The Supreme Court and Percolation in the Lower Courts: An Optimal Stopping Model

Tom S. Clark   Emory University
Jonathan P. Kastellec   Princeton University

We examine how the Supreme Court learns from lower court decisions to evaluate new legal issues. We present a theory of optimal stopping in which the Court learns from successive rulings on new issues by lower courts but incurs a cost when lower courts come into conflict with one another. The Court faces a strategic trade-off between allowing conflict to continue while it learns about a new legal issue and intervening to end a costly conflict between the lower courts. We evaluate how factors such as the quality of lower courts, the distribution of judicial preferences, and the timing of the emergence of conflict affect how the Court weighs this trade-off. We provide empirical evidence that supports one of the theory's novel predictions: the Court should be more likely to end a conflict immediately when it emerges after several lower courts have already weighed in on a new legal issue.

Justices like the smell of well-percolated cases –
H.W. Perry (1991, 230)

With few exceptions, judiciaries are organized hierarchically, with trial courts at the bottom of the system, sitting below intermediate appellate courts in the middle and a court of last resort at the top.[1] The fact that a single court has to oversee an entire judiciary—essentially, a massive bureaucracy—creates a significant potential problem for the judges of a high court: how can they ensure that judges at the lower levels follow their wishes? In the United States, this problem is particularly acute, given that, unlike in most hierarchical organizations, superior judges in judicial hierarchies have few formal tools with which to compel compliance. Even more problematically, the U.S. Supreme Court today hears only about 70 cases per term, meaning lower court judges are effectively disposing of all but a relative handful of legal cases in the United States.

A wealth of research in the last two decades has examined how the Supreme Court (as principals) can effectively oversee lower court judges (its agents). Potential solutions include strategic auditing by the Supreme Court (Cameron, Segal, and Songer 2000); fire alarms by litigants in the form of strategic appeals or amicus briefs (Caldeira and Wright 1988; Songer, Cameron, and Segal 1995); judicial whistle-blowing by judges in the lower levels of the form in dissent (Cross and Tiller 1998; Kastellec 2007); and the Supreme Court's Rule of Four (Lax 2003). The common thread to this line of inquiry is that is the Court is perceived as engaged in *error correction*; in this view, hierarchy creates *costs* for the Court, in the form of potential noncompliance.

It is sometimes forgotten that hierarchy creates *benefits* for the Supreme Court as well. Because their docket is so selective, the justices use most of these cases not to engage in simple error correction of lower courts; instead, they can focus on taking cases that present novel and important questions of law. Indeed, the Court expressly claims its primary function is not error correction, but *law creation*. Seen in this light, the more significant problem for the Court is not ensuring compliance by errant lower courts but rather learning about how the rules it creates will play out in practice. This evaluation presents the justices with an opportunity: the fact that its agents make decisions allows the Supreme Court to *learn* from lower courts. Thus, rather than a *problem* to be mitigated, hierarchy may represent a *solution* to the Court's law creation problem, which is:

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[1]An online appendix containing supplemental information for this article is available at http://journals.cambridge.org/jop. Replication code and data and supporting materials needed to reproduce the numerical results can be found at http://dvn.iq.harvard.edu/dvn/dv/jkastellec.

how can the Court create good law in the face of inherent uncertainty?

In this article we develop a theory of how the Supreme Court evaluates new legal issues and leverages information from lower courts in creating legal policy. We model the Court's monitoring of lower court decisions about issues as a learning process in which the Court uses this information to learn about its preferred resolution of a new legal issue. In particular, we focus on the role of judicial *conflict* in informing the Supreme Court. We begin by assuming that lower court decisions provide information to the justices. As more lower courts reach a similar conclusion, the justices can update their beliefs accordingly about whether that conclusion is the preferred one. On the other hand, if the lower courts are more equally divided about an issue, the Supreme Court may struggle to identify its preferred outcome. Of course, if the justices incurred no costs when leaving a legal question or conflict unresolved, then they could simply let an issue percolate indefinitely, allowing many lower courts to reach decisions. However, there is an inherent trade-off involved in allowing a conflict to persist—conflict also imposes costs on the legal system by increasing the unpredictability of the law and by decreasing the uniformity of the law across jurisdictions where lower courts reach conclusions that are in conflict. Thus, learning about an issue comes at a cost.

We capture this trade-off by modeling the Supreme Court's oversight of lower court conflict as an *optimal-stopping problem*: Given the emergence of a new legal question, the Court seeks to find an optimal point at which to grant cert and decide an issue, rather than allowing it to persist further. Whether a conflict emerges in the lower court plays a large role in determining this optimal-stopping point. Our model is the first to capture this tension and is one of only a handful of formal models of law creation and learning, joining such articles as Cooter, Kornhauser, and Lane (1979), Gennaioli and Shleifer (2007), and Baker and Mezzetti (2010).

The article proceeds as follows. We begin by reviewing the importance of learning and conflict in the Supreme Court's case-selection decisions. We next introduce a "baseline" model of optimal stopping. We then turn to an "extended" model in which preferences vary across the levels of the hierarchy. In these models, we evaluate how factors such as the quality of lower courts, the distribution of judicial preferences, and the timing of the emergence conflict influence how the Court weighs the trade-off between learning and the cost of conflict. Finally, we provide empirical evidence that supports one novel prediction of the theory: the extent to which conflict among the lower courts induces the Court to intervene and resolve the conflict depends on how many previous courts have ruled on the question.

The Supreme Court, *Certiorari,* and Conflict

Spurred by the observation that the Supreme Court cannot feasibly oversee all lower court decision making, scholarship on the judicial hierarchy traditionally focuses on the question: why do lower courts comply with the Supreme Court? This research is largely concerned with how the judicial hierarchy can help resolve the lower courts' ability and incentive to "shirk" and disregard Supreme Court dictates. A line of inquiry stretching back as far as Schubert (1958) has examined whether the justices use their discretionary review strategically by engaging in "aggressive grants" and "defensive denials"—deciding to hear cases where they believe their favored outcome will gather the support of a majority of justices and denying petitions where they believe they will lose on the merits, respectively (Boucher and Segal 1995; Ulmer 1972, *inter alia*). Formal models of the cert process paired with empirical analysis have found substantial evidence of aggressive grants and defensive denials (Caldeira, Wright, and Zorn 1999) as well as strategic review in the context of interactive games between higher and lower courts (Cameron, Segal, and Songer 2000; Clark 2009; Lax 2003).

These models, though, generally privilege *error correction* as a motivation for discretionary jurisdiction, modeling certiorari decisions as what Perry (1991, 274–75) labels "outcome mode" decision making. However, there exists another, arguably more important, mode of decision making, which Perry labels the "jurisprudential" mode. When operating from this perspective, the Court is less concerned with the outcome of the particular case, but rather how it can use the particular case to achieve doctrinal goals that extend beyond the instant case. Importantly, scholars of the courts generally recognize that high courts, such as the Supreme Court, operate primarily in the jurisprudential mode, rather than the outcome mode. Because almost every case that reaches the Court in the form of a cert petition has already been reviewed by at least one appellate court, the justices are generally reticent to operate as an error-correction institution and instead prefer to play the role of providing

uniformity in the law, and interpreting the U.S. Constitution when necessary. Chief Justice Vinson (1949) nicely captured this viewpoint: "The Supreme Court is not, and never has been, primarily concerned with the correction of errors in lower court decisions. ... The function of the Supreme Court is ... to resolve conflicts of opinion on federal questions that have arisen among lower courts, to pass upon questions of wide import under the Constitution, laws, and treaties of the United States, and to exercise supervisory power over the lower federal courts" (quoted in Stern and Gressman 1978, 255). In brief, the literature on Supreme Court oversight of lower courts overemphasizes a minor function the Court plays—correcting errors below—and underemphasizes a critical, primary role for the Court—the establishment and maintenance of uniform, consistent law throughout the country. As Cameron, Segal, and Songer acknowledge in presenting their outcome-oriented model of the cert process, the "role of certiorari in enforcing doctrine [offers] a very partial view of process," and "equally important is the selection of cases as vehicles for creating *new* doctrine," which "often occur in the context of inter-circuit conflict" (2000, 102).

Intercircuit conflict occurs when two Courts of Appeals (the intermediate appellate courts whose jurisdiction is geographically defined) reach conflicting decisions on the same legal question. The empirical literature on certiorari has documented this as an important predictor of the Supreme Court's decision to exercise discretionary jurisdiction (e.g., Caldeira and Wright 1988). The reason is directly connected to the Court's function as a body responsible for the uniformity of the law, rather than its role as an error-correcting institution. Usually, though not always, circuit conflicts occur because the Supreme Court has not articulated a legal rule that is directly on point, meaning there exists a void in the national body of law. Reconciling discrepancies in the law and filling voids in doctrine is precisely the job of the Supreme Court.

Of course, the Court's ability to do this job effectively depends on it having information on how best to resolve unanswered legal questions. With few institutional resources, the Supreme Court depends crucially on litigation in lower courts to yield information about the relationship between legal rules and outcomes in the real world. One of the key sources of information of which the Court can make use of "percolation" on the issue in the lower courts. As Justice Ginsburg wrote, "We have in many instances recognized that when frontier legal problems are presented, periods of 'percolation' in, and diverse opinions from, state and federal

appellate courts may yield a better informed and more enduring final pronouncement by this Court" (*Arizona v. Evans*, 514 U.S. 1, 23, n.1 (1995)). A case can be said to be "well-percolated" when a number of courts have weighed in on a legal issue, providing the justices with multiple lower court opinions to consider. And, in fact, there is systematic evidence that, when settling inter-circuit conflicts, the justices base their decisions on how the percolation process develops in the lower courts. Evaluating the Court's resolution of circuit conflicts from 1985 to 1995, Lindquist and Klein (2006) found that the justices were likely to support the position taken by a majority of the circuits weighing in on the conflict.

Conflict among lower courts presents the Supreme Court with two important considerations that are inherently in tension. The first consideration is that a conflict, by definition, harms the uniformity of the law. For example, following the Supreme Court's 2005 decision in *United States v. Booker*, which ruled that federal district court judges were to treat the U.S. sentencing guidelines as advisory rather than mandatory, several circuit splits emerged as the Courts of Appeals dealt with the ramifications of the decision (Harrison 2008). As a consequence, defendants with similar cases faced different standards of appellate review of their sentences, depending on where they committed their crimes. Given their role as promoters of uniformity on the law, this first consideration is one in favor of intervening when a conflict arises. As one justice told Perry, it is "intolerable to have a certain law for the people in the Second Circuit and something else for the people in the Eighth" (1991, 247).

At the same time, legal conflict provides a potential benefit. Multiple lower-court decisions regarding a legal issue may provide information to the justices about which way the conflict should be resolved. The simplest form of conflict occurs when one circuit decides a legal issue one way and then another circuit reaches the opposite conclusion, putting the circuits in conflict. In this case, two courts have ruled on the legal issue. The Supreme Court can decide to resolve this conflict as soon as the conflict emerges with the decision by the second court. Doing so swiftly eliminates the lack of uniformity in the law created by the conflict, by settling the issue. This course of action, however, comes at a cost. Specifically, it eliminates the Court's ability to take advantage of further percolation in the lower courts, limiting its ability to learn more about the underlying issue by allowing other lower courts to make their own independent judgments. It chooses to forego the additional information it might glean from allowing the legal question to further play out in the lower courts.

Moreover, the Court's resolution will create a new precedent that the justices will be hesitant to overturn, at least in the immediate future.

Conflict as an Optimal-Stopping Problem

Given the trade-off between the information gleaned from percolation versus the costs of an ongoing conflict, we view the Court's review of new issues and legal conflict at the cert stage as an *optimal–stopping problem*. The theory of optimal-stopping involves decision-theoretic problems where an agent chooses a time or point to take a given action and end a sequence of events in order to maximize benefits and minimize costs (Chow, Robbins, and Siegmund 1971; Ferguson N.d.). Though political science applications of optimal-stopping models are still relatively rare, a few recent studies have used them to study such phenomena as FDA drug-approval decisions (Carpenter 2002), the decision by an incumbent government to call an election (Kayser 2005), and the decision to continue confirmation hearings for a judicial nominee (Cameron 2009). We contribute to the growing literature by applying the logic of optimal stopping to substantive political problems by considering how the Supreme Court uses it supervision of the lower courts to create law.

The Models

Overview. Formal models of the judicial hierarchy generally fall into two broad camps: team models and principal-agent models. Team-theoretic models assume that judges share the same preferences and explore how hierarchical institutions can minimize the number of legal errors and thus maximize the number of correct decisions; the problem is that hidden information may make it difficult for judges to uncover the correct decision in some cases, given an existing legal rule (Cameron and Kornhauser 2006). Agency models, on the other hand, endow judges with varying political preferences and explore how hierarchical institutions can minimize noncompliance by lower court judges (see e.g., Clark 2009; Kastellec 2007; Songer, Segal, and Cameron 1994).

We present two versions of our optimal-stopping model. In both we adopt a definition of correctness that is akin to the team-theory view (although our model differs from existing work in that the existence of a legal rule is usually assumed): if judges had no information constraints, the correct rule would be the one that gives them the most utility as that rule is applied going forward. For example, to use this contextual example from Baker and Mezzetti (2010), given perfect information, a court would choose a threshold in tort cases to deter motorists from driving too dangerously while at the same time not imposing too many costs on society in the form of excessive regulation. Importantly, this definition of correctness is consistent with both legalistic interpretation of preferences (e.g., pragmatist judges might have different ideal thresholds than formalist judges) as well as political interpretations (e.g., conservative judges might seek higher thresholds for negligence than liberal judges). In either case, the inherent uncertainty of judicial decision-making limits the ability of judges to make correct decisions.

In addition, in both models, we black box the process by which lower courts make decisions and do not allow lower courts to learn from prior lower courts' decisions.[2] We discuss the implications of relaxing this assumption below. Each model, however, allows lower-court judges to vary in quality, as we explain below. Our two models differ in their assumptions about the nature of preferences across the hierarchy. In the "baseline" model, we assume that all judges across the hierarchy have similar preferences—this models falls squarely in the team-theory camp. In the extended model, we allow for the divergence of preferences among the Supreme Court and the lower courts and thus an evaluation of the effect of varying preferences on percolation. The extended model draws on both principal-agent models of the judicial hierarchy and related literature on bureaucratic organizations that has examined how under certain conditions, principals may leverage information from multiple agents to improve the quality of their decision making (see, e.g., Battaglini 2004; Dewatripont and Tirole 1999; Wolinsky 2002, *inter alia*). While, in contrast to these studies, we treat our agents—i.e., lower courts—as nonstrategic, our focus on how the Supreme Court obtains information from its agents flows naturally from this literature.

The Baseline Model

Players, rules, and sequence of decisions. We model a decision made by a Supreme Court, denoted

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[2]Given the lack of horizontal *stare decisis* across circuits, lower courts are not obligated to follow the decisions of courts in other circuits. However, as Klein (2002) demonstrates, three-judge panels are sometimes persuaded by the reasoning of panels in other circuits.

SC, with information from the lower courts making decisions in T possible periods, with individual periods denoted by t. In doing so, we adopt the structure of the Bayesian sequential-analysis model developed in Ross (1983, 58–59). The model begins in period $t = 1$, with a lower court deciding a *case of first impression*. That is, a lower-court decides a case that concerns a legal question not previously addressed by the courts. Let $x_{\ell t}$ denote the tth lower-court to rule on a new issue. We begin by assuming an infinite horizon of possible lower-court decisions; we move to a finite horizon model below. The task for the lower court is to select a legal rule. While we do not directly model the lower courts' decisions, we assume lower courts make their best judgments about the proper rule in light of the facts of a case. We assume the lower court selects one of two possible rules, $x_{\ell t} \in \{A, B\}$. For ease of exposition, let A_t and B_t denote a decision of A or B by a lower court at t, respectively. There are two ways to motivate this simplification. First, the dichotomous choice of a legal rule can be thought of as a simplification of a continuum of possible legal rules. Second, while some legal questions present a continuum of possible solutions, the majority of decisions judges make are, in fact, dichotomous (Kornhauser 1992, 443). May suspects be questioned without being informed of their rights against self-incrimination? Do police need a warrant to seize evidence in plain sight?

Let $x_{\ell 1} = A$ denote the scenario where the first lower court to decide on the issue chooses rule A. We assume that for every lower-court case, the losing litigant files a cert petition.[3] The Supreme Court can either (a) grant the petition, hear the case, and issue a national legal policy binding on all lower courts; or (b) deny cert, meaning the legal question remains resolved by only the single lower court that heard the case. Let $\theta = 1$ denote the Court's choice to stop the process, and $\theta = 0$ denote the Court's choice to continue. If the Court hears the case, it chooses between the two legal rules, and the process stops.

Specifically, the Court must select $x_{SC} \in \{A, B\}$. If the Court declines to hear the case, we say that the legal question remains "open," and the process continues to the next period, $t = 2$, at which point another court decides a case concerning the legal question at issue. In deciding that case, the lower court selects one of two rules, $x_{\ell 2} \in \{A, B\}$. We assume that successive lower courts make *independent legal judgments*; that is, their decisions are not influenced by previous lower-court decisions on the same issue. If one court selects a different rule than a previous court, there exists "conflict" among the lower courts. Let I denote an indicator variable that equals 1 in every period in which there is conflict among the lower courts and 0 in periods in which no conflict exists. Following each successive lower-court decision, the Supreme Court must decide whether to hear the case or not. Essentially, then, this is a model of successive experiments, well-known to classical statistical-decision theory (DeGroot 1960; Ross 1983).

Beliefs. We assume that both lower courts and the Supreme Court are uncertain about which rule should be selected. That is, the Court is uncertain whether it would prefer to implement rule A rather than rule B, given that all lower courts will be bound by the chosen rule and will attempt to implement it as effectively as possible (that is, they will try to minimize deviations from the rule given information and resource constraints). Let γ denote the "correct rule"—this is the rule the Supreme Court would adopt if it had no uncertainty over which rule it preferred. (Recall from above that we simply assume the Court is uncertain about which rule it prefers. Our definition subsumes preferences that are ideologically or otherwise derived.) We assume that when rule A is better than rule B, there is some probability that a lower court will nevertheless select rule B. Define the following *conditional rates of error*, the probability a lower court will select a rule that is not the correct rule:

$$\lambda_A = Pr(A_t | \gamma = B) \qquad \lambda_B = Pr(B_t | \gamma = A)$$

We assume that the conditional error rates are not dependent upon the previous sequence of decisions and that they are constant across all lower courts. That is, lower courts do not learn or improve their decision making with time or exposure to previous decisions. These parameters capture the extent to which the Supreme Court believes that lower courts are more likely to come to the correct decision. If $\lambda_A = 0$, the lower court will never make an error, and as a consequence, a single signal is

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[3]This assumption sets aside the possibility of strategic litigants. While it is true that the majority of losing litigants at the Courts of Appeals do not seek Supreme Court review, very few cases in the lower courts involve questions of first impression or potential conflicts among the lower courts. Instead, the vast majority of what the lower courts do involves direct application of straightforward legal rules from existing doctrine. Thus, while a strategic litigant may opt to not file a petition for certiorari in such a case, those cases are irrelevant for our purposes as they are beyond the scope of the dynamics we model. We discuss below how our model can incorporate uncertainty over whether litigants will bring an issue to the Court in any given period.

sufficient to put the Supreme Court's belief at certainty. Conversely, if $\lambda_A = 5$, the Supreme Court cannot learn anything from a lower-court decision. (The same holds for λ_B.)

We model the Supreme Court as a Bayesian decision maker who updates its beliefs about the correct legal rule as information from the lower courts comes to it.[4] Let the Supreme Court's belief that A is the better rule in period t conditional on having observed the sequence of lower-court decisions, $\{x_{\ell 1}, x_{\ell 2}, \ldots, x_{\ell t}\}$, be given by $Pr(\gamma = A | \{x_{\ell 1}, x_{\ell 2}, \ldots, x_{\ell t}\}) = \omega_t(x_{\ell 1}, x_{\ell 2}, \ldots, x_{\ell t})$. For ease of exposition, we condense this expression to ω_t. With this representation in hand, we can characterize the Court's belief about the correct legal rule after observing any possible combination of t lower-court decisions. Denote the Court's initial belief as ω_0 and the Court's beliefs in any given prior period $t - 1$ as ω_{t-1}. Thus, from Bayes' rule, we can express the Court's updated belief that the probability that A is the better rule in a given period as the following, depending on whether it observes A_t or B_t:

$$Pr(\gamma = A | A_t) = \frac{\omega_{t-1} * (1 - \lambda_B)}{\omega_{t-1} * (1 - \lambda_B) + (1 - \omega_{t-1}) * \lambda_A} \quad (1)$$

$$Pr(\gamma = A | B_t) = \frac{\omega_{t-1} * (\lambda_B)}{\omega_{t-1} * (\lambda_B) + (1 - \omega_{t-1}) * (1 - \lambda_A)} \quad (2)$$

The probability that B is the better rule is the complement of Equations (1) and (2), respectively.

Utility and costs. The Supreme Court's goal is to select the correct legal rule. Without loss of generality, we normalize the Court's payoff from selecting the correct rule to 0. We assume the Court receives disutility from failing to select the correct rule; specifically, the Court pays $L > 0$ if it selects the incorrect one. We assume that the loss L is symmetric

for each kind of error—that is, the disutility to the Court is the same for erroneously choosing A or B. We also assume that the Court has a distaste for legal uncertainty; it dislikes explicit lack of clarity in national legal policy. This distaste can be broken down into two components. First, the Court dislikes the lack of a stated national policy—as the highest court in the land, it likes to "weigh in" on legal questions. However, the extent to which the Court cares about weighing in on any given policy issue does vary with the significance of the legal question at hand. Second, the Court dislikes conflict among lower courts. Once conflict arises, then the Court suffers a cost from the lack of uniformity across jurisdictions, should it allow the conflict to persist.

Thus, we assume that by allowing the legal issue to remain open until period t, the Court pays a cost of $(t - 1)k + \sum_{i=1}^{t-1} I_i c$. The parameter $k > 0$ captures the extent to which the Court cares about weighing in on the legal issue; the larger k, the costlier the Court finds it to leave the legal question open.[5] The parameter I_i is an indicator for whether conflict exists in period i, and c represents the cost of allowing conflict to persist. To be explicit, the Court pays k for every period in which it allows a dispute to persist; for instance, if it settled a legal issue after the 5th lower-court decision, it would pay $4k$, since it allowed the issue to continue in the first, second, third, and fourth periods. The Court also pays c if a conflict arises *and* the Court allows the conflict to persist. Thus, the Court can preempt this cost by granting cert immediately should a conflict arise. On the other hand, if it allows the conflict to continue, the Court continues to pay c in every period until it stops the process. For example, if a conflict arose in the second period, the Court could avoid paying c by settling the issue at that point. If, on the other hand, it waited until after the fifth period, it would pay $3c$ for allowing the conflict to persist in the second, third, and fourth periods. Figure 1 (A) depicts the sequence of play, as well as payoffs and costs. We assume throughout our analysis of the baseline model, without loss of generality, that $x_{\ell 1} = A$ (the results are symmetric for $x_{\ell 1} = B$).

Note that our representation of the costs of conflict and delay allow for multiple substantive interpretations. In essence, the parameters capture the Court's sense of immediacy. Thus, it could be that the

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[4]We believe that, as a generalization, it a weak assumption that the justices will be able to monitor the development of important and novel legal issues in the lower courts via the cert process. In Perry (1991), for example, both justices and clerks discussed the "fungibility" of cases, meaning the broader issue at dispute in a particular case was likely to come back to the Court even if it denies cert. Said one clerk: "[The issue] is going to come up again if it's really an important issue. ... I can say I never really feared that if we don't take it now or miss this one, that we won't have the chance to decide it again" (1991, 221). In addition, as part of the standard practice by which the Court reviews certiorari petitions, clerks prepare memoranda summarizing the major points at issue in the case, with particular attention paid to evaluating alleged conflicts and recounting the history of the conflict (that is, which courts decided what).
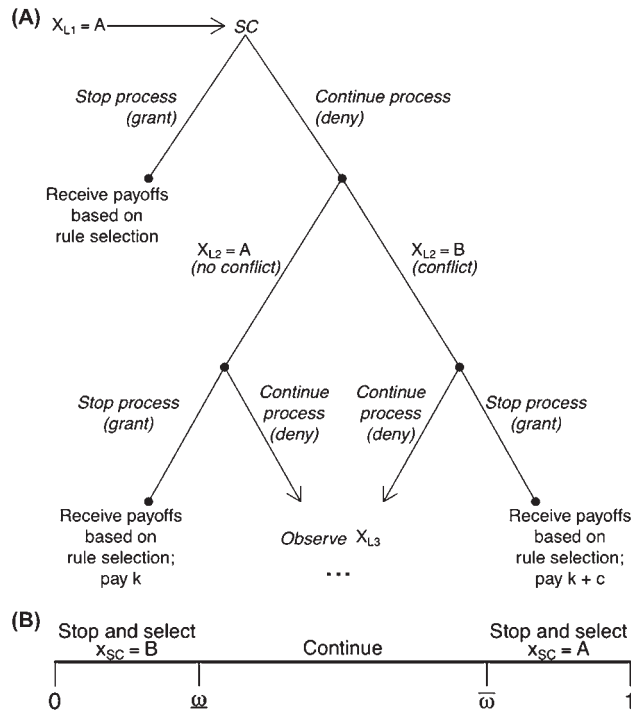
[5]While we assume $k > 0$, we recognize it is possible that the Court might face no cost from leaving a legal question open. In this event, the Court would never have an incentive to intervene in the absence of a conflict.

FIGURE 1 **Summary of the Model**

(a) probabilistically selecting an incorrect rule or (b) proceeding to the next period. In any period T, for a belief ω_T, the Court's optimal-cost function $V(\omega_T)$ must therefore satisfy:

$$
V(\omega_T) = \min\Bigg\{ (1 - \omega_T)L, \quad \omega_T L,
$$
$$
V\left(\frac{\omega_T(1 - \lambda_B)}{\omega_T(1 - \lambda_B) + (1 - \omega_T)\lambda_A} \right)
$$
$$
\times \left[\omega_T(1 - \lambda_B) + (1 - \omega_T)\lambda_A \right]
$$
$$
+ V\left(\frac{\omega_t \lambda_B}{\omega_t \lambda_B + (1 - \omega_T)(1 - \lambda_A)} \right)
$$
$$
\times \left[\omega_t \lambda_B + (1 - \omega_T)(1 - \lambda_A) \right] + k + Ic \Bigg\}
$$

$$(3)$$

where $k + Ic$ is the cost associated with proceeding to period $T + 1$. Thus, the Court seeks to minimize the cost of stopping and choosing A incorrectly or B incorrectly, or continuing into another period, observing A and B, then choosing between them. Notice that, as a consequence, this function is recursive—the value of continuing to the next period is again the optimal-cost function for that period, conditional on the Court's updated beliefs after observing the next period's signal. Observe that each of the interior $V()$ functions is weighted by the probability of seeing A or B in the next period, conditional on the Court's current beliefs and the conditional rates of error.

Ross (1983, 58–59) shows that there exist values, $\underline{\omega}$ and $\bar{\omega}$ such that the Court always prefers to stop the process in period T and select $x_{SC} = A$ if $\omega_T > \underline{\omega}$, to stop the process and select $x_{SC} = B$ if $\omega_T < \bar{\omega}$, or to allow the process to continue to period $T + 1$ if $\omega_T \in [\underline{\omega}, \bar{\omega}]$. The intuition behind this relationship is straightforward. As the Court becomes increasingly sure that $\gamma = A$, the expected utility from selecting $x_{SC} = A$ increases; this is because the Court's expected utility when it intervenes and selects A is simply the chance that $\gamma = B$, multiplied by the loss from selecting the "wrong" rule (recall we normalize the utility from a correct decision to 0). By Bayes' Rule, as the Court's belief becomes more certain (i.e., as it approaches either 0 or 1), the marginal impact of an additional signal decreases. The consequence of that decreasing marginal effect is that at some point, the marginal benefit to the Court's expected utility is outweighed by the cost of allowing the legal question to remain open. In essence, the Court decides that it prefers the risk of making a mistake to the cost of persisting, because the cost of persisting cannot be justified by the marginal benefit

Note: (A): Sequence of play in the baseline model. The figure assumes the first lower court makes a decision of A. Results are symmetric for a decision of B by the first lower court. The process continues until the Supreme Court grants cert and decides the issue. Note that this is not a game tree; the lower courts are not strategic actors. (B): Three regions in the model. The figure depicts how the Court decides whether to stop the process based on its updated beliefs. If its beliefs that A is correct are high enough, it will stop the process and select A. If low eough, it will stop and select B. If its beliefs are moderate, it will allow the process to continue.

Court does not anticipate having an opportunity to hear another case involving the particular legal issue anytime soon (the amount of time between periods will be long). For instance, if we relaxed our assumptions that litigants always file a cert petition, uncertainty over whether litigants appeal new issues would also factor into the cost of delay. The longer the Court expects to have to wait for another case, the higher the cost of delaying. Alternatively, one might imagine that different legal issues are associated with differing levels of legal or political salience, thus increasing or decreasing the cost associated with not intervening in the dispute. In this sense, the dynamics we analyze here are amenable to multiple substantive lines of inquiry.

Analysis. We begin our analysis of the Court's optimal-stopping problem by identifying an optimal-cost function—or optimal utility the Court can possibly incur in any period—the cost of either

of an additional lower-court decision to the Court's beliefs.[6] Thus, we know that there exists some threshold at which point the Court's belief that the better rule is *A* or *B* will be sufficiently certain that the Court will prefer to end the process and select a rule. We also know there exists a region within which the Court's belief is sufficiently ambiguous that it prefers to allow the legal question to remain open. Figure 1(B) shows these regions graphically.

Unfortunately, the infinite-horizon version of the model does not allow for the evaluation of comparative statics via analytical solution. Instead, we proceed to a finite version of the model and use backward induction to analyze the model via simulation Ferguson (N.d., chap. 2). The cost of this move is less severe than it might first seem; indeed, a finite model may better represent the Court's evaluation of new issues than an infinite-horizon model. Perhaps most importantly, there is a practical limitation on the number of independent lower-court signals the Supreme Court may actually observe (we present empirical evidence for this claim below). To use the Courts of Appeals as an example, there are only 13 circuit courts (including the Federal Circuit) that can weigh in on a new legal issue (given the existence of strict horizontal stare decisis *within* each circuit). Thus, the Supreme Court does not truly have the option to wait indefinitely, taking new, independent draws from the lower courts in each period. What is more, at least theoretically, if judges were immortal like Dworkin's (1978) *Hercules*, they could afford to wait forever to make their decisions. Mortal judges, on the other hand, must make their decisions within a reasonable period of time or risk missing their chance to set legal policy. Thus, there are good practical and theoretical reasons to suspect a finite-horizon model better approximates the context in which the Supreme Court oversees the lower courts than does an infinite-horizon model.

To evaluate the model via simulation, we set $T = 10$ and proceed as follows. At stage T, the Court must stop the process, grant cert, and choose a rule. Knowing this, we first evaluate the Court's decision to stop or continue at period $T - 1$, based on its probabilistic prediction of what it would do at period T. We continue working

backwards in this way until we reach $t = 1$. More specifically, assuming $X_{\ell 1} = A$, there are 512 possible sequences of lower-court decisions (each of length 10). Let H denote the set of possible histories, with H^t giving the subset of histories at period t. For any given history at any given period, we can calculate ω_t. If the Supreme Court chooses to stop at a given period, it will choose A if $\omega_t > = .5$; otherwise, it will choose B. Thus, for every element of H, we calculate the Court's expected utility from stopping:

$$E(\theta_t = 1) = \begin{cases} -(1 - \omega_t) * L - (t - 1)k + \sum_{i=1}^{t-1} I_i c \\ \quad \text{if } X_{SC} = A \\ -\omega_t L - (t - 1)k + \sum_{i=1}^{t-1} I_i c \\ \quad \text{if } X_{SC} = B \end{cases} \quad (4)$$

Next, we need to obtain the continuation value for the Court at any element of H. Again, the Court must stop at the final stage. Thus, we begin at the $T - 1$ (i.e., ninth) stage, where the Court knows the expected utility of continuing. It can also look ahead one step and ascertain what its beliefs would be if it observed $x_{\ell_{t+1}} = A$ or $x_{\ell_{t+1}} = B$. Based on those beliefs, the Court can calculate its expected utility of continuing into the final period. With this information in hand, at each prior stage, the Court can simply use backward induction to calculate the expected utility of continuing the process, which is thus:

$$\begin{aligned} E(\theta_t = 0) = & [\omega_t(1 - \lambda_B) + (1 - \omega_t)\lambda_A] \\ & * \max[E(\theta_{t+1} = 0 | x_{\ell_{t+1}} = A), \\ & E(\theta_{t+1} = 1 | x_{\ell_{t+1}} = A)] \\ & + [\omega_t \lambda_B + (1 - \omega_t)(1 - \lambda_A)] \\ & * \max[E(\theta_{t+1} = 0 | x_{\ell_{t+1}} = B), \\ & E(\theta_{t+1} = 1 | x_{\ell_{t+1}} = B)] - k - I_i c \end{aligned} \quad (5)$$

A stopping rule for the Court is simply to stop if $E(\theta_t = 1) > E(\theta_t = 0)$.

Results. To analyze the model, we use simulations to calculate $E(\theta_t = 0)$ and $E(\theta_t = 1)$ in each period, thereby allowing us to determine the period at which the Court stops in every possible sequence. By iteratively varying the values of the key parameters, while holding one parameter constant, we can study how changing conditions affects the Court's stopping decisions and the length of legal issues. Specifically, we consider (1) the consequences of conflict emerging, (2) the cost of conflict (*c*), (3) the rate of error in the lower courts (λ), and (4) the cost of legal error (*L*). For reference, Table A-1 in the online appendix summarizes the parameters in the model and also gives the values used to produce the results of each simulation.

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[6]In terms of Equation (3), as the Court becomes more certain about the state of the world, the first two terms stabilize, while the third term continues to grow with successive periods. That is, as the Supreme Court observes more signals, the marginal effect of additional signals on its belief about the law decreases. By contrast, the marginal effect of persisting does not decrease. Thus, there will reach a point at which the marginal benefit from learning from another signal is outweighed by the marginal cost of persisting for another period.

The Consequences of Conflict Emerging. As noted, many observers of the Supreme Court's certiorari process implicitly posit that intercircuit conflict *strictly* increases the probability that the Supreme Court will grant cert (e.g., Caldeira and Wright 1988; Caldeira, Wright, and Zorn 1999; Ulmer 1984), even while scholars and justices have recognized the value of percolation and allowing legal questions to remain open (e.g., Perry 1991, 230). Our model reveals that decision is more complicated than is often suggested, while also providing microfoundations for the mechanism by which the Court decides whether and for how long to allow circuit conflicts to stand. Figure 2(A) plots the difference between the Court's expected utility from stopping a conflict and its expected utility from allowing a conflict to persist, as a function of the period in which conflict first emerges, for three values of *L*: "low," "medium," and "high" (we return to Figure 2(B) and 2(C) below). Specifically, the lines depict the values of *EU*(*stop*) − *EU*(*continue*) at each period *x*, assuming that up until period *x* only *A* signals have been observed; a *B* signal (and thus a conflict) emerges at period *x*. Negative values indicate that the Court would prefer to allow a conflict arising at period *x* to continue, since the expected utility of continuing is greater than that for stopping, while positive values translate to a decision to stop the process.

Figure 2(A) demonstrates that the value of percolation adds nuance to the conventional wisdom. Specifically, the effect of conflict on the decision to intervene depends on when conflict emerges. Early on in the life of the legal question—i.e., at early periods—the Court prefers to leave the issue unresolved. The logic behind this effect is that early on, the Court's beliefs are more sensitive to conflict, whereas after having observed more *A*'s, the Court's belief is less sensitive to observing a *B* signal. This is a feature of Bayes' Rule—the more certain the Court is that *A* is the correct state of the world, the less effect a conflict will have on its belief. As a consequence, when conflict emerges later in the process, the incentive it creates for stopping is more likely to outweigh the incentive for allowing the conflict to persist (the uncertainty it induces) than when conflict emerges earlier in the process. When the shift towards stopping occurs—i.e., when each line crosses zero—depends on the cost of error: as the undesirability of getting the wrong answer increases, so do the number of periods in which the Court will allow the process to continue upon the emergence of a conflict.

Result 1. *The effect of the emergence conflict on the Supreme Court's incentive to resolve a legal question depends on when it emerges. Early in a legal question's*

life, *conflict creates an incentive to leave a legal question open. Later in a legal question's life, conflict creates an incentive to resolve a legal question.*

The Rate of Error in the Lower Courts. We turn next to the rate of error in the lower courts (λ). Substantively, in this baseline model the parameter λ can be thought of representing the underlying quality of the lower courts. We again perform our simulations, now varying the value of λ. The results of our simulations are shown in Figure 3(A), which shows the average period in which the Court decides to stop (*y*-axis) as a function of λ (*x*-axis), for each value of *L*.

A striking, yet intuitive, relationship emerges. First, if $\lambda = 0$, the first lower-court decision is a perfect signal, and the Supreme Court stops immediately. As λ increases, the signal-to-noise ratio of each lower-court decision decreases. Thus, the Court learns less from any given signal and allows the process to continue for longer. However, as λ further increases, there exists a point at which higher values of λ induce the Court to make its decision more quickly. The reason for this effect is straightforward. When the lower courts are very accurate (i.e., when λ is very low), one or two signals from the lower courts will push the Court's beliefs about the correct rule to choose very close to certainty, minimizing the risk of error from stopping. As a consequence, the Court will have less incentive to pay the cost of persisting just to learn more from lower courts. On the other hand, when the lower courts are of poor quality (i.e., when λ is very high), there is little incentive to persist. However, the reason in this case is different. Because the lower courts are of such poor quality, *there is little to be learned from further percolation*; the lower courts' decisions are not very informative to the Supreme Court. By contrast, when the lower courts are not perfect but also not substantially prone to error (i.e., when λ takes on midrange values), then a lot can be gained from persisting another period and waiting to intervene. This is because any one signal from the lower courts is sufficiently noisy that it will not drive the Supreme Court's beliefs to certainty but *is* sufficiently precise that it is worth paying the cost of persisting to observe.

Result 2. *The Supreme Court prefers to delay and wait for an additional lower court to weigh in when the lower courts are neither too accurate nor too prone to error. When the lower courts are either too prone to error or too accurate, percolation has less value.*

The cost of conflict and legal error. Both the cost of conflict (*c*) and legal error (*L*) influence the Court's

FIGURE 2 **The Relationship between Conflict and the Court's Stopping Decision**
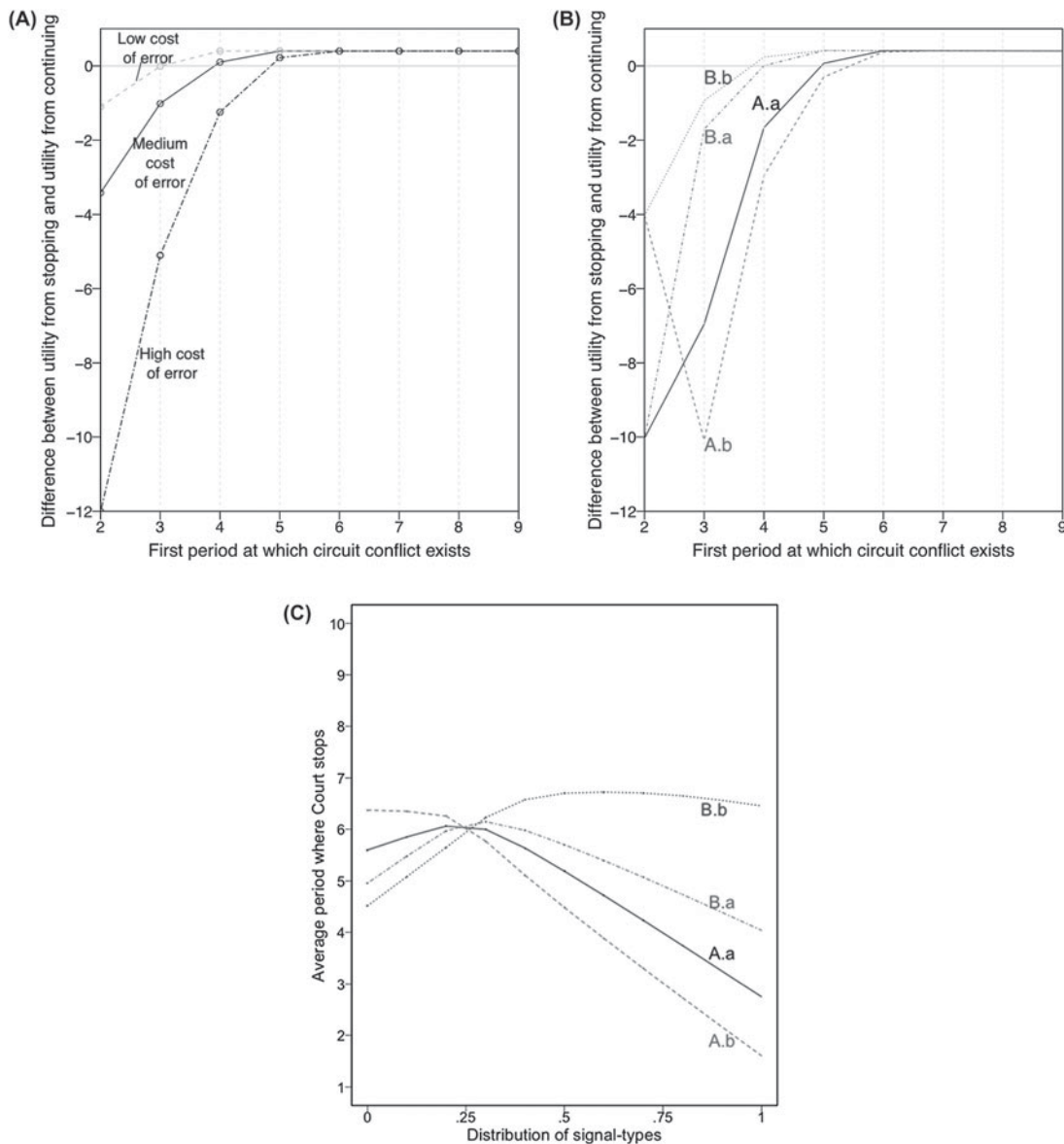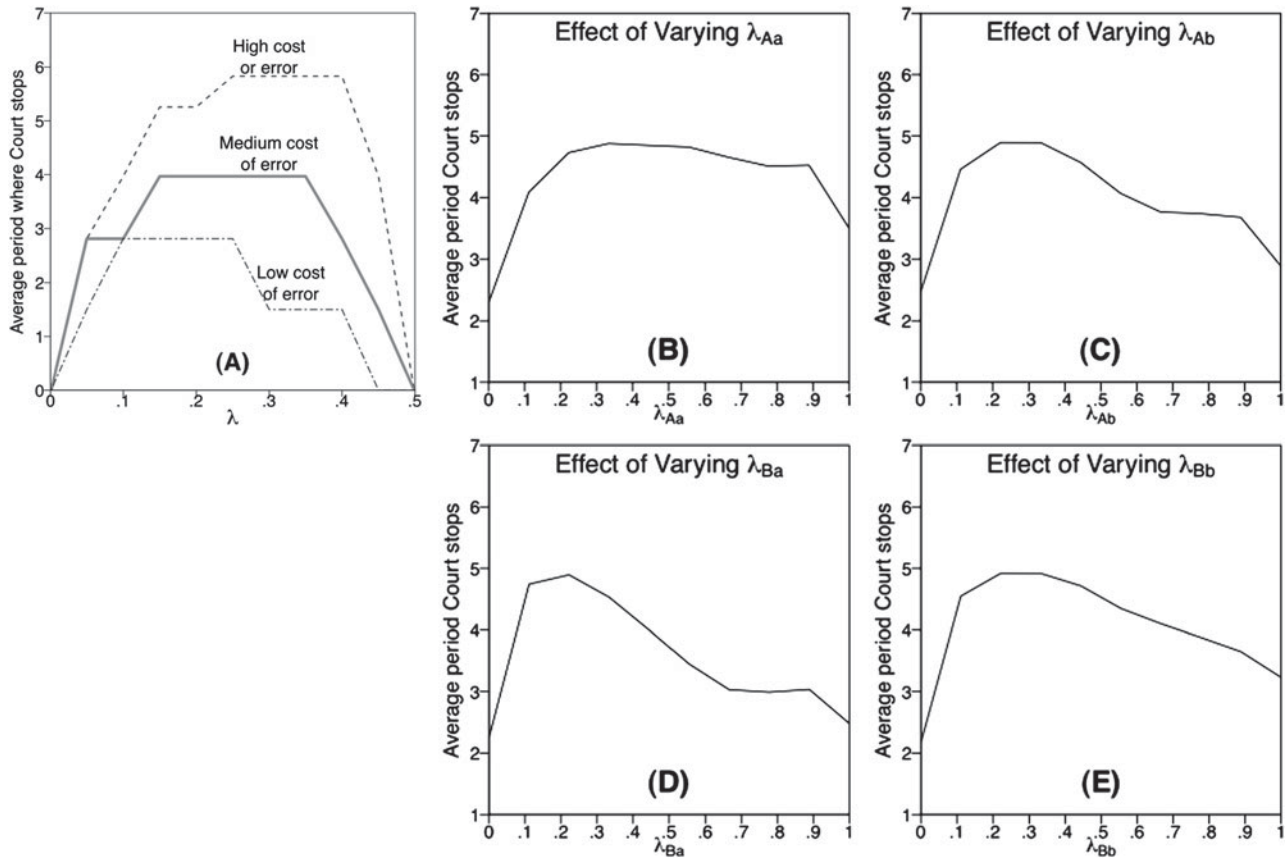

Note: (A): From the baseline model, the effect of the emergence of conflict on the Court's stopping decision. The graph plots the difference between the Court's expected utility from stopping a conflict and its expected utility from allowing a conflict to persist, as a function of the period in which conflict first emerges, for all three values of L. The early emergence of conflict is less likely to lead the Court to decide a legal issue. (B): From the extended model, the effect of the emergence of conflict on the Court's stopping decision. The graph plots the difference between the Court's expected utility from stopping and continuing, across all four combination of signal types. (C): From the extended model, the distribution of signal types and the length of legal issues. The graph plots the average period the Supreme Court stops, as the distributions of signal types vary.

stopping decision in ways that one would naturally expect—increasing the former leads to earlier stopping decisions, while increasing the later leads to later stopping decisions. We do find a nonobvious result with respect to variation in the cost of the conflict (for space reasons, we do not present this result graphically.) Moving from a low cost of conflict to a high cost leads to the largest effects on the Supreme Court's decision during the "middle sequences" in a legal conflict. Early on, greater conflict costs do not affect the Court's decision as much because the Court's beliefs are sufficiently uncertain such that it is more willing to persist even under higher costs

FIGURE 3   **The Effect of Lower-Court Error Rates on the Court's Stopping Decision**

Note: The effect of lower court error rates on the Court's stopping decision.(A): From the baseline model, the effect of the lower court error rate on Court's decision from baseline model. The figure depicts the average period in which the Court decides to stop (on the *y*-axis) as a function of λ (on the *x*-axis), for each value of *L*. (B)-(E): From the extended model, the effect of varying each of the four conditional error rates. In each panel, the nonlabeled error rates are held fixed.

of conflict. At later stages, there is less to be gained from persisting—the Court, on average, is already either very certain or sufficiently uncertain that additional lower-court decisions will not help the Court. Therefore, even for small costs of conflict, the Court is willing to persist early in the process. However, at "middle" periods, the magnitude of the cost of conflict is most likely to matter. We summarize these findings in the following results:

Result 3. *Decreasing the cost of conflict delays the Court's decision to stop. The effect is most pronounced during the "middle" of the legal process, while it is attenuated early and late in the life of the legal question.*

Result 4. *The greater the cost of legal error, the longer the Court will allow legal questions and conflicts to remain unresolved.*

The Extended Model: Incorporating Judicial Preferences

While pure team-theoretic models are useful for understanding certain dynamics in judicial hierarchies, it is well-known that judges have policy preferences that will vary across and within the levels of the hierarchy. We now extend our model to evaluate how judicial preferences will influence the Supreme Court's learning and stopping decisions.

Players, rules, sequence of decisions, and utilities. The extended model maintains the same structure, parameters, and utilities as the previous model, save for two modifications. First, we retain our assumption that there is some underlying "correct" legal rule. However, we begin by giving the Supreme Court an inherent preference for one rule or the other. Without loss of generality, we assume the Supreme Court has a preference for

rule A. We do so by assuming the Supreme Court has a stronger distaste for incorrectly choosing B—that is, if the Court is going to make an error, it prefers to make an error by choosing A when it should have chosen B, rather than vice versa. Let L_A denote the Supreme Court's loss if it selects A when $\gamma = B$, and L_B denote the Supreme Court's loss if it selects B when $\gamma = A$, where $L_B > L_A$. This representation of the Court's utility function captures the idea that a conservative (liberal) judge or court, while not foreclosed to issuing liberal (conservative) opinions, will require greater convincing in the direction away from their inherent preferences before issuing such a decision.

Second, to account for judicial preferences among the lowercourts, we consider two lower-court "types;" specifically, we denote the Lower Court as ℓ_i, where $i \in \{a, b\}$. Lower courts with type $i = a$ have a ceteris paribus preference for rule A; lower courts with type $i = b$ have a ceteris paribus preference for rule B. For presentational clarity, we use uppercase A's and B's to denote "signals" (i.e., outcomes) and lowercase a's and b's to denote "types" (i.e., the the type of court). An uppercase-lowercase pair denotes a "signal-type;" thus, $A.b$ means an A signal has been issued by a b lower court. We define the lower court's preferences over rules in a similar manner to that of the Supreme Court. While a lower court's type does not strictly determine the rule it will choose (otherwise, the Supreme Court could learn nothing about the state of the world from the lower courts' decisions), a lower court of a given type is more prone to use one preferred legal rule than the other. Formally, we capture this bias with the conditional error rates introduced in the previous model. Previously, we defined $\lambda_A = \Pr(A_t | \gamma = B)$ and $\lambda_B = \Pr(B_t | \gamma = A)$. We now index these parameters, such that $\lambda_{Ai} = \Pr(A | \gamma = B, i)$ and $\lambda_{Bi} = \Pr(B | \gamma = A, i)$. To capture judicial ideology, we assume that $\lambda_{Aa} > \lambda_{Ab}$ and $\lambda_{Bb} > \lambda_{Ba}$. That is, A type Lower Courts are more likely to send an A signal in a B world than is a b type; similarly, b type Lower Courts are more likely to send a B signal in a A world than is an A type.

Beliefs. Following from our extension to incorporate two lower-court types, the Supreme Court's beliefs are now affected by not only the rule it observes the lower court using at each period but also the type of court that issues the rule. As above, though, the Supreme Court continues to update its belief about the state of the world using Bayes' Rule:

$$Pr(\gamma = A | A_t, i) = \frac{\omega_{t-1} * (1 - \lambda_{B_i})}{\omega_{t-1} * (1 - \lambda_{B_i}) + (1 - \omega_{t-1}) * \lambda_{A_i}}$$

(6)

$$Pr(\gamma = A | B_t, i) = \frac{\omega_{t-1} * (\lambda_{B_i})}{\omega_{t-1} * (\lambda_{B_i}) + (1 - \omega_{t-1}) * (1 - \lambda_{A_i})}$$

(7)

In addition, we must specify the distribution of lower-court types, as the Supreme Court must have beliefs about the likelihood of seeing a court of type i in any given period. We assume that the proportion of a type lower courts is given by $\eta \in (0, 1)$.

Utilities. The Court's utility from stopping in any given period is the same as in the previous model and shown in Equation (4)—given a belief that $\gamma = A$ in period t, the Court receives utility equal to its expected loss, minus the costs incurred for any conflict allowed to persist and the number periods the Court has left the legal question unresolved.

However, the Court's expected utility from continuing at period t is now more complicated. Whereas before, in any subsequent period there were two possible things that could happen—the Court could see an A or a B from the lower courts—there now exist four possible combinations of signal types the Court could see in a subsequent period: $A.a$, $A.b$, $B.a$, $B.b$. The following equation represents the Court's value of continuing, recognizing that either signal may come from either type:

$$
\begin{aligned}
E(\theta_t = 0) = &[\eta * [\omega_t(1 - \lambda_{Ba}) + (1 - \omega_t)\lambda_{Aa}] \\
&+ (1 - \eta) * [\omega_t(1 - \lambda_{Bb}) + (1 - \omega_t)\lambda_{Ab}]] \\
&* \max[E(\theta_{t+1} = 0 | x_{\ell_{t+1}} = A), \\
&\times E(\theta_{t+1} = 1 | x_{\ell_{t+1}} = A)] \\
&+ [\eta * [\omega_t \lambda_{Ba} + (1 - \omega_t)(1 - \lambda_{Aa})] \\
&+ (1 - \eta) * [\omega_t \lambda_{Bb}(1 - \omega_t)(1 - \lambda_{Ab})]] \\
&* \max[E(\theta_{t+1} = 0 | x_{\ell_{t+1}} = B), \\
&\times E(\theta_{t+1} = 1 | x_{\ell_{t+1}} = B)] - k - I_i c
\end{aligned}
$$

(8)

The first term captures the chances of seeing an A signal from an a type (either in error or not), plus the chances of seeing an A signal from a b type (either in error or not). The second term shows the value to the Court of persisting for another period and seeing an A signal. The third term shows the chances of seeing a B signal from an a type (either in error or not), plus the chances of seeing a B signal from a b type (either in error or not). The fourth term shows the value to the Court of persisting for another period and seeing

a B signal. The final two terms show the cost of leaving a legal question unanswered and of allowing a conflict to stand, respectively.

Analysis. We proceed directly to the finite-horizon version of our model and conduct our analysis using simulation. The key difference now is that whereas in the earlier model there were 512 possible sequences of signals the Supreme Court might observe in the 10-period game (only those beginning with A), there are now 1024×1024 possible sequences. Because the Supreme Court's preference for an A rule over a B rule, we can no longer assume without loss of generality that the first signal is an A; thus, each sequence of signals could come from any of the 1024 possible sequences of lower-court types. Our analysis proceeds in two stages. First, we consider how judicial bias may condition the results described above. Second, we consider how the extent of judicial bias in the lower courts affects the Supreme Court's optimal-stopping rule. Again, Table A-1 in the online appendix gives the simulation values used to produce each result; we set $\eta = .5$ throughout.

Judicial Ideology and the Emergence of Conflict. Our extended model allows us to assess how divergence in ideological preferences among the various courts conditions the results described above. We begin by reconsidering the first result from the baseline model—that the timing of a conflict emergence conditions the incentive to intervene and resolve the conflict. Result 1 demonstrated that conflict will be more likely to trigger intervention by the Supreme Court when that conflict emerges after more lower courts have weighed in than when conflict emerges after fewer lower courts have weighed in. The extended model allows us to disaggregate that result by the *types* of conflict that might emerge. There are two types of "biased" conflict that may emerge and two types of "unbiased" conflict that may emerge. Biased conflicts are conflicts that are relatively more likely to have been motivated by judicial ideology—an *a*-type lower court creating conflict by sending an A signal, or a *b*-type lower court creating conflict by sending a B signal. By contrast, unbiased conflict emerges when an *a*-type lower court creates conflict by sending a B signal, or a *b*-type lower court creates conflict by sending an A signal. Figure 2(B) shows the same comparison as in Figure 2(A)—comparing the utility of stopping to the utility of continuing—but now broken down by the signal type that creates the conflict at the relevant period. We see that the same dynamic that emerges in the absence of judicial ideology (Result 1) holds here—the effect of the emergence of conflict on the Court's decision to grant cert depends on when the conflict emerges.

However, the extended model also reveals a complex subtlety in the effect of conflict timing on Supreme Court intervention. Specifically, the Court, on average, prefers to stop sooner when conflict comes from observing a B signal—whether the B signal is biased or unbiased. This can be seen by the fact that the $B.a$ and $B.b$ lines cross zero earlier in time than the $A.a$ and $A.b$ lines. To understand the intuition behind this relationship, note first that when a conflict emerges from a B signal, the Court has, by definition, already seen at least one A signal. As a consequence of having observed an A signal, the Court is already inclined towards believing that A is the right choice. Moreover, because we assume the Court has an inherent preference for A and is more willing to make an error when choosing A than when choosing B, the threshold for intervening and choosing A ($\bar{\omega}$) is less extreme than the mirror threshold for intervening and choosing B ($\underline{\omega}$). (This is true regardless of the Court's prior at the beginning of the game.) Thus, the cost of conflict emerging is more likely to push the Court to stop when it has already seen A signals than when a conflict emerges after it has observed B signals. In other words, the Court needs to be extra certain that B is the right choice to stop and choose B, so the marginal cost of conflict is more likely to be enough to intervene and resolve a conflict when that conflict comes from a B signal.

Result 5. *Conflicts that are triggered by lower court decisions that run against the Supreme Court's inherent ideological preferences will push the Court to intervene earlier than conflicts that are triggered by lower court decisions that are aligned with the Supreme Court's inherent ideological preferences.*

The distribution of signal-types and the length of legal issues. We next consider how the length of percolation varies as the Court sees different distributions of signals and types. Figure 2(C) depicts the average period where the Court stops (on the y-axis) against the distribution of all four signal types. The graph reveals that, consistent with the logic seen above, the Court will allow for less percolation as it sees more A signals, particularly unbiased signals from b types. By contrast, percolation lasts longer as the Court sees B signals, particularly biased signals from b types. This results accords with the "Nixon goes to China" result presented in Cameron, Segal, and Songer (2000): a decision by a lower court that runs against the court's ideological predispositions is more informative to the Supreme Court than one that conforms with a lower court's ideology.

Result 6. *As the Court receives more signals that conform with its inherent ideological preferences, it should grant cert sooner. This is particularly true if it receives more unbiased signals in that direction.*

At first glance, it might appear that Results 5 and 6 are contradictory, given that the ordering of the signal types is reversed with respect to the expected stopping period. Recall, however, that Figure 2(B) shows the signal type that generates a conflict, meaning up until that period the Court has seen the opposite signal. Thus, a *B.b*-generated conflict means that the Court has seen *A* signals to that point. Consistent with Figure 2(C), sequences that feature more *A* signals are more likely to lead the Court to stop sooner.

Judicial Ideology and the Accuracy of Lower Courts.

Lastly, consider next the effect of the lower courts' ideological preferences on Supreme Court oversight. Above, we saw that the Supreme Court can learn from additional signals from the lower courts and therefore prefers to wait longer before stopping, when the lower courts are neither too accurate nor too inaccurate (Result 2). Whereas in the baseline model we conceptualized the lower courts' error rates as based on quality, in the context of our extended model, they can also now correspond to the intensity of their ideology; more precisely, they can represent the extent to which the lower courts are ideologically aligned with the Supreme Court. In other words, if an *a* type lower court is too ideological, then it will have a very high probability of sending an *A* signal in a *B* world—λ_{Aa} will be nearly 1. Thus, as we increase λ_{Aa} from 0 toward 1, the lower court moves from being a very accurate, high-quality lower court whose decisions always reflect the true state of the world to a fiercely ideological lower court whose decisions are independent of the state of the world. We replicate the simulations that led to Result 2, now holding constant three of the four conditional error rates (λ_{Aa}, λ_{Ab}, λ_{Bb}, and λ_{Bb}). Whereas in the previous analysis there was no reason to consider a value of λ either equal to 0 or greater than .5, in this model, we can explore the effect of any one of the four λ parameters taking any possible value from 0 to 1. The results of our analysis are reported in the four panels of Figure 3(B)–(E). So, for example, in Figure 3(B), we vary λ_{Aa} while holding the other three constant.

As the graphs make clear, a pattern similar to that of Result 2 emerges here. When the lower courts are high-quality courts that always reflect the true state of the world, the Supreme Court intervenes relatively early in a legal question's life. This is true regardless of which type of error is being varied. Even small

increases from a perfect signal ($\lambda = 0$) are associated with a jump in the Court's willingness to delay and take advantage of percolation. However, our analysis also reveals an interesting pattern concerning the different conditional error rates for each signal. In particular, we see in Figure 3(D) and Figure 3(E) that once the probability of seeing a *B* signal in error reaches a certain threshold level, further increases in the error rate rapidly decrease the average period at which the lower court stops, relative to the effect of increasing the probability of observing an *A* signal in error (see Figure 3(B) and Figure 3(C)). This is particularly true of *B* signals from *a* types.

To understand the intuition behind this result, recall first that the Court has a stronger distaste for incorrectly choosing *B* than it does for incorrectly choosing *A*. Thus, in the absence of a very high-quality signal that *B* is the best option (i.e., when the conditional error rate associated with observing a *B* signal is even marginally greater than *0*), the Court prefers to delay and take the opportunity to learn more from additional signals from the lower courts. Further increases in the conditional error rate, however, diminish the value of allowing percolation, because there is little that can be learned from waiting for additional input from the lower courts.

This is particularly pronounced in the case where the probability of seeing a *B* signal incorrectly from an *a* court in error is high. While the most credible signal the Supreme Court can receive that *B* is the better rule is when an *a* type is the sender, as λ_{Ba} increases, that credibility declines as well. Thus, when the Court cannot make such use of such signals, relative to other types of signals, the value of percolation is undermined, and the Court prefers to stop earlier.

Result 7. *For any conditional error rate across the four signal types, the Supreme Court prefers to delay and wait for an additional lower court to weigh in when the lower courts are neither too accurate nor too prone to error. However, percolation is least valuable and most sensitive to increases in conditional error rates when the most valuable signals—decisions that run against the Court's inherent preferences that are made by an ideological ally—are the most error prone and hence the least informative.*

Empirical Evidence

While a full empirical analysis of the predictions from the baseline and extended models is beyond the scope of this article, we do have available empirical evidence

to evaluate the prediction seen in Result 1: the Supreme Court should be more likely to stop at a conflict that arises after more percolation than a conflict that arises after less percolation. To test this hypothesis, we turn to the data analyzed in Lindquist and Klein (2006). The authors identified all cases decided by the Supreme Court between 1985 and 1995 in which the Court's majority opinion stated that it was resolving an intercircuit conflict, a search criterion that yielded 338 such cases. Lindquist and Klein then recorded every circuit decision (either by a three-judge panel or the full circuit sitting *en banc*) that weighed in on the legal issue and which side of the conflict each circuit supported.

With Linquist and Klein's data, we are able to construct 336 sequences of unique legal issues that resulted in a conflict resolved by the Supreme Court.[7] To be clear, a sequence consists of two or more more cases heard by circuit courts that resulted in the Supreme Court weighing in on the issue. A period is the element of the sequence in which a lower court made a decision. For example, a sequence of length four features four periods—in each period, a unique lower court makes a decision; these decisions are analogous to the *A*'s and *B*'s in our optimal-stopping model. Across these 336 sequences, the total number of lower court decisions in the dataset is 1,500.

We begin our empirical analysis by depicting the distribution of sequence lengths (i.e., how long the issue was allowed to percolate) in Figure 4(A). While the modal length is two periods, only 26% of sequences end at the second period, and 54% of sequences last for four or more periods (the average length is 4.5 periods). Of the 336 sequences, only 12 are longer than nine periods in length; the three longest sequences are 13 periods in length. Returning to our finite versions of the theoretical models, the distribution of sequence lengths suggests that a 10-period model is sufficient to capture the dynamics with which our model is concerned

To evaluate the empirical support for Result 1, we compare when conflicts emerge with the probability that the Supreme Court intervenes at the emergence of conflict. Recall that Result 1 predicts that the probability of stopping at conflict should be lower for conflicts that emerge earlier than for conflicts that emerge later (after more percolation). Figure 4(B) shows the proportion of sequences in which the Supreme Court intervenes when conflict emerges, as

a function of when conflict emerges. The points are the proportion of new conflicts at that period for which the Court intervenes to resolve the conflict; the solid line is a loess fit; the horizontal line is a reference line at .5. These data indicate that the Supreme Court is much more likely to stop at a later emergence of conflict than at an earlier emergence of conflict. The difference between early and late stopping is sizeable. When a conflict emerges in the second period, the Court grants cert immediately in only 46% of sequences; by the seventh period, new conflicts are stopped 71% of the time.

Two natural questions arise. First, does this pattern result from the Court taking cases later in the sequence, regardless of conflict playing any roll? Figure 4(C) shows that this is not the case. The figure plots the distribution of when conflict emerges and shows that, by far, most conflicts emerge very early (period 2), while few emerge later in the life of a legal question. Thus, while more conflicts emerge early on than later, and the Court tends to grant cert early on than later, proportionally the Court is still more likely to continue letting lower courts weigh in on an issue when a conflict emerges early compared to when it emerges late.

Second, how much percolation is actually going on? As Figure 4(B) shows, the modal response to circuit conflict when it emerges in periods 2, 3, or 4 is *not* to intervene but instead to allow further percolation. Moreover, looking at the entire data, the Supreme Court only intervened right at the emergence of conflict in 47% of the cases; its modal response to conflict is to allow further percolation. Finally, when conflict emerges in later periods, by then several lower courts have produced the same signal, which is itself a form of percolation. Figure 4(D) adds additional information on this point. Analyzing each period in which conflict emerges separately, the figure depicts the distribution of additional periods that a legal issue persists, once conflict has emerged in the specified period (for sample size reasons, we only examine cases in which conflict emerges in periods 2–7). For each period we present violin plots, which combine a boxplot with a density plot: the white circles depict medians, the dotted horizontal lines depict means, the thick vertical black lines connect the 25th and 75th percentiles, and the shaded area depicts a density trace. The mean values reveal that even after conflict emerges, on average the Supreme Court will generally wait one to two periods before granting cert. We also find there is significant mass in the tails of the distribution, especially when conflict emerges early (in periods 2–5), showing that in many

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[7]We dropped two cases that did not appear to resolve a conflict in the circuit courts.

FIGURE 4 Empirical Evaluation of Supreme Court Review of Intercircuit Conflicts
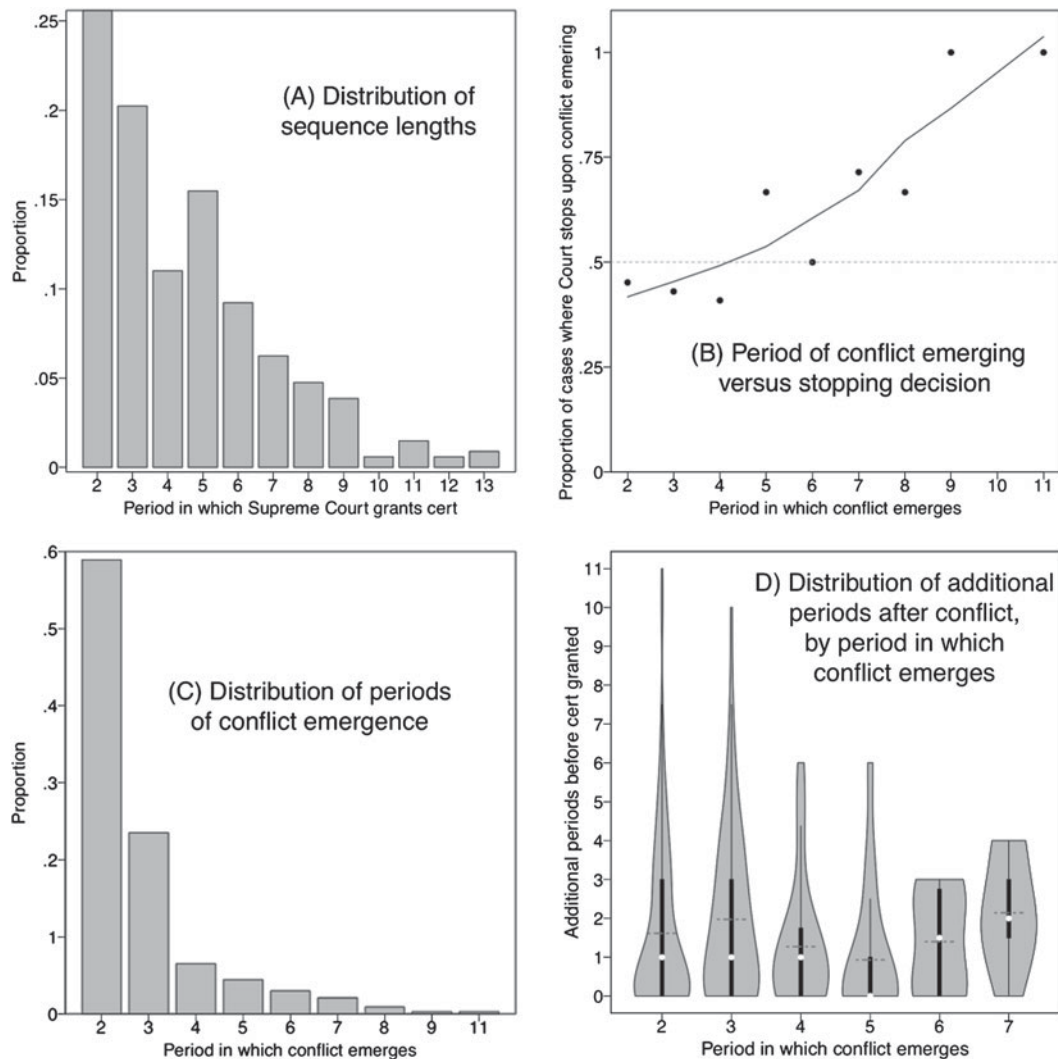
Note: (A) The distribution of lengths of the 336 sequences of intercircuit conflict between 1985 and 1995, as taken from Lindquist and Klein (2006); (B) The proportion of sequences in which the Supreme Court intervenes at the emergence of conflict, as a function of the period in which conflict emerges. The line is a lowess line (locally weighted regression); (C) The distribution of periods in which conflict emerges. (D) The distribution of additional periods before cert is granted after a conflict emerges, by the period in which conflict emerges. The violin plots combine a boxplot with a density plot; the horizontal dotted lines depict the mean number of additional periods before cert is granted, the open circles the median. There is significant variation in how long a conflict persists after it emerges, especially when it emerges early.

sequences the Court is waiting several periods before granting cert.

Thus, we can conclude there does exist a significant amount of percolation in how the Supreme Court evaluates lower court decisions on new issues. And taken together, the four plots demonstrate the nuanced interaction of conflict and percolation. The empirical support for one of the model's main predictions demonstrates the role of circuit conflict in certiorari is more nuanced than conventional understandings. Importantly, it is nuanced in a way that

expands our understanding of how the Court can make use of the judicial hierarchy to its benefit.[8]

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[8]One other concern is that litigants might be waiting for conflict to emerge before asking the Supreme Court to review a new issue. We certainly do not want to rule out the possibility that litigant strategies might influence the dynamics we uncover in our model. However, we note that this litigant strategy of waiting for conflict to emerge before seeking cert would *not* confound our empirical test, since the effect would arise uniformly in any period in which conflict arises and thus would not be correlated with the timing of conflict emerging.

Discussion and Conclusion

The Supreme Court's transformation from an institution with almost no discretion over its caseload to one with virtually full discretion means that how the Court uses (or chooses not to use) the cert process to oversee lower courts and enhance the uniformity of the law is a central question in the study of judicial politics. If the number of cases that reach the Court's doors and the number of cases to which the Court grants cert continue to move in opposite directions, the question of how the Court evaluates new legal issues and circuit splits is likely to receive even further attention from scholars and politicians alike. Indeed, the manner in which the Supreme Court has handled circuit conflicts has been questioned recently by some senators (Specter 2010).

Our article sheds important new light on these questions by developing an optimal-stopping model of the Supreme Court's supervision of conflict and new issue resolution in the lower courts. The model formalizes the inherent trade-off the Court faces: learning from multiple decisions on new issues versus the cost of uncertainty and predictability that occurs with a conflict. The model is the first to present the Court's evaluation of lower-court conflicts as a learning process—it thus adheres more closely to how the Court uses the cert process than the error-correction models used to date in the political science literature.

While some of the insights we have developed follow naturally from the informal literature on the cert process and percolation, several are new to the literature. Most strikingly, whereas existing work has supposed that the emergence of lower-court conflict should increase the likelihood that the Court immediately grants cert, we demonstrate that the emergence of conflict has an ambiguous effect on the likelihood the Court will end the percolation process. Early in the process, conflict actually creates an incentive for the Court *not* to grant cert immediately in order to facilitate more learning; it is only later in the process when conflict induces the Court to grant cert and stop process. In addition, we also show that percolation offers the greatest benefit when lower courts are of neither too low nor too high quality—that is, more or less prone to errors. This result is also new to the literature. And while we do not evaluate the decisions the Court makes on the merits, the insights from optimal-stopping could easily be extended to probe the further the relationship between the percolation process and what the rule the justices eventually settle on. Finally, our model provides microfoundations for the intuitive results that increasing the cost of conflict makes the Court more likely to end the legal process, as does a lower cost of being wrong. As scholarship on law creation in the judicial hierarchy continues to grow, future research may both empirically evaluate these implications and explore additional avenues for refinement of the argument. Political scientists may also profit from further incorporating optimal-stopping models into the study of political actors and institutions, as they have general implications for the ways in which principals can leverage information from multiple subordinates to improve the quality of information and thus the quality of decision making in hierarchical institutions.

While we have presented the first optimal-stopping model of the cert process, we certainly do not believe that this article represents the last word on the subject. Indeed, the model is extendable in several interesting ways. One possible extension would be to allow the lower courts to learn from previous lower-court decisions—just as we have allowed the Supreme Court to learn from lower court decisions. There is a tension here, however: the more that lower court decisions are interdependent, the less information the Supreme Court can obtain from multiple lower-court rulings. As Kornhauser (1995) notes, lower courts do not generally follow horizontal precedent; that is, lower courts are not usually bound by precedents decided by parallel courts in other jurisdictions. One justification for this rule concerns efficiency. If lower courts follow each other, superior courts gain less information from their decisions than if the lower courts ignore each other. That is, higher courts learn most from lower courts if their decisions are "independent draws;" when lower courts observe each others' decisions and follow each other, there is a risk of an information cascade occurring in which lower courts ignore their own signals about the state of the world. This raises the possibility of a "bad" information cascade of the kind that can occur in jury deliberations under strategic voting (Austen-Smith and Banks 1996). Thus, lower-court "learning" may have a normative downside. Practically, an information cascade implies that the higher court cannot learn from lower courts, in which case the dynamic we investigate has no purchase. The questions become, then, (a) under what conditions does an information cascade arise and undermine the Supreme Court's ability to learn from lower courts?; (b) are there models of judicial learning in which the Supreme Court could benefit from lower-court horizontal stare decisis?

Another potentially fruitful avenue for future modeling would be to relax our assumption that

the Supreme Court is a unitary actor and embed our model into a model of the Court's internal certiorari decision making. Scholars have long been interested in the bargaining among the justices over which cases to hear, though the research has largely been focused on incentives motivated by ideological disagreement among the justices (Caldeira, Wright, and Zorn 1999). That the Court's informational and political goals, along with institutions like the Court's "Rule of 4," interact is a feature of judicial politics with which scholars have become increasingly interested (e.g., Lax 2003). We believe that incorporating preference heterogeneity across justices over into our optimal-stopping model would be a productive avenue for future research.

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Tom S. Clark is an Associate Professor at Emory University. Atlanta, GA, 30322.

Jonathan P. Kastellec is an Assistant Professor at Princeton University, Princeton, NJ 08544.