2018 Prison Population Projection

Methods and Technical Description

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Introduction

George Box once said that "Essentially, all models are wrong but some are useful."[1] This prison population projection model is a model that answers the question, "What if we make a sentencing policy change?" With consistent calculations, the projection estimates future impacts of proposed policy changes, including the cumulative impact of multiple changes. It is not meant to be, nor could it ever be, a crystal ball that predicts the future with 100% accuracy. Instead, it is a carefully vetted model that produces reliable projections of how the prison population will change over time and in response to new policies which hopefully will prove useful.[2]

This report describes the methodology used to produce the 2018 prison population projection. It provides a detailed description of the assumptions, definitions, and calculations used, as well as technical details on data sources. The underlying logic of the model is that the size of the prison population in the Illinois Department of Corrections (IDOC) is determined by (a) prison admissions, (b) sentences imposed, and (c) the length of time a person spends in prison. Policy changes can affect one or all of these factors. The model applies a set of assumptions that remain constant to create an estimate of the future prison population. This model's methods project subgroups, such as drug possession offenders or elderly offenders, as needed by SPAC and policymakers.

The fundamental challenge in projecting future impacts of policy proposals is that data on prison admissions and exits do not exist for future years. SPAC simulates the future admissions and exits using the assumption that the recent past, defined as the previous year, approximates future admissions, sentences imposed, and lengths of stay, allowing all the results to be seen in the context of recent experience. This approach creates a baseline and then allows SPAC to modify the inputs of admissions and length of stay to model different population impacts. The model uses IDOC data from the current prison population file and recent admissions. New for 2018's projection, the model uses the most recent year of IDOC admission data rather than data from the three previous years in order to avoid unusual and unexplained spikes in the projected population. SPAC tested the model against historical data and found that this approach produced an accurate calculation. While the past is a good predictor of the future, unknown events or shifts can dramatically change the main inputs of length of stay and admissions, thus the fundamental challenge will always remain.

The following example demonstrates the utility of the projection model: If a policy is enacted to reduce the length of stay for non-violent Class 4 offenders by 60 days, SPAC could simply remove 60 days from the length of stay for all future admissions for Class 4 non-violent offenses. Additional details could be incorporated, such as (1) adjusting the probability of getting the 60 day reduction, *i.e.*, only 50% of those eligible receive the 60 day credit in the future; (2) setting floor restrictions, such as applying the 60 days only if the person's expected length of stay is greater than 60 days; and/or (3) other conditions or limits as needed. The policy-specific inputs result in a projected population that can be compared to the

[1] George Box was the founder of the Department of Statistics and co-founder of the Center for Quality and Productivity Improvement at the University of Wisconsin-Madison. Box made profound contributions in experimental design, time series and quality improvement.

[2] The Illinois Sentencing Policy Advisory Council (SPAC) is statutorily mandated to produce annual prison population projections to inform policymakers and the public of how the population is changing. 730 ILCS 5/5-8-8(d)(2).

baseline projection, allowing for detailed analysis of the timing of the changes, the demographic impacts, and other population characteristics of interest.

This model is the product of collaboration with a number of talented people. SPAC would like to thank them for their significant contributions to developing and rigorously vetting the model: Robert Minton, University of Chicago economics major who began work on this model as a student intern with SPAC; Lindsay Bostwick, a Ph.D. candidate at Carnegie Mellon University, whose insight informed the process of designing and testing the SPAC projection model; Dr. Sharon Shipinski, Research Director for the Illinois Department of Corrections, an invaluable resource who consistently offers practical reality checks; Christine Devitt-Wesley and Ernst Melchior from the Illinois Criminal Justice Information Authority, whose contributions to criminal justice research in this state is longstanding and outstanding. Additional thanks go to those individuals who vetted the model, tested its calculations, and offered valuable feedback from "fresh eyes:" Peter Brown (Indiana University), Forest Gregg (DataMade), Dr. Megan Alderden (Illinois Criminal Justice Information Authority), Dr. Richard Gorvett (University of Illinois-Champaign/Urbana), Dr. David Olson (Loyola University-Chicago), and Dr. Bruce Spencer (Northwestern University).

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Model Projection and Results

Current Model

The SPAC projection model assumes that the number of admissions in future years will be equal to the number of admissions in the past fiscal year and reflect the same sentence lengths, type of offenses, felony classes, and demographics. Admissions include both new court admissions, which are driven by crime, policing practices, and the court system, and technical violators, which are driven by the practices of IDOC, parole, and the Prisoner Review Board, as well as crime and other factors related to all admissions.

The use of a single year of admissions is new for 2018. SPAC uses the one-year assumption to improve the accuracy of the short-term projection and reduce the likelihood of overestimating admissions. In past projections, SPAC used an average of the past three years of admissions. The continual trend of declining admissions led the past approach to overestimate the admissions in the near future. SPAC simulations tested this improvement and the results now avoid any dramatic, unexplained increase in admissions and, therefore, any unexplainable spikes in the population projection. The risk, however, is that the recent year may be an anomaly. If the downward trend reverses, returning to the three year average may be appropriate. However, using one year of admissions produces a better short-term estimate that is both reasonable and understandable to policymakers and system stakeholders.

Admissions

This projection includes two types of admissions into IDOC new court and technical violator admissions. New court admissions are new prison sentences resulting from a new felony conviction. Technical violators are individuals who are returned to prison after they violate a condition of their mandatory supervised release (MSR) and had their parole revoked but do not have a new conviction.

Length of Stay

Length of stay is different for new court and technical violator admissions. This section describes the length of stay calculations, as well as how the model determines a length of stay for natural life sentences and those sentences that exceed normal life expectancies. The future admissions are assumed to have the same sentences as those imposed over the past year, in other words, both the number of admissions (previous section) and types of sentences (imposed by court) are expected to be the same. This approach also assumes that the sentences imposed, jail time, truth-in-sentencing, and adjustment terms will apply as in the past. These data sentencing patterns will be adjusted as sentencing changes over time.

Individuals who receive a prison sentence as a result of a new felony offense rarely spend their entire sentence in prison due to sentence credits for good behavior, programming participation, and additional discretionary credit awards. To account for these rules, the model starts with an estimated preliminary length of stay for individuals in IDOC based upon the most common sentence credits, including credits for time served in pre-trial detention and good-time behavior. The model calculates a preliminary length of stay[3] by multiplying the general good-time behavior credits available[4] by the sentence length for each sentence and subtracting the time credited for a jail stay prior to sentencing.[5]

The model adjusts the preliminary length of stay estimate to account for discretionary credit awards and other unforeseen events that can increase or decrease lengths of stay. SPAC calculated the

[3] This preliminary length of stay number is an early part of the calculation in the projection method and not preliminarily served in prison.

[4] These good-time behavior credits are usually one day of credits per day of incarceration, or day-for-day good-time, thus the sentence is multiplied by 0.50. Truth-in-sentencing restrictions may require the multiplier to be 0.75, 0.85, or 1.0 for some offense types.

[5] When an individual has multiple consecutive sentences, this step is repeated for each consecutive sentence.

preliminary length of stay for past admissions where the individual had already exited, which allowed for a calculation of the difference between the preliminary and true lengths of stay. This difference encompasses anything excluded in the formula for the preliminary length of stay that would add or remove days to the actual length of stay—for example, the inmate may lose good-time credits; may take additional programming credits; or may have his or her conviction reversed and be immediately released. The model aggregates the differences by felony classes, violent or non-violent offenses, and sentence types (concurrent or consecutive) and adds them to future admissions' preliminary length of stay.[6] This calculation thus represents the past years' sentencing patterns, sentence credit laws and policies, and other factors that have increased or decreased time served in state prisons.[7]

After release from prison, inmates enter mandatory supervised release (MSR), formerly known as parole. Illinois requires one year of MSR for Class 3 and 4 offenders, two years for Class 1 and 2 offenders, and three years for murderers and Class X offenders. There are some additional, extended MSR terms for certain offenses. The supervised population is not currently estimated by the model, however, individuals that are returned to prison for violating conditions of MSR are counted in the model.[8] Technical violators may stay in prison for up to the remainder of the MSR term in prison, pursuant to a Prison Review Board (PRB) decision and adjusted by IDOC's credit determinations. The lengths of stay are thus partially due to the offense class, partially due to current policies, and partially related to PRB and IDOC discretion. For example, prior research indicates that in periods with more technical violation admissions, the length of stay for those admissions decreased. In this model, the length of stay for a technical violator is determined by using previous years' admissions and exits files as a reference. The model uses averages of past lengths of stay to estimate future lengths of stay for these cases, based on the original admissions' offense classes and types.

The projection accounts for natural life sentences, long sentences, and admissions of elderly individuals by using data from the U.S. Centers for Disease Control and Prevention's Division of Vital Statistics. For these unique admissions, the model creates an exit date based on the life expectancy, adjusted by research on access to healthcare within prisons. Mortality data are by age, race/ethnicity, and sex.[9] Recent national research indicates that mortality rates within prison are different from the general population, varying in the direction and magnitude of difference by race and sex.[10] SPAC uses this research to adjust the mortality rates and life expectancy. SPAC analysis shows that the simulation without such adjustment indicates a fairly large (30-50%) increase in the number of deaths in prison compared to the actual number of deaths; in other words, life expectancy is longer in prison. The model thus uses the CDC mortality rates but adjusts to match national research and Illinois data.

Results: Future Status Quo Projection

SPAC projected the prison population for FY2018-2035 using the past year's (FY2017's) average prison admissions, sentences, and policies. The model projects the prison population to decrease to around 42,000 and then to stay relatively flat with a slight annual increase occurring in the future. This result is the status quo projection when used in comparison to proposed legislation or policy changes.

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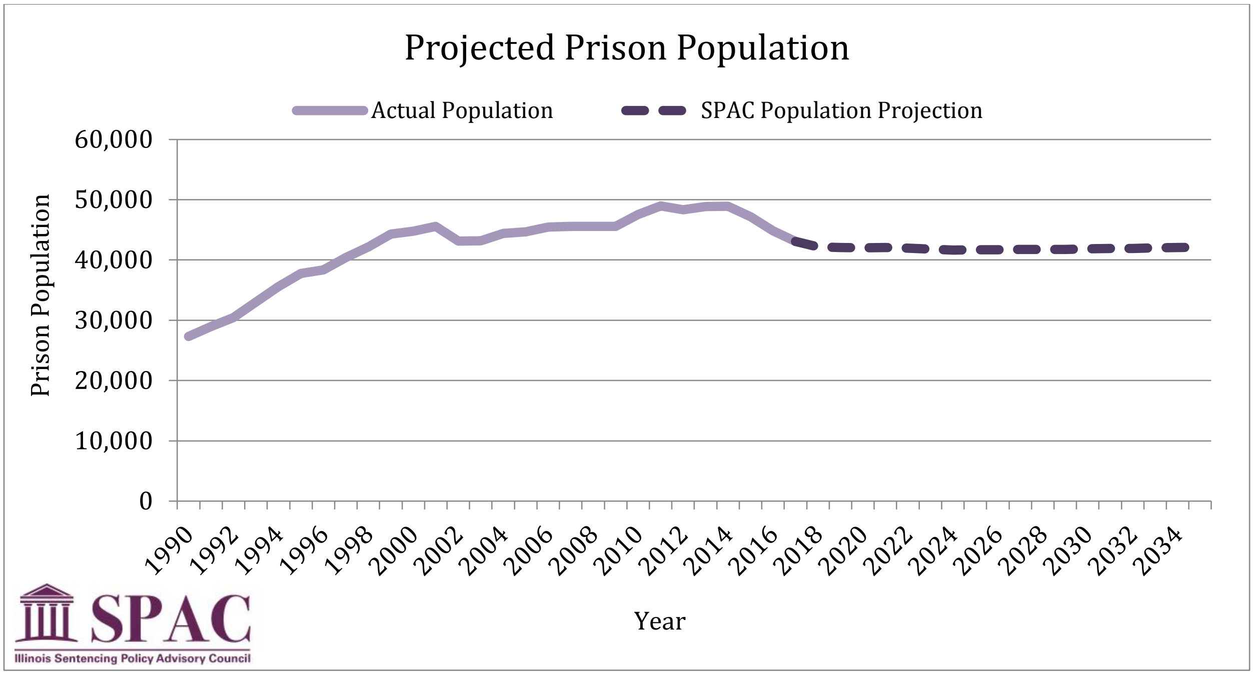
[6] For example, an admission for a 1 year sentence on a Class 4, non-violent, concurrent offense with a preliminary length of stay estimate of 6 months is adjusted by adding or subtracting the average difference between the estimated and actual lengths of stay for those types of admissions.

[7] The technical calculations sections have more detailed and technical descriptions of these calculations, starting on page 9.

[8] If the person is rearrested, reconvicted, and the new conviction returns the individual to prison, that case is counted as a new admission to prison. In contrast, if the person does not receive a new conviction but is returned to prison for violating the terms of their release, that case is counted as a technical violation admission and is discussed in this section.

[9] U.S. Center for Disease Control and Prevention (CDC). 2016. Tables 1, 5-12. Available at: http://www.cdc.gov/nchs/nvss/mortality_tables.htm.

[10] Noonan, Margaret E. and Scott Ginder. June 2015. Understanding Mortality in State Prison: Do Male Prisoners Have an Elevated Risk of Death? *Justice Research and Policy*. 16: 65-80.



The use of constant admissions results in a stable projection. The model may overestimate the population in the short-term because admissions have continued to fall to below FY2017 admissions. However, the use of historical admissions presents a realistic estimate of future prison populations if the downward trend of admissions slows and eventually stabilizes. The results also have a slight but steady increase in the prison population in future years, which is an expected result of the increase in both the number of offenses subject to truth-in-sentencing restrictions and an increase in the number of those offenses' admissions that have lengthened stays for long-term prison inmates.

Strengths of SPAC Projection

The SPAC prison population projection takes the two key policy levers—admissions and length of stay—to create a reasonable estimate of the state's future prison population. Both admissions and the average prison terms are held constant from the past year. Using these consistent inputs, the model provides a plausible baseline to compare any simulated policy changes. The assumptions are also familiar to system stakeholders—for example, if a reader believes admissions were abnormally low for the past year, they can read the model's output as a conservative underestimate of the future prison population. Likewise, a reader who believes admissions will continue to fall can read the output as an overestimate of the future prison population. Both can understand the projection based on familiarity with past experience.

From the model's baseline estimate, SPAC can now demonstrate the relationship between the key policy levers and simulate changes in state policies and practices. For example, SPAC could estimate the effect of removing admissions for drug offenses, changing the sentences imposed, or sentence credit policies that lead to more or fewer early releases. Importantly, the model can also show the interaction between all three options and the cumulative effect of implementing multiple policy changes. "What if" scenarios can now be simulated, described, and incorporated into future policy discussions.

Assumptions and Future Improvements

The projections are a result of the assumptions about inputs. This model assumes that future admissions will, in quantity and quality, resemble the admissions in the past year relative to when the projections are run. Admission data will be updated annually. So, for example, when running projections in 2018, the admissions data used will be from FY2017.

SPAC believes the admissions assumption is reasonable for two reasons: First, the model is not intended to supply a precise forecast (estimate where assumptions are expected to be correct), but instead a projection (estimate where assumptions are expected to be reasonable for purposes of modeling policy changes). Second, this assumption is reasonable for lack of other reliable data. If the past year's admissions are not used for future baseline estimates, what alternative should be used? The use of a broader set of data, such as crime data or changing demographics, may lead to short-term improvements, but the underlying assumptions of future crime must still be made. Further, the relationship between arrests, convictions, and prison sentences would need to remain stable over time, or the resulting inaccuracies could compound in the long-run projection and building the biases from the assumptions rather than improve accuracy. In the future, SPAC will consider making adjustments based on changing demographics and age profiles of the general population using public health and population census data for Illinois.

Feedback loops may also impact the model's ability to describe accurately the "what if" scenarios. For example, if drug possession admissions are no longer allowed in prison, some of those people who would have been admitted into prison on a drug offense will instead get probation, violate probation by committing a more serious property offense, and perhaps enter prison on that more severe offense. In this "what if" scenario, the drug possession admissions would decrease but, with a slight delay, admissions for other offenses may rise. The simulation model allows SPAC to incorporate these feedback loops. The challenge will be to identify the feedback loop outputs and reasonably predict the timing, people affected, magnitude of the effect, and other interactions. These feedback loop mechanisms will be difficult to predict, although plausible simulations may give policymakers and stakeholders a better understanding of possible outcomes of policy change.[11]

There are some data limitations for adjusting the lengths of stay for individuals currently in the prison population. Under the current model, only the most serious offense is considered when estimating length of stay adjustments and future admissions for concurrent sentences. For consecutive sentences, each sentence is considered separately and added to the length of stay for that individual. Future iterations may take into account that a change in sentence for one offense may result in a different conviction becoming the most serious or change the likelihood of getting a prison sentence, which would decrease admissions. These complexities are important to consider for accuracy but are not likely to significantly alter the projection's results. SPAC intends to address this issue in the future using additional data from Offender 360, the new IDOC record management system.

Data Source and Definitions

The model was designed to maximize use of available source data, so understanding the data helps understand how the model works. The projection uses historical data from IDOC. Each year the IDOC Planning and Research Division shares event-level (prison admission, prison exit) files for the fiscal year prior and a snapshot of the prison population on two dates (June 30 and December 31).[12] These files show the distribution of offense classes, age groups, lengths of stay, or other subgroup, over time. Based on past experience working with the data, as well as discussions with national researchers such as at the U.S. Bureau of Justice Statistics, the data are of high quality and sufficient for analysis.

Some terms that are used in the description of this model are as follows:

- *Prison admission*: The entry of a person into a prison facility. The entry can be the result of a court sentence or a technical violation of mandatory supervised release (MSR, or commonly

[11] Some experts have suggested a simple 20% discount of any expected policy-driven change from the status quo baseline because stakeholders and criminal justice actors tend to revert to past practices. Habit and institutional momentum are difficult to change, but at this time SPAC has not adopted any inertia discount.
[12] See Illinois Department of Corrections. Prison Population Data Sets. Available at https://www.illinois.gov/idoc/reportsandstatistics/Pages/Prison-Population-Data-Sets.aspx.

referred to as parole) that does not have a new sentence at the time of the admission. A person can enter prison more than one time in any given year. Movements such as a return from work release, prison transfers, and court transfers are not included. For this file, the movements originating from court or parole are included.

- *Prison exit*: The exit of a person from prison out to the community. Generally, all people who enter prison as a result of a sentence imposed will exit prison and be on mandatory supervised release. If the person was admitted as a technical violator, they may exit back onto parole if their sentence has not been fully discharged (completed), or be released without further supervision if their MSR term has expired. For this file, the movements from prison to the community regardless of admission type are included.
- *Sentence length*: The court imposed sentence term for a convicted individual. Offenders can have more than one sentence, and each sentence can be concurrent (served simultaneously) or consecutive (served sequentially). The minimum sentence to prison is one year and the maximum sentence can extend to or beyond the natural life of the offender.
- *Length of stay*: The actual time spent in prison for each sentence imposed. In most cases, the length of stay will be less than the sentence imposed by the court because of sentence credits offenders can earn in prison that reduce their length of stay. Some offenders are prohibited from being awarded sentence credits, such as those sentenced to natural life, and those who serve under a truth-in-sentencing restriction on sentence credit. The focus for the projection model is the prison length of stay. Other lengths of stay (jail, parole) can be or are incorporated in the model, but are not of primary importance as an output.
- *Violent vs. non-violent crime*: A categorization based on the nature of the offense. SPAC categorized crimes as violent or non-violent based on Illinois Rights of Crime Victims and Witnesses Act (725 ILCS 120). This is just one of several possible classification methods, but is the variation currently implemented in the model and the method used by IDOC.

Technical Calculations: Admissions

Number of Future Admissions

The SPAC projection model assumes that the number of admissions in future years will be equal to the number of admissions in the past year. However, if admissions have been on a declining trend and continue to do so in the future, this approach may overestimate the number of admissions. This assumption can be relaxed or modified in future iterations of the model, but the simplicity of the past year gives a baseline estimate that is both reasonable and understandable to policymakers and system stakeholders.

Technical Calculations: Length of Stay

Length of Stay in Future Admissions

This assumption coincides with the methodology for determining the number of admissions. These data sentencing patterns will be adjusted as sentencing changes over time. For the present, the approach is to keep the sentences, offense classes, offense types, and other sentence data consistent with admission records from FY2017.

After a conviction for a felony offense, a person may be sentenced to prison for a term within the range for that felony class. For example, an offender sent to prison for a Class 1 offense may be sentenced to 5 years, one year above the minimum allowable sentence of 4 years and below the maximum of 15.[13] Most offenders will not serve that entire sentence in prison due to sentence credits awarded based on good behavior, time served in pretrial detention, and/or completing programming while incarcerated. In

[13] Some offenders may receive extended terms beyond the prison term authorized for the offense class. These extensions are based on a variety of factors specified by statute. 730 ILCS 5/5-5-3.2.

general, SPAC uses the following equation to describe the length of stay a person will ultimately serve in prison:

Equation 1

$$Length\ of\ Stay_i = \left[\sum\left(Multiplier\_TIS_{ij}\ \times\ Sentence_{ij}\right)\right] - JailTime_i + adjustment_i$$

$Length\ of\ Stay_i$ is the actual length of stay for individual i and is only observable at the time of the exit from prison.[14] Additional time served due to a technical violation would be counted as a separate prison admission with its own length of stay.

$Sentence_{ij}$ is the *jth* prison sentence for individual i that is determined in court. Incarcerated persons can serve the entire imposed sentence but often serve much less. For example, murderers and other offenders subject to Illinois' truth-in-sentencing laws must serve 100%, 85%, or 75% of the sentence imposed, depending on the exact offense, minus jail time. (730 ILCS 5/3-6-3(a)(2).) Each offender can have one or more sentences, including consecutive sentences.[15] (730 ILCS 5/5-8-4.) The sentences for a single offender can be mixed, with some having truth-in-sentencing restrictions and others not.

$Multiplier\_TIS_{ij}$ is an adjustment to $Sentence_{ij}$ for individual *i* based on if the *jth* sentence was subject to the truth-in-sentencing restrictions on good-time sentence credit. Most offenders are not subject to truth-in-sentencing and get "day-for-day" sentence credits, *i.e.*, one day of credit for each day served. For these individuals the model will assume $Multiplier\_TIS_{ij} = 0.50$. Depending on the offense of conviction, the truth-in-sentencing multiplier can have a value of 0.75, 0.85, or 1.00 to match the credit eligibility, as determined by statute. First-degree murderer admissions, for example, receive a multiplier of 1.00 because they are statutorily required to serve 100% of the sentence imposed. Exceptions to this rule are discussed below.

$JailTime_i$ is how much time individual *i* served in jail before admission to IDOC. Some individuals serve their entire prison sentence in a county jail. In these cases, the admission will result in no—or a very short—length of stay in prison.

SPAC initially calculates a preliminary length of stay, a prison term with no time actually served, by applying a truth-in-sentencing (TIS) multiplier to each sentence and subtracting the time credited for detention prior to sentencing.[16] At individual *i's* exit, the difference between the true length of stay and the preliminary length of stay is labeled $adjustment_i$. For future admissions, SPAC has the data required to calculate the preliminary length of stay but not the true adjustment term because the exit has not yet occurred. The adjustment term encompasses anything excluded in the formula for the preliminary length of stay that determines the actual length of stay. For example, the inmate may lose good-time credits; may take additional programming credits; or may have his or her conviction reversed and be immediately released. Each exit has its own adjustment, which can be zero, negative, or positive.

SPAC estimates the adjustment term from the exits in the prior three years, conditional on several grouping variables. For a projection beginning with the prison population as of 6/30/2017, the calculations use exits from 7/1/2013 through 6/30/2015 to estimate the adjustment term. The additional two years increase the number of admissions and exits and improve accuracy of the adjustment term. For most future admissions, the adjustment term associated with their "group" is added to or subtracted from the estimated preliminary length of stay. The grouping strategy is discussed below.

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[14] The subscript *i* indicates that the variable differs for each individual. Equation 1 is repeated for each individual *i* in the data. When multiple letters are in the subscript (for example, sentence *j*), the additional letter means that the variable will be individualized (for example, the *TIS_Multiplier* will be specific to individual *i*'s sentence *j* for each sentence imposed).

[15] The '∑' symbol denotes a sum. In Equation 1, the sum is of all consecutive sentences for that individual.

[16] When individual *i* has multiple consecutive sentences, this step is repeated for each consecutive sentence.

Without the adjustment term, the distribution of the length of stay for the exits in any given year is likely biased downwards if applied to future admissions due to a large number of exits with relatively shorter sentences and lengths of stay. Therefore, the adjustment term is estimated to be the average adjustment from the exits grouped with the combination of:

a. offense class
b. violent vs. non-violent offense
c. sentence type (regular/concurrent vs. consecutive)
d. the 15-day preliminary length of stay increment

The adjustment term is only calculated if there are at least 15 exits in each group defined by a, b, c, and d (*i.e.*, an adjustment for all offenders who meet these four criteria: Class 4, non-violent, regular/concurrent, and with an estimated stay of 301 to 315 days). Exits on technical violation admissions are not included in the adjustment estimation, nor are deaths.[17] If there are not at least 15 exits in this group defined by the combination, the adjustment is instead calculated on the same groupings in {a,b,c,d} using a 30-day preliminary length of stay increment. This process is recursive until an increment with at least 15 exits is found from 15, 30, 60, 180, or 365.25-day increments.[18] If no such increment exits, the adjustment is fixed to a value of zero, meaning that the model only uses the sentence length, truth-in-sentencing classification, and jail term to calculate the expected exit date.

Equation 2

$$\widehat{Length\ of\ Stay_i} = \sum \left(Multiplier\_TIS_{ij} \times Sentence_{ij}\right) - JailTime_i + \overline{adjustment}_{abcd}$$

For example, a regularly sentenced admission with a Class 1 violent offense having a preliminary estimated length of stay between 1,426 and 1,440 days (roughly 4 years) would have an adjustment of -109 days.[19] There were 17 exits with those groupings from FY2013-FY2015 and they served on average 109 days less than what was preliminarily estimated. A preliminary estimated length of stay between 1,471 and 1,485 days in those same groupings would require the recursive step, as there were only 8 exits in FY2013-FY2015 that met that criteria. Instead, the adjustment of -136 days is drawn from 22 exits with a preliminary estimated length of stay between 1,471 and 1,500 days.

In equation 2, $Length\ of\ Stay_i$ is an estimate of the length of stay. As described above, the true length of stay will not be observed until the time of the exit. Overall, the adjustment calculation used by SPAC intends to arrive at a more accurate length of stay estimate by including a mean adjustment from actual exits conditional on the group described in each {a,b,c,d} grouping. The projected length of stay is then calculated by summing the preliminary length of stay and $\overline{adjustment}_{abcd}$ for each individual. Using the projected length of stay, an estimated exit date is then created.

The true length of stay would have an additional adjustment term γ that is only observable upon release and is specific to a particular length of stay on an admission of a particular offender, as in equation 3. This equation shows the true length of stay, which cannot be known in the projection because the last adjustment, γ is left out of our projected length of stay prediction, as shown in equation 2, which represents the best estimate based on the available data.

Equation 3

$$Length\ of\ Stay_i = \sum \left(Multiplier\_TIS_{ij} \times Sentence_{ij}\right) - JailTime_i + \overline{adjustment}_{abcd} + \gamma$$

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[17] Deaths are separately estimated as a probability based on life expectancy in the projection.

[18] The 1/4th day is added to the 365-day increment to account for leap years.

[19] Note: the hat symbol ($\widehat{Length\ of\ Stay_i}$) represents an estimation of the true value. The bar symbol ($\overline{adjustment}_{abcd}$) represents an average for the calculated adjustments from the IDOC data.

In sum, this approach is intended to reduce, on average, the difference between the estimated length of stay and real length of stay for each individual *i*. Restated: Equation 2 uses all available historical data to estimate the expected length of stay as realistically as possible. The approach allows the model to account for variation known at the time of exit but that is, prior to release from prison, unknown. Because the known variation represents in part discretionary sentence credit policies, the model can then simulate future changes to these policies to see the population impacts. As long as past discretionary policies and unpredictable releases match the patterns over the past three years, the approach results in an accurate length of stay predictor.

Length of Stay for Technical Violators

Illinois requires one year of mandatory supervised release (MSR) for Class 3 and 4 offenders, two years for Class 1 and 2 offenders, and three years for murderers and Class X offenders. There are some additional, extended MSR terms for certain offenses. If an individual violates a condition of MSR, the person may be returned to prison as a "technical violator."[20] Technical violators may serve up to the remainder of the MSR term in prison, depending on a PRB determination and IDOC's credit policies.[21]

SPAC uses a simulation approach where the length of stay for technical violators in the initial prison population and future admissions is drawn randomly from a recent cohort of technical violator admission and prison population records, conditional on class. The random selection is from the FY2014 technical violator admissions and prison population data, which are linked to their exits to determine the lengths of stay. The choice of year or years here is important because it reflects the revocation policies, PRB practices, and recidivism patterns. SPAC can adjust the data used for the simulation, but FY2014 is sufficiently recent to give a reasonable estimate but not so recent that a large portion of observations would lack an exit to match for determining the length of stay. If an exit had not yet occurred (about 10%), the simulation uses the projected sentence discharge date, which is calculated by IDOC. Much like simulation of the sentence length and number of admissions, the length of stay and number of technical violation admissions can be adjusted to test various policy proposals.

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[20] If the person is rearrested, reconvicted, and the new conviction returns the individual to prison, that case is counted as a new admission to prison. In contrast, if the person does not receive a new conviction but is returned to prison for violating the terms of their release because of the rearrest, that case is counted as a technical violation admission and is discussed in this section.

[21] Olson, David, Stemen, Don, Saltmarsh, Kathryn, Karr, Steve, & Sharon Shipinski. Summer 2013. Drivers of the Sentenced Population: MSR Violators. Research Briefing, Illinois Sentencing Policy Advisory Council. Springfield, Illinois. Available at: http://www.icjia.state.il.us/spac/pdf/SPAC%20Report%20MSR%20violator%209-13.pdf.

The cumulative distribution of length of stay was constructed for both the admissions and prison population by offense class. An example of this analysis is below. For 2014, Class 1 technical violator admissions, one had a length of stay of 2 days, one had a length of stay of 4 days, and three had a length of stay of 9 days. Twelve had a length of stay of 9 days or less (the cumulative number exiting), which is approximately 1% of the Class 1 technical violator admissions (99% had more than 9 days in prison after a technical violation). The data are used by assigning each individual *i* the length of stay (fourth column) by matching a pseudo-random number with the cumulative distribution percent.[22] For example, one Class 1 technical violation admission row with pseudo-random number 0.94721 would use 716 days as the technical violation length of stay.

Figure 1. Technical Violator Length of Stay Cumulative Distribution View

Source	Fiscal Year	Class	Length of Stay (days)	Number with LOS	Number in Class	Cumulative Number Exiting	Cumulative Distribution	Proportion Remaining
A	2014	1	**2**	1	1,149	1	**0.087%**	99.913%
A	2014	1	**4**	1	1,149	2	**0.174%**	99.826%
A	2014	1	**5**	1	1,149	3	**0.261%**	99.739%
A	2014	1	**6**	6	1,149	9	**0.783%**	99.217%
A	2014	1	**9**	3	1,149	12	**1.044%**	98.956%
…	…	…	**…**	…	…	…	**…**	…
A	2014	1	**716**	1	1,149	1,088	**94.691%**	5.309%
A	2014	1	**717**	2	1,149	1,090	**94.865%**	5.135%
…	…	…	**…**	…	…	…	**…**	…

Applying Length of Stay to Future Admissions

To simulate future admissions, SPAC joins the real admission information with a calculation table to create a row for each future admission and the expected exit date for that admission.[23] Figure 2 shows a graphic of how this join works. The incremented value is added to the admission year to create a new admission year, creating 30 future admission rows for each admission in the base admission set and essentially duplicating the admissions from FY2017 once for each year in the future defined by the projection model. Figure 3 shows the result of the cross join and the new simulated admission year. Only the first 4 rows for each result of the cross join are shown while in reality the join continues up to 30 future years of data.

Figure 2. Imputation of admissions simulation – cross join

Admissions rows from FY2017

Admission ID	Admission Month	Admission Date	Admission Year	…Other Fields…	Weight
125	7	18	2016	….	1.0
126	11	10	2016	….	1.0
127	4	8	2017	….	1.0

X

Future admission year end dates

Fiscal Year End Date	Increment
6/30/2018	1
6/30/2019	2
6/30/2020	3
6/30/2021	4
….	…30

Figure 3. Imputation of admissions simulation – cross join results (Admission Year + Increment)

[22] A pseudo-random number is simply a random number generated by a computer. It is technically pseudo random because the creation of the number follows a set pattern and, although it closely resembles random numbers, it can be reproduced.
[23] In practice, this is a Cartesian product in SQL via a cross join against a table of dates and a value that is incremented relative to the starting prison population date (in this case, the prison population on 6/30/2017).

Admission ID	Admission Month	Admission Date	Admission Year	Weight	…Other Fields…	Fiscal Year End Date	Increment	New Admission Year
125	7	18	~~2016~~	1.0	….	6/30/2018	1	2017
125	7	18	~~2016~~	1.0	….	6/30/2019	2	2018
125	7	18	~~2016~~	1.0	….	6/30/2020	3	2019
125	7	18	~~2016~~	1.0	….	6/30/2021	4	2020
126	11	10	~~2016~~	1.0	….	6/30/2018	1	2017
126	11	10	~~2016~~	1.0	….	6/30/2019	2	2018
126	11	10	~~2016~~	1.0	….	6/30/2020	3	2019
126	11	10	~~2016~~	1.0	….	6/30/2021	4	2020
127	4	8	~~2017~~	1.0	….	6/30/2018	1	2018
127	4	8	~~2017~~	1.0	….	6/30/2019	2	2019
127	4	8	~~2017~~	1.0	….	6/30/2020	3	2020
127	4	8	~~2017~~	1.0	….	6/30/2021	4	2021

The Current Prison Population

The person-level file of inmates held in prison on June 30, 2017 is the starting point for the projection. This number represents all individuals in prison on this date at the beginning of the projection. The length of stay is not calculated any differently for this group compared to admissions in the status quo simulation—SPAC uses the sentence imposed, truth-in-sentencing and sentencing characteristics, jail time, and the adjustment term to estimate a projected release date. Each individual in the prison population data is assigned a weight of 1.0. After estimating the length of stay as described above, the prison population is checked for exiting and mortality just as described for the admissions calculations.

Accounting for Mortality

The simulation requires some estimation of life expectancy to account for natural life sentences, long sentences, and admissions of the elderly. The model uses mortality data from the U.S. Centers for Disease Control and Prevention’s Division of Vital Statistics representing life expectancy for the general population by age, race/ethnicity, and sex.[24] Recent national research indicates that mortality rates within prison are different from the general population, varying in the direction and magnitude of difference by race and sex.[25] SPAC uses this research to adjust the mortality rates and life expectancy. Preliminary analyses show that the simulation without such adjustment indicates a fairly large (30-50%) increase of the number of deaths in prison compared to the actual number of deaths. SPAC uses the CDC mortality rates but adjusts to match the recent national research and Illinois data.

SPAC accounts for mortality as follows: For each admission row, a join is performed to an age-race-sex specific mortality table to estimate the life expectancy for that row. When the calculated age for the individual in future prison populations (see Figure 5 below) is greater than the life expectancy number, the person is not counted in the prison population. The result is an approximation of prison mortality and provides a realistic estimation of the growth of prison populations of individuals with natural life and long sentences, and for elderly admissions.

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[24] U.S. Center for Disease Control and Prevention (CDC). 2016. Tables 1, 5-12. Available at: http://www.cdc.gov/nchs/nvss/mortality_tables.htm.

[25] Noonan, Margaret E. and Scott Ginder. June 2015. Understanding Mortality in State Prison: Do Male Prisoners Have an Elevated Risk of Death? *Justice Research and Policy*. 16: 65-80.

Technical Calculations: Future Prison Populations

Prison Population in Future Year

The 'Other Fields' column in Figures 2 and 3 includes the projected length of stay (LOS) and projected release date. As discussed above in the length of stay calculations section, each record will combine the observable sentence imposed, truth-in-sentencing, jail time, and an adjustment term to create a projected release date. The records are then duplicated for each expected future admission (Figure 2) and then a second join is applied on the result to compare if that record still exists on a set future date.

The simulation then shows the prison population when each row is kept, keeping all rows where the simulated admission date is less than the desired date (*i.e.*, to check the simulated population on January 1, 2025, the row was admitted before that date) *and* the projected exit date is greater than the desired date (*i.e.*, the row has not yet left prison on that date). The resulting rows are the admissions that are in prison on the given *Future Prison Population Date*, based on our estimated length of stay. Figure 4 shows a graphic of the join and the full result set in Figure 5, while the rows that match the two conditions above are given a value of 1 in the last field, "In Prison," and are retained.

Figure 4. Add Future Prison Population Check Date – Inner Join

Simulated future admission rows

Admission ID	Simulated Admission Date	Projected LOS (days)	Projected Exit Date	…Other Fields….	Weight
125	7/18/2018	524	12/23/2019	….	1.0
125	7/18/2019	524	12/24/2020	….	1.0
125	7/18/2020	524	12/24/2021	….	1.0
125	…….	524		….	1.0
125	7/18/2045	524	12/24/2046	….	1.0
126	11/10/2018	1200	02/22/2022	….	1.0
126	11/10/2019	1200	02/22/2023	….	1.0
126	11/10/2020	1200	02/22/2024	….	1.0
126	11/10/2021	1200	02/22/2025	….	1.0
126	…..	1200	…	….	1.0
126	11/10/2045	1200	02/22/2049	….	1.0

X

Future Prison Population Date
6/30/2018
6/30/2019
6/30/2020
6/30/2021
….
6/30/2045

Figure 5. Imputation of admissions simulation – inner join results

Admission ID	Simulated Admission Date	Projected LOS (days)	Projected Exit Date	…Other Fields….	Weight	Future Prison Population Date	In Prison (0/1)
125	7/18/2018	524	12/23/2019	….	1.0	6/30/2019	1
125	7/18/2018	524	12/23/2019	….	1.0	6/30/2020	0
125	7/18/2018	524	12/23/2019	….	1.0	6/30/2021	0
125	7/18/2018	524	12/23/2019	….	1.0	….	
125	7/18/2018	524	12/23/2019	….	1.0	6/30/2045	0
126	11/10/2018	1200	02/22/2019	….	1.0	6/30/2019	1
126	11/10/2018	1200	02/22/2019	….	1.0	6/30/2020	1
126	11/10/2018	1200	02/22/2019	….	1.0	….	
126	11/10/2018	1200	02/22/2019	….	1.0	6/30/2045	0

Final Steps

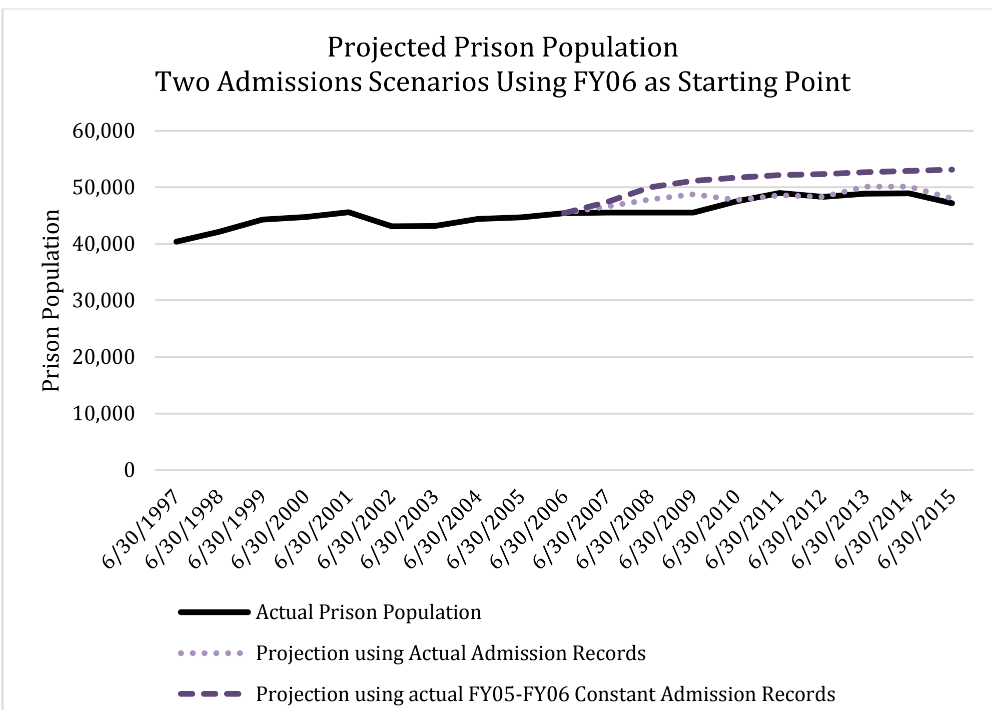
After performing the Prison Population Date Check and the Mortality Check, the weights in the retained rows can be summed by the future prison population dates to obtain the prison population in the future. The future population will solely be the result of estimated future admissions, the expected lengths of stay, and the calculations with those inputs described above.

The key advantage for this model is that the weight can be modified before summation based on proposed policy and/or changes to assumptions. For example, if a policy would propose to no longer allow sentences to prison for drug possession, the weight for these admissions can be changed to zero or reduced, if the model assumes that some offenders entering for a drug possession will no longer be sent to prison. If they would instead enter on some other offense, the weights of those other offenses could be increased to account for expected increases in future admissions. If a lapse of time is expected before a policy is fully implemented, the weight can be adjusted using the increment field with conditional logic in the SQL. The flexibility of the weight field allows SPAC to account for changes to admissions over time, depending on the type of policy proposal and the "what if" scenario SPAC needs to model.

After running the model, SPAC can export the rows of data for a selected future date to create simulated admissions, population, and exits files. These files would look like the past data extracts provided by IDOC and allow for examination of potential problems in the simulation. As opposed to a complex formula for a projection, this approach is, for the most part, a count of individuals in prison on a certain date based on admissions and expected lengths of stay.

Results: Historical Performance

SPAC tested the model on historical data and compared the projection to the actual prison population. Using admissions from 2005 and 2006, SPAC simulated a projection of the 2016 prison population. The model's calculations are the same as the forward-looking projection but used historical data to test the methodology. Using the FY2006 prison population data as a starting point, SPAC added the average admissions from the FY2005 and FY2006[26] for ten years until FY2015.



[26] Consecutive sentence data is limited prior to FY2005. As a result, for the historical check beginning with the FY2006 prison population, two years of admissions were used to simulate future admissions. Each admission was weighted by 1/2.

The model overestimated the actual prison population by several thousand because between FY06 and FY15 admissions declined by over 25%. Therefore the model's assumption that admissions would remain constant and match the FY2005-06 admissions patterns did not occur and the 2016 population was overestimated (dotted purple line in the graph). However, if the true number of admissions were used, the model's calculations results track the actual prison population within 3% of the true value. The results demonstrate that the length of stay and adjustment factors are reliable.

Inaccuracies can be expected because the projection is not intended as a forecast—the inputs assume admissions are constant into the future despite the fact that the number of admissions may vary significantly over the next ten years. However, for the purposes of running baseline projections and comparing policy options, the model performs well.

Conclusion

This model will continue to evolve as more data becomes available and the underlying assumptions are refined and improved. With the finalization of this model, population projections are included in SPAC's fiscal impact analyses and annual prison population projections will be published as mandated in SPAC's authorizing legislation. While 100% accuracy will be forever elusive, SPAC is confident that the results produced with this methodology will prove to be useful as Illinois continues to examine sentencing policy and use data-driven approaches to reform the criminal justice system.