices reported in Tables 21 and 24 we see that the mean capacity factor pre-2000 is lower than post-2000 reactors. At year 10 the pre-2000 mean capacity factor is 70.9% versus 77.8% post-2000. This is a result of differences in both the conditional probability matrix, Φ, and the probability of permanent shutdowns, Θ. As one can see in Tables 21 and 24, the steady-state mean conditional capacity factor in pre-2000 reactors is lower than post-2000 reactors, 71.5% versus 78.2%. The probability of shutdowns is greater among reactors pre-2000 than post-2000.

A comparison of Tables 21 and 24 reveals that the variance of the capacity factor is greater when constructed from the pre-2000 data than when constructed from the post-2000 data. For example, in the second year of operation, the unconditional variance constructed using the pre-2000 data is 4.8% versus 3.6% using the post-2000 data. The variance of the steady-state conditional distribution from the pre-2000 data is 2.9% versus 2.1% for the post-2000 data.

Age results

The base case dataset is divided into transitions occurring during the first 5 years of operation and transitions occurring after the first 5 years of operation. Transitions from year 4 into year 5 are in the first category, and transitions from year 5 into year 6 are in the second category. Tables 25 and 26 show the estimation of the parameters of the conditional probability distributions for the conditional transition matrix, Φ^{pre5}, and the estimation of the probabilities of permanent shutdown, Θ^{pre5}, using the experience from the first 5 years of operation. These matrices include the start-up probability distribution. Tables 27 and 28 shows the corresponding estimates, Φ^{post5} and Θ^{post5}, using the experience from the years of operation after the first 5 years of operation. These matrices, of course, do not include a start-up probability distribution. Table 29 shows the mean and variance from the unconditional transition matrix, P, through the life of the reactor constructed using Φ^{pre5} and Θ^{pre5} to generate the probabilities over the first 5 years of operation and Φ^{post5} and Θ^{post5}, to generate the probabilities for the remaining years.

Comparisons of Tables 25 and 27 show that differences in the conditional probability matrix, Φ, do not yield an unambiguous comparison of mean conditional capacity factors independent of the prior year's capacity factor. When the prior year's capacity factor is high, reactors with more than 5-years operating experience have a higher conditional mean operating factor than do reactors with less than 5-years operating experience. However, when the prior year's capacity factor is low, reactors with more than 5-years operating experience have a lower conditional mean operating factor than do reactors with less than 5-years operating experience. This would make sense if, for example, a low capacity factor in the early years reflected, in part, shake-out problems that can occur at the start-up of any reactor, while a low capacity factor in later years more purely reflected reactor specific problems that persist across years.

The sample frequency of permanent shutdowns is concentrated in the early years of operation.

A comparison of Table 29 against Table 12 shows that segmenting the data set by age of operation produces a slightly lower mean capacity factor in the early years of operation, and a slightly higher mean capacity factor in the later years. In year 2, the unconditional mean load factor is 66.1%, very slightly below the 67.1% unsegmented base case result. By year 10, the unconditional mean load factor is 74.3%, very slightly above the 74% unsegmented base case result. The steady-state conditional load factor is 75.1% in the segmented data, as opposed to 74.5% in the unsegmented base case results.

Interestingly, segmenting by age lowers the volatility of the unconditional distribution in the first years of operation as can also be seen in a comparison of Tables 29 and 12. For example, shows that the unconditional variance in year 2 constructed using age segmented data is 3.8% versus 5.2% in the base case. The variance of the steady-state conditional distribution from the age segmented data is by construction identical to the figure for the base case, 3.1%.

Country specific results

The relatively low mean capacity factors reported above for the OECD and for post-2000 data are surprising to some. This is especially true for those who have given attention to the very high capacity factors attained in the United States in recent years. The explanation is to be found in the fact that country specific results are highly variable. For example, in this period when the US began to attain very high capacity factors, Japan confronted major problems at a number of reactors, lowering the average in Japan dramatically. Persons focusing on one country will arrive at starkly different estimates depending upon which is chosen. Our results above average across these individual country samples. Also, as mentioned in the opening discussion about capacity factors, the situations vary across countries, and France, in particular, runs a number of reactors to follow load and so has lower capacity factors.

To see this, we report results for these three countries estimated separately using post-2000 data. Tables 30-31 report results for the US, Tables 32-33 report results for Japan, and Tables 34-35 report results for France. In each case, we report the parameters of the Conditional Transition Probability matrix, Φ, calculated using post-2000 data. Since none of the countries had any of what we classify as involuntary permanent shutdowns during this period, we only report the distribution moments for the load factor, conditional on continuing operation, from P. Also, due to the small number of reactor starts—none in some cases—we employ the conditional probability vector for a start-up reactor calculated from the full OECD data.

Obviously, when one repeats the analysis for finer subsets of the data one obtains more variable results as one can see by comparing the starkly different mean capacity factors for these three countries using the post-2000 dataset. Table 31 shows that the steady-state mean conditional capacity factor in the US post-2000 is 92.7%. Table 33 shows that the same parameter for Japan is only 66.7%, while Table 34 shows that it is 75.2% for France.

The variance of the steady-state conditional distributions are also different, although the time pattern is similar. For the US the variance of the steady-state conditional distribution is 0.4%, for Japan it is 2.9% and for France is is 0.5%.

The contrasts across these countries makes clear how large a role judgement must play in making use of the available data. Obviously, if one wants to forecast the capacity factor risk structure in the US, it may make good sense to set aside or otherwise minimize the French data since one knows a priori that the institutional settings are starkly different and this may be the major factor in the different mean capacity factors. However, setting aside the Japanese data is more troublesome. One can make an argument that Japanese specific geography—vulnerability to earthquakes—as well as country specific corporate and regulatory failures are the reasons for the low capacity factors, and that these do not apply to the US. However, the fact that in an earlier era it was the US that saw very low capacity factors due to country specific corporate and regulatory failures, makes this a weaker position. The current Japanese experience and the earlier US experience could reflect a common underlying vulnerability for this complicated technology, one that could show-up in any country in the future, always in the guise of country specific circumstances. It is not our objective here to resolve this issue, but only to highlight the significant judgment that must be applied in deciding which data to rely upon for making future projections.

5. CONCLUSIONS

We developed a fully specified model of the dynamic structure of capacity factor risk. It incorporates the risk that the capacity factor may vary widely from year-to-year, and also the risk that the reactor may be permanently shutdown prior to its anticipated useful life. We then fit the parameters of the model to the IAEA's PRIS dataset of historical capacity factors on reactors across the globe.

Our main result is that capacity factor risk is greatest in the first year of operation, declining quickly over the next couple of years, after which it is approximately constant or gradually increasing. Whether risk is constant or increasing in later years depends significantly on the probability of an early, permanent shutdown of the reactor. Our base case is parameterized with a conservatively low probability of a permanent shutdown which yields approximately constant variance after the first few years.

Although our original objective was to understand the dynamic structure of capacity factor risk, in estimating our model we also found interesting results about the expected *level* of the capacity factor. Our model, combined with the global historical dataset, yields relatively low estimates for the expected *level* of the capacity factor through the life of the plant. Our base case estimate is approximately 74%. If we construct our estimate using historical data only for reactors installed in OECD countries, the estimate improves by approximately 1 percentage point. If we construct our estimate using historical data only for reactor performance since the year 2000, the estimate improves by approximately 4 percentage points. If we construct our estimate recognizing the different performance characteristics of young and old reactors, the estimated mean capacity factor is *reduced* in the first few years of operation, and increased in the later years. In this preliminary analysis, we did not attempt to construct an estimate combining each of these effects. But it is difficult to see from this first pass through the data how that would likely yield a result at all close to the 85% or 90% figures that are commonly used in advocating construction of new nuclear power plants.

Justification for such a high estimated mean capacity factor appears to require focusing exclusively on a much smaller subset of the data—e.g. only at the performance of mature plants in the United States since the year 2000—and simultaneously ignoring all of the other available data and experience. Certainly there may be a good reason for focusing on a small subset of the data and ignoring the other data. It is equally wrong to naively treat all datapoints as equally informative as it is to naively focus on only some of the datapoints and ignore the others. But we have not seen a careful justification for high estimates of the mean capacity factor that seriously confront the potential information available in the full data set.

We should reiterate here that we have been very conservative in calculating our estimate of the probability of a permanent shutdown. Our estimates using the raw data set show that a higher probability of a permanent shutdown could be easily rationalized using the historical experience. This parameter has a very strong influence on the unconditional mean capacity factor. Here again, judgment in exploiting the historical data is key. We obtain our low estimate of the unconditional mean capacity factor despite being very conservative in estimating the probability of a permanent shutdown.

REFERENCES

David, Paul A, Roland Maude-Griffin, and Geoffrey Rothwell, 1996, Learning by Accident? Reductions in the Risk of Unplanned Outages in U.S. Nuclear Power Plants After Three Mile Island, Journal of Risk and Uncertainty, 13, 175-198.

Easterling, Robert G., 1982, Statistical Analysis of U.S. Power Plant Capacity Factors through 1979, Energy, 7.3, 253-258.

Hultman, Nathan E., Jonathan G. Koomey, and Daniel M. Kammen, 1 April 2007, What History Can Teach Us about the Future Costs of U.S. Nuclear Power, Environmental Science and Technology, 2088-2093.

Joskow, Paul L. and George A. Rozanski, 1979, The Effects of Learning by Doing on Nuclear Plant Operating Reliability, The Review of Economics and Statistics, 61.2, 161-168.

Komanoff, Charles, 1981, Power Plant Cost Escalation: Nuclear and Coal Capital Costs, Regulations, and Economics, New York: Van Nostrand Reinhold Company.

Koomey, Jonathan and Nathan E. Hultman, 2007, A reactor-level analysis of busbar costs for US nuclear plants, 1970-2005, Energy Policy, 35, 5630-5642.

Krautmann, Anthony C. and John L. Solow, 1988, Economies of Scale in Nuclear Power Generation, Southern Economic Journal, 55.1, 70-85.

Lester, Richard K. and Mark J. McCabe, 1993, The Effect of Industrial Structure on Learning by Doing in Nuclear Power Plant Operation, The RAND Journal of Economics, 24.3, 418-438.

Rothwell, Geoffrey, 1990, Utilization and Service: Decomposing Nuclear Reactor Capacity Factors, Resources and Energy, 12, 215-229.

---, 1996, Organizational Structure and Expected Output at Nuclear Power Plants, The Review of Economics and Statistics, 78.3, 482-488.

---, 2006. “A Real Options Approach to Evaluating New Nuclear Power Plants,” The Energy Journal 27, 1.

Rothwell, Geoffrey and John Rust, 1995, A dynamic programming model of US nuclear power plant operations, University of Wisconsin Department of Economics.

---, 1995, Optimal Response to a Shift in Regulatory Regimes, Journal of Applied Econometrics, 10. S75-S118.

---, 1997, On the Optimal Lifetime of Nuclear Power Plants, Journal of Business and Economic Statistics, 15.2, 195-208.

Samis, Michael, 2009, Using Dynamic Discounted Cash Flow and Real Option Simulation to Analyze a Financing Proposal for a Nuclear Power Plant, Ernst & Young presentation.

Sturm, Roland, 1993, Nuclear power in Eastern Europe: Learning or forgetting curves?, Energy Economics, 15.3, 183-189.

---, 1994, Proportional hazard regression models for point processes: An analysis of nuclear power plant operations in Europe, Journal of Applied Statistics, 21.6, 533-540.

---, 1995, Why does nuclear power performance differ across Europe?, European Economic Review, 39.6, 1197-1214.

Figure 1
Transition Matrix from Raw PRIS Database

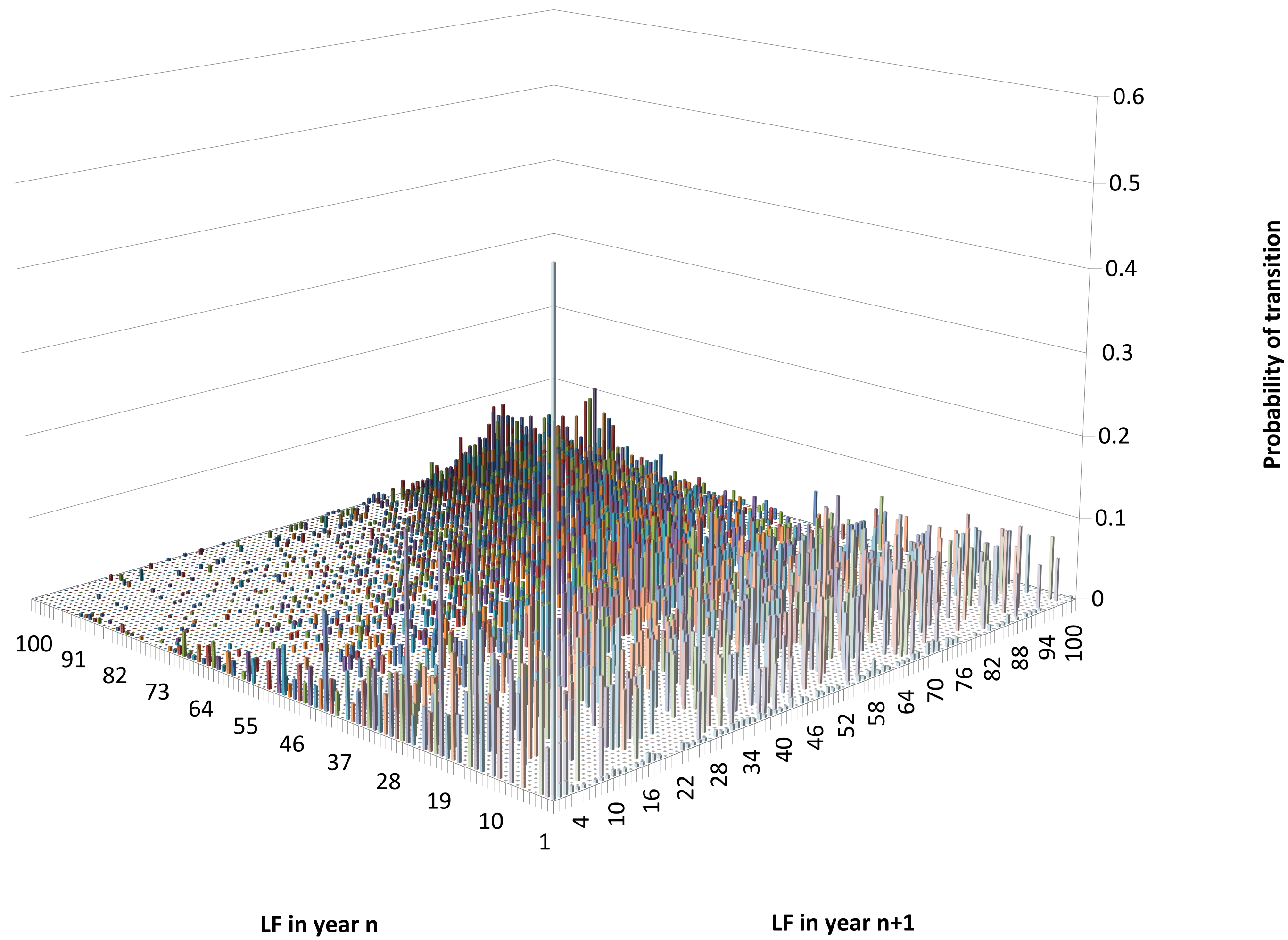

Figure 2
Sample and Fitted Mean of the Conditional Transition Probabilities

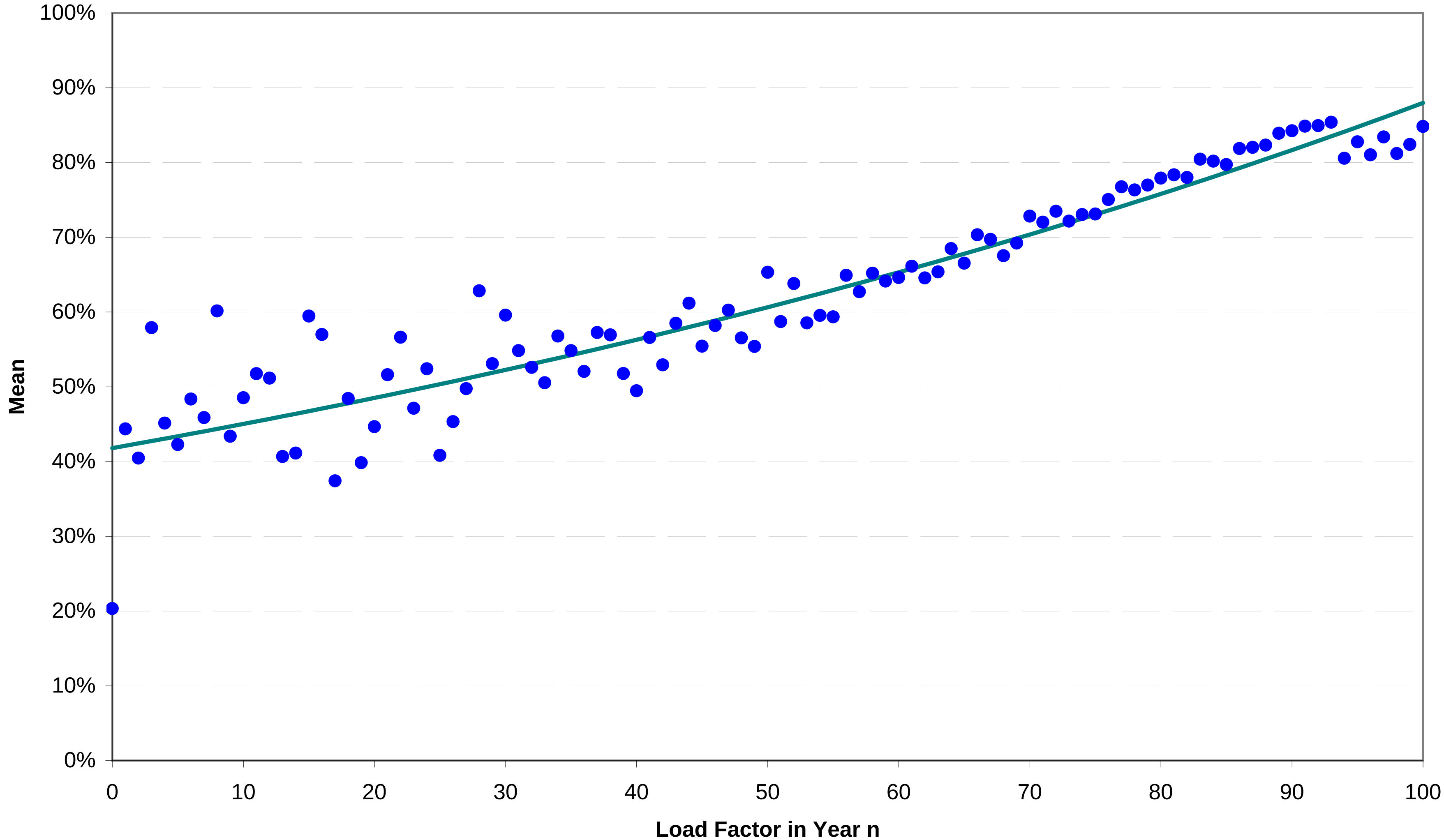

Figure 3
Sample and Fitted Variance of the Conditional Transition Probabilities

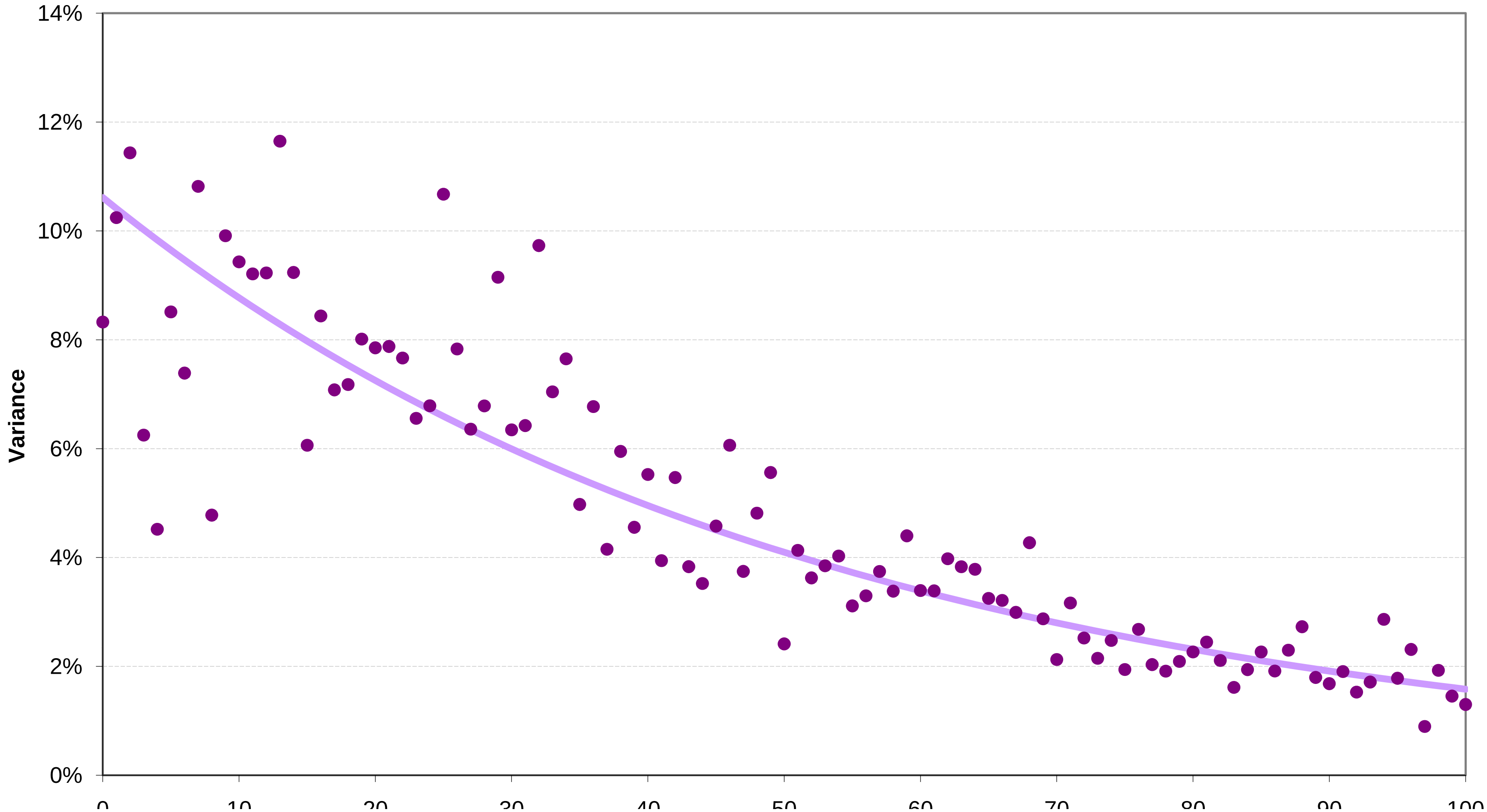

Figure 4: Implied Beta Probability Density Function over Load Factor in Year n+1, Conditional on Load Factor in Year n

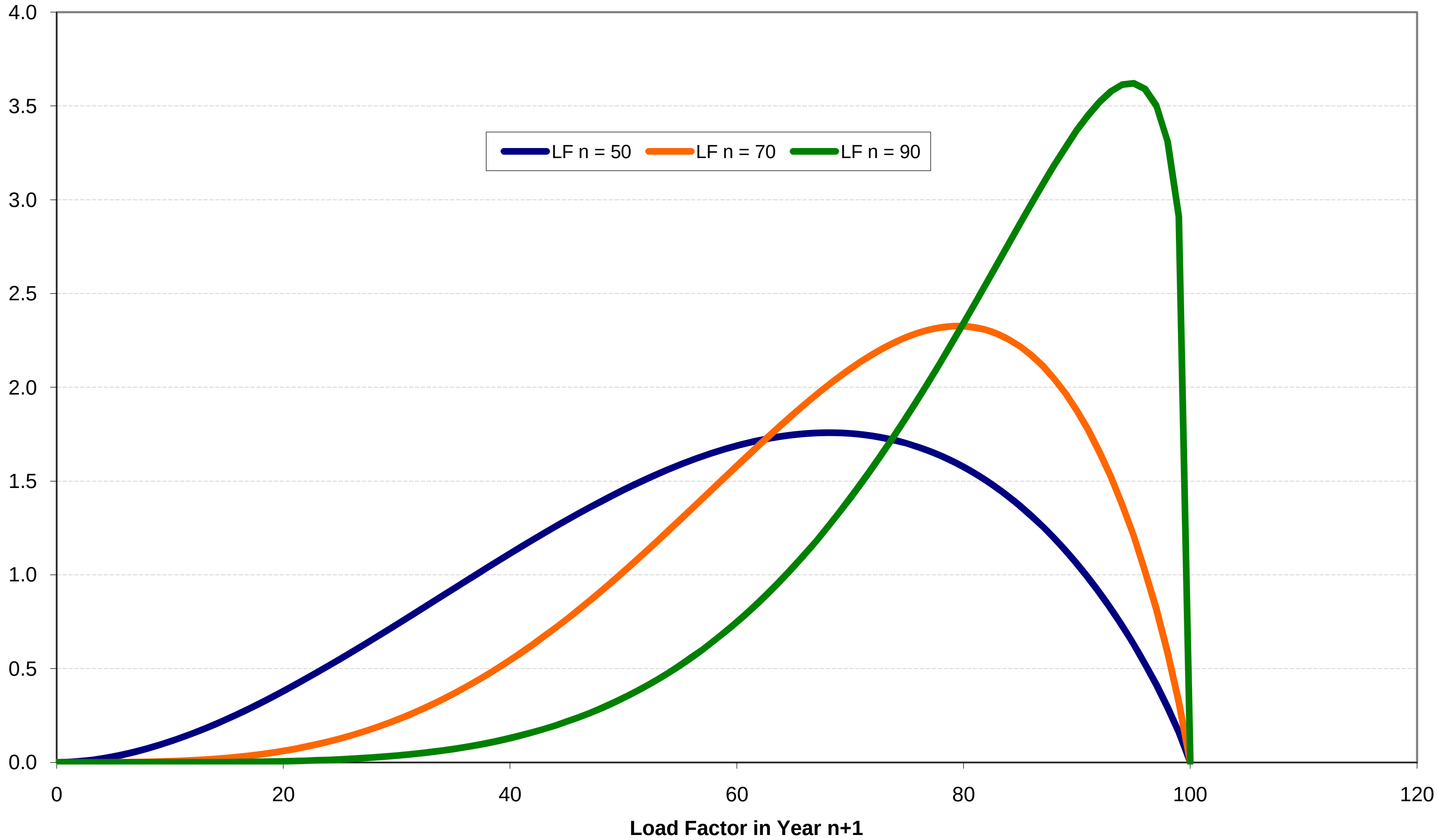

Figure 5: Unconditional Variance of the Capacity Factor Through the Life of the Reactor (est. from the raw data set)

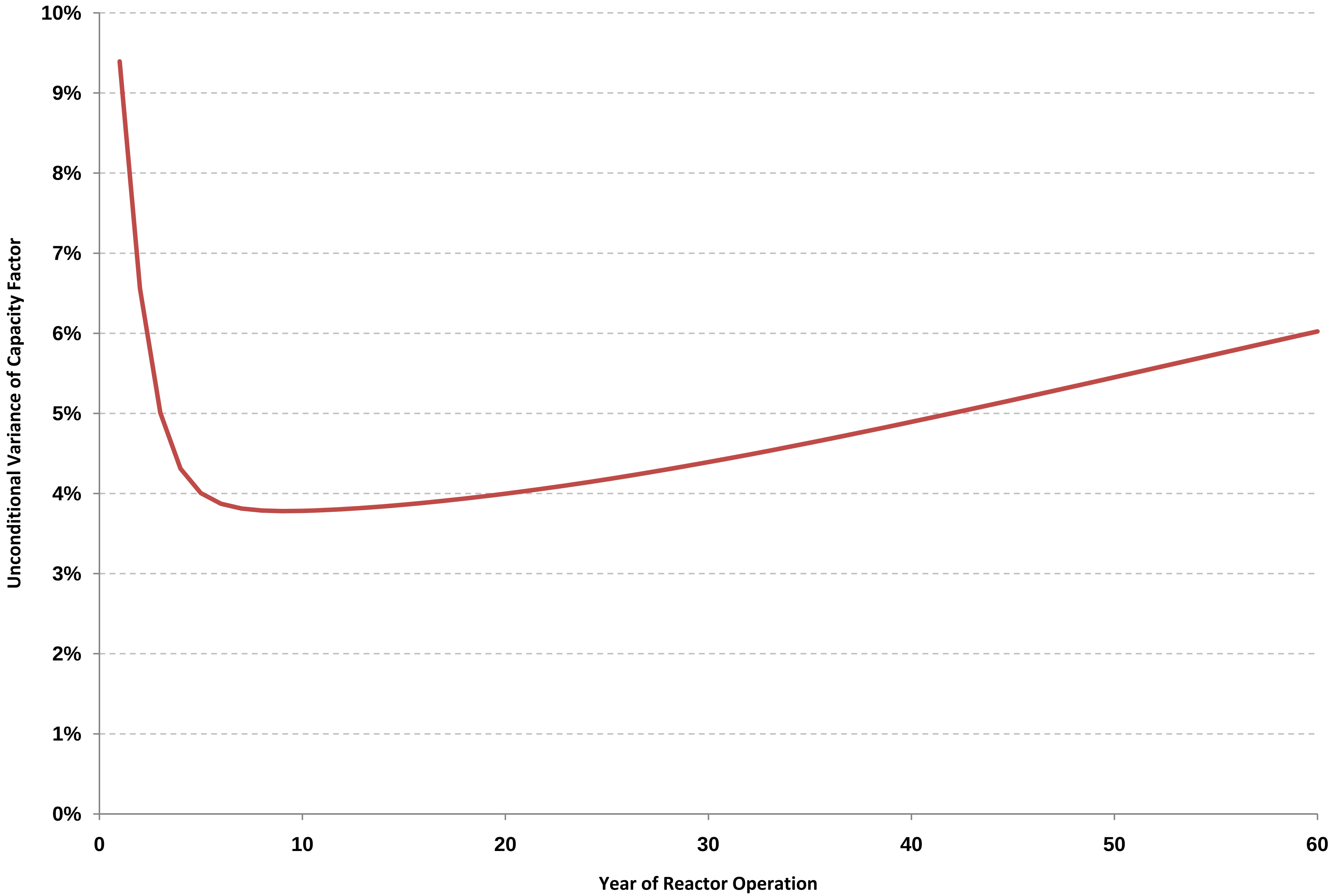

Table 1: Summary Annual Reactor Statistics

Year	Number of Operating Reactors			Median Years of Operation			Permanent Shutdowns	
	All	OECD	non-OECD	All	OECD	non-OECD	Annual	Cum.
1969	1	1	0	1	1		0	0
1970	29	29	0	1	1		0	0
1971	66	64	2	1	1	1	1	1
1972	84	79	5	2	2	1	2	3
1973	102	94	8	3	3	2	1	4
1974	127	115	12	3	4	2	4	8
1975	141	125	16	4	4	2.5	0	8
1976	157	139	18	5	5	3	2	10
1977	171	152	19	5	5	4	4	14
1978	183	164	19	5	6	5	1	15
1979	194	173	21	6	6	6	2	17
1980	209	186	23	7	7	7	1	18
1981	230	201	29	7	8	7	1	19
1982	249	214	35	8	8	7	2	21
1983	266	229	37	8	8.5	7	1	22
1984	300	258	42	8	8	5.5	3	25
1985	326	277	49	8	8	5	3	28
1986	347	296	51	8	9	6	1	29
1987	376	313	63	8	9	6	4	33
1988	391	327	64	9	9	7	5	38
1989	407	335	72	9	10	7.5	7	45
1990	406	335	71	10	10	8.5	14	59
1991	408	336	72	11	11	9	6	65
1992	407	334	73	11	12	10	3	68
1993	414	339	75	12	13	10	0	68
1994	418	340	78	13	13.5	11	3	71
1995	423	343	80	14	14	12	0	71
1996	427	346	81	14	15	13	2	73
1997	424	344	80	15	15	14	3	76
1998	420	340	80	16	16	15	5	81
1999	420	341	79	17	17	16	2	83
2000	428	343	85	18	18	16	3	86
2001	428	344	84	19	19	17	0	86
2002	434	347	87	19	20	18	5	91
2003	435	348	87	20	21	19	6	97
2004	440	348	92	21	22	19	5	102
2005	444	352	92	22	23	19.5	2	104
2006	444	350	94	23	24	20	8	112
2007	439	344	95	24	25	21	0	112
2008	439	344	95	25	26	22	1	113

Table 2: Sample Capacity Factor Data from PRIS

			Country & Reactor			
			France	South Korea	Japan	United States
	Data Label	Units	Cattenom-1	Wolsong-4	Genkai-4	Sequoyah-1
	[A]	[B]	[C]	[D]	[E]	[F]
[1]	RUP	MW	1,300	685	1,127	1,150
[2]	T	h	8,766	8,766	8,766	8,766
[3]	t	h	8,432	8,163	8,766	7,674
[4]	REG	MWh	11,395,800	6,004,710	9,879,282	10,080,900
[5]	EG	MWh	9,698,200	5,770,400	10,025,300	8,758,300
[6]	PUF	%	0.2	6.6	0.0	12.5
[7]	UUF	%	5.9	0.6	0.0	0.0
[8]	XUF	%	1.5	0.0	0.0	0.0
[9]	OF	%	96.2	93.1	100.0	87.5
[10]	LF	%	85.1	96.1	101.5	86.9
[11]	EAF	%	92.4	92.8	100.0	87.5
[12]	UCF	%	93.9	92.8	100.0	87.5

Notes:

All figures as reported for 2007 annual. The following relationships hold:

[9]= 100 x [3]/[2].

[10]= 100 x [5]/[4].

[11]= 100 - [6] - [7] - [8].

[12]= 100 - [6] - [7].

Table 3: Summary Annual Load Factor Statistics

Year	Median Load Factor			Standard Deviation of Load Factor		
	All	OECD	non-OECD	All	OECD	non-OECD
1969	5.8	5.8				
1970	66.4	66.4		21.3	21.3	
1971	66.0	66.4	1.7	25.2	23.2	0.6
1972	61.8	63.7	35.4	21.7	20.7	23.0
1973	61.0	61.9	53.3	24.5	24.7	23.0
1974	62.1	62.5	58.1	24.6	25.1	19.5
1975	66.0	69.3	49.4	24.2	24.6	18.3
1976	64.5	65.6	62.4	22.4	22.8	19.1
1977	67.9	68.9	63.1	22.0	22.5	17.2
1978	69.3	69.4	69.2	23.1	23.4	21.0
1979	64.9	63.4	73.2	22.3	22.3	22.1
1980	67.3	66.3	78.2	23.0	22.7	25.6
1981	67.9	67.4	75.7	23.1	22.8	25.5
1982	68.0	67.0	73.0	24.7	24.3	27.5
1983	69.9	69.4	76.9	23.3	23.3	23.8
1984	74.0	73.0	79.3	23.7	24.0	21.8
1985	75.2	75.2	77.3	21.1	21.2	20.7
1986	73.5	73.7	73.0	23.0	23.2	21.6
1987	73.0	72.9	73.6	22.5	22.2	23.9
1988	72.0	71.3	74.6	20.4	20.7	18.5
1989	72.8	72.8	73.2	21.5	21.4	21.9
1990	72.6	73.0	69.8	20.3	19.8	22.3
1991	74.7	75.9	64.3	20.1	19.9	19.0
1992	74.2	75.2	69.2	20.8	20.0	22.8
1993	75.0	77.2	63.4	21.5	20.5	22.1
1994	76.4	78.9	56.1	22.5	20.3	23.6
1995	77.9	79.6	60.5	21.4	18.9	23.0
1996	78.2	80.1	64.5	21.0	19.3	23.2
1997	78.4	80.9	67.4	22.6	22.3	21.5
1998	80.6	82.7	64.1	22.2	21.8	18.8
1999	82.4	84.8	66.4	19.7	18.5	19.5
2000	82.7	84.8	72.0	20.0	19.9	17.7
2001	83.8	85.7	73.7	19.2	19.0	17.2
2002	85.4	87.3	76.2	20.4	19.7	20.8
2003	83.5	85.1	79.3	21.8	22.3	19.0
2004	84.4	86.0	80.2	19.0	16.9	23.8
2005	84.1	85.8	76.7	18.6	17.3	21.0
2006	85.1	86.9	76.3	19.0	17.2	22.5
2007	84.4	85.4	79.7	20.9	20.2	22.1
2008	84.5	85.8	79.4	23.6	23.2	24.2

Table 4: Extract of Transition Matrix Calculated Using Raw PRIS Historical Data

Load Factor in year n	Load Factor in year n+1: 100	99	98	97	96	95	94	93	92	91	90
100	3.3	0.4	0.7	0.7	3.7	1.1	4.4	5.9	5.6	6.3	6.7
99	0.7	0.7	0.7		1.5		0.7	3.6	4.4	2.9	5.1
98	3.1	0.8	2.3		0.8	1.6	0.8	3.1	3.9	3.1	6.2
97	3.9	1.0		1.0		1.0		4.9	6.8	2.9	5.8
96	2.2	0.7	1.5	0.7	0.7	6.6	1.5	2.9	3.7	5.1	3.7
95	5.8	2.2	0.7	1.4	2.9	2.2	5.8	5.0	2.9	2.9	5.0
94	3.0	1.8	1.8	0.6	1.8	3.7	3.0	6.1	4.3	4.9	3.0
93	8.1	2.3	1.7	1.7	3.5	7.0	5.8	2.3	2.9	6.4	4.1
92	8.7	1.4	0.9	2.8	1.8	2.8	4.1	4.6	6.0	4.1	7.8
91	10.2	2.5	2.5	1.6	1.6	2.9	2.5	3.7	6.1	4.5	4.9
90	4.9	3.0	1.5	0.8	1.5	3.0	2.3	2.3	4.6	6.5	4.9
89	7.2	2.7	1.1	3.0	2.7	1.1	1.5	2.7	3.8	2.3	7.2
88	6.7	2.2	1.9	2.2	2.9	2.2	2.5	3.2	1.9	4.8	2.2
87	5.9	2.1	4.2	1.7	1.0	1.4	1.4	1.7	2.1	3.8	5.5
86	3.0	2.7	3.0	0.7	1.7	2.0	1.7	1.0	1.0	3.4	2.7
85	3.2	2.5	1.6	1.0	0.3	1.6	1.6	2.5	2.2	2.5	4.8
84	3.5	1.2	1.4	0.9	0.9	2.0	1.2	1.2	1.4	2.6	3.5
83	2.5	1.2	2.2	1.5	2.5	1.9	1.5	2.5	2.8	1.5	1.5
82	2.0	1.6	1.0	1.0	1.3	0.3	2.0	2.0	2.0	1.6	2.3
81	2.5	1.3	0.3	1.6	2.2	1.3	1.0	1.9	2.2	2.2	1.3
80	1.3	1.9	1.3	1.9	0.9	1.6	1.6	1.6	4.1	4.1	1.6
79	2.3	1.9	0.6	0.6	1.6	0.6	0.3	2.6	0.6	1.6	1.3
78	2.7	1.0	3.1	0.3	1.7	1.0	1.0	0.7	1.0	1.0	1.7
77	2.2	1.5	1.5	1.5	1.1	1.1	1.8	0.4	1.5	1.8	0.4
76	0.7	4.1	1.5	0.4	1.1	0.4	1.8	0.7	1.1	1.1	1.1
75	0.3	0.7	1.3	0.7	0.3		0.7	1.3	0.7	1.0	1.6
74	1.9	1.5	1.1	0.4	1.1			0.4	1.9	1.9	1.5
73	0.4	1.1		1.5		0.8	1.1	0.8	0.8	0.4	1.9
72	1.2	1.2		1.6	1.2	1.6	2.0	0.8	0.8	1.6	0.8
71	0.9	1.4	1.4	0.9	1.4	1.4	0.5	0.9	2.3	3.3	0.9
70	0.4	0.4		0.4	0.8	1.6	2.1	0.4	1.2	0.8	2.1
69	2.1	1.0		2.1	0.5		1.0		0.5	1.0	0.5
68	1.5	1.0	0.5	1.0	1.5	0.5	1.0	0.5	0.5	1.5	1.0
67	0.5		1.5	1.0	1.0	1.0	0.5	1.5	1.5	2.1	1.5
66	0.6	0.6	0.6	0.6	2.3	1.8	0.6	1.2	1.2	1.2	0.6
65		0.7		0.7	1.4	0.7	1.4		0.7	1.4	0.7
64	0.6	0.6	0.6	1.3	1.3	0.6	1.3	0.6	1.9		0.6
63			0.8				1.6		1.6		0.8
62	1.6				0.8		0.8		0.8	0.8	1.6
61				2.3		1.5	0.8	1.5	0.8		
60	0.8	0.8				0.8				1.5	

Table 5: Parameters of the Conditional Transition Probability, Φ, Raw Data

Load Factor in Year n	Sample Moments		Fitted Moments		Implied Beta Distribution	
	Mean	Var	Mean	Var	Alpha	Beta
100	85%	1%	88%	2%	5.01	0.69
99	82%	1%	87%	2%	5.13	0.75
98	81%	2%	87%	2%	5.23	0.81
97	83%	1%	86%	2%	5.32	0.86
96	81%	2%	85%	2%	5.39	0.92
95	83%	2%	85%	2%	5.45	0.98
94	81%	3%	84%	2%	5.50	1.04
93	85%	2%	83%	2%	5.53	1.09
92	85%	2%	83%	2%	5.56	1.15
91	85%	2%	82%	2%	5.57	1.20
90	84%	2%	82%	2%	5.58	1.25
89	84%	2%	81%	2%	5.57	1.30
88	82%	3%	80%	2%	5.56	1.35
87	82%	2%	80%	2%	5.54	1.40
86	82%	2%	79%	2%	5.52	1.44
85	80%	2%	79%	2%	5.49	1.49
84	80%	2%	78%	2%	5.45	1.53
83	80%	2%	78%	2%	5.41	1.57
82	78%	2%	77%	2%	5.36	1.61
81	78%	2%	76%	2%	5.31	1.64
80	78%	2%	76%	2%	5.25	1.68
79	77%	2%	75%	2%	5.19	1.71
78	76%	2%	75%	2%	5.13	1.74
77	77%	2%	74%	2%	5.06	1.77
76	75%	3%	74%	2%	4.99	1.79
75	73%	2%	73%	3%	4.92	1.82
74	73%	2%	72%	3%	4.85	1.84
73	72%	2%	72%	3%	4.77	1.86
72	73%	3%	71%	3%	4.70	1.88
71	72%	3%	71%	3%	4.62	1.90
70	73%	2%	70%	3%	4.54	1.91
69	69%	3%	70%	3%	4.46	1.92
68	68%	4%	69%	3%	4.38	1.94
67	70%	3%	69%	3%	4.29	1.95
66	70%	3%	68%	3%	4.21	1.95
65	67%	3%	68%	3%	4.13	1.96
64	68%	4%	67%	3%	4.05	1.97
63	65%	4%	67%	3%	3.96	1.97

Table 5: Parameters of the Conditional Transition Probability, Φ, Raw Data

Load Factor in Year n	Sample Moments		Fitted Moments		Implied Beta Distribution	
	Mean	Var	Mean	Var	Alpha	Beta
62	65%	4%	66%	3%	3.88	1.97
61	66%	3%	66%	3%	3.80	1.97
60	65%	3%	65%	3%	3.72	1.97
59	64%	4%	65%	3%	3.63	1.97
58	65%	3%	64%	4%	3.55	1.97
57	63%	4%	64%	4%	3.47	1.96
56	65%	3%	63%	4%	3.39	1.96
55	59%	3%	63%	4%	3.31	1.95
54	60%	4%	62%	4%	3.23	1.94
53	59%	4%	62%	4%	3.16	1.93
52	64%	4%	62%	4%	3.08	1.92
51	59%	4%	61%	4%	3.00	1.91
50	65%	2%	61%	4%	2.93	1.90
49	55%	6%	60%	4%	2.85	1.89
48	57%	5%	60%	4%	2.78	1.87
47	60%	4%	59%	4%	2.71	1.86
46	58%	6%	59%	4%	2.64	1.84
45	55%	5%	58%	5%	2.57	1.83
44	61%	4%	58%	5%	2.50	1.81
43	58%	4%	58%	5%	2.43	1.79
42	53%	5%	57%	5%	2.36	1.77
41	57%	4%	57%	5%	2.30	1.75
40	49%	6%	56%	5%	2.23	1.73
39	52%	5%	56%	5%	2.17	1.71
38	57%	6%	55%	5%	2.11	1.69
37	57%	4%	55%	5%	2.05	1.67
36	52%	7%	55%	5%	1.99	1.65
35	55%	5%	54%	5%	1.93	1.63
34	57%	8%	54%	6%	1.87	1.60
33	51%	7%	53%	6%	1.81	1.58
32	53%	10%	53%	6%	1.76	1.56
31	55%	6%	53%	6%	1.70	1.53
30	60%	6%	52%	6%	1.65	1.51
29	53%	9%	52%	6%	1.60	1.49
28	63%	7%	51%	6%	1.55	1.46
27	50%	6%	51%	6%	1.50	1.44
26	45%	8%	51%	6%	1.45	1.41
25	41%	11%	50%	7%	1.41	1.39

Table 5: Parameters of the Conditional Transition Probability, Φ, Raw Data

Load Factor in Year n	Sample Moments		Fitted Moments		Implied Beta Distribution	
	Mean	Var	Mean	Var	Alpha	Beta
24	52%	7%	50%	7%	1.36	1.36
23	47%	7%	50%	7%	1.31	1.34
22	57%	8%	49%	7%	1.27	1.31
21	52%	8%	49%	7%	1.23	1.28
20	45%	8%	49%	7%	1.19	1.26
19	40%	8%	48%	7%	1.14	1.23
18	48%	7%	48%	8%	1.10	1.21
17	37%	7%	47%	8%	1.07	1.18
16	57%	8%	47%	8%	1.03	1.16
15	59%	6%	47%	8%	0.99	1.13
14	41%	9%	46%	8%	0.96	1.10
13	41%	12%	46%	8%	0.92	1.08
12	51%	9%	46%	8%	0.89	1.05
11	52%	9%	45%	9%	0.85	1.03
10	49%	9%	45%	9%	0.82	1.00
9	43%	10%	45%	9%	0.79	0.98
8	60%	5%	44%	9%	0.76	0.95
7	46%	11%	44%	9%	0.73	0.93
6	48%	7%	44%	9%	0.70	0.90
5	42%	9%	43%	10%	0.67	0.87
4	45%	5%	43%	10%	0.64	0.85
3	58%	6%	43%	10%	0.62	0.83
2	40%	11%	42%	10%	0.59	0.80
1	44%	10%	42%	10%	0.56	0.78
0	20%	8%	42%	11%	0.54	0.75
start-up	52%	9%	NA	NA	0.86	0.80

Notes:

Sample moments correspond to the Transition Matrix shown in Table 4.

Fitted moment values are based on the regression results shown in Table 6. The regression fits the log mean and log variance. The fitted log values are then translated back into percentage levels.

Beta Distribution Parameters are calculated by the method of moments using these equations:

Mean = alpha / (alpha+beta),

Variance = (alpha*beta) / [(alpha+beta)^2 * (alpha+beta+1)].

Table 6: Regressions of Sample Mean and Sample Variance on Load Factor in Year *n* , Raw Data

Dependent Variable: Log Sample Mean

	Coefficient	Std. Error	t-ratio	p-value
Constant	-0.872274	0.0376668	-23.16	0.0000
lf_initial	0.007440	0.0005464	13.26	0.0000

Mean dependent var	-0.500273	S.D. dependent var	0.244701
Sum squared resid	1.235737	S.E. of regression	0.111724
R-squared	0.793627	Adjusted R-squared	0.791542
F(1,99)	185.4252	P-Value (F)	2.02E-24
Log-likelihood	79.06160	Akaike criterion	-154.1232
Schwartz criterion	-148.8930	Hannan-Quinn	-152.0058

Dependent Variable: Log Sample Variance

	Coefficient	Std. Error	t-ratio	p-value
Constant	-2.243050	0.0549316	-40.83	0.0000
lf_initial	-0.0190384	0.0009123	-20.87	0.0000

Mean dependent var	-3.194967	S.D. dependent var	0.602650
Sum squared resid	5.201509	S.E. of regression	0.229217
R-squared	0.856781	Adjusted R-squared	0.855335
F(1,99)	435.5258	P-Value (F)	4.97E-38
Log-likelihood	6.478882	Akaike criterion	-8.957763
Schwartz criterion	-3.727522	Hannan-Quinn	-6.840411

Table 7: Shutdown Probabilities, Θ, Raw Data

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
100	0.00%	0.49%	0.31%
99	0.73%	0.50%	0.31%
98	0.00%	0.51%	0.32%
97	0.00%	0.53%	0.33%
96	0.74%	0.54%	0.34%
95	0.72%	0.55%	0.35%
94	0.61%	0.57%	0.36%
93	1.16%	0.59%	0.37%
92	0.92%	0.60%	0.38%
91	0.00%	0.62%	0.39%
90	0.76%	0.63%	0.40%
89	0.38%	0.65%	0.41%
88	0.64%	0.67%	0.42%
87	1.04%	0.69%	0.43%
86	0.00%	0.71%	0.45%
85	0.96%	0.73%	0.46%
84	0.87%	0.74%	0.47%
83	0.93%	0.76%	0.48%
82	0.00%	0.79%	0.50%
81	0.32%	0.81%	0.51%
80	0.00%	0.83%	0.52%
79	0.98%	0.85%	0.54%
78	0.34%	0.87%	0.55%
77	1.10%	0.90%	0.57%
76	0.74%	0.92%	0.58%
75	0.33%	0.95%	0.60%
74	0.75%	0.97%	0.61%
73	0.38%	1.00%	0.63%
72	0.00%	1.03%	0.65%
71	0.47%	1.05%	0.66%
70	1.23%	1.08%	0.68%
69	1.03%	1.11%	0.70%
68	0.49%	1.14%	0.72%
67	2.05%	1.17%	0.74%
66	0.00%	1.21%	0.76%
65	1.35%	1.24%	0.78%
64	0.00%	1.27%	0.80%
63	0.00%	1.31%	0.82%

Table 7: Shutdown Probabilities, Θ, Raw Data

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
62	0.00%	1.34%	0.85%
61	2.31%	1.38%	0.87%
60	0.76%	1.42%	0.89%
59	2.52%	1.45%	0.92%
58	0.86%	1.49%	0.94%
57	0.00%	1.53%	0.97%
56	0.92%	1.58%	0.99%
55	1.14%	1.62%	1.02%
54	0.00%	1.66%	1.05%
53	2.86%	1.71%	1.08%
52	2.94%	1.75%	1.11%
51	0.00%	1.80%	1.14%
50	4.76%	1.85%	1.17%
49	1.72%	1.90%	1.20%
48	0.00%	1.95%	1.23%
47	0.00%	2.00%	1.26%
46	0.00%	2.06%	1.30%
45	0.00%	2.12%	1.33%
44	0.00%	2.17%	1.37%
43	2.22%	2.23%	1.41%
42	2.44%	2.29%	1.44%
41	6.90%	2.35%	1.48%
40	0.00%	2.42%	1.52%
39	1.96%	2.48%	1.57%
38	2.78%	2.55%	1.61%
37	0.00%	2.62%	1.65%
36	0.00%	2.69%	1.70%
35	2.08%	2.76%	1.74%
34	7.41%	2.84%	1.79%
33	0.00%	2.92%	1.84%
32	3.45%	3.00%	1.89%
31	0.00%	3.08%	1.94%
30	3.03%	3.16%	1.99%
29	0.00%	3.25%	2.05%
28	3.23%	3.33%	2.10%
27	0.00%	3.42%	2.16%
26	0.00%	3.52%	2.22%
25	0.00%	3.61%	2.28%

Table 7: Shutdown Probabilities, Θ, Raw Data

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
24	0.00%	3.71%	2.34%
23	0.00%	3.81%	2.40%
22	0.00%	3.91%	2.47%
21	0.00%	4.02%	2.53%
20	3.85%	4.13%	2.60%
19	0.00%	4.24%	2.67%
18	0.00%	4.36%	2.75%
17	0.00%	4.47%	2.82%
16	5.26%	4.60%	2.90%
15	0.00%	4.72%	2.98%
14	0.00%	4.85%	3.06%
13	0.00%	4.98%	3.14%
12	0.00%	5.12%	3.22%
11	8.33%	5.25%	3.31%
10	0.00%	5.40%	3.40%
9	0.00%	5.54%	3.49%
8	7.14%	5.69%	3.59%
7	6.67%	5.85%	3.69%
6	14.29%	6.01%	3.79%
5	0.00%	6.17%	3.89%
4	0.00%	6.34%	3.99%
3	20.00%	6.51%	4.10%
2	7.69%	6.69%	4.21%
1	5.26%	6.87%	4.33%
0	0.32%	7.05%	4.45%
start-up	NA	NA	NA

Table 8: Distribution Moments for the Load Factor, Unconditional and Conditional on Continuing Operation, From P, Raw Data

Year of Operation	Unconditional		Conditional on Operation	
	Mean	Var	Mean	Var
1	52%	9.4%	52%	9.4%
2	63%	6.6%	64%	6.6%
3	68%	5.0%	69%	5.1%
4	69%	4.3%	71%	4.4%
5	70%	4.0%	72%	4.1%
6	70%	3.9%	73%	3.9%
7	70%	3.8%	73%	3.9%
8	70%	3.8%	73%	3.9%
9	69%	3.8%	73%	3.8%
10	69%	3.8%	73%	3.8%
11	69%	3.8%	73%	3.8%
12	68%	3.8%	73%	3.8%
13	68%	3.8%	73%	3.8%
14	68%	3.8%	73%	3.8%
15	67%	3.9%	73%	3.8%
16	67%	3.9%	73%	3.8%
17	66%	3.9%	73%	3.8%
18	66%	3.9%	73%	3.8%
19	66%	4.0%	73%	3.8%
20	65%	4.0%	73%	3.8%
21	65%	4.0%	73%	3.8%
22	64%	4.1%	73%	3.8%
23	64%	4.1%	73%	3.8%
24	64%	4.1%	73%	3.8%
25	63%	4.2%	73%	3.8%
26	63%	4.2%	73%	3.8%
27	63%	4.3%	73%	3.8%
28	62%	4.3%	73%	3.8%
29	62%	4.3%	73%	3.8%
30	61%	4.4%	73%	3.8%
31	61%	4.4%	73%	3.8%
32	61%	4.5%	73%	3.8%
33	60%	4.5%	73%	3.8%
34	60%	4.6%	73%	3.8%
35	60%	4.6%	73%	3.8%

Table 8: Distribution Moments for the Load Factor, Unconditional and Conditional on Continuing Operation, From P, Raw Data

Year of Operation	Unconditional		Conditional on Operation	
	Mean	Var	Mean	Var
36	59%	4.7%	73%	3.8%
37	59%	4.7%	73%	3.8%
38	59%	4.8%	73%	3.8%
39	58%	4.8%	73%	3.8%
40	58%	4.9%	73%	3.8%
41	58%	4.9%	73%	3.8%
42	57%	5.0%	73%	3.8%
43	57%	5.1%	73%	3.8%
44	57%	5.1%	73%	3.8%
45	56%	5.2%	73%	3.8%
46	56%	5.2%	73%	3.8%
47	56%	5.3%	73%	3.8%
48	55%	5.3%	73%	3.8%
49	55%	5.4%	73%	3.8%
50	55%	5.5%	73%	3.8%
51	54%	5.5%	73%	3.8%
52	54%	5.6%	73%	3.8%
53	54%	5.6%	73%	3.8%
54	53%	5.7%	73%	3.8%
55	53%	5.7%	73%	3.8%
56	53%	5.8%	73%	3.8%
57	53%	5.9%	73%	3.8%
58	52%	5.9%	73%	3.8%
59	52%	6.0%	73%	3.8%
60	52%	6.0%	73%	3.8%

Table 9a: Permanent Shutdowns From IAEA PRIS Categorization

Reactor	Shutdown Date	Reason for shutdown according to IAEA 1	2	3	4	5	6	7	8	9	10	Our Categorization
GARIGLIANO	3/1/1982	0	0	1	1	0	0	0	0	1	0	Inv
BIG ROCK POINT	8/29/1997	0	1	0	0	0	0	0	0	0	0	Vol
BOHUNICE-1	12/31/2006	0	0	0	0	0	0	1	0	0	0	Vol
BR-3	6/30/1987	0	1	0	0	1	0	0	0	0	0	Vol
CAORSO	7/1/1990	0	0	0	0	0	0	1	0	1	0	Vol
DODEWAARD	3/26/1997	0	1	0	0	0	0	0	0	1	0	Vol
DOUGLAS POINT	5/4/1984	0	1	0	0	0	0	0	0	0	0	Vol
DRESDEN-1	10/31/1978	0	0	0	0	0	1	0	0	0	0	Vol
GREIFSWALD-1 (KGR 1)	2/14/1990	0	0	1	0	0	1	1	0	0	0	Vol
GREIFSWALD-2 (KGR 2)	2/14/1990	0	0	1	0	0	1	1	0	0	0	Vol
GREIFSWALD-3 (KGR 3)	2/28/1990	0	0	1	0	0	1	0	0	0	0	Vol
GREIFSWALD-4 (KGR 4)	7/22/1990	0	0	1	0	1	0	1	0	0	0	Vol
HUMBOLDT BAY	7/2/1976	0	0	0	0	1	0	0	0	0	0	Vol
INDIAN POINT-1	10/31/1974	0	0	0	0	1	0	0	0	0	0	Vol
LINGEN (KWL)	1/5/1979	0	1	0	0	0	0	0	0	0	0	Vol
MAINE YANKEE	8/1/1997	0	0	0	0	0	1	0	0	0	0	Vol
MILLSTONE-1	7/1/1998	0	0	0	0	0	1	0	0	0	0	Vol
OBRIGHEIM (KWO)	5/11/2005	0	0	0	0	0	0	0	0	0	1	Vol
PEACH BOTTOM-1	11/1/1974	1	0	0	0	0	0	0	0	0	0	Vol
RANCHO SECO-1	6/7/1989	0	0	0	0	1	1	0	0	0	0	Vol
STADE (KKS)	11/14/2003	0	1	0	0	0	0	0	0	0	0	Vol
TROJAN	11/9/1992	0	0	0	0	0	1	0	0	0	0	Vol
WUERGASSEN (KWW)	8/26/1994	0	1	0	0	0	0	0	0	0	0	Vol
ZION-1	1/1/1998	0	0	0	0	1	1	0	0	0	0	Vol
ZION-2	1/1/1998	0	0	0	0	1	1	0	0	0	0	Vol
THREE MILE ISLAND-2	3/28/1979	0	0	0	1	0	0	0	0	0	0	Inv
ARMENIA-1	2/25/1989	0	0	0	0	0	0	0	0	1	0	Inv
BARSEBACK-1	11/30/1999	0	0	0	0	0	0	0	0	1	0	Inv
BARSEBACK-2	5/31/2005	0	0	0	0	0	0	0	0	1	0	Inv
CHOOZ-A (ARDENNES)	10/30/1991	0	0	0	0	0	0	0	0	1	0	Inv
KOZLODUY-1	12/31/2002	0	0	0	0	0	0	0	0	1	0	Inv
KOZLODUY-2	12/31/2002	0	0	0	0	0	0	0	0	1	0	Inv
KOZLODUY-3	12/31/2006	0	0	0	0	0	0	0	0	1	0	Inv
KOZLODUY-4	12/31/2006	0	0	0	0	0	0	0	0	1	0	Inv
NOVOVORONEZH-2	8/29/1990	0	0	0	0	0	0	0	0	1	0	Inv
SAN ONOFRE-1	11/30/1992	0	0	0	0	0	0	0	0	1	0	Inv
MUELHEIM-KAERLICH (KMK)	9/9/1988	0	0	0	0	0	0	0	0	0	1	Inv

Reasons for shutdown

1 = technological obsolescence

2 = unprofitability

3 = change in license requirements

4 = operating incident

5 = other technological reasons

6 = other economical reasons

7 = public acceptance/political reasons

8 = component deterioriation or failure

9 = other reasons

10 = reason not given

Voluntary - 1,2,3,5,6,7

Involuntary - 4,8,9,10 (assumed involuntary if reason is not specified or disclosed)

All reactors shutdown for involuntary reasons (if given and specified) are classified as 'involuntary' regardless of other reasons listed.

Table 9b: Reactors reporting extended dormancy

Reactor	Start of Dormancy	Consecutive Years of Dormancy	Operational at Year End 2008	Restarted as of 2009	Base case classification for dormancy period: Permanent shutdown	New reactor upon restart
Browns Ferry 1	1985	21	1	1	1	1
Browns Ferry 2	1985	6	1	1	1	1
Browns Ferry 3	1985	9	1	1	1	1
Bruce 1	1997	11	1	0	1	0
Bruce 2	1995	13	1	0	1	0
Bruce 3	1998	5	1	1	1	1
Bruce 4	1998	4	1	1	1	1
Pickering 1	1997	7	1	1	1	0
Pickering 2	1997	11	1	0	1	1
Pickering 3	1997	11	1	0	1	1
Pickering 4	1997	6	1	1	1	0
Armenia 2	1989	6	1	1	0	
Hamaoka 1	2001	7	1	0	0	
Hamaoka 2	2004	4	1	0	0	
Barsebäck 2	1996	7	0		0	

Notes

Extended dormancy is defined as 4+ consecutive years with no commercial power generation.
In the database, years of dormancy include only calendar years without commercial power production.
Hamaoka 1 and 2 were permanently shut down as of January 2009 but are classified as operational during the date range of the database.
Barsebäck 2 was closed in 1997 due to government decision to phase out nuclear power (reversed as of June 2010).
Bruce 1 and 2 are scheduled to restart in 2011.

Table 10: Parameters of the Conditional Transition Probability, Φ, Base Case

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
100	0.8480	0.0129	0.8468	0.0154	6.3000	1.1401
99	0.8283	0.0125	0.8422	0.0156	6.3132	1.1831
98	0.8122	0.0195	0.8376	0.0159	6.3193	1.2252
97	0.8339	0.0092	0.8331	0.0162	6.3186	1.2663
96	0.8099	0.0241	0.8285	0.0165	6.3115	1.3062
95	0.8328	0.0186	0.8240	0.0168	6.2985	1.3450
94	0.8215	0.0248	0.8196	0.0171	6.2799	1.3826
93	0.8612	0.0150	0.8151	0.0174	6.2561	1.4191
92	0.8574	0.0132	0.8107	0.0177	6.2273	1.4542
91	0.8596	0.0152	0.8063	0.0180	6.1941	1.4882
90	0.8490	0.0168	0.8019	0.0183	6.1565	1.5208
89	0.8475	0.0181	0.7976	0.0186	6.1150	1.5522
88	0.8361	0.0238	0.7932	0.0190	6.0698	1.5823
87	0.8275	0.0228	0.7889	0.0193	6.0213	1.6111
86	0.8269	0.0169	0.7846	0.0196	5.9695	1.6385
85	0.8088	0.0198	0.7804	0.0200	5.9148	1.6646
84	0.8085	0.0188	0.7761	0.0203	5.8575	1.6895
83	0.8141	0.0144	0.7719	0.0207	5.7976	1.7130
82	0.7863	0.0207	0.7677	0.0211	5.7355	1.7352
81	0.7959	0.0213	0.7636	0.0214	5.6714	1.7561
80	0.7793	0.0226	0.7594	0.0218	5.6053	1.7757
79	0.7772	0.0197	0.7553	0.0222	5.5375	1.7941
78	0.7709	0.0195	0.7512	0.0226	5.4683	1.8111
77	0.7713	0.0198	0.7471	0.0230	5.3976	1.8269
76	0.7554	0.0265	0.7431	0.0234	5.3257	1.8415
75	0.7326	0.0192	0.7390	0.0238	5.2527	1.8549
74	0.7368	0.0225	0.7350	0.0242	5.1788	1.8670
73	0.7223	0.0219	0.7310	0.0246	5.1040	1.8780
72	0.7463	0.0219	0.7271	0.0251	5.0286	1.8878
71	0.7325	0.0295	0.7231	0.0255	4.9526	1.8964
70	0.7304	0.0218	0.7192	0.0260	4.8761	1.9039
69	0.6854	0.0315	0.7153	0.0264	4.7992	1.9103
68	0.6874	0.0364	0.7114	0.0269	4.7221	1.9157
67	0.7021	0.0268	0.7075	0.0274	4.6447	1.9199
66	0.7042	0.0331	0.7037	0.0278	4.5673	1.9231
65	0.6628	0.0359	0.6999	0.0283	4.4899	1.9254
64	0.6807	0.0382	0.6961	0.0288	4.4125	1.9266
63	0.6663	0.0300	0.6923	0.0293	4.3352	1.9268
62	0.6427	0.0428	0.6885	0.0299	4.2581	1.9262
61	0.6680	0.0350	0.6848	0.0304	4.1813	1.9246

Table 10: Parameters of the Conditional Transition Probability, Φ, Base Case

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
60	0.6487	0.0329	0.6811	0.0309	4.1048	1.9221
59	0.6595	0.0363	0.6774	0.0315	4.0287	1.9187
58	0.6723	0.0269	0.6737	0.0320	3.9529	1.9145
57	0.6470	0.0356	0.6701	0.0326	3.8777	1.9095
56	0.6644	0.0300	0.6664	0.0331	3.8030	1.9036
55	0.5968	0.0356	0.6628	0.0337	3.7288	1.8970
54	0.6255	0.0334	0.6592	0.0343	3.6552	1.8897
53	0.5998	0.0380	0.6556	0.0349	3.5822	1.8816
52	0.6554	0.0356	0.6521	0.0355	3.5099	1.8729
51	0.6065	0.0347	0.6485	0.0362	3.4382	1.8634
50	0.6594	0.0219	0.6450	0.0368	3.3673	1.8533
49	0.5616	0.0542	0.6415	0.0375	3.2972	1.8426
48	0.5737	0.0351	0.6380	0.0381	3.2277	1.8313
47	0.6233	0.0378	0.6346	0.0388	3.1591	1.8194
46	0.6400	0.0548	0.6311	0.0395	3.0913	1.8069
45	0.5781	0.0357	0.6277	0.0402	3.0243	1.7939
44	0.6268	0.0217	0.6243	0.0409	2.9581	1.7804
43	0.5772	0.0365	0.6209	0.0416	2.8928	1.7663
42	0.5600	0.0606	0.6175	0.0423	2.8283	1.7518
41	0.5776	0.0353	0.6142	0.0431	2.7647	1.7369
40	0.5085	0.0453	0.6108	0.0438	2.7020	1.7215
39	0.5238	0.0552	0.6075	0.0446	2.6401	1.7057
38	0.6250	0.0481	0.6042	0.0454	2.5792	1.6895
37	0.5438	0.0397	0.6009	0.0462	2.5191	1.6729
36	0.5678	0.0725	0.5977	0.0470	2.4600	1.6559
35	0.5706	0.0507	0.5944	0.0478	2.4017	1.6387
34	0.6924	0.0665	0.5912	0.0487	2.3444	1.6211
33	0.5550	0.0873	0.5880	0.0495	2.2879	1.6032
32	0.6310	0.0653	0.5848	0.0504	2.2324	1.5850
31	0.7308	0.0108	0.5816	0.0513	2.1778	1.5665
30	0.6300	0.0538	0.5785	0.0522	2.1240	1.5478
29	0.6891	0.0665	0.5753	0.0531	2.0712	1.5289
28	0.6741	0.0515	0.5722	0.0540	2.0193	1.5097
27	0.5517	0.0717	0.5691	0.0550	1.9682	1.4903
26	0.4762	0.0784	0.5660	0.0560	1.9181	1.4707
25	0.5150	0.1080	0.5629	0.0570	1.8688	1.4510
24	0.5463	0.0654	0.5599	0.0580	1.8204	1.4311
23	0.5165	0.0615	0.5568	0.0590	1.7729	1.4110
22	0.6877	0.0239	0.5538	0.0600	1.7263	1.3908
21	0.6100	0.0790	0.5508	0.0611	1.6805	1.3705

Table 10: Parameters of the Conditional Transition Probability, Φ, Base Case

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
20	0.5082	0.1065	0.5478	0.0622	1.6356	1.3500
19	0.4583	0.0659	0.5448	0.0632	1.5915	1.3295
18	0.5185	0.0872	0.5419	0.0644	1.5482	1.3089
17	0.3550	0.0800	0.5389	0.0655	1.5058	1.2881
16	0.5947	0.0720	0.5360	0.0666	1.4642	1.2674
15	0.6650	0.0362	0.5331	0.0678	1.4234	1.2466
14	0.4756	0.1152	0.5302	0.0690	1.3834	1.2257
13	0.3826	0.1213	0.5273	0.0702	1.3441	1.2048
12	0.5920	0.0830	0.5245	0.0715	1.3057	1.1838
11	0.6067	0.0694	0.5216	0.0727	1.2681	1.1629
10	0.6210	0.0740	0.5188	0.0740	1.2312	1.1420
9	0.5900	0.0745	0.5160	0.0753	1.1950	1.1210
8	0.6650	0.0392	0.5132	0.0766	1.1596	1.1001
7	0.6133	0.0948	0.5104	0.0780	1.1250	1.0791
6	0.6875	0.0297	0.5076	0.0794	1.0910	1.0583
5	0.6113	0.0529	0.5049	0.0808	1.0578	1.0374
4	0.4608	0.0515	0.5021	0.0822	1.0253	1.0166
3	0.5783	0.0796	0.4994	0.0836	0.9934	0.9958
2	0.5375	0.0738	0.4967	0.0851	0.9623	0.9751
1	0.5640	0.1041	0.4940	0.0866	0.9318	0.9544
0	0.2311	0.0933	0.4913	0.0881	0.9020	0.9339
start-up	0.53527	0.09501			0.85936	0.76121

Table 11: Shutdown Probabilities, Θ, Base Case

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
100	0	0.255%	0.016%
99	0	0.265%	0.017%
98	0	0.275%	0.018%
97	0	0.286%	0.018%
96	0	0.297%	0.019%
95	0	0.309%	0.020%
94	0.690%	0.321%	0.021%
93	0	0.333%	0.022%
92	0	0.346%	0.022%
91	0	0.359%	0.023%
90	0	0.373%	0.024%
89	0	0.388%	0.025%
88	0	0.403%	0.026%
87	0.395%	0.418%	0.027%
86	0	0.435%	0.028%
85	0.749%	0.452%	0.029%
84	0	0.469%	0.030%
83	0.360%	0.487%	0.031%
82	0	0.506%	0.033%
81	0	0.526%	0.034%
80	0	0.546%	0.035%
79	0	0.567%	0.037%
78	0	0.589%	0.038%
77	0	0.612%	0.040%
76	0.422%	0.636%	0.041%
75	0.389%	0.661%	0.043%
74	0	0.686%	0.044%
73	0	0.713%	0.046%
72	0	0.741%	0.048%
71	0	0.769%	0.050%
70	0	0.799%	0.052%
69	1.299%	0.830%	0.054%
68	0	0.862%	0.056%
67	0.592%	0.896%	0.058%
66	0	0.931%	0.060%
65	0	0.967%	0.062%
64	0	1.004%	0.065%
63	0	1.043%	0.067%
62	0	1.084%	0.070%
61	0	1.126%	0.073%

Table 11: Shutdown Probabilities, Θ, Base Case

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
60	0.971%	1.169%	0.076%
59	1.064%	1.215%	0.078%
58	0	1.262%	0.082%
57	0	1.311%	0.085%
56	0	1.362%	0.088%
55	0	1.415%	0.091%
54	0	1.469%	0.095%
53	0	1.526%	0.099%
52	0	1.586%	0.102%
51	0	1.647%	0.106%
50	0	1.711%	0.111%
49	0	1.777%	0.115%
48	0	1.846%	0.119%
47	0	1.918%	0.124%
46	0	1.993%	0.129%
45	0	2.070%	0.134%
44	0	2.150%	0.139%
43	0	2.234%	0.144%
42	0	2.320%	0.150%
41	0	2.410%	0.156%
40	0	2.504%	0.162%
39	0	2.601%	0.168%
38	0	2.702%	0.175%
37	0	2.807%	0.181%
36	0	2.916%	0.188%
35	0	3.029%	0.196%
34	0	3.146%	0.203%
33	0	3.268%	0.211%
32	0	3.395%	0.219%
31	0	3.527%	0.228%
30	0	3.664%	0.237%
29	0	3.806%	0.246%
28	0	3.953%	0.255%
27	0	4.107%	0.265%
26	0	4.266%	0.276%
25	0	4.432%	0.286%
24	0	4.604%	0.297%
23	0	4.782%	0.309%
22	0	4.968%	0.321%
21	0	5.161%	0.333%

Table 11: Shutdown Probabilities, Θ, Base Case

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
20	0	5.361%	0.346%
19	0	5.569%	0.360%
18	0	5.785%	0.374%
17	0	6.009%	0.388%
16	0	6.242%	0.403%
15	0	6.485%	0.419%
14	0	6.736%	0.435%
13	0	6.998%	0.452%
12	0	7.269%	0.470%
11	0	7.551%	0.488%
10	0	7.844%	0.507%
9	0	8.148%	0.526%
8	0	8.465%	0.547%
7	0	8.793%	0.568%
6	12.500%	9.134%	0.590%
5	0	9.489%	0.613%
4	0	9.857%	0.637%
3	0	10.239%	0.662%
2	0	10.636%	0.687%
1	0	11.049%	0.714%
0	0	11.478%	0.742%
start-up	NA	NA	NA

Table 12: Distribution Moments for the Load Factor, Unconditional and Conditional on Continuing Operation, From P, Base Case

Year of Operation	Unconditional		Conditional on Operation	
	Mean	Var	Mean	Var
1	53.5	0.095	53.5	0.095
2	67.1	0.052	67.2	0.052
3	71.7	0.037	71.9	0.037
4	73.3	0.032	73.5	0.032
5	73.9	0.030	74.2	0.030
6	74.1	0.030	74.4	0.030
7	74.1	0.030	74.5	0.030
8	74.1	0.030	74.5	0.030
9	74.1	0.030	74.5	0.030
10	74.0	0.029	74.5	0.030
11	74.0	0.029	74.5	0.030
12	73.9	0.029	74.5	0.030
13	73.9	0.029	74.5	0.030
14	73.9	0.029	74.5	0.030
15	73.8	0.029	74.5	0.030
16	73.8	0.029	74.5	0.030
17	73.7	0.029	74.5	0.030
18	73.7	0.029	74.5	0.030
19	73.7	0.029	74.5	0.030
20	73.6	0.029	74.5	0.030
21	73.6	0.029	74.5	0.030
22	73.5	0.029	74.5	0.030
23	73.5	0.029	74.5	0.030
24	73.4	0.029	74.5	0.030
25	73.4	0.029	74.5	0.030
26	73.4	0.029	74.5	0.030
27	73.3	0.029	74.5	0.030
28	73.3	0.029	74.5	0.030
29	73.2	0.029	74.5	0.030
30	73.2	0.029	74.5	0.030
31	73.2	0.029	74.5	0.030
32	73.1	0.029	74.5	0.030
33	73.1	0.029	74.5	0.030
34	73.0	0.029	74.5	0.030
35	73.0	0.029	74.5	0.030
36	73.0	0.029	74.5	0.030
37	72.9	0.029	74.5	0.030
38	72.9	0.029	74.5	0.030
39	72.8	0.029	74.5	0.030

Table 12: Distribution Moments for the Load Factor, Unconditional and Conditional on Continuing Operation, From P, Base Case

Year of Operation	Unconditional		Conditional on Operation	
	Mean	Var	Mean	Var
40	72.8	0.029	74.5	0.030
41	72.8	0.029	74.5	0.030
42	72.7	0.029	74.5	0.030
43	72.7	0.029	74.5	0.030
44	72.6	0.029	74.5	0.030
45	72.6	0.029	74.5	0.030
46	72.5	0.029	74.5	0.030
47	72.5	0.029	74.5	0.030
48	72.5	0.029	74.5	0.030
49	72.4	0.029	74.5	0.030
50	72.4	0.029	74.5	0.030
51	72.3	0.029	74.5	0.030
52	72.3	0.029	74.5	0.030
53	72.3	0.029	74.5	0.030
54	72.2	0.029	74.5	0.030
55	72.2	0.029	74.5	0.030
56	72.1	0.029	74.5	0.030
57	72.1	0.029	74.5	0.030
58	72.1	0.029	74.5	0.030
59	72.0	0.029	74.5	0.030
60	72.0	0.029	74.5	0.030

Table 13: Parameters of the Conditional Transition Probability, Φ, OECD

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
100	0.8480	0.0132	0.8487	0.0163	5.8585	1.0446
99	0.8280	0.0131	0.8442	0.0165	5.8756	1.0842
98	0.8126	0.0206	0.8398	0.0168	5.8862	1.1230
97	0.8333	0.0095	0.8354	0.0171	5.8907	1.1608
96	0.8147	0.0238	0.8310	0.0174	5.8894	1.1978
95	0.8333	0.0189	0.8266	0.0177	5.8828	1.2338
94	0.8220	0.0256	0.8223	0.0180	5.8709	1.2688
93	0.8613	0.0150	0.8180	0.0183	5.8543	1.3028
92	0.8622	0.0129	0.8137	0.0186	5.8332	1.3358
91	0.8622	0.0151	0.8094	0.0189	5.8079	1.3676
90	0.8493	0.0174	0.8052	0.0192	5.7786	1.3984
89	0.8477	0.0200	0.8009	0.0195	5.7456	1.4281
88	0.8367	0.0247	0.7967	0.0198	5.7091	1.4567
87	0.8274	0.0244	0.7925	0.0202	5.6694	1.4841
86	0.8252	0.0181	0.7884	0.0205	5.6267	1.5104
85	0.8098	0.0209	0.7842	0.0208	5.5813	1.5355
84	0.8072	0.0205	0.7801	0.0212	5.5332	1.5596
83	0.8166	0.0141	0.7760	0.0216	5.4827	1.5824
82	0.7902	0.0176	0.7719	0.0219	5.4301	1.6042
81	0.7970	0.0232	0.7679	0.0223	5.3754	1.6248
80	0.7852	0.0226	0.7639	0.0227	5.3188	1.6442
79	0.7790	0.0204	0.7599	0.0230	5.2605	1.6626
78	0.7735	0.0209	0.7559	0.0234	5.2007	1.6798
77	0.7713	0.0199	0.7519	0.0238	5.1394	1.6959
76	0.7662	0.0249	0.7479	0.0242	5.0769	1.7109
75	0.7290	0.0211	0.7440	0.0246	5.0132	1.7248
74	0.7372	0.0237	0.7401	0.0250	4.9485	1.7376
73	0.7280	0.0225	0.7362	0.0254	4.8829	1.7494
72	0.7489	0.0231	0.7324	0.0259	4.8165	1.7602
71	0.7414	0.0263	0.7285	0.0263	4.7493	1.7699
70	0.7354	0.0229	0.7247	0.0267	4.6816	1.7786
69	0.6815	0.0332	0.7209	0.0272	4.6134	1.7862
68	0.6826	0.0394	0.7171	0.0276	4.5448	1.7930
67	0.7057	0.0284	0.7133	0.0281	4.4759	1.7987
66	0.7235	0.0333	0.7096	0.0286	4.4067	1.8035
65	0.6702	0.0379	0.7059	0.0291	4.3373	1.8074
64	0.6870	0.0389	0.7022	0.0295	4.2679	1.8104
63	0.6716	0.0319	0.6985	0.0300	4.1984	1.8124
62	0.6413	0.0490	0.6948	0.0305	4.1289	1.8137
61	0.6786	0.0322	0.6912	0.0311	4.0595	1.8140

Table 13: Parameters of the Conditional Transition Probability, Φ, OECD

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
60	0.6587	0.0327	0.6875	0.0316	3.9903	1.8136
59	0.6684	0.0397	0.6839	0.0321	3.9213	1.8123
58	0.6754	0.0269	0.6803	0.0326	3.8525	1.8102
57	0.6724	0.0342	0.6768	0.0332	3.7840	1.8074
56	0.6754	0.0336	0.6732	0.0337	3.7159	1.8039
55	0.6082	0.0341	0.6697	0.0343	3.6481	1.7996
54	0.6314	0.0356	0.6661	0.0349	3.5808	1.7946
53	0.6044	0.0381	0.6627	0.0355	3.5139	1.7889
52	0.6880	0.0343	0.6592	0.0361	3.4475	1.7825
51	0.6057	0.0392	0.6557	0.0367	3.3816	1.7755
50	0.6592	0.0230	0.6523	0.0373	3.3162	1.7679
49	0.5558	0.0679	0.6488	0.0379	3.2514	1.7597
48	0.6063	0.0364	0.6454	0.0385	3.1873	1.7509
47	0.6565	0.0391	0.6420	0.0392	3.1237	1.7415
46	0.6317	0.0678	0.6387	0.0398	3.0608	1.7316
45	0.5588	0.0392	0.6353	0.0405	2.9985	1.7212
44	0.6309	0.0213	0.6320	0.0412	2.9369	1.7102
43	0.5979	0.0423	0.6287	0.0419	2.8760	1.6988
42	0.6045	0.0644	0.6254	0.0426	2.8158	1.6868
41	0.6000	0.0467	0.6221	0.0433	2.7563	1.6745
40	0.5232	0.0530	0.6188	0.0440	2.6976	1.6617
39	0.5477	0.0629	0.6156	0.0448	2.6395	1.6484
38	0.6209	0.0498	0.6123	0.0455	2.5823	1.6348
37	0.5739	0.0363	0.6091	0.0463	2.5257	1.6208
36	0.5732	0.0742	0.6059	0.0470	2.4700	1.6064
35	0.5600	0.0644	0.6027	0.0478	2.4150	1.5917
34	0.7020	0.0741	0.5996	0.0486	2.3608	1.5766
33	0.5550	0.0873	0.5964	0.0494	2.3073	1.5612
32	0.6076	0.0722	0.5933	0.0503	2.2546	1.5455
31	0.7340	0.0081	0.5902	0.0511	2.2027	1.5296
30	0.6393	0.0657	0.5871	0.0520	2.1516	1.5133
29	0.7500	0.0323	0.5840	0.0528	2.1013	1.4968
28	0.7206	0.0348	0.5809	0.0537	2.0517	1.4800
27	0.6100	0.0509	0.5779	0.0546	2.0029	1.4631
26	0.4955	0.0880	0.5748	0.0555	1.9549	1.4458
25	0.5150	0.1080	0.5718	0.0565	1.9077	1.4284
24	0.5463	0.0760	0.5688	0.0574	1.8612	1.4108
23	0.5393	0.0646	0.5658	0.0584	1.8156	1.3930
22	0.7350	0.0208	0.5629	0.0593	1.7706	1.3751
21	0.6120	0.0825	0.5599	0.0603	1.7265	1.3570

Table 13: Parameters of the Conditional Transition Probability, Φ, OECD

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
20	0.4333	0.0994	0.5570	0.0614	1.6831	1.3387
19	0.5022	0.0616	0.5540	0.0624	1.6404	1.3204
18	0.5133	0.0941	0.5511	0.0634	1.5985	1.3019
17	0.3550	0.0800	0.5482	0.0645	1.5573	1.2832
16	0.6477	0.0585	0.5454	0.0656	1.5169	1.2645
15	0.6582	0.0375	0.5425	0.0667	1.4772	1.2457
14	0.4325	0.1129	0.5397	0.0678	1.4382	1.2269
13	0.3826	0.1213	0.5368	0.0689	1.4000	1.2079
12	0.5667	0.0858	0.5340	0.0701	1.3624	1.1889
11	0.5971	0.0886	0.5312	0.0712	1.3255	1.1698
10	0.6100	0.0955	0.5284	0.0724	1.2894	1.1507
9	0.5283	0.0603	0.5256	0.0737	1.2539	1.1316
8	0.6850	0.0471	0.5229	0.0749	1.2191	1.1124
7	0.6900	0.0538	0.5201	0.0761	1.1850	1.0932
6	0.6986	0.0330	0.5174	0.0774	1.1515	1.0740
5	0.6113	0.0529	0.5147	0.0787	1.1187	1.0548
4	0.4633	0.0557	0.5120	0.0800	1.0865	1.0356
3	0.5783	0.0796	0.5093	0.0814	1.0550	1.0165
2	0.6400	0.0629	0.5066	0.0827	1.0240	0.9973
1	0.6244	0.0792	0.5040	0.0841	0.9938	0.9782
0	0.2188	0.0911	0.5013	0.0855	0.9641	0.9590
start-up	0.53814	0.09681			0.83694	0.73282

Table 14: Shutdown Probabilities, Θ, OECD

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
100	0	0.164%	0.001%
99	0	0.173%	0.001%
98	0	0.183%	0.001%
97	0	0.193%	0.001%
96	0	0.204%	0.001%
95	0	0.215%	0.001%
94	0	0.227%	0.001%
93	0	0.240%	0.002%
92	0	0.254%	0.002%
91	0	0.268%	0.002%
90	0	0.283%	0.002%
89	0	0.299%	0.002%
88	0	0.315%	0.002%
87	0	0.333%	0.002%
86	0	0.352%	0.002%
85	0.417%	0.371%	0.002%
84	0	0.392%	0.003%
83	0.418%	0.414%	0.003%
82	0	0.437%	0.003%
81	0	0.461%	0.003%
80	0	0.487%	0.003%
79	0	0.515%	0.003%
78	0	0.543%	0.004%
77	0	0.574%	0.004%
76	0.508%	0.606%	0.004%
75	0.459%	0.640%	0.004%
74	0	0.675%	0.004%
73	0	0.713%	0.005%
72	0	0.753%	0.005%
71	0	0.795%	0.005%
70	0	0.840%	0.005%
69	1.471%	0.887%	0.006%
68	0	0.936%	0.006%
67	0	0.989%	0.006%
66	0	1.044%	0.007%
65	0	1.102%	0.007%
64	0	1.164%	0.008%
63	0	1.229%	0.008%
62	0	1.298%	0.008%
61	0	1.371%	0.009%

Table 14: Shutdown Probabilities, Θ, OECD

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
60	0	1.447%	0.009%
59	1.351%	1.528%	0.010%
58	0	1.614%	0.010%
57	0	1.704%	0.011%
56	0	1.799%	0.012%
55	0	1.900%	0.012%
54	0	2.006%	0.013%
53	0	2.119%	0.014%
52	0	2.237%	0.015%
51	0	2.362%	0.015%
50	0	2.494%	0.016%
49	0	2.634%	0.017%
48	0	2.781%	0.018%
47	0	2.937%	0.019%
46	0	3.101%	0.020%
45	0	3.274%	0.021%
44	0	3.458%	0.022%
43	0	3.651%	0.024%
42	0	3.855%	0.025%
41	0	4.071%	0.026%
40	0	4.299%	0.028%
39	0	4.539%	0.029%
38	0	4.793%	0.031%
37	0	5.061%	0.033%
36	0	5.344%	0.035%
35	0	5.643%	0.037%
34	0	5.959%	0.039%
33	0	6.292%	0.041%
32	0	6.644%	0.043%
31	0	7.016%	0.045%
30	0	7.409%	0.048%
29	0	7.823%	0.051%
28	0	8.261%	0.054%
27	0	8.723%	0.057%
26	0	9.211%	0.060%
25	0	9.726%	0.063%
24	0	10.270%	0.067%
23	0	10.844%	0.070%
22	0	11.451%	0.074%
21	0	12.092%	0.078%

Table 14: Shutdown Probabilities, Θ, OECD

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
20	0	12.768%	0.083%
19	0	13.482%	0.087%
18	0	14.236%	0.092%
17	0	15.033%	0.097%
16	0	15.874%	0.103%
15	0	16.762%	0.109%
14	0	17.699%	0.115%
13	0	18.689%	0.121%
12	0	19.735%	0.128%
11	0	20.839%	0.135%
10	0	22.005%	0.143%
9	0	23.236%	0.151%
8	0	24.535%	0.159%
7	0	25.908%	0.168%
6	0	27.357%	0.177%
5	0	28.887%	0.187%
4	0	30.503%	0.198%
3	0	32.210%	0.209%
2	0	34.012%	0.221%
1	0	35.914%	0.233%
0	0	37.923%	0.246%
start-up	NA	NA	NA

Table 15: Distribution Moments for the Load Factor, Unconditional and Conditional on Continuing Operation, From P, OECD

Year of Operation	Unconditional		Conditional on Operation	
	Mean	Var	Mean	Var
1	53.8	0.097	53.8	0.097
2	67.9	0.052	67.9	0.052
3	72.6	0.037	72.7	0.037
4	74.3	0.032	74.4	0.032
5	74.9	0.031	75.0	0.031
6	75.1	0.030	75.2	0.030
7	75.2	0.030	75.3	0.030
8	75.2	0.030	75.3	0.030
9	75.2	0.030	75.3	0.030
10	75.2	0.030	75.3	0.030
11	75.2	0.030	75.3	0.030
12	75.2	0.030	75.3	0.030
13	75.2	0.030	75.3	0.030
14	75.2	0.030	75.3	0.030
15	75.2	0.030	75.3	0.030
16	75.2	0.030	75.3	0.030
17	75.2	0.030	75.3	0.030
18	75.2	0.030	75.3	0.030
19	75.2	0.030	75.3	0.030
20	75.2	0.030	75.3	0.030
21	75.2	0.030	75.3	0.030
22	75.2	0.030	75.3	0.030
23	75.2	0.030	75.3	0.030
24	75.2	0.030	75.3	0.030
25	75.2	0.030	75.3	0.030
26	75.2	0.030	75.3	0.030
27	75.2	0.030	75.3	0.030
28	75.2	0.030	75.3	0.030
29	75.1	0.030	75.3	0.030
30	75.1	0.030	75.3	0.030
31	75.1	0.030	75.3	0.030
32	75.1	0.030	75.3	0.030
33	75.1	0.030	75.3	0.030
34	75.1	0.030	75.3	0.030
35	75.1	0.030	75.3	0.030
36	75.1	0.030	75.3	0.030
37	75.1	0.030	75.3	0.030
38	75.1	0.030	75.3	0.030
39	75.1	0.030	75.3	0.030

Table 15: Distribution Moments for the Load Factor, Unconditional and Conditional on Continuing Operation, From P, OECD

Year of Operation	Unconditional Mean	Unconditional Var	Conditional on Operation Mean	Conditional on Operation Var
40	75.1	0.030	75.3	0.030
41	75.1	0.030	75.3	0.030
42	75.1	0.030	75.3	0.030
43	75.1	0.030	75.3	0.030
44	75.1	0.030	75.3	0.030
45	75.1	0.030	75.3	0.030
46	75.1	0.030	75.3	0.030
47	75.1	0.030	75.3	0.030
48	75.0	0.030	75.3	0.030
49	75.0	0.030	75.3	0.030
50	75.0	0.030	75.3	0.030
51	75.0	0.030	75.3	0.030
52	75.0	0.030	75.3	0.030
53	75.0	0.030	75.3	0.030
54	75.0	0.030	75.3	0.030
55	75.0	0.030	75.3	0.030
56	75.0	0.030	75.3	0.030
57	75.0	0.030	75.3	0.030
58	75.0	0.030	75.3	0.030
59	75.0	0.030	75.3	0.030
60	75.0	0.030	75.3	0.030

Table 16: Parameters of the Conditional Transition Probability, Φ, non-OECD

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
100	0.8483	0.0023	0.8829	0.0119	6.7794	0.8991
99	0.8325	0.0030	0.8756	0.0119	7.1148	1.0112
98	0.8063	0.0037	0.8683	0.0120	7.4312	1.1274
97	0.8460	0.0023	0.8610	0.0120	7.7294	1.2474
96	0.7150	0.0209	0.8539	0.0120	8.0100	1.3708
95	0.8133	0.0044	0.8468	0.0120	8.2738	1.4972
94	0.8080	0.0023	0.8397	0.0121	8.5212	1.6265
93	0.8575	0.0142	0.8327	0.0121	8.7530	1.7582
92	0.7600	0.0096	0.8258	0.0121	8.9697	1.8922
91	0.8185	0.0149	0.8189	0.0122	9.1720	2.0281
90	0.8456	0.0090	0.8121	0.0122	9.3603	2.1656
89	0.8452	0.0031	0.8053	0.0122	9.5351	2.3046
88	0.8290	0.0131	0.7986	0.0122	9.6971	2.4449
87	0.8292	0.0077	0.7920	0.0123	9.8467	2.5861
86	0.8356	0.0104	0.7854	0.0123	9.9844	2.7280
85	0.7996	0.0098	0.7789	0.0123	10.1107	2.8706
84	0.8174	0.0072	0.7724	0.0123	10.2260	3.0135
83	0.7990	0.0162	0.7660	0.0124	10.3307	3.1567
82	0.7670	0.0355	0.7596	0.0124	10.4254	3.2998
81	0.7898	0.0106	0.7533	0.0124	10.5103	3.4429
80	0.7373	0.0204	0.7470	0.0125	10.5860	3.5856
79	0.7684	0.0161	0.7408	0.0125	10.6527	3.7279
78	0.7520	0.0092	0.7346	0.0125	10.7109	3.8696
77	0.7711	0.0192	0.7285	0.0125	10.7608	4.0106
76	0.7025	0.0309	0.7224	0.0126	10.8030	4.1508
75	0.7526	0.0082	0.7164	0.0126	10.8376	4.2900
74	0.7336	0.0137	0.7104	0.0126	10.8650	4.4282
73	0.6934	0.0178	0.7045	0.0127	10.8856	4.5652
72	0.7333	0.0156	0.6987	0.0127	10.8995	4.7009
71	0.6726	0.0467	0.6929	0.0127	10.9072	4.8353
70	0.7075	0.0159	0.6871	0.0127	10.9089	4.9682
69	0.7150	0.0178	0.6814	0.0128	10.9049	5.0996
68	0.7205	0.0142	0.6757	0.0128	10.8954	5.2293
67	0.6804	0.0165	0.6701	0.0128	10.8807	5.3574
66	0.6313	0.0257	0.6645	0.0129	10.8610	5.4838
65	0.6273	0.0248	0.6590	0.0129	10.8366	5.6083
64	0.6426	0.0323	0.6535	0.0129	10.8077	5.7310
63	0.6447	0.0216	0.6480	0.0129	10.7745	5.8518
62	0.6484	0.0158	0.6426	0.0130	10.7372	5.9706
61	0.5867	0.0488	0.6373	0.0130	10.6960	6.0875

Table 16: Parameters of the Conditional Transition Probability, Φ, non-OECD

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
60	0.6017	0.0313	0.6320	0.0130	10.6512	6.2022
59	0.6265	0.0225	0.6267	0.0131	10.6028	6.3149
58	0.6569	0.0268	0.6215	0.0131	10.5512	6.4255
57	0.5811	0.0332	0.6163	0.0131	10.4965	6.5339
56	0.6228	0.0141	0.6112	0.0131	10.4388	6.6401
55	0.5580	0.0386	0.6061	0.0132	10.3783	6.7442
54	0.5918	0.0199	0.6011	0.0132	10.3151	6.8460
53	0.5911	0.0379	0.5961	0.0132	10.2495	6.9456
52	0.5336	0.0217	0.5911	0.0133	10.1816	7.0429
51	0.6100	0.0143	0.5862	0.0133	10.1115	7.1380
50	0.6600	0.0179	0.5813	0.0133	10.0393	7.2308
49	0.5775	0.0162	0.5765	0.0134	9.9651	7.3213
48	0.4638	0.0149	0.5717	0.0134	9.8892	7.4095
47	0.5547	0.0281	0.5669	0.0134	9.8116	7.4954
46	0.6686	0.0092	0.5622	0.0134	9.7324	7.5790
45	0.6471	0.0168	0.5575	0.0135	9.6518	7.6603
44	0.5600	0.0225	0.5529	0.0135	9.5698	7.7393
43	0.5150	0.0140	0.5483	0.0135	9.4866	7.8160
42	0.3967	0.0126	0.5437	0.0136	9.4022	7.8905
41	0.5217	0.0024	0.5392	0.0136	9.3168	7.9626
40	0.4686	0.0222	0.5347	0.0136	9.2304	8.0325
39	0.4486	0.0235	0.5302	0.0137	9.1432	8.1001
38	0.7200	0.0000	0.5258	0.0137	9.0552	8.1655
37	0.3633	0.0220	0.5215	0.0137	8.9665	8.2286
36	0.5425	0.0632	0.5171	0.0137	8.8771	8.2895
35	0.6022	0.0086	0.5128	0.0138	8.7872	8.3482
34	0.6200	0.0036	0.5085	0.0138	8.6968	8.4047
33	NA	NA	0.5043	0.0138	8.6060	8.4590
32	0.7300	0.0238	0.5001	0.0139	8.5149	8.5111
31	0.7150	0.0240	0.4959	0.0139	8.4234	8.5611
30	0.6144	0.0336	0.4918	0.0139	8.3318	8.6089
29	0.0800	0.0000	0.4877	0.0140	8.2400	8.6547
28	0.4650	0.0733	0.4837	0.0140	8.1480	8.6983
27	0.4000	0.0942	0.4796	0.0140	8.0560	8.7399
26	0.3700	0.0121	0.4756	0.0141	7.9640	8.7795
25	NA	NA	0.4717	0.0141	7.8721	8.8170
24	0.5467	0.0086	0.4678	0.0141	7.7802	8.8526
23	0.3450	0.0056	0.4639	0.0142	7.6884	8.8861
22	0.5300	0.0019	0.4600	0.0142	7.5968	8.9177
21	0.6033	0.0674	0.4562	0.0142	7.5054	8.9474

Table 16: Parameters of the Conditional Transition Probability, Φ, non-OECD

Load Factor in Year n	Sample Moments		Fitted Moments		Implied Beta Distribution	
	Mean	Var	Mean	Var	Alpha	Beta
20	0.8450	0.0000	0.4524	0.0142	7.4143	8.9752
19	0.3267	0.0558	0.4486	0.0143	7.3235	9.0011
18	0.5800	0.0000	0.4449	0.0143	7.2329	9.0251
17	NA	NA	0.4412	0.0143	7.1427	9.0474
16	0.2500	0.0225	0.4375	0.0144	7.0529	9.0678
15	0.7800	0.0000	0.4339	0.0144	6.9635	9.0864
14	0.8200	0.0000	0.4303	0.0144	6.8745	9.1033
13	NA	NA	0.4267	0.0145	6.7860	9.1185
12	0.8200	0.0000	0.4231	0.0145	6.6980	9.1320
11	0.6400	0.0009	0.4196	0.0145	6.6105	9.1438
10	0.6375	0.0412	0.4161	0.0146	6.5235	9.1540
9	0.9600	0.0000	0.4126	0.0146	6.4371	9.1626
8	0.5850	0.0000	0.4092	0.0146	6.3512	9.1695
7	0.0000	0.0000	0.4058	0.0147	6.2659	9.1749
6	0.6100	0.0000	0.4024	0.0147	6.1813	9.1788
5	NA	NA	0.3991	0.0147	6.0972	9.1812
4	0.4300	0.0000	0.3958	0.0148	6.0138	9.1821
3	NA	NA	0.3925	0.0148	5.9310	9.1815
2	0.3667	0.0454	0.3892	0.0148	5.8489	9.1795
1	0.0200	0.0000	0.3860	0.0149	5.7675	9.1761
0	0.3371	0.0999	0.3827	0.0149	5.6868	9.1714
start-up	0.5212	0.0860			0.9830	0.9211

Table 17: Shutdown Probabilities, Θ, non-OECD

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
100	0	3.539%	0.223%
99	0	3.644%	0.230%
98	0	3.753%	0.237%
97	0	3.864%	0.244%
96	0	3.979%	0.251%
95	0	4.098%	0.258%
94	20.000%	4.220%	0.266%
93	0	4.345%	0.274%
92	0	4.475%	0.282%
91	0	4.608%	0.291%
90	0	4.745%	0.299%
89	0	4.886%	0.308%
88	0	5.032%	0.317%
87	4.167%	5.182%	0.327%
86	0	5.336%	0.336%
85	3.704%	5.495%	0.347%
84	0	5.658%	0.357%
83	0	5.827%	0.367%
82	0	6.000%	0.378%
81	0	6.179%	0.390%
80	0	6.363%	0.401%
79	0	6.552%	0.413%
78	0	6.747%	0.425%
77	0	6.948%	0.438%
76	0	7.155%	0.451%
75	0	7.368%	0.465%
74	0	7.588%	0.478%
73	0	7.813%	0.493%
72	0	8.046%	0.507%
71	0	8.286%	0.522%
70	0	8.532%	0.538%
69	0	8.786%	0.554%
68	0	9.048%	0.571%
67	4.167%	9.317%	0.588%
66	0	9.595%	0.605%
65	0	9.880%	0.623%
64	0	10.175%	0.642%
63	0	10.477%	0.661%
62	0	10.789%	0.680%
61	0	11.111%	0.701%

Table 17: Shutdown Probabilities, Θ, non-OECD

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
60	5.556%	11.441%	0.721%
59	0	11.782%	0.743%
58	0	12.133%	0.765%
57	0	12.494%	0.788%
56	0	12.866%	0.811%
55	0	13.249%	0.835%
54	0	13.643%	0.860%
53	0	14.050%	0.886%
52	0	14.468%	0.912%
51	0	14.899%	0.940%
50	0	15.342%	0.967%
49	0	15.799%	0.996%
48	0	16.269%	1.026%
47	0	16.754%	1.056%
46	0	17.253%	1.088%
45	0	17.766%	1.120%
44	0	18.295%	1.154%
43	0	18.840%	1.188%
42	0	19.401%	1.223%
41	0	19.978%	1.260%
40	0	20.573%	1.297%
39	0	21.186%	1.336%
38	0	21.816%	1.376%
37	0	22.466%	1.417%
36	0	23.135%	1.459%
35	0	23.823%	1.502%
34	0	24.533%	1.547%
33	0	25.263%	1.593%
32	0	26.015%	1.641%
31	0	26.790%	1.689%
30	0	27.587%	1.740%
29	0	28.409%	1.791%
28	0	29.254%	1.845%
27	0	30.125%	1.900%
26	0	31.022%	1.956%
25	0	31.946%	2.015%
24	0	32.897%	2.074%
23	0	33.876%	2.136%
22	0	34.885%	2.200%
21	0	35.923%	2.265%

Table 17: Shutdown Probabilities, Θ, non-OECD

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
20	0	36.993%	2.333%
19	0	38.094%	2.402%
18	0	39.228%	2.474%
17	0	40.396%	2.547%
16	0	41.599%	2.623%
15	0	42.837%	2.701%
14	0	44.113%	2.782%
13	0	45.426%	2.865%
12	0	46.778%	2.950%
11	0	48.171%	3.038%
10	0	49.605%	3.128%
9	0	51.082%	3.221%
8	0	52.603%	3.317%
7	0	54.169%	3.416%
6	100.000%	55.782%	3.518%
5	0	57.442%	3.622%
4	0	59.153%	3.730%
3	0	60.914%	3.841%
2	0	62.727%	3.956%
1	0	64.595%	4.073%
0	0	66.518%	4.195%
start-up	NA	NA	NA

Notes:

Sample moments correspond to the Transition Matrix shown in Table 4.

Fitted moment values are based on the regression results shown in Table 6. The regression fits the l

log variance. The fitted log values are then translated back into percentage levels.

Beta Distribution Parameters are calculated by the method of moments using these equations:

Mean = alpha / (alpha+beta),

Variance = (alpha*beta) / [(alpha+beta)^2 * (alpha+beta+1)].

Table 18: Distribution Moments for the Load Factor, Unconditional and Conditional on Continuing Operation, From P, non-OECD

Year of Operation	Unconditional		Conditional on Operation	
	Mean	Var	Mean	Var
1	52.1	0.086	52.1	0.086
2	60.8	0.035	61.6	0.035
3	64.0	0.023	65.4	0.023
4	65.3	0.020	67.2	0.020
5	65.8	0.019	68.1	0.019
6	65.9	0.019	68.6	0.019
7	65.7	0.019	68.9	0.019
8	65.5	0.019	69.0	0.019
9	65.2	0.019	69.1	0.019
10	64.8	0.019	69.2	0.019
11	64.5	0.020	69.2	0.019
12	64.1	0.020	69.2	0.019
13	63.7	0.020	69.2	0.019
14	63.4	0.020	69.2	0.019
15	63.0	0.021	69.2	0.019
16	62.6	0.021	69.2	0.019
17	62.2	0.021	69.2	0.019
18	61.9	0.022	69.2	0.019
19	61.5	0.022	69.2	0.019
20	61.1	0.022	69.2	0.019
21	60.8	0.023	69.2	0.019
22	60.4	0.023	69.2	0.019
23	60.0	0.024	69.2	0.019
24	59.7	0.024	69.2	0.019
25	59.3	0.025	69.2	0.019
26	59.0	0.025	69.2	0.019
27	58.6	0.025	69.2	0.019
28	58.3	0.026	69.2	0.019
29	57.9	0.026	69.2	0.019
30	57.6	0.027	69.2	0.019
31	57.2	0.027	69.2	0.019
32	56.9	0.028	69.2	0.019
33	56.5	0.029	69.2	0.019
34	56.2	0.029	69.2	0.019
35	55.9	0.030	69.2	0.019
36	55.5	0.030	69.2	0.019
37	55.2	0.031	69.2	0.019
38	54.9	0.031	69.2	0.019
39	54.5	0.032	69.2	0.019

Table 18: Distribution Moments for the Load Factor, Unconditional and Conditional on Continuing Operation, From P, non-OECD

Year of Operation	Unconditional		Conditional on Operation	
	Mean	Var	Mean	Var
40	54.2	0.032	69.2	0.019
41	53.9	0.033	69.2	0.019
42	53.6	0.034	69.2	0.019
43	53.2	0.034	69.2	0.019
44	52.9	0.035	69.2	0.019
45	52.6	0.035	69.2	0.019
46	52.3	0.036	69.2	0.019
47	52.0	0.036	69.2	0.019
48	51.7	0.037	69.2	0.019
49	51.4	0.038	69.2	0.019
50	51.1	0.038	69.2	0.019
51	50.7	0.039	69.2	0.019
52	50.4	0.039	69.2	0.019
53	50.1	0.040	69.2	0.019
54	49.8	0.041	69.2	0.019
55	49.5	0.041	69.2	0.019
56	49.2	0.042	69.2	0.019
57	49.0	0.042	69.2	0.019
58	48.7	0.043	69.2	0.019
59	48.4	0.044	69.2	0.019
60	48.1	0.044	69.2	0.019

Table 19: Parameters of the Conditional Transition Probability, Φ, pre-2000

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
100	0.8004	0.0130	0.8508	0.0141	7.2119	1.5799
99	0.8135	0.0044	0.8472	0.0143	7.1860	1.6201
98	0.7796	0.0111	0.8436	0.0145	7.1550	1.6590
97	0.7848	0.0089	0.8400	0.0147	7.1191	1.6966
96	0.7552	0.0235	0.8365	0.0149	7.0788	1.7328
95	0.7753	0.0212	0.8329	0.0150	7.0342	1.7677
94	0.7621	0.0334	0.8294	0.0152	6.9857	1.8013
93	0.8092	0.0186	0.8259	0.0154	6.9336	1.8335
92	0.8219	0.0110	0.8224	0.0156	6.8781	1.8643
91	0.8013	0.0196	0.8189	0.0158	6.8194	1.8938
90	0.8217	0.0165	0.8155	0.0160	6.7578	1.9218
89	0.8269	0.0182	0.8120	0.0162	6.6936	1.9486
88	0.7888	0.0286	0.8086	0.0164	6.6268	1.9739
87	0.8008	0.0240	0.8052	0.0166	6.5578	1.9979
86	0.8103	0.0183	0.8018	0.0168	6.4867	2.0205
85	0.7824	0.0220	0.7984	0.0171	6.4137	2.0418
84	0.7883	0.0219	0.7950	0.0173	6.3390	2.0618
83	0.8022	0.0125	0.7916	0.0175	6.2628	2.0804
82	0.7656	0.0248	0.7883	0.0177	6.1851	2.0977
81	0.7914	0.0203	0.7849	0.0179	6.1063	2.1137
80	0.7598	0.0279	0.7816	0.0182	6.0263	2.1285
79	0.7688	0.0193	0.7783	0.0184	5.9453	2.1420
78	0.7561	0.0188	0.7750	0.0186	5.8635	2.1543
77	0.7588	0.0213	0.7718	0.0189	5.7810	2.1653
76	0.7495	0.0255	0.7685	0.0191	5.6979	2.1752
75	0.7156	0.0206	0.7652	0.0193	5.6142	2.1839
74	0.7277	0.0227	0.7620	0.0196	5.5302	2.1914
73	0.7042	0.0212	0.7588	0.0198	5.4459	2.1978
72	0.7398	0.0215	0.7556	0.0201	5.3614	2.2030
71	0.7022	0.0327	0.7524	0.0203	5.2768	2.2072
70	0.7188	0.0188	0.7492	0.0206	5.1921	2.2103
69	0.6723	0.0301	0.7460	0.0209	5.1075	2.2124
68	0.6794	0.0316	0.7429	0.0211	5.0230	2.2135
67	0.6946	0.0270	0.7397	0.0214	4.9386	2.2135
66	0.6969	0.0361	0.7366	0.0217	4.8546	2.2126
65	0.6617	0.0339	0.7335	0.0219	4.7708	2.2108
64	0.6537	0.0362	0.7304	0.0222	4.6874	2.2080
63	0.6624	0.0286	0.7273	0.0225	4.6044	2.2044
62	0.6560	0.0330	0.7242	0.0228	4.5218	2.1999
61	0.6602	0.0353	0.7211	0.0231	4.4398	2.1945

Table 19: Parameters of the Conditional Transition Probability, Φ, pre-2000

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
60	0.6533	0.0292	0.7181	0.0234	4.3583	2.1883
59	0.6499	0.0337	0.7151	0.0237	4.2774	2.1813
58	0.6658	0.0289	0.7120	0.0240	4.1972	2.1736
57	0.6280	0.0391	0.7090	0.0243	4.1176	2.1650
56	0.6554	0.0304	0.7060	0.0246	4.0387	2.1558
55	0.5970	0.0322	0.7030	0.0249	3.9605	2.1459
54	0.6395	0.0236	0.7001	0.0252	3.8831	2.1353
53	0.5973	0.0379	0.6971	0.0255	3.8065	2.1240
52	0.6465	0.0348	0.6941	0.0259	3.7306	2.1121
51	0.5986	0.0377	0.6912	0.0262	3.6556	2.0996
50	0.6433	0.0193	0.6883	0.0265	3.5814	2.0865
49	0.5825	0.0441	0.6854	0.0268	3.5081	2.0728
48	0.5597	0.0324	0.6825	0.0272	3.4357	2.0586
47	0.6210	0.0394	0.6796	0.0275	3.3641	2.0439
46	0.6242	0.0372	0.6767	0.0279	3.2934	2.0287
45	0.5620	0.0338	0.6739	0.0282	3.2237	2.0129
44	0.6222	0.0221	0.6710	0.0286	3.1548	1.9968
43	0.5990	0.0240	0.6682	0.0290	3.0869	1.9802
42	0.4790	0.0530	0.6653	0.0293	3.0199	1.9631
41	0.6165	0.0206	0.6625	0.0297	2.9539	1.9457
40	0.4855	0.0437	0.6597	0.0301	2.8888	1.9279
39	0.5182	0.0562	0.6569	0.0304	2.8246	1.9097
38	0.5711	0.0476	0.6542	0.0308	2.7614	1.8912
37	0.5415	0.0415	0.6514	0.0312	2.6991	1.8724
36	0.5463	0.0528	0.6486	0.0316	2.6378	1.8532
35	0.5504	0.0631	0.6459	0.0320	2.5774	1.8337
34	0.6843	0.0799	0.6432	0.0324	2.5180	1.8140
33	0.5483	0.0800	0.6404	0.0328	2.4595	1.7940
32	0.6489	0.0465	0.6377	0.0333	2.4020	1.7738
31	0.7464	0.0089	0.6350	0.0337	2.3454	1.7533
30	0.6085	0.0588	0.6323	0.0341	2.2897	1.7326
29	0.6867	0.0806	0.6297	0.0345	2.2350	1.7118
28	0.7062	0.0313	0.6270	0.0350	2.1812	1.6907
27	0.5213	0.0723	0.6244	0.0354	2.1283	1.6695
26	0.4455	0.0707	0.6217	0.0359	2.0763	1.6481
25	0.4936	0.1123	0.6191	0.0363	2.0252	1.6265
24	0.5271	0.0662	0.6165	0.0368	1.9750	1.6049
23	0.5306	0.0620	0.6139	0.0372	1.9257	1.5831
22	0.6570	0.0226	0.6113	0.0377	1.8773	1.5612
21	0.6100	0.0790	0.6087	0.0382	1.8298	1.5392

Table 19: Parameters of the Conditional Transition Probability, Φ, pre-2000

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
20	0.5267	0.0882	0.6061	0.0387	1.7831	1.5171
19	0.5000	0.0511	0.6035	0.0392	1.7373	1.4950
18	0.5185	0.0872	0.6010	0.0397	1.6924	1.4728
17	0.3550	0.0800	0.5984	0.0402	1.6482	1.4505
16	0.5592	0.0689	0.5959	0.0407	1.6050	1.4282
15	0.6580	0.0415	0.5934	0.0412	1.5625	1.4059
14	0.4756	0.1152	0.5909	0.0417	1.5209	1.3836
13	0.3829	0.1186	0.5884	0.0422	1.4800	1.3612
12	0.5750	0.0488	0.5859	0.0428	1.4400	1.3388
11	0.5763	0.0697	0.5834	0.0433	1.4007	1.3165
10	0.6210	0.0740	0.5809	0.0439	1.3622	1.2941
9	0.5900	0.0745	0.5785	0.0444	1.3245	1.2718
8	0.6333	0.0336	0.5760	0.0450	1.2875	1.2495
7	0.6133	0.0948	0.5736	0.0456	1.2513	1.2272
6	0.6875	0.0297	0.5712	0.0461	1.2158	1.2050
5	0.6113	0.0529	0.5688	0.0467	1.1810	1.1828
4	0.4608	0.0515	0.5664	0.0473	1.1469	1.1607
3	0.5100	0.0676	0.5640	0.0479	1.1136	1.1387
2	0.4743	0.0524	0.5616	0.0485	1.0809	1.1167
1	0.5038	0.1102	0.5592	0.0491	1.0489	1.0948
0	0.2609	0.0869	0.5568	0.0498	1.0175	1.0730
start-up	0.5353	0.0950			0.8594	0.7612

Table 20: Shutdown Probabilities, Θ, pre-2000

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
100	0	3.539%	0.024%
99	0	3.644%	0.025%
98	0	3.753%	0.026%
97	0	3.864%	0.026%
96	0	3.979%	0.027%
95	0	4.098%	0.028%
94	1.471%	4.220%	0.029%
93	0	4.345%	0.030%
92	0	4.475%	0.031%
91	0	4.608%	0.032%
90	0	4.745%	0.033%
89	0	4.886%	0.035%
88	0	5.032%	0.036%
87	0	5.182%	0.037%
86	0	5.336%	0.038%
85	0	5.495%	0.039%
84	0	5.658%	0.041%
83	0.541%	5.827%	0.042%
82	0	6.000%	0.044%
81	0	6.179%	0.045%
80	0	6.363%	0.047%
79	0	6.552%	0.048%
78	0	6.747%	0.050%
77	0	6.948%	0.051%
76	0.588%	7.155%	0.053%
75	0.543%	7.368%	0.055%
74	0	7.588%	0.057%
73	0	7.813%	0.059%
72	0	8.046%	0.061%
71	0	8.286%	0.063%
70	0	8.532%	0.065%
69	0.893%	8.786%	0.067%
68	0	9.048%	0.069%
67	0.725%	9.317%	0.072%
66	0	9.595%	0.074%
65	0	9.880%	0.077%
64	0	10.175%	0.079%
63	0	10.477%	0.082%
62	0	10.789%	0.085%
61	0	11.111%	0.088%

Table 20: Shutdown Probabilities, Θ, pre-2000

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
60	1.124%	11.441%	0.091%
59	1.282%	11.782%	0.094%
58	0	12.133%	0.097%
57	0	12.494%	0.100%
56	0	12.866%	0.104%
55	0	13.249%	0.107%
54	0	13.643%	0.111%
53	0	14.050%	0.114%
52	0	14.468%	0.118%
51	0	14.899%	0.122%
50	0	15.342%	0.126%
49	0	15.799%	0.131%
48	0	16.269%	0.135%
47	0	16.754%	0.140%
46	0	17.253%	0.144%
45	0	17.766%	0.149%
44	0	18.295%	0.154%
43	0	18.840%	0.159%
42	0	19.401%	0.165%
41	0	19.978%	0.170%
40	0	20.573%	0.176%
39	0	21.186%	0.182%
38	0	21.816%	0.188%
37	0	22.466%	0.195%
36	0	23.135%	0.201%
35	0	23.823%	0.208%
34	0	24.533%	0.215%
33	0	25.263%	0.222%
32	0	26.015%	0.230%
31	0	26.790%	0.238%
30	0	27.587%	0.246%
29	0	28.409%	0.254%
28	0	29.254%	0.263%
27	0	30.125%	0.272%
26	0	31.022%	0.281%
25	0	31.946%	0.290%
24	0	32.897%	0.300%
23	0	33.876%	0.310%
22	0	34.885%	0.321%
21	0	35.923%	0.331%

Table 20: Shutdown Probabilities, Θ, pre-2000

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
20	0	36.993%	0.343%
19	0	38.094%	0.354%
18	0	39.228%	0.366%
17	0	40.396%	0.379%
16	0	41.599%	0.391%
15	0	42.837%	0.405%
14	0	44.113%	0.418%
13	0	45.426%	0.433%
12	0	46.778%	0.447%
11	0	48.171%	0.462%
10	0	49.605%	0.478%
9	0	51.082%	0.494%
8	0	52.603%	0.511%
7	0	54.169%	0.528%
6	12.500%	55.782%	0.546%
5	0	57.442%	0.564%
4	0	59.153%	0.583%
3	0	60.914%	0.603%
2	0	62.727%	0.624%
1	0	64.595%	0.645%
0	0	66.518%	0.666%
start-up	NA	NA	NA

Table 21: Distribution Moments for the Load Factor, Unconditional and Conditional on Continuing Operation, From P, pre-2000

Year of Operation	Unconditional Mean	Unconditional Var	Conditional on Operation Mean	Conditional on Operation Var
1	53.5	0.095	53.5	0.095
2	65.6	0.048	65.7	0.048
3	69.3	0.035	69.5	0.035
4	70.5	0.031	70.8	0.031
5	70.9	0.030	71.2	0.030
6	71.0	0.029	71.4	0.029
7	71.0	0.029	71.4	0.029
8	71.0	0.029	71.4	0.029
9	70.9	0.029	71.4	0.029
10	70.9	0.029	71.5	0.029
11	70.8	0.029	71.5	0.029
12	70.8	0.029	71.5	0.029
13	70.7	0.029	71.5	0.029
14	70.7	0.029	71.5	0.029
15	70.6	0.029	71.5	0.029
16	70.6	0.029	71.5	0.029
17	70.5	0.029	71.5	0.029
18	70.4	0.029	71.5	0.029
19	70.4	0.029	71.5	0.029
20	70.3	0.029	71.5	0.029
21	70.3	0.029	71.5	0.029
22	70.2	0.029	71.5	0.029
23	70.2	0.029	71.5	0.029
24	70.1	0.029	71.5	0.029
25	70.1	0.029	71.5	0.029
26	70.0	0.029	71.5	0.029
27	70.0	0.029	71.5	0.029
28	69.9	0.029	71.5	0.029
29	69.9	0.029	71.5	0.029
30	69.8	0.029	71.5	0.029
31	69.8	0.029	71.5	0.029
32	69.7	0.029	71.5	0.029
33	69.7	0.029	71.5	0.029
34	69.6	0.029	71.5	0.029
35	69.6	0.029	71.5	0.029
36	69.5	0.029	71.5	0.029
37	69.5	0.029	71.5	0.029
38	69.4	0.029	71.5	0.029
39	69.4	0.029	71.5	0.029

Table 21: Distribution Moments for the Load Factor, Unconditional and Conditional on Continuing Operation, From P, pre-2000

Year of Operation	Unconditional Mean	Unconditional Var	Conditional on Operation Mean	Conditional on Operation Var
40	69.3	0.029	71.5	0.029
41	69.3	0.029	71.5	0.029
42	69.2	0.029	71.5	0.029
43	69.2	0.029	71.5	0.029
44	69.1	0.029	71.5	0.029
45	69.0	0.029	71.5	0.029
46	69.0	0.029	71.5	0.029
47	68.9	0.029	71.5	0.029
48	68.9	0.029	71.5	0.029
49	68.8	0.029	71.5	0.029
50	68.8	0.029	71.5	0.029
51	68.7	0.029	71.5	0.029
52	68.7	0.029	71.5	0.029
53	68.6	0.029	71.5	0.029
54	68.6	0.029	71.5	0.029
55	68.5	0.029	71.5	0.029
56	68.5	0.029	71.5	0.029
57	68.4	0.029	71.5	0.029
58	68.4	0.029	71.5	0.029
59	68.3	0.029	71.5	0.029
60	68.3	0.029	71.5	0.029

Table 22: Parameters of the Conditional Transition Probability, Φ, post-2000

Load Factor in Year n	Sample Moments		Fitted Moments		Implied Beta Distribution	
	Mean	Var	Mean	Var	Alpha	Beta
100	0.8630	0.0122	0.8508	0.0141	6.7970	1.1921
99	0.8437	0.0195	0.8472	0.0143	6.8217	1.2305
98	0.8353	0.0251	0.8436	0.0145	6.8415	1.2684
97	0.8776	0.0054	0.8400	0.0147	6.8565	1.3057
96	0.8429	0.0230	0.8365	0.0149	6.8669	1.3424
95	0.8797	0.0117	0.8329	0.0150	6.8731	1.3785
94	0.8684	0.0125	0.8294	0.0152	6.8750	1.4139
93	0.8944	0.0107	0.8259	0.0154	6.8730	1.4487
92	0.8909	0.0097	0.8224	0.0156	6.8673	1.4828
91	0.9041	0.0078	0.8189	0.0158	6.8579	1.5162
90	0.8650	0.0172	0.8155	0.0160	6.8451	1.5489
89	0.8584	0.0181	0.8120	0.0162	6.8290	1.5809
88	0.8858	0.0115	0.8086	0.0164	6.8098	1.6120
87	0.8682	0.0170	0.8052	0.0166	6.7877	1.6425
86	0.8428	0.0147	0.8018	0.0168	6.7627	1.6721
85	0.8425	0.0156	0.7984	0.0171	6.7351	1.7010
84	0.8430	0.0122	0.7950	0.0173	6.7050	1.7290
83	0.8414	0.0165	0.7916	0.0175	6.6724	1.7563
82	0.8247	0.0106	0.7883	0.0177	6.6375	1.7827
81	0.8007	0.0243	0.7849	0.0179	6.6005	1.8083
80	0.8134	0.0108	0.7816	0.0182	6.5615	1.8332
79	0.7883	0.0209	0.7783	0.0184	6.5206	1.8572
78	0.8077	0.0200	0.7750	0.0186	6.4778	1.8803
77	0.8055	0.0134	0.7718	0.0189	6.4333	1.9027
76	0.7582	0.0290	0.7685	0.0191	6.3873	1.9242
75	0.7793	0.0115	0.7652	0.0193	6.3397	1.9449
74	0.7730	0.0220	0.7620	0.0196	6.2907	1.9648
73	0.7700	0.0217	0.7588	0.0198	6.2404	1.9839
72	0.7613	0.0240	0.7556	0.0201	6.1888	2.0022
71	0.8035	0.0139	0.7524	0.0203	6.1361	2.0196
70	0.7683	0.0303	0.7492	0.0206	6.0823	2.0362
69	0.7106	0.0380	0.7460	0.0209	6.0276	2.0521
68	0.7124	0.0521	0.7429	0.0211	5.9719	2.0671
67	0.7325	0.0268	0.7397	0.0214	5.9154	2.0814
66	0.7367	0.0182	0.7366	0.0217	5.8580	2.0949
65	0.6520	0.0508	0.7335	0.0219	5.8000	2.1076
64	0.7748	0.0378	0.7304	0.0222	5.7414	2.1195
63	0.6929	0.0426	0.7273	0.0225	5.6821	2.1307
62	0.5637	0.0763	0.7242	0.0228	5.6223	2.1411
61	0.7267	0.0083	0.7211	0.0231	5.5621	2.1508

Table 22: Parameters of the Conditional Transition Probability, Φ, post-2000

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
60	0.6000	0.0617	0.7181	0.0234	5.5014	2.1597
59	0.6958	0.0564	0.7151	0.0237	5.4404	2.1680
58	0.7300	0.0067	0.7120	0.0240	5.3790	2.1755
57	0.7060	0.0201	0.7090	0.0243	5.3174	2.1823
56	0.7520	0.0137	0.7060	0.0246	5.2556	2.1884
55	0.5978	0.0608	0.7030	0.0249	5.1935	2.1938
54	0.5267	0.0961	0.7001	0.0252	5.1314	2.1985
53	0.6000	0.0529	0.6971	0.0255	5.0691	2.2026
52	0.8400	0.0016	0.6941	0.0259	5.0068	2.2060
51	0.6673	0.0135	0.6912	0.0262	4.9444	2.2088
50	0.7289	0.0272	0.6883	0.0265	4.8821	2.2110
49	0.4778	0.0858	0.6854	0.0268	4.8198	2.2125
48	0.6580	0.0430	0.6825	0.0272	4.7576	2.2134
47	0.5833	0.0454	0.6796	0.0275	4.6954	2.2138
46	0.6943	0.1113	0.6767	0.0279	4.6335	2.2135
45	0.8500	0.0000	0.6739	0.0282	4.5716	2.2127
44	0.7000	0.0100	0.6710	0.0286	4.5100	2.2113
43	0.3667	0.1089	0.6682	0.0290	4.4486	2.2093
42	0.7900	0.0059	0.6653	0.0293	4.3874	2.2068
41	0.3867	0.0828	0.6625	0.0297	4.3264	2.2038
40	0.6350	0.0349	0.6597	0.0301	4.2658	2.2002
39	0.6800	0.0000	0.6569	0.0304	4.2054	2.1962
38	0.7480	0.0086	0.6542	0.0308	4.1453	2.1916
37	0.5900	0.0000	0.6514	0.0312	4.0856	2.1866
36	0.6700	0.1533	0.6486	0.0316	4.0263	2.1811
35	0.6267	0.0119	0.6459	0.0320	3.9673	2.1751
34	0.7300	0.0021	0.6432	0.0324	3.9087	2.1687
33	0.5850	0.1189	0.6404	0.0328	3.8504	2.1618
32	0.4600	0.2116	0.6377	0.0333	3.7926	2.1545
31	0.5600	0.0000	0.6350	0.0337	3.7353	2.1468
30	0.7375	0.0149	0.6323	0.0341	3.6783	2.1387
29	0.7000	0.0025	0.6297	0.0345	3.6218	2.1301
28	0.0000	0.0000	0.6270	0.0350	3.5657	2.1212
27	0.8200	0.0000	0.6244	0.0354	3.5102	2.1119
26	0.6450	0.0870	0.6217	0.0359	3.4551	2.1023
25	NA	NA	0.6191	0.0363	3.4004	2.0923
24	0.7100	0.0289	0.6165	0.0368	3.3463	2.0819
23	0.2900	0.0000	0.6139	0.0372	3.2926	2.0712
22	0.8400	0.0144	0.6113	0.0377	3.2395	2.0602
21	NA	NA	0.6087	0.0382	3.1869	2.0489

Table 22: Parameters of the Conditional Transition Probability, Φ, post-2000

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
20	0.4250	0.1806	0.6061	0.0387	3.1347	2.0373
19	0.0000	0.0000	0.6035	0.0392	3.0831	2.0254
18	NA	NA	0.6010	0.0397	3.0321	2.0131
17	NA	NA	0.5984	0.0402	2.9815	2.0007
16	0.8250	0.0306	0.5959	0.0407	2.9315	1.9879
15	0.7000	0.0086	0.5934	0.0412	2.8820	1.9749
14	NA	NA	0.5909	0.0417	2.8331	1.9616
13	0.3800	0.1444	0.5884	0.0422	2.7846	1.9481
12	0.6175	0.1332	0.5859	0.0428	2.7368	1.9344
11	0.8500	0.0000	0.5834	0.0433	2.6894	1.9204
10	NA	NA	0.5809	0.0439	2.6426	1.9063
9	NA	NA	0.5785	0.0444	2.5964	1.8919
8	0.9500	0.0000	0.5760	0.0450	2.5507	1.8773
7	NA	NA	0.5736	0.0456	2.5055	1.8625
6	NA	NA	0.5712	0.0461	2.4609	1.8476
5	NA	NA	0.5688	0.0467	2.4168	1.8325
4	NA	NA	0.5664	0.0473	2.3733	1.8172
3	0.9200	0.0000	0.5640	0.0479	2.3303	1.8017
2	0.9800	0.0000	0.5616	0.0485	2.2878	1.7861
1	0.8050	0.0072	0.5592	0.0491	2.2459	1.7704
0	0.2031	0.1053	0.5568	0.0498	2.2045	1.7545
start-up	0.5353	0.0950			0.8594	0.7612

Table 23: Shutdown Probabilities, Θ, post-2000

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
100	0	0.058%	0.058%
99	0	0.058%	0.058%
98	0	0.058%	0.058%
97	0	0.058%	0.058%
96	0	0.058%	0.058%
95	0	0.058%	0.058%
94	0	0.058%	0.058%
93	0	0.058%	0.058%
92	0	0.058%	0.058%
91	0	0.058%	0.058%
90	0	0.058%	0.058%
89	0	0.058%	0.058%
88	0	0.058%	0.058%
87	0.935%	0.058%	0.058%
86	0	0.058%	0.058%
85	2.020%	0.058%	0.058%
84	0	0.058%	0.058%
83	0	0.058%	0.058%
82	0	0.058%	0.058%
81	0	0.058%	0.058%
80	0	0.058%	0.058%
79	0	0.058%	0.058%
78	0	0.058%	0.058%
77	0	0.058%	0.058%
76	0	0.058%	0.058%
75	0	0.058%	0.058%
74	0	0.058%	0.058%
73	0	0.058%	0.058%
72	0	0.058%	0.058%
71	0	0.058%	0.058%
70	0	0.058%	0.058%
69	2.857%	0.058%	0.058%
68	0	0.058%	0.058%
67	0	0.058%	0.058%
66	0	0.058%	0.058%
65	0	0.058%	0.058%
64	0	0.058%	0.058%
63	0	0.058%	0.058%
62	0	0.058%	0.058%
61	0	0.058%	0.058%

Table 23: Shutdown Probabilities, Θ, post-2000

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
60	0	0.058%	0.058%
59	0	0.058%	0.058%
58	0	0.058%	0.058%
57	0	0.058%	0.058%
56	0	0.058%	0.058%
55	0	0.058%	0.058%
54	0	0.058%	0.058%
53	0	0.058%	0.058%
52	0	0.058%	0.058%
51	0	0.058%	0.058%
50	0	0.058%	0.058%
49	0	0.058%	0.058%
48	0	0.058%	0.058%
47	0	0.058%	0.058%
46	0	0.058%	0.058%
45	0	0.058%	0.058%
44	0	0.058%	0.058%
43	0	0.058%	0.058%
42	0	0.058%	0.058%
41	0	0.058%	0.058%
40	0	0.058%	0.058%
39	0	0.058%	0.058%
38	0	0.058%	0.058%
37	0	0.058%	0.058%
36	0	0.058%	0.058%
35	0	0.058%	0.058%
34	0	0.058%	0.058%
33	0	0.058%	0.058%
32	0	0.058%	0.058%
31	0	0.058%	0.058%
30	0	0.058%	0.058%
29	0	0.058%	0.058%
28	0	0.058%	0.058%
27	0	0.058%	0.058%
26	0	0.058%	0.058%
25	0	0.058%	0.058%
24	0	0.058%	0.058%
23	0	0.058%	0.058%
22	0	0.058%	0.058%
21	0	0.058%	0.058%

Table 23: Shutdown Probabilities, Θ, post-2000

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
20	0	0.058%	0.058%
19	0	0.058%	0.058%
18	0	0.058%	0.058%
17	0	0.058%	0.058%
16	0	0.058%	0.058%
15	0	0.058%	0.058%
14	0	0.058%	0.058%
13	0	0.058%	0.058%
12	0	0.058%	0.058%
11	0	0.058%	0.058%
10	0	0.058%	0.058%
9	0	0.058%	0.058%
8	0	0.058%	0.058%
7	0	0.058%	0.058%
6	0	0.058%	0.058%
5	0	0.058%	0.058%
4	0	0.058%	0.058%
3	0	0.058%	0.058%
2	0	0.058%	0.058%
1	0	0.058%	0.058%
0	0	0.058%	0.058%
start-up	NA	NA	NA

Table 24: Distribution Moments for the Load Factor, Unconditional and Conditional on Continuing Operation, From P, post-2000

Year of Operation	Unconditional Mean	Unconditional Var	Conditional on Operation Mean	Conditional on Operation Var
1	53.5	0.095	53.5	0.095
2	70.9	0.036	71.0	0.036
3	75.9	0.024	76.0	0.024
4	77.4	0.022	77.5	0.022
5	77.8	0.021	78.0	0.021
6	77.9	0.021	78.1	0.021
7	77.9	0.021	78.2	0.021
8	77.9	0.021	78.2	0.021
9	77.9	0.021	78.2	0.021
10	77.8	0.021	78.2	0.021
11	77.8	0.021	78.2	0.021
12	77.7	0.021	78.2	0.021
13	77.7	0.021	78.2	0.021
14	77.6	0.021	78.2	0.021
15	77.6	0.021	78.2	0.021
16	77.5	0.021	78.2	0.021
17	77.5	0.021	78.2	0.021
18	77.5	0.021	78.2	0.021
19	77.4	0.021	78.2	0.021
20	77.4	0.021	78.2	0.021
21	77.3	0.021	78.2	0.021
22	77.3	0.021	78.2	0.021
23	77.2	0.021	78.2	0.021
24	77.2	0.021	78.2	0.021
25	77.1	0.021	78.2	0.021
26	77.1	0.021	78.2	0.021
27	77.1	0.021	78.2	0.021
28	77.0	0.021	78.2	0.021
29	77.0	0.021	78.2	0.021
30	76.9	0.021	78.2	0.021
31	76.9	0.021	78.2	0.021
32	76.8	0.021	78.2	0.021
33	76.8	0.021	78.2	0.021
34	76.7	0.021	78.2	0.021
35	76.7	0.021	78.2	0.021
36	76.7	0.021	78.2	0.021
37	76.6	0.021	78.2	0.021
38	76.6	0.021	78.2	0.021
39	76.5	0.021	78.2	0.021

Table 24: Distribution Moments for the Load Factor, Unconditional and Conditional on Continuing Operation, From P, post-2000

Year of Operation	Unconditional Mean	Unconditional Var	Conditional on Operation Mean	Conditional on Operation Var
40	76.5	0.021	78.2	0.021
41	76.4	0.021	78.2	0.021
42	76.4	0.021	78.2	0.021
43	76.4	0.021	78.2	0.021
44	76.3	0.021	78.2	0.021
45	76.3	0.021	78.2	0.021
46	76.2	0.021	78.2	0.021
47	76.2	0.021	78.2	0.021
48	76.1	0.021	78.2	0.021
49	76.1	0.021	78.2	0.021
50	76.0	0.021	78.2	0.021
51	76.0	0.021	78.2	0.021
52	76.0	0.021	78.2	0.021
53	75.9	0.021	78.2	0.021
54	75.9	0.021	78.2	0.021
55	75.8	0.021	78.2	0.021
56	75.8	0.021	78.2	0.021
57	75.7	0.021	78.2	0.021
58	75.7	0.021	78.2	0.021
59	75.7	0.021	78.2	0.021
60	75.6	0.021	78.2	0.021

Table 25: Parameters of the Conditional Transition Probability, Φ, year 0-5

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
100	0.7776	0.0258	0.8038	0.0129	9.0487	2.2088
99	0.8067	0.0057	0.8002	0.0131	8.9927	2.2459
98	0.7896	0.0130	0.7965	0.0133	8.9330	2.2817
97	0.8218	0.0033	0.7929	0.0135	8.8698	2.3161
96	0.8067	0.0253	0.7894	0.0137	8.8035	2.3492
95	0.6793	0.0377	0.7858	0.0139	8.7342	2.3809
94	0.7346	0.0714	0.7822	0.0141	8.6621	2.4113
93	0.8831	0.0071	0.7787	0.0143	8.5875	2.4403
92	0.7841	0.0100	0.7752	0.0145	8.5104	2.4680
91	0.8200	0.0091	0.7717	0.0148	8.4311	2.4944
90	0.8079	0.0057	0.7682	0.0150	8.3497	2.5195
89	0.7850	0.0301	0.7647	0.0152	8.2665	2.5432
88	0.8227	0.0148	0.7613	0.0155	8.1816	2.5656
87	0.8133	0.0075	0.7578	0.0157	8.0950	2.5868
86	0.8223	0.0064	0.7544	0.0160	8.0071	2.6066
85	0.7830	0.0110	0.7510	0.0162	7.9178	2.6252
84	0.7662	0.0228	0.7476	0.0165	7.8274	2.6425
83	0.8046	0.0086	0.7442	0.0167	7.7359	2.6586
82	0.7536	0.0353	0.7409	0.0170	7.6435	2.6735
81	0.7321	0.0339	0.7375	0.0172	7.5503	2.6872
80	0.7814	0.0161	0.7342	0.0175	7.4564	2.6996
79	0.7644	0.0127	0.7309	0.0178	7.3619	2.7109
78	0.7606	0.0158	0.7276	0.0180	7.2669	2.7211
77	0.7713	0.0299	0.7243	0.0183	7.1715	2.7301
76	0.7098	0.0245	0.7210	0.0186	7.0758	2.7380
75	0.7386	0.0174	0.7177	0.0189	6.9798	2.7448
74	0.7534	0.0141	0.7145	0.0192	6.8837	2.7506
73	0.7137	0.0178	0.7113	0.0195	6.7875	2.7552
72	0.6917	0.0128	0.7081	0.0198	6.6913	2.7589
71	0.7000	0.0338	0.7049	0.0201	6.5951	2.7615
70	0.7398	0.0184	0.7017	0.0204	6.4991	2.7632
69	0.6547	0.0230	0.6985	0.0207	6.4033	2.7639
68	0.6619	0.0219	0.6953	0.0210	6.3077	2.7636
67	0.7157	0.0162	0.6922	0.0214	6.2123	2.7624
66	0.6529	0.0409	0.6891	0.0217	6.1174	2.7603
65	0.6600	0.0290	0.6860	0.0220	6.0228	2.7573
64	0.6294	0.0368	0.6829	0.0224	5.9287	2.7534
63	0.6705	0.0102	0.6798	0.0227	5.8351	2.7487
62	0.6027	0.0374	0.6767	0.0231	5.7420	2.7432
61	0.6092	0.0426	0.6736	0.0234	5.6495	2.7369

Table 25: Parameters of the Conditional Transition Probability, Φ, year 0-5

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
60	0.6466	0.0323	0.6706	0.0238	5.5575	2.7298
59	0.6563	0.0153	0.6676	0.0242	5.4662	2.7220
58	0.6497	0.0171	0.6646	0.0245	5.3756	2.7134
57	0.6374	0.0304	0.6616	0.0249	5.2857	2.7041
56	0.6429	0.0188	0.6586	0.0253	5.1965	2.6941
55	0.5983	0.0320	0.6556	0.0257	5.1080	2.6835
54	0.6140	0.0145	0.6526	0.0261	5.0203	2.6722
53	0.5938	0.0403	0.6497	0.0265	4.9334	2.6602
52	0.6371	0.0217	0.6467	0.0269	4.8473	2.6477
51	0.6448	0.0196	0.6438	0.0273	4.7621	2.6345
50	0.6232	0.0101	0.6409	0.0277	4.6777	2.6208
49	0.6283	0.0476	0.6380	0.0282	4.5941	2.6066
48	0.6164	0.0296	0.6351	0.0286	4.5115	2.5918
47	0.6325	0.0333	0.6323	0.0290	4.4297	2.5764
46	0.5500	0.1024	0.6294	0.0295	4.3488	2.5606
45	0.5883	0.0317	0.6266	0.0299	4.2689	2.5443
44	0.5936	0.0173	0.6237	0.0304	4.1898	2.5276
43	0.6973	0.0068	0.6209	0.0309	4.1117	2.5104
42	0.4250	0.0733	0.6181	0.0314	4.0345	2.4928
41	0.5380	0.0464	0.6153	0.0318	3.9583	2.4747
40	0.4822	0.0359	0.6125	0.0323	3.8830	2.4563
39	0.4967	0.0707	0.6098	0.0328	3.8087	2.4375
38	0.6445	0.0299	0.6070	0.0333	3.7353	2.4184
37	0.6310	0.0320	0.6043	0.0339	3.6629	2.3988
36	0.6233	0.0609	0.6015	0.0344	3.5914	2.3790
35	0.5663	0.0551	0.5988	0.0349	3.5209	2.3589
34	0.5200	0.1221	0.5961	0.0355	3.4513	2.3384
33	0.5556	0.0788	0.5934	0.0360	3.3827	2.3177
32	0.6720	0.0525	0.5907	0.0366	3.3151	2.2967
31	0.7371	0.0139	0.5881	0.0371	3.2484	2.2755
30	0.6750	0.0767	0.5854	0.0377	3.1826	2.2540
29	0.7100	0.1045	0.5828	0.0383	3.1179	2.2323
28	0.7113	0.0101	0.5801	0.0389	3.0540	2.2104
27	0.6667	0.0105	0.5775	0.0395	2.9911	2.1883
26	0.5280	0.0689	0.5749	0.0401	2.9291	2.1660
25	0.6925	0.0193	0.5723	0.0407	2.8681	2.1435
24	0.4900	0.0973	0.5697	0.0413	2.8080	2.1208
23	0.5500	0.0501	0.5671	0.0420	2.7488	2.0980
22	0.6340	0.0155	0.5646	0.0426	2.6906	2.0751
21	0.8000	0.0115	0.5620	0.0433	2.6332	2.0520

Table 25: Parameters of the Conditional Transition Probability, Φ, year 0-5

Load Factor in Year n	Sample Moments		Fitted Moments		Implied Beta Distribution	
	Mean	Var	Mean	Var	Alpha	Beta
20	0.6500	0.0591	0.5595	0.0440	2.5767	2.0288
19	0.4720	0.0741	0.5570	0.0446	2.5212	2.0055
18	0.5478	0.0620	0.5544	0.0453	2.4665	1.9822
17	0.4525	0.0594	0.5519	0.0460	2.4127	1.9587
16	0.6510	0.0278	0.5494	0.0468	2.3598	1.9351
15	0.6570	0.0486	0.5470	0.0475	2.3077	1.9115
14	0.3650	0.0922	0.5445	0.0482	2.2566	1.8878
13	0.4344	0.1125	0.5420	0.0490	2.2062	1.8641
12	0.5750	0.0488	0.5396	0.0497	2.1567	1.8404
11	0.5500	0.0896	0.5371	0.0505	2.1080	1.8166
10	0.7388	0.0175	0.5347	0.0513	2.0602	1.7927
9	0.5980	0.0791	0.5323	0.0521	2.0132	1.7689
8	0.6388	0.0375	0.5299	0.0529	1.9669	1.7451
7	0.6850	0.0702	0.5275	0.0537	1.9215	1.7212
6	0.6400	0.0284	0.5251	0.0545	1.8769	1.6974
5	0.6014	0.0597	0.5227	0.0554	1.8330	1.6736
4	0.5813	0.0241	0.5204	0.0562	1.7899	1.6498
3	0.2950	0.0342	0.5180	0.0571	1.7476	1.6260
2	0.3640	0.0283	0.5157	0.0580	1.7060	1.6023
1	0.5000	0.0867	0.5134	0.0589	1.6652	1.5786
0	0.4831	0.0815	0.5110	0.0598	1.6251	1.5549
start-up	0.5353	0.0950			0.8594	0.7612

Table 26: Shutdown Probabilities, Θ, year 0-5

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
100	0	2.505%	0.109%
99	0	2.547%	0.111%
98	0	2.590%	0.113%
97	0	2.634%	0.115%
96	0	2.678%	0.117%
95	0	2.723%	0.119%
94	7.692%	2.769%	0.121%
93	0	2.816%	0.123%
92	0	2.863%	0.125%
91	0	2.912%	0.127%
90	0	2.961%	0.129%
89	0	3.011%	0.131%
88	0	3.062%	0.133%
87	0	3.113%	0.136%
86	0	3.166%	0.138%
85	0	3.219%	0.140%
84	0	3.274%	0.143%
83	0	3.329%	0.145%
82	0	3.385%	0.147%
81	0	3.442%	0.150%
80	0	3.500%	0.152%
79	0	3.559%	0.155%
78	0	3.619%	0.158%
77	0	3.680%	0.160%
76	0	3.743%	0.163%
75	1.587%	3.806%	0.166%
74	0	3.870%	0.169%
73	0	3.935%	0.171%
72	0	4.002%	0.174%
71	0	4.069%	0.177%
70	0	4.138%	0.180%
69	2.632%	4.208%	0.183%
68	0	4.279%	0.186%
67	0	4.351%	0.190%
66	0	4.424%	0.193%
65	0	4.499%	0.196%
64	0	4.575%	0.199%
63	0	4.652%	0.203%
62	0	4.731%	0.206%
61	0	4.811%	0.210%

Table 26: Shutdown Probabilities, Θ, year 0-5

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
60	0	4.892%	0.213%
59	0	4.974%	0.217%
58	0	5.058%	0.220%
57	0	5.144%	0.224%
56	0	5.230%	0.228%
55	0	5.319%	0.232%
54	0	5.408%	0.236%
53	0	5.500%	0.240%
52	0	5.593%	0.244%
51	0	5.687%	0.248%
50	0	5.783%	0.252%
49	0	5.880%	0.256%
48	0	5.980%	0.260%
47	0	6.081%	0.265%
46	0	6.183%	0.269%
45	0	6.288%	0.274%
44	0	6.394%	0.278%
43	0	6.502%	0.283%
42	0	6.611%	0.288%
41	0	6.723%	0.293%
40	0	6.836%	0.298%
39	0	6.952%	0.303%
38	0	7.069%	0.308%
37	0	7.188%	0.313%
36	0	7.310%	0.318%
35	0	7.433%	0.324%
34	0	7.558%	0.329%
33	0	7.686%	0.335%
32	0	7.816%	0.340%
31	0	7.948%	0.346%
30	0	8.082%	0.352%
29	0	8.218%	0.358%
28	0	8.357%	0.364%
27	0	8.498%	0.370%
26	0	8.641%	0.376%
25	0	8.787%	0.383%
24	0	8.935%	0.389%
23	0	9.086%	0.396%
22	0	9.240%	0.402%
21	0	9.396%	0.409%

Table 26: Shutdown Probabilities, Θ, year 0-5

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
20	0	9.554%	0.416%
19	0	9.715%	0.423%
18	0	9.879%	0.430%
17	0	10.046%	0.438%
16	0	10.216%	0.445%
15	0	10.388%	0.452%
14	0	10.563%	0.460%
13	0	10.742%	0.468%
12	0	10.923%	0.476%
11	0	11.107%	0.484%
10	0	11.295%	0.492%
9	0	11.485%	0.500%
8	0	11.679%	0.509%
7	0	11.876%	0.517%
6	16.667%	12.077%	0.526%
5	0	12.280%	0.535%
4	0	12.488%	0.544%
3	0	12.698%	0.553%
2	0	12.913%	0.562%
1	0	13.131%	0.572%
0	0	13.352%	0.582%
start-up	NA	NA	NA

Table 27: Parameters of the Conditional Transition Probability, Φ, year 5+

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
100	0.8565	0.0110	0.8633	0.0173	5.0268	0.7962
99	0.8298	0.0140	0.8580	0.0175	5.1019	0.8441
98	0.8156	0.0207	0.8528	0.0178	5.1682	0.8918
97	0.8324	0.0100	0.8477	0.0180	5.2263	0.9392
96	0.8090	0.0240	0.8425	0.0183	5.2766	0.9862
95	0.8540	0.0129	0.8374	0.0185	5.3194	1.0327
94	0.8336	0.0189	0.8323	0.0188	5.3552	1.0787
93	0.8639	0.0150	0.8273	0.0190	5.3843	1.1240
92	0.8666	0.0131	0.8223	0.0193	5.4071	1.1686
91	0.8657	0.0152	0.8173	0.0196	5.4239	1.2124
90	0.8531	0.0183	0.8124	0.0198	5.4350	1.2554
89	0.8576	0.0158	0.8074	0.0201	5.4407	1.2976
88	0.8383	0.0258	0.8025	0.0204	5.4415	1.3389
87	0.8354	0.0232	0.7977	0.0206	5.4374	1.3792
86	0.8268	0.0196	0.7928	0.0209	5.4288	1.4185
85	0.8143	0.0223	0.7880	0.0212	5.4160	1.4568
84	0.8154	0.0184	0.7833	0.0215	5.3992	1.4941
83	0.8158	0.0162	0.7785	0.0218	5.3787	1.5303
82	0.7941	0.0171	0.7738	0.0221	5.3546	1.5653
81	0.8069	0.0185	0.7691	0.0224	5.3272	1.5993
80	0.7786	0.0244	0.7644	0.0227	5.2968	1.6322
79	0.7854	0.0192	0.7598	0.0230	5.2634	1.6639
78	0.7729	0.0213	0.7552	0.0233	5.2274	1.6944
77	0.7717	0.0179	0.7506	0.0237	5.1888	1.7238
76	0.7685	0.0269	0.7461	0.0240	5.1479	1.7520
75	0.7311	0.0205	0.7416	0.0243	5.1048	1.7791
74	0.7315	0.0251	0.7371	0.0246	5.0596	1.8049
73	0.7273	0.0238	0.7326	0.0250	5.0126	1.8296
72	0.7582	0.0242	0.7282	0.0253	4.9639	1.8532
71	0.7509	0.0271	0.7237	0.0257	4.9136	1.8755
70	0.7236	0.0234	0.7194	0.0260	4.8618	1.8967
69	0.6981	0.0347	0.7150	0.0264	4.8087	1.9168
68	0.6950	0.0439	0.7107	0.0267	4.7544	1.9357
67	0.6986	0.0320	0.7064	0.0271	4.6990	1.9534
66	0.7270	0.0290	0.7021	0.0275	4.6426	1.9701
65	0.6649	0.0404	0.6978	0.0279	4.5853	1.9856
64	0.6959	0.0375	0.6936	0.0282	4.5272	2.0000
63	0.6634	0.0373	0.6894	0.0286	4.4684	2.0133
62	0.6501	0.0454	0.6852	0.0290	4.4090	2.0255
61	0.6853	0.0317	0.6811	0.0294	4.3491	2.0367

Table 27: Parameters of the Conditional Transition Probability, Φ, year 5+

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
60	0.6421	0.0336	0.6769	0.0298	4.2888	2.0468
59	0.6626	0.0418	0.6728	0.0302	4.2280	2.0559
58	0.6786	0.0345	0.6688	0.0306	4.1670	2.0640
57	0.6525	0.0374	0.6647	0.0311	4.1057	2.0711
56	0.6792	0.0325	0.6607	0.0315	4.0442	2.0772
55	0.5990	0.0382	0.6567	0.0319	3.9827	2.0823
54	0.6278	0.0485	0.6527	0.0323	3.9211	2.0865
53	0.6035	0.0366	0.6487	0.0328	3.8595	2.0898
52	0.6726	0.0447	0.6448	0.0332	3.7979	2.0921
51	0.5802	0.0439	0.6409	0.0337	3.7364	2.0936
50	0.6774	0.0289	0.6370	0.0342	3.6751	2.0942
49	0.5373	0.0544	0.6331	0.0346	3.6140	2.0940
48	0.5542	0.0364	0.6293	0.0351	3.5531	2.0929
47	0.6306	0.0367	0.6255	0.0356	3.4925	2.0910
46	0.6663	0.0378	0.6217	0.0361	3.4322	2.0884
45	0.5617	0.0405	0.6179	0.0366	3.3722	2.0849
44	0.6419	0.0206	0.6142	0.0371	3.3126	2.0808
43	0.5143	0.0406	0.6105	0.0376	3.2533	2.0759
42	0.6267	0.0500	0.6068	0.0381	3.1945	2.0702
41	0.6136	0.0225	0.6031	0.0386	3.1362	2.0639
40	0.5886	0.0160	0.5994	0.0391	3.0783	2.0570
39	0.5360	0.0477	0.5958	0.0397	3.0209	2.0493
38	0.6225	0.0655	0.5922	0.0402	2.9640	2.0411
37	0.4645	0.0334	0.5886	0.0408	2.9076	2.0322
36	0.5482	0.0751	0.5850	0.0413	2.8518	2.0227
35	0.5947	0.0411	0.5815	0.0419	2.7966	2.0127
34	0.7642	0.0258	0.5780	0.0425	2.7419	2.0021
33	0.5546	0.0932	0.5745	0.0430	2.6878	1.9909
32	0.5610	0.0697	0.5710	0.0436	2.6343	1.9793
31	0.7220	0.0063	0.5675	0.0442	2.5815	1.9671
30	0.6075	0.0409	0.5641	0.0448	2.5292	1.9545
29	0.6640	0.0196	0.5607	0.0455	2.4776	1.9414
28	0.6529	0.0740	0.5573	0.0461	2.4266	1.9278
27	0.4942	0.0924	0.5539	0.0467	2.3763	1.9138
26	0.4400	0.0931	0.5505	0.0473	2.3266	1.8994
25	0.4263	0.1287	0.5472	0.0480	2.2776	1.8846
24	0.5875	0.0496	0.5439	0.0487	2.2292	1.8695
23	0.4714	0.0784	0.5406	0.0493	2.1815	1.8539
22	0.7457	0.0252	0.5373	0.0500	2.1345	1.8380
21	0.4825	0.0794	0.5341	0.0507	2.0881	1.8218

Table 27: Parameters of the Conditional Transition Probability, Φ, year 5+

Load Factor in Year n	Sample Moments		Fitted Moments		Implied Beta Distribution	
	Mean	Var	Mean	Var	Alpha	Beta
20	0.4271	0.1156	0.5308	0.0514	2.0424	1.8052
19	0.4486	0.0598	0.5276	0.0521	1.9973	1.7883
18	0.4525	0.1376	0.5244	0.0528	1.9530	1.7712
17	0.2575	0.0816	0.5212	0.0535	1.9093	1.7538
16	0.5775	0.1310	0.5181	0.0542	1.8662	1.7361
15	0.6750	0.0206	0.5149	0.0550	1.8239	1.7181
14	0.5640	0.1160	0.5118	0.0557	1.7822	1.6999
13	0.3338	0.1260	0.5087	0.0565	1.7411	1.6815
12	0.6175	0.1332	0.5056	0.0573	1.7008	1.6629
11	0.7200	0.0098	0.5026	0.0581	1.6610	1.6441
10	0.1500	0.0225	0.4995	0.0589	1.6220	1.6251
9	0.5700	0.0625	0.4965	0.0597	1.5835	1.6059
8	0.9500	0.0000	0.4935	0.0605	1.5458	1.5866
7	0.4700	0.1133	0.4905	0.0613	1.5086	1.5671
6	0.9100	0.0000	0.4875	0.0622	1.4721	1.5475
5	0.6800	0.0000	0.4846	0.0630	1.4362	1.5278
4	0.2680	0.0349	0.4816	0.0639	1.4010	1.5079
3	0.7200	0.0422	0.4787	0.0647	1.3663	1.4879
2	0.8267	0.0160	0.4758	0.0656	1.3323	1.4678
1	0.8500	0.0089	0.4729	0.0665	1.2989	1.4477
0	0.2081	0.0879	0.4701	0.0674	1.2661	1.4274
start-up	NA	NA			NA	NA

Table 28: Shutdown Probabilities, Θ, year 5+

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
100	0	0.357%	0.010%
99	0	0.368%	0.010%
98	0	0.380%	0.011%
97	0	0.392%	0.011%
96	0	0.404%	0.011%
95	0	0.417%	0.012%
94	0	0.430%	0.012%
93	0	0.444%	0.013%
92	0	0.458%	0.013%
91	0	0.472%	0.013%
90	0	0.487%	0.014%
89	0	0.502%	0.014%
88	0	0.518%	0.015%
87	0.503%	0.535%	0.015%
86	0	0.551%	0.016%
85	0.935%	0.569%	0.016%
84	0	0.587%	0.017%
83	0.472%	0.605%	0.017%
82	0	0.624%	0.018%
81	0	0.644%	0.018%
80	0	0.665%	0.019%
79	0	0.685%	0.019%
78	0	0.707%	0.020%
77	0	0.729%	0.021%
76	0.592%	0.752%	0.021%
75	0	0.776%	0.022%
74	0	0.801%	0.023%
73	0	0.826%	0.023%
72	0	0.852%	0.024%
71	0	0.879%	0.025%
70	0	0.907%	0.026%
69	0.901%	0.935%	0.027%
68	0	0.965%	0.027%
67	0.893%	0.995%	0.028%
66	0	1.027%	0.029%
65	0	1.059%	0.030%
64	0	1.092%	0.031%
63	0	1.127%	0.032%
62	0	1.162%	0.033%
61	0	1.199%	0.034%

Table 28: Shutdown Probabilities, Θ, year 5+

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
60	1.429%	1.237%	0.035%
59	1.351%	1.276%	0.036%
58	0	1.316%	0.037%
57	0	1.358%	0.038%
56	0	1.401%	0.040%
55	0	1.445%	0.041%
54	0	1.491%	0.042%
53	0	1.538%	0.044%
52	0	1.586%	0.045%
51	0	1.636%	0.046%
50	0	1.688%	0.048%
49	0	1.741%	0.049%
48	0	1.796%	0.051%
47	0	1.853%	0.053%
46	0	1.911%	0.054%
45	0	1.971%	0.056%
44	0	2.034%	0.058%
43	0	2.098%	0.059%
42	0	2.164%	0.061%
41	0	2.232%	0.063%
40	0	2.303%	0.065%
39	0	2.375%	0.067%
38	0	2.450%	0.069%
37	0	2.528%	0.072%
36	0	2.607%	0.074%
35	0	2.690%	0.076%
34	0	2.775%	0.079%
33	0	2.862%	0.081%
32	0	2.953%	0.084%
31	0	3.046%	0.086%
30	0	3.142%	0.089%
29	0	3.241%	0.092%
28	0	3.343%	0.095%
27	0	3.449%	0.098%
26	0	3.558%	0.101%
25	0	3.670%	0.104%
24	0	3.786%	0.107%
23	0	3.905%	0.111%
22	0	4.028%	0.114%
21	0	4.155%	0.118%

Table 28: Shutdown Probabilities, Θ, year 5+

Load Factor in Year n	Sample Frequency	Fitted Frequency	Scaled, Fitted Frequency
20	0	4.287%	0.122%
19	0	4.422%	0.125%
18	0	4.561%	0.129%
17	0	4.705%	0.133%
16	0	4.854%	0.138%
15	0	5.007%	0.142%
14	0	5.165%	0.146%
13	0	5.328%	0.151%
12	0	5.496%	0.156%
11	0	5.670%	0.161%
10	0	5.849%	0.166%
9	0	6.033%	0.171%
8	0	6.223%	0.176%
7	0	6.420%	0.182%
6	0	6.622%	0.188%
5	0	6.831%	0.194%
4	0	7.047%	0.200%
3	0	7.269%	0.206%
2	0	7.499%	0.213%
1	0	7.736%	0.219%
0	0	7.980%	0.226%
start-up	NA	NA	NA

Table 29: Distribution Moments for the Load Factor, Unconditional and Conditional on Continuing Operation, From P, Base Case adjusted by vintage

Year of Operation	Unconditional		Conditional on Operation	
	Mean	Var	Mean	Var
1	53.5	0.09501	53.5	0.09501
2	66.1	0.03751	66.3	0.03761
3	69.4	0.02602	69.8	0.02614
4	70.3	0.02355	70.8	0.02368
5	70.5	0.02292	71.1	0.02308
6	72.6	0.03026	73.2	0.03048
7	73.6	0.03112	74.3	0.03135
8	74.0	0.03097	74.7	0.03121
9	74.2	0.0308	75.0	0.03104
10	74.3	0.0307	75.0	0.03095
11	74.3	0.03064	75.1	0.0309
12	74.3	0.03062	75.1	0.03088
13	74.3	0.0306	75.1	0.03087
14	74.3	0.03059	75.1	0.03086
15	74.3	0.03059	75.1	0.03086
16	74.3	0.03058	75.1	0.03086
17	74.3	0.03058	75.1	0.03086
18	74.2	0.03057	75.1	0.03086
19	74.2	0.03057	75.1	0.03086
20	74.2	0.03056	75.1	0.03086
21	74.2	0.03056	75.1	0.03086
22	74.2	0.03055	75.1	0.03086
23	74.1	0.03055	75.1	0.03086
24	74.1	0.03055	75.1	0.03086
25	74.1	0.03054	75.1	0.03086
26	74.1	0.03054	75.1	0.03086
27	74.1	0.03053	75.1	0.03086
28	74.0	0.03053	75.1	0.03086
29	74.0	0.03053	75.1	0.03086
30	74.0	0.03052	75.1	0.03086
31	74.0	0.03052	75.1	0.03086
32	74.0	0.03051	75.1	0.03086
33	73.9	0.03051	75.1	0.03086
34	73.9	0.03051	75.1	0.03086
35	73.9	0.0305	75.1	0.03086
36	73.9	0.0305	75.1	0.03086
37	73.9	0.0305	75.1	0.03086
38	73.8	0.03049	75.1	0.03086
39	73.8	0.03049	75.1	0.03086

Table 29: Distribution Moments for the Load Factor, Unconditional and Conditional on Continuing Operation, From P, Base Case adjusted by vintage

Year of Operation	Unconditional		Conditional on Operation	
	Mean	Var	Mean	Var
40	73.8	0.03049	75.1	0.03086
41	73.8	0.03049	75.1	0.03086
42	73.8	0.03048	75.1	0.03086
43	73.8	0.03048	75.1	0.03086
44	73.7	0.03048	75.1	0.03086
45	73.7	0.03047	75.1	0.03086
46	73.7	0.03047	75.1	0.03086
47	73.7	0.03047	75.1	0.03086
48	73.7	0.03047	75.1	0.03086
49	73.6	0.03046	75.1	0.03086
50	73.6	0.03046	75.1	0.03086
51	73.6	0.03046	75.1	0.03086
52	73.6	0.03046	75.1	0.03086
53	73.6	0.03046	75.1	0.03086
54	73.5	0.03045	75.1	0.03086
55	73.5	0.03045	75.1	0.03086
56	73.5	0.03045	75.1	0.03086
57	73.5	0.03045	75.1	0.03086
58	73.5	0.03045	75.1	0.03086
59	73.4	0.03044	75.1	0.03086
60	73.4	0.03044	75.1	0.03086

Table 30: Parameters of the Conditional Transition Probability, Φ, US, post-2000

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
100	0.8840	0.0050	0.9390	0.0035	14.4556	0.9392
99	0.8600	0.0170	0.9366	0.0036	14.6127	0.9891
98	0.9022	0.0028	0.9342	0.0037	14.7478	1.0383
97	0.8879	0.0025	0.9319	0.0037	14.8618	1.0869
96	0.8748	0.0077	0.9295	0.0038	14.9560	1.1346
95	0.9068	0.0067	0.9271	0.0039	15.0314	1.1815
94	0.8909	0.0111	0.9248	0.0040	15.0890	1.2275
93	0.9158	0.0055	0.9224	0.0041	15.1298	1.2725
92	0.9175	0.0054	0.9201	0.0042	15.1547	1.3165
91	0.9367	0.0052	0.9177	0.0043	15.1647	1.3593
90	0.9121	0.0056	0.9154	0.0044	15.1605	1.4010
89	0.9164	0.0145	0.9131	0.0045	15.1430	1.4415
88	0.9376	0.0048	0.9108	0.0046	15.1130	1.4808
87	0.9420	0.0052	0.9084	0.0047	15.0712	1.5189
86	0.9404	0.0028	0.9061	0.0048	15.0183	1.5557
85	0.9064	0.0069	0.9038	0.0050	14.9551	1.5912
84	0.9196	0.0077	0.9015	0.0051	14.8821	1.6254
83	0.9306	0.0055	0.8992	0.0052	14.8001	1.6582
82	0.8845	0.0080	0.8970	0.0053	14.7095	1.6897
81	0.9283	0.0039	0.8947	0.0054	14.6110	1.7199
80	0.8927	0.0095	0.8924	0.0056	14.5050	1.7487
79	0.8500	0.0089	0.8901	0.0057	14.3923	1.7762
78	0.9431	0.0022	0.8879	0.0058	14.2731	1.8024
77	0.9263	0.0024	0.8856	0.0060	14.1480	1.8272
76	0.9100	0.0026	0.8834	0.0061	14.0174	1.8506
75	0.8683	0.0044	0.8811	0.0063	13.8818	1.8727
74	0.9217	0.0128	0.8789	0.0064	13.7416	1.8935
73	0.9850	0.0002	0.8767	0.0065	13.5971	1.9130
72	0.9400	0.0024	0.8744	0.0067	13.4487	1.9313
71	0.9280	0.0018	0.8722	0.0069	13.2968	1.9482
70	0.8800	0.0105	0.8700	0.0070	13.1417	1.9638
69	0.9400	0.0036	0.8678	0.0072	12.9838	1.9782
68	0.9500	0.0025	0.8656	0.0074	12.8233	1.9914
67	0.9100	0.0000	0.8634	0.0075	12.6604	2.0034
66	0.4200	0.0000	0.8612	0.0077	12.4956	2.0142
65	0.8300	0.0000	0.8590	0.0079	12.3290	2.0238
64	0.8900	0.0109	0.8568	0.0081	12.1609	2.0323
63	NA	NA	0.8546	0.0083	11.9915	2.0396
62	1.0000	0.0000	0.8525	0.0085	11.8211	2.0459
61	NA	NA	0.8503	0.0087	11.6498	2.0510

Table 30: Parameters of the Conditional Transition Probability, Φ, US, post-2000

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
60	1.0000	0.0000	0.8481	0.0089	11.4778	2.0551
59	NA	NA	0.8460	0.0091	11.3053	2.0582
58	NA	NA	0.8438	0.0093	11.1326	2.0603
57	NA	NA	0.8417	0.0095	10.9597	2.0614
56	NA	NA	0.8396	0.0097	10.7869	2.0615
55	NA	NA	0.8374	0.0100	10.6142	2.0607
54	NA	NA	0.8353	0.0102	10.4419	2.0590
53	NA	NA	0.8332	0.0104	10.2699	2.0564
52	NA	NA	0.8311	0.0107	10.0986	2.0530
51	0.8500	0.0000	0.8289	0.0109	9.9279	2.0487
50	NA	NA	0.8268	0.0112	9.7580	2.0436
49	NA	NA	0.8247	0.0114	9.5890	2.0378
48	NA	NA	0.8226	0.0117	9.4209	2.0312
47	NA	NA	0.8205	0.0120	9.2540	2.0238
46	NA	NA	0.8185	0.0123	9.0882	2.0158
45	NA	NA	0.8164	0.0126	8.9236	2.0071
44	NA	NA	0.8143	0.0129	8.7603	1.9977
43	NA	NA	0.8122	0.0132	8.5984	1.9876
42	0.7700	0.0000	0.8102	0.0135	8.4379	1.9770
41	NA	NA	0.8081	0.0138	8.2789	1.9658
40	NA	NA	0.8061	0.0141	8.1214	1.9540
39	NA	NA	0.8040	0.0144	7.9655	1.9416
38	NA	NA	0.8020	0.0148	7.8112	1.9288
37	NA	NA	0.7999	0.0151	7.6586	1.9154
36	0.9900	0.0000	0.7979	0.0155	7.5076	1.9016
35	NA	NA	0.7959	0.0159	7.3584	1.8873
34	NA	NA	0.7939	0.0162	7.2110	1.8725
33	NA	NA	0.7918	0.0166	7.0653	1.8574
32	NA	NA	0.7898	0.0170	6.9215	1.8418
31	NA	NA	0.7878	0.0174	6.7795	1.8259
30	NA	NA	0.7858	0.0178	6.6393	1.8096
29	NA	NA	0.7838	0.0182	6.5010	1.7930
28	NA	NA	0.7818	0.0187	6.3645	1.7761
27	NA	NA	0.7798	0.0191	6.2300	1.7588
26	NA	NA	0.7779	0.0196	6.0973	1.7413
25	NA	NA	0.7759	0.0200	5.9665	1.7235
24	NA	NA	0.7739	0.0205	5.8376	1.7054
23	NA	NA	0.7719	0.0210	5.7106	1.6871
22	NA	NA	0.7700	0.0215	5.5855	1.6686
21	NA	NA	0.7680	0.0220	5.4624	1.6498

Table 30: Parameters of the Conditional Transition Probability, Φ, US, post-2000

Load Factor in Year n	Sample Moments		Fitted Moments		Implied Beta Distribution	
	Mean	Var	Mean	Var	Alpha	Beta
20	NA	NA	0.7661	0.0225	5.3411	1.6309
19	NA	NA	0.7641	0.0230	5.2217	1.6118
18	NA	NA	0.7622	0.0236	5.1041	1.5926
17	NA	NA	0.7603	0.0241	4.9885	1.5731
16	NA	NA	0.7583	0.0247	4.8747	1.5536
15	NA	NA	0.7564	0.0253	4.7628	1.5339
14	NA	NA	0.7545	0.0258	4.6527	1.5142
13	NA	NA	0.7526	0.0265	4.5445	1.4943
12	0.4700	0.2209	0.7506	0.0271	4.4381	1.4743
11	NA	NA	0.7487	0.0277	4.3335	1.4543
10	NA	NA	0.7468	0.0284	4.2308	1.4342
9	NA	NA	0.7449	0.0290	4.1297	1.4140
8	NA	NA	0.7430	0.0297	4.0305	1.3938
7	NA	NA	0.7412	0.0304	3.9330	1.3736
6	NA	NA	0.7393	0.0311	3.8373	1.3534
5	NA	NA	0.7374	0.0319	3.7433	1.3331
4	NA	NA	0.7355	0.0326	3.6509	1.3128
3	NA	NA	0.7336	0.0334	3.5603	1.2926
2	NA	NA	0.7318	0.0342	3.4713	1.2723
1	0.8900	0.0000	0.7299	0.0350	3.3840	1.2521
0	0.7400	0.0000	0.7281	0.0358	3.2983	1.2319
start-up	NA	NA			NA	NA

Table 31: Distribution Moments for the Load Factor, Unconditional and Conditional on Continuing Operation, From P, US, post-2000

Year of Operation	Unconditional Mean	Unconditional Var	Conditional on Operation Mean	Conditional on Operation Var
1			53.8	0.097
2			84.3	0.018
3			90.8	0.006
4			92.2	0.005
5			92.6	0.004
6			92.6	0.004
7			92.7	0.004
8			92.7	0.004
9			92.7	0.004
10			92.7	0.004
11			92.7	0.004
12			92.7	0.004
13			92.7	0.004
14			92.7	0.004
15			92.7	0.004
16			92.7	0.004
17			92.7	0.004
18			92.7	0.004
19			92.7	0.004
20			92.7	0.004
21			92.7	0.004
22			92.7	0.004
23			92.7	0.004
24			92.7	0.004
25			92.7	0.004
26			92.7	0.004
27			92.7	0.004
28			92.7	0.004
29			92.7	0.004
30			92.7	0.004
31			92.7	0.004
32			92.7	0.004
33			92.7	0.004
34			92.7	0.004
35			92.7	0.004
36			92.7	0.004
37			92.7	0.004
38			92.7	0.004
39			92.7	0.004

Table 31: Distribution Moments for the Load Factor, Unconditional and Conditional on Continuing Operation, From P, US, post-2000

Year of Operation	Unconditional Mean	Unconditional Var	Conditional on Operation Mean	Conditional on Operation Var
40			92.7	0.004
41			92.7	0.004
42			92.7	0.004
43			92.7	0.004
44			92.7	0.004
45			92.7	0.004
46			92.7	0.004
47			92.7	0.004
48			92.7	0.004
49			92.7	0.004
50			92.7	0.004
51			92.7	0.004
52			92.7	0.004
53			92.7	0.004
54			92.7	0.004
55			92.7	0.004
56			92.7	0.004
57			92.7	0.004
58			92.7	0.004
59			92.7	0.004
60			92.7	0.004

Notes:

Unconditional values not calculated due to lack of any permanent shutdowns during the relevant period.

Distribution in Year 1 are based on start-up parameters for the OECD as a whole, i.e. from Table 13.

Table 32: Parameters of the Conditional Transition Probability, Φ, Japan, post-2000

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
100	0.6950	0.0404	0.7111	0.0242	5.3366	2.1678
99	0.7340	0.0377	0.7097	0.0243	5.3154	2.1740
98	0.5689	0.0579	0.7083	0.0244	5.2940	2.1802
97	0.8700	0.0000	0.7069	0.0245	5.2725	2.1862
96	0.6188	0.0836	0.7055	0.0246	5.2509	2.1921
95	0.6667	0.0223	0.7041	0.0247	5.2291	2.1978
94	0.6900	0.0438	0.7027	0.0248	5.2073	2.2034
93	0.7500	0.0047	0.7013	0.0250	5.1854	2.2089
92	0.8420	0.0068	0.6999	0.0251	5.1634	2.2142
91	0.8388	0.0059	0.6985	0.0252	5.1413	2.2194
90	0.7750	0.0011	0.6971	0.0253	5.1191	2.2244
89	0.7240	0.0656	0.6957	0.0254	5.0968	2.2294
88	0.8582	0.0090	0.6943	0.0255	5.0745	2.2342
87	0.7393	0.0512	0.6929	0.0257	5.0521	2.2388
86	0.8575	0.0058	0.6915	0.0258	5.0296	2.2433
85	0.8125	0.0135	0.6902	0.0259	5.0070	2.2477
84	0.8179	0.0216	0.6888	0.0260	4.9844	2.2520
83	0.8110	0.0402	0.6874	0.0261	4.9617	2.2561
82	0.8044	0.0072	0.6861	0.0263	4.9389	2.2601
81	0.6855	0.0873	0.6847	0.0264	4.9161	2.2640
80	0.8458	0.0126	0.6833	0.0265	4.8933	2.2677
79	0.7750	0.0264	0.6820	0.0266	4.8704	2.2714
78	0.8089	0.0287	0.6806	0.0268	4.8474	2.2749
77	0.8100	0.0269	0.6792	0.0269	4.8244	2.2782
76	0.6638	0.0726	0.6779	0.0270	4.8014	2.2815
75	0.7100	0.0330	0.6765	0.0271	4.7783	2.2846
74	0.7743	0.0327	0.6752	0.0273	4.7552	2.2876
73	0.7142	0.0704	0.6738	0.0274	4.7321	2.2904
72	0.5486	0.0654	0.6725	0.0275	4.7089	2.2932
71	0.8343	0.0119	0.6712	0.0277	4.6857	2.2958
70	0.6067	0.0874	0.6698	0.0278	4.6625	2.2983
69	0.7267	0.0505	0.6685	0.0279	4.6393	2.3007
68	0.5700	0.1243	0.6672	0.0280	4.6160	2.3029
67	0.5700	0.0523	0.6658	0.0282	4.5928	2.3051
66	0.8120	0.0183	0.6645	0.0283	4.5695	2.3071
65	0.4580	0.0899	0.6632	0.0284	4.5462	2.3090
64	0.6680	0.1289	0.6619	0.0286	4.5229	2.3108
63	0.5567	0.1690	0.6605	0.0287	4.4996	2.3125
62	0.2683	0.0651	0.6592	0.0288	4.4763	2.3140
61	0.6667	0.0006	0.6579	0.0290	4.4530	2.3155

Table 32: Parameters of the Conditional Transition Probability, Φ, Japan, post-2000

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
60	0.7600	0.0000	0.6566	0.0291	4.4297	2.3168
59	0.6640	0.1178	0.6553	0.0292	4.4064	2.3180
58	NA	NA	0.6540	0.0294	4.3832	2.3191
57	0.6100	0.0000	0.6527	0.0295	4.3599	2.3201
56	0.8050	0.0056	0.6514	0.0297	4.3366	2.3210
55	0.2050	0.0420	0.6501	0.0298	4.3133	2.3218
54	0.3325	0.1226	0.6488	0.0299	4.2901	2.3224
53	0.3700	0.0000	0.6475	0.0301	4.2669	2.3230
52	NA	NA	0.6462	0.0302	4.2437	2.3235
51	0.6600	0.0324	0.6449	0.0304	4.2205	2.3238
50	0.9300	0.0000	0.6436	0.0305	4.1973	2.3240
49	0.2275	0.0705	0.6423	0.0306	4.1741	2.3242
48	0.8800	0.0000	0.6411	0.0308	4.1510	2.3242
47	0.8800	0.0000	0.6398	0.0309	4.1279	2.3241
46	1.0000	0.0000	0.6385	0.0311	4.1049	2.3240
45	NA	NA	0.6372	0.0312	4.0818	2.3237
44	0.6000	0.0000	0.6360	0.0314	4.0588	2.3233
43	0.0000	0.0000	0.6347	0.0315	4.0358	2.3228
42	0.7567	0.0038	0.6334	0.0317	4.0129	2.3222
41	0.3450	0.1190	0.6322	0.0318	3.9900	2.3216
40	0.5650	0.0600	0.6309	0.0320	3.9671	2.3208
39	NA	NA	0.6297	0.0321	3.9443	2.3199
38	0.7500	0.0000	0.6284	0.0323	3.9215	2.3190
37	0.5900	0.0000	0.6271	0.0324	3.8988	2.3179
36	NA	NA	0.6259	0.0326	3.8761	2.3168
35	0.6325	0.0177	0.6247	0.0327	3.8534	2.3155
34	0.7550	0.0012	0.6234	0.0329	3.8308	2.3142
33	0.4933	0.1250	0.6222	0.0330	3.8083	2.3127
32	0.4600	0.2116	0.6209	0.0332	3.7858	2.3112
31	NA	NA	0.6197	0.0333	3.7633	2.3096
30	0.6933	0.0120	0.6185	0.0335	3.7409	2.3079
29	0.6500	0.0000	0.6172	0.0336	3.7185	2.3061
28	NA	NA	0.6160	0.0338	3.6962	2.3042
27	NA	NA	0.6148	0.0339	3.6740	2.3023
26	0.3500	0.0000	0.6135	0.0341	3.6518	2.3002
25	NA	NA	0.6123	0.0343	3.6296	2.2981
24	0.7100	0.0289	0.6111	0.0344	3.6075	2.2959
23	NA	NA	0.6099	0.0346	3.5855	2.2936
22	0.8400	0.0144	0.6087	0.0347	3.5635	2.2912
21	NA	NA	0.6074	0.0349	3.5416	2.2887

Table 32: Parameters of the Conditional Transition Probability, Φ, Japan, post-2000

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
20	0.0000	0.0000	0.6062	0.0351	3.5198	2.2862
19	0.0000	0.0000	0.6050	0.0352	3.4980	2.2835
18	NA	NA	0.6038	0.0354	3.4763	2.2808
17	NA	NA	0.6026	0.0356	3.4546	2.2780
16	0.8250	0.0306	0.6014	0.0357	3.4330	2.2752
15	0.6750	0.0110	0.6002	0.0359	3.4115	2.2722
14	NA	NA	0.5990	0.0361	3.3900	2.2692
13	0.0000	0.0000	0.5978	0.0362	3.3686	2.2661
12	0.8100	0.0000	0.5966	0.0364	3.3473	2.2630
11	0.8500	0.0000	0.5954	0.0366	3.3260	2.2597
10	NA	NA	0.5943	0.0367	3.3048	2.2564
9	NA	NA	0.5931	0.0369	3.2837	2.2530
8	NA	NA	0.5919	0.0371	3.2627	2.2496
7	NA	NA	0.5907	0.0373	3.2417	2.2460
6	NA	NA	0.5895	0.0374	3.2208	2.2424
5	NA	NA	0.5884	0.0376	3.1999	2.2388
4	NA	NA	0.5872	0.0378	3.1792	2.2350
3	0.9200	0.0000	0.5860	0.0380	3.1585	2.2312
2	0.9800	0.0000	0.5849	0.0381	3.1379	2.2273
1	0.7200	0.0000	0.5837	0.0383	3.1173	2.2234
0	0.2596	0.0955	0.5825	0.0385	3.0969	2.2194
start-up	0.53814	0.09681			0.83694	0.73282

Table 33: Distribution Moments for the Load Factor, Unconditional and Conditional on Continuing Operation, From P, Japan, post-2000

Year of Operation	Unconditional Mean	Unconditional Var	Conditional on Operation Mean	Conditional on Operation Var
1			53.8	0.097
2			65.5	0.032
3			66.9	0.029
4			67.1	0.029
5			67.1	0.029
6			67.1	0.029
7			67.1	0.029
8			67.1	0.029
9			67.1	0.029
10			67.1	0.029
11			67.0	0.029
12			67.0	0.029
13			67.0	0.029
14			67.0	0.029
15			67.0	0.029
16			67.0	0.029
17			67.0	0.029
18			67.0	0.029
19			67.0	0.029
20			67.0	0.029
21			67.0	0.029
22			67.0	0.029
23			67.0	0.029
24			67.0	0.029
25			67.0	0.029
26			66.9	0.029
27			66.9	0.029
28			66.9	0.029
29			66.9	0.029
30			66.9	0.029
31			66.9	0.029
32			66.9	0.029
33			66.9	0.029
34			66.9	0.029
35			66.9	0.029
36			66.9	0.029
37			66.9	0.029
38			66.9	0.029
39			66.9	0.029

Table 33: Distribution Moments for the Load Factor, Unconditional and Conditional on Continuing Operation, From P, Japan, post-2000

Year of Operation	Unconditional Mean	Unconditional Var	Conditional on Operation Mean	Conditional on Operation Var
40			66.8	0.029
41			66.8	0.029
42			66.8	0.029
43			66.8	0.029
44			66.8	0.029
45			66.8	0.029
46			66.8	0.029
47			66.8	0.029
48			66.8	0.029
49			66.8	0.029
50			66.8	0.029
51			66.8	0.029
52			66.8	0.029
53			66.8	0.029
54			66.8	0.029
55			66.7	0.029
56			66.7	0.029
57			66.7	0.029
58			66.7	0.029
59			66.7	0.029
60			66.7	0.029

Notes:

Unconditional values not calculated due to lack of any permanent shutdowns during the relevant period.

Distribution in Year 1 are based on start-up parameters for the OECD as a whole, i.e. from Table 13.

Table 34: Parameters of the Conditional Transition Probability, Φ, France, post-2000

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
100	NA	NA	0.7322	0.0086	15.9103	5.8197
99	NA	NA	0.7329	0.0084	16.3289	5.9517
98	0.7700	0.0009	0.7336	0.0082	16.7579	6.0864
97	NA	NA	0.7343	0.0080	17.1975	6.2239
96	NA	NA	0.7350	0.0078	17.6480	6.3642
95	NA	NA	0.7357	0.0076	18.1097	6.5073
94	0.7650	0.0006	0.7364	0.0074	18.5829	6.6534
93	0.7800	0.0121	0.7371	0.0072	19.0678	6.8025
92	NA	NA	0.7378	0.0070	19.5647	6.9546
91	0.7550	0.0012	0.7385	0.0069	20.0738	7.1099
90	0.6000	0.0306	0.7392	0.0067	20.5956	7.2683
89	0.6811	0.0079	0.7399	0.0065	21.1303	7.4299
88	0.6467	0.0198	0.7406	0.0063	21.6782	7.5948
87	0.7540	0.0069	0.7413	0.0062	22.2397	7.7630
86	0.7481	0.0067	0.7420	0.0060	22.8150	7.9347
85	0.7446	0.0045	0.7427	0.0059	23.4045	8.1099
84	0.7433	0.0066	0.7434	0.0057	24.0085	8.2885
83	0.7588	0.0070	0.7441	0.0056	24.6274	8.4708
82	0.7565	0.0121	0.7448	0.0054	25.2616	8.6568
81	0.7670	0.0074	0.7455	0.0053	25.9114	8.8465
80	0.7713	0.0079	0.7462	0.0052	26.5771	9.0401
79	0.7781	0.0075	0.7469	0.0050	27.2593	9.2375
78	0.7226	0.0197	0.7476	0.0049	27.9582	9.4389
77	0.7695	0.0051	0.7483	0.0048	28.6742	9.6443
76	0.7672	0.0041	0.7490	0.0047	29.4079	9.8539
75	0.7668	0.0076	0.7497	0.0046	30.1595	10.0676
74	0.7509	0.0065	0.7504	0.0044	30.9296	10.2856
73	0.7810	0.0029	0.7512	0.0043	31.7185	10.5079
72	0.7794	0.0056	0.7519	0.0042	32.5268	10.7346
71	0.7213	0.0125	0.7526	0.0041	33.3548	10.9659
70	0.7900	0.0092	0.7533	0.0040	34.2031	11.2018
69	0.6683	0.0388	0.7540	0.0039	35.0722	11.4423
68	0.7523	0.0077	0.7547	0.0038	35.9624	11.6875
67	0.7713	0.0085	0.7554	0.0037	36.8744	11.9377
66	0.7617	0.0060	0.7562	0.0036	37.8086	12.1927
65	0.8000	0.0012	0.7569	0.0035	38.7657	12.4528
64	0.8113	0.0043	0.7576	0.0034	39.7460	12.7180
63	0.7875	0.0050	0.7583	0.0033	40.7502	12.9884
62	0.6567	0.0008	0.7590	0.0033	41.7788	13.2640
61	0.7791	0.0039	0.7597	0.0032	42.8325	13.5451

Table 34: Parameters of the Conditional Transition Probability, Φ, France, post-2000

Load Factor in Year n	Sample Moments		Fitted Moments		Implied Beta Distribution	
	Mean	Var	Mean	Var	Alpha	Beta
60	0.7450	0.0072	0.7605	0.0031	43.9118	13.8317
59	0.8900	0.0000	0.7612	0.0030	45.0172	14.1238
58	0.8050	0.0000	0.7619	0.0029	46.1495	14.4217
57	0.7780	0.0040	0.7626	0.0029	47.3093	14.7253
56	0.7650	0.0000	0.7634	0.0028	48.4972	15.0348
55	0.7800	0.0003	0.7641	0.0027	49.7138	15.3503
54	0.5850	0.0132	0.7648	0.0027	50.9599	15.6719
53	0.8300	0.0000	0.7655	0.0026	52.2361	15.9997
52	0.8000	0.0000	0.7662	0.0025	53.5432	16.3338
51	NA	NA	0.7670	0.0025	54.8819	16.6743
50	NA	NA	0.7677	0.0024	56.2528	17.0214
49	NA	NA	0.7684	0.0023	57.6568	17.3751
48	0.7800	0.0064	0.7692	0.0023	59.0947	17.7356
47	NA	NA	0.7699	0.0022	60.5671	18.1029
46	0.7400	0.0169	0.7706	0.0022	62.0751	18.4772
45	NA	NA	0.7713	0.0021	63.6192	18.8587
44	NA	NA	0.7721	0.0021	65.2005	19.2474
43	NA	NA	0.7728	0.0020	66.8197	19.6434
42	NA	NA	0.7735	0.0020	68.4778	20.0469
41	NA	NA	0.7743	0.0019	70.1756	20.4581
40	0.7100	0.0000	0.7750	0.0019	71.9141	20.8769
39	NA	NA	0.7757	0.0018	73.6943	21.3036
38	0.9000	0.0000	0.7765	0.0018	75.5169	21.7383
37	NA	NA	0.7772	0.0017	77.3832	22.1812
36	0.8300	0.0000	0.7780	0.0017	79.2940	22.6323
35	0.6100	0.0000	0.7787	0.0016	81.2504	23.0917
34	NA	NA	0.7794	0.0016	83.2534	23.5598
33	0.8600	0.0000	0.7802	0.0016	85.3041	24.0364
32	NA	NA	0.7809	0.0015	87.4036	24.5219
31	NA	NA	0.7816	0.0015	89.5531	25.0164
30	NA	NA	0.7824	0.0014	91.7536	25.5199
29	NA	NA	0.7831	0.0014	94.0064	26.0327
28	NA	NA	0.7839	0.0014	96.3125	26.5549
27	0.8200	0.0000	0.7846	0.0013	98.6734	27.0866
26	NA	NA	0.7854	0.0013	101.0901	27.6279
25	NA	NA	0.7861	0.0013	103.5640	28.1792
24	NA	NA	0.7869	0.0012	106.0963	28.7404
23	NA	NA	0.7876	0.0012	108.6884	29.3117
22	NA	NA	0.7883	0.0012	111.3417	29.8934
21	NA	NA	0.7891	0.0011	114.0575	30.4855

Table 34: Parameters of the Conditional Transition Probability, Φ, France, post-2000

Load Factor in Year n	Sample Moments Mean	Sample Moments Var	Fitted Moments Mean	Fitted Moments Var	Implied Beta Distribution Alpha	Implied Beta Distribution Beta
20	NA	NA	0.7898	0.0011	116.8372	31.0883
19	NA	NA	0.7906	0.0011	119.6823	31.7018
18	NA	NA	0.7913	0.0011	122.5943	32.3263
17	NA	NA	0.7921	0.0010	125.5746	32.9619
16	NA	NA	0.7928	0.0010	128.6248	33.6087
15	0.7500	0.0000	0.7936	0.0010	131.7465	34.2670
14	NA	NA	0.7943	0.0010	134.9413	34.9369
13	NA	NA	0.7951	0.0009	138.2107	35.6186
12	NA	NA	0.7958	0.0009	141.5565	36.3123
11	NA	NA	0.7966	0.0009	144.9804	37.0180
10	NA	NA	0.7974	0.0009	148.4841	37.7361
9	NA	NA	0.7981	0.0008	152.0694	38.4667
8	NA	NA	0.7989	0.0008	155.7380	39.2099
7	NA	NA	0.7996	0.0008	159.4919	39.9659
6	NA	NA	0.8004	0.0008	163.3329	40.7349
5	NA	NA	0.8011	0.0008	167.2630	41.5172
4	NA	NA	0.8019	0.0007	171.2841	42.3128
3	NA	NA	0.8027	0.0007	175.3981	43.1220
2	NA	NA	0.8034	0.0007	179.6073	43.9449
1	NA	NA	0.8042	0.0007	183.9135	44.7817
0	NA	NA	0.8049	0.0007	188.3191	45.6326
start-up	0.53814	0.09681			0.836935	0.73282

Table 35: Distribution Moments for the Load Factor, Unconditional and Conditional on Continuing Operation, From P, France, post-2000

Year of Operation	Unconditional Mean	Unconditional Var	Conditional on Operation Mean	Conditional on Operation Var
1			53.8	0.097
2			77.0	0.004
3			75.3	0.005
4			75.4	0.005
5			75.4	0.005
6			75.4	0.005
7			75.4	0.005
8			75.4	0.005
9			75.4	0.005
10			75.4	0.005
11			75.4	0.005
12			75.4	0.005
13			75.4	0.005
14			75.4	0.005
15			75.4	0.005
16			75.4	0.005
17			75.4	0.005
18			75.4	0.005
19			75.4	0.005
20			75.4	0.005
21			75.3	0.005
22			75.3	0.005
23			75.3	0.005
24			75.3	0.005
25			75.3	0.005
26			75.3	0.005
27			75.3	0.005
28			75.3	0.005
29			75.3	0.005
30			75.3	0.005
31			75.3	0.005
32			75.3	0.005
33			75.3	0.005
34			75.3	0.005
35			75.3	0.005
36			75.3	0.005
37			75.3	0.005
38			75.3	0.005
39			75.3	0.005

Table 35: Distribution Moments for the Load Factor, Unconditional and Conditional on Continuing Operation, From P, France, post-2000

Year of Operation	Unconditional Mean	Unconditional Var	Conditional on Operation Mean	Conditional on Operation Var
40			75.3	0.005
41			75.3	0.005
42			75.3	0.005
43			75.3	0.005
44			75.3	0.005
45			75.3	0.005
46			75.3	0.005
47			75.3	0.005
48			75.3	0.005
49			75.3	0.005
50			75.3	0.005
51			75.2	0.005
52			75.2	0.005
53			75.2	0.005
54			75.2	0.005
55			75.2	0.005
56			75.2	0.005
57			75.2	0.005
58			75.2	0.005
59			75.2	0.005
60			75.2	0.005

Notes:

Unconditional values not calculated due to lack of any permanent shutdowns during the relevant period.

Distribution in Year 1 are based on start-up parameters for the OECD as a whole, i.e. from Table 13.