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**Using Information Technology to Examine the Communication of Precedent:
Initial Findings and Lessons From the CITE-IT Project¹**

Wayne McIntosh, Ken Cousins, James Rose, Steve Simon, Mike Evans,
Kimberly Karnes, John McTague and Shanna Pearson-Merkowitz

Department of Government and Politics
University of Maryland
College Park, MD 20742

wmcintosh@gvpt.umd.edu

Abstract

The CITE-IT project employs information technologies in innovative ways to investigate the development and dissemination of precedent in the American legal system, based on a study of the issue of “regulatory takings.” This manuscript describes the initial phases of this multidisciplinary project, specifically the methodologies we have developed to identify the corpus on which the study itself will build – all federal-level regulatory takings decisions following the 1978 Penn Central Supreme Court decision. While a comprehensive, clearly identified collection of decisions – pertinent to a single area of law – presents a great resource for legal scholars, defining such a collection is in fact quite challenging, and has rarely (if ever) been attempted. Using a combination of conventional research techniques and computer automation, we identified 2,780 decisions, triangulating across multiple search approaches to identify “best candidates” for the pool. By exploiting formatting patterns across these decision texts, we then automatically extracted additional data from each (e.g., formal citation, court location, date, and prior decisions cited), which we then converted to graphical form (as well as more formal metrics for further analysis). This manuscript describes these processes, as well as a review of the scholarship on precedent and citation analysis, and a summary of the history of regulatory takings. We conclude with our future research goals, including expanding this pool to include all federal cases since 1922, as well as all relevant decisions handed down by the state supreme courts.

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1. Introduction

The United States judicial system can be viewed as a multi-tiered network, connected not only by institutional design but also by mutual reliance (albeit, to varying degrees) upon a common set of reference points in the body of law. The CITE-IT project (Courts and Influence Tracking Employing Innovative Technologies), an NSF-funded (SES-0416455) multi-disciplinary research initiative at the University of Maryland,² is focused on the relational dynamics among these courts, assessing the articulation, development, and dissemination of legal precedent across the system. With few exceptions, empirical judicial research has had a single-court or single layer focus (Haire, Lindquist and Songer 2003). By contrast, our project focuses on the interactions of several judicial layers – the US Supreme Court, all US Circuits, all US Districts, and all state supreme courts – to investigate the manner in which the judiciary have collectively developed the law on a particularly high-stakes political issue.

As a substantive vehicle, our focus is on the case law whose central question is whether environmental, land-use, and other regulations implemented by state and federal governments amount to “regulatory takings” under the Fifth and Fourteenth Amendments. We chose this issue for several reasons. Although it presents a constitutional question, it is comparatively narrow, and has involved courts at every level. Moreover, the Supreme Court's recognition of regulatory takings has a clear beginning point of demarcation (1922) with a relatively long time horizon. We estimate the total universe of decisions – casting the net widely and running to the most current judicial terms – to number around 3000, which is sufficiently large to capture both spatial and temporal variations. While it is a commonplace and rather straightforward research problem to locate the major, core case law addressing a legal question, we are aware of no published work that has attempted to identify a comprehensive corpus of judicial decisions on a particular area of law (though possibly Glick's 1992 study of “right to die” case law comes closest).

Due to the magnitude and complexity of the task at hand, our project also includes innovative methodological elements that we believe present exciting opportunities for future legal scholarship and other social sciences. Over the past several decades, advances in computing technologies have been applied throughout the physical sciences, enabling researchers to address questions of greater scale and complexity with more accuracy, consistency, and transparency. Adoption of such technology by social scientists has been slower – and for scholars of American political life, largely limited to statistical analysis. Our project contributes to narrowing this methodological lacuna by employing and developing a variety of computer-supported research methods: automated file acquisition and transformation; dynamic relational databases; mapping (network) relations between cases; and code-and-retrieve software (to facilitate qualitative case review). Especially pertinent for our study is the use of computer-based network analytical techniques to investigate the structural influences of the court system on legal developments. By tracking the communication of precedent throughout the various levels of the court system, we are taking steps to improve our understanding of the geographic and hierarchical distribution of (regulatory takings) cases across time. Citation analysis is a well-established method – scholars

² Further information about the CITE-IT project can be found at www.bsos.umd.edu/gvpt/CITE-IT.

have used this technique to investigate a variety of dimensions of legal change for nearly seven decades (see Mott 1936). Citations to precedent are objective, statistically measurable evidence (Landes, Lessig, and Solimine 1998) of the institutional aspect of law – providing clues about factors that influence its development (Johnson 1986, p 538). By studying such links among decisions, we will eventually identify zones of influence across both geographical, hierarchical, and temporal dimensions (Harris 1982; Landes and Posner 1976; Walsh 1997).

In the initial phase of the study, we began by crafting a series of search protocols seeking to capture all regulatory takings cases decided in the federal courts since 1978. In addition, we have written retrieval algorithms to automate the process of downloading opinion texts, coding relevant information from each, and organizing it into a readable database. We have also conducted a preliminary network analysis of these cases, observing patterns of decision citation references in all federal courts over the last quarter-century.

This paper proceeds as follows. In Sections 2, we overview the literature on precedent and citation analysis, followed by Section 3, on the legal history of the regulatory takings issue. Then, in Sections 4 and 5, we discuss techniques and strategies we have developed for addressing the formidable problem of capturing an entire corpus of case law. Next, in section 6, we present the preliminary results of our network structure analysis. Finally, we conclude with a preview of where our project is heading in the months ahead. Readers should be aware that this paper, like the CITE-IT project itself, casts a wide net, covering various theoretical, methodological, and legal issues and findings.³

2. Precedent and Citation Histories

What exactly is the influence of precedent in judicial decision making? Attitudinalists have long argued that justices consistently vote their policy and ideological preferences, with minimal regard for precedent (Segal and Spaeth 1996; Segal and Spaeth 2002). Others maintain that the justices should and do take pre-existing law seriously and that yesterday’s decisions serve as an ongoing source of meaningful reference (Knight and Epstein 1996; Spriggs and Hansford 2002). Indeed, as Spriggs and Hansford (2000) assert, “[i]ncreasingly . . . scholars recognize that to understand judicial decision-making fully we must move beyond mere votes and study what is arguably the judiciary’s most important policy output—the precedents set by court opinions” (p 328). There is also some debate about *how* the judiciary manages to collectively develop the law across multiple levels and jurisdictions. Is the judiciary best characterized as a “team,” each member contributing to the effort to “get it right” (e.g., Kornhauser 1995)? Or as a “principal-agent” model, in which semi-independent lower court judges with widely disparate views work to avoid a higher court audit (e.g., Songer, Segal, and Cameron 1994; Cameron, Segal, and Songer 2000)? These are among the theoretical debates we will briefly discuss in this section.

The decisional norm of *stare decisis* dictates that judges are to utilize rules from prior cases to structure the approach to current ones that present similar or analogous questions. While there are general expectations regarding horizontal precedent (according to which a court is consistent with itself), vertical precedent (judges follow rules articulated by higher courts) seems to exert

³ While there is undoubtedly something here for everyone, we are certain that not everyone will find every detail equally interesting. Fortunately, each section (with the exception of 4 and 5, which are closely related)³ should stand alone, so readers can safely skip around.

the strongest pull. Indeed, some have argued that the creation of legal parameters under this scheme produces a decision-making calculus that is less costly than it otherwise would be, and that it has helped to structure our system of courts as an authority hierarchy (Phelps and Gates 1991; Topf 1992).

The precise contours of a legal rule established by the Supreme Court do not remain constant. In fact, determining boundaries of a rule is generally an iterative process, in which the Court broadens, restricts, and or explains the rule in a series of cases (Landes and Posner 1976, p 250). Legal rules thus exist in a state of perpetual evolutionary development, as changes in the larger context affect their efficacy, the Court's personnel is renewed, and as variations on each central theme present themselves in litigation—all resulting in continuous demand for re-interpretation and clarification. The Supreme Court's lead in this process is both a non-trivial responsibility and something expected by observers and practitioners. And, the expectations embedded here have fed a rich vein of social science research addressing responses to Supreme Court precedent among lower court judges, especially where the controversy involves a hot-button social issue accompanied by serious division in policy and ideological preferences (Peltason 1961; Manwaring 1962; Johnson and Canon 1984; Songer and Sheehan, 1990). Although there is abundant evidence that non-legal influences infect the process throughout, research points to a general tendency among lower court judges to comply with High Court precedent (Baum 1978; Johnson 1987; Songer, Segal, and Cameron 1994), rather than striking their own course.⁴

This also comports with Kornhauser's (1995) theoretical conception of a "resource-constrained team," in which judges at all levels are engaged in a collective effort to reach the right decisions, and where the hierarchically arrayed structure is as conducive to error prevention as it is to error correction (also see Caminker 1994). Thus, legal principle is adjusted at the top, as warranted by changes in circumstances, providing signals and guides to judges below who preside over the great bulk of the system's caseload. Others have emphasized relative independence and heterogeneity in policy preferences among the judiciary to construct a theoretical model of courts as a principal-agent system (Songer, Segal, and Cameron 1994; Cameron, Segal, and Songer 2000). Because the Supreme Court can, at best, only selectively monitor its agents, the real incentive for judges below is less to "toe the line" than to minimize the likelihood of review by not straying too far from the mark. In addition, circuit-level judges might want to remain fairly consistent with each other, since divergence among circuits seems to be a fairly strong cue for Supreme Court review (Songer, Segal and Cameron 1994).

A handful of scholars have studied citation patterns (Caldeira 1985; Harris 1985; Klein 2002; Merryman 1954; Merryman 1977; Walsh 1997),⁵ but our understanding of the communications process that binds courts together is far from complete. Caldeira (1985) finds that geographic proximity has some influence on the patterns among state supreme courts, and Cannon and Baum (1981) report that adoption of tort innovation tends to occur where there are strong professional networks.⁶ Moreover, in his study of state supreme courts between 1870-1970,

⁴ We do not mean to imply that defiance among lower court judges does not occur (see Peltason 1961; Manwaring 1962; Uchida and Bynum 1991), but the general tendency seems to be some degree of compliance.

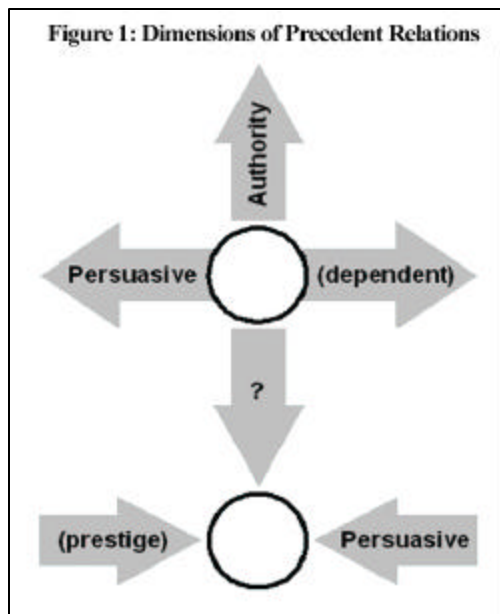
⁵ In addition, Manz (2002) compares citation use in Supreme Court opinions with those in briefs submitted to the Court during the 1996 term.

⁶ Berry and Berry (1990) also find that adoption of state lotteries tends to have a regional influence.

Harris (1985) finds that “if *amici curiae* are involved, both out-of-state and federal citations increase more than in-state citations,” suggesting that amici involvement is indicative of broader implications, and judges respond accordingly, demonstrating “attention to more than just local authority” (p 218). We believe that this is also suggestive of the role that attorney and interest networks play in the process of communication. Outside the law, geographic location and professional networks play an important role in business practices (Pouder and St. John 1996), and spatial proximity is significant to political communications among citizens (Huckfeldt, et al. 1995).

Because of the centrality of precedent to the perceived authority of judicial decisions, and the importance placed upon transmission of legal principle both to the process of legal argumentation and to sustaining the legal hierarchy, a network analytical framework seems particularly apt to the study of courts. While many network concepts are not applicable (e.g., “betweenness”) to citation networks (especially precedent networks), it is still possible to learn a great deal about the court system by tracking the flow of precedent, operationalized as citations within courts’ decisions (Caldeira 1983; Mott 1936). In his 1985 analysis of state supreme courts, Caldeira compared frequencies of cross-jurisdictional citations, interpreting courts with higher proportions of “IN” citations as prestigious, and those with higher levels of “OUT” citations as dependent on other courts’ legal reasoning. It is possible to build upon this approach, adding the dimension of hierarchy. The basic concepts are the same: citations within a given decision are understood as OUT links to other cases (see Figure 1); where they reference parallel courts (i.e., those of the same “strata”), they are understood as an appeal to persuasive precedent; OUT citations to higher courts may be understood as appeals to authority. Similarly, IN citations to a given decision by parallel courts hint at its persuasiveness, IN citations from lower courts suggest acknowledgement of binding authority. Moreover, variations in the degree to which courts cite (or are cited by) others suggests either a movement towards a common (higher citation rates) or isolation of individual courts (Harris 1982).

Based on prior results (Caldeira 1985; Harris 1982), “prestige” is expected to be heterogeneously distributed across courts. Whereas earlier efforts have focused solely on single court strata (e.g., state supreme courts), we expand our analysis to federal circuit and district courts, and provide a more comprehensive test of change over time. Because we are able to identify decisions not merely by court, but also by judge, we can also test whether it is more proper to attribute prestige (or recognized expertise) to a jurisdiction or to individual judges. Moreover, since prestige (or comparative expertise) has been shown to vary according to the legal issue under consideration (Canon and Baum 1981), our research will also establish a benchmark for the pattern of judicial prestige within a narrowly defined area of law.⁷



⁷ Klein and Roe (1999) take references to a judge by name, rather than a simple citation, as an indication of prestige (see also

Although the US Supreme Court clearly cites appellate court rulings on a regular basis, almost no empirical or theoretical attention has been paid to this phenomenon (indeed, this is true of all “downward” citations). For instance, although Landes and Posner (1976) count citations of courts of appeals decisions by the US Supreme Court, they fail to question the implications of such patterns for hierarchical models of court interaction. We surmise that such widespread scholarly disinterest stems from the formal importance of *stare decisis* in American law. While it appears logically consistent to ignore such citations in studies of the transmission of precedent, it may also be that downward citations serve an important role in the clarification (or even justification) of precedent by higher courts. Should such patterns be shown to be significant, this would be in general agreement with a team-based model of legal development.

Because our database will be of such broad jurisdictional and temporal scope (yet focused on a relatively narrow, rapidly evolving area of law), we believe it will provide nearly clinical conditions to test theories about the development of law. Walsh (1997) has suggested that citation patterns should reflect whether a court is developing a new legal doctrine (i.e., broader and more frequent references) or addressing a “settled” area of law. Similarly, Johnson has argued that the “age” of citations can be expected to vary according to whether an area of law is “typified by a high degree of consensus” (1985, p 321). In general, it has been observed that citations in well-established areas of law are much older than those in more dynamic areas (Landes and Posner 1976). Klein (2002, p 59-61) reports that subsequent favorable citation of new rules among circuit court judges varies slightly among the three issues included in his study, but that the average is about two-thirds. Moreover, he finds reason to suspect that judges will on occasion purposely ignore precedents with which they disagree and that some decisions failed to be cited because subsequent courts are simply unaware of them. Penetration of precedent is not always immediate, which, in addition to the above, can be attributed in part to differences in judicial taste, or intellectual curiosity for specific legal questions (e.g., McIntosh and Cates 1997).]

3. Regulatory Takings: A Brief Legal History

The concept of regulatory takings is rooted in the Fifth Amendment of the US Constitution, which states, “nor shall private property be taken for public use, without just compensation.” In a significant break from the past, Justice Holmes, writing for the Court in 1922, found that this clause could be applied not only to physical seizure of property, but also to land use regulation: “while property may be regulated to a certain extent, if regulation goes too far it will be recognized as a taking” (*Pennsylvania Coal Co. v. Mahon*, 260 US 393).⁸ Four years later, the Court upheld the authority of local governments to regulate land use by enacting zoning ordinances under state police power. The Court noted that zoning was of modern vintage but a

Klein 2002). Moreover, Klein (2002) differentiates prestige from expertise, which he measures as a judge’s case experience with a particular issue.

⁸ “The original understanding of the Takings Clause of the Fifth Amendment was clear on two points. The clause required compensation when the federal government physically took private property, but not when government regulations limited the ways in which property could be used” (Treanor 1995, at 782). See *Mugler v. Kansas*, 123 US 623 (1887) (holding that state prohibition on manufacture of beer and liquor is within the state police power and does not constitute a taking); *Hamilton v. Kentucky Distillers*, 251 US 146 (1919) (upholding the War-Time Prohibition Act, which made it illegal to sell alcoholic beverages in the US during World War I, against a takings clause challenge).

necessity of modern urban life.⁹ Although the ordinance in question forbade commercial and industrial usages of specified parcels of land, thus diminishing the value of the appellee's property, the Court rejected the claim that a regulatory taking had occurred (*Village of Euclid v. Ambler Realty Co.*, 272 US 365 [1926]). Interestingly, Justice Sutherland (at 397) closed his opinion for the Court as follows:

In the realm of constitutional law, especially, this court has perceived the embarrassment which is likely to result from an attempt to formulate rules or decide questions beyond the necessities of the immediate issue. It has preferred to follow the method of a gradual approach to the general by a systematically guarded application and extension of constitutional principles to particular cases as they arise, rather than by out of hand attempts to establish general rules to which future cases must be fitted. This process applies with peculiar force to the solution of questions arising under the due process clause of the Constitution as applied to the exercise of the flexible powers of police, with which we are here concerned.

A “gradual approach” indeed! After issuing these two landmarks in the 1920s, the Court remained relatively silent for an extended period, despite comprehensive advances in regulatory scale, allowing lower courts to develop the law without guidance—but not without notice. Writing in the mid-1970s, Bruce Ackerman (1977) remarked upon the virtual flood of environmental legislation in that era. “The result,” Ackerman observes, “has been a set of confused judicial responses More significant than one or another judicial decision, however, is the pervasive judicial recognition that compensation law—after a long period of neglect—is in need of a fundamental reconsideration. As is often true of the early stages of constitutional reappraisal, the Supreme Court has thus far been content to stand serenely aloof from the struggle, permitting the lower courts to glimpse its future views by consulting Delphic high court pronouncements handed down when Warren Harding and Calvin Coolidge were in the White House” (referring to *Mahon* and *Ambler Realty*) (p 3-4).¹⁰

Mahon and *Ambler Realty* are of particular importance for local governments because they are the primary land use regulators, exercising their police power with a variety of devices, including zoning ordinances, subdivision approvals, conditional use permits and fees, building permits, as well as environmental and natural resource protection regulations, restrictions on architectural design, rent control, and the like. If, in exercising this authority, a government “goes too far” and deprives a property owner of her Fifth Amendment rights, as the Court asserted in *Mahon*, litigation and a compensation order may well be in the offing. Arguably, many, if not most, government regulations effectively reduce somebody's property value, and, in theory at least, the takings clause could require government to compensate landowners for losses in property value. Moreover, *Ambler Realty* specifically left the matter to subsequent courts. Meltz, Merriam, and Frank (1999) note that jurisprudence on takings, beyond the 1920s, was predominantly developed in the state courts;¹¹ however, when the Supreme Court returned to the issues in the

⁹ Until recent years, urban life was comparatively simple; but, with the great increase and concentration of population, problems have developed, and constantly are developing, which require, and will continue to require, additional restrictions in respect of the use and occupation of private lands in urban communities (*Ambler Realty*, at 386-387).

¹⁰ Coyle (1993) makes a similar observation: “Between 1928 and 1974, the US Supreme Court did not even hear a zoning case, and most state courts gradually adopted the ‘see-no-land-rights, hear-no-land-rights’ attitude of the Court” (p 4).

¹¹ For example, the California legislature rejected calls for the creation of a specialized “Land Use Court,” but decreed that the superior court in most counties must designate one or more judges to develop expertise in the area of takings to make adjudication in that area more widely available (Meltz, Merriam, and Frank 1999, p 38).

1970s, federal courts experienced a rise in their profile. Meltz, Merriam, and Frank attribute this shift, in part, to the fact that 42 USC § 1983 had become a potential avenue for bringing takings cases before the federal courts.¹²

In 1978, in the face of a long-flowing stream of litigation and a variety of approaches developed in lower courts during its fifty-year hiatus, the Court acknowledged that it had failed “to develop any ‘set formula’ for determining when ‘justice and fairness’ require that economic injuries caused by public action be compensated by the government,” relying instead on *ad hoc*, fact-specific inquiries (*Penn Central Transportation Co. v. City of New York*, 438 US 104, 128). The Court in that case did, however, point to a number of relevant factors in evaluating the government’s action (at 124):

The economic impact of the regulation on the claimant and, particularly, the extent to which the regulation has interfered with distinct investment-back expectations are, of course, relevant considerations. So, too, is the character of the governmental action. A “taking” may more readily be found when the interference with property can be characterized as a physical invasion by government . . . than when interference arises from some public program adjusting the benefits and burdens of economic life to promote the common good.

If the Court had let its *Penn Central* test germinate, regulatory takings law might well be less confused than it has become. Two years later, however, in *Agins v. City of Tiburon* (447 US 255 [1980]), the Court articulated a new standard: “The application of a general zoning law to particular property effects a taking if the ordinance does not substantially advance legitimate state interests . . . or denies an owner economically viable use of his land” (at 260). A series of Supreme Court decisions since then has created a complex, often confusing, body of law regarding what regulations “go too far” to become a compensable taking. Two cases from 1987 are illustrative. In *First English Evangelical Lutheran Church of Glendale v. LA County*, 482 US 304 (1987) the Court held that, although temporary, a local ordinance preventing rebuilding after a flood deprived the property of all value; thus the ordinance should be considered a taking. In a second case during the same term, *Keystone Bituminous Coal Assoc. v. DeBenedictis*, 480 US 470 (1987), on facts similar to *Mahon* (1922), the Court reached a contrary conclusion: restrictions preventing surface mining subsidence were permissible because the company could continue to operate profitably despite the regulation.

Clearly, determining what it means for government to “go too far” is not an easy task, and the Supreme Court, itself, has struggled to reconcile its own precedent; indeed, the ambiguity of this “standard” first stated in *Mahon* is a problem noted with great frequency in the law review literature (see Epstein 1985, at 64). Our search finds scores and scores of articles addressing Justice Holmes’ *Mahon* opinion in one way or another, often noting that the one clear fact in this area is pervasive uncertainty and debate about the meaning of takings precedents (see e.g., Alperin 2002). Friedman (1986) observes that *Mahon* “poses a persistent riddle: where is the boundary line between regulation and seizure? Holmes offered no formula for solving the riddle. His ‘test’ was, to say the least, ‘opaque.’ Obviously, and no doubt deliberately, the case offered

¹² 42 USC § 1983, commonly referred to as “section 1983,” was enacted on April 20, 1871 as part of the Civil Rights Act. The number of cases filed in federal courts under section 1983 has dramatically increased since 1961, when the Supreme Court decided *Monroe v. Pape* (365 US 167 [1961]) (allowing liability to attach where a government official, a police officer, acted outside the scope of authority granted by state law).

no real guidelines” (p.5). One obvious consequence, is an “immense quantity of litigation,” as property owners sought protection under the 5th Amendment (Ackerman 1977, p3).

Using West’s *KeyCite* function,¹³ we quickly find evidence to support these assessments. References to *Mahon* (1922) have been heavy; the case has been cited in 1140 decisions, all but 48 of which occurred in the lower courts. Despite this volume, *Mahon* was essentially left undeveloped for a half-century. The Court finally “explained” it in *Penn Central* (1978), and in 1979 followed *Mahon* in *Kaiser Aetna v. United States*, 444 US 164 but distinguished it in *Andrus v. Allard*, 444 US 51. Similarly, 2189 decisions have cited *Ambler Realty* (1926). Although the Court immediately reinforced its understanding of zoning (*Beery v. Houghton*, 273 US 671 (1927); *Nectow v. City of Cambridge*, 277 US 183 (1928)), another favorable reference did not occur until 1977 (*New Motor Vehicle Bd. v. Orrin W. Fox Co*, 434 US 1345). On the other side of the ledger, the Court distinguished *Ambler Realty* in 1976 (*Eastlake v. Forest City Enterprises*, 426 US 668) and again in 1977 (*Moore v. East Cleveland*, 431 US 494).

Thus, regulatory takings, a heavily litigated area of law, began with vague precedent and open invitation to lower court experimentation in the 1920s, experienced a half-century without the expected guiding hand from above, and has since seen a series of conflicting, confusing decisions by the High Court.

4. Identifying the Regulatory Takings Corpus

In this, the first phase of our research, we limited searches to federal court decisions following the Supreme Court’s 1978 decision in *Penn Central* (438 US 104). As we have noted, this decision marks the Court’s re-engagement with the question of regulatory takings, after over a half-century of relative inaction. Generating this population of decisions has allowed us to experiment with a variety of search and retrieve protocols, as well as to do some initial analysis of citation networks.

Our approach to identifying regulatory takings decisions (RTDs) involved two major tasks. The first is to create a pool of decisions that is over-inclusive but encompasses all RTDs. The second part is to estimate the error rate in that pool (i.e., false-positives). Since the problem of generalizing network structures from smaller samples (Frank 1978) is different from the challenge we face (Kossinets 2004), we believe “false-positives” to be more tolerable than omitted decisions. Whereas sampling concerns center on the potential for subpopulations to be structured differently than the networks of which they are a part (e.g., cliques), we are concerned with the possible impact of “non-relevant” decisions. There are four possible effects such “false-positive” decisions might have on our results: 1) their outgoing citations may be stochastically distributed and merely “dilute” the significance of our results; 2) the pattern of their citations may be “opposite” those of “genuine” regulatory takings cases, and thus also dilute our results; 3) the pattern of citations may be the same as valid regulatory takings cases—only stronger, leading us to over-estimate the significance of our results; or 4) the “background” structure of citations may be stable and generalized, regardless of precedent concerns. We would expect the degree to which these may influence our results to be related to proportion of “true” and “false”

¹³ *KeyCite* is a legal citation index, one of the most important features of which is its list of all subsequent opinions that note a previously issued one, as well as a notation of each citation’s character.

cases in the regulatory takings pool, an estimated value derived from our validity sampling technique (described in Section 5).

The task of identifying the comprehensive pool of RTDs is a challenge quite distinct from traditional legal research. An attorney preparing a brief is principally concerned with identifying binding authority—a statute, or a handful of decisions interpreting a statute or principle of common law. While attorneys may ultimately hope to extend an existing rule of law to a new situation, the focus, nevertheless, is the current state of the law governing the dispute.

Our needs are different because we are more interested in the processes through which law develops, via the dissemination of precedent throughout the nation’s legal system. Thus, our initial challenge was to identify the entire pool of decisions related to the development of a particular area of the law. Again, we are unaware of any published work that has identified such a comprehensive set of judicial decisions. Indeed, this step proved to be more of a challenge than we had originally anticipated.¹⁴

The two major legal databases, Westlaw and Lexis-Nexis, each reference the same pool of legal decisions, and provide comparable interfaces to help researchers locate decisions through “terms and connectors” (i.e., Boolean) searches (MacLeod 1996; Songer 1988). We chose Westlaw because of the great usefulness of the additional material it adds: summaries of each decision; headnotes; and *KeyDigest* numbers (Norman 2004). We have found these summaries and headnotes (described further below) to be extremely helpful during validity checks. Moreover, because judges and courts are not always explicit about the fundamental terms of each area of law they address, and since language tends to vary geographically and across time, Westlaw’s efforts to “translate” into a standard language greatly improves our ability to identify decisions when searching for general terms (Gerson 1999). Our use of these tools is described below.

4.1.DEVELOPING SEARCH PROTOCOLS

As we detailed in Section 3, the question of regulatory takings gradually emerged over the course of the past century, becoming commonly (though not universally) identified as such only after the 1978 *Penn Central* decision. Accordingly, there is clearly no single “marker” that identifies the pool of RTDs. While hundreds of RTDs contain the phrase “regulatory takings,” courts often address the issue without employing that precise phrase anywhere in the decision¹⁵. Other phrases extremely common in RTDs (e.g., *just compensation*) are also often found in claims under the Takings Clause that involve physical (rather than regulatory) takings.

Since there is no single marker for RTDs, our approach is to employ a large number of overlapping search techniques. Through trial-and-error, we have designed a combination of 33 searches that maximize our confidence that any (federal, post-*Penn Central*) RTD would be captured by *at least* one of the searches. These searches can be categorized into two groups: KeyCite searches, and Boolean searches.

¹⁴ In fact, our initial set of external reviewers and the NSF panel also seemed to minimize this as an issue, instead focusing on the problem of automating the process of retrieving internal and external citations associated with each decision, a task which has proven to be far easier than expected.

¹⁵ At the same time, a surprisingly significant percentage of decisions containing the phrase “regulatory takings” do not meet our criteria for inclusion in the pool (see the inset in Section 5 for examples).

4.1.1. KeyCite searches

Through a careful reading of the law review literature on regulatory takings, we identified twenty-three Supreme Court decisions from *Penn Central* forward that address questions concerning regulatory takings. Given the highly visible and binding nature of the Court's decisions, we assume that any federal RTD following *Penn Central* is exceedingly likely to cite that case or *at least* one of the other twenty-two subsequent Supreme Court decisions.

Westlaw's KeyCite reference system allows a researcher to identify all decisions that cite a given precedent (Liebert 1999). In the interest of inclusion, it is tempting to identify all subsequent decisions which reference one of these cases. In fact, such a search overshoots our target. Supreme Court decisions that address regulatory takings often also discuss other areas of the law, as well. Thus, courts might cite those Supreme Court decision on points unrelated to regulatory takings. For this reason, citing a Supreme Court decision that discusses regulatory takings is not a guarantee that the citing decision itself concerns regulatory takings. Consequently, we have had to develop more sophisticated methods of distinguishing regulatory-takings decisions.

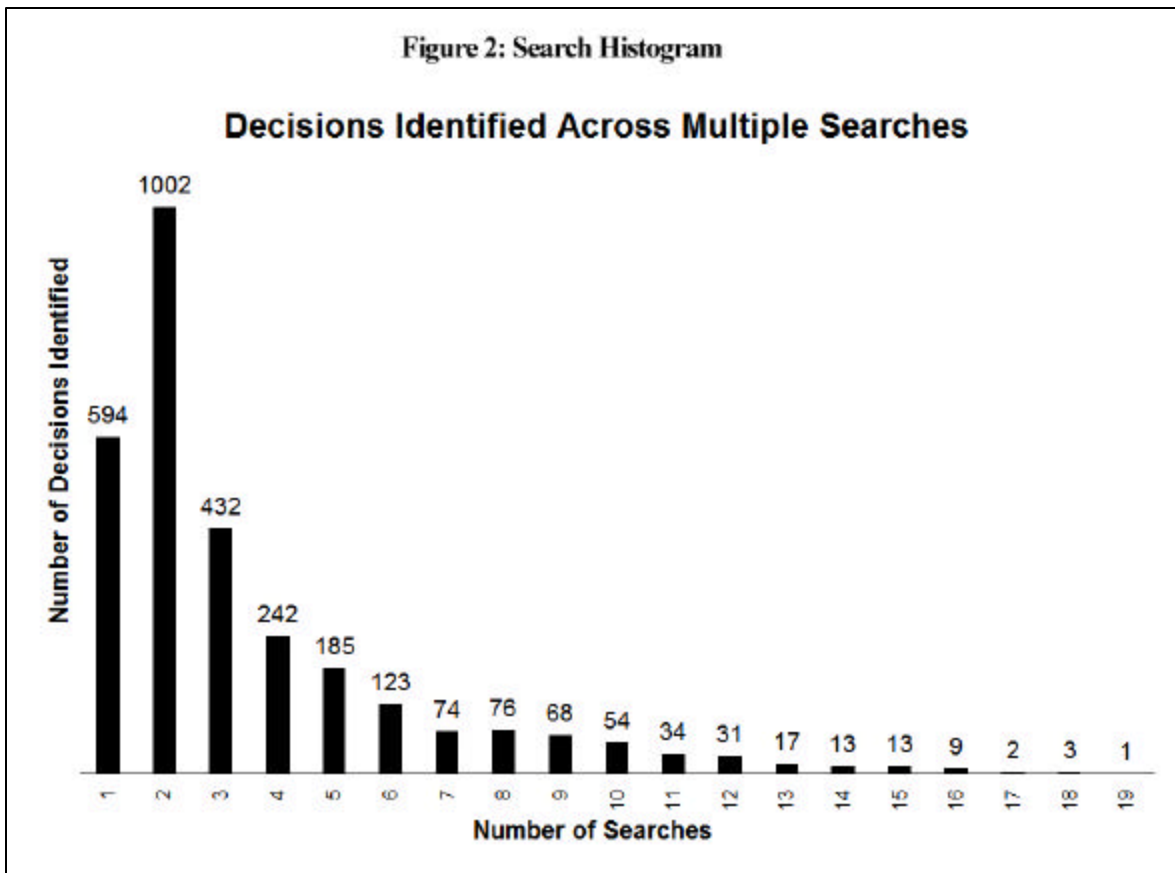
We have found Westlaw's *headnote* system to be extremely useful for this task. At the top of each published decision (and some unpublished decisions, as well) Westlaw adds summaries of the issues addressed and legal statements made by the court in particular portions of the opinion. Headnotes are useful for our purposes, because judicial decisions typically address questions in more than one area of the law. Thus, a decision primarily focused on regulatory takings may also include discussion of (and headnotes on) the standards for summary judgment, for instance. As a result, the fact that a decision cites an RTD does not ensure that it is itself an RTD.

To improve the accuracy of these KeyCite searches, we employed a Westlaw feature that allows researchers to limit searches to decisions that cite earlier decisions on the issues of law associated with specific headnotes (Harrison 1999). After identifying those headnotes that addressed regulatory takings in each of the twenty-three base decisions, we were then able to retrieve decisions that referenced any of these twenty-three decisions specifically on a relevant headnote. This approach assumes that federal courts citing one of these Supreme Court decisions – on a point of law related to a headnote addressing regulatory takings – are highly likely to be relevant to our study. However, while we suspect that this approach significantly improves the accuracy of our pool (i.e., fewer false-positives), we were still concerned that it may omit some cases.

4.1.2. Boolean searches

Accordingly, we attempted to improve our results with Westlaw's *KeyDigest* and "terms and connectors" (i.e., Boolean) search capabilities. The KeyDigest number system is essentially an outline that Westlaw has created to "tag" headnotes as addressing particular areas of the law (e.g., headnotes associated with "EMINENT DOMAIN" begin with "148k"). KeyDigest numbers grow longer as issues becomes more specific. For example, the KeyDigest number 148k2.27 refers to the following: EMINENT DOMAIN/WHAT CONSTITUTES A TAKING; POLICE AND OTHER POWERS DISTINGUISHED/ENVIRONMENTAL PROTECTION. Working from our deepening understanding of regulatory takings issue, we identified a number of highly relevant KeyDigest numbers, we are thus likely to be strongly associated with RTDs. We then created eight searches that combined these numbers with other keywords identified while reading the twenty-three decisions, a technique that Songer has suggested (1988) is the most likely to produce comprehensive and reliable results.

It is unlikely that any single search will produce results that are both comprehensive and accurate (Gillaspie 1992). There is too much variation in the courts’ choice of language and citations for a single search to maximize efficiency. Rather, we believe the soundest approach is to triangulate across multiple search approaches. Between the KeyCite and Boolean search methods, we produced thirty-one unique searches – each a distinct means by which a decision could be brought into our initial (over-inclusive) pool. An RTD may have escaped one, two or even thirty of our searches, but it is extremely unlikely that any would be missed by all thirty-one. After eliminating duplication (results from decisions which arise multiple times, we have determined that the first phase of the search protocols yields a pool of 2,780 decisions (see Figure 2).

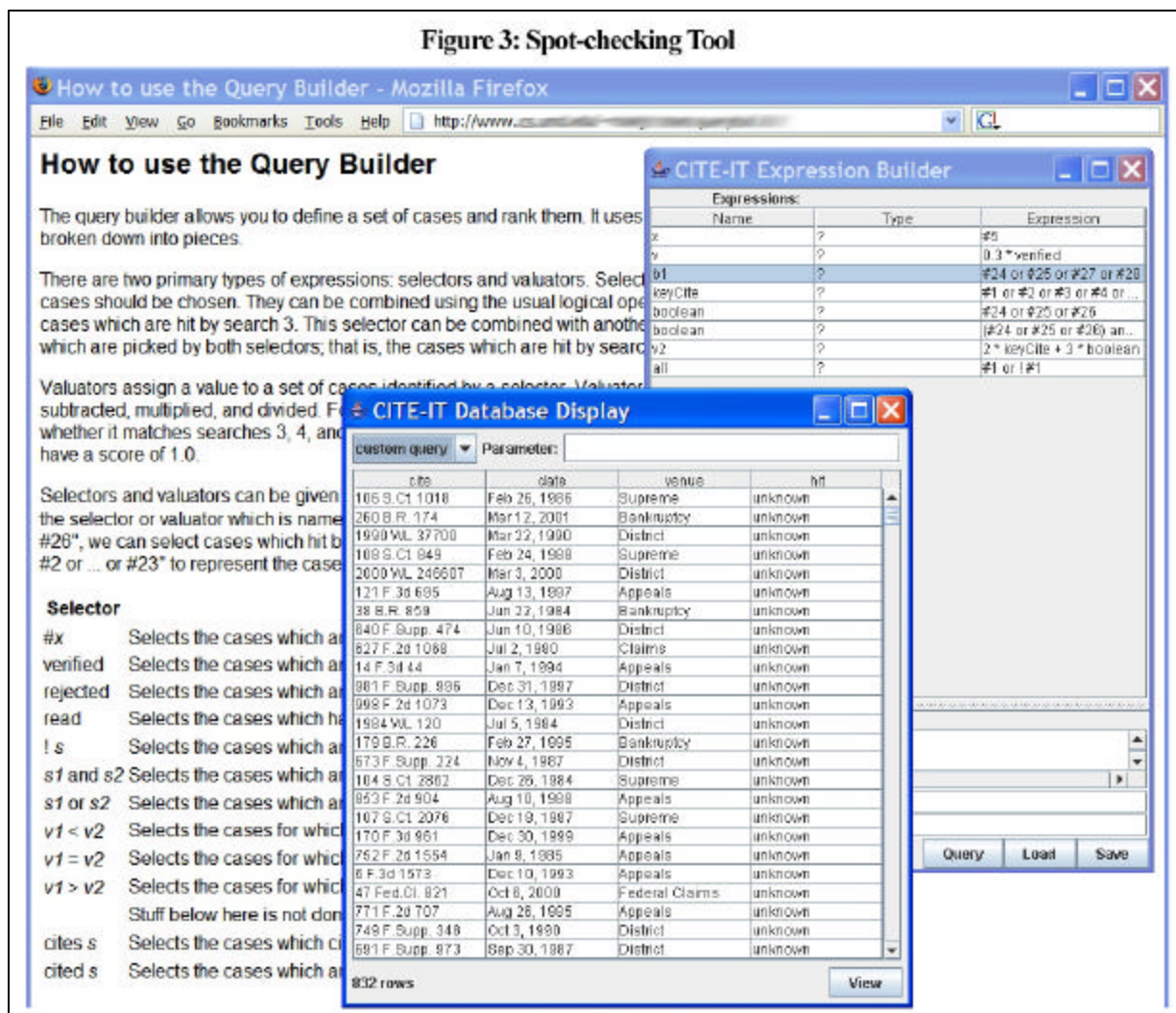


5. Estimating Accuracy

This is clearly many more than we could ever hope to review individually. We must therefore use a sampling method to estimate the “accuracy” of our pool (i.e., the proportion of “true” RTDs). Since we can infer that the frequency by which cases are identified across the full range of these searches is directly related to their likelihood of being a “true” RTD, we are biasing these spot-checks towards decisions with lower “hit counts” across all searches. Using intuition, experience, and a simple Java-based computer program¹⁶, we have been able to identify these

¹⁶ Given the magnitude and complexity of many of our research tasks, we are using a variety of computer-supported research methods. The computational tasks of the project are wide-ranging: HTML document retrieval and parsing, interactive visualization, and later Web application hosting. We chose the Java programming language because it is both free and widely

Figure 3: Spot-checking Tool



likely “sub-pools,” based on a variety of Boolean combinations (e.g., intersection, sum, or difference) of the original thirty-one searches (see Figure 3).

In addition to striving for a high degree of accuracy, we are also concerned that our approach be tractable. While concern for the ability of computerized techniques to match the accuracy of manual research has been voiced by researchers in the past (Gillaspie 1992), the reliability of citation systems has been demonstrated (Spriggs II and Hansford 2000), as has the efficacy of keyword and full-text searches (Songer 1988).

The first step in determining the accuracy of our decision pool (i.e., the proportion of “true” RTDs) validity is to define criteria for inclusion (see Inset). After manually reviewing a random selection of decisions from each sub-pool, we estimate the sub-pool's hit¹⁷ ratio. While we are

used, and it has an exceptionally large standard library (many third-party libraries are also available), which dramatically simplifies programming tasks (Savitch 2004). Moreover, features such as types, exceptions, and automatic memory management eliminate many sources of programmer error that exist in other languages (Johnston 2004).

¹⁷ For the sake of brevity, we refer to “true” RTDs as “hits” and non-RTDs as “misses.”

still in the early stages of this process, we anticipate that we will find that a substantial number of RTDs will be found in relatively accurate search sub-pools. For instance, decisions citing more than three of our twenty-three Supreme Court decisions will be nearly certain hits. Similarly, several of our Boolean searches will likely contain extremely high true RTD ratios. There are a number of ways by which we can manipulate the sub-pools to generate high hit ratios. We can create sub-pools of decisions meeting a combination of criteria – for example, decisions that cite at least one of our twenty-three base Supreme Court decisions AND appear in at least one of the eight Boolean searches.

Defining a Regulatory Takings Decision – an Illustration

In Case A, the plaintiff claims that a regulatory taking has occurred. The court declines to consider the claim for procedural reasons unrelated to the law of regulatory takings. Case A is not an RTD.

In Case B, the plaintiff brings a claim that a regulatory taking has occurred. The court declines to consider the merits of the claim on the grounds that the claim is not ripe, because the plaintiff has not exhausted other available remedies for recovering compensation from the government. Case B is an RTD, because the policies governing the ripeness analysis are particular to the regulatory takings context.

In Case C, the plaintiff asserts multiple grounds of recovery, including a claim that a regulatory taking has occurred. The Court declines to consider the merits of the regulatory takings claim, because it holds that the outcome of the dispute is determined by its disposition of the plaintiff's other claims. Case C is not an RTD.

In Case D, the plaintiff does not explicitly assert that a regulatory taking has occurred. The Court, however, elects to treat the claim as a regulatory taking claim, and adjudicates the case under the law of regulatory takings. Case D is an RTD.

This approach not only enables us to estimate the proportion of “false-positives” in our decision pool, but by combining multiple, heterogeneous approaches, we are confident that we have not omitted “true” RTDs.

Of course, we recognize the inherent research opportunities of an exhaustive, yet relatively “clean” pool of cases (i.e., one in which all false-positives have been eliminated) within a single area of law. With this in mind, we aim to not only estimate the initial error rate across this population of RTDs, but to improve upon it with time. Because our spot-checking tool enables us to identify individual false-positives, as well as searches (or Boolean combinations of searches) with low proportions of “true” RTD cases, we will be able to “cull” or “winnow¹⁸” the database, continually improving its accuracy. Moreover, as we perform relational (i.e., citation) analyses on the pool, the results will themselves enable us to further eliminate false-positives (e.g.,

¹⁸ Though these strategies are both focused on producing an RTD pool with a low proportion of false-positives, they approach the problem from opposite ends – “culling” involves isolating those cases that are highly likely to be true RTDs, while “winnowing” is the elimination of cases with a higher probability of being false-positives.

decisions not cited by any other decision in the pool). Through this multi-faceted approach, we expect to be able to create a pool of decisions with a high RTD hit ratio¹⁹.

Over the coming months, we plan to repeat these steps to identify the full corpus of regulatory takings decisions dating back to 1900 (at both federal and state supreme court levels), adapting our searches as necessary (e.g., adjusting to historical changes in legal language). Considering that our methods will likely vary somewhat, we plan to sample each segment (i.e., post- and pre-1978 federal courts, and state supreme courts) separately for overall accuracy.

6. Preliminary network results

Although a variety of formats are available from Westlaw, hypertext (HTML) is the most appropriate to our needs, as it is simple, open, and includes links. While all files contain the full text of each decision, a case summary and headnotes, HTML files also include other useful information. Again, one of our major goals is to identify precedent networks, in which vertices (or nodes) represent decisions and directed lines (or arcs) represent citations of one decision to another. To accomplish this, we need to identify all citations in the body of each decision and, in turn, locate the decisions to which they refer. Although such operations can be easily performed by a person with minimal training, this is infeasible for a database including thousands of decisions.

However, by exploiting regularities in Westlaw's hypertext formatting, we are able to automate this process. Near the top of each decision are four lines of basic information. For example:

```
<b>Meriden Trust and Safe Deposit Co. v. F.D.I.C.</b><br>
<b>62 F.3d 449</b><br>
<b>C.A.2 (Conn.), 1995.</b><br>
<b>Aug 02, 1995</b><br>
```

Using a simple Java program, we can identify lines framed by the tags “” and “
”.²⁰ This technique works for all published decisions. Unpublished decisions are also included in our database; these use Westlaw-specific identifiers (e.g., “2004 WL 2341811”), which are also consistently found after HTML tags (e.g., “”).

Identifying all citations within a particular decision is considerably more challenging, but again, Westlaw's hypertext formatting is quite helpful, since every citation is hyperlinked to the decision it references. Just as it is easy to recognize such blue-underlined text in a browser, a program can be designed to identify the “” and “” tags that surround links. The difficulty arises in parsing the text within links. We might avoid this step altogether (at the cost of slower performance), by simply following the links to the cited documents and retrieving the easily-identified cite within that document. However, this requires a request to Westlaw for every citation in a decision; and while 1-2 seconds to retrieve each of these is not prohibitive, a faster alternative is desirable.

¹⁹ Given the magnitude and diversity of the analytical tasks we face, we expect this to be a gradual process. That is, we expect the composition of the “true” RTD pool to change somewhat over time; accordingly, we are considering using a “versioning” system, similar to that used by software companies.

²⁰ In HTML, such tabs indicate boldface and a line break.

While the basic pattern of a legal citation is fairly simple (e.g., [Volume number][Reporter name][Page number]), actual citations can be considerably more complicated. For example:

```
538 F.2d 308 (CA2 1976)
87 S.Ct., at 1515- 1517
11 Wall., at 123,
60 Fed.Reg. 37,280, 37,283 (1995)
8 Pa.Super. 339, at pages 353, 357
244 U.S. 590, 37 S.Ct. 662, 664, 61 L.Ed. 1336, L.R.A. 1917F,
1163, Ann.Cas.1917D, 973
```

In particular, note that commas can have several different functions: separating parallel citations, separating the initial page number of a decision from the specific page within the decision that is cited, separating thousands from hundreds (e.g., “37,280”), and finally separating the reporter name from the page number. However, since the Java program only considers the text occurring between hyperlink tags, we have found the following regular expression²¹ successfully identifies all such variations:

```
^(\\d+) (.*) (? : , ? at) ? (\\d+ | (\\d\\d? , \\d{3})) ( -- ? ? \\d+ ) ?
```

To facilitate later analysis (including the identification of network structures), we have also designed this program to append all citations in a canonical format to the top of each decision. It is a simple matter to compare these to the total number of hyperlinks within a decision, and to visually scan for the consistency of those results.

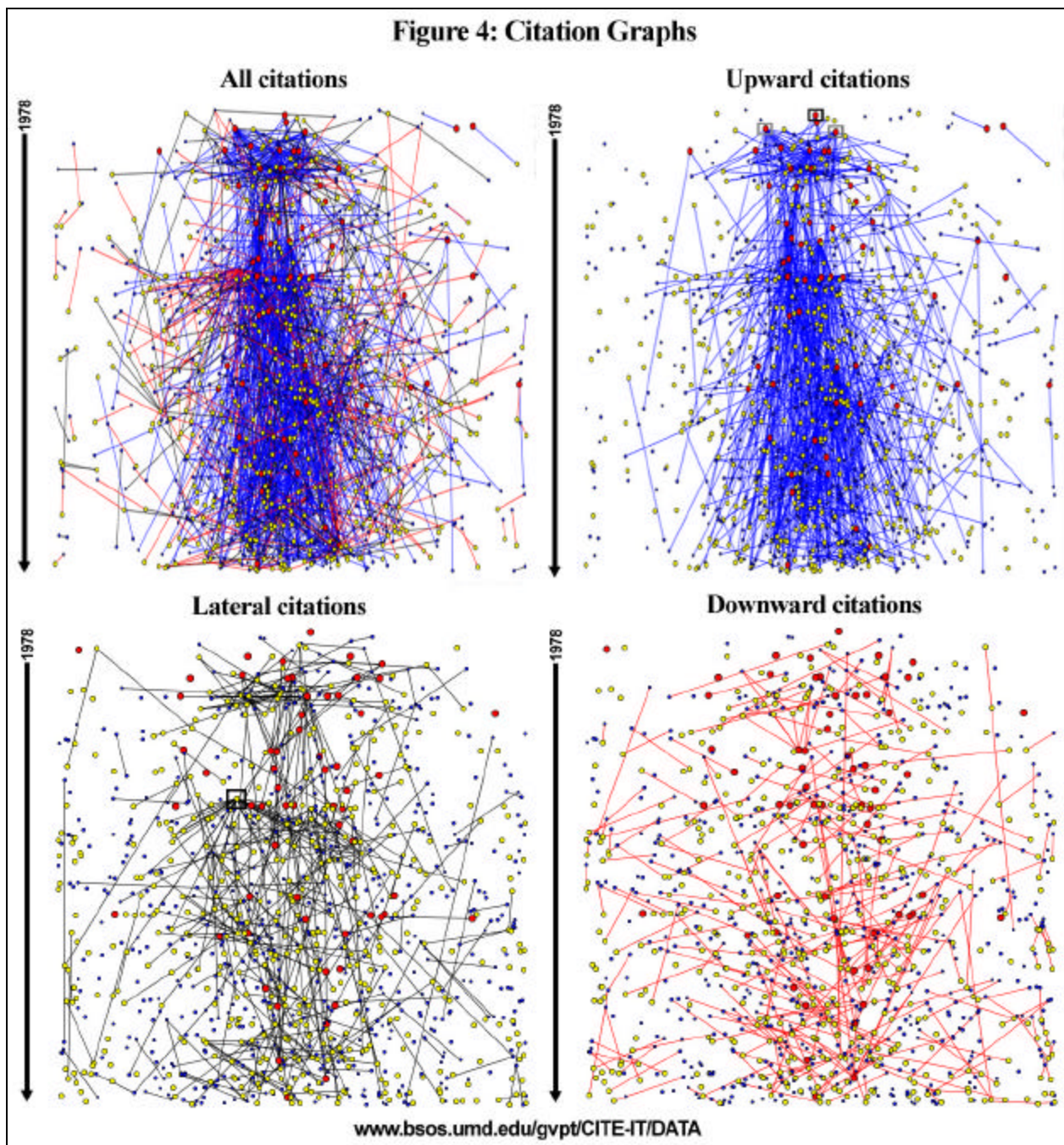
Once we have identified the references contained within each decision, we use another Java-based program to graph that network²². We chose the open-source JUNG (Java Universal Network Graph) framework²³ partly because it is seamlessly compatible with our other Java-based tools and supports a broad range of analytical and visualization approaches, but also because this rapidly evolving tool promises to become even more useful in the near future (Huisman and van Duijn 2004). With JUNG, we are able to annotate any graph element (e.g., providing metadata about nodes or links) and dynamically link it to its original source data (e.g., full-text decisions). The framework includes filtering and optimization tools, enabling us to explore networks interactively. Finally, JUNG can also be embedded into other applications (e.g., Internet browsers), greatly facilitating our ability to communicate our data and results to a larger audience. We have already generated graphs from references (see Figure 4), identified in our initial search results. As mentioned earlier, JUNG provides us virtually unlimited control over how we visually present our network (Huisman and van Duijn 2004). Thus, we can

²¹ Regular expressions are means of describing patterns in text (e.g., “all words beginning with the letter A,” or “lines with two commas and no capital letter F.” See Savitch, Walter J. 2004. Java: an introduction to computer science and programming. 3rd ed. Upper Saddle River, NJ: Prentice-Hall.

²² While it appears that virtually all past citation analyses have been based on data organized as sociomatrices, (Wasserman and Faust 1994), managing networks with languages such as Java both simplifies this task, and provides greater analytical flexibility. Rather than maintain static maps of the (presence or absence of) relationships between each pair of actors, we need only record the various links from each case. With all files stored on our local computer, it is a trivial programming task to identify the full set of links to any decision (or set of decisions), information which can be appended to each file as meta-data, or exported in a variety of forms (including sociomatrices) for additional analysis.

²³ The JUNG framework also supports a wide range of algorithms for quantitative network analysis. See <http://jung.sourceforge.net> for source files and further information.

organize and color-code²⁴ decisions (nodes) and citations (links), highlighting (for instance) communication between geographical or hierarchical jurisdictions, or those connected with a specific decision, court, or court level.



In the figures above, the largest (red) circles represent decisions handed down by the US Supreme Court, slightly smaller (yellow circles) represent US Circuit Courts. The smallest (blue)

²⁴ Larger, full-color graphics are available on the CITE-IT website: www.bsos.umd.edu/CITE-IT/DATA.

dots are decisions issued by the various US District Courts. The lines connecting decisions depict citations. While position along the x-axis is (currently) arbitrary, we have ordered the decisions temporally, with 1978 cases appearing at the top of each graph and more recent cases towards the bottom. This feature of the graph is especially critical – *all* OUT-cites²⁵ originate from cases nearer the bottom. For instance, while the tendency may be to interpret lines in the DOWNWARD CITATIONS graph as “moving” from top to bottom, the actual relationship is in fact the opposite – *all* IN-cites “arrive” from below, in each of these graphs.

With this in mind, we are able to observe interesting patterns in the data. Perhaps the most obvious (and least surprising) is the dominance of appeals to authority (i.e., upward citations). While this graph may mask differences between the magnitude of appeals to the US Supreme Court or the US Circuit courts²⁶, it is clear that authority is much more common than persuasion (i.e., citation between courts of similar levels of authority). Similarly, these lateral citations are much more common than “downward citations” (those to decisions from lower courts).

Again, although these graphs are based on preliminary results that have yet to be fully verified, we have already found them to be useful for identifying cases of special interest (e.g., decision 830 F.2d 968 [1987], highlighted in the LATERAL CITATION graph), which is referenced by so many courts of similar hierarchical authority. Another noticeable pattern is the apparent decline in the number of federal level regulatory takings classes in the mid-1980s. Finally, as we suggested in the previous section, these network relations (or especially their absence) may also help us with the process of defining the pool of “true” RTD cases.

7. What’s Next for the CITE-IT Project?

These observations, as well as the scholarship we touch on, raise questions about relationships among courts as legal principle develops. We believe that constitutional takings litigation offers an excellent window through which we can observe the larger system and address some important issues. The way in which the law developed over the course of the 20th century allows us to compare the relative value of the “team” model with the “principal-agent” conceptualization. In addition, we can evaluate the flow of precedent and citation patterns across a century of legal development under varying conditions. And, finally, we can assess expansion and geographic dispersal in the advocacy network. In the months ahead we will collect the complete corpus of regulatory takings cases from 1922 to present, undoubtedly learning strategies and developing more effective tools along the way. We will then begin to employ network analytics to examine several questions pertaining to the flow of precedent across time, space, jurisdiction, level, and so on.

By Summer 2005 we plan to have finished identifying the corpus of regulatory takings decisions which have been issued by state supreme courts (as well as any lower-level decisions which cite, or are cited by, those decisions). As with the federal-level decisions, we will check this database for validity, biasing our sample towards cases which were identified by relatively fewer searches. With this accomplished, we believe we will have gone further than any other researchers to

²⁵ Please refer back to Figure 1 and the associated discussion on page four.

²⁶ We will use formal network models to test this (and other) hypothesis once the accuracy of the population has been estimated.

identifying and acquiring a complete record of state and federal decisions relevant to a single question of law, from courts at multiple levels.

After identifying all cases decided (with published opinion) by the US Supreme Court, US Circuit, District, and Court of Claims, and the 51 courts of final appeals in the states and the District of Columbia, from 1900 through the most current court terms, we will then deploy network analytical techniques to assess the development and flow of case law temporally and spatially, to map the judicial activity in this legal area and identify the existence of nodes of influence among the courts.²⁷

The questions we will investigate in the months ahead have important implications more broadly, as well, for the two-way connections between law and politics, and relational dynamics among political institutions. How have courts reacted to the explosion of political attention that has been focused on regulatory takings since the High Court reentered the field in the 1970s? Did lower courts comply immediately, or not at all? Or, rather, have lower courts come on board more gradually? Assuming that a network of attorneys and organized interests have mined this area of law to engineer legal development, how closely does such legal mobilization track decision-making across the court system? Do competing networks emerge? Does the network radiate from a single core, or is it regional, with multiple centers? To what extent have different layers of the judicial system used legal doctrine to expand or limit their involvement in policy-making?²⁸ Ending its half-century holiday, did the Court engage primarily in self-reference to fit its old principles to dramatically different political and economic conditions? Or, did the Court follow new developments from below—e.g., from prestigious circuits or states, from better-known or experienced judges, when more than one circuit and/or state had adopted a common standard? Other important questions concern the manner in which appellate courts may use pronouncements of doctrine as signals to lower courts—as a means of regulating the flow of certain kinds of cases into the federal court system.²⁹

As we expand our pool of cases to include the pre-*Penn Station* decisions from 1922 to 1978, we will ask questions specifically about lower court behavior absent High Court guidance. How do lower courts address questions left dormant by the Supreme Court over an extended period? In the absence of leadership from the top, do lower courts act relatively independently? Has a US Circuit or a state supreme court entered the breach to assume an acknowledged lead? Or, have

²⁷ Using opinion citations as a proxy for judicial influence originates with the work of Landes and Posner (1976), who assessed the subsequent citations generated by 1000 Supreme Court opinions from the 1960s and 70s. Landes, Lessig, and Solimine (1998) similarly gauged the influence of circuit judges by the number and patterns of citations to their opinions. In addition, Kosma (1998) analyzed citations to the more than 24,000 opinions produced by Supreme Court justices over the entire expanse of history (1793-1991).

²⁸ Harrison (1982) observes, for example, that state courts may calibrate their level of activity in issues concerning exclusionary zoning according to “how broadly they define due process requirements, equal rights guarantees, and eligibility for standing” (p 59).

²⁹ Meltz, Merriam, and Frank (1999) note that the Federal Circuit negated the efforts of the Federal Court of Claims to ease access to federal court for takings claims, only to be instructed by the Supreme Court that it had overreached in its interference with Court of Claims decisions (p 41-42). In addition, the story of how the lower courts have responded to Supreme Court cues, and how they have behaved during the prolonged absence of such cues, is also inevitably intertwined with the interactions between courts and legislatures. Indeed, the high political profile that regulatory takings has achieved within some circles, and the numerous calls for legislative action which it has engendered, make the topic an especially rich one for observing the interplay between the multi-layered judicial system and the legislative branch.

rival factions emerged with clusters of courts coalescing around alternate strands of legal development?

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