Assessing Risk-based Policies for Pretrial Release and Split Sentencing in Los Angeles County Jails

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Abstract

Court-mandated downsizing of the CA prison system has led to a redistribution of detainees from prisons to CA county jails, and subsequent jail overcrowding. Using data that is representative of the LA County jail system, we build a mathematical model that tracks the flow of individuals during arraignment, pretrial release or detention, case disposition, jail sentence, and possible recidivism during pretrial release, after a failure to appear in court, during non-felony probation and during felony supervision. We assess 64 joint pretrial release and split-sentencing (where low-level felon sentences are split between jail time and mandatory supervision) policies that are based on the type of charge (felony or non-felony) and the risk category as determined by the CA Static Risk Assessment tool, and compare their performance to that of the policy LA County used in early 2014, before split sentencing was in use. In our model, policies that offer split sentences to all low-level felons optimize the key tradeoff between public safety and jail congestion by, e.g., simultaneously reducing the rearrest rate by 7% and the mean jail population by 20% relative to the policy LA County used in 2014. The effectiveness of split sentencing is due to two facts: (i) convicted felony offenders comprised ≈ 45% of LA County’s jail population in 2014, and (ii) compared to pretrial release, split sentencing exposes offenders to much less time under recidivism risk per saved jail day.
To mitigate severe prison overcrowding, the U.S. Supreme Court (*Brown v. Plata*, 2011) forced the state of California (CA) to reduce its prison population by 25% within two years. In response, CA passed the Public Safety Realignment Act (Assembly Bill 109, often referred to as realignment), which called for low-level (i.e., non-serious, non-violent, non-sex-related) felonies and state parole violations to be punishable by incarceration in county jails rather than state prisons. Although realignment has successfully reduced the state prison population, it has caused a significant increase in the CA jail population: of the 58 CA counties, 19 (including LA County) have court-ordered jail population caps [1] (some counties rent jail space from other counties), and 21 counties are receiving CA state funds to add > 10k additional jail beds [2].

CA counties have two primary options for reducing jail overcrowding in the short run. They can offer pretrial release to defendants, in the hope that these defendants appear in court and do not recidivate (i.e., commit another crime) prior to case disposition. In addition, Assembly Bill 1468 requires that – unless the court finds it is not in the interest of justice – as of January 1, 2015 low-level felony sentences be split between jail time and mandatory supervision. To aid in these decisions, correctional systems throughout the U.S. employ risk-based tools that use a defendant’s demographic data and criminal history to predict the likelihood of recidivism and of appearing in court. These tools are moderately predictive, achieving an area under the curve of the receiver operating characteristic curve of $\approx 0.7$ [3], meaning, e.g., that the probability a three-year recidivist has a higher risk score than a three-year non-recidivist is 0.7.

To investigate jail management under these circumstances, we build a simulation model that tracks the flow of inmates over time in LA County jails, which is the world’s largest jail system. In our model, individuals arrive for arraignment as one of six types, according to whether their current charge is a felony or non-felony, and whether their risk category is low, medium or high in the California Static Risk Assessment (CSRA) tool [4], which is one
of the risk tools used in CA. Using a queueing network model for process flow and statistical models for risk-based recidivism and failure to appear in court, we follow individuals through arraignment, pretrial detention or release, case disposition and jail sentence, as well as recidivism that may occur during pretrial release, after a failure to appear in court, during regular probation for non-felonies, and during supervision of a split sentence for felons. We assess 64 joint pretrial release and split-sentencing policies that are risk-based, and compare them to the status quo policy that LA County was using in 2014; despite the passage of Assembly Bill 1468, LA County used split sentencing only sparingly in early 2015 (Fig. 6 in [5]). Our goal is to identify policies that optimize the tradeoff between public safety – as measured by the annual rearrest rate of anyone on pretrial release, after a failure to appear in court, on regular probation or on supervision during a split sentence – and jail congestion, as measured by the mean jail population or the mean amount of jail overcrowding (i.e., population in excess of jail capacity).

**Methods**

The model is depicted in Fig. 1, the policies are described in Tables 1-2 and a list of model parameters and their values are given in Tables 3-4. Details of the parameter estimation procedure appear in the Supporting Information (SI).

**Process Flow.** New inmates arrive to the county jail system according to a renewal process, where the time between consecutive arrivals has an Erlang distribution. The county jail has a fixed capacity, but we assume that some detainees are held in a different jail (e.g., in another county or at a U.S. Immigration and Customs Enforcement facility) if the current jail population exceeds its capacity. The arriving defendants are randomly assigned to one of six types, according to a combination of their charge (non-felony or felony, where the former consists of misdemeanors and lesser charges) and their CSRA risk category (low, medium or high), where the risk category and charge probabilities are assumed to be statistically independent. After a short random delay, defendants undergo arraignment, during which
the first of two key decisions is made: based on a defendant’s charge-risk type, either release the defendant until case disposition (i.e., pretrial release) or hold him (we adopt the male gender throughout) in custody until case disposition (our model does not incorporate the many arrests that do not result in arraignment [9]).

The time delay from arraignment until case disposition is random and depends upon a defendant’s charge (non-felony vs. felony) and pretrial release vs. custody status, but not on his CSRA risk. Defendants on pretrial release possess two competing random times: the time from arraignment to recidivism (which is based on a statistical model that depends on his CSRA risk but not on his charge, and which can be infinite) and the time from arraignment until case disposition. If the former time is shorter than the latter time, then the defendant recidivates before case disposition; his recidivism charge is assumed to be the same as his original charge and his risk is unchanged (note that CSRA and some other risk tools do not use the current charge as a predictive variable due to its lack of predictiveness [4]). The recidivating defendant re-enters the jail and waits for a new arraignment, and the new pretrial release vs. custody decision takes into account his recent recidivism, as described later.

If the time from arraignment to case disposition is shorter than the time from arraignment to recidivism for a defendant on pretrial release, he does not recidivate before case disposition. In this case, we assume that the likelihood of failing to appear in court for case disposition depends on the defendant’s risk category but not on his charge type. If he does not appear in court, then his time from arraignment to recidivism remains active, and he may recidivate at a later time, at which point he is treated in the same way as those who recidivate before case disposition.

Case disposition for non-felonies has three possible outcomes, with probabilities that depend upon the pretrial release vs. custody status: acquittal/dismissal (and exit from the system), probation, or a jail term that also includes a probation component. The random
length of probation is statistically identical, whether or not it is preceded by a jail term. Similarly, felony cases have four possible dispositions with probabilities that depend upon the release vs. custody status: acquittal/dismissal, probation, jail (without probation), and prison, where those going to prison exit our model. The length of the post-sentence jail term depends on both the charge (non-felony vs. felony) and the pretrial status (release vs. custody). Later we discuss the key assumption that the time from arraignment to case disposition, the court outcome and the length of the post-sentencing jail term depend on whether the offender is released or detained prior to trial.

The second of our two policy decisions is made during case disposition of felonies: whether or not – depending upon the risk category of the offender – to offer split sentences for felonies (all felons in our model are low-level felons that are eligible for split sentencing). Felons receiving a split sentence spend the first half of their post-sentence jail term in jail, and spend the second half out on mandatory community supervision, where the 50-50 split is based on recent reports from CA counties [5, 17, 18]. Finally, offenders on probation or supervision are assumed to recidivate according to the same statistical model as offenders on pretrial release, but – in contrast to recidivists on pretrial release, who are typically released for a shorter amount of time – they are assigned a new charge at random (although their risk does not change) before returning for re-arraignment, and the new pretrial release vs. custody decision takes into account his recent recidivism, as described later.

**Policies.** Our pretrial release decisions are based on an offender’s charge-risk type, and the split-sentencing decisions for felons are based on their risk category. We restrict ourselves to policies that are independent of the current number of inmates in jail and are monotonic in risk; i.e., if a certain offender is offered pretrial release then all offenders with the same charge and with the same or lower risk is also offered pretrial release, and if a felon is offered a split sentence then all felons with the same or lower risk is also offered a split sentence. Hence, because there are four options for each risk category (offering the option to no one,
to only low-risk individuals, to low- and medium-risk individuals, or to everyone) and three
decisions (pretrial release for non-felonies, pretrial release for felonies, split-sentencing for
felonies), we consider $4^3 = 64$ policies that correspond to all combinations of one option
from each of the three columns in Table 1.

In addition, we consider a policy that represents the status quo in LA County in early
2014. This policy does not offer split-sentencing to any offenders because LA County’s use
of split sentencing was < 1% during June 2013 - May 2014 (Fig. 6 in [5]). The probability
of pretrial release in LA County depended upon the charge-risk type (Table 2), and these
probabilities are estimated using data in [9, 19, 20] (§1 in SI).

The decisions in Tables 1 and 2 apply only to new arrivals. If an offender recidivates
during pretrial release, then he is detained after rearraignment under the 64 policies in
Table 1 and the status quo policy. If an offender recidivates during probation or supervision,
then he is offered pretrial release with probability 0.2 if his recidivism charge is a non-felony
and with probability 0.1 if his recidivism charge is a felony, independent of an offender’s risk
category (§2 in SI); these pretrial release probabilities are based on financial conditions (i.e.,
defendants are able to post bail or a bond, which is rarely denied in LA County) rather than
risk, and are applied to all 65 policies.

**Performance Measures.** Our key tradeoff is between public safety and jail congestion.
We measure public safety by the annual number of jailed rearrests of (i.e., recidivist crimes
by) anyone on pretrial release, probation or supervision, or after a failure to appear in court.
We measure jail congestion in two ways: by the mean size of the jail population over the
length of the simulation, or by the mean amount of overcrowding, which is the mean of the
number of inmates in excess of the county jail capacity at each point in time.

**Parameter Estimation.**

**Jail Capacity.** The jail capacity of 19,000 is approximately halfway between the functional
bed capacity (set at 90% of capacity to allow for seasonal fluctuations and the need to
separate special-need and high-risk inmates) of LA County projection options A and C (19,530) and option B (18,630) in Table 14 of [6]. This estimate is also consistent with the rated (by the Board of State and Community Corrections) capacity with the inclusion of fire camps of 19,474 (page 4 of [7]) minus the ≈ 500 prison inmates and transfers that are housed in jail.

Interarrival Times. The interarrival time distribution is derived from arraignment data (e.g., [8]) during 2008-2012 in LA County (§3 in SI).

Time Delay From Arrest To Arraignment. The parameters for the time delay from arrest to arraignment are derived from 2008 data from LA County [9] via maximum likelihood estimation (§4 in SI).

Charge Proportion. Using the “Cases Matched from PIMS to AJIS” column in Table 3 of [9], we estimate that the proportion of defendants who have a felony charge is 49,549/112,201=0.442, and the proportion who have a non-felony charge is 0.558.

Risk Tool. We initially considered two risk tools, Correctional Offender Management Profiling for Alternative Sanctions (COMPAS) [21] and CSRA [4], that have been used by CA correctional agencies and externally validated (albeit on pre-alignment state parole populations rather than post-alignment jail populations). The main advantage of COMPAS is that it has a finer granularity of risk (10 risk categories) than CSRA (three risk categories). However, we chose to adopt CSRA in this study because its validation study for recidivism [10] has finer temporal granularity and less right-censoring (recidivism at 1, 2 and 3 years for 110,313 parolees) than the COMPAS validation study [22] (recidivism at 2 years for a sample of 24,418 parolees), both of which are required to develop a reliable statistical model for time to recidivism. Here, recidivism refers to an arrest and return to custody, which is the most relevant definition for jail capacity and cost [21]. However, because we could not locate any studies that calibrated the CSRA risk tool to failure-to-appear data, we use COMPAS (after aggregating its 10 risk categories into CSRA’s three risk categories, as in
Risk Proportion. We use the risk category breakdown of the 110,313 parolees in Table 15 of [10] to get the proportions in Table 3.

Time to Recidivism. Using maximum likelihood estimation, we fit five models (§5 in SI) to the raw data in Table 15 of [10] (recidivism within 1 year, 2 years and 3 years for each of three risk categories): a lognormal model (where the mean parameter is an affine function of the risk score), a split lognormal model (where a proportion of the population – independent of risk – never recidivate [23] and the others recidivate according to a lognormal distribution), a split lognormal model with heteroskedasticity (the standard deviation parameter is also an affine function of the risk score), a proportional hazards model [24], and a split proportional hazards model. The split lognormal model with heteroskedasticity provides the best fit (§5 in SI). The lognormal distribution exhibits a unimodal hazard rate, which captures a brief period of desistance followed by a peak incidence of recidivism and a slowdown thereafter (Fig. 1 in SI). The split improves the empirical fit, as seen in earlier studies (e.g., [25]).

Failure to Appear. We use a study that validates the COMPAS tool using 18 months of data from Broward County’s (FL) jail system [11] to estimate the failure-to-appear probabilities in Table 3 (§6 in SI).

Time from Arraignment to Disposition. We use maximum likelihood estimation to fit lognormal and gamma distributions to arrest-to-disposition time data from [9] (§7 in SI).

Case Disposition Probabilities. The 14 case disposition probabilities in Table 4 are estimated in §8 in SI using Bayes rule and data in Table 4 of [9], pages 57 and 129 of [9] and Table 1 in [13], and odds ratio estimates on page 10 of [12].

Post-sentence Jail Terms. We fit mixture (of pretrial release and pretrial custody) lognormal and gamma distributions for jail sentences using non-felony data on page 129 in [9] and Fig. 25 in Appendix C in [9], and felony data in Chart 3 in [13] (§9 in SI).

Length of Probation. Although typical non-felony probation duration is widely reported by
criminal law offices as one year (with no minimum and a maximum of three years) [15] and typical felony probation duration is given as three years (with a minimum of one year and a maximum of five years) [16], we could not locate data on their distribution. Consequently, we chose triangular distributions with these ranges and with modes as their typical durations.

**Results**

For all reported results, we simulate 1000 runs of 2000 days each – collecting statistics only after the 900th day – and report on the mean of the 1000 replications.

**Model Validation of Jail Population and Composition.** We begin by simulating the status quo policy (Table 2) and find that the total jail population, the composition of felons vs. non-felons and sentenced vs. non-sentenced, and the amount of overcrowding are generally consistent with reported values for LA County (Table 5).

**A Simple Metric.** To provide a framework for interpreting our main results, we introduce a simple metric that quantifies the tradeoff involved in the three components of our policies (Table 1): pretrial release for non-felons, pretrial release for felons, and split sentences for felons. Each decision entails releasing a defendant or offender for an amount of time, and – in exchange for the increased recidivism risk - we are reducing the jail population by one person for a possibly different amount of time. Our metric, which we call the risk ratio, is the amount of time that a defendant or offender is released divided by the number of jail-days saved, where both of these quantities are conditioned on the person not recidivating. By our modeling assumptions, this ratio is 1.0 for split sentencing because the number of jail-days saved is the same as the number of days on supervision. In contrast, calculating the means of the gamma and lognormal distributions specified in Table 4, we see (Table 6) that the pretrial release of a non-felon achieves an average reduction of 8 jail-days in exchange for a recidivism risk over an average of 128 days (for a ratio of 16) and the pretrial release of a felon achieves an average reduction of 53 jail-days in exchange for a recidivism risk over an average of 191 days (for a ratio of 3.6). Although this ratio is crude – it fails to account for
the reduction in jail-days saved due to recidivism on supervision or before case disposition, the larger reduction in jail-days saved if a defendant fails to appear in court, and the future increase in jail population after a recidivist is rearraigned. Nonetheless, this ratio provides a first-order quantification of the nature of these tradeoffs. This ratio reveals that – for a specified risk category (low, medium or high) - split sentencing offers the most favorable tradeoff, followed by the pretrial release for felons, with the pretrial release of non-felons generating the least desirable tradeoff.

**Main Results.** In our numerical results, the mean jail overcrowding is a nondecreasing function of the mean jail population; consequently, we focus most of our discussion on the tradeoff between the annual rearrest rate and the mean jail population. Our main results (Fig. 2a) show the performance of the status quo policy and four tradeoff curves, one for each of the split-sentencing options in Table 1. Each of the four tradeoff curves connects up to 16 points, one for each of the 16 possible pretrial release policies in Table 1. The optimal pretrial release policies for these four tradeoff curves are specified in Fig. 3, using the numbering system in Table 1. In total, eight of the 64 policies are dominated by other policies that use the same split-sentencing option (i.e., these other policies achieve simultaneous reductions in rearrest rate and mean jail population) and do not appear in Fig. 3. Not surprisingly (Table 5), the dominated policies favor the pretrial release of non-felons over felons; e.g., in Fig. 3a, the two dominated pretrial release policies are (2,0) and (3,0), using the numbering system in Table 1. For a given split-sentencing option, we connect these points to create a tradeoff curve only for ease of visualization, and did not assess the performance of any policies that randomize between different points on a tradeoff curve.

The main insight from Fig. 2a is the importance of offering split sentencing to high-risk felons. The reduction in the performance measures between the tradeoff curve that offers split sentencing to all felons and the tradeoff curve that offers split sentencing to only low- and medium-risk felons is much larger than the reduction in the performance measures
between the tradeoff curve offering split sentencing to only low- and medium-risk felons and the tradeoff curve offering no split sentencing. This result is due to the low risk ratio of split sentencing (Table 6), coupled with the facts that convicted felons make up a significant portion of the jail population (Table 5) and the majority of them are high risk (Table 4). Relative to the status quo policy, the tradeoff curve that provides split sentencing to all felons achieves a 29% reduction in the jail population level at the same rearrest rate, or, e.g., simultaneously reduces the jail population by 20% and the rearrest rate by 7%. The suboptimality of the status quo policy relative to all four of these tradeoff curves stems from the fact that the status quo policy is not purely risk-based (Table 2).

The four curves in Fig. 2a do not exhibit the strong convexities that would be associated with increasing marginal risk at a higher release rate. The one exception is the near vertical jump from (3,2) to (0,3) (Fig. 3), where a switch from pretrial releasing all non-felons and some felons to pretrial releasing all felons and no non-felons leads to a very small reduction in jail population but a significant increase in the rearrest rate.

The optimal tradeoff curve among all 64 policies is the lower-left envelope of the four tradeoff curves, which consists of the entire leftmost (i.e., split sentencing for everyone) curve and the bottom portions of the other three curves. The only scenario in which offering split sentencing to all felons is not optimal is where it is deemed important to minimize the total rearrest rate below 51.5k/yr (which is the lowest level achievable by any policy that offers split sentencing to all felons). Comparing the lower endpoints of the two leftmost curves in Fig. 2a, we see that disallowing split sentencing for high-risk felons while continuing to offer split sentencing to other felons and pretrial release to everyone, the average annual rearrest rate can be decreased by 2%, but the jail population increases by 14%; this change represents a much less attractive tradeoff than when the total arrest rate is > 51.5k/yr. In contrast, if the primary concern is with jail overcrowding rather than the mean jail population, then less aggressive jail population reduction policies can be considered because many of the policies
from Table 1 totally eliminate jail overcrowding (Fig. 2b; the analog of Fig. 3 for the jail overcrowding metric appears in Fig. 2 in SI).

Despite the risk ratios in Table 6, it may not be practical to use a more aggressive pretrial release policy for felonies than for non-felonies. Consequently, we restrict our consideration of policies to those that treat felonies at least as strictly (with respect to pretrial release) as non-felonies of the same risk category; i.e., we only allow pretrial release policies \((i,j)\) such that \(i \geq j\). The resulting tradeoff curves with this additional restriction appear in Fig. 3 of SI, and are nearly linear.

**Discussion**

While LA County may be the most prominent example, many other counties in CA [1, 2] and throughout the U.S. are struggling with overcrowding. Our model allows us to assess how pretrial release and split-sentencing decisions impact the key tradeoff between public safety and jail congestion. In our view, the study’s main contributions are in (i) developing a mathematical model that captures the salient features of the problem and provides a framework for quantifying the tradeoff between public safety and jail congestion, (ii) introducing a simple metric - the risk ratio in Table 6 – that sheds light on the varying amount of risk inherent in each type of decision in Table 1, (iii) identifying key data needs, and (iv) highlighting key assumptions and issues. However, there are a number of limitations to our study that need to be addressed before our main results can be directly applied. Hence, before discussing our main results, we describe the limitations of the study, from a data and a structural viewpoint.

**Limitations.** There are several shortcomings in the data. First, the survival model used to determine the time to recidivism is the same, regardless of whether a person is out on pretrial release, has failed to appear in court, is on probation after a non-felony, or is on supervision during the latter part of a split sentence for a low-level felony. Moreover, the recidivism model is calibrated using pre-alignment state parolee data, which is a different
population than the post-alignment jail population that is the focus of our model. Because many state prisoners and parolees became the responsibility of the county jail system during realignment, it is possible that the pre-alignment parole population does not behave very differently than the post-alignment jail population. But before our model can be applied to a CA county jail system, the risk models commonly used in CA (e.g., CSRA and COMPAS) need to be validated separately for the jail subpopulations that are on pretrial release, after failure to appear in court, non-felony probation and low-level felony supervision.

On a similar note, we also estimate the risk profile of defendants entering arraignment in our model from the risk profile of released state parolees during pre-alignment. Because many offenders arraigned on non-felony charges have a felony background, this assumption may not be as bold as it appears at first blush. Nonetheless, our model needs to use the risk profile of the actual jail population before it can be reliably used. We also assume that risk category and charge type are statistically independent, and this assumption should be investigated, which requires separate risk distributions for non-felons and felons.

The only failure-to-appear data we found that is sufficiently detailed for our purposes are from Broward County, FL [11], which may have a different defendant population than LA County. The failure-to-appear probability in [11] is consistent with other estimates from KY (page 2 in [29]) and a nationwide study of federal prisoners [12], although lower than a 0.4 estimate from a large urban center [30]. In addition, the data in [11] do not include the time of each defendant’s case disposition, which prevents us from assessing (e.g., via logistic regression) whether the likelihood of appearing in court is impacted by the arraignment-to-disposition delay.

The CA jail system continues to be in flux due to the November 4, 2014 passage of Proposition 47 (Safe Neighborhoods and Schools Act), which reclassifies several drug- and theft-related offenses as non-felonies and allows for resentencing of previously convicted felons. This change altered the composition and total population of CA jails, and the
immediate reduction in jail population in November 2014 was largely counteracted by an increase in time served for traditional jail inmates (pages 3-4 in [5]). Our model needs to account for these recent changes before it can be used in CA.

A provocative aspect of our model – and indeed of the U.S. correctional system – is that the time from arraignment to case disposition, the court outcomes and the length of post-sentencing jail terms depend on whether the offender is released or held in custody prior to trial. More specifically, the delays are shorter, the outcomes are more severe and the jail terms are longer for those held in custody. These phenomena have been observed elsewhere in the literature (§2b of [31]), even after controlling for prior convictions, the severity of the current charge, and the strength of the evidence against the defendant [32]. However, we assume that these structural differences, which can be seen by comparing the columns in Table 4, hold regardless of the aggressiveness of the pretrial release policy (Table 1). As a result, awarding a defendant pretrial release reduces the jail population in our model in three ways: it keeps the offender out of jail before case disposition, it reduces the likelihood that he is returned to jail at case disposition, and it reduces his jail time if he is returned to jail. There may be some merit in this assumption (beyond the results in [31, 32]) because those on pretrial release have a greater opportunity to impress jurors and judges (e.g., by appearing in a socially acceptable attire instead of a jail uniform, maintaining a job and not recidivating) and to provide a strong legal defense [31]. However, it is also likely that the pretrial release decisions are based partially on data that are not included in our model; e.g., that judges set higher bonds – leading to less likely pretrial release – when they view the probability of acquittal as low [33], or when they incorporate retribution concerns (e.g., LA County does not accept inmates with bail < $25k for non-felonies, and so courts set the bail ≥ $25k if they want to guarantee detention [9]). To the extent that this is true, we may be overestimating the benefit (in terms of a reduction in jail population and retribution) of pretrial release. However, because our main result is that an aggressive split-sentencing policy is optimal,
this assumption – by overstating the benefits of pretrial release – is conservative.

Another implicit set of assumptions is the model’s boundaries. While the correctional system has many interacting parts [2], we consider several important aspects as exogenous. One aspect is court processing capacity and prosecution behavior, both of which can delay case disposition [31]. Note that by assuming exogenous delays until case disposition, we do not capture the counterintuitive fact (implied by priority queueing theory in equation (3.42) in [34] under the assumptions of a Markovian system with nonpreemptive priority) that if there is an increase in the pretrial release rate, the average waiting times (i.e., the time from arraignment to case disposition) for those in pretrial custody and those in pretrial release both decrease (even though the mean overall waiting time remains the same). Another exogenous aspect of the model is probation capacity and related rehabilitation services capacity. Indeed, the stated goal of CA realignment is to reduce recidivism of low-level felons by localizing their rehabilitation services [2]. Although the number of probationers increased during realignment, LA County has greatly enhanced staffing and has reached most of its goals for caseload per probation officer (Table 3 in [35]). We also take policing capacity and crime clearance policy as exogenously specified.

Our results naïvely assume that all of these policies are fully enforceable. In practice, even though the proportion of eligible low-level felons receiving split sentences increased from < 1% in May 2014 to 27.7% in Feb 2015 (Fig. 6 of [5]), many judges were not offering split sentences in the months after the passage of AB 1468. Moreover, some low-level felons may prefer to spend their entire sentence in jail rather than on mandatory community supervision (pg 12 in [36]). Similarly, the predicted improvements achieved by pretrial release will inevitably require a shift from a cash-based bail process to a risk-based bail process [31, 37]. Finally, we note that for simplicity and for equity concerns, we consider only policies that are independent of the current jail population. In other queueing systems with no waiting rooms, such as some telecommunications systems, it is known that system performance can
be enhanced by using flow management policies that depend on the current queue length

38.

**Results.** Our model predicts that offering all low-level felons – including those in the high-risk category – split sentences is the key to achieving a substantial improvement in performance, and can simultaneously reduce the mean jail population level and the annual rearrest rate relative to the status quo policy that attempts to mimic LA County’s policy in early 2014. This result is not inconsistent with the observation in the prison setting that the most effective way to substantially reduce the prison population is to focus on prisoners who serve long sentences 39.

In addition, we introduce the risk ratio metric (Table 6), which explains why – for a given CSRA risk level – split sentencing for felonies is more effective than pretrial release for felonies, which in turn is more effective than pretrial release for non-felonies. The large risk ratios for pretrial release are due to the courts prioritizing cases of defendants in custody over cases of defendants under pretrial release; indeed, the pretrial risk ratios would be 1.0 in Table 6, the same as the risk ratio for split sentencing – if the courts processed cases in a first-come first-served manner. In light of the fact that prioritizing defendants in custody reduces the jail population relative to using first-come first-served, the high risk ratios in Table 6 are due to a systemic aspect of the criminal justice system that is not easily fixed (e.g., without significantly increasing court capacity), and hence split sentencing is intrinsically a more attractive option than pretrial release from a purely operational standpoint.

The slopes of the curves in Fig. 2 are $\approx -2$ crimes per jail-year, which is somewhat higher than the empirical estimate of -1.2 crimes per prison-year from CA realignment (although their estimate from a simpler cross county model is -2.5 crimes per prison-year) 40. It would be interesting to understand the reason for this discrepancy, particularly whether it is due to improved supervision or the localization of rehabilitation services during realignment. The additional crimes due to prison downsizing in 40 were not violent and were
dominated by auto thefts, at a cost of $9533 per crime. The differential cost of detention relative to supervision is ≈ $40k/yr ($113/day for detention \[41\] minus $1533/yr for probation, page 12 in \[42\]), implying a marginal return from incarceration of ≈ 50%, which is higher than the marginal return of 23% in \[40\]. In either case, a comparison with the marginal returns from additional police of 160% \[43\] or additional substance abuse disorder treatment of 156-300% \[44\] suggests that there may be more cost-effective ways than incarceration to reduce crime.

Conclusion

Although our results need to be confirmed by calibrating every aspect of the model with data from a single county, they suggest that split sentencing for all low-level felons is the key lever in managing the tradeoff between public safety and jail congestion, as demonstrated by a representative model and a powerful yet simple metric.

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References


Table 1: The 64 policies are all combinations of one option from each of the three columns. The numbers in the pretrial release columns are used in Fig. 3 to refer to these policies.

<table>
<thead>
<tr>
<th>Pretrial Release for Non-felony</th>
<th>Pretrial Release for Felony</th>
<th>Split-sentencing for Felony</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - no one</td>
<td>0 - no one</td>
<td>no one</td>
</tr>
<tr>
<td>1 - only low risk</td>
<td>1 - only low risk</td>
<td>only low risk</td>
</tr>
<tr>
<td>2 - low and medium risk</td>
<td>2 - low and medium risk</td>
<td>low and medium risk</td>
</tr>
<tr>
<td>3 - everyone</td>
<td>3 - everyone</td>
<td>everyone</td>
</tr>
</tbody>
</table>

Table 2: The pretrial release probabilities for the status quo policy in LA County (see §2 in SI for derivations). The status quo policy does not offer split-sentencing to any offenders.

<table>
<thead>
<tr>
<th>Charge</th>
<th>Risk</th>
<th>Probability of Pretrial Release</th>
</tr>
</thead>
<tbody>
<tr>
<td>non-felony</td>
<td>low</td>
<td>0.80</td>
</tr>
<tr>
<td>non-felony</td>
<td>medium</td>
<td>0.70</td>
</tr>
<tr>
<td>non-felony</td>
<td>high</td>
<td>0.60</td>
</tr>
<tr>
<td>felony</td>
<td>low</td>
<td>0.55</td>
</tr>
<tr>
<td>felony</td>
<td>medium</td>
<td>0.31</td>
</tr>
<tr>
<td>felony</td>
<td>high</td>
<td>0.10</td>
</tr>
<tr>
<td>Parameter Description</td>
<td>Parameter Value</td>
<td>Reference</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>---------------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>jail capacity</td>
<td>19,000</td>
<td>[6, 7]</td>
</tr>
<tr>
<td>interarrival times (days)</td>
<td>Erlang(shape = 2, scale = 1/395)</td>
<td>[8, §3 in SI]</td>
</tr>
<tr>
<td>time delay until arraignment</td>
<td>lognormal(3.87,0.51)</td>
<td>[9, §4 in SI]</td>
</tr>
<tr>
<td>proportion non-felony</td>
<td>0.558</td>
<td>[9]</td>
</tr>
<tr>
<td>proportion felony</td>
<td>0.442</td>
<td>[9]</td>
</tr>
<tr>
<td>proportion low risk</td>
<td>0.170</td>
<td>[10]</td>
</tr>
<tr>
<td>proportion medium risk</td>
<td>0.281</td>
<td>[10]</td>
</tr>
<tr>
<td>proportion high risk</td>
<td>0.549</td>
<td>[10]</td>
</tr>
<tr>
<td>time to recidivism, low risk</td>
<td>∞ with probability 0.23, \text{lognormal}(0.94,2.80)</td>
<td>[10, §5 in SI]</td>
</tr>
<tr>
<td>time to recidivism, medium risk</td>
<td>∞ with probability 0.23, \text{lognormal}(0.14,1.98)</td>
<td>[10, §5 in SI]</td>
</tr>
<tr>
<td>time to recidivism, high risk</td>
<td>∞ with probability 0.23, \text{lognormal}(-0.64,1.16)</td>
<td>[10, §5 in SI]</td>
</tr>
<tr>
<td>failure to appear, low risk</td>
<td>0.117</td>
<td>[11, §6 in SI]</td>
</tr>
<tr>
<td>failure to appear, medium risk</td>
<td>0.178</td>
<td>[11, §6 in SI]</td>
</tr>
<tr>
<td>failure to appear, high risk</td>
<td>0.178</td>
<td>[11, §6 in SI]</td>
</tr>
</tbody>
</table>

Table 3: Pre-disposition parameters and values for defendants. The two lognormal parameters are the mean and standard deviation of the underlying normal distribution.
<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Non-felony</th>
<th>Felony</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretrial</td>
<td>Pretrial</td>
<td>Pretrial</td>
</tr>
<tr>
<td>time from arraignment</td>
<td>gamma</td>
<td>gamma</td>
<td>lognormal</td>
</tr>
<tr>
<td>to disposition (days)</td>
<td>(1.07,119.78)</td>
<td>(0.46,16.80)</td>
<td>(5.13,0.47)</td>
</tr>
<tr>
<td>proportion dismissed</td>
<td>0.207</td>
<td>0.052</td>
<td>0.153</td>
</tr>
<tr>
<td>proportion probation</td>
<td>0.481</td>
<td>0.280</td>
<td>0.681</td>
</tr>
<tr>
<td>proportion jail (and</td>
<td>0.312</td>
<td>0.668</td>
<td>0.066</td>
</tr>
<tr>
<td>(probation if non-felony)</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>proportion prison</td>
<td>—</td>
<td>—</td>
<td>0.100</td>
</tr>
<tr>
<td>post-sentence jail term</td>
<td>gamma</td>
<td>gamma</td>
<td>lognormal</td>
</tr>
<tr>
<td>(days for non-felony,</td>
<td>(0.368,29.92)</td>
<td>(0.397,77.08)</td>
<td>(1.203,0.633)</td>
</tr>
<tr>
<td>months for felony)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>length of probation</td>
<td>triangular</td>
<td>triangular</td>
<td>triangular</td>
</tr>
<tr>
<td>(years)</td>
<td>(0,3,1)</td>
<td>(0,3,1)</td>
<td>(1,5,3)</td>
</tr>
</tbody>
</table>

Table 4: Parameters and values related to case disposition. The gamma parameters are the shape and the scale. The lognormal parameters are the mean and standard deviation of the underlying normal distribution. The triangular parameters are the minimum, the maximum, and the mode.
<table>
<thead>
<tr>
<th>Statistic</th>
<th>Simulation of Status Quo Policy</th>
<th>Reported Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean jail population</td>
<td>17,744 ±48</td>
<td>18,693 in 2013 [26]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17,712 in Oct. 2012 [27]</td>
</tr>
<tr>
<td>felons in jail</td>
<td>14,026 ±43 (79%)</td>
<td>17,259 (0.923) in 2013 [26]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.78 in Dec. 2011 [6]</td>
</tr>
<tr>
<td>non-felons in jail</td>
<td>3718 ±13 (21%)</td>
<td>1434 (0.077) in 2013 [26]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.22 in Dec. 2011 [6]</td>
</tr>
<tr>
<td>sentenced inmates</td>
<td>10,182 ±35 (57.4%)</td>
<td>8845 (0.473) in 2013 [26]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8378 (0.451) in June 2013 [28]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.55 in Dec. 2011 [6]</td>
</tr>
<tr>
<td>non-sentenced inmates</td>
<td>7562 ±19 (42.6%)</td>
<td>9848 (0.527) in 2013 [26]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10,198 (0.549) in June 2013 [28]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.45 in Dec. 2011 [6]</td>
</tr>
<tr>
<td>fraction of time overcrowded</td>
<td>0.151 ±0.009</td>
<td>0.132 in 2012 [6, 26]</td>
</tr>
</tbody>
</table>

Table 5: Model validation of the status quo policy.

<table>
<thead>
<tr>
<th>Decision</th>
<th>Mean Increase in Recidivism Exposure (Days)</th>
<th>Mean Reduction in Jail-Days</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>pretrial release of non-felony</td>
<td>128</td>
<td>8</td>
<td>16.0</td>
</tr>
<tr>
<td>pretrial release of felony</td>
<td>191</td>
<td>53</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Table 6: The tradeoff and its ratio. The means in the second and third columns are derived from the gamma and lognormal parameters in Table 4. The risk ratio is the second column divided by the third column. The risk ratio equals 1.0 for split sentencing of felons.
Figure Legends

**Fig. 1:** A depiction of the process flow. The two key decisions (dotted lines) are whether to offer pretrial release (denoted by PTR?) and split sentencing (SS?), where the latter is available only to felons. The key tradeoff is between public safety, as measured by recidivism (dashed lines), and jail population, which is the total number of inmates waiting for arraignment, in pretrial custody or serving a post-sentence jail term. Each arrival has a charge type (non-felony or felony) and a CSRA risk category (low, medium or high), and some of the routing probabilities and time durations are functions of charge type, risk category and/or pretrial status (release or custody).

**Fig. 2:** For each of the four options for split sentencing in the right column of Table 1, the optimal (i.e., optimizing over the remaining 16 options in Table 1) tradeoff curves of the annual rearrest rate vs. (a) the mean jail population and (b) mean jail overcrowding. The circle denotes the status quo policy for LA County in early 2014.

**Fig. 3:** For each of the four tradeoff curves in Fig. 2a, the optimal policy along the different points on the curve. Each policy is denoted by a pair of numbers, where the first number corresponds to the pretrial release for non-felonies (left column of Table 1) and the second number corresponds to the pretrial release for felons (middle column of Table 1).
Fig. 1
Fig. 3
1 Status Quo Pretrial Release Probabilities

To derive the six probabilities of pretrial release conditioned on risk category and charge that appear in Table 2 in the main text, we proceed in three steps: compute the pretrial detention probability conditioned only on risk category, then compute the pretrial detention probability conditioned only on charge, and then derive the probability of pretrial detention conditioned jointly on risk and charge.

We first derive the probability that a defendant of each risk category (regardless of charge) is released prior to trial, using a nationwide study of federal courts [1] and a study of Salt Lake County (UT) jails [2]. We note that – like LA County – the federal courts and Salt Lake County allow for commercial bail, bounty hunters and a uniform bail schedule. On page 31 of [1], risk categories 1 and 2 correspond to low risk, category 3 corresponds to medium risk, and categories 4 and 5 correspond to high risk. The five risk categories have equal numbers of defendants in them. By Fig. 23 in [1], the release probabilities are \((0.871+0.623)/2=0.747\) for low risk, 0.494 for high risk, and \((0.400+0.279)/2=0.3395\) for high risk.

The seven risk categories in [2] are equally probable by construction, with risk categories 1, 2-3, and 4-7 corresponding to low, medium and high risk (Table 17 in [2]). We denote the events that a defendant belongs to the low, medium and high risk category by \(L\), \(M\) and \(H\), and denote the events of pretrial release and detention by \(R\) and \(D\). Our goal is to compute conditional probabilities \(P(R|L)\), \(P(R|M)\) and \(P(R|H)\). By construction of the risk categories, we know \(P(L)=0.143\), \(P(M)=0.286\) and \(P(H)=0.571\). Table 19 of [2] gives the conditional probabilities \(P(L|R)=0.43\), \(P(L|D)=0.25\), \(P(M|R)=0.26\), \(P(M|D)=0.22\), \(P(H|R)=0.31\) and \(P(H|D)=0.53\). On page 5 of [2], the sample size includes 4,986 defendants with pretrial release interviews and 2,981 without pretrial release interviews. Of a random sample of 1,456 from
the 4986 defendants with pretrial release interviews, 390 were not released. Assuming that all 2981 defendants without pretrial release interviews were detained, we estimate that \((1-390/1456)\times 4986=3650\) were released and \((390/1456)\times 4986+2981=4317\) were detained, giving \(P(R)=0.458\) and \(P(D)=0.542\). We substitute all of these probabilities into the law of total probability to get

\[
P(R|L) = \frac{P(L|R)P(R)}{P(L|R)P(R) + P(L|D)P(D)} = 0.593. \tag{1}
\]

Replacing \(L\) in \((1)\) by \(M\) and \(H\) yields \(P(R|M)=0.500\) and \(P(R|H)=0.331\). Finally, taking an average of these conditional probabilities over the two studies \([1, 2]\), we assume that the probability of release for a defendant of low, medium or high risk is 0.667, 0.500 and 0.333, respectively. Therefore, the conditional probabilities of pretrial detention given risk category are \(P(D|L)=0.333\), \(P(D|M)=0.500\) and \(P(D|H)=0.667\).

Having derived the pretrial detention probabilities conditioned on risk, we now compute the pretrial detention probabilities conditioned on charge. By the top right box on page 79 of \([3]\), the probability that a felon in LA County was released is 0.23 and the probability that a defendant with a non-felony in LA County was released is 0.66. Letting \(N\) denote non-felony and \(F\) denote felony, the conditional probabilities of pretrial detention given charge are \(P(D|N)=0.34\) and \(P(D|F)=0.77\). Using the risk proportions in Table 1 of the main text, we find that the probability of being detained is \(P(D)=0.549(0.667)+0.281(0.500)+0.170(0.333) =0.563\).

Our goal now is to derive a mathematical expression for the conditional probability of pretrial detention given the charge type \(C\) (either \(N\) or \(F\)) and risk category \(R\) (either \(L\), \(M\) or \(H\)), which we denote by \(P(D|C,R)\), in terms of the probabilities \(P(D|R)\), \(P(D|C)\) and \(P(D)\) calculated above. By our assumption that \(C\) and \(R\) are independent, it follows that \(P(C|R)=P(C)\) and \(P(C|R,D)=P(C|D)\). By the definition of conditional probability, we have \(P(C|D)=P(C,D)/P(D)\) and \(P(C|R,D)=P(C,D|R)/P(D|R)\). Substituting the right sides
of these two equations into \( P(C\mid R, D) = P(C\mid D) \) yields \( P(C\mid R) / P(D\mid R) = P(C\mid D) / P(D) \). Substituting \( P(D\mid C) P(C) \) for \( P(C, D) \) in this equation and rearranging gives

\[
\frac{P(C, D\mid R)}{P(C)} = \frac{P(D\mid C) P(D\mid R)}{P(D)}.
\] (2)

Finally, we find that

\[
P(D\mid C, R) = \frac{P(D, C\mid R)}{P(C\mid R)}, \quad \text{because } C \text{ and } R \text{ are independent},
\] (3)

\[
= \frac{P(D, C\mid R)}{P(C)}
\] (4)

\[
= \frac{P(D\mid C) P(D\mid R)}{P(D)} \quad \text{by (2)}. \quad \text{(5)}
\]

Substituting the numerical values above into the right side of (5) and then noting that the conditional probability of release given crime type and risk category is \( 1 - P(D\mid C, R) \), we get the conditional release probabilities in Table 2 of the main text.

### 2 Pretrial Release After Recidivism

According to Table 2 of [3], 20-21% of felons in LA County receive financial release. Table 19 in the Appendix of [4] states that 19% of felons receive financial release in LA County, confirming the numbers in [3]. When averaged over the 75 largest counties in the U.S., Table 6 in [4] states that 33% of felons receive financial release and Table 8 in [4] states that 18% of felons with custody history receive financial release. Extrapolating these nationwide numbers back to LA County, we estimate that \( 18(19) / 33 = 10.4\% \) of felons in LA County with custody history receive financial release. For lack of data on non-felony defendants, we assume that 20% (10%, respectively) of defendants charged with non-felonies (respectively, felonies) during a recidivism event receive financial release.
3 Interarrival Times

The arraignments under custody from the LA County Sheriff’s Department’s Year in Review reports (e.g., [5]) for the years 2008-2012 give an average of 350.4/day with no obvious long-term trend (Table 1). There is little variability over the time of year (page 36 of Appendix C in [3]), and we ignore the fact that fewer arraignments occur over the weekend (page 34 of Appendix C in [3]). We estimate the squared coefficient of variation (i.e., the variance divided by the square of the mean) of the interarrival times to be 0.465 from the data in Table 1 by assuming that the times between consecutive arrivals are independent and identically distributed. The Erlang distribution is characterized by its shape parameter and scale parameter. The Erlang shape parameter is the reciprocal of the squared coefficient of variation, and so we set the shape parameter equal to two. The mean of an Erlang distribution is the product of its shape and scale parameters. Because the arrival rate of 350/day includes recidivists, who account for slightly less than half of the total number of arrivals, we adjust the rate of new arrivals to be 193/day so that the total arrival rate is 350/day. This yields a shape parameter of 1/395.

4 Time to Arraignment

Arraignment data from LA County in 2008 states that 4% of defendants were arraigned within 24 hours of arrest, 56.4% were arraigned within 48 hours, 70.4% were arraigned within 72 hours, and 95% were arraigned within 96 hours (page 63 of [3]). The maximum likelihood estimate for the lognormal parameters from these data yield the values in Table 3 of the main text.
5  Time to Recidivism

Let the cumulative distribution function (CDF) $F(t; \Theta, j)$ be the probability that an offender recidivates within $t$ time units of being released, given that he is of risk category $j$ (where $j = 1, 2, 3$ correspond to low, medium and high risk) under parameter set $\Theta$. These CDFs are specified for our five models in Table 2. Let $N_j$ be the number of offenders in the CSRA cohort with risk category $j$, where $N = \sum_{j=1}^{3} N_j$. Let $N_{jk}$ be the number of offenders in the CSRA cohort with risk category $j$ that did not recidivate within $k - 1$ years but did recidivate within $k$ years. The data from [6] are $N = 110,313$, $N_1 = 18,768$, $N_2 = 31,024$, $N_3 = 60,521$, $N_{11} = 4845$, $N_{12} = 1681$, $N_{13} = 641$, $N_{21} = 12,002$, $N_{22} = 3403$, $N_{23} = 1269$, $N_{31} = 33,243$, $N_{32} = 7925$ and $N_{33} = 2584$. We choose the values of $\Theta$ to maximize the log-likelihood function,

$$
\begin{align*}
\sum_{j=1}^{3} N_{j1} \log F(1; \Theta, j) + \sum_{j=1}^{3} N_{j2} \log (F(2; \Theta, j) - F(1; \Theta, j)) \\
+ \sum_{j=1}^{3} N_{j3} \log (F(3; \Theta, j) - F(2; \Theta, j)) + \sum_{j=1}^{3} (N_j - N_{j1} - N_{j2} - N_{j3}) \log (1 - F(3; \Theta, j)).
\end{align*}
$$

The estimation results (Table 3) suggest that the lognormal models outperform the proportional hazards models (as measured by the negative log-likelihood values), and the split is statistically significant in the lognormal model only if we incorporate risk-associated heteroskedasticity. We use the split lognormal model with heteroskedasticity, and the three probability density functions (one for each risk category) are pictured in Fig. 1. Using quarterly average cumulative recidivism probabilities for three years from Fig. 2 of [6], we perform a granular cross-validation and find that the pointwise root mean square error between the predicted (by the split lognormal model with heteroskedasticity) and actual probabilities is 0.022, with a pointwise maximum difference of 0.049.
6 Failure To Appear

We use a validation study of COMPAS for predicting failure to appear in court in Broward County, FL [7]. COMPAS’s 10 risk scores were aggregated into CSRA’s three risk categories, where scores 1-4, 5-7 and 8-10 correspond to low, medium and high risk (page 20 of [7]). Table 13 in [7] gives failure-to-appear probabilities for the three risk groups at six different follow-up periods, but does not provide information on the time from arraignment to disposition. Hence, we cannot attempt to estimate (e.g., via logistic regression) whether the failure-to-appear probability depends on the arraignment-to-disposition delay. To minimize right-censoring (i.e., due to a case disposition date that is far in the future), we use their largest follow-up period of 12 months; these data are reproduced in Table 4. Because the failure-to-appear probability is slightly higher for medium risk than high risk (the same is true for follow-up periods of three months and six months in Table 13 in [7]), we combine medium risk and high risk in our analysis. Hence, we assume that the failure-to-appear probability is 0.117 for low risk and is \[ \frac{456(0.180)+163(0.172)}{456+163} = 0.178 \] for both medium risk and high risk.

7 Time from Arraignment to Case Disposition

Because the time from arrest to arraignment is typically much smaller than the time from arraignment to disposition, we use arrest-to-disposition time data from pages 55-56 in [3], which appear in Table 5 to estimate the time from arraignment to disposition, using both gamma and lognormal distributions. Lognormal provides a better fit (using the Kolmogorov distances in Table 5) for felonies in pretrial release, and gamma (with an increasing failure rate for those released and a decreasing failure rate for those in custody) provides a better fit for felonies under pretrial custody and for all non-felonies.
8 Case Disposition Probabilities

The 14 case disposition probabilities in Table 4 in the main text are derived in three groups. Ignoring the ongoing cases in Table 4 of [3] and combining acquitted and dismissed cases, we estimate the four proportion dismissed values that appear in Table 4 in the main text (e.g., for felons on pretrial release, \((1635+46)/(12,154-1168)=0.153\)).

We denote the proportion of non-felony charges that are put on probation after pretrial release, put on probation after pretrial custody, receive a jail sentence after pretrial release and receive a jail sentence after pretrial custody by \(p_1\), \(p_2\), \(p_3\) and \(p_4\), respectively. We jointly solve for these four unknowns using four equations. The first two equations use the proportion dismissed values, 0.207 and 0.052, in Table 4 in the main text:

\[
\begin{align*}
    p_1 + p_3 &= 1 - 0.207, \quad (7) \\
p_2 + p_4 &= 1 - 0.052. \quad (8)
\end{align*}
\]

The third equation specifies that the proportion of all non-felony charges that result in jail sentences is \(7310/16,891 = 0.433\) (page 129 of [3]):

\[
0.66p_3 + (1 - 0.66)p_4 = 0.433, \quad (9)
\]

where 0.66 was estimated in §1. The final equation uses the result that the odds ratio to be jailed for a non-felony in pretrial custody relative to a non-felony under pretrial release is 4.44 (page 10 in [8]):

\[
\frac{p_4(1-p_3)}{p_3(1-p_4)} = 4.44. \quad (10)
\]

Solving (7)-(10) jointly gives the proportions in Table 4 in the main text.

The remaining six case disposition probabilities are derived jointly. We denote the proportion of felons who are put on probation after pretrial release, put on probation after pretrial custody, receive a jail sentence after pretrial release, receive a jail sentence after
pretrial custody, are sent to prison after pretrial release, and are sent to prison after pretrial
custody by $p_5$, $p_6$, $p_7$, $p_8$, $p_9$ and $p_{10}$, respectively. We jointly solve for these six unknowns
using six equations. The first two equations use the proportion dismissed values, 0.153 and
0.069:

$$p_5 + p_7 + p_9 = 1 - 0.153,$$
$$p_6 + p_8 + p_{10} = 1 - 0.069.$$  \tag{11} \tag{12}

The third equation states that the proportion of felons that get probation is, using the last
four columns in Table 1 in [9], $23,476/41,725=0.563$:

$$0.23p_5 + (1 - 0.23)p_6 = 0.563,$$  \tag{13}

where 0.23 was estimated in [11] Similarly, the fourth equation specifies that the proportion
of all felons that receive jail sentences is $(7407+125)/41,725 = 0.181$ (the last four columns
in Table 1 in [9]):

$$0.23p_7 + (1 - 0.23)p_8 = 0.181.$$ \tag{14}

As in (10), the fifth equation uses the result that the odds ratio to be jailed for a felony in
pretrial custody relative to a felony under pretrial release is 3.32 (page 10 in [8]):

$$\frac{(p_8 + p_{10})(1 - p_7 - p_9)}{(p_7 + p_9)(1 - p_8 - p_{10})} = 3.32.$$ \tag{15}

The sixth equation states that the probability of pretrial release given a prison charge (as
opposed to a prison sentence) is 0.15 (page 57 in [3]), which we derive using Bayes rule as
follows. Using the proportion dismissed values 0.153 and 0.069, we find that the probability
of a prison charge given pretrial release is $p_9/(1 - 0.153)$, and the probability of a prison
charge given pretrial custody is $p_{10}(1 - 0.069)$. Because the probability of pretrial release for
a felony is 0.23 ([1]), it follows from Bayes rule that the sixth equation is

\[
0.23 \left( \frac{p_9}{1-0.153} \right) \quad 0.23 \left( \frac{p_{10}}{1-0.069} \right)
\]

Simultaneously solving (11)-(16) gives the proportions in Table 4 in the main text.

9 Post-sentence Jail Terms

We fit mixture (of pretrial release and pretrial custody) gamma and lognormal distributions for jail sentences for non-felonies using data on page 129 in [3] and Fig. 25 in Appendix C in [3], and for jail sentences for felonies using data in Chart 3 in [10]. The data (reproduced in Table 6) are of the form: \( N_i \) offenders have jail terms in the interval \((a_i, a_{i+1}]\) for \( i = 1, \ldots, 7 \), where \( \sum_{i=1}^{7} N_i = N \). We consider the mixture CDF

\[
F(x; \Theta) = \frac{w_R}{w_R + w_D} G(x; \Theta_R) + \frac{w_D}{w_R + w_D} G(x; \Theta_D),
\]

where \( R \) and \( D \) denote the populations that are in pretrial release and pretrial detention, respectively, and \( w_R \) and \( w_D \) are weights proportional to the sizes of these two populations. Because 66% of non-felonies and 23% of felonies receive pretrial release ([1]), and 55.8% of defendants are charged with felonies (Table 3 of the main text), we have that \( w_R = 0.66(0.558) = 0.368 \) and \( w_D = 0.34(0.558) = 0.190 \) for non-felonies, and \( w_R = 0.23(0.442) = 0.102 \) and \( w_D = 0.77(0.442) = 0.340 \) for felonies. We consider two cases: \( G(x) \) is lognormal with parameters \( (\mu, \sigma) \) and \( G(x) \) is gamma with scale parameter \( k \) and shape parameter \( \theta \), where \( R \) and \( D \) are subscripts on the parameters in (17) to denote the released or detained populations. We use a constrained maximum likelihood approach, where we require the mean jail sentence for non-felonies to be 2.78 times longer for those undergoing pretrial detention relative to those receiving pretrial release, and the mean jail sentence for felonies to be 2.36 times longer for those undergoing pretrial detention relative to those receiving
pretrial release (page 10 of [8]). Hence, setting $r = 2.78$ for non-felonies and $r = 2.36$ for felonies, and setting $F(0; \Theta) = 0$ and $F(\infty; \Theta) = 1$, we solve

$$
\min_{\Theta=(\Theta_R, \Theta_D)} - \sum_{i=1}^{7} N_i \ln(F(a_{i+1}; \Theta) - F(a_i; \Theta)),
$$

subject to

$$
e^{\mu_D + \sigma_D^2/2} = r e^{\mu_R + \sigma_R^2/2} \quad \text{if } G(x) \text{ is lognormal},
$$

subject to

$$
k_D \theta_D = r k_R \theta_R \quad \text{if } G(x) \text{ is gamma}.
$$

The results appear in Table [7] and we adopt the distribution with the lower negative log-likelihood: gamma for non-felonies and lognormal for felonies.
References


<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Arraignments Under Custody</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>122,436</td>
</tr>
<tr>
<td>2009</td>
<td>126,352</td>
</tr>
<tr>
<td>2010</td>
<td>130,959</td>
</tr>
<tr>
<td>2011</td>
<td>134,271</td>
</tr>
<tr>
<td>2012</td>
<td>125,965</td>
</tr>
</tbody>
</table>

Table 1: Raw data to estimate the interarrival time distribution [5].

<table>
<thead>
<tr>
<th>Model</th>
<th>Parameter Set (Sign Constraint)</th>
<th>CDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>lognormal</td>
<td>( \beta(-), \mu, \sigma(+) )</td>
<td>( \frac{1}{2} \left( 1 + \text{erf} \left( \frac{\ln t - \mu - \beta T x}{\sqrt{2} \sigma} \right) \right) )</td>
</tr>
<tr>
<td>split lognormal</td>
<td>( \beta(-), \mu, \sigma(+), \delta(+) )</td>
<td>( \frac{\delta}{2} \left( 1 + \text{erf} \left( \frac{\ln t - \mu - \beta T x}{\sqrt{2} \sigma} \right) \right) )</td>
</tr>
<tr>
<td>split lognormal with heteroskedasticity</td>
<td>( \beta(-), \mu, \sigma(+), \delta(+), \gamma(-) )</td>
<td>( \frac{\delta}{2} \left( 1 + \text{erf} \left( \frac{\ln t - \mu - \beta T x}{\sqrt{2} (\sigma + \gamma T x)} \right) \right) )</td>
</tr>
<tr>
<td>proportional hazards</td>
<td>( \beta(+), \lambda )</td>
<td>( 1 - e^{(-\lambda t)^{\alpha x}} )</td>
</tr>
<tr>
<td>split proportional hazards</td>
<td>( \beta(+), \lambda, \delta(+) )</td>
<td>( \delta \left( 1 - e^{(-\lambda t)^{\alpha x}} \right) )</td>
</tr>
</tbody>
</table>

Table 2: Five survival models for time to recidivism.

<table>
<thead>
<tr>
<th>Model</th>
<th>( \beta )</th>
<th>( \mu )</th>
<th>( \sigma )</th>
<th>( \delta )</th>
<th>( \gamma )</th>
<th>( \lambda )</th>
<th>NLL</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>lognormal</td>
<td>-1.10</td>
<td>2.94</td>
<td>2.59</td>
<td></td>
<td></td>
<td></td>
<td>118,698</td>
<td>base</td>
</tr>
<tr>
<td>split lognormal</td>
<td>-1.10</td>
<td>2.94</td>
<td>2.59</td>
<td>1.00</td>
<td></td>
<td></td>
<td>118,698</td>
<td>1.00</td>
</tr>
<tr>
<td>split lognormal with heteroskedasticity</td>
<td>-0.80</td>
<td>1.74</td>
<td>3.62</td>
<td>0.77</td>
<td>-0.82</td>
<td></td>
<td>118,310</td>
<td>&lt; 10^{-3}</td>
</tr>
<tr>
<td>proportional hazards</td>
<td>0.56</td>
<td>(1.64,1.84)</td>
<td>(3.51,3.74)</td>
<td>(0.76,0.78)</td>
<td>-0.78,0.87</td>
<td>0.10</td>
<td>129,390</td>
<td>base</td>
</tr>
<tr>
<td>split proportional hazards</td>
<td>0.69</td>
<td></td>
<td>0.69</td>
<td>0.18</td>
<td></td>
<td></td>
<td>120,522</td>
<td>&lt; 10^{-3}</td>
</tr>
</tbody>
</table>

Table 3: Results from the maximum likelihood estimation in [6], with 95% confidence intervals in parentheses for the two models that provide the best fit. NLL is negative log-likelihood, and p-value is the likelihood ratio test of the enhanced model relative to the base (lognormal or proportional hazards) model.

<table>
<thead>
<tr>
<th>Risk Category</th>
<th>Sample Size</th>
<th>Failure-to-Appear Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>low</td>
<td>1901</td>
<td>0.117</td>
</tr>
<tr>
<td>medium</td>
<td>456</td>
<td>0.180</td>
</tr>
<tr>
<td>high</td>
<td>163</td>
<td>0.172</td>
</tr>
</tbody>
</table>

Table 4: Raw data for estimation of the failure-to-appear probabilities, reproduced from Table 13 in [7]. The sample size is the number of defendants in each risk category who did not recidivate during their first 12 months under pretrial release. The failure-to-appear probability is the proportion of these defendants who failed to appear for a court date during their first 12 months of pretrial release.
Table 5: Fit of gamma and lognormal models to data on time to case disposition. The 50th and 90th columns refer to the median and 90th fractile. The gamma parameters are the shape and scale, the lognormal parameters are the mean and standard deviation of the underlying normal distribution, K refers to the Kolmogorov distance, P refers to the Pearson’s goodness-of-fit statistic with three categories (0-29 days, 30-131 days, and >132 days), and *, ** and *** refer to p-values that are less than 0.05, 0.01 and 0.001, respectively (meaning that there is evidence to reject the null hypothesis that the data are from the specified distribution).

Table 6: Raw data for estimation of the length of jail sentences. \( N_i \) is the number of offenders whose jail sentence was in the interval \([a_i, a_{i+1})\). We have \( a_8 = \infty \) for non-felonies (page 129 in [3]) and \( a_8 = 252 \) (Chart 3 in [10]). The population values for felonies were derived by multiplying the probabilities in [3] and [10] times the respective sample sizes of 7310 and 8336, and then rounding to the nearest integer.

Table 7: Results of maximum likelihood estimation in (18)-(20) for lengths of jail sentences. NLL denotes negative log-likelihood.
Fig. 1: The lognormal probability density functions for the time to recidivism for the three risk categories.
Fig. 2: For each of the four tradeoff curves in Fig. 2b in the main text, the optimal policy along the different points on the curve. Each policy is denoted by a pair of numbers, where the first number corresponds to the pretrial release for non-felonies (left column of Table 1 in the main text) and the second number corresponds to the pretrial release for felonies (middle column of Table 1 in the main text).
Fig. 3: For each of the four options for split sentencing in the right column of Table 1, the optimal (i.e., optimizing over the remaining 16 options in Table 1) tradeoff curves of the annual rearrest rate vs. (a) the mean jail population and (b) mean jail overcrowding, restricting to policies that treat felonies at least as strictly (with respect to pretrial release) as non-felonies of the same risk category. The circle denotes the status quo policy for LA County in early 2014.