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Do Economic Downturns Dampen Patent Litigation?

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Do Economic Downturns Dampen Patent Litigation?

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Recent studies estimate that the economic impact of U.S. patent litigation may be as large as $80 billion per year and that the overall rate of U.S. patent litigation has been growing rapidly over the past 20 years. And yet, the relationship of the macroeconomy to patent litigation rates has never been studied in any rigorous fashion. This lacuna is notable given that there are two opposing theories among lawyers regarding the effect of economic downturns on patent litigation. One camp argues for a substitution theory, holding that patent litigation should increase in a downturn because potential plaintiffs have a greater incentive to exploit patent assets relative to other investments. The other camp posits a capital constraint theory that holds that the decrease in cash flow and available capital disincentivizes litigation. Analyzing quarterly patent infringement suit filing data from 1971-2009 using a time-series vector autoregression (VAR) model, we show that economic downturns have significantly affected patent litigation rates. (To aid other researchers in testing and extending our analyses, we have made our entire dataset available online.) Importantly, we find that these effects have changed over time. In particular, patent litigation has become more dependent on credit availability in a downturn. We hypothesize that such changes resulted from an increase in use of contingent-fee attorneys by patent plaintiffs and the rise of nonpracticing entities (NPEs), which unlike most operating companies, generally fund their lawsuits directly from outside capital sources. Over roughly the last 20 years, we find that macroeconomic conditions have affected patent litigation in contrasting ways. Decreases in GDP (particularly economy-wide investment) are correlated with significant increases in patent litigation and countercyclical economic trends. On the other hand, increases in T-bill and real interest rates as well as increases in economy-wide financial risk are generally correlated with significant decreases in patent suits, leading to

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procyclical trends. Thus, the specific nature of a downturn predicts whether patent litigation rates will tend to rise or fall.

I. INTRODUCTION

In the arena of patent litigation, there are two competing theories that explain the influence of the macroeconomic environment on firms' motives to file suit. On one account, the decline in firm revenues associated with falling aggregate demand encourages firms to reduce litigation in intellectual property suits as a method of reducing costs and maintaining profitability.[1] For example, during the most recent downturn, an American Bar Association email to intellectual property lawyers advertising a seminar on how to reduce expenses declared "The economy is still in the doldrums, and electronic documents have exponentially increased the costs and burdens of discovery. What can you do?"[2] Relatedly, shortages in available capital may reduce the supply of contingent-fee law firms available to represent plaintiffs, especially independent inventors and small firms, who have increasingly used contingent-fee arrangements in patent infringement actions.[3]

On another account, a decline in profits spurs firms to extract greater revenue from dormant assets by litigating more aggressively against perceived infringers.[4] Because the *relative* internal rate of return on investing in patent litigation rises during downturns, it becomes a more attractive business strategy relative to other investment opportunities. A front-page article from the *New Jersey Law Journal* printed during the downturn of the early 2000s demonstrates this tack: "However Hard the Market Falls, Soft Landing Seen for IP Lawyers,"[5] as does an *IP Law 360* headline from the most recent downturn: "Drive for IP Profits Accelerates Q2 Patent Suits."[6] The *IP Law 360* article noted that several patent litigators attributed a short-term uptick in patent litigation to efforts to generate revenue in a weak economy.[7] Additionally, economic downturns may make the financial benefits of

[1] See Section II; see also Bachmeier et al. (2003, 192) ("Litigation is a costly endeavor, and individual plaintiffs and their attorneys, who may be financing the expenses of a lawsuit and are paid through contingency arrangements, would presumably be influenced by economic conditions.").

[2] Bureau of National Affairs & American Bar Association (2009); see also Tu (2009) (making a series of recommendations to reduce patent-related costs during the most recent downturn). Additionally, the value of winning a patent infringement suit may decrease in an economic downturn, though one would expect this effect to be marginal, since winning patentees can recover damages going back six years and garner either an injunction or damages on a going-forward basis. See 35 U.S.C. § 286; eBay, Inc. v. MercExchange, 547 U.S. 388 (2006).

[3] See Thomas (1998, 328); Cahr and Kalina (2006); Fabricant & Dickstein Shapiro (2009, 2010); Schwartz (2012).

[4] See also Bachmeier et al. (2003, 193) ("[D]oes a weak economy force firms to seek opportunities within the legal system to replace diminished opportunities in the marketplace?").

[5] See Bachmeier et al. (2003, p. 192) (citing Gottlieb (2001, 1-16).

[6] See Cherney (2010).

infringement greater relative to potential costs, thus increasing overall infringing activity and potentially spurring more suits.

Both accounts of how economic downturns affect the rates of patent litigation are theoretically plausible and, indeed, could simultaneously drive the expansion and contraction of patent litigation.[8] Given the downturn in suits filed during the most recent economic recession—with its concomitant effects on attorney hiring, law firm and judicial planning, and corporate budgeting—determining which tendencies are more salient is certainly of great interest to law firms, the corporate sector, and the judiciary.[9] Moreover, other than scattered anecdotal accounts and simple graphical analysis (e.g., superimposing graphs of GDP over patent litigation counts),[10] there has been no systematic study of how macroeconomic conditions affect the rates of patent litigation. Thus, rigorous study of these macroeconomic effects is also of significant interest to economists and empirical legal scholars.

To answer these questions, we assembled data covering patent litigation suits filed in U.S. district courts from 1971-2009, as well as more than 15 macroeconomic variables of interest during the same time period. Consistent with previous studies examining macroeconomic effects on litigation rates,[11] we use a time-series vector autoregression (VAR) approach—a sophisticated econometric method developed by Christopher Sims, who won the Nobel Prize for his work.[12] Controlling for a host of potential explanatory factors, we find that the macroeconomy has had significant effects on patent litigation rates during the time period in question. However, we find these effects started to change substantially sometime in the mid-80s to mid-90s. Of course, the rise of nonpracticing entities (NPEs) and operating companies seeking to generate substantial licensing revenue has changed the nature of patent litigation dramatically.[13] Starting in the mid-1980s and continuing throughout the 1990s, patent litigation embarked on a shift from suits that were primarily between competitors to suits often driven by the desire of patentees to obtain licensing revenue from non-

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[7] Id.; see also Chopra and Negi (2010) ("Whatever the reason, patent activity (litigation, innovation etc) only surges in response to a recession.").

[8] See, e.g., Bachmeier et al. (2003:193) ("For example, will intellectual property lawsuits more likely occur in an up or down economy?").

[9] Although we do not expect law firms to engage in forecasting on the basis of our results, simply knowing that patent litigation may increase or decrease in volume given the general characteristics of a current downturn may be helpful in general planning, especially for very large law firms and corporations that engage in or defend numerous suits per year. For instance, based on a search in Docket Navigator, Google is currently involved in over 100 patent cases in the district courts, and the most active law firms routinely handle more than 100 cases at any given time.

[10] See, e.g., Riel and Meiklejohn (2010).

[11] See Bachmeier et al. (2003).

[12] See Sims et al. (1990).

[13] See Risch (2012) (reporting that large-scale NPEs began at least the mid-1980s and were active by the 1990s); Rivette and Kline (2000) (discussing strategies for operating companies to boost their patent licensing revenue), and Detkin (2007) (discussing various patent licensing business models).

competitors.[14] These licensing-driven suits are often handled by contingent-fee attorneys and funded by outside capital sources.[15]

Thus, it is not surprising that in the earlier years of our sample (roughly the 1970s and 1980s) scarcity of credit had no negative impact on patent litigation. Moreover, economic downturns in this period, particularly declines in investment and consumption (important components of GDP), were associated with decreases in patent litigation rates. On the other hand, decreases in the NASDAQ index were associated with increases in patent litigation, but the effects were relatively small compared to those of investment and consumption. We interpret these results as showing that patent litigation rates in the 1970s and 1980s were mainly driven by the level of total private infringement, which is proxied by economy-wide investment and consumption, along with a mild increase in patent litigation during downturns for NASDAQ-listed companies. Thus, for these earlier years, it appears that the macroeconomy played only a minor role in determining the overall amount of patent litigation.

Yet in the later period (roughly the last 20-25 years), we find evidence for both contemporary (and seemingly countervailing) theories of economic downturns. Our results thus explain the current debate. We show statistically significant countercyclical correlations between patent litigation and GDP (particularly, economy-wide investment), and generally procyclical correlations with T-bill and real interest rates and the TED spread (a measure of overall financial risk). In general, over the past 20 years or so, our analysis shows that patent litigation rates may rise or fall following an economic decline depending on the relative shifts in macroeconomic factors driving the downturn. Patent litigation rates tend to increase in economic downturns characterized mostly by declines in investment and other measures of productivity, provided that credit remains freely available. Declines characterized by the converse situation, as in the most recent recession, are associated with a decrease in litigation rates. Based on our regressions, we delineate the procyclical and countercyclical factors affecting patent litigation.

Section II of the article describes the relevant background literature, including statistically unreliable attempts made by practicing lawyers to study the issue addressed here, as well as more reliable studies on the effects of the economy on other types of lawsuits. Section III describes our data set and methods. Section IV presents our results, and Section V offers some reflections and caveats. Section VI concludes.

To aid other researchers in testing and extending our analyses, we have made our entire dataset available for download online.[16]

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[14] Id..

[15] See Schwartz (2012).

[16] See https://www.dropbox.com/s/b6ez7xqvx5s266q/Dataset%20-%20Economic%20Downturns%20and%20Patent%20Litigation%20--%2003-29-15.xlsx?dl=0. We have also made our STATA log files for our main specifications and Granger causality tests available. See https://drive.google.com/file/d/0By8e96MfxcvWY0JCbmhJM0FEYXM/view?usp=sharing.

II. BACKGROUND LITERATURE

Despite the presence of off-hand remarks of one ilk or another concerning the effect of economic downturns on the incidence patent litigation—and rough-hand superimpositions by lawyers of graphs of GDP or stock market indices on patent suit counts—we know of no study to examine the issue in any empirically rigorous fashion. Riel and Meiklejohn (2010), a law student and practicing lawyer, respectively, purport to estimate the relationship between the "state of the US economy" and "patent litigation activity" by superimposing line graphs of GDP on the total numbers of patent cases filed in U.S. district courts, the Court of Appeals for the Federal Circuit, and the International Trade Commission. In so doing, they conclude that (1) "there appears to be no correlation between changes in the US economy and patent litigation" over the "long-term"; (2) following "contractions in the economy patent litigation activity in the district courts tends to increase substantially"; and (3) more recently, patent litigation has not increased following downturns, and this is "likely a result of influences other than changes in the US economy."[17]

Although Riel and Meiklejohn (2010) is instructive in terms of descriptive statistics, it is unreliable as a predictive model. Specifically, such a method offers no quantifiable measure of statistical significance. It also fails to distinguish among different elements of the economy, each of which may produce different effects. More importantly it fails to account for several statistical problems common to time-series data. First, graphical analyses can account for the relationship between two—or at most three—variables of interest. For example, Riel and Meiklejohn (2010) analyze GDP in isolation. Because economic downturns may be different in character,[18] just measuring GDP fails to capture how differences in downturns may differentially affect patent litigation rates. Notably, Riel and Meiklejohn (2010) fail to examine macroeconomic variables concerning overall financial risk and the availability of credit—and as we show below—because of this, mistakenly posit that the reduction in patent litigation rates in the most recent recession likely results from "influences other than changes in the US economy." Further, explanatory variables may influence patent litigation with a lag, complicating any simple graphical analysis. Last, time-series data are known to suffer from problems of simultaneity. Simultaneity occurs because macroeconomic variables such as GDP, consumption, unemployment, and the like are interdependent.[19]

Other studies contain useful anecdotal data or address related issues. Based on data obtained from the U.S. Patent and Trademark Office (USPTO), Crouch (2009) and Quinn (2009) report a mild to moderate decline—ranging roughly from 2-15 percent—in patent applications in FY2009.[20] Relatedly, Harhoff and von Graevenitz (2009) show that decreases

[17] Riel and Meiklejohn (2010, 103).

[18] See, e.g., Krugman & Wells (2009, 315-16).

[19] Similarly, in a presentation made at an intellectual property attorney conference, Olson (2009) graphically examines stock indices and patent litigation data, attempting to draw conclusions about the effects of market changes on filing rates. Again, while instructive, it is an inappropriate method from which to draw statistical inferences.

[20] See also Goldman (2009) (noting the recent drop in patent filings) and Breitzman (2013) (noting that small firms decreased patent filings more than large firms in the most recent downturn).

in private investment in the United States are correlated with reductions in filings at the U.S. Patent Office. Although Crouch's (2009) and Harhoff and von Graevenitz's (2009) investigations indicate that economic downturns may decrease patent filings, the drivers of patent litigation are arguably quite different—in particular, patent applications do not mature into assertable rights for several years and, thus, cannot provide immediate value to a cash-constrained patentee. In fact, the filing of patent applications and the filing of patent lawsuits can be competing investment opportunities. On the other hand, litigation and patent applications may be complements at the firm level if a reputation for patent enforcement makes new applications more valuable. Additionally, Quinn (2009) suggests that increasing rejection rates at the USPTO from 2005 to 2008 might explain the drop in applications in 2009. As such, patent application rates may differ systematically from patent litigation rates.

In a study on litigation costs, BTI Consulting (2009) surveyed general counsels of corporate firms, who stated that they planned to reduce spending on intellectual property suits by about 7.7 percent in the wake of the recent economic downturn. This budgetary reduction was the largest estimated spending decrease among several categories, topping corporate transactions, intellectual property transactions (as opposed to litigation), environmental law, and general litigation. According to BTI's CEO: "The thing that surprised me was just the wholesale drop in IP litigation, because that market had really been growing dramatically." And while Fulbright & Jaworski's (2009) Litigation Trends Survey reported that 15 percent of its corporate respondents stated that intellectual property/patents accounted for the largest litigation increase for them attributable to the changes in the economy, overall, respondents reported that they expected to file or be defendants in fewer patent infringement suits in the following 12 months. However, neither study investigated the effect of the economy on the overall rate of patent litigation. Moreover, decreased spending on patent litigation may not necessarily lead to fewer total lawsuits filed—rather, firms may simply spend less per lawsuit. Additionally, the BTI (2009) and Fulbright & Jaworski (2009) surveys focused on large corporate firms.[21] Because a substantial number of suits are filed by smaller firms, particularly nonpracticing entities (NPEs) that do not sell products or services,[22] these surveys may not reflect more global trends. Finally, the results of these spending surveys may be endemic to the nature of the most recent recession. As such, while instructive, they are far from definitive on the topic of discussion.

In a more general study of civil litigation, Bachmeier et al. (2003) find that consumption, output, and inflation are each statistically significant, countercyclical predictors of *total* federal civil and bankruptcy litigation filing rates from the years 1960-2000.[23] In a

[21] The overseas law firm, Freshfields Bruckhaus Deringer, conducted a similar survey of large corporate firms in Europe and the United States, and found that 38 percent of firms were more likely to assert "IP rights" against "third parties," and 52 percent had "no change" in their assertions plans (Freshfields Bruckhaus Deringer, 2009). However, like the surveys by BTI and Fulbright & Jaworski, this survey focused on large corporations. Moreover, the survey did not specifically examine patent enforcement. Finally, the survey failed to examine actual litigation trends.

[22] See Ball & Kesan (2009, 29) (finding that over 50 percent of patent infringement suits are filed by small firms—namely, those with revenues of less than $10 million per year), Chien (2013) (showing the increasing incidence of suits by NPEs), Patent Freedom (2013) (same).

[23] However, anecdotal reports indicate that like patent litigation, in the most recent recession, overall civil filings were down (Haynes, 2009).

similar vein, Siegelman and Donohue (1995) find a negative relationship between economic health and the number of employment-related lawsuits filed.[24] To the extent that patent litigation may differ significantly from other forms of civil litigation, this work does not resolve the debate over the special case of patent litigation. In this regard, patent litigation is especially noteworthy to study because of its overall importance to the economy. Some recent studies estimate that the economic impact of U.S. patent litigation may be as large as $80 billion per year[25] and the overall rate of U.S. patent litigation has been growing rapidly over the past 20 years.[26]

In view of this important lacuna in the literature, we decided to undertake a rigorous empirical analysis of standard macroeconomic indicators and their relationship to patent litigation filing rates.

III. METHODOLOGY AND THEORETICAL APPROACH

A. Patent Litigation Filing Data

Our focus in this study is to determine the relationship between macroeconomic indicators and the rate of new patent litigation filings in federal district courts.[27] For filings, we use quarterly counts for court-identified "patent" actions filed from January 1, 1971, through December 31, 2009.[28] For the period January 1, 1971, through December 31, 1996, we use case counts as compiled by the Federal Judicial Center (FJC),[29] which is "the education and research agency for the federal courts."[30] For the period January 1, 1997 through December

[24] See also Donohue and Siegelman (1991).

[25] See Bessen et al. (2012). Although there are reasons to doubt that the overall impact of patent litigation is as large as Bessen et al. (2012) estimate, see, e.g., Kesan and Schwartz (2014), nobody has argued that it is not considerable.

[26] See Figure 1.

[27] In future work, we hope to examine the relationship between macroeconomic indicators and filings in the International Trade Commission (ITC) as well as in the Court of Appeals for the Federal Circuit (CAFC), the duration and intensity of litigation, and the effects on case outcomes, including settlement and damages values.

[28] We did not continue our time series beyond 2009 for two reasons. First, a large number of "false marking" suits were filed in 2010 and the first half of 2011, and we could not easily determine counts of these suits for this 18-month period nor for prior periods. See Ratanen (2011). Second, changes in the recently passed America Invents Act that went into effect in Q3-2011—which made it more difficult for patentees to join multiple defendants in one lawsuit—substantially increased the number of separate lawsuits overnight. See Chien (2013). Because we did not have access to the total number of defendants back to 1971, we could not compare the pre- and post-AIA defendant counts.

[29] See Federal Judicial Center, Federal Court Cases Integrated Database, http://www.icpsr.umich.edu.

[30] See Federal Judicial Center homepage, http://www.fjc.gov/ (last visited July 29, 2009).

31, 2009, we compiled data from the FJC (through mid-2007) as well as from the federal judiciary's PACER electronic docketing and filing system.[31]

The FJC compiles data from the Administrative Office (AO) of the Courts, which purportedly classifies all filed federal cases.[32] Those data include nearly all patent cases, since no affirmative patent actions can be filed in state court,[33] and it appears that very few counterclaims are brought in state court.[34] By using the AO's classifications, we generated quarterly counts of newly filed patent cases from 1971 through mid-2007.[35] Additionally, the AO manages the PACER docketing system, which contains dockets from most of the federal courts,[36] especially since 1997.[37] Interestingly, at the time we collected our data, PACER reported higher numbers of patent cases than were found in the raw FJC data for cases filed in 2002 and later. After examining the FJC and PACER data more carefully, we determined that the PACER data were more complete than the raw FJC data for these years, apparently because of time lags in collecting and tabulating a full set of data at the FJC.[38] As such, in our analysis we used FJC counts from 1971 through 2002, and PACER counts from 2003 through the end of 2009.[39]

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[31] PACER stands for "Public Access to Court Electronic Records" and is available at http://pacer.psc.uscourts.gov/.

[32] See Eisenberg and Schlanger (2003, 1462-63).

[33] See 35 U.S.C. § 1338(a).

[34] See Green v. Hendrickson Publishers, Inc., 770 N.E.2d 784, 793 (Ind. 2002). Recently, the America Invents Act eliminated even counterclaim patent actions from being filed in state court. See Leahy-Smith America Invents Act, Pub. Law 112-29. § 19(a), 125 Stat. 331 (2011).

[35] Although FJC data was available through the end of 2008, since the numbers were far less than those reported in PACER (see below), we did not believe that the FJC had finished its data collection process for those quarters, so we truncated our AO sample.

[36] For differences between the AO compiled data and the PACER data, especially regarding the "coding" of case outcomes, see Eisenberg and Schlanger (2003), Hadfield (2004), and Beebe (2006).

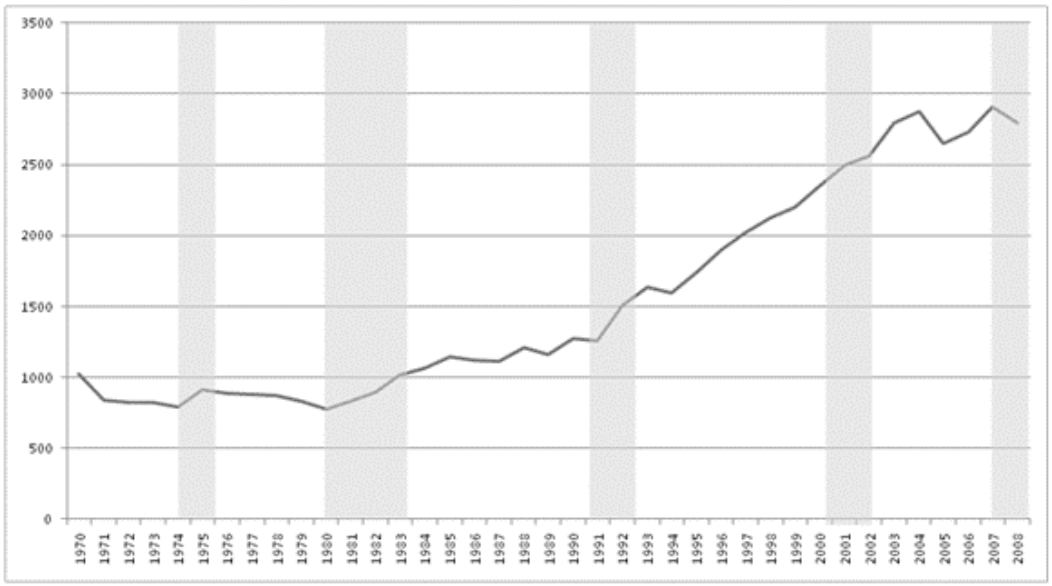
[37] See PACER U.S. Party/Case Index Date Ranges, https://pacer.uspci.uscourts.gov/cgi-bin/range.pl?puid=01248922566 (last visited July 27, 2009).

[38] In the earlier years, 2002-2004, the differences between the FJC and PACER data are relatively minor, on the order of 0.5-1.0 percent, which leads us to believe that the raw FJC and PACER would essentially be equivalent after 2003 but for collection lags at the AO and other minor categorization differences, which would not affect the results here.

[39] One shortcoming with both the AO/FJC and PACER data is that they contain Type I errors (designating a docket as a patent case when it is not) and Type II errors (failing to designate a docket as a patent case when it is). See generally Moore (2003:1507-09 & n.34) (noting "deficiencies in the Administrative Office data due to a lack of reporting or inconsistent reporting"). The Stanford IP Litigation Clearinghouse (http://www.lexmachina.com) has made a first pass at identifying these Type I and Type II errors for patent infringement actions filed from 2000 through 2009 available in PACER. However, using these statistics, we find relatively minor differences between these corrected counts and the PACER counts. Indeed, the overall linear correlation factor between the two sets of data is 0.98. Nonetheless, in an abundance of caution, we ran our preliminary statistical tests

Figure 1 shows these annual counts with bars superimposed on the graph for time periods during or just following recessionary phases in the U.S. economy. As Figure 1 indicates, in all but the most recent recession, patent litigation increased during these periods.

Figure 1: Number of patent lawsuits filed in U.S. district courts, 1970-2009



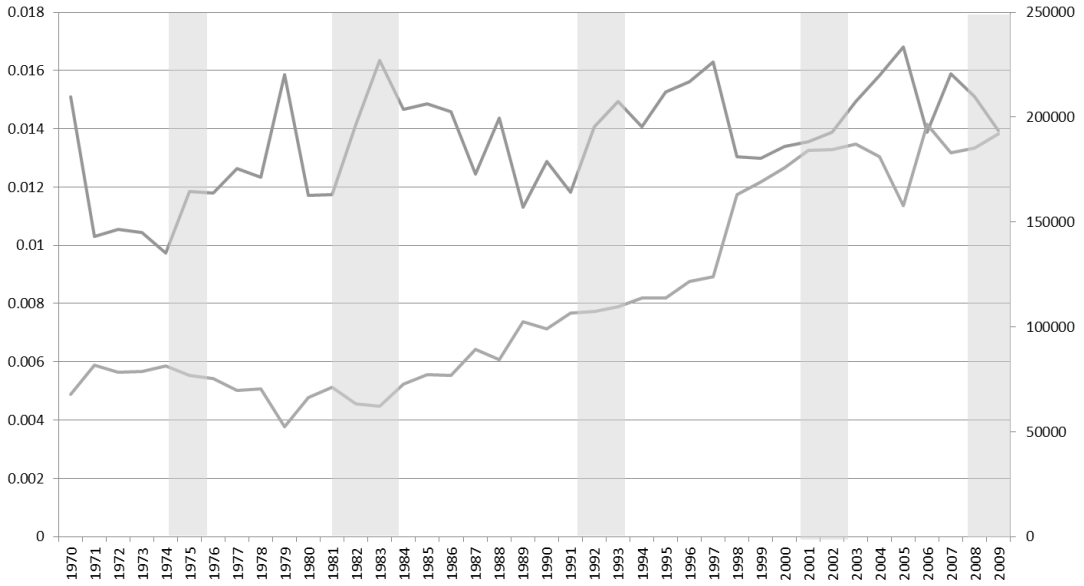
SOURCES: FJC (1970-2002 counts) and PACER (2003-2009 counts).

We also assembled data on the number of patent grants and in-force patents to use as control variables. Figure 2 shows annual patent litigation counts per issued patent (top line) superimposed on the raw issued patent counts (bottom line).[40]

Figure 2: Patent lawsuits filed in U.S. district courts per issued U.S. patent, 1970-2009

against both the PACER and Stanford data, and all significant and nonsignificant results were substantially identical. Because the PACER/FJC analysis is more easily verifiable, we only report those statistics.

[40] Total patent grants were obtained from the USPTO. U.S. Patent Statistics Chart: Calendar Years 1963 – 2013: http://www.uspto.gov/go/taf/us_stat.htm (last visited February 11, 2015).



NOTE: Number of U.S. patent lawsuits filed per issued U.S. patent (top line) with magnitude on left y-axis. Raw number of U.S. patents issued (bottom line) with magnitude on right y-axis.

Like Figure 1, the vertical shaded bands represent periods during or just following recessions (based on NBER classifications).[41] Similar to the raw patent litigation counts, during these periods patent litigation per patent has increased historically, except during the most recent recession.

Finally, we examined total patent litigation counts per in-force patents—namely, those patents that are unexpired and, hence, may be asserted in litigation. In this regard, patents either expire 1 years from issuance or 20 years from filing, sometimes extended for a variety of reasons.[42] Additionally, starting in 1980, patents expire for the failure of patentees to pay maintenance fees, charged at four, eight, and twelve years after issuance.[43] Given the difficulty of obtaining data on patent term extensions and maintenance fee payments, previous scholars have worked with rough estimates of the numbers of in-force patents.[44]

For this article, we obtained new data from the U.S. Patent and Trademark Office providing a much more accurate estimate of in-force patents using internal data.[45] Figure 3

[41] See note 50.

[42] See generally Bair (2013).

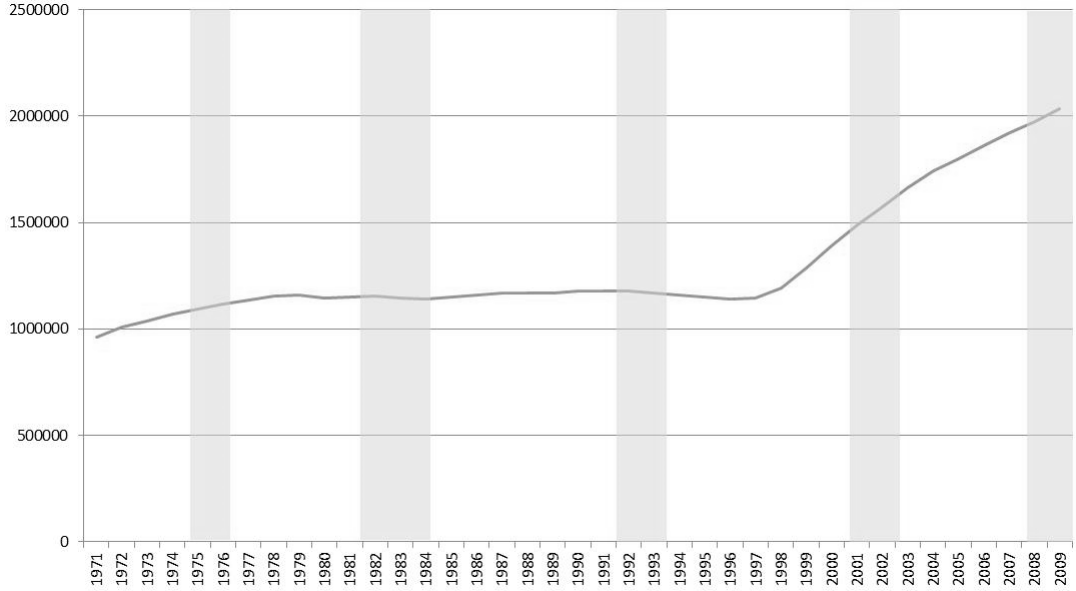
[43] See 35 U.S.C. § 41 (2013), 37 C.F.R. § 1.362 (2014).

[44] See, e.g., Bessen and Love (2013, 87-88), Crouch (2012), and Kesan et al. (2012).

[45] The number of in-force patents does not include design and plant patents, but because patent litigation overwhelmingly involves utility patents (greater than 90 percent of filed cases, see, e.g., Lex Machina, Year in Review, Continued Analysis, https://lexmachina.com/2014/07/year-review-continued-analysis/) and because utility patents account for 85-95 percent of all issued patents during the period of our sample (see U.S. Patent Statistics Chart, *supra* note 40), we believe it is adequate as a control against total litigation filings. In this regard, we also control by an estimate of the total

shows the total number of in-force patents from 1971-2009, again with vertical shaded bands indicating periods during or just following recessions.[46]

Figure 3: Total in-force U.S. patents, 1971-2009



SOURCE: Internal USPTO data.

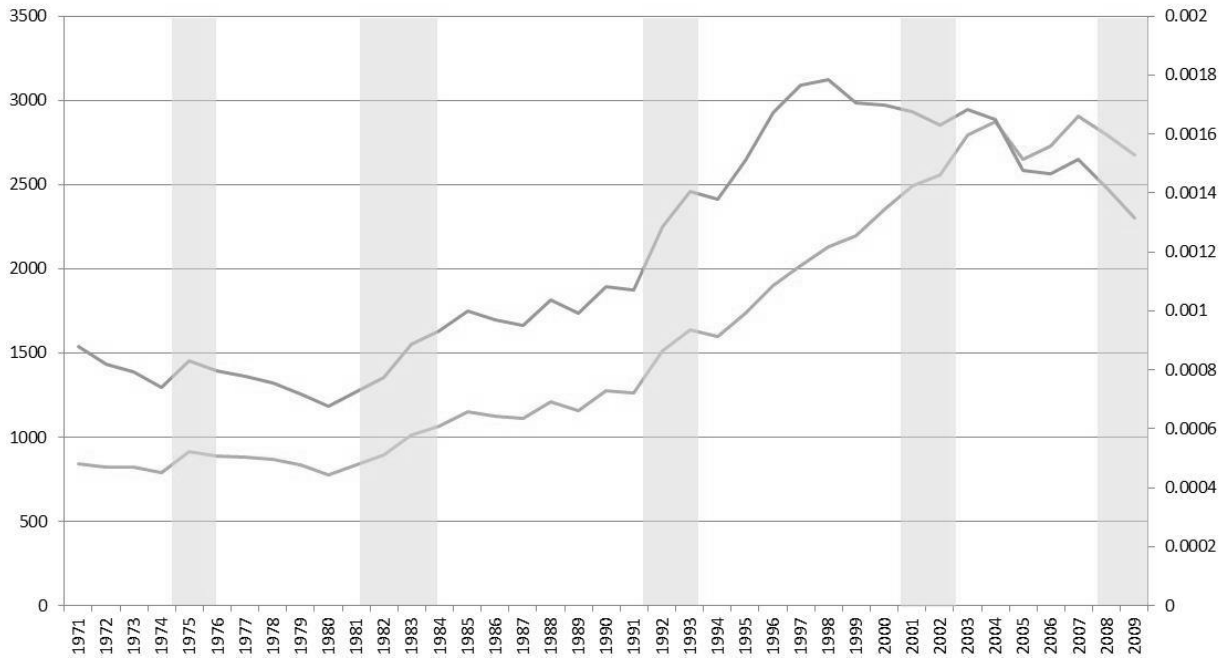
Like issued patents, there is a sharp uptick in the total number of in-force patents starting in the late 1990s. However, unlike patent grants, there is relatively no growth in in-force patents from the early 1970s through the late 1990s, indicating that an increasing percentage of patentees from 1980 through the late 1990s failed to pay maintenance fees.

Figure 4 shows annual patent litigation counts per in-force patent (top line through 2004) superimposed on the raw issued patent counts (bottom line through 2004).

Figure 4: U.S. patent lawsuits per in-force U.S. patent, 1971-2009

number of issued patents, which does include design and plant patents, and obtain similar results to our specification using in-force patents. See Appendix C.

[46] Previous data on in-force patents have been limited. Crouch (2014) estimates the number of in-force utility patents but does not account for regulatory-approval related patent term extensions or the impact of litigation, reexamination, review, or reissues. Comparing the USPTO's to Crouch's raw data, we find that although Crouch generally underestimates the number of in-force patents, the USPTO's data are typically within 20 percent of Crouch's estimations for any given year.



NOTE: Number of U.S. patent lawsuits filed per in-force U.S. patent (top line through 2004) with magnitude on right y-axis. Number of U.S. patent lawsuits (bottom line through 2004) with magnitude on left y-axis.

Two interesting trends appear in this Figure 4. First, unlike patent litigation per issued patent, there is a notable increase in overall patent litigation per in-force patent starting in the early 1980s and increasing rapidly throughout the 1990s, with a downturn in the 2000s. Second, during the downturn periods, prior to 2000, overall patent litigation increased during downturns, whereas after 2000, patent litigation decreased during downturns (though, notably, against an overall decreasing trend of patent litigation per in-force patent during the 2000s).

B. Macroeconomic Indicators

Since 1971, the U.S. economy has undergone six recessions: two 16-month recessions in the mid-1970s and the early 1980s, a slowdown in the late 1980s/early 1990s as well as the early 2000s, and the most recent recession, which lasted from the end of 2007 through the middle of 2009 (see Table 1).[47] Additionally, the four decades under consideration in our study include two significant economic expansions: the 97-month expansion of the 1980s and the 10-year expansion from 1991-2001.[48] This large number of expansions and contractions provides a robust data set to test the effects of downturns (and upswings) on filing counts. We

[47] See Bachmeier et al. (2003, p. 194). Additionally, another recession ended in 1970, but since we do not have patent litigation data from before 1970, we cannot analyze the effects of this recession.

[48] Id.

control for the steadily rising count of patent litigation suits during our sample time period (see Figure 1).[49]

The nature of these recessions has varied, especially the last one, which was characterized by much greater financial risk and more difficulty in obtaining credit than previous recessions.[50]

Table 1: Economic Contractions, 1969-2009

Years	*Unemployment*	*GDP Decline*	*Description*
1969-70	6.1%	-0.6%	Rising inflation; high interest rates
1973-75	9.0%	-3.2%	High oil prices; high government spending; stock market crash; high unemployment; rising inflation
1980; 1981-82	10.8%	-2.7%	Energy crisis; high interest rates; high unemployment
Early 1990s	7.8%	-1.4%	Increasing inflation; high oil prices; debt accumulation
Early 2000s	6.3%	-0.3%	Terrorism and related stock market crash; decline in outlays and investments; dot-com bust
2007-09	10.2%	-3.9%	High oil prices; real estate & banking collapse; credit crunch; high unemployment

SOURCES: Cecchetti et al. (2009); Labonte (2009); Claessens et al. (2009); Knoop (2004); Labonte (2002); Estrella and Mishkin (1998); Walsh (1993).

As such, in order to measure the relationship between these recessionary trends and patent litigation, we chose a variety of macroeconomic indicators of the U.S. economy to use as independent variables,[51] including investment[52] and personal consumption[53] (important

[49] One might wonder whether there is an endogeneity concern regarding patent litigation and the macroeconomy—namely, whether patent litigation can affect the macroeconomy, which in turns affects patent litigation. Based on preliminary work for an in-progress study, the answer is largely no—namely, we do not find any statistically significant effect of patent litigation on GDP (Miller & Sichelman, 2015). Although we do find a relatively small significant negative effect of patent litigation on total R & D spending over the period 1984-2007, about 2 percent annually on average, at least for the study in this article, endogeneity concerns are of no import.

[50] See Cecchetti et al. (2009), Labonte (2009), Claessens et al. (2008), Estrella and Mishkin (1998).

[51] For the present version of the study, we analyzed many, but not all, of these indicators. See infra Section IV. A nontrivial portion (about 15 percent) of patent infringement suits are filed by foreign

components of real aggregate GDP),[54] stock market indices (NYSE, S&P 500, NASDAQ),[55] the TED spread (the difference between the three-month London Interbank Offered Rate (LIBOR) and the three month T-bill rate; the TED spread is used to measure perceived macroeconomic financial risk),[56] T-bill and real interest rates, [57] inflation (as measured by the Consumer Price Index), [58] and the unemployment rate.[59] Additionally, because previous studies have shown a relationship between total patent litigation and the number of issued patents,[60] and as noted above, there is a similar relationship between patent litigation and the

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firms (Moore 2003). Although it appears most infringement claims are predicated on domestic activity of the accused infringer, foreign economic conditions would affect the decisions of foreign plaintiffs to file suit. Here, because of the difficulty of determining the home country of foreign plaintiffs, and the relatively small percentage of suits filed by those firms, we use U.S. economic conditions as a proxy for foreign conditions.

[52] Gross Domestic Investment, Quarterly, http://research.stlouisfed.org/fred2/series/W170RC1Q027SBEA/downloaddata?cid=33037. For our entire analysis, we converted nominal investment and all other monetary variables to real values in fourth-quarter 2009 dollars, using the Consumer Price Index for All Urban Consumers: All Items (hereinafter CPI-U), available at http://research.stlouisfed.org/fred2/series/CPIAUCNS/downloaddata?cid=9.

[53] Personal Consumption Expenditures, http://research.stlouisfed.org/fred2/series/PCEC/downloaddata.

[54] Nominal GDP, Quarterly, http://research.stlouisfed.org/fred2/series/GDP/downloaddata.

[55] The market indices are derived from Yahoo! Finance, http://finance.yahoo.com. Quarterly averages were constructed by taking the average of each daily close during the applicable quarter.

[56] Mortgage-X, http://mortgage-x.com/general/indexes/wsj_libor_history.asp?y=2009 (LIBOR rates); Yahoo! Finance, http://finance.yahoo.com/q/hp?s=^IRX (T-bill rates). Specifically, when overall financial risk is high, banks tend to charge high rates for unsecured loans, which increases the LIBOR rate. At the same time, when financial risk is high, banks desire to hold more Treasury bonds, which decreases T-bill rates. Thus, in terms of high financial uncertainty, the TED spread increases. See Brunnermeier (2009).

[57] Real interest rates are calculated by taking the T-bill rates and subtracting the Consumer Price Index. See Caporale and Grier (2005: 86).

[58] Consumer Price Index for All Urban Consumers: All Items, CPIAUCNS, http://research.stlouisfed.org/fred2/series/CPIAUCNS/downloaddata?cid=9. There have been some changes in the methodology used to calculate the CPI, and the CPI-U-RS series uses the current methodology throughout the series. See generally CPI Research Series Using Current Methods (CPI-U-RS), http://www.bls.gov/cpi/cpirsdc.htm. Unfortunately, the RS series starts in 1978, so we chose to use the CPI-U series. However, we did run some alternative specifications using the RS series (available from the authors upon request) for later subperiods in our dataset and found similar results to those presented here.

[59]Unemployment,UNRATE, http://research.stlouisfed.org/fred2/series/UNRATE/downloaddata?cid=12. Quarterly rates are derived by averaging over three monthly rates.

[60] See, e.g., Cook (2007).

number of in-force patents, we used the quarterly issued and in-force patent counts from the USPTO as control variables.[61] For good measure, we included quarterly R & D as an additional control variable.[62] We also included several lags of these variables to account for the delay with which the changes may propagate through the economy.

Finally, we also used patent litigation itself in previous quarters as a control variable to compensate for potential autocorrelation as well as background increases or decreases in patent litigation due to changes in case law, such as the recent *eBay v. MercExchange* decision, which made injunctive relief more difficult to obtain, possibly reducing the value of patent litigation;[63] changes in patent law institutions, such as the creation of the Federal Circuit in 1982, which arguably made patent litigation more valuable;[64] general changes in attorney compensation; and the like.[65] Specifically, by adopting this approach, our regressions show the short-term effects of macroeconomic variables on patent litigation rates from quarter-to-quarter *relative to the longitudinal, background changes* in patent litigation rates (primarily increases) caused by other factors. Thus, our method isolates the effects of macroeconomic shocks on patent litigation.

C. Statistical Methods

We estimate a linear regression between the total number of cases filed in each quarter and several macroeconomic variables. We employ a vector autoregressive (VAR) model, where each variable is specified as a function of its own lags and the lags of the other variables.[66]

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[61] United States Patent & Trademark Office, Patent Full-Text and Full-Page Image Database, Advanced Search, http://patft.uspto.gov/netahtml/PTO/search-adv.htm (issued patents) (last visited July 2, 2010); see also infra note 75. We did not control for the technology class of the litigated patents, because we did not have a sufficiently representative set of patent numbers for the lawsuits in our dataset.

[62] We obtained total annual U.S. R&D spending from the National Science Board's 2014 Science and Engineering Indicators report, Appendix Table 4.2 " U.S. R&D expenditures, by all sectors and all sources of funds: 1953-2011", http://www.nsf.gov/statistics/seind14/index.cfm/appendix. . Unfortunately, there is no reported quarterly series of total U.S. R&D spending so we extrapolated quarterly seasonally adjusted values from the National Science Board's data using the Bureau of Economic Analysis's narrower quarterly industrial R&D series, National Income and Product Accounts Tables, Table 5.3.5. Private Fixed Investment by Type, line 18 "Research and development," available at http://www.bea.gov/iTable/iTable.cfm?ReqID=9&step=1#reqid=9&step=3&isuri=1&903=145.

[63] eBay, Inc. v. MercExchange, LLC, 547 U.S. 388 (2006).

[64] See Atkinson et al. (2009) (noting that the Federal Circuit decreased invalidation findings relative to the pre-1982 regional circuit outcomes).

[65] On the other hand, as discussed earlier, we did attempt to avoid very sharp changes in patent litigation caused by the sudden rise of false marking suits and the passage of the America Invents Act, as our model would have difficultly discerning the effects of these sharp changes on patent litigation from macroeconomic effects. See note 28.

[66] For a review of the VAR method, see Hamilton (1994).

The model accounts for common underlying time trends across all variables, as long as the variables are stationary.[67]

More formally, our VAR model describes the evolution of a set of k variables over the same sample period ($t = 1, \ldots, T$) as a linear function of only their past values. The variables are collected in a k x 1 vector y_t, with the ith element, $y_{i,t}$, equal to the time t observation of the ith variable. For example, if the ith variable is patent litigation, then $y_{i,t}$ is the value of patent litigation at time t.

A *p-th order reduced VAR*, denoted VAR(p), is:

$$y_t = c + A_1 y_{t-1} + A_2 y_{t-2} + \ldots + A_p y_{t-p} + e_t,$$

where y_{t-1}, is an observation l-periods in the past and called the lth lag of y, c is a k x 1 vector of intercepts, A_i is a time-invariant k x k matrix and e_t is a k x 1 vector of error terms. A pth-order VAR is also called a VAR with p lags.[68] Thus, the reduced form of our seven-lag main specification, reported in Table 2, is:

$$y_t = c + A_1 y_{t-1} + A_2 y_{t-2} + A_3 y_{t-3} + A_4 y_{t-4} + A_5 y_{t-5} + A_6 y_{t-6} + A_7 y_{t-7} + e_t.$$[†]

Following common practice, we use logged values for all levels (GDP, investment, consumption, market indices, etc.) and actual values for rates (inflation, interest rates, and unemployment). Additionally, we difference all variables (except for inflation) to ensure stationarity based on unit root tests.[69] Time-series variables depend on their own histories; thus, it is critical to determine the lag structure of the model. Our data are quarterly, so a one-period lag corresponds with a one-quarter lag. Using standard criteria, we determined that the optimal approach was two-fold, a short-lag model and a long-lag model.[70] Overall, the results

[67] Nonstationarity indicates that any short run shocks become permanent, as in the case of a pure "random walk." See Wang (2009).

[68] See Hamilton (1994).

[†] In our main specification y_t is a 10-by-1 vector of values of patent litigation, investment, consumption, unemployment, the real interest rate, R & D, in-force patents, inflation, NASDAQ, and the TED spread all during quarter t. y_{t-1} through y_{t-7} are similar vectors containing the values of these variables during the previous seven quarters. A_1 through A_7 contain the estimated coefficients on each variable for each lag, one through seven quarters. [Authors' Note: This footnote was mistakenly deleted in printing the forthcoming article in the *Journal of Empirical Legal Studies*.]

[69] Stationarity is required for VAR models. The fact that the variables are stationary over time ensures that underlying time trends are accounted for. Formally, unit root tests show that only inflation is stationary without differencing, i.e., it is I(0). All other variables are found to be stationary in differences, i.e., they are "trend stationary," or I(1). Thus, differences are used in the estimation. (Campbell & Perron (1991, 143-145).

of the short-lag model were not as highly significant as the long-lag model. As such, we report on the seven-period lag model. (The results of the one-period lag model are available in Appendix A.)

IV. RESULTS AND ANALYSIS: CHANGES IN PATENT LITIGATION DEPEND ON THE SPECIFIC NATURE OF THE ECONOMIC DOWNTURN

Table 2 shows the results of the estimation.[71] The first specification shows the results of the seven-quarter model for the entire time period (1971-2009), the second specification shows the results during the period 1971-1991, and the third specification shows the results during the period 1986-2009. It may seem odd to include two overlapping time periods. However, because of our seven-lag model and the large number of variables of concern, soaking up a large number of degrees of freedom, the shortest period of comparison during the earlier years was of necessity 20 years.[72] (We report the results from other periods and for a smaller number of variables in Appendix B.)[73]

We find that some factors are consistently significant across the models and lags in their direction of impact on litigation volume, though the magnitude varied according to the specification. Other variables were significant, but of alternating direction depending on the time lag between the variable of interest and the volume of patent litigation cases.

Table 2: Vector Autoregression of Patent Litigation, 7-Quarter Lag Main Specifications

			1971-2009			*1971-1991*			*1986-2009*		
Variable		*Lag*	*Coef.*		*S.E.*	*Coef.*		*S.E.*	*Coef.*		*S.E.*
Patent	diff,	1	-0.76	***	0.08	-1.40	***	0.11	-0.81	***	0.13
Litigation	log	2	-0.56	***	0.10	-1.60	***	0.17	-0.74	***	0.12
		3	-0.37	***	0.11	-1.45	***	0.19	-0.62	***	0.13

[70] Two standard criteria were used to determine the optimal number of lags: the Aikaike information criterion (AIC) and the Bayesian information criterion (BIC). The AIC and BIC are standard statistics based on the log likelihood of the estimated model and the number of parameters estimated by the model. The AIC invariantly pointed to longer lags and the BIC indicated shorter lags (Chizi & Maimon (2010, 96).

[71] Note that we only present the equation where current patent litigation is the dependent variable. The full simultaneous equations results are available upon request.

[72] Moreover, we found that for all of the variables showing significance (we report variables showing no or low significance in the appendices), the period 1986-2009 showed substantially stronger trends than alternative time periods. As we note below, we believe there was a shift in the nature of patent litigation that began sometime in the mid-1980s, which could likely explain these differences.

[73] We determined that the optimal lag structure for these shorter-period models was four lags. Because the shorter-period models allowed a much smaller number of macroeconomic variables given the lower number of degrees of freedom, the results generally did not show the levels of significance of the longer-period models. Additionally, because of the smaller number of variables, this led to greater omitted variable bias, making the results much more difficult to interpret. As such, we do not rely on these results.

		4	-0.37	***	0.11	-1.66	***	0.19	-0.69	***	0.14
		5	-0.17		0.11	-1.45	***	0.20	-0.43	**	0.15
		6	-0.19	*	0.10	-1.31	***	0.16	-0.34	**	0.13
		7	-0.02		0.08	-0.60	***	0.10	0.01		0.13
Investment	diff,	1	-0.40		0.39	-1.96	***	0.34	-0.61		0.61
	log	2	0.16		0.40	0.03		0.46	-2.59	***	0.80
		3	0.29		0.41	1.50	***	0.40	-0.28		0.73
		4	0.74	*	0.40	0.11		0.42	-2.11	**	0.86
		5	0.15		0.39	0.73		0.44	-0.94		0.70
		6	-0.66	*	0.37	-0.65		0.41	-1.99	**	0.77
		7	0.71	**	0.34	1.26	***	0.35	-0.45		0.89
Consumption	diff,	1	2.66	**	1.19	2.83	**	1.01	4.75	*	2.51
	log	2	4.72	***	1.35	4.12	***	1.00	-0.18		2.86
		3	-0.54		1.40	1.27		1.16	-3.75		3.17
		4	-2.71	*	1.43	-1.27		1.57	-3.74		3.87
		5	-0.84		1.45	5.30	***	1.49	-2.72		3.40
		6	-2.62	*	1.48	1.90		1.47	0.27		3.31
		7	-1.91		1.47	4.69	***	1.38	-5.65		3.27
Unemployment	diff	1	-0.01		0.04	0.07		0.05	-0.25	***	0.09
		2	-0.01		0.04	-0.09	**	0.04	-0.35	***	0.07
		3	0.02		0.04	0.39	***	0.04	-0.15		0.10
		4	0.00		0.04	0.11	*	0.06	0.03		0.09
		5	0.01		0.05	0.17	**	0.06	-0.15		0.09
		6	-0.01		0.05	-0.07		0.04	-0.04		0.08
		7	0.07		0.04	0.17	***	0.04	0.20	**	0.07
Real interest	diff	1	-0.01		0.01	0.07	***	0.01	-0.02		0.03
Rate		2	-0.02	*	0.01	-0.01		0.02	-0.06		0.05
		3	0.01		0.01	0.00		0.02	0.08	*	0.04
		4	-0.02		0.01	0.01		0.01	-0.13	***	0.04
		5	0.02	**	0.01	-0.02	*	0.01	-0.04		0.05
		6	-0.00		0.01	-0.05	***	0.01	0.10	*	0.05
		7	0.02	**	0.01	-0.04	**	0.01	-0.02		0.03
R and D	diff,	1	-1.27	**	0.58	4.23	***	0.87	-1.63		1.04
	log	2	0.62		0.60	4.83	***	0.84	0.85		0.96
		3	0.57		0.58	3.85	***	1.07	2.05	**	0.80
		4	0.01		0.57	0.21		0.86	0.93		0.95
		5	0.36		0.62	-4.15	***	0.85	1.02		0.85
		6	0.43		0.60	-3.37	***	0.81	0.38		0.89
		7	-0.38		0.59	-0.40		0.64	-0.24		0.94
In force	diff,	1	-1.76		1.90	-11.54	***	3.31	1.39		2.22
Patents	log	2	0.47		2.39	3.69		3.74	-1.09		2.77
		3	-0.13		2.44	3.24		4.94	3.04		2.62
		4	2.45		2.28	-11.44	***	3.39	-0.67		2.11
		5	-5.98	**	2.27	-1.29		3.37	-3.58		2.56
		6	6.06	***	2.25	3.46		2.88	5.54	*	2.65
		7	-2.43		1.89	-14.10	***	2.90	-4.07	*	2.13
Inflation (CPI)		1	-0.02		0.02	0.07	***	0.02	-0.05		0.04
		2	0.02		0.03	0.00		0.03	-0.04		0.08
		3	0.02		0.03	0.02		0.03	0.21	**	0.09
		4	-0.04		0.03	-0.06	*	0.03	-0.25	***	0.08

		5	0.05	*	0.03	-0.15	***	0.03	0.16	**	0.08
		6	-0.02		0.03	0.06	**	0.02	0.08		0.08
		7	-0.05	**	0.02	-0.01		0.02	-0.24	***	0.08
NASDAQ	diff,	1	0.03		0.07	-0.08		0.08	-0.23	**	0.11
	log	2	0.01		0.07	-0.43	***	0.08	0.33	***	0.10
		3	-0.11		0.08	-0.26	**	0.11	-0.28	**	0.12
		4	0.01		0.08	-0.82	***	0.11	0.19	*	0.10
		5	0.09		0.08	0.25	**	0.11	-0.13		0.11
		6	-0.07		0.08	-0.63	***	0.11	0.23		0.15
		7	0.02		0.07	-0.29	**	0.11	0.06		0.16
TED spread	diff	1							-0.14	***	0.04
		2							-0.04		0.06
		3							-0.06		0.05
		4							-0.11	**	0.05
		5							-0.11	**	0.05
		6							0.09	*	0.04
		7							0.11	***	0.04
Constant			0.07	***	0.03	0.05		0.04	0.24	***	0.08
Observations			148			76			88		
AIC			-25.6			-37.1			-34.2		
BIC			-14.0			-19.5			-14.2		

NOTE: All variables are quarterly values. 156 quarters from 1971 through 2009. *Stata* "small" option used to increase standard errors ("*S.E.*") to account for number of observations.
*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

Interestingly, across the entire time period of 1971-2009, other than patent litigation and consumption, none of the macroeconomic variables were consistently significant. This may seem odd because many variables were significant—and in the same cyclical or countercyclical direction—in the sub-divided time periods. For instance, R & D was positively correlated to patent litigation counts in both subperiods, but had little statistical significance across the entire 40-year time period and the significance that does exist is negative. However, it is important to recall that VAR models are sensitive to interperiod changes. Thus, the differing effects of time lags in each subperiod may effectively "cancel out" significance in each subperiod when examining the entire time period. Additionally, each variable in a VAR model acts as a control, such that the regression measures only the residual effect of a variable taking into account other variables. As several variables have differing effects in the early and later subperiods, these competing tendencies also diminish the significance of other variables over the entire time period (e.g., R & D).

A number of indicators showed statistical significance in each subperiod. In terms of the lagged dependent variable (patent litigation counts), lags of previous patent litigation counts have a consistently negative effect on current litigation. This implies that a one-period positive "shock" in patent litigation will generally lead to lower litigation in the following period. Based on the experience of one of the authors, managers at firms tend to make decisions to file patent suits over relatively long periods of time, usually three months to a year or longer. We believe this helps to explain our patent litigation "shock" finding—namely, if a given quarter has a relatively high rate of filings simply because of random hazard within a longer overall decision period, one would expect that all else equal, the next quarter would contain a lower number of case filings. In this regard, although large numbers of patent suits

are filed each quarter (roughly 250 to 750 in our dataset), they numbers are not large enough to eliminate significant random quarter-to-quarter variation over the lengthy time period during which managers make decisions to file suit.

Most of the other significant indicators were generally consistent across the two time periods (in terms of the sign of the coefficients) when the coefficients were statistically significant, though as we describe below, some notable ones differed in sign from the earlier to the later period. Additionally, most of the indicators were "unidirectional" in the sense that the sign of the regression coefficient was the same or nearly the same across all time lags, for statistically significant coefficients. That is, the indicator was consistently either cyclically or countercyclically correlated with patent litigation counts, or the magnitude of the coefficients is such that the total effect is primarily cyclical or countercyclical.

There was one unidirectional indicator with primarily consistent results across both time periods:

- Domestic R & D (procyclical)

Other indicators were significant and unidirectional in both subperiods, but of different directions in each subperiod:

- Investment (procyclical in earlier period; countercyclical in later period)[74]
- Unemployment (countercyclical in earlier period; procyclical in the later period)

Other indicators were significant and unidirectional only in one subperiod:

- Consumption (procyclical in earlier period)
- In-force patents (countercyclical in earlier period)[75]
- NASDAQ index (countercyclical in earlier period)
- TED spread (procyclical in the later period)[76]

Finally, some indicators showed statistical significance over multiple lags, sometimes the coefficient was positive and other times negative:

- NASDAQ (in the later period)

[74] As we discuss below, in an alternative specification, overall GDP showed similar trends to investment. See infra Section IV.B.

[75] We ran an alternative specification based on quarterly patent grants during the years 1971-2009. In this specification, there were no substantial differences in results from the primary specification (Appendix C).

[76] As LIBOR was only implemented in 1986, we only included the TED spread in the later period regression. Because interactions between this extra variable and those common to the three specifications in Table 2 could theoretically change the sign or significance of the common variables in the later period, we ran the later period specification excluding the TED spread. We report those results in Appendix D and find they are consistent with the later period results in Table 2.

- Real interest rate (in both periods)
- Inflation (in both periods)

These results are summarized in Table 3 below.

Table 3: Summary of Trends of Macroeconomic Variables

Independent Variable of Interest	*Early Subperiod (1971-1991)*	*Later Subperiod (1986-2009)*
Patent litigation	Countercyclical	Countercyclical
R&D	Procyclical	Procyclical
Investment	Procyclical	Countercyclical
Unemployment	Countercyclical	Procyclical
Real interest rate	Competing trends	Competing trends
Consumption	Procyclical	No significant trends
In-force patents	Countercyclical	No significant trends
NASDAQ index	Countercyclical	Competing trends
TED Spread	n/a	Procyclical
Inflation	Competing trends	Competing trends

NOTE: Trends with respect to patent litigation rates (based on results in Table 2).

Following standard practice in VAR analysis, we performed Granger-causality tests to determine the robustness of our results in Table 2.[77] Granger-causality statistics examine whether lagged values of one variable help predict another variable. If, for example, investment does not help predict patent litigation, then the coefficients on the lags of investment in the reduced-form patent litigation equation will all be zero.[78]

We performed separate Granger-causality tests for each of the three time periods used in Table 2 and report these results in Appendix E. Again, few of our macroeconomic variables appear to explain patent litigation across the entire time period 1971-2009. However, for both of the shorter periods, most of the variables of interest in our primary specification are significant predictors of patent litigation (see Appendix E).[79] Below we briefly discuss our results of the significant indicators.

A. Unidirectional Indicators

Seven indicators—investment, NASDAQ index, unemployment, consumption, TED spread, domestic R & D, and in-force patents—were statistically significant across multiple lags and unidirectional in one or both subperiods. Two of these indicators were countercyclical in the sense that in times of economic expansion these indicators were associated with decreases in

[77] Stock and Watson (2001, p. 104).

[78] Id.

[79] The exceptions were consumption and in-force patents (in the later subperiod). See Appendix E.

patent litigation, and vice-versa in times of economic contraction. Specifically, the NASDAQ index generally showed countercyclical correlations, particularly in the earlier subperiod (i.e., 1971-1991).[80] Specifically, a 1 percent increase in the NASDAQ led to approximately a 0.4 percent decrease in patent litigation two quarters later in the earlier subperiod.[81] In-force patents also showed countercyclical trends, but only in the earlier subperiod.

On the other hand, domestic R & D, consumption (in the earlier period), and the TED spread (in the later period[82]) were cyclical in nature. For R & D, a 1 percent increase in the prior quarter implied a 4.2 percent increase in patent litigation one quarter later in the earlier subperiod and a 2.1 percent increase three quarters later in the later subperiod. For consumption, a 1 percent increase implied a 2.8 percent increase in patent litigation one period later and a 4.1 percent increase two periods later in the earlier subperiod. For the TED spread, a 1 percent increase implied a 1.1 percent decrease in patent litigation four quarters later in the later subperiod.[83]

Finally, investment showed procyclical trends in the earlier subperiod, but countercyclical trends in the later subperiod. A 1 percent increase in the earlier period led to a 1.3 percent increase in litigation seven quarters later, while a 1 percent increase in the later period led to 2.0 percent decrease in litigation six quarters later. Conversely, unemployment showed countercyclical trends in the earlier subperiod, but procyclical trends in the later subperiod. A 1 percent increase in the unemployment in the earlier period implied a 0.4 percent increase in patent litigation three quarters later and a 0.17 percent increase seven quarters later. However, in the later subperiod, A 1 percent increase implied a 0.35 percent decrease in patent litigation two quarters later.

B. Bidirectional Indicators

For the earlier subperiod, inflation was negatively correlated with patent litigation in some quarters but positively correlated in other quarters, with coefficients around the same order of magnitude. Similarly, NASDAQ in the later subperiod showed countercyclical effects in quarters 1 and 3 but procyclical effects for quarters 2 and 4. Real interest rates and inflation displayed similar oscillatory activity in both subperiods. To be certain we found similar intralag period oscillations for several other indicators, but the magnitudes of the coefficients were such that the trends pointed in one direction or the other overall. However, to correct for these intralag period oscillations—as well as to account for the large number of degrees of freedom used by our main specification—we performed additional analysis.

First, we ran the main specification with fewer independent variables, which reduced the number of degrees of freedom used in the regressions (see Appendices D, F and G).

[80] In an alternative model, the S&P 500 and Dow Jones indices yielded similar results, though the Dow Jones index provided no meaningful significant effects in the later subperiod.

[81] There were procyclical, significant correlations for the NASDAQ in the earlier subperiods, but these were much smaller than the countercyclical correlations.

[82] To be certain, we only measured the TED spread in the later period. See supra note 76.

[83] Because the TED spread was not logged, it was necessary to reinterpret the coefficients via exponentiation to determine their relationship to the overall change in patent litigation.

Although most of these specifications did not eliminate intralag period oscillations, they were routinely consistent with our primary specification. For instance, eliminating the TED spread in the later subperiod produces the same overall results as our main specification (and, moreover, shows a countercyclical rather than an ambiguous trend for real interest rates) (see Appendix D). Other permutations of fewer variables show similar results, including a countercyclical trend for real interest rates in the later subperiod (see Appendix F). For example, by replacing investment and consumption with GDP, we found similar results to our main specification (see Appendix G).[84] In this regard, GDP showed procyclical trends in the earlier subperiod and countercyclical trends in the later period, consistent with the trends of investment in the main specification. In three other specifications, we eliminated the NASDAQ index, then removed in-force patents, then finally removed consumption. Again, these alternative specifications produced results consistent with those of our main specification (see Appendix F).

Second, as we noted above, we ran a specification with a one-quarter lag, though we did not find this model led to many highly significant results, making it of limited usefulness (see Appendix A).[85] Third, we used four-quarter trailing averages of each variable of interest in an attempt to "smear" out these intralag period effects. Unfortunately, these results generally led to bidirectional indicators for the same variables as the main specification, and the "lag upon lag" effect produced confounding results (see Appendix H).

Fourth, we calculated impulse response functions (IRFs), which are used in time series analyses to estimate the effects of exogenous shocks on a dependent variable, here the change in overall patent litigation.[86] However, unlike our primary specification, which examines how specific changes in macroeconomic variables correspond to changes in patent litigation, IRFs use a one standard deviation shock—that is, one standard deviation more than the average change in a variable of interest across a given time period—of the independent variables in order measure how "unexpected changes" affect a dependent variable.[87] Roughly, IRFs measure the shocks coming from the error term related to the underlying independent variables of interest, in order to determine how these shocks affect the dependent variable.[88] We employed a bivariate regression model using the variables of interest in our main specification over the entire time period and during each subperiod, recalculating the optimal number of lags for each variable.[89] For example, the IRF for the real interest rate during the later subperiod (1986-2009) is shown in Figure 5 below.

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[84] A few variables, particularly in-force patents and the TED spread (in the later subperiod) lost significant and clear trends in this alternative specification, but these results do not contradict the significant and clear trends of the primary specification for these variables.

[85] Those results that were significant were largely consistent with those of the main specification (see Appendix A).

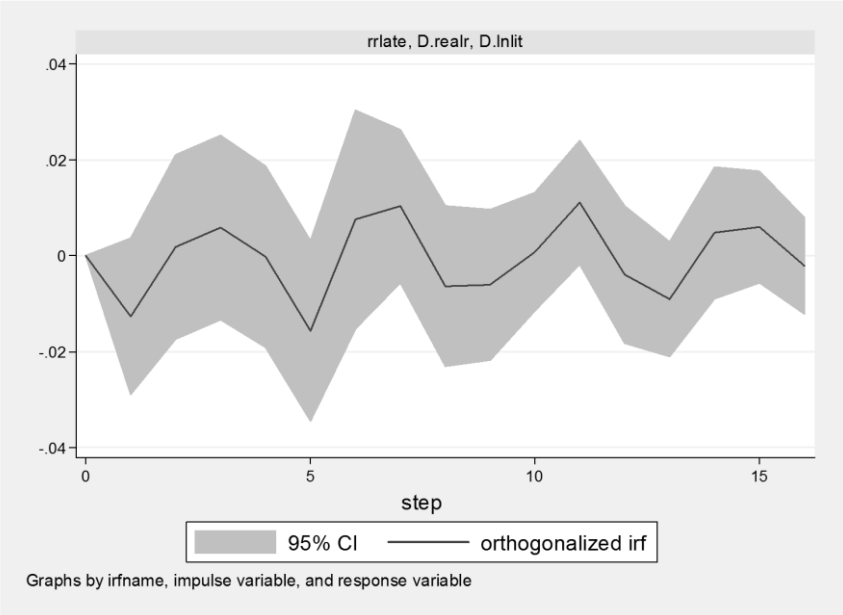
[86] See generally Cain (2011).

[87] Id.

[88] Id.

[89] Specifically, we calculated orthogonal impulse response functions over 16 quarters. Tabular results are available from the authors upon request.

Figure 5: Effect of real interest shock on patent litigation for Table 2 VAR, 1986-2009



NOTE: Solid lines represent the orthogonalized impulse response of patent litigation in a given quarter (horizontal axis) to a one standard deviation shock to the real interest rate in quarter zero. Vertical axis measures the percent change in patent litigation in a quarter given that impulse. Ninety-five percent confidence intervals in gray.

In Figure 5, the vertical axis shows the overall change in patent litigation from a one standard deviation shock at a given time (Step 0) in the real interest rate, and shows the change in patent litigation as a percentage as that shock progresses over each subsequent quarter (represent as a step on the horizontal axis). The gray shading displays the 95 percent confidence level relative to the orthogonalized IRF measure, depicted as a black line. Unfortunately, like the results in Figure 5, most of the IRF results (see Appendix I), were too noisy to provide any useful information. In particular, they showed no clear procyclical or countercyclical trends within the 95 percent confidence level over a given time period of interest. Notably, because the IRFs essentially measure the effects of the error term of the variables of interest—roughly "unexpected" shocks—the IRF results may diverge substantially from those of the underlying trends related to the variables of interest as measured by the coefficients of the vector autoregression (VAR). In other words, the lack of clear trends in the IRFs indicates that any "noise" in the changes in the underlying macroeconomic variables has no clear procyclical or countercyclical effect in the rates of patent litigation.

Fifth, in contrast to the IRFs, we performed simple, bivariate time series regressions against each variable of interest over 14 separate time periods representing nonrecessionary and recessionary periods respectively, with the variables of interest averaged over each time period (using patent litigation counts as a control variable to normalize for time periods of different lengths). Many of these results were significant and, importantly, generally consistent with the findings of our primary model (see Appendix J). For instance, a 1 percent

decrease in GDP over one period led to a 1.6 percent decrease in patent litigation in the immediately following period.[90]

Overall, we believe these additional specifications show that our results are sufficiently robust and not caused by overfitting. Moreover, these results indicate that the intralag period effects found in our primary specification for some of our variables are generally of little import when examining overall trends.

V. REFLECTIONS AND CAVEATS

A. The Data Support Both Explanations of Downturns and Filing Rates for Recent Patent Litigation Trends

As we described in Section I, there are two prominent causal theories held by practicing lawyers regarding the effects of economic downturns on patent litigation rates. First, some lawyers believe that downturns reduce patent litigation by constraining the available capital needed to fund litigation ("capital constraint" theory). Second, other lawyers believe that downturns increase litigation by making it more attractive relative to returns on selling products and services ("substitution" theory).

Our results indicate that neither theory was likely at work, at least to any substantial degree, in the early subperiod (1971-1991). However, for the later subperiod (1986-2009), our results are partly consistent with both explanations—namely, depending on the type of downturn, patent litigation rates may rise or fall.

As a preliminary matter, one indicator—R & D—showed procyclical trends across both subperiods. One would expect that as absolute R & D increased, overall patent litigation would eventually rise. In our model, because we controlled for overall long-term increases in patent litigation, increased R & D is more of a measure of patent litigation *density*, namely, that as R & D rises, there is more patent litigation per R & D dollar.[91] Thus, it appears not only has patent litigation increased with the rise in overall R & D, but it has increased more and more quickly as R & D has increased over time.

Other than R & D, we generally found quite different trends in the earlier subperiod compared with the later subperiod. Starting with the earlier subperiod, investment and consumption showed procyclical trends. Yet, NASDAQ was countercyclical in the earlier period, though with much weaker effects than investment and consumption. Real interest rates had little overall effect.[92] As such, our general view is that neither the substitution nor the capital constraint theory played substantial roles during the bulk of the earlier time period.

We also divided the 14 periods into two subperiods—one from 1970-1991 and another from 1983-2009, which roughly matched the length of the subperiods in our primary model. Because of the short periods and hence few degrees of freedom, only one result was clearly significant (investment in the later subperiod, which was countercyclical at a 95 percent confidence level).

[91] Like the NASDAQ indicator, we found that this trend weakened, perhaps even reversed in the latest period (1997-2009), again, potentially a result of increasing NPE-driven litigation (see Appendix B).

[92] Real interest rates showed no clear effects in the primary specification and weakly procyclical effects in some alternative specifications in the earlier subperiod.

Rather, generally speaking, as consumption and investment increased, the overall number of patent lawsuits increased. As we explain further below, to the extent there was a shift starting in the mid-1980s from competitor versus competitor litigation to licensing-driven litigation filed by non-competitors, these early trends are sensible. Namely, as consumption and investment increase, overall infringement increases, and thereby patentholders become more likely to sue their competitors. Because these competitor-driven suits are generally not funded via external financing, it is sensible that real interest rates have little to no effect. The weak relationship of NASDAQ declines to increases in patent litigation perhaps shows a mild substitution effect, but nothing remarkable.[93] So, overall, it appears that patent litigation in this early period was not particularly prone to macroeconomic forces, other than as a proxy for the overall amount of infringement fundamentally occurring on a microeconomic level.

In contrast, the later subperiod trends indicate that macroeconomic forces *per se* played an important role. Notably, investment—which was procyclical in the earlier subperiod—is strongly countercyclical in the later subperiod. Similarly, our alternative specification shows strongly procyclical trends for real aggregate GDP in the earlier subperiods but strong counter-cyclical trends in the later subperiod (Appendix G). Of course, decreases in overall productivity and output are generally associated with decreased returns on investment in products and services. As such, following downturns in the later subperiod, it appears the substitution theory was at work. Namely, patent litigation rates rose as managers at firms chose to channel capital into launching patent litigation (or, alternatively, as investors shifted their investments from traditional firms to ones that routinely engage in patent litigation and licensing, such as NPEs), rather than ordinary products and services.

So far in our explanation of the later subperiod it appears the substitution theory is correct and the capital constraint theory is not. Namely, based on the above analysis, increases in patent litigation in the later subperiod all seem to be strongly correlated to declining firm revenues from products and services and outside investment. Yet, in the later subperiod, we also found a competing trend. Specifically, we found primarily that as real interest rates rose, patent litigation rates declined. Additionally, as the TED spread widened—a measure of economy-wide financial risk—near-term patent litigation rates fell consistently over many quarters. These results are consistent with the capital constriction theory. Namely, as the TED spread rises—which it did substantially in the most recent recession—raising capital becomes increasingly difficult. Similarly, as real interest rates rise, capital generally becomes more costly. Presumably, as capital constricts with rises in the TED spread and real interest rates, firms reduce spending on patent litigation, leading to overall decreases in filing rates.

In our belief, the clue to interpreting these changing time trends is the changing nature of patent litigation. Especially starting in the mid-1980s and increasingly over time, firms have brought patent litigation suits not so much to stem competition, but to earn licensing fees on patents they do not practice.[94] Part of this trend may reflect the strengthening of patents by the Federal Circuit Court of Appeals, which was created in 1982.[95] Texas Instruments and IBM were early pioneers in this licensing-driven approach, each reportedly generating

[93] Similarly, unemployment in the earlier subperiod showed very small overall effects.

[94] See sources cited in note 13.

[95] See Atkinson et al. (2009).

roughly $500 million to $1 billion in annual licensing revenue by the mid- to late-1990s from their patents, many of which they apparently did not practice.[96] Several years later, nonpracticing entities (NPEs)—roughly speaking, firms that sell no products or services, and generally perform little to no R & D—entered the fray, particularly in the fields of software and financial methods.[97] Like the licensing-driven business model of operating companies, the NPE trend was arguably enabled in large part—at least early on—by the Federal Circuit's 1990s decisions providing broad leeway for of patenting for software and business methods.[98] Importantly, NPE litigation is often driven by contingent-fee attorneys, funded by outside capital sources.[99] Thus, as litigation has transformed into an investment-driven enterprise, it is not surprising to see macroeconomic forces at work that were not particularly salient in the 1970s and 1980s.[100]

In sum, from the 1970s through at least the mid-1980s, economic downturns played little to no role other than as a proxy for overall private infringement. Specifically, during this period, as private infringement increased, so did the number of lawsuits, and vice-versa. However, contrary to recent anecdotal accounts and limited study, more recent economic downturns have not definitively increased or decreased patent litigation rates. Rather, depending on the nature of the downturn, it appears patent litigation may either increase or decrease following a downturn.

Specifically, if the downturn is characterized by severe constraints on capital and financing—such as the most recent one—then it is much more likely that patent litigation rates will decrease. Indeed, just prior to and during the last recession, the TED spread more than quadrupled at its peak, very likely substantially constraining overall patent litigation counts. During the same time period, GDP remained fairly stable. Thus, while a 1 percent drop in GDP was associated with steep declines in patent litigation two quarters later—about 4.5 percent—in a severe credit crunch, procyclical capital constraint effects may dominate

[96] See Barnett (2011); Somaya and Teece (2007), Rivette and Klein (2000), and Grindley and Teece (1997). In this regard, our procyclical real interest rate trends show strong significance beginning as early as 1994 in our alternative specifications (see Appendix B). Thus, these trends likely cannot be explained merely by the rise of non-practicing entities (NPEs).

[97] See sources cited in note 13.

[98] See Meurer (2008).

[99] See Ewing (2012) and Schwartz (2012). Longer- term (six to seven quarters out) TED spreads were positively correlated with litigation rates in the later subperiod. However, the availability of immediate credit is likely to be of the greatest concern to contingent-fee lawyers, supporting the inference that TED spreads are generally negatively correlated with the decision to initiate patent infringement suits. Additionally, in the 14-period alternative specification, increases in the TED spread were significantly correlated with decreases in patent litigation during the period 1983-2009, supporting this interpretation.

[100] We would have liked to test this claim empirically, but we did not have data on the number of NPE or licensing-driven suits filed on a quarterly basis during the relevant time periods. The only publicly available data on the number of lawsuits filed by NPEs over any significant time period is from RPX and PatentFreedom, which have tracked the annual filing of NPE suits since 2000. We have concerns regarding the overall accuracy of these data, but even if they were accurate, unfortunately it would provide an insufficient number of data points to generate meaningful results.

countercyclical substitution effects. However, if the downturn is characterized by substantial declines in productivity and relatively mild constrictions in available capital, then it is very likely for litigation counts to increase. This latter result likely reflects the increased relative return on investment from litigation when the sales of products and services slump.

B. Caveats

Because the patent litigation process is exceedingly complex—and much remains to be discovered about its underlying mechanisms—we lacked a baseline functional form with which to compare our results. Although we tried to overcome these limitations through a reduced form analysis as well as alternative specifications, with so many variables and lags the number of possible regressions quickly becomes immense, and these techniques can only capture only a portion of the potential permutations. Thus, while our analysis adds to the literature, it may overlook some of the nuanced interactions among various macroeconomic variables vis-à-vis the volume of patent litigation.

Additionally, because we focus on the macroeconomic indicators rather than micro-level data, our analysis abstracts away from the likely heterogeneous relationship between macroeconomic indicators and litigation rates in different industries, technologies, geographic regions, and party types (e.g., public vs. private company, large vs. small companies, practicing vs. nonpracticing entities). Because patents often play very differing roles from industry to-industry, our aggregate data might obscure more nuanced and richer accounts. For example, the increased volume of suits filed by nonpracticing entities (NPEs) may make the recent effects of rising TED spreads and real interest rates even more pronounced, leading to larger coefficients for these variables than reported here when controlling for entity type.

Last, because we use counts, we do not measure the effects of the macroeconomy on the *intensity* of litigation, such as the amount spent on attorneys, experts, discovery, and the like, or on the *outcomes* of litigation, such as damages awards and settlement amounts. As we mentioned earlier, one survey found that general counsels planned on spending about 7.5 percent less on litigation during the most recent downturn. One would expect, then, that litigation intensity would have decreased, but exactly when and in what manner remains a future research topic.

VI. CONCLUSION

Practicing attorneys dispute whether economic downturns increase or decrease patent litigation rates. One camp—relying on data from all but the most recent recession—argues that downturns increase litigation because the rate of return from patent litigation rises relative to the sale of products and services. In other words, during downturns, litigation substitutes for traditional sales. Another camp, emphasizing the decline of patent litigation in the most recent recession, contends that capital constraints tend to reduce overall litigation rates during downturns.

In the first study of its kind, we resolve this debate. For patent litigation in the 1970s and 1980s, neither theory appears able to explain overall trends. However, both theories appear capable of explaining recent trends relative to the particular macroeconomic conditions of a downturn. The substitution theory is supported by a rise in overall patent litigation

concomitant with declines in GDP and investment. In contrast, the capital constraint theory is bolstered by the declines in patent litigation rates associated with increases in macroeconomic financial risk as measured by the TED spread and in T-bill and real interest rates. Our study indicates that in recent times overall patent litigation rates rise or fall depending on the nature of the economic downturn itself.

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APPENDIX A: ONE-QUARTER LAG SPECIFICATION

Table A reproduces the VARs in Table 2 with one-quarter lag instead of seven-quarter lags. Standard optimal lag tests supported the choice of either one or seven lags for these main specifications.

Table A: Vector Autoregression of Patent Litigation, 1-Quarter Lag Main Specifications

			1971-2009			*1971-1991*			*1986-2009*		
Variable		*Lag*	*Coef.*		*S.E.*	*Coef.*		*S.E.*	*Coef.*		*S.E.*
Patent litigation	diff, log	1	-0.49	***	0.07	-0.48	***	0.09	-0.44	***	0.09
Investment	diff, log	1	0.72	*	0.38	1.40	***	0.51	-0.05		0.58
Consumption	diff, log	1	-0.07		1.26	-0.19		1.83	0.74		2.12
Unemployment	diff	1	0.06	*	0.04	0.13	***	0.05	-0.05		0.06
Real interest rate	diff	1	-0.02	***	0.01	-0.026	*	0.01	-0.027	**	0.01
R and D	diff, log	1	-0.72		0.63	-0.81		0.98	-1.76	**	0.78
In force Patents	diff, log	1	-1.34		1.21	-4.37		2.84	-0.34		1.29
Inflation (CPI)		1	0.00		0.01	-0.00		0.02	0.00		0.02
NASDAQ	diff, log	1	0.14		0.09	0.19		0.15	0.06		0.11
TED spread	diff	1							-0.04		0.03
constant			0.02		0.02	0.03		0.04	0.02		0.03
Observations			154			82			94		
AIC			-25.9			-25.7			-28.2		
BIC			-24.1			-23.1			-25.2		

NOTE: All variables are quarterly values. 156 quarters from 1971 through 2009. *Stata* "small" option used to increase standard errors ("*S.E.*") to account for number of observations.
*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

APPENDIX B: ALTERNATIVE TIME PERIODS

Table B-1 reports the results of the main specification in Table 2 but with shorter alternative time periods. Because there are fewer quarters in these periods, the number of optimal lags is four instead of seven. To compare the results in Table B-1 to the time periods in Table 2, Table B-2 reports the results of the main specification with the same time periods as in Table 2 but with four-quarter lags. Four is not the optimal number of lags for the main specification time periods in Table 2. Thus, the results in Table B-2 are less reliable than those in Table 2.

Table B-1: Vector Autoregression of Patent Litigation, Alternative Time Periods

			1971-1984			*1982-1996*		
Variable		*Lag*	*Coef.*		*S.E.*	*Coef.*		*S.E.*
Patent	diff,	1	-1.20	***	0.11	-0.39	**	0.14
litigation	log	2	-0.93	***	0.14	-0.29	**	0.12
		3	-0.47	***	0.15	-0.17		0.12
		4	-0.12		0.12	-0.11		0.11
Investment	diff,	1	-0.59		0.39	1.23	*	0.72
	log	2	-0.00		0.46	-1.32	*	0.77
		3	-0.77		0.46	1.25	*	0.63
		4	-0.36		0.31	0.24		0.63
Consumption	diff,	1	1.20		1.47	5.88	**	2.33
	log	2	4.55	**	1.94	-2.92		2.97
		3	2.69		2.18	-4.91	*	2.63
		4	-1.96		1.85	-4.08		2.74
Real	diff	1	0.03	**	0.01	0.08	**	0.03
interest rate		2	0.01		0.01	-0.06	*	0.03
		3	0.03	**	0.01	-0.01		0.02
		4	-0.03	**	0.01	-0.01		0.02
R and D	diff,	1	-0.36		0.94	-2.66	**	1.03
	log	2	-1.22		0.95	2.02	*	1.06
		3	1.47	*	0.84	2.74	***	0.91
		4	3.14	***	0.80	-0.78		1.05
Inflation	diff,	1	-0.06	**	0.02	0.15	***	0.05
	log	2	-0.00		0.04	-0.24	***	0.08
		3	0.01		0.04	0.09		0.07
		4	0.03		0.03	0.00		0.04
NASDAQ	diff,	1	0.05		0.11	-0.05		0.18
	log	2	-0.00		0.12	-0.12		0.16
		3	-0.42	***	0.12	0.11		0.17
		4	-0.01		0.14	-0.04		0.14
TED spread	diff	1						
		2						
		3						
		4						
constant			0.01		0.11	0.06		0.06
Observations			51			55		
AIC			-17.5			-21.1		

BIC	-9.8	-13.7

NOTE: All variables are quarterly values. *Stata* "small" option used to increase standard errors ("*S.E.*") to account for number of observations. *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

Table B-1 (continued): Vector Autoregression of Patent Litigation, Alternative Time Periods

			1994-2007			*1997-2009*		
Variable		*Lag*	*Coef.*		*S.E.*	*Coef.*		*S.E.*
Patent litigation	diff, log	1	-0.75	***	0.16	-0.98	***	0.12
		2	-0.41	**	0.19	-0.40	***	0.13
		3	-0.14		0.18	0.05		0.15
		4	-0.27		0.16	0.06		0.11
Investment	diff, log	1	-0.82		0.80	-2.27	***	0.57
		2	0.06		0.71	-3.02	***	0.57
		3	0.80		0.72	-1.46	**	0.51
		4	0.32		0.67	-0.33		0.40
Consumption	diff, log	1	-2.55		3.65	-0.49		1.90
		2	-1.99		5.02	9.91	**	3.40
		3	4.57		3.14	14.63	***	2.49
		4	-3.90		3.84	9.35	***	2.59
Real interest rate	diff	1	-0.15	***	0.05	-0.02		0.03
		2	0.06		0.05	-0.00		0.03
		3	0.01		0.05	0.13	***	0.03
		4	-0.03		0.03	-0.01		0.01
R and D	diff, log	1	-0.39		1.00	-3.98	***	0.97
		2	-1.76	*	0.95	-3.14	***	0.56
		3	2.16	**	0.96	-0.95		0.72
		4	-1.33		1.13	-1.12		0.80
Inflation			-0.12	*	0.06	-0.09	**	0.04
			0.19	**	0.09	0.02		0.06
			-0.00		0.08	0.17	***	0.05
			-0.06		0.07	-0.14	***	0.04
NASDAQ	diff, log	1	0.14		0.13	0.23	**	0.10
		2	0.43	***	0.12	0.39	***	0.07
		3	-0.23		0.16	-0.17	*	0.09
		4	0.11		0.15	-0.31	***	0.10
TED spread	diff	1	-0.02		0.05	0.04	*	0.02
		2	0.04		0.06	0.11	***	0.03
		3	0.04		0.06	0.13	***	0.03
		4	-0.00		0.05	0.06	**	0.03
constant			0.05		0.09	-0.09	**	0.03
Observations			51			47		
AIC			-23.8			-22.9		
BIC			-13.8			-12.5		

NOTE: All variables are quarterly values. *Stata* "small" option used to increase standard errors ("*S.E.*") to account for number of observations. *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

Table B-2: Vector Autoregression of Patent Litigation, Table 2 Specifications with 4 Lags

			1971-2009			*1971-1991*			*1986-2009*		
Variable		*Lag*	*Coef.*		*S.E.*	*Coef.*		*S.E.*	*Coef.*		*S.E.*
Patent litigation	diff, log	1	-0.83	***	0.08	-1.10	***	0.11	-0.73	***	0.11
		2	-0.57	***	0.10	-0.94	***	0.15	-0.58	***	0.13
		3	-0.28	***	0.10	-0.52	***	0.16	-0.44	***	0.12
		4	-0.13		0.08	-0.19	*	0.11	-0.21	**	0.10
Investment	diff, log	1	0.11		0.42	-0.31		0.52	-0.08		0.64
		2	0.16		0.43	0.72		0.56	-0.77		0.71
		3	0.40		0.40	1.52	***	0.54	1.20	*	0.68
		4	0.25		0.36	0.41		0.48	-0.74		0.60
Consumption	diff, log	1	2.17	*	1.27	3.36	**	1.58	1.59		2.13
		2	3.73	**	1.43	5.44	***	1.68	-0.03		2.98
		3	0.32		1.44	2.33		1.85	3.76		2.82
		4	-3.25	**	1.52	-5.47	***	1.74	-5.01	*	2.87
Unemployment	diff	1	0.08	**	0.04	0.10	*	0.05	-0.07		0.08
		2	-0.02		0.05	-0.02		0.06	0.07		0.07
		3	0.03		0.05	0.18	***	0.06	-0.08		0.07
		4	-0.00		0.04	0.03		0.05	-0.07		0.06
Real interest rate	diff	1	-0.02	*	0.01	0.00		0.01	-0.04		0.03
		2	0.00		0.01	0.01		0.01	-0.03		0.03
		3	0.01		0.01	0.01		0.01	-0.00		0.03
		4	0.00		0.01	-0.00		0.01	-0.01		0.02
R and D	diff, log	1	-1.10	*	0.58	-0.31		0.95	-1.51	*	0.76
		2	0.14		0.59	-0.74		0.99	0.58		0.78
		3	0.61		0.58	0.18		0.89	0.85		0.79
		4	0.11		0.57	0.44		0.74	-0.42		0.88
In force patents	diff, log	1	-3.22		2.07	-10.31	***	3.45	-2.12		2.41
		2	2.80		2.58	7.12	*	3.88	1.31		2.99
		3	-1.85		2.59	-2.19		4.20	1.05		2.87
		4	0.71		2.09	-5.36		3.80	-0.91		2.23
Inflation (CPI)		1	-0.01		0.02	0.02		0.03	-0.00		0.04
		2	0.04		0.03	0.02		0.04	-0.02		0.07
		3	-0.02		0.02	-0.03		0.03	0.06		0.06
		4	-0.02		0.02	-0.05		0.03	-0.05		0.05
NASDAQ	diff, log	1	0.08		0.08	0.13		0.12	-0.08		0.11
		2	0.02		0.08	-0.43	***	0.13	0.17		0.11
		3	-0.02		0.09	-0.10		0.13	-0.07		0.11
		4	0.01		0.08	-0.21	*	0.12	0.22	**	0.11
TED spread	diff	1							-0.07	**	0.03
		2							-0.05		0.03
		3							-0.03		0.04
		4							-0.00		0.03
Constant			0.01		0.02	0.05		0.05	0.05		0.05
Observations			151			79			91		
AIC			-26.1			-26.4			-28.1		
BIC			-19.4			-16.4			-16.8		

NOTE: All variables are quarterly values. *Stata* "small" option used to increase standard errors ("*S.E.*") to account for number of observations. *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

APPENDIX C: IMPACT OF CONTROLLING FOR NUMBER OF PATENT GRANTS

Table C reproduces the main specification VAR in Table 2 for the later subperiod (1986-2009) using the number of in-force patents and alternatively the number of patent grants as an independent variable.

Table C: Vector Autoregression of Patent Litigation, Alternative Specification Using Number of Patent Grants Instead of Number of In-Force Patents

			1986-2009 (in force patents)			*1986-2009 (patent grants)*		
Variable		*Lag*	*Coef.*		*S.E.*	*Coef.*		*S.E.*
Patent litigation	diff, log	1	-0.81	***	0.13	-0.82	***	0.13
		2	-0.74	***	0.12	-0.68	***	0.11
		3	-0.62	***	0.13	-0.63	***	0.12
		4	-0.69	***	0.14	-0.78	***	0.13
		5	-0.43	**	0.15	-0.45	***	0.13
		6	-0.34	**	0.13	-0.31	**	0.12
		7	0.01		0.13	-0.03		0.12
Investment	diff, log	1	-0.61		0.61	-0.30		0.68
		2	-2.59	***	0.80	-2.24	***	0.71
		3	-0.28		0.73	0.19		0.74
		4	-2.11	**	0.86	-1.60	*	0.90
		5	-0.94		0.70	-0.54		0.66
		6	-1.99	**	0.77	-1.63	**	0.71
		7	-0.45		0.89	0.31		0.88
Consumption	diff, log	1	4.75	*	2.51	8.22	***	2.46
		2	-0.18		2.86	-2.92		2.85
		3	-3.75		3.17	-8.49	**	3.27
		4	-3.74		3.87	-5.66		4.03
		5	-2.72		3.40	-0.22		3.62
		6	0.27		3.31	1.32		2.81
		7	-5.65		3.27	-4.17		3.02
Unemployment	diff	1	-0.25	***	0.09	-0.28	***	0.08
		2	-0.35	***	0.07	-0.38	***	0.07
		3	-0.15		0.10	-0.06		0.10
		4	0.03		0.09	0.10		0.09
		5	-0.15		0.09	-0.22	**	0.08
		6	-0.04		0.08	-0.02		0.08
		7	0.20	**	0.07	0.21	***	0.07
Real interest rate	diff	1	-0.02		0.03	-0.02		0.03
		2	-0.06		0.05	-0.06		0.05
		3	0.08	*	0.04	0.10	**	0.05
		4	-0.13	***	0.04	-0.17	***	0.05
		5	-0.04		0.05	-0.08	*	0.05
		6	0.10	*	0.05	0.11	**	0.04
		7	-0.02		0.03	-0.01		0.02
R and D	diff,	1	-1.63		1.04	-2.14	**	0.92

	log	2	0.85		0.96	0.64		0.96
		3	2.05	**	0.80	2.90	***	0.87
		4	0.93		0.95	1.24		0.90
		5	1.02		0.85	0.77		0.98
		6	0.38		0.89	0.91		0.83
		7	-0.24		0.94	-0.36		0.95
In force	diff,	1	1.39		2.22			
patents	log	2	-1.09		2.77			
		3	3.04		2.62			
		4	-0.67		2.11			
		5	-3.58		2.56			
		6	5.54	*	2.65			
		7	-4.07	*	2.13			
Patent grants	diff,	1				0.01		0.08
	log	2				0.14		0.09
		3				0.31	***	0.10
		4				0.19	*	0.10
		5				0.13		0.10
		6				0.19	**	0.09
		7				0.14		0.09
Inflation (CPI)		1	-0.05		0.04	-0.02		0.04
		2	-0.04		0.08	-0.02		0.08
		3	0.21	**	0.09	0.21	**	0.09
		4	-0.25	***	0.08	-0.31	***	0.09
		5	0.16	**	0.08	0.19	**	0.08
		6	0.08		0.08	0.13		0.08
		7	-0.24	***	0.08	-0.23	***	0.07
NASDAQ	diff,	1	-0.23	**	0.11	-0.34	***	0.12
	log	2	0.33	***	0.10	0.37	***	0.11
		3	-0.28	**	0.12	-0.31	**	0.12
		4	0.19	*	0.10	0.13		0.10
		5	-0.13		0.11	-0.17		0.12
		6	0.23		0.15	0.31	**	0.14
		7	0.06		0.16	-0.12		0.15
TED spread	diff	1	-0.14	***	0.04	-0.13	***	0.04
		2	-0.04		0.06	0.00		0.05
		3	-0.06		0.05	-0.03		0.05
		4	-0.11	**	0.05	-0.05		0.05
		5	-0.11	**	0.05	-0.09	*	0.05
		6	0.09	*	0.04	0.13	***	0.04
		7	0.11	***	0.04	0.12	***	0.04
constant			0.24	***	0.08	0.17	**	0.07
Observations			88			88		
AIC			-34.2			-28.8		
BIC			-14.2			-8.8		

NOTE: All variables are quarterly values. 96 quarters from 1986 through 2009. *Stata* "small" option used to increase standard errors ("*S.E.*") to account for number of observations.
*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

APPENDIX D: ALTERNATIVE MAIN SPECIFICATION FOR 1986-2009 WITHOUT TED SPREAD

Table D: Vector Autoregression of Patent Litigation, Alternative Specification without TED Spread, 1986-2009

Variable		*Lag*	*Coef.*		*S.E.*
Patent litigation	diff, log	1	-0.61	***	0.11
		2	-0.65	***	0.11
		3	-0.48	***	0.12
		4	-0.40	***	0.13
		5	-0.20		0.13
		6	-0.20		0.12
		7	-0.06		0.11
Investment	diff, log	1	-0.18		0.59
		2	-2.07	**	0.79
		3	0.20		0.76
		4	-0.86		0.76
		5	-0.28		0.71
		6	-1.64	**	0.77
		7	0.41		0.64
Consumption	diff, log	1	5.79	**	2.29
		2	-1.11		2.89
		3	-3.90		2.97
		4	0.89		3.68
		5	1.45		3.49
		6	0.75		3.21
		7	-0.59		2.95
Unemployment	diff	1	-0.15	*	0.08
		2	-0.17	**	0.07
		3	-0.02		0.08
		4	-0.05		0.07
		5	-0.06		0.08
		6	0.06		0.07
		7	0.18	**	0.07
Real interest rate	diff	1	0.02		0.03
		2	-0.04		0.04
		3	0.03		0.03
		4	-0.13	***	0.04
		5	0.05		0.04
		6	0.04		0.03
		7	0.01		0.02
R and D	diff, log	1	-2.87	***	0.89
		2	2.49	**	0.90
		3	1.88	**	0.83
		4	-0.69		0.88
		5	2.54	***	0.79
		6	0.27		0.84
		7	-1.22		0.93

In Force Patents	diff, log	1	-0.86		2.22
		2	3.40		2.65
		3	-0.35		2.63
		4	-1.18		2.19
		5	-6.76	**	2.60
		6	8.38	***	2.23
		7	-3.30		2.17
Inflation (CPI)		1	0.04		0.04
		2	-0.07		0.07
		3	0.06		0.08
		4	-0.20	**	0.08
		5	0.28	***	0.07
		6	-0.03		0.07
		7	-0.08		0.06
NASDAQ	diff, log	1	-0.03		0.10
		2	0.19	**	0.09
		3	-0.34	***	0.10
		4	0.19	*	0.09
		5	0.02		0.11
		6	0.04		0.11
		7	-0.06		0.10
constant			0.04		0.05
Observations			88		
AIC			-30.8		
BIC			-14.6		

NOTE: All variables are quarterly values. 96 quarters from 1986 through 2009. *Stata* "small" option used to increase standard errors ("*S.E.*") to account for number of observations.
*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

APPENDIX E: GRANGER CAUSALITY TESTS

Each cell in Table E reports a Wald test that the coefficients on the lags of the independent variables on the left column are zero in the equation for patent litigation. Thus, for the entire time period 1971-2009, p = 0.01 for consumption means that the coefficients on the lags of consumption are not jointly zero in the equation for patent litigation, indicating that the evidence favors the alternative that consumption causes patent litigation. Note that TED spread is only available from to 1986-2009.

Table E: Granger Causality Test Results for VAR Regressions in Table 2

Reject the null that below does not cause patent litigation	*1971-2009*	*1971-1991*	*1986-2009*
Investment	0.08	0.00	0.00
Consumption	0.01	0.00	0.26
Unemployment	0.87	0.00	0.00
Real interest rate	0.14	0.00	0.03
R and D	0.37	0.00	0.07
In force patents	0.12	0.00	0.22
Inflation	0.03	0.00	0.04
NASDAQ	0.70	0.00	0.04
TED			0.02

NOTE: All variables used in underlying VAR are quarterly values. 156 quarters from 1971 through 2009. *Stata* "small" option used in underlying VAR to increase standard errors ("*S.E.*") to account for number of observations. *p*-values for F-statistics for joint Wald tests on lags reported.

APPENDIX F: ALTERNATIVE SPECIFICATIONS WITH FEWER INDEPENDENT VARIABLES

Table F.1: Vector Autoregression of Patent Litigation, 1986-2009

			1: Table 2 minus NASD			*2: 1 minus In Force*			*3: 2 minus Consump.*		
Variable		*Lag*	*Coef.*		*S.E.*	*Coef.*		*S.E.*	*Coef.*		*S.E.*
Patent	diff,	1	-0.87	***	0.12	-0.95	***	0.11	-0.92	***	0.11
litigation	log	2	-0.81	***	0.13	-0.85	***	0.13	-0.84	***	0.12
		3	-0.65	***	0.13	-0.69	***	0.13	-0.67	***	0.12
		4	-0.63	***	0.15	-0.62	***	0.14	-0.66	***	0.13
		5	-0.42	**	0.15	-0.48	***	0.14	-0.51	***	0.13
		6	-0.25	*	0.13	-0.29	**	0.12	-0.31	**	0.12
		7	-0.11		0.10	-0.11		0.09	-0.09		0.09
Investment	diff,	1	-0.92		0.62	-0.95		0.61	-0.63		0.47
	log	2	-1.51	**	0.71	-1.70	**	0.70	-1.56	***	0.51
		3	-0.63		0.73	-0.76		0.71	-0.78		0.55
		4	-1.39		0.82	-1.07		0.80	-1.01	**	0.48
		5	-0.90		0.65	-0.80		0.64	-0.85		0.54
		6	-1.64	**	0.63	-1.90	***	0.65	-2.40	***	0.57
		7	-0.09		0.64	-0.07		0.66	0.21		0.59
Consumption	diff,	1	3.66		2.30	2.58		2.11			
	log	2	1.27		2.59	1.51		2.53			
		3	-4.64		3.27	-3.19		2.85			
		4	-1.91		3.56	-3.50		3.18			
		5	-2.06		3.50	-3.58		3.16			
		6	-0.81		3.20	-0.02		2.82			
		7	-4.37		3.15	-2.64		2.88			
Unemployment	diff	1	-0.16	**	0.07	-0.20	***	0.07	-0.24	***	0.06
		2	-0.32	***	0.07	-0.32	***	0.08	-0.26	***	0.07
		3	-0.13		0.08	-0.14		0.08	-0.09		0.07
		4	-0.08		0.08	-0.08		0.08	-0.03		0.07
		5	-0.10		0.07	-0.12		0.08	-0.12	*	0.07
		6	-0.02		0.08	-0.02		0.08	-0.01		0.07
		7	0.20	**	0.07	0.17	**	0.07	0.26	***	0.06
Real	diff	1	-0.02		0.03	-0.04		0.03	-0.03		0.03
interest rate		2	-0.05		0.04	-0.04		0.04	-0.04		0.04
		3	0.03		0.04	0.02		0.04	0.01		0.03
		4	-0.09	**	0.04	-0.08	**	0.04	-0.08	**	0.03
		5	-0.01		0.04	-0.03		0.04	-0.00		0.04
		6	0.04		0.04	0.03		0.04	0.02		0.04
		7	-0.00		0.03	-0.00		0.03	0.01		0.02
R and D	diff,	1	-1.66	*	0.86	-1.35	*	0.79	-1.33	*	0.72
	log	2	1.56	*	0.81	1.60	**	0.74	1.91	**	0.74
		3	1.06		0.70	1.33	*	0.70	1.19	*	0.70
		4	0.62		0.80	0.93		0.78	0.80		0.74
		5	1.98	**	0.75	2.07	***	0.75	1.66	**	0.73
		6	0.25		0.80	-0.01		0.80	-0.39		0.70
		7	0.65		0.89	0.66		0.76	0.71		0.66

In Force	diff,	1	-1.88		2.15						
Patents	log	2	2.97		2.66						
		3	0.97		2.73						
		4	0.13		2.27						
		5	-4.56	*	2.33						
		6	6.43	**	2.31						
		7	-4.41	**	2.09						
Inflation (CPI)		1	-0.03		0.04	-0.06		0.04	-0.06	*	0.04
		2	-0.02		0.08	0.02		0.08	-0.01		0.07
		3	0.10		0.08	0.08		0.08	0.07		0.06
		4	-0.13		0.08	-0.11		0.08	-0.10	*	0.06
		5	0.14	*	0.07	0.10		0.07	0.13	**	0.06
		6	0.01		0.07	0.02		0.07	-0.00		0.06
		7	-0.16	**	0.07	-0.13	*	0.07	-0.07		0.06
TED spread	diff	1	-0.09	**	0.04	-0.12	***	0.04	-0.09	***	0.03
		2	-0.11	**	0.05	-0.10	*	0.05	-0.06		0.04
		3	-0.07		0.06	-0.08		0.05	-0.03		0.04
		4	-0.09	*	0.05	-0.10	*	0.05	-0.07	*	0.04
		5	-0.06		0.05	-0.07		0.05	-0.05		0.04
		6	0.04		0.04	0.04		0.04	0.05		0.04
		7	0.09	**	0.03	0.09	**	0.03	0.08	**	0.03
constant			0.20	**	0.08	0.19	**	0.08	0.11	**	0.04
Observations			88			88			88		
AIC			-29.5			-20.1			-10.9		
BIC			-13.3			-7.3			-1.1		

NOTE: All variables are quarterly values. 96 quarters from 1986 through 2009. *Stata* "small" option used to increase standard errors ("*S.E.*") to account for number of observations.
*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

Table F.2: Vector Autoregression of Patent Litigation, 1971-1991

			1: Table 2 minus NASD			*2: 1 minus In Force*			*3: 2 minus Consump.*		
Variable		*Lag*	*Coef.*		*S.E.*	*Coef.*		*S.E.*	*Coef.*		*S.E.*
Patent	diff,	1	-1.26	***	0.13	-1.14	***	0.12	-1.06	***	0.11
litigation	log	2	-1.02	***	0.18	-0.92	***	0.16	-0.97	***	0.15
		3	-0.85	***	0.19	-0.66	***	0.18	-0.93	***	0.17
		4	-0.70	***	0.18	-0.52	***	0.18	-0.86	***	0.16
		5	-0.86	***	0.21	-0.58	***	0.20	-0.88	***	0.18
		6	-0.94	***	0.20	-0.66	***	0.20	-0.78	***	0.16
		7	-0.67	***	0.16	-0.43	***	0.14	-0.41	***	0.12
Investment	diff,	1	-0.11		0.53	-0.35		0.54	0.22		0.54
	log	2	0.32		0.59	0.41		0.55	0.22		0.54
		3	2.87	***	0.66	1.86	***	0.60	1.07	*	0.53
		4	0.95		0.71	0.92		0.59	0.16		0.49
		5	-0.08		0.66	-0.25		0.66	-0.26		0.45
		6	-1.63	**	0.65	-1.67	**	0.64	-1.06	**	0.48
		7	0.77		0.54	0.68		0.48	0.98	**	0.47
Consumption	diff,	1	4.82	***	1.48	3.46	**	1.47			
	log	2	5.08	***	1.64	3.88	**	1.57			

		3	-1.17		1.70	-1.90		1.67			
		4	-5.71	***	1.88	-6.07	***	1.79			
		5	0.49		1.95	-1.20		2.00			
		6	2.56		2.15	-0.53		2.16			
		7	2.69		2.21	-0.06		2.20			
Unemployment	diff	1	0.18	***	0.06	0.06		0.05	0.04		0.05
		2	0.03		0.06	0.06		0.06	0.05		0.06
		3	0.24	***	0.07	0.16	**	0.06	0.16	**	0.06
		4	0.13	*	0.07	0.07		0.06	0.05		0.06
		5	0.01		0.06	-0.02		0.05	-0.02		0.06
		6	-0.02		0.06	-0.07		0.06	-0.03		0.06
		7	-0.00		0.05	0.01		0.05	0.02		0.05
Real interest rate	diff	1	-0.01		0.02	-0.01		0.02	-0.01		0.02
		2	0.00		0.02	-0.01		0.02	-0.02		0.02
		3	-0.02		0.02	0.00		0.02	0.00		0.02
		4	0.01		0.01	-0.00		0.02	-0.00		0.02
		5	-0.00		0.01	-0.00		0.01	-0.01		0.01
		6	-0.02		0.02	-0.03	**	0.01	-0.04	**	0.02
		7	-0.03	*	0.01	-0.01		0.01	-0.02		0.02
R and D	diff, log	1	2.96	**	1.25	2.20	*	1.15	3.07	***	1.11
		2	3.25	***	1.09	3.59	***	1.12	4.17	***	1.10
		3	2.21		1.43	2.42	**	1.16	2.98	**	1.22
		4	0.16		1.06	-0.21		0.94	-0.65		0.98
		5	-1.84	*	1.02	-0.43		1.02	-1.34		1.09
		6	-3.97	***	1.15	-2.06	*	1.02	-2.61	**	1.01
		7	-1.04		0.92	-1.30		0.81	-1.58	*	0.86
In force patents	diff, log	1	-7.82		4.96						
		2	-2.50		4.63						
		3	6.51		6.45						
		4	-11.29	**	4.65						
		5	1.02		4.67						
		6	3.59		4.46						
		7	-2.39		4.19						
Inflation (CPI)		1	0.03		0.03	0.03		0.03	0.00		0.03
		2	0.09	**	0.04	0.07		0.04	0.02		0.04
		3	-0.10	*	0.05	-0.06		0.04	-0.04		0.04
		4	0.02		0.04	-0.03		0.04	0.01		0.04
		5	-0.10	**	0.04	-0.04		0.04	-0.04		0.04
		6	0.03		0.04	0.02		0.04	0.03		0.03
		7	-0.04		0.03	-0.04		0.03	-0.04		0.03
constant			0.10		0.06	0.12	*	0.06	0.09	**	0.04
Observations			76			76			76		
AIC			-29.0			-16.8			-8.8		
BIC			-15.1			-6.0			-0.8		

NOTE: All variables are quarterly values. 84 quarters from 1971 through 1991. *Stata* "small" option used to increase standard errors ("*S.E.*") to account for number of observations.
*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

APPENDIX G: ALTERNATIVE SPECIFICATIONS WITH GDP INSTEAD OF CONSUMPTION AND INVESTMENT

Table G reports results for the Table 2 main specifications, but where real consumption and real investment have been replaced with real GDP.

Table G: Vector Autoregression of Patent Litigation, Alternative Specification with GDP

			1971-2009			*1971-1991*			*1986-2009*		
Variable		*Lag*	*Coef.*		*S.E.*	*Coef.*		*S.E.*	*Coef.*		*S.E.*
Patent litigation	diff, log	1	-0.70	***	0.08	-1.04	***	0.09	-0.85	***	0.11
		2	-0.51	***	0.10	-1.14	***	0.14	-0.76	***	0.13
		3	-0.36	***	0.11	-1.30	***	0.15	-0.71	***	0.13
		4	-0.39	***	0.11	-1.38	***	0.15	-0.58	***	0.14
		5	-0.22	*	0.11	-1.17	***	0.17	-0.23		0.15
		6	-0.20	*	0.11	-0.88	***	0.15	-0.11		0.13
		7	-0.01		0.08	-0.49	***	0.09	-0.02		0.12
Real GDP	diff, log	1	1.39		1.19	-0.04		0.99	1.65		1.96
		2	1.85		1.24	0.97		1.12	-4.47	*	2.28
		3	-0.17		1.26	5.06	***	1.15	-3.76		2.46
		4	1.24		1.27	-1.05		1.32	-0.64		2.43
		5	-0.28		1.26	3.88	**	1.41	-5.64	**	2.28
		6	-3.53	***	1.20	-0.73		1.27	-8.26	***	2.42
		7	1.23		1.23	7.28	***	1.23	0.46		2.59
Unemployment	diff	1	0.00		0.04	0.05		0.04	-0.22	***	0.07
		2	-0.01		0.04	-0.05		0.03	-0.16	**	0.07
		3	0.02		0.04	0.34	***	0.04	-0.03		0.08
		4	-0.03		0.04	0.04		0.04	-0.08		0.09
		5	-0.00		0.04	0.04		0.05	-0.18	*	0.09
		6	0.02		0.04	0.05		0.04	0.07		0.07
		7	0.04		0.04	0.11	***	0.03	0.23	***	0.07
Real interest rate	diff	1	-0.01		0.01	0.04	***	0.01	-0.05		0.03
		2	-0.03	**	0.01	-0.00		0.02	0.01		0.04
		3	0.01		0.01	0.02		0.01	0.01		0.04
		4	-0.01		0.01	-0.02	**	0.01	-0.07	*	0.04
		5	0.03	**	0.01	-0.01		0.01	-0.01		0.05
		6	0.00		0.01	-0.05	***	0.01	0.05		0.05
		7	0.02	**	0.01	-0.03	**	0.01	0.01		0.03
R and D	diff, log	1	-1.31	**	0.62	4.69	***	1.02	-2.46	***	0.83
		2	0.64		0.64	3.66	***	0.94	1.61	*	0.92
		3	0.56		0.62	3.61	***	1.08	1.43	*	0.80
		4	-0.36		0.58	-2.93	***	0.91	-0.10		0.86
		5	0.11		0.63	-2.10	**	0.90	1.85	*	0.93
		6	0.25		0.61	-2.16	***	0.72	1.21		0.93
		7	-0.46		0.60	-0.02		0.73	0.80		0.91
In force patents	diff, log	1	-1.32		1.99	-16.82	***	3.16	1.11		2.22
		2	1.46		2.47	7.76	**	3.63	2.09		2.76
		3	-2.01		2.53	11.30	**	4.50	-1.96		2.52
		4	3.15		2.38	-9.12	**	3.78	3.15		2.39

		5	-4.13	*	2.38	-4.41		3.54	-3.49		2.61
		6	5.48	**	2.35	-4.59		3.28	3.24		2.95
		7	-3.71	*	1.96	-3.85		3.24	-4.41	**	2.08
Inflation (CPI)		1	-0.02		0.02	0.01		0.03	-0.02		0.05
		2	0.01		0.03	0.05		0.04	0.06		0.08
		3	0.02		0.03	0.03		0.03	0.01		0.08
		4	-0.01		0.03	-0.04	***	0.03	-0.06		0.07
		5	0.05	*	0.03	-0.05	*	0.03	0.08		0.08
		6	-0.03		0.03	0.07		0.03	-0.03		0.07
		7	-0.03		0.02	0.03		0.02	-0.05		0.06
NASDAQ	diff, log	1	0.09		0.07	0.05		0.08	-0.02		0.10
		2	0.06		0.08	-0.38	***	0.08	0.09		0.11
		3	-0.18	**	0.08	-0.37	***	0.10	-0.22	*	0.12
		4	0.06		0.08	-0.52	***	0.10	0.00		0.09
		5	0.10		0.08	0.23	**	0.10	0.08		0.11
		6	-0.11		0.08	-0.63	***	0.10	-0.09		0.13
		7	0.04		0.08	-0.00		0.10	-0.03		0.13
TED spread	diff	1							-0.07	*	0.04
		2							-0.06		0.05
		3							-0.04		0.06
		4							-0.05		0.04
		5							0.01		0.04
		6							0.10	**	0.05
		7							0.07		0.04
Constant			0.05	**	0.02	0.05		0.03	0.16	**	0.06
Observations			148			76			88		
AIC			-20.5			-25.6			-25.3		
BIC			-11.3			-11.6			-9.1		

NOTE: All variables are quarterly values. 156 quarters from 1971 through 2009. *Stata* "small" option used to increase standard errors ("*S.E.*") to account for number of observations.
*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

APPENDIX H: ALTERNATIVE SPECIFICATION USING FOUR-QUARTER TRAILING AVERAGES

Table H reproduces the main specifications in Table 2, but with that value of every independent variable recalculated as four-quarter trailing averages.

Table H: Vector Autoregression of Patent Litigation, Four-Quarter Trailing Averages

			1971-2009			*1971-1991*			*1986-2009*		
Variable		*Lag*	*Coef.*		*S.E.*	*Coef.*		*S.E.*	*Coef.*		*S.E.*
Patent litigation	diff, log	1	-0.87	***	0.08	-1.50	***	0.11	-0.95	***	0.13
		2	-0.77	***	0.11	-1.75	***	0.20	-0.89	***	0.17
		3	-0.63	***	0.12	-1.56	***	0.29	-0.72	***	0.20
		4	-0.39	***	0.13	-1.24	***	0.36	-0.14		0.22
		5	-0.27	**	0.12	-0.55		0.32	-0.01		0.22
		6	-0.31	***	0.11	-0.39	*	0.21	-0.05		0.17
		7	-0.15	*	0.08	-0.43	***	0.12	-0.12		0.12
Investment	diff, log	1	-0.34		1.47	-7.61	***	1.90	2.62		3.09
		2	2.14		1.77	11.75	***	2.50	-6.60	*	3.45
		3	-1.84		1.71	-4.65	**	1.93	0.34		4.66
		4	4.45	***	1.61	3.50	*	1.83	2.10		3.53
		5	-2.65	*	1.44	0.24		1.54	0.95		3.79
		6	-2.25		1.42	-1.13		1.90	-10.12	***	3.35
		7	1.53		1.14	0.81		1.61	3.28		2.52
Consumption	diff, log	1	6.21		4.11	-10.32		6.71	11.81		13.58
		2	5.20		5.58	20.32	***	6.26	-11.46		12.74
		3	-6.38		5.99	4.65		7.73	-6.59		13.41
		4	-6.54		5.79	-12.95		9.10	13.13		18.88
		5	7.21		6.36	-1.29		7.63	8.19		19.06
		6	-10.99	*	6.18	-12.29	**	5.57	-9.70		23.26
		7	5.60		5.21	12.43	**	4.83	27.10	*	15.38
Unemployment	diff	1	0.01		0.14	-1.25	***	0.29	-0.40		0.30
		2	-0.08		0.19	0.89	***	0.25	-0.26		0.36
		3	0.01		0.20	0.64	**	0.21	0.00		0.49
		4	0.18		0.19	-0.58	**	0.22	0.34		0.40
		5	0.04		0.21	-0.43		0.26	0.19		0.40
		6	-0.20		0.21	0.37		0.29	0.42		0.44
		7	0.29	**	0.13	0.53	**	0.19	0.15		0.33
Real interest rate	diff	1	-0.03		0.05	0.21	**	0.08	0.12		0.17
		2	-0.02		0.06	-0.26	***	0.08	-0.10		0.33
		3	0.05		0.06	0.24	**	0.09	0.00		0.25
		4	-0.04		0.05	-0.11	*	0.05	-0.16		0.27
		5	0.11	**	0.05	0.13	**	0.05	0.37		0.24
		6	0.00		0.05	-0.10		0.06	-0.16		0.21
		7	0.01		0.03	0.34	***	0.07	0.18		0.11
R and D	diff, log	1	-5.04	**	2.39	-4.62		6.18	-7.23		5.32
		2	5.69	*	3.34	20.72	***	6.62	7.86		5.81
		3	1.82		3.02	-24.88	***	5.99	9.32	*	4.82
		4	-3.47		2.99	-10.01	**	4.26	-6.61		6.67
		5	-0.94		3.02	9.09	**	4.12	5.92		6.23

		6	6.18	*	3.22	13.01	**	4.35	-2.00		4.49
		7	-2.50		2.50	1.53		4.52	-7.12		6.13
In force	diff,	1	-7.43		6.70	-60.8	***	12.4	0.63		10.39
patents	log	2	12.87		12.33	61.2	***	19.3	16.86		15.75
		3	-11.94		13.42	1.42		18.7	-20.10		14.57
		4	17.25		11.28	16.9		23.6	-1.84		12.89
		5	-31.42	***	10.80	-68.4	***	17.2	-16.66		12.28
		6	42.04	***	11.33	50.4	**	21.2	44.92	***	13.30
		7	-25.92	***	6.78	-23.4	*	12.0	-27.92	**	9.73
Inflation (CPI)		1	-0.06		0.07	-0.25	*	0.14	0.33		0.20
		2	0.02		0.14	0.33		0.21	-0.63		0.49
		3	0.16		0.16	-0.07		0.22	0.21		0.55
		4	-0.18		0.14	-0.33		0.22	-0.25		0.52
		5	0.27	*	0.14	0.07		0.21	0.95	**	0.44
		6	-0.21		0.14	0.59	***	0.18	-0.90	*	0.47
		7	-0.07		0.09	-0.48	***	0.11	0.32		0.27
NASDAQ	diff,	1	0.20		0.27	-1.05	*	0.54	-0.32		0.46
	log	2	-0.42		0.38	-0.50		0.62	0.32		0.54
		3	-0.19		0.38	-1.37		0.78	-1.06	*	0.52
		4	0.01		0.38	-0.70		0.54	1.03	*	0.55
		5	0.66	*	0.40	1.17		0.66	-0.43		0.69
		6	-1.06	***	0.39	-2.01	**	0.76	0.20		0.71
		7	0.55	**	0.26	0.52		0.61	0.31		0.58
TED spread	diff	1							-0.12		0.18
		2							0.03		0.16
		3							0.28		0.19
		4							0.25		0.16
		5							0.07		0.18
		6							-0.15		0.13
		7							-0.05		0.17
constant			0.12	***	0.04	0.25		0.17	-0.10		0.28
Observations			148			76			88		
AIC			-46.1			-61.5			-61.7		
BIC			-34.4			-43.8			-41.7		

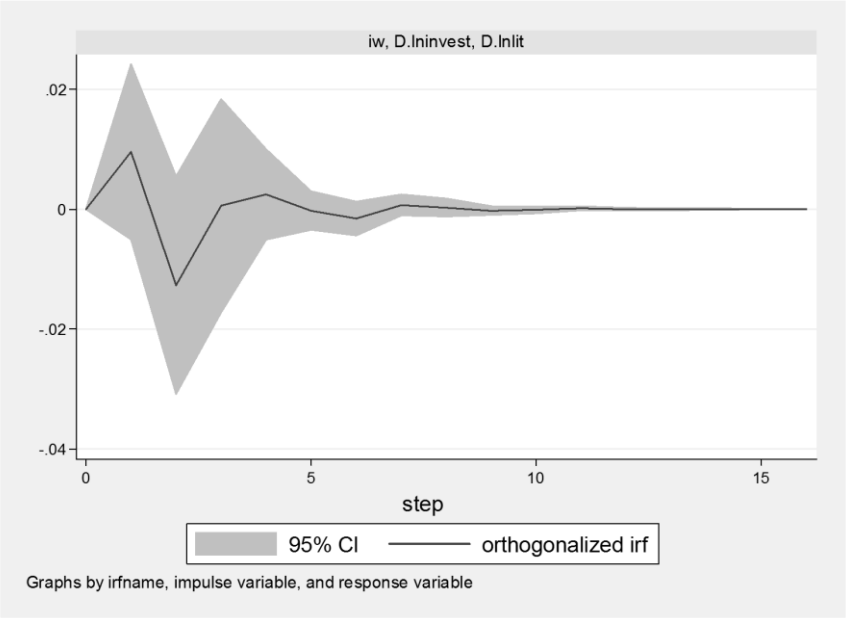
NOTE: All variables are quarterly values. 156 quarters from 1971 through 2009. *Stata* "small" option used to increase standard errors ("*S.E.*") to account for number of observations.
*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

APPENDIX I: EFFECTS OF SHOCKS ON PATENT LITIGATION

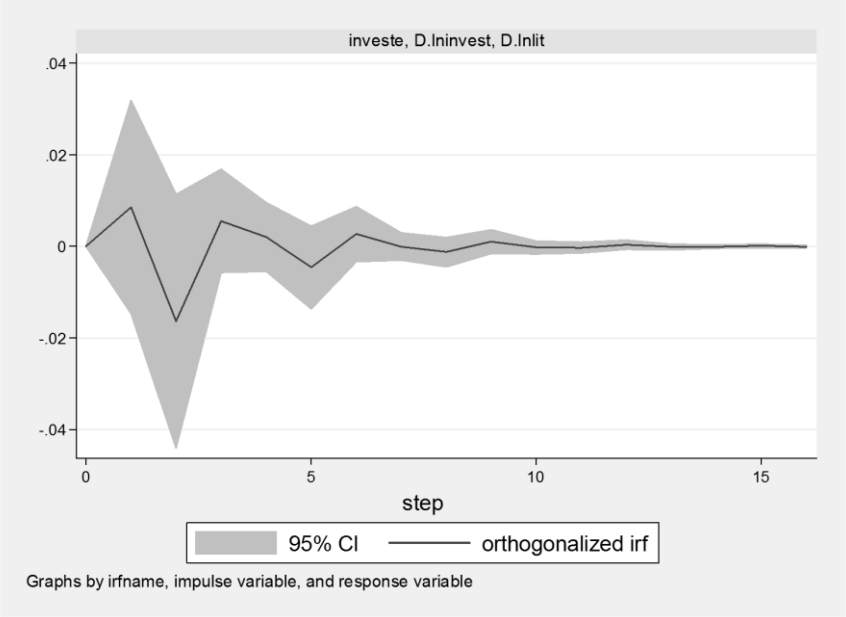
Figures I-1 through I-9 report orthogonalized impulse response functions generated from the VAR regressions in Table 2.

Figure I-1: Effect of investment shock on patent litigation for Table 2 VAR specifications

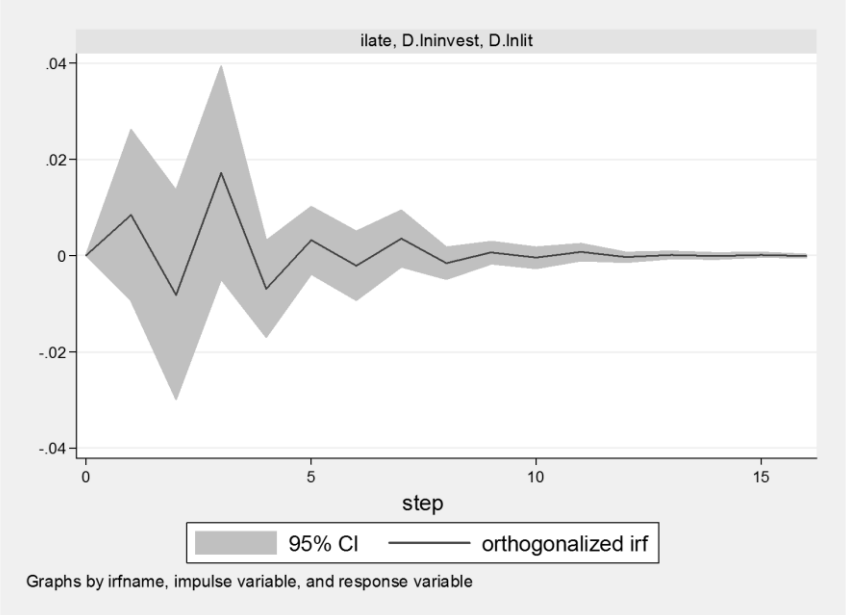
(a) 1971-2009



(b) 1971-1991



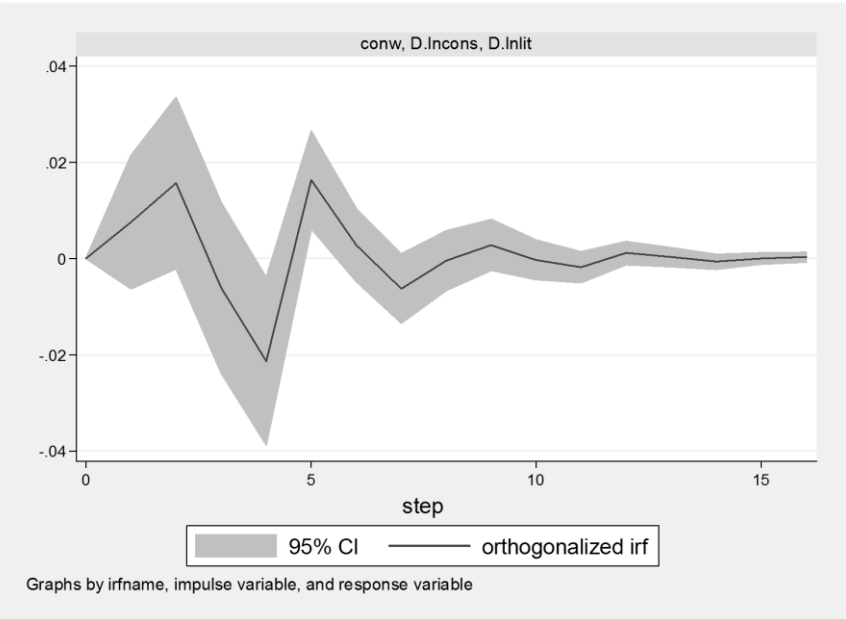
(c) 1986-2009



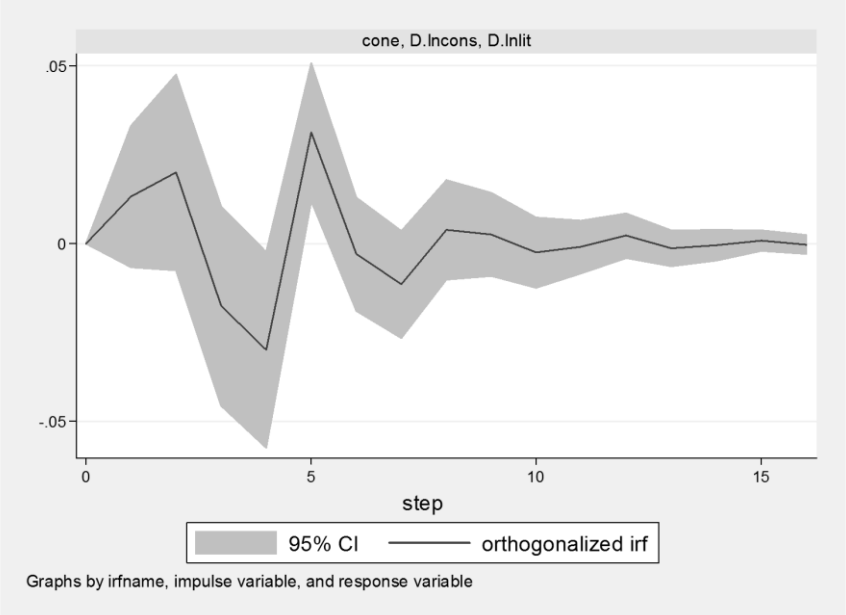
NOTE: Solid lines represent the impulse response of patent litigation in a given quarter (horizontal axis) to a one standard deviation shock to the log of real investment in Quarter 0. Vertical axis measures the percent change in litigation in a quarter given that impulse. Ninety-five percent confidence intervals in gray.

Figure I-2: Effect of consumption shock on patent litigation for Table 2 VAR specifications

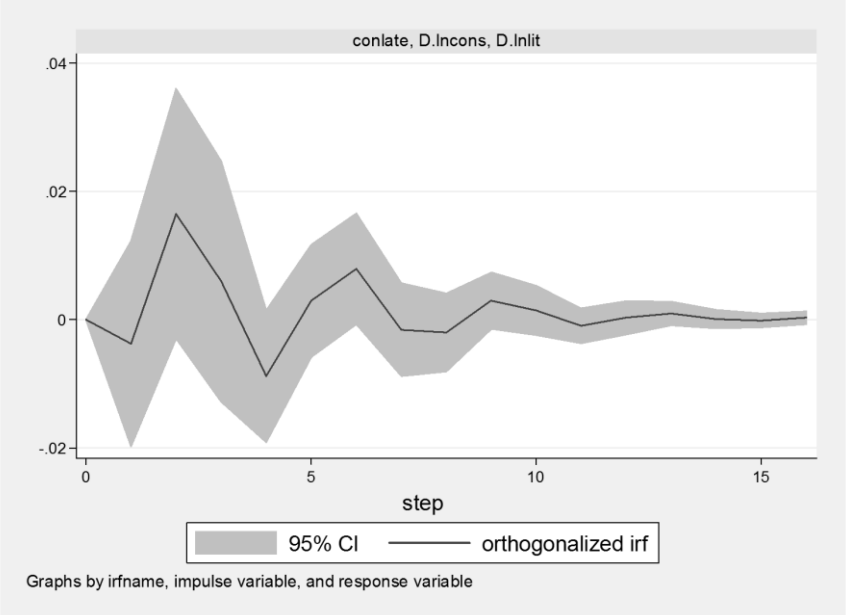
(a) 1971-2009



(b) 1971-1991



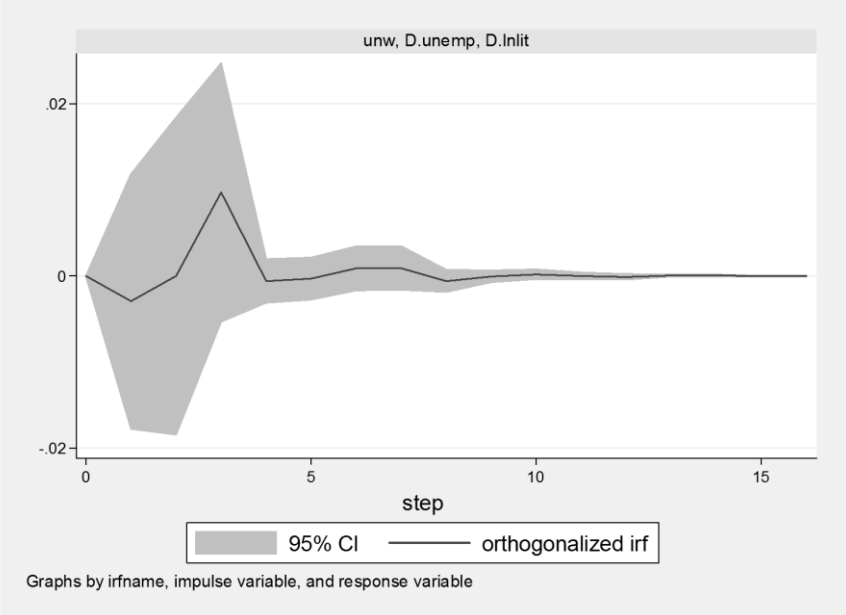
(c) 1986-2009



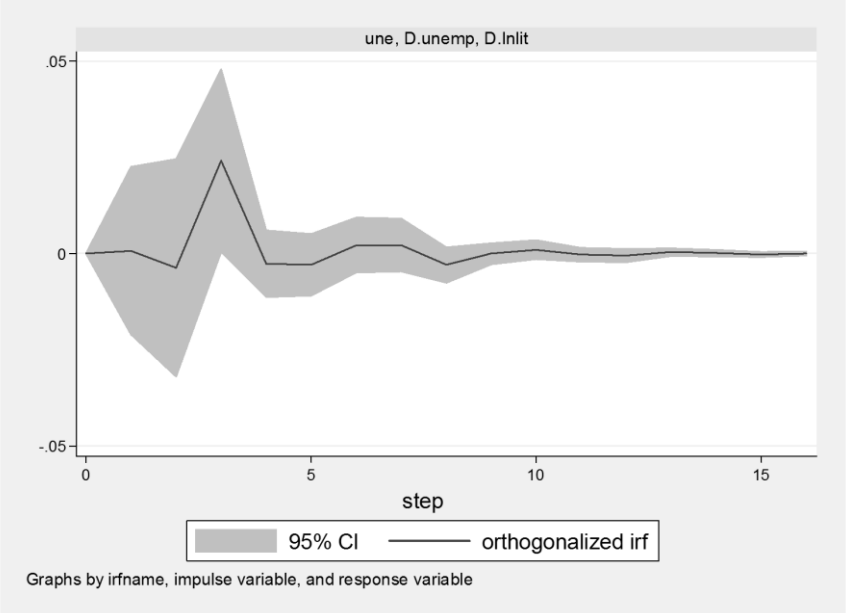
NOTE: Solid lines represent the impulse response of patent litigation in a given quarter (horizontal axis) to a one standard deviation shock to the log of real consumption in Quarter 0. Vertical axis measures percent change in litigation in a quarter given that impulse. Ninety-five percent confidence intervals in gray.

Figure I-3: Effect of unemployment shock on patent litigation for Table 2 VAR specifications

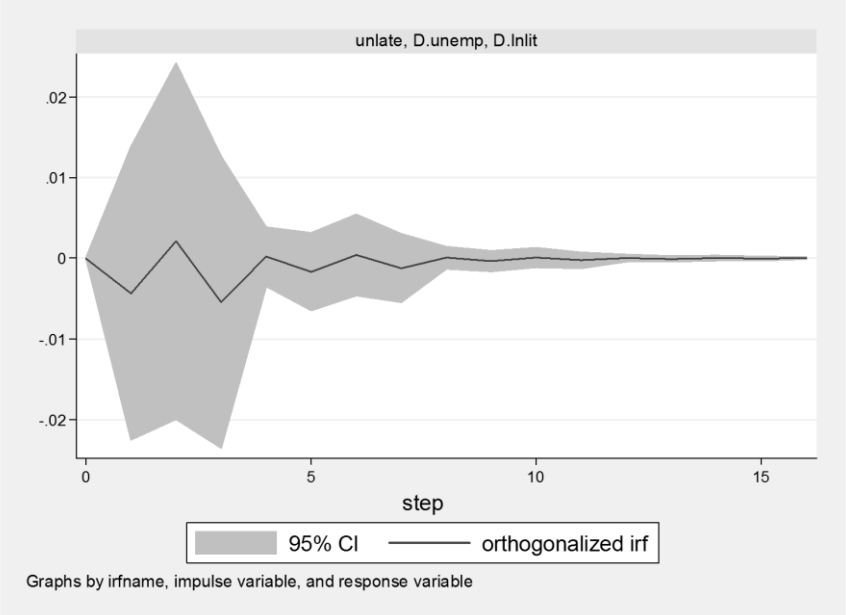
(a) 1971-2009



(b) 1971-1991



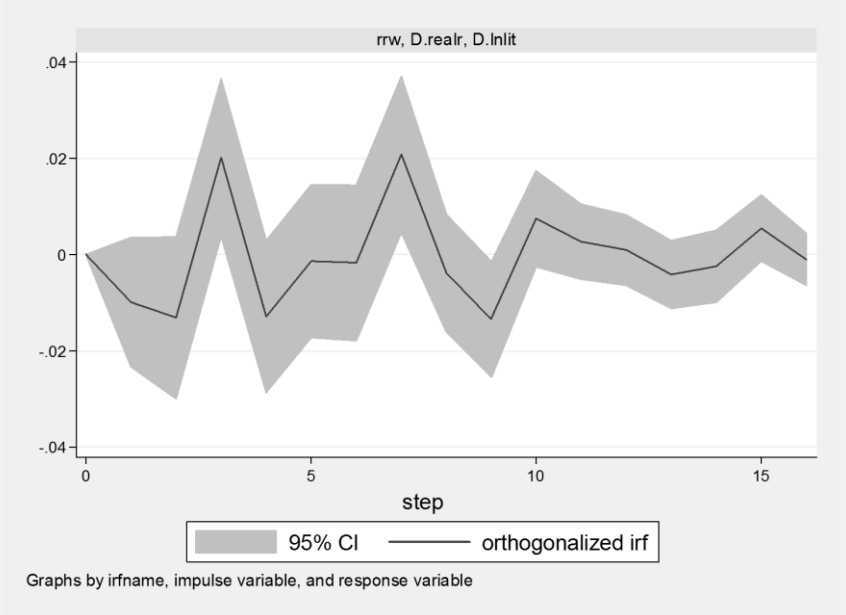
(c) 1986-2009



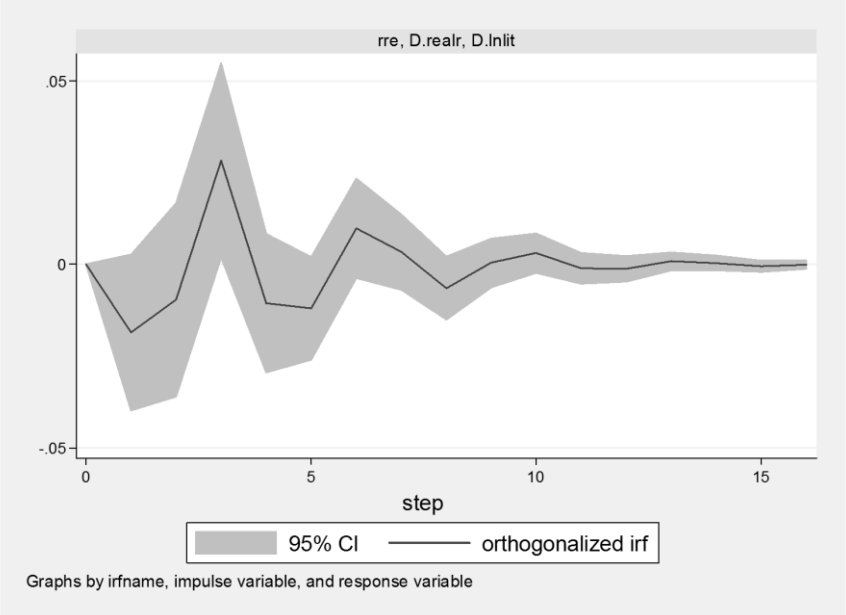
NOTE: Solid lines represent the impulse response of patent litigation in a given quarter (horizontal axis) to a one standard deviation shock to unemployment in Quarter 0. Vertical axis measures the percent change in litigation in a quarter given that impulse. Ninety-five percent confidence intervals in gray.

Figure I-4: Effect of real interest shock on patent litigation for Table 2 VAR specifications

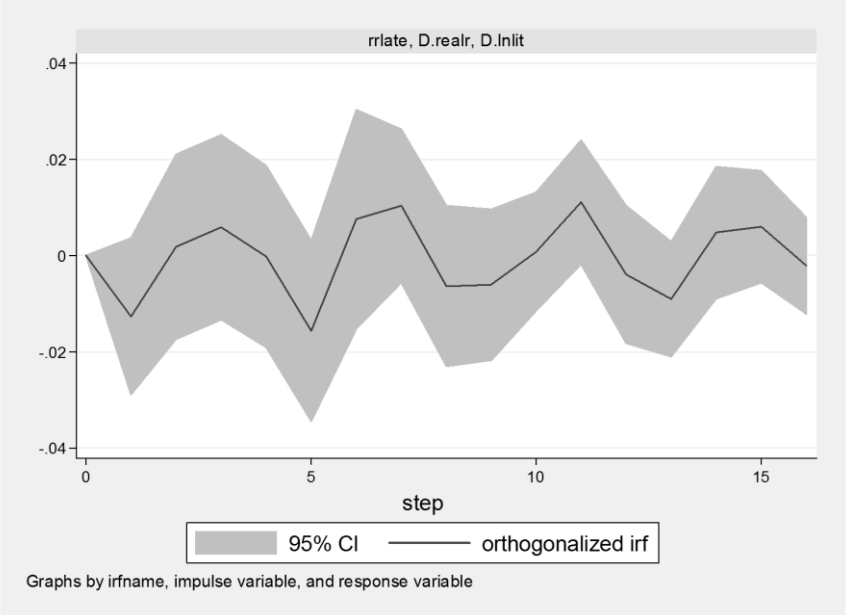
(a) 1971-2009



(b) 1971-1991



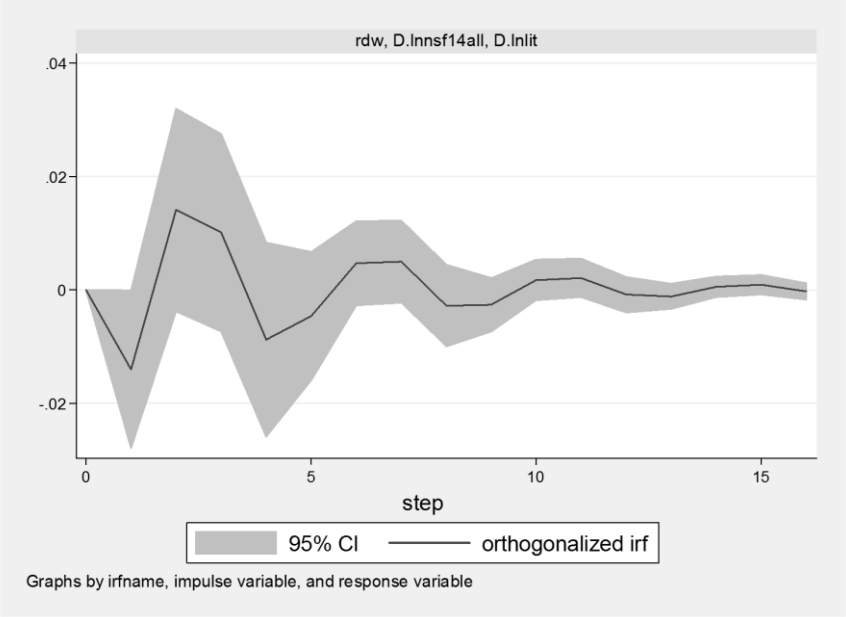
(c) 1986-2009



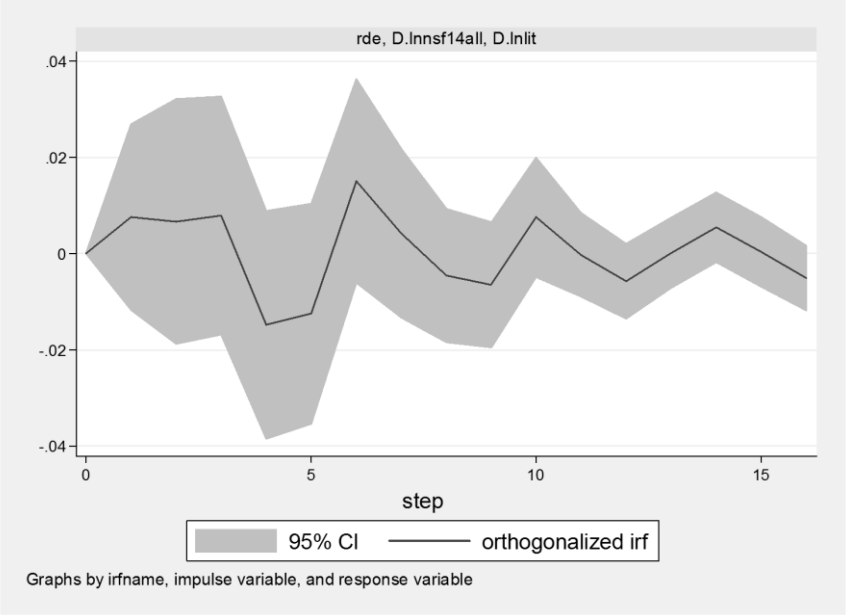
NOTE: Solid lines represent the impulse response of patent litigation in a given quarter (horizontal axis) to a one standard deviation shock to the real interest rate in Quarter 0. Vertical axis measures the percent change in litigation in a quarter given that impulse. Ninety-five percent confidence intervals in gray.

Figure I-5: Effect of R&D shock on patent litigation for Table 2 VAR specifications

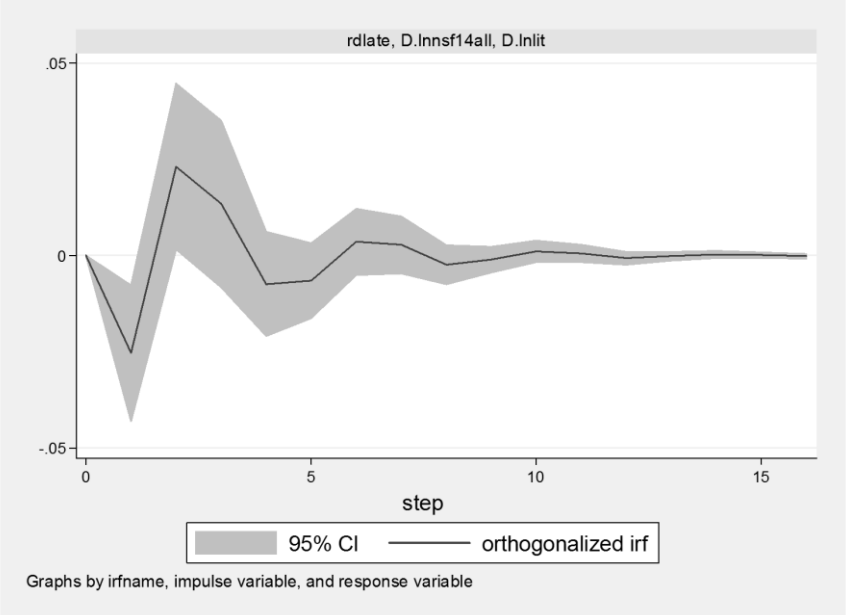
(a) 1971-2009



(b) 1971-1991



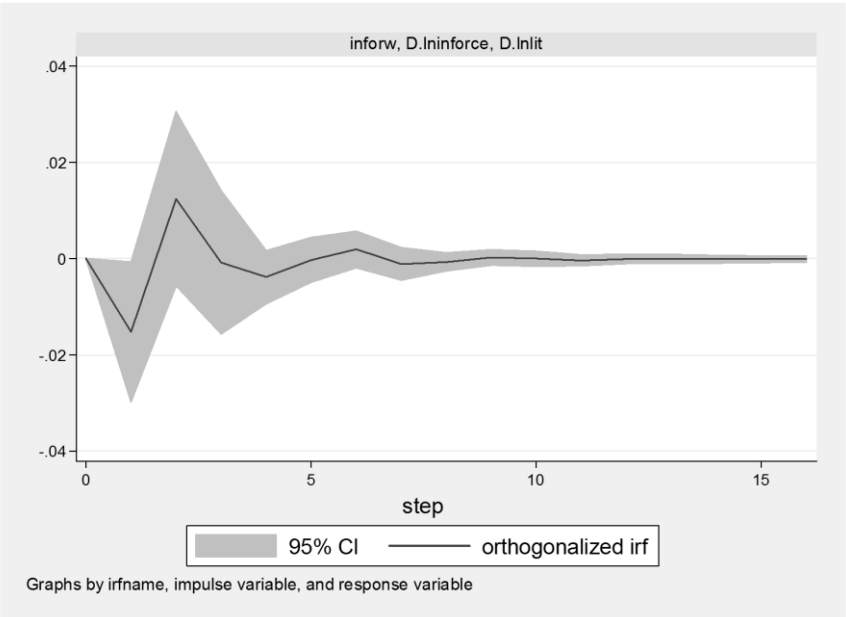
(c) 1986-2009



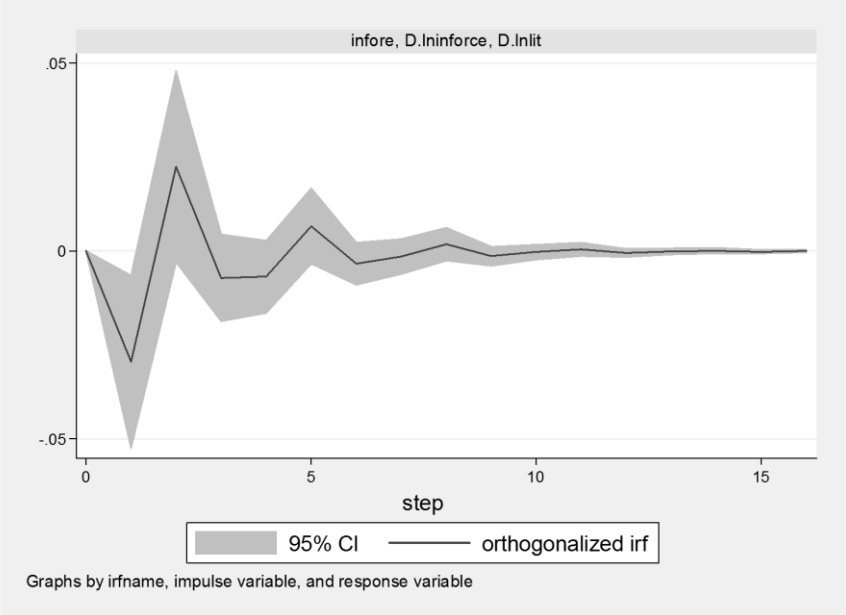
NOTE: Solid lines represent the impulse response of patent litigation in a given quarter (horizontal axis) to a one standard deviation shock to the log of real R&D in Quarter 0. Vertical axis measures the percent change in litigation in a quarter given that impulse. Ninety-five percent confidence intervals in gray.

Figure I-6: Effect of in force patent shock on patent litigation for Table 2 VAR specifications

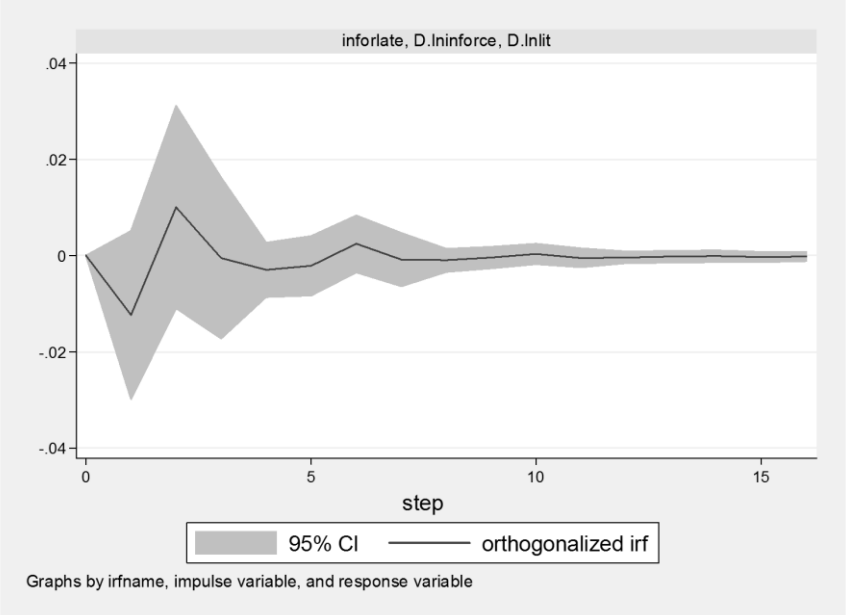
(a) 1971-2009



(b) 1971-1991



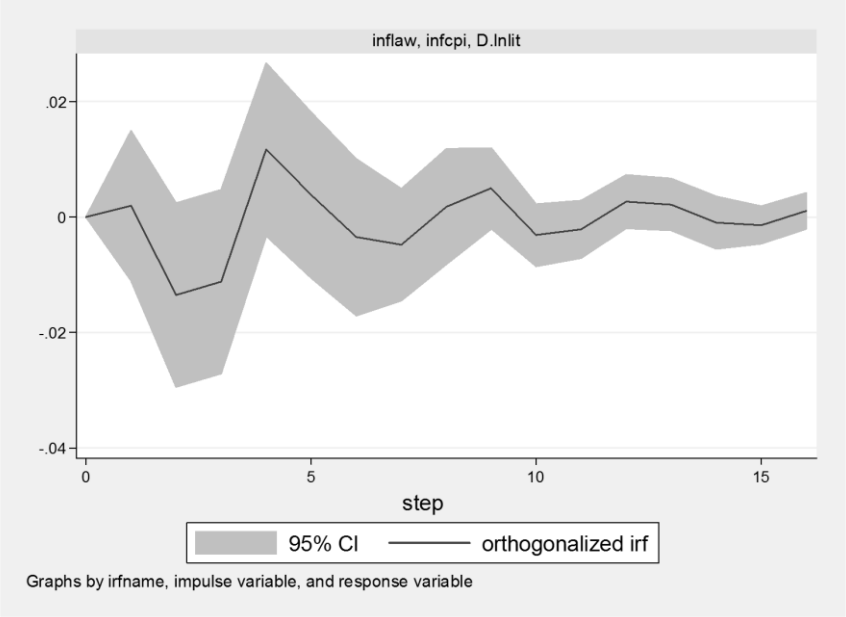
(c) 1986-2009



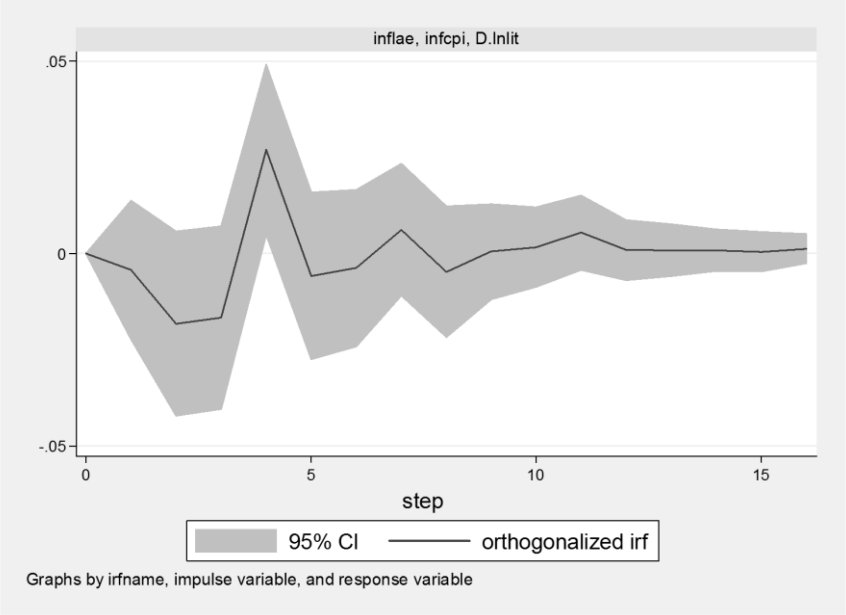
NOTE: Solid lines represent the impulse response of patent litigation in a given quarter (horizontal axis) to a one standard deviation shock to the log of total in force patents in Quarter 0. Vertical axis measures the percent change in litigation in a quarter given that impulse. Ninety-five percent confidence intervals in gray.

Figure I-7: Effect of inflation shock on patent litigation for Table 2 VAR specifications

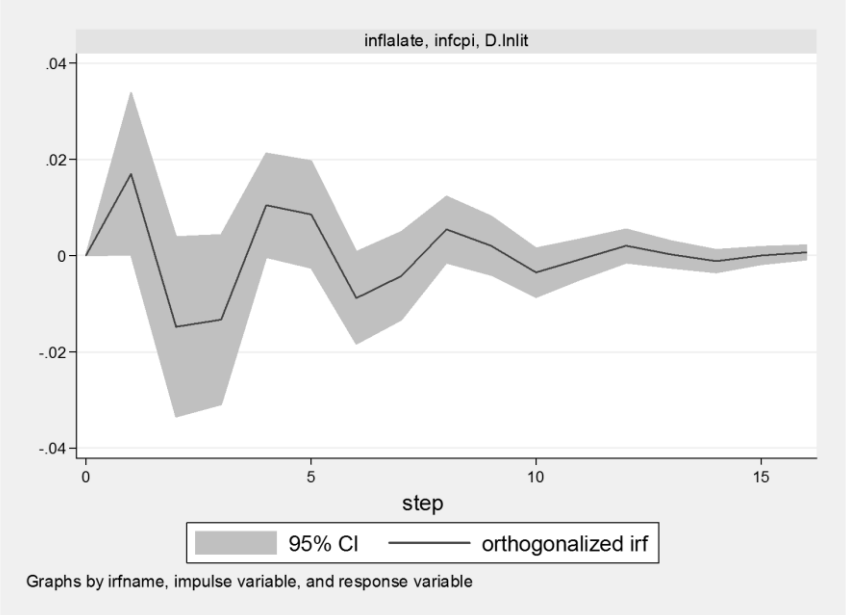
(a) 1971-2009



(b) 1971-1991



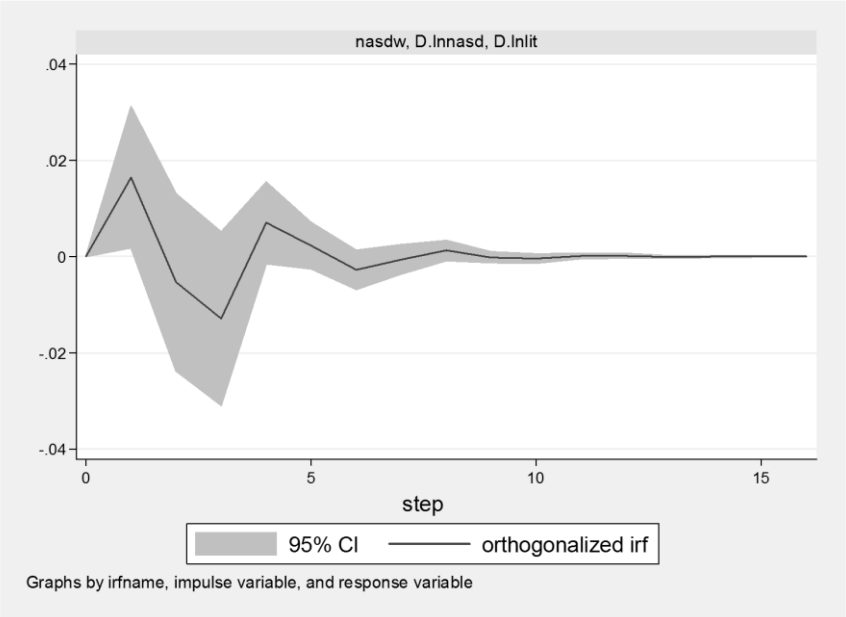
(c) 1986-2009



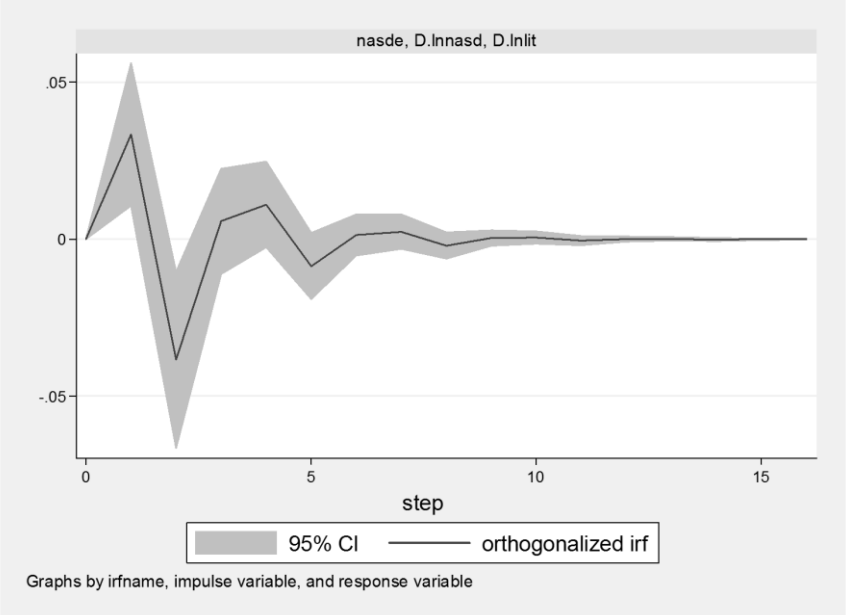
NOTE: Solid lines represent the impulse response of patent litigation in a given quarter (horizontal axis) to a one standard deviation shock to inflation in Quarter 0. Vertical axis measures the percent change in litigation in a quarter given that impulse. Ninety-five percent confidence intervals in gray.

Figure I-8: Effect of NASDAQ shock on patent litigation for Table 2 VAR specifications

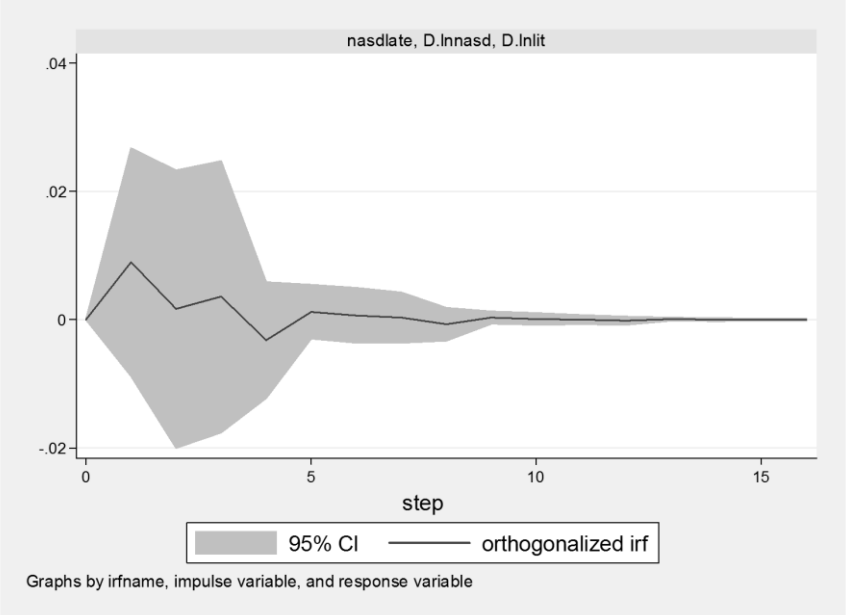
(a) 1971-2009



(b) 1971-1991

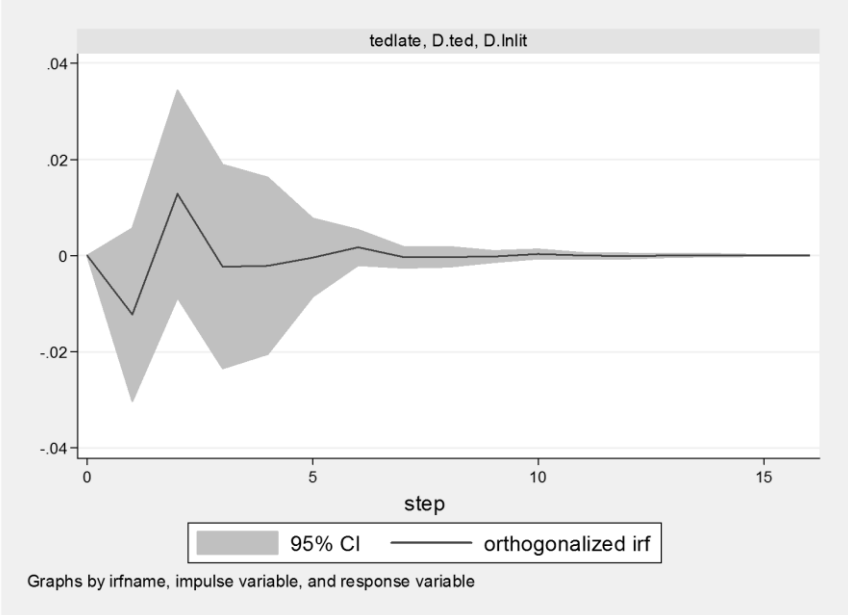


(c) 1986-2009



NOTE: Solid lines represent the impulse response of patent litigation in a given quarter (horizontal axis) to a one standard deviation shock to the log of NASDAQ in Quarter 0. Vertical axis measures the percent change in litigation in a quarter given that impulse. Ninety-five percent confidence intervals in gray.

Figure I-9: Effect of TED spread shock on patent litigation for Table 2 VAR, 1986-2009



NOTE: Solid line represents the impulse response of patent litigation in a given quarter (horizontal axis) to a one standard deviation shock to the TED spread in Quarter 0. Vertical axis measures the percent change in litigation in a quarter given that impulse. Ninety-Five percent confidence intervals in gray.

APPENDIX J: FOURTEEN-PERIOD BIVARIATE REGRESSIONS

Table J includes the results of bivariate VAR regressions of patent litigation on one of the independent variables analyzed and listed in the table. Each data point in these regressions is the value of the variable over one of 14 alternative periods of economic expansion or contraction that occurred from 1970-2009. The seven contractionary periods are: (1) 1970Q1-1970Q4; (2) 1973Q4-1975Q1; (3) 1980Q1-1980Q3; (4) 1981Q3-1982Q4; (5) 1990Q3-1991Q1; (6) 2001Q1-2001Q4; and (7) 2007Q4-2009Q2.

Because LIBOR was only available after 1986, we constructed an alternative measure of financial risk that we term "TED Prime"—the difference between the U.S. prime rate and the 3-month T-bill rate, rather than the LIBOR and the 3-month T-bill rate as in the standard TED spread. Because fewer data points are available, the optimal number of lags for the bivariate VAR with TED is one. Three lags are optimal for all other variables, including TED Prime.

Table J: Bivariate VAR of Patent Litigation Over 14 Macroeconomic Periods

Variable		*Lag*	*Coef.*		*S.E.*
Real GDP	diff,	1	-1.62	***	0.50
	log	2	2.40	***	0.57
		3	-2.86	***	0.45
Investment	diff,	1	-0.25		0.67
	log	2	0.22		1.12
		3	-1.36	*	0.77
Consumption	diff,	1	-2.65	***	0.51
	log	2	2.46	***	0.52
		3	-2.88	***	0.45
Unemployment	diff	1	-0.03		0.04
		2	-0.13	***	0.04
		3	0.00		0.06
Real	diff	1	0.02		0.04
interest rate		2	-0.03		0.03
		3	0.02		0.03
T-bill	diff	1	0.00		0.03
		2	-0.02		0.03
		3	-0.00		0.03
R and D	diff,	1	0.33		0.53
	log	2	2.56	***	0.56
		3	1.71	***	0.65
In force	diff,	1	-2.05	***	0.77
patents	log	2	-1.73	**	1.01
		3	0.11		0.60
Patent grants	diff,	1	0.07		0.83
	log	2	0.23		0.68
		3	-0.89		0.57
Inflation (CPI)		1	-0.05		0.10
		2	0.09		0.15
		3	0.06		0.08
NASDAQ	diff,	1	0.05		0.28

	log	2	-0.02		0.23
		3	0.03		0.22
TED prime	diff	1	0.04		0.04
		2	-0.12	***	0.04
		3	0.02		0.06
TED	diff	1	-0.27	**	0.14

NOTE: All variables equal to their values over one of 14 economic expansions or contractions during the years 1970-2009. *Stata* "small" option used to increase standard errors ("*S.E.*") to account for number of observations. Constants for each bivariate VAR omitted.
*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.