Abstract:
We provide the first evidence that firms—not just voters—are gerrymandered by demonstrating that firms are overallocated to the mapmakers’ party when partisans control the redistricting process. We do so by comparing allocations of firms in legislatively approved redistricting plans to allocations of firms in a representative set of thousands of alternative redistricting plans which we construct using simulation methods. In addition to broadening our understanding of partisan gerrymandering, these findings raise important questions about the relationship between business and politicians, revealing heretofore unrecognized sources of structural alignments between firms and those holding power.

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1. INTRODUCTION

As single-minded reelection seekers (Mayhew 1974), legislators have long sought to draw the borders of their districts to include voters most favorable to them (Cox & Katx 2002), a practice popularly known as gerrymandering. Over the decades, the technology for gerrymandering has become increasingly advanced (Berghel 2016; Fifield 2020a), and while the threat of judicial scrutiny has historically constrained how far legislators can go in gerrymandering their voters in the pursuit of re-election, legislators have many additional tools in their arsenal. While there is substantial evidence that legislators capture their preferred voters, we are the first to document that they also capture firms. Leveraging cutting-edge simulation methods bolstered by interviews with legislators, staffers, redistrictors, consultants, and lobbyists, we find a clear pattern of firm gerrymandering: legislative mapmakers disproportionately allocate firms to their co-partisans, while bipartisan and independent commissions distribute firms more proportionately. Hence, this research contributes to the nascent study of the role mapmakers play in endogenously shaping economic, and political economic, outcomes (Nagaraj & Stern 2020).

This pattern of reallocating firms from minority party districts to majority party districts reshapes the relationship between firms, legislators, and the national political parties. Firms support their representatives’ re-election efforts in a number of ways: they provide campaign financing via political action committees (Stratmann 1996; Stratmann 2005), executives’ (Gordon et al. 2007; Fremeth et al. 2013; Fremeth et al. 2016; Richter & Werner 2017), and employees’ contributions (Ovtchinnikov & Pantaleoni 2012; Stukatz 2021); they provide a path to power via committee assignments (Jenkins 2021); they provide an easy way to connect to and mobilize voters (Hertel-Fernandez 2018); they provide public goods in their districts (Card et al. 2010; Bertrand et al. 2020); and, they provide legislative subsidies to enable more policymaking (Hall & Deardorff 2006; Ellis & Groll 2020). In turn, firms develop long-term relationships with elected representatives and expand their influence over policy outcomes. Legislators fight to keep firms in their districts and capture other firms from the opposing party, reaping the electoral benefits and clout. The end result is a systematic alignment between major firms and the statewide majority party, whoever it may be, potentially diluting the political power of voters, distorting Congressional representation, and limiting either national party’s willingness to buck corporate influence.

In this paper, we bring to bear a suite of quantitative computational evidence, motivated and supported by qualitative interviews, on the topic of firm gerrymandering. Through our interviews we find that legislators consciously strive to capture important physical capital for their districts, for motivations both electoral and otherwise. One former member of Congress heavily involved in redistricting tells us:
"Legislators at the federal, state and local level subject to redistricting are first and foremost concerned about the impact of new district boundaries on their ability to get re-elected. However many also fight hard to keep or have included in their new boundaries structures which have no voters. Examples are major corporate headquarters, sports arenas, airports, historical landmarks."

With this motivation in mind, we leverage recently developed simulation methods to show that firm gerrymandering is widespread, and though we find that different states implement firm gerrymandering in different ways, the patterns we discover are clear. In states with partisan control of redistricting, districts controlled by the majority party include a far disproportionate number of firms compared to a simulated counterfactual. This pattern is especially clear among safe seats, which fits the expectation that legislators seek to build relationships with firms over the course of their career. Most surprisingly of all, we find strong evidence for firm gerrymandering even in states where there is only weak evidence of partisan seat gerrymandering, indicating that legislators may prefer to strengthen their own positions even at the expense of their delegation.

We root our quantitative inferences in outlier analysis (Ramachandran & Gold 2018), a well-established method for discovering gerrymanders. The approach, applied to simulated counterfactuals, has been adopted by courts across the US to evidence racial and partisan gerrymandering (Chen & Rodden 2015). Courts explicitly use the “extreme outlier approach” (Rucho v. Common Cause) employing “computers [that] can use census data” to “generate a hundred or a thousand different maps” (Gonzalez v. City of Aurora) to demonstrate that an “adopted map is a statistical outlier in contrast with other maps drawn utilizing traditional districting criteria” (League of Women Voters v. Pennsylvania 2017). Whereas most outlier analysis in the US focuses on showing that a state’s legislatively-approved enacted plan is a statistical outlier either due to minority underrepresentation or a partisan skew, we extend this method to study the allocation of firms.

Mapmakers could over-allocate firms to their party (a) unintentionally as a byproduct of intentional seat gerrymandering, (b) intentionally in conjunction with intentional seat gerrymandering, or (c) intentionally in instances where seats are allocated neutrally and therefore not gerrymandered. ¹ As empiricists, we care whether or not there are instances in which firms are explicitly targeted by mapmakers, consistent with intentional firm gerrymandering. We present unambiguous evidence our firm gerrymandering results do not simply arise as an unintentional byproduct of seat gerrymandering. Specifically, firms are overallocated to the mapmakers’ party in at least two ways consistent with being explicit targets. First, we provide evidence that, in some instances (e.g. Pennsylvania), firms are overallocated to the mapmakers party conditional on a seat gerrymander. Second, we provide evidence that, in some instances

¹ Cases (a) and (b) might at first seem to be observationally equivalent, but the two can be separated in some instances (by looking at conditional distribution of firm allocations fixing seats). Case (c) is distinct.
(e.g. Texas), firms are gerrymandered while seats are not. Regardless of whether the over-allocation of firms to the mapmakers’ party is intentional, it may, nonetheless, distort the functioning of democratic institutions by aligning firms with power.

The rest of this paper proceeds as follows. Section 2 explains why we expect legislators to gerrymander firms, in addition to voters, drawing on existing literature about the value of firms to politicians, bolstered by insights from qualitative interviews. Section 3 introduces workable definitions of firm (and seat) gerrymandering in a stylized numerical example where we can pinpoint outliers given the full spectrum of choices available to mapmakers. Section 4 explains how simulation methods allow us to extend the approach in application to real world data. Section 5 presents our quantitative evidence that firm gerrymandering exists in practice, exploring different ways it manifests itself in detailed case studies. Section 6 discusses the implications for policy, practice, and research. Section 7 concludes.

2. DRAWING MAPS AROUND NOT ONLY VOTERS, BUT ALSO FIRMS

Why should parties, or politicians, care about whether their districts contain firms? Given the chance to redistrict, politicians gerrymander voters as a means of tilting the deck in their favor. Yet, gerrymandering voters alone may not be enough to secure re-election, so politicians still must still advertise, credit-claim and position-take to court those voters (Mayhew 1974). Firms, and the relationships they forge with their elected representatives, may help politicians do so. In other words, while voters may be an obvious object of desire for gerrymandering, having more large firms in a politicians’ district also improves re-election prospects, even though firms themselves cannot vote.

We build our theoretical discussion in three steps. First, we review why politicians want to gerrymander voters. Then we explore why having firms in their districts is valuable for politicians, giving them an incentive to gerrymander firms. Then, in the next section, through a stylized numerical example, we examine how mapmakers might think about firm gerrymandering in practice and how it relates to seat gerrymandering.

2.1. Why Politicians Want to Gerrymander Voters

While there is no unified theory of gerrymandering, there is broad agreement that it helps politicians select a favorable set of voters, improving politicians' election prospects and reducing their fundraising needs. In most states, partisan legislatures draw the lines, using the process to improve their electoral fortunes. Parties’ incentives are often at odds with individual politicians: party leaders might want more seats in their delegation, while individual legislators also want to insure their personal chances of re-election. These dynamics have led to a number of common redistricting strategies across states (Friedman & Holden 2008; Gul & Pesendorfer 2010).
Two common methods for partisan gerrymandering of districts in states where one party controls the process are packing and cracking.² These were pioneered in the Jim Crow South to limit the influence of newly-enfranchised African-American voters. In packing, out-voters are placed into districts easily won by their preferred candidates, giving the remaining districts to the mapmakers’ party. In cracking, pockets of out-voters are split up and diluted, preventing them from achieving a majority anywhere. Recent theoretical advances consider the conditions under which the techniques are optimal. (Friedman & Holden 2008)

In essence, while any given state’s redistricting outcomes may be idiosyncratic, partisan control over district boundaries is a tool politicians use to craft electoral advantages. And while historically, legislators had to gerrymander maps by hand, recent advances in redistricting technology (Berghel 2016; Fifield 2020a) have opened up many opportunities for legislators seeking to advance their position, far outpacing the judiciary’s ability or willingness to regulate gerrymandering.

2.2. Why Politicians Want to Gerrymander Firms

Even if partisan mapmakers select a favorable allocation of voters, that alone does not guarantee election outcomes, and if firms can aid their representative’s reelection chances, legislators may seek to include them in their districts. This might occur directly through campaign donations or voter mobilization, or indirectly through increased visibility and by providing politicians a platform to credit-claim. But firms might be valuable for a number of other reasons as well, including obtaining valuable committee assignments or developing a reputation for expertise in domains relevant to those firms, both of which elevate a politician’s rank within their own party.

2.2.1. Electoral Benefits

First, and foremost, firms assist with campaign fundraising. Ricco Garcia,³ a Democratic political operative with extensive experience on redistricting in Texas, argued that “Politicians are interested in the companies [being assigned to their district or party] for fundraising.” This claim is supported by a large amount of academic literature on corporations as a source of campaign finance, particularly to politicians representing districts where firms are located. There is a large set of research showing that corporate-linked PACs, employees, and executives give more money, more often to politicians located in their home districts. E.g. Ovtchinnikov and

² In more gridlocked states, legislators may adopt bi-partisan gerrymanders in which Republican legislators trade their Democratic precincts to Democratic legislators in neighboring districts in exchange for their Republican voters, improving everyone’s election chances but preventing future gains on either side. One famous bipartisan gerrymander occurred in California in 2000; after a decade of impressive legislative gains following many years of partisan swings, California Democrats decided to entrench their incumbents with a bi-partisan gerrymander rather than risk a swing back in the Republican direction.

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Pantaleoni (2012) find that individual constituents are more likely to make campaign contributions to politicians when they represent Congressional districts with a greater clustering of firms in a single industry, particularly when those politicians serve on economically relevant Congressional committees.

Hence, the more firms a politician has in her district, the more she is likely to be able to fundraise effectively. More money can help win tight re-election races, can be built into a “war chest” to stave off potential challengers, can be re-allocated to more marginal legislators to help build a politician’s support within their own party, or can be transferred as “party dues” in exchange for advantageous Congressional committee assignments (Jenkins 2021).

In addition to being a source of money that politicians can use to advertise themselves, firms are visible actors in local economies, giving politicians opportunities to attend events such as ribbon-cuttings. This can provide further opportunities for politicians to advertise in a low cost way, via photo opportunities constituents will see. Moreover, attending these events firms host can help politicians connect with voters in their constituencies who may be employees of these firms or otherwise aligned with business interests (e.g. Fenno 1977). Site visits from government officials also boost firms’ market valuations so have an effect in the marketplace. (Schuler et al. 2017) In the event that a politician created a policy environment that was favorable to the firm’s economic empowerment in their district, it would also enable politicians to claim credit. Hence, firms’ public events in home districts provide opportunities for politicians both to advertise themselves and to credit-claim for their activities in the district.

Of course firms can also influence voters more directly to help politicians beyond doing so indirectly via events. Bertrand et al. (2018) and Bondardi & Urbiztondo (2013) show that some firms use the timing of employment decisions, i.e. hiring and firing, to help re-election efforts of local incumbent politicians, even when they receive nothing in return from those politicians. Moreover, Hertel-Fernandez (2018) shows how large firms are particularly apt at mobilizing employees to turn out to vote for particular candidates.

### 2.2.2. Power and Prestige

Firms can also help politicians elevate their position within their party, an important criterion for advancing to positions like Majority Leader or for moving to higher office.

For example, politicians often receive committee appointments related to the sectors of the firms in their districts. Ricco Garcia notes that “one of the reasons firms are drawn into

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3 The interview with Ricco Garcia occurred on August 13, 2021. He was general counsel/legislative director in 2017 for a member of the Texas House of Representatives Redistricting Committee; he was general counsel/legislative director in 2019 for a member of the Texas Senate Special Committee on Redistricting; and, in 2021 he was Deputy Chief of Staff for a member of the Texas delegation to the US House of Representatives who faced a potential redistricting threat.
districts is to [help politicians] get on prestige committees,” advancing their positions within the party. This builds a symbiosis between firms and politicians: firm support helps politicians advance in seniority on relevant committees, which in turn improves the value of those firms’ privileged access to their representatives. Weingast and Marshall (1998) argue that “service to local interests attracts both votes and organized resources for the district's representative. Service to this group by an outsider, in contrast, attracts only the latter and may lose votes” (emphasis ours). Serving on prestige committees also helps politicians attract more campaign contributions from firms inside and outside of their districts (Grier & Munger 1991).

Finally, home district businesses are a source of information for politicians that improve position-taking in policymaking; politicians may trust information from firms in their districts because it comes from their constituency and is more closely linked to re-election prospects (Fenno 1977). Information from firms outside of a politician’s district, even if it is accurate, is less tied to home district constituency welfare and to that constituency’s evaluations of their representative’s performance. Congressional staffers affiliated with both parties believe that local businesses can be one of the most valuable sources of information on what is happening in their districts (Hertel-Fernandez, Mildenberger, & Stokes 2019), consistent with Hall and Deardorff’s (2006) legislative subsidy model which suggests that time-constrained politicians may rely on interest groups, including firms in their districts, as “service bureaus” to supplement their legislative staff through information gather that enables them to sponsor more legislation and engage in more credit claiming.

3. A SIMPLIFIED ILLUSTRATION OF FIRM AND SEAT GERRYMANDERING

Since firms have value to politicians, we expect partisan mapmakers to consider them in their redistricting plans. As with seat gerrymandering, there are many ways firm gerrymandering could happen in practice, but in general when maps are drawn by partisan redistricting bodies, we expect that firms will be disproportionately allocated to districts the majority party controls.

In this section we explore three core ideas: i) what firm gerrymandering might look like, ii) how it is different from seat gerrymandering, and iii) how both firm and seat gerrymandering might interact. We begin with a stylized example to build intuition and set up our simulation approach. Figure 1A presents a map for New Gerryland, a hypothetical state with 20 equal sized

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4 We don’t know exactly what strategies are used in firm gerrymandering nor does it matter for our conceptual introduction or empirical results. It is certainly possible that seat and firm gerrymandering move together; this may even be at times a mechanical relationship. Yet, there is no reason that we should expect that strategies used to gerrymander firms are the same as the strategies used to gerrymander seats (i.e. drawing non-compact districts, “packing” some districts, and cracking other districts). There may even be trade-offs in seat gerrymandering and firm gerrymandering in practice, given tensions between the goals of each. In seat gerrymandering, the goal is to waste the out-party’s votes by crossing a threshold of own-party voters. (Stephanopoulos & McGhee 2015) In firm gerrymandering, the goal is to maximize firms allocated to your own party, given each firm has value. There may be exceptions where particular firms or clusters of firms are toxic in general or toxic to the majority party in the district (McDonnell & Werner 2016). Regardless of the exact strategies used to draw individual gerrymandered districts, we can still evaluate whether or not there was firm gerrymandering occurred (either in conjunction with or separately from seat gerrymandering) in aggregate in state-wide redistricting plans.
and equally-populated voting precincts to be allocated by a mapmaker into 5 electoral districts. Each precinct has a share of Democratic voters (Panel A) and a number of firms (Panel B). The top-left precinct (A1) has a 50% vote share for Democrats and 4 firms; the top-right precinct (A5) has a 25% vote share for Democrats and 5 firms.

Overall, 40% of voters in New Gerryland are Democrats and there are 100 firms. In a completely proportional allocation, we would expect 2 Democratic and 3 Republican districts, with 40 firms in Democratic districts and 60 firms in Republican districts.\(^5\)

New Gerryland contains 5 districts of 4 precincts each, whose vote shares and firms are summed to produce a district value.\(^6\) For example, we could draw a square district around the 4 districts closest to the top-left corner of the map (Precincts A1, A2, B1, and B2). Doing so yields a voting district with a vote share of \((50\% + 40\% + 85\% + 95\%) / 4 = 67.5\%\) and a \((4 + 5 + 5 + 6 =) 20\) firm count, a safe Democrat majority district with a count of firms equal to the state-wide average. Of course, to fill out the rest of the redistricting plan, a mapmaker must create 4 more, non-overlapping districts using the remaining unclaimed precincts. The Appendix contains the full set of all 100 feasible redistricting plans for this hypothetical state.

### 3.1. A State-wide Proportional Redistricting Plan

First, let’s consider a mapmaker seeking to allocate both seats and firms proportionally to voters, such that Democrats win 2 of 5 seats and 40 of 100 firms. We show such a plan in Figure 1B, with districts numbered 1 through 5. Districts 1 and 4 are majority-Democratic, with 55.0%...

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\(^5\) While the hypothetical map presents a simplified representation, it contains a number of realistic features with respect to the location of firms and voters. First, the state is not a perfect 4x5 rectangle, consistent with rough boundaries in many states. Second, like-minded ideological voters tend to be clustered closer to others with similar views. Third, firms and voters are clustered more densely together in some areas than others. Finally, there is a positive correlation between Democratic voters and firms within precincts, yet this correlation is imperfect; in the real world this arises from Democratic voters and corporate headquarters tending to reside in or near urban areas.

\(^6\) We exclude the possibility that two precincts could be contiguous if their corners touch for simplicity.
and 52.5% of the vote share respectively, and contain 15 and 25 firms. The bottom row in this table presents state-wide summary statistics: the state-wide vote share, the percentage of districts won by Democrats, and the percentage of firms allocated to districts with a Democratic majority. While the state-wide vote share is mechanically fixed at 40%, both the seat share and firm share are manipulable by mapmakers.

**Figure 1B - New Gerryland Redistricting Plan 29:**

**Example of a Redistricting Plan with Partisan Seat and Firm Allocations Proportional to State-wide Vote Shares**

It is also possible to draw maps where seats are proportional to voters, but where the allocation of firms is not. In both panels of Figure 1C, Democrats win 2 of 5 seats, but their firm yield varies considerably. Plan 19, displayed in Panel A, yields only 32 firms for Democrats, while in Plan 1 displayed in Panel B yields 57, a large and politically meaningful difference: even when requiring seat allocations to be proportional to vote shares, mapmakers can reallocate 25% of a state’s total firms from one party to another. Even plans that look neutral in their seat allocations may favor one party in terms of firms, leaving room for mapmakers to gerrymander firms.

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7 E.g. to calculate percentage of firms allocated to a Democratic majority district in this example of a redistricting plan we perform the following operation = (1 * 15 + 0 * 17 + 0 * 24 + 1 * 25 + 0 * 19) / 100 = 40%.
Figure 1C - New Gerryland Redistricting Plan 19 and Redistricting Plan 1: Examples of Redistricting Plans with Partisan Seat Allocations Proportional to State-wide Vote Shares, but Not Proportional in Partisan Firm Shares

Panel A - 2D/3R Seats with 32 D Firms

Panel B - 2D/3R Seats with 57 D Firms

3.2. A Republican-biased Plan

Now we consider a biased mapmaker seeking to favor their party. Since Republicans control the majority of voters in our hypothetical state, what type of map might Republicans draw? They might prefer a plan that limits Democrats to 1 seat, giving Republicans 4 out of 5 seats and maximizing their delegation.

Figure 1D - New Gerryland Redistricting Plan 5: Example of a Redistricting Plan with Partisan Bias in Seat Allocation Relative to State-wide Vote Shares that remains Proportionally Biased in Firm Allocations

One such plan is Plan 5 displayed in Figure 1D. The 80 firms allocated to Republicans here (and 20 to Democrats) is what we might expect from a 1D/4R split if seats and firms were proportional: Democrats get 20% of both seats and firms. Republicans strictly prefer this plan to any that only yields 3 seats for them: the maximum firm yield among 3-Republican-seat plans is
68, 12 fewer than Plan 5. We will see later that in New Gerryland, Republicans can only maximize firms by also maximizing seats.

But even among plans where Republicans win 4 seats, there is substantial variation in firm allocations as Figure 1E in Panel A, Redistricting Plan 86, Republicans obtain as many as 88 firms, while in Panel B, Redistricting Plan 81, Republicans obtain as few as 65 firms, despite substantial seat gerrymandering in their favor. This range of 23 firms is almost as large as for 2D/3R plans (25 firms): firm gerrymandering may exist within any seat allocation.  

Figure 1E - New Gerryland Redistricting Plan 86 and Redistricting Plan 81: Examples of Redistricting Plans with Partisan Seat Allocations favoring Republicans With Dramatically Different Firm Allocations

3.3. The Full Distribution of Gerrymandering Possibilities

Since New Gerryland only has 20 precincts, we are able to draw all 100 feasible redistricting plans and summarize their characteristics to obtain a complete picture of what redistricting in New Gerryland could look like, sketching a possibilities frontier of both seats and firms. This frontier identifies which outcomes might be gerrymandered by revealing whether they are statistical outliers, falling in the extremes of the seat distribution, firm distribution, or the joint distribution of both.

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8 It is worth pointing out that more firms go to Republican districts in the 1D/4R redistricting plans than the 2D/3R redistricting plans shown in our example above. More generally, a disproportionate allocation of either seats or firms may spillover into a disproportionate allocation of the other. As long as there are some firms located in additional electoral districts taken by one party, the spillover of seats into firms happens mechanically. Grabbing an additional firm can cut either way, however, as it depends on the number and characteristics of voters in the area surrounding coveted firms; if adjacent voters are sufficiently numerous and palatable, then drawing district appendages to incorporate more firms and surrounding voters can spillover into additional seats. In our example, it is also worth pointing out that the range of possible firm allocations for 2D/3R and 1D/4R maps overlaps; this implies that simply knowing that the count of firms allocated to either party falls in the overlapping range is insufficient to help us disambiguate whether the plan was a 2D/3R or 1D/4R plan. More broadly, neither the disproportionate allocation of seats nor the disproportionate allocation of firms in a given redistricting plan alone is sufficient to optimize on the other dimension.
### 3.3.1. Seat Gerrymandering Defined

First we look at the empirical distribution of seats. For each of 100 plans, we calculate how many seats Democrats would win and present that distribution on Figure 1F. Each bin represents a possible seat allocation, from 5-Republican to 5-Democratic seats; each bin’s height represents how many possible plans result in that allocation. Although there are six conceivable outcomes, only three are feasible: 1D/4R, 2D/3R, and 3D/2R. The expected outcome of redistricting in New Gerryland is a 2D/3R plan—occurring in 55 out of 100 plans—consistent with an expectation that a neutral plan might allocate seats proportional to voters.

Which of the alternative outcomes might we call a seat gerrymander? A 1D/4R seat allocation biasing towards Republicans’ arises in 44 out of 100 feasible plans so is relatively statistically likely, illustrating that not all deviations from that expectation are gerrymanders. A 3D/2R seat allocation biasing towards Democrats, however, only occurs once among all 100 feasible plans. Hence, the 3D/2R seat allocation falls at the 99th percentile of the seat distribution; consequently such a realization provides strong evidence of seat gerrymandering. According to standard methods of outlier analysis, a one-sided p-value for a randomly selected plan being as, or more, favorable to Democrats than a 3D/2R realization is 0.01, while the p-value of selecting a random plan as, or more, favorable to Republicans as a 1D/4R seat allocation is 0.44.

**Figure 1F - New Gerryland: Histogram of Seat Allocation in Population of Feasible Redistricting Plans**

### 3.3.2. Firm Gerrymandering Defined

We can extend the same logic for seats to firms to help identify firm gerrymanders. Looking again at each of the 100 plans, we calculate how many firms fall into districts that
Democrats win, presenting that distribution in Figure 1G. Under a proportional plan, we would expect 40 firms allocated to Democratic districts, which is what we find near the median of the distribution. The modal outcome, occurring in 14 different plans, and represented by the tallest bar, is an allocation of 20 firms to Democratic districts. A plan where Democrats receive the minimum possible 12 firms falls at the 99th percentile of Republican firm gerrymandering, while the plan where they receive the maximum possible 70 firms falls at the 99th percentile of Democratic firm gerrymandering.

That said, with a one-sided quantile threshold of 0.1 we can consider the 10 leftmost plans (out of 100) to be Republican firm gerrymanders and the 10 right-most plans to be Democratic firm gerrymanders. Hence, in New Gerryland, any plan allocating 19 or fewer firms to Democrats is a firm gerrymander for Republicans and any plan allocating 51 or more firms to Democrats is a firm gerrymander for Democrats.

Figure 1G - New Gerryland: Histogram of Firm Allocations in Population of Feasible Redistricting Plans

3.3.3. Considering Firm and Seat Gerrymandering Jointly

Firm and seat gerrymandering interact in important ways. To illuminate these interactions, we present the joint distribution of firms and seats in Figure 1H. The vertical axis indicates the number of seats allocated to Democrats, while the horizontal axis presents bins for the number of firms allocated to Democrats; darker bars indicate more frequent firm-seat combinations. The lightest bars appear in cells for 1D seat/12 Democratic firms and 3D seats/70 Democratic firms as these allocations only occur once among the 100 feasible redistricting plans.
The 3D/2R seat, 70 Democratic firm districting plan, in the top right of the figure, is as extreme as possible on both dimensions, and therefore appears to be the optimal choice for Democrats. According to our definitions above, it is both a seat gerrymander (because there are 3 or more seats allocated to Democrats) and a firm gerrymander (because there are 51 or more Democratic firms). But importantly, because there is only one map allocating 3 seats to Democrats, we cannot positively conclude that by selecting this plan mapmakers intentionally maximized firms rather than targeting seats.

Next, we consider the most Republican extreme, a redistricting plan allocating only 1 seat and only 12 firms to Democrats. In this case, we have new leverage to disentangle firm targeting from seat targeting. If Republicans were merely trying to maximize seats, there is a large range of options for how many firms they could obtain among the 44 plans that do so. These options form the seat-conditional firm distribution, supplying Democrats with anywhere from 12 to 35 firms, with 20 being both the most common and the median. Holding fixed the number of seats Democrats win at 1, the number of firms they control in a 12-firm plan is still a statistical outlier favoring Republicans, evidencing a seat conditional firm gerrymander, or firm targeting, given an allocation of firms as extreme occurs only 1 out of 44 times (p-value = 0.023) among the set of plans that yield 1D/4R seats.

Note also that a given redistricting plan can be at extreme bounds and optimal on both dimensions (i.e. near the corners of the joint distribution) and be a joint firm and seat gerrymander (i.e. taking into account both dimensions) without necessarily being a seat or firm gerrymander by itself (i.e. when only accounting for statistical extremity in one dimension). This is because when we look at two dimensions the statistical rarity of any given cell representing a seat-firm allocation pairing can be taken into account rather simply a bin of either seats or firms which may have too many observations in it to declare it a gerrymander, e.g. as in the case of 1D/4R seat allocations not being a seat gerrymander given the frequency with which they arise.
It is a complex problem to disambiguate between seats and firms being targeted explicitly by mapmakers. If we define firm gerrymandering only as an extreme firm allocation relative to the unconditional full set of possible maps, we may miss cases where firms are targeted in conditional firm gerrymanders. Consider plans in the 2D/3R row. Given this allocation of seats, Democrats may yield anywhere from 32 to 57 firms. The 57-firm plan is extreme both overall/unconditionally and conditional on its firm allocation and is a Democratic firm gerrymander either way; however, a 32-firm plan is only extreme in the conditional distribution and is a Republican conditional firm gerrymander but not an unconditional one. Either a 32-firm allocation or a 57-firm allocation, nevertheless, provides strong evidence that mapmakers prized firms given some reason to select a 2D/3R plan. Hence, it can be important to analyze both the overall/unconditional allocation of firms into districts and the allocation conditional on the number of seats in the enacted plan if we want to detect whether or not firms were targeted by mapmakers.

Importantly, the New Gerryland example exposes that extreme outcomes on the firm distribution could be intentional (i.e., reflecting specific targeting by mapmakers) or merely a by-product of the mapmakers’ focus on seats. Regardless of why a firm gerrymander occurs, an extreme, disproportionate allocation of firms to one party and/or firms being targeted by mapmakers is consequential: it structurally aligns those firms with the party in power that drew the lines, changing incentives for both firms and politicians. We consider the implications for various stakeholders in more detail in our discussion.

3.4. Picking the Optimal Plan?

We close this section by noting that mapmakers may not always optimize by selecting the plan that maximizes both firms and seats for their party. It is easy to construct a case where the goals of the party directly conflict with the goals of individual incumbents, and to imagine how mapmakers’ expectations about the future shape their redistricting decisions. For example, consider Figure 11 of New Gerryland Redistricting Plan 38; the plan maximizes both seats and firms for Democrats at 3 of 5 and 70 of 100 despite a minority of 40% of the voters.

While Democrats win three seats in this plan, they do so by slim margins. The safest of the three is won by only 5 percentage points, and the others by less than 3, meaning that a normal-size national swing would endanger 2 of the 3 seats. Democratic incumbents or a risk-averse mapmaker might prefer 2 safe seats to 3 marginal ones, and may instead maximize the firms they yield conditional on winning those 2. On the other hand, Democratic mapmakers might have more optimistic expectations. If demographic changes in their marginal districts bode well, they might ambitiously opt to seize 3 seats after all, betting that they will become safer over time.
Redistricting is an idiosyncratic process, relying on political geography, incumbent demands, partisan constraints, judicial scrutiny, party power structures, and much more. It is impossible to capture the full complexity in a simplified example like New Gerryland because different actors face different constraints when optimizing. Nevertheless we have outlined clear expectations about how partisan mapmakers might draw lines with firms in mind, expectations that we systematically test in Section 5 after explaining our methodology for constructing a counterfactual distribution next.

4. METHODS: SIMULATION OF REDISTRICTING PLANS

In our New Gerryland example with only 20 precincts, we were able to enumerate the complete set of feasible redistricting plans and identified which ones are optimal to different partisan actors. It is not feasible to identify every unique redistricting plan in the real world; there are trillions of ways to draw district boundaries in a given state.

Using real-world data and simulation methods, we can nevertheless randomly sample from the set of redistricting plans, obtaining the probabilities for different seat and firm allocations. There is a long literature advancing Monte Carlo methods (Chen & Rodden 2013, 2015; Tam Cho & Liu 2016; Wang 2015; Cain et al. 2017; Chen & Stephanopoulous 2020; Fifield et al 2020a, 2020b; Duchin & Spencer 2021, and many others) to study racial and partisan gerrymandering; we are the first to apply them to firms.

We draw our inferences using those representative samples from the simulation as a benchmark for potential outcomes, a null distribution with which we conduct outlier analysis.\(^\text{10}\)

\(^{10}\) Presumably, mapmakers, in 2012, like us, did not have access to the full set of feasible redistricting plans (and relevant summary statistics on each). Furthermore, it is unlikely they even had access to a representative sample of the full set because, in 2012, the methods we employ to construct alternatives were not as refined and the data required was not as accessible (at least at the level of granularity required). Nevertheless, mapmakers then undoubtedly considered some (limited) set of feasible
We calculate p-values capturing how extreme an observed allocation of firms falls relative to the simulated null distribution of potential allocations of firms, allowing us to say how likely it is that extreme outcome occurred by chance, i.e. whether or not there was gerrymandering at the state-level. E.g. if a redistricting plan generated a firm allocation that was in the 500 most extreme allocations out of 50,000 simulated plans, the p-value for observing something as extreme by chance would be 0.01.

4.1. Data

We conduct these simulations for 16 districting plans across 13 states (see Table 1). We selected these states through data availability considerations. To conduct these simulations we require precinct-level population (to satisfy One Person, One Vote requirements), racial and ethnic demographics (to satisfy Voting Rights Act compliance), and vote share (to calculate district winners) linked to precinct geographies; we draw these data from the Metric Geometry and Gerrymandering Group’s MGGG States Project. We link these data to the geolocated addresses of publicly-traded US firms’ headquarters, acquired from the COMPUSTAT data set, using a spatial intersect (Pebesma 2018).

We have good reason to believe that our simulation methods capture extreme allocations of firms approaching the feasible limit given we are able to draw a large number of simulated plans and given that the more plans we simulate, the more likely we are to capture the most extreme allocations feasible. We do not know, however, how many redistricting plans actual mapmakers were able to draw or had the capacity to consider or how close their set got to approaching the most extreme allocations feasible.

redistricting plans—and likely did not draw those randomly, but instead, presumably constructed them in a search for plans that generated favorable partisan allocations. For our analysis, the relevant question, then, is: did mapmakers have a set of redistricting possibilities in front of them that captured the same extremes in terms of both seat and firm allocations? If the plans mapmakers considered captured the same extremes that our simulations produce, then mapmakers interested in gerrymandering could have selected redistricting plans producing those extremes, leaving our inferences unadulterated. If the set of plans mapmakers considered, however, did not have equivalent range, then mapmakers may not have been aware they could select plans as extreme as those generated in our simulations; in such instances, inference from our outlier analysis would be conservative, given mapmakers would have selected redistricting plans from among a set with a tighter range of firm allocations than the counterfactual distributions we construct.

We conducted these simulations for 16 districting plans across 13 states (see Table 1). We selected these states through data availability considerations. To conduct these simulations we require precinct-level population (to satisfy One Person, One Vote requirements), racial and ethnic demographics (to satisfy Voting Rights Act compliance), and vote share (to calculate district winners) linked to precinct geographies; we draw these data from the Metric Geometry and Gerrymandering Group’s MGGG States Project. We link these data to the geolocated addresses of publicly-traded US firms’ headquarters, acquired from the COMPUSTAT data set, using a spatial intersect (Pebesma 2018).
4.2. Simulation Mechanics

Our simulation procedure follows the Sequential Monte Carlo (SMC) procedure of McCartan and Imai (2020), who formulate the redistricting simulation problem as a “graph cut problem”. Considering a precinct map as a network with precincts as nodes and precinct adjacency as edges connecting those nodes, the process of generating a district map involves selectively removing edges of that network. Our simulation procedure follows five steps. First, we generate the precinct adjacency matrix from a state precinct map. Second, we conduct the SMC procedure, drawing 50,000 plans per state, with constraints for compactness, contiguity, county boundaries, and majority-minority districts, thereby ensuring that each district we draw is legally valid. Third, we overlay each generated plan with our data set of geolocated firms. Fourth, we infer expected two-party vote shares for every district in every plan. Finally, we assign firms to parties based on district vote shares.

4.2.1. Estimating District Vote Shares

In estimating vote share for simulated districts, researchers typically make a number of key assumptions. Consider the 2012 Congressional districts for a given state. Once we generate 50,000 simulated plans, we must identify how many seats Democrats are expected to win in each

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14 The redist R package includes tools for correcting imperfect precinct geometries with incomplete adjacency matrices by suggesting neighboring precincts. This helps account for states with discontiguous segments like the Hawaiian islands or Michigan’s Upper Peninsula.

15 We note that in the 20 September 2021 draft of the paper, for Texas and Wisconsin we only completed simulations for 10,000 alternative redistricting plans and in Virginia we simulated 100,000 alternative redistricting plans.

16 The first three parts of this procedure we discuss in greater detail in the Appendix; steps four and five we elaborate upon below.
plan. To do this, we identify how each precinct voted in the 2012 House of Representatives elections, then sum each party’s vote in each district in each plan. In doing so we are making a district invariance assumption: a precinct’s vote is invariant to the district that precinct is in.\footnote{This assumption may not hold if different districts feature candidates of different quality: in the extreme case, some districts might not have a candidate for one of the two parties at all.}

Moreover, for some states, precinct-level vote totals for the election of interest may not be publicly available, and researchers may use 2012 Presidential vote share or 2014 House of Representatives vote share to infer how precincts would vote under simulated plans in the 2012 House of Representatives. Using these introduce new assumptions: for the 2012 Presidential election results, that vote share is invariant to the ballot item, and for 2014 House of Representatives election results, that vote share is stable over time.\footnote{Both the election invariance and ballot item invariance assumptions may not hold for different reasons. The correlation between ballot items is strong but not perfect (Kuriwaki 2019), threatening the ballot item invariance assumption; and while vote shares are often stable over time, there are both systematic differences between Presidential and midterm elections and secular national swings that threaten the election invariance assumption.} To weaken our reliance on these assumptions, rather than use a single election to infer precinct-level vote, we average the precinct-level vote for as many elections as we have available to produce an estimate of a precinct’s latent vote share for each party.\footnote{We note in the Appendix which elections we aggregate for each state, and discuss some of the complications that arise.}

\subsection*{4.2.2. Assigning Firm Allocations to Parties}

Having identified the partisan balance of each district in each simulated plan, we can calculate any number test statistics to capture seat or firm gerrymandering. Just as we calculate the number of seats that Democrats win to measure seat gerrymandering, our primary test statistic to capture firm gerrymandering calculates the proportion of firms that fall in districts with a simple Democratic majority.

In states where Democrats draw the lines, we expect that the realized proportion of firms in Democratic districts will be much higher than in the modal simulated plan, and in states where Republicans draw the lines, the realized plan will give more firms to their districts than the modal simulated plan. As well, in states redistricted by non-partisan or bipartisan agents, the realized proportion of firms in Democratic districts will be much closer to the modal simulation.

To weaken our reliance on allocating firms to the party with a simple majority, we conduct a robustness check focused on how our results change if we introduce different assumptions around firms in ‘marginal’ electoral districts near the 50%+1 threshold.

\section{RESULTS: EXTREME ALLOCATIONS OF FIRMS DRAWN BY PARTISANS}

Our core analysis parallels our approach to detect firm gerrymandering in New Gerryland, substituting our simulated set of representative maps (described above) for the entire
set of feasible maps. First, we look for unconditional firm gerrymandering across 13 states by comparing the firm allocations in their enacted plans to the distribution of allocations we simulate. Next, examine three states (Oregon, Pennsylvania, and Texas) in detail, showing different possibilities for how seat and firm gerrymandering interact in practice. Finally, we move to a robustness analysis on a core underlying assumption.

5.1. Comparing Enacted Plans to Simulated Plans

Figure 2 displays the simulated distribution of firms located in districts won by Democrats; this is our null distribution. We present one histogram for each of the 13 states (covering 16 redistricting plans) in our sample.

Recall that we simulate 50,000 constitutionally valid redistricting plans for each state by allocating voting precincts to districts. This null distribution represents our expectations for how firms are allocated across districts if those districts were drawn in an as-if random way, using knowledge only of precinct populations and race demographics and considering only the constitutionally-required constraints of compactness, contiguity, and adherence to the Voting Rights Act (VRA).

These histograms in Figure 2 display the proportion of firms that we expect to fall in districts won by Democrats, in 5% bins. Looking at Arizona, the tallest bar indicates that districts won by Democrats contain between 40% and 45% of all major firms in the state in the modal simulated plan. In Arizona, we generated no plans out of 50,000 where fewer than 10% of the firms in the state fall in Democratic districts.

The vertical dashed line represents the actual enacted plans; e.g. in Georgia, 30%-35% of firms fall in Democratic districts in the enacted plan. Therefore, the mass under the distribution to the left or right of the vertical line tells us how extreme an enacted redistricting plan is compared to simulations. If 50% of redistricting plans fell to both the right and left of the enacted plan, that enacted plan falls on the simulated median, indicating that it meets our expectations under the null distribution; we might conclude that firms are not gerrymandered. If 90% of simulated redistricting plans fall to the right (left) of the vertical line representing the enacted plan, then that plan biases in favor of locating firms in Republican (Democratic) districts, suggesting that factors other than constitutional requirements are influencing firm placement.

If an enacted plan falls in the bottom 1% of the null distribution, it means that out of every 100 simulated redistricting plans such a Republican-biased plan appears only once--or that it happened fewer than 500 times out of 50,000 simulations. Likewise if a plan falls at the 99th

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20 We may expect some natural constraints around the redistricting plans that can be drawn if, for instance, Democrats tend to live more densely in the vicinity of firm headquarters than Republicans because Democrats and firms’ headquarters are both more likely to reside in urban areas (Roddan 2010). Our simulations account for this aspect of political and economic geography.
percentile, then out of every 100 simulated plans, we only observe a plan as extreme in its bias toward Democrats a single time. We can interpret these numbers as p-values: they encode how extreme an observation is relative to a null distribution. These will form the basis for our statistical inference.

Figure 2 - Distributions of the Fraction of Firms assigned to Democratic Districts by State arising from our Simulations

Notes: these null distributions are based on our simulated data. The vertical dotted lines represent 2012 enacted plans, while the vertical dashed lines represent plans that were redrawn after courts struck earlier plans after 2012.

Row 1 of Figure 2 shows states in which Democrats controlled the redistricting process. In each of these states, the distribution of simulated plans is skewed to the right -- no simulation allocates more than 40% of the firms to Republicans in these states -- indicating that due to the geography of voters, more firms fall naturally into Democratic districts. However, we observe that the enacted plans (dotted vertical lines) consistently fall near the right edge of the simulated distribution: Democrats place a disproportionate number of firms in districts they control in states where they draw the lines, beyond what the skewed natural geography of firms and voters might dictate.
States in Row 2 of Figure 2 use some form of a commission to decide district boundaries, which, presumably, would generate less gerrymandered outcomes. Consistent with this expectation, in each of these states, we find the enacted plan falls at a global or local mode. The enacted plan sits at the center of the distribution and the global mode in both Arizona and Ohio where the simulated distributions are relatively symmetric. In Iowa, which only has 4 districts (complicating inference) and where firms are situated in a relatively compact area, the enacted plan falls at a local mode, albeit to the left of the global mode.

Row 3 contains states where Republicans led redistricting. In these cases, the realized plans fall to the left of the realized distributions, giving more firms to Republicans than we might expect. This result is, again, consistent with the idea that the party drawing the lines places a disproportionate number of firms in districts they control, compared to the expectation provided by the natural geography of firms and voters.

Row 4 displays plans in states where Republicans drew the lines in 2012 that were later redrawn subsequent to judicial rulings. Here we have two vertical lines: the dotted line corresponds to the original plan, while the dashed line corresponds to those resulting from court orders. In each of these states, consistent with results in Row 3, the party-drawn 2012 enacted plans placed a higher number of firms in Republican districts than the null expectation. When courts ordered new plans, the new plans shifted firm allocations towards the median of the simulated distribution; fewer firms fell into Republican districts, most visibly in Pennsylvania.21

We summarize these findings in Figure 3, collapsing each state’s originally enacted plans onto a single graph displaying quantile values comparing those plans to the simulated null distributions22. For example, a value of 0.25 means that in 25% of simulated plans the same number or fewer firms than in the enacted plan are placed in Democratic districts. Hence, a plan with a value close to 0 favors Republicans while a value close to 1 favors Democrats.

The results reveal a consistent pattern. When Republicans draw the lines, firms end up in Republican districts beyond what we would expect in the absence of firm gerrymandering (generally with a quantile < 0.1). Similarly, when Democrats draw the lines, firms end up in Democratic districts beyond what we would expect in the absence of firm gerrymandering (generally with a quantile > 0.9). In the case of commissions, enacted plans fall towards the middle of the distribution. In two of three states where commissions draw the lines, the enacted

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21 The gains to Democrats were fairly marginal in Virginia and North Carolina where Republicans drew the revised maps subject to Voting Rights Act challenges on select districts. The gains to Democrats were greater in Pennsylvania where the court mandated a plan more consistent with partisan requirements in the state constitution. The skew towards favoring Democrats in the redrawn Pennsylvania plan might be explained by a Democratic majority on the state Supreme Court.

22 We calculate these quantiles as the number of simulated plans with as many or fewer firms going to Democrats at the enacted plan, divided by the total number of simulated plans.
plan falls within a small margin of 0.5—exactly what we would expect if commissions allocated firms to districts in a neutral manner while accounting for the co-locations of firms and voters.\footnote{Iowa ends up with a p-value of 0.095, looking a bit like firms are skewed towards a Republican friendly allocation; however, this may be in part due to seats skewing towards a Democrat friendly allocation.}

**Figure 3:** Plans drawn by Republicans (Democrats) put fewer (more) firms in Democratic districts compared to simulated plans.

Taking this together, Figure 3 tells us that firms appear to be gerrymandered when partisans draw the maps, even taking into account the underlying co-location of firms’ headquarters and voters with tendencies towards either party. It also suggests that when commissions draw the maps, they tend not to gerrymander firms.

We can combine these independent state-level tests into a global p-value (Caughey et al. 2017) testing the sharp null that no states have firm gerrymandering. Our theory tells us that in states drawn by Democrats, we expect quantiles in the right tail, and the opposite for Republicans, so first we convert quantiles to one-sided p-values. In states with plans drawn by commission, we expect quantiles close to 0.5, so we convert those to p-values by subtracting 0.5 such that if an enacted plan produces the simulated modal number of firms for Democrats, its p-value would be 0. Following Caughey et al. (2017), we then take the Fisher product and calculate a global p-value of $9.62 \times 10^{-10}$ providing strong statistical evidence that firm gerrymandering exists in at least some states.

5.2. Recognizing and Disentangling the Relationship between Firm Targeting and Seat Targeting in Gerrymandering Efforts

Having established strong evidence for unconditional firm gerrymandering, we turn to conditional firm gerrymandering for evidence that mapmakers specifically target firms. As we show in New Gerryland, identifying when firms are targeted is challenging since acquiring more seats also leads to acquiring more firms.\footnote{In such instances, the gerrymandering of seats would predictably imply the gerrymandering of firms. Firms are not uniformly distributed with the population of voters by party in the real world, but there is almost always some degree of correlation between firm and voter locations.} To show some of the possible ways that firm gerrymandering appears in practice, we provide a detailed examination of three separate states, working through both (i) joint distributions of firm-and-seat allocations, and (ii) conditional distributions of firm allocations, holding the number of seats fixed.
Oregon provides a case where firm and seat targeting by mapmakers may be observationally equivalent. Pennsylvania shows that even when there is an extreme partisan seat gerrymander, we can sometimes still disentangle seat gerrymandering from firm gerrymandering. Finally, in Texas, we show that mapmakers can produce firm gerrymanders even in the absence of seat gerrymanders.

5.2.1. The Oregon Case: Why Separating the Targeting of Firms from the Targeting of Seats presents a Challenge

Figure 4 presents the simulated joint distribution of seat (vertical axis) and firm (horizontal axis) allocations in Oregon. Each bar is a unique combination of firms and seats, and darker bars indicate a higher proportion of simulated plans with that allocation. The enacted plan drawn by Democrats in 2012 is marked with a circle.

**Figure 4 - Oregon’s Joint Distribution of Firms and Seats from Simulation**

In Oregon in 2012, there were 5 seats and 48 firms to be allocated. In no simulated plan did Democrats obtain more than 4 seats or 47 firms. In practice, Democratic mapmakers enacted a plan allocating 4 seats and 44 firms to their party, achieving the maximum number of seats and an unusually large number of firms.25

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25 We note that while Oregon Democrats maximized seats among the feasible set, that the choice to do so does not necessarily register as a seat gerrymander as it occurs relatively frequently in 17.1% of plans.
Is this a seat or firm gerrymander? In practice, any plan that allocates 4 seats to Democrats must also allocate at least 37 firms to Democrats, so observing a plan with 4 seats and 44 firms may not suggest deliberate firm gerrymandering; the extreme allocation of firms might be a consequence of mapmakers’ maximizing seats. Likewise, mapmakers trying to gerrymander firms but not seats must also allocate 4 seats to Democrats.

In New Gerryland, we examined the joint distribution of firm allocations (Figure 1H). Doing so taught us that if we wanted to learn whether firms were targeted, we might have to look deeper at conditional distributions holding seats fixed. Figure 5 presents that data for Oregon narrowing in on plans that allocate exactly 4 seats to Democrats as in the enacted plan--and suggests that despite finding an unconditional firm gerrymander in Oregon, that we may not be able to say firms were targeted over and beyond seats in the conditional distribution. The range of feasible firm allocations is so narrow in the conditional distribution that variation within it may not be politically or economically meaningful; moreover, there is also a pronounced central tendency, limiting variation altogether. Unfortunately, this combination of attributes complicates our ability to make inferences about whether firms were targeted explicitly so we cannot reject the null: while we found evidence of Democrats absorbing firms into co-partisan districts on the whole in Oregon, the natural geography of firms and voters in the state limits our ability to determine whether firms were targeted explicitly.

Note that this represents data only for the subset of 8,534 simulated plans for Oregon that had 4 seats allocated to Democrats, whereas the joint distribution displays all 50,000 simulated plans for Oregon.

Approximately 98.6% of simulated redistricting plans where Democrats win 4 seats also yield either 44 or 45 firms.

Essentially, the narrow range and low variation require us to have a p-value less than 0.0005, rather than at a more conventional level, in order to reject a null hypothesis. i.e. to get statistical evidence consistent with firms being targeted intentionally above-and-beyond seats, we would need to observe that mapmakers selected one of less than a handful of plans out of the 50,000 simulated possibilities that had both 4 seats and 46 firms allocated to Democrats, which they may have had sound, but idiosyncratic reasons to reject given party and/or politician demands.

Constructing a p-value for an allocation of 44 firms in this conditional distribution: we find a p-value of 0.580--as out of 8,534 simulated plans for Oregon that give 4 seats to Democrats, 4,864 of the simulated plans give them 44 firms and 8 of the simulated plans given them 42 firms--so we cannot reject the hypothesis that firm allocations are randomly selected by mapmakers conditional of selecting a redistricting plan with 4 Democratic seats in Oregon.
5.2.2. The Pennsylvania Case: Valuing Firms even within Extreme Seat Allocations

In Pennsylvania, we can show more conclusively that mapmakers targeted firms in their gerrymandering efforts above and beyond seats: Republican mapmakers maximized their allocation of firms conditional on seizing the maximum feasible number of seats.

Figure 6 presents the simulated joint density of seat and firm allocations in Pennsylvania. Note that in Pennsylvania, we have two enacted plans. The enacted plan drawn by Republicans in 2012 is marked with an “X”. The revised plan drawn by the State Supreme Court in 2018 is marked with a circle.
In Pennsylvania, there are 18 seats and 398 firms to be allocated by Republicans, who might want to maximize their share of both. The simulated range of seats allocated to Democrats is 5 to 11; the range for firms is 108 to 326.

In 2012, Republican mapmakers allocated the lower bound of 5 seats to Democrats, consistent with a seat gerrymander in favor of Republicans, and 121 firms, the second-lowest possible. The choice of allocating only 121 firms to Democrats is a clear unconditional firm gerrymandering by Republicans: only 3 of 50,000 simulated redistricting plans give fewer firms to Democrats.

But the 2012 Pennsylvania map is a conditional firm gerrymander as well. Figure 7 shows the conditional distribution of firms Democrats may yield conditional on winning five seats. This figure is similar to Oregon in Figure 5, but while in Pennsylvania only 0.12% (63 of 50,000) simulated redistricting plans give the Democrats the same number of seats as in the enacted plan, that percentage is 17.1% in Oregon. Another notable difference is that the range of possibilities is much wider in Pennsylvania and each bin is sparser: there is no strong central tendency. Fixing seats at 5 for Democrats, the range of firm allocations runs from 115 to 249, more than half of the entire range of feasible redistricting possibilities from our simulation (108

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The p-value for a seat gerrymander is 0.001 as only 63 out of 50,000 simulated redistricting plans have only 5 Democratic majority districts.

This yields a p-value of only 0.00006.
to 326). The large variation in Pennsylvania’s conditional distribution allows for stronger inferences than in Oregon.

The enacted plan is a conditionally extreme allocation of firms: there are only 2 plans out of 63 that are more extreme giving a p-value of 0.032, suggesting that Pennsylvania mapmakers targeted firms above and beyond seats.$^{33}$

**Figure 7 - Pennsylvania’s Distribution of Firms conditional on Five Democratic Seats as in Enacted Plan**

$^{33}$While we did not discuss in detail the 2018 court-drawn map (denoted by a circle on the heatmap of the joint density), it looks very different from the 2012 Republican drawn map. The 2018 court-drawn map came in response to a finding the 2012 map was a partisan gerrymander favoring Republicans that violated the state Constitution. Perhaps unsurprisingly then, it appreciably shifted seats and firms towards Democrats, allocating 9 seats and 297 firms to them.
5.2.3. The Texas Case: Valuing Firms even when Eschewing Seats

In Texas, Republican mapmakers chose not to maximize their seat allocation. Texas is not an outlier in this respect: partisan seat maximization happens in fewer than half of the states we study. But while Texas is not a seat gerrymander, it is clearly a firm gerrymander.

Figure 8 - Texas’ Joint Distribution of Firms and Seats from Simulation

Figure 8 presents the simulated joint distribution of firm and seat allocations in Texas. There are 36 seats and 715 firms to allocate; Democrats may capture from 8 to 15 seats and from 70 to 431 firms. The enacted plan drawn by Republicans yields 11 seats to Democrats, which is the modal outcome of our simulations (occurring in 4,289 out of 10,000 plans). A standard notion of partisan gerrymandering would therefore reject the claim that Texas’ map was gerrymandered to favor Republicans in terms of seats.

However, examining firm allocations suggests otherwise. The 215 firms that the 2012 enacted plan allocated to Democrats is substantially lower than we would expect (p = 0.105), indicating that mapmakers preferred to overallocate firms to themselves rather than seats.

Examining Texas’ conditional firm distribution in Figure 9 makes this even clearer. Fixing the Democrats to 11 seats, the conditional distribution of firms ranges from 97 to 396,
covering over 80% of the full range of possibilities for firms.\(^\text{34}\) The 215 firms given to Democrats in the enacted plan falls far to the left within this distribution, with \(p = 0.015\). Even though Republicans chose a relatively bipartisan allocation of seats, conditional on that choice, they allocated themselves far more firms than can be explained by random chance. We discuss why Texas Republicans might have chosen this plan in Section 6.2.

Figure 9 - Texas’ Distribution of Firms conditional on Eleven Democratic Seats as in Enacted Plan

5.3. Robustness

An assumption we made throughout our core analysis was that we could allocate firms to the party that captures a simple majority of predicted vote shares (i.e. 50% +1 votes) for each district in a redistricting plan, ignoring mapmakers’ risk tolerance vis-a-vis placing firms in marginal districts. It also ignores mapmakers' calculus when there is potential for an aggregate shock to voter preferences as in Gul & Pesendorfer (2010). Hence, we conduct a bounding exercise in which we change the assumption that in the enacted plan the party holding a simple majority acquires all of the firms in marginal districts.\(^\text{35}\) At the lower bound, Republicans

\(^{34}\) This range is much broader than in Oregon or Pennsylvania, where the party drawing the lines maximized on seats to themselves. This occurs in part because there tend to be broader possibilities when drawing a more neutral number of seats being allocated to each party. E.g. if, in Texas, Republicans chose a seat-maximizing plan fixing seats at 8 for Democrats the range of simulated possibilities for firms runs from 70 to 308, which is a narrower range.

\(^{35}\) In this analysis, we leave the counterfactual distribution unchanged, i.e. it represents firm allocations going to the party with a simple majority in each district of each redistricting plan. Leaving this counterfactual unperturbed will lead to a relatively conservative test.
acquire all firms in marginal districts; and, at the upper bound, Democrats acquire all firms in marginal districts.\textsuperscript{36}

Table 2 displays quantile values for these bounds relative to each state’s counterfactual distribution. Column 2 contains reference values for firm quantiles obtained in our core analysis (in which we presented them visually in Figure 3). Column 1 displays the lower bound from the exercise, and Column 3, the upper bound.

Table 2 - Quantiles of Firms Allocations by State from Bounding Exercise

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<th>Type</th>
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<th>Upper Bound</th>
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</table>

Notes:

\textit{The lower bound is the quantile of the enacted plan when Republicans are given all of the firms located in marginal (45.55\%) districts.}

\textit{The baseline is the quantile of the enacted plan when the party with the simple majority is given firms in marginal (45.55\%) districts.}

\textit{The upper bound is the quantile of the enacted plan when Democrats are given all of the firms located in marginal (45.55\%) districts.}

This analysis exposes how robust the mapmakers’ choice of a redistricting plan is relative to a counterfactual world in which firms in all other potential redistricting plans are allocated by simple majority. In some states (e.g. Maryland, Ohio, and Wisconsin) both bounds are equivalent to the reference point because mapmakers enacted a plan with no firms in marginal seats. In other states, one bound may equal the baseline, while the other may not, reflecting that firms only reside in marginal districts of one party in the enacted plan. In a few states (e.g. Oregon, Pennsylvania, and Iowa), we see a large range in quantiles obtained at different bounds.

\textsuperscript{36} We define marginal seats as those with a predicted district vote share falling within the 45\% - 55\% interval. Defining marginal seats as those in an interval this wide will lead to relatively conservative results in our bounding exercise.
indicating that a large number of firms reside in the few districts we classified as marginal. The quantity of firms in marginal districts could represent geographic constraints or mapmakers’ appetite for risk.\textsuperscript{37}

Taken together, these results show that our finding that firms are gerrymandered does not hinge on assumptions we made about the treatment of marginal seats. Following Caughey et al. (2017), as above, we calculate a global p-value for the bounding analysis of $9.55 \times 10^{-5}$, indicating strong statistical evidence that firm gerrymandering exists in at least some states even when actual election results bias against the existence of firm gerrymandering in enacted plans.\textsuperscript{38}

6. DISCUSSION

We find that when partisans control the redistricting process, firms are overallocated to the mapmakers’ party. We also find that while firm gerrymandering occurs in instances when seats are gerrymandered, it also occurs in instances when seats are \textit{not} gerrymandered. Having established that firm gerrymandering is systematic, we show that it is also widespread. While 7 of the 10 states we consider satisfy our definitions of firm gerrymandering, only 5 are partisan seat gerrymanders under an equal standard of evidence; firm gerrymandering therefore cannot simply be a byproduct of seat gerrymandering.

We may also be interested how many firms are gerrymandered. Compared to the median in our simulated counterfactuals, we found that the mapmakers’ party received 322 more firms than we would have expected. This is approximately 14% of the 2,259 firms that reside in states where partisans draw the lines. In practice, however, all of these firms are not available to be reallocated in a partisan firm gerrymander given both (i) the constraints of the natural geography of firms and voters and (ii) that parties only want to acquire more (not fewer) firms. This limits the feasible allocations of firms that either party can acquire to a maximum of 625 firms.\textsuperscript{39} Thus, parties acquire approximately 52% of the firms that can be gerrymandered to their advantage.

Why might firm gerrymandering be more common than seat gerrymandering? First, there is a greater opportunity to gerrymander firms since there are more firms than there are seats\textsuperscript{40} and shifting one firm is relatively easier for a mapmaker than shifting one seat. Second, while the

\textsuperscript{37} We note that the choice of an enacted plan is endogenous to the mapmakers’ appetite for risk: risk tolerant mapmakers may focus on the lower bound, while risk averse mapmakers may focus on the upper bound subject to other tradeoffs.

\textsuperscript{38} In constructing this global p-value, we assume: when Democrats draw maps, they lose all marginal districts to Republicans; when Republicans draw maps, they lose all marginal districts to Democrats; and, when commissions draw maps the election outcome falls farthest from neutrality given marginal district outcomes.

\textsuperscript{39} We calculate this number as the difference between (i) the maximum feasible number of firms a party can acquire in the simulated alternatives and (ii) the median number of firms in simulated counterfactual.

\textsuperscript{40} Firms are at least 2x more numerous, if not orders of magnitude more numerous, than seats for every state in our sample.
most extreme allocation of seats is not always a seat gerrymander, the most extreme allocation of firms is always a firm gerrymander for the states in our sample.\footnote{This happens because extreme seat allocations occur relatively more frequently than extreme firm allocations; the seat allocation distribution has fatter tails.}

6.1. Implications for Politicians, Firms, and Voters

While dominant strains of literature argue that firms capture politicians (Stigler 1971), our results suggest that politicians (and political parties) also capture firms (McChesney 1997): drawing firms into majority party districts creates a structural alignment between firms and the majority party politicians in their state, regardless of which party is in the majority. While, in some instances, we do not have the statistical leverage to make an inference that firm gerrymandering is distinct from seat gerrymandering, whether or not firm gerrymandering occurs intentionally is irrelevant to the structural alignment it creates.

Among the many important implications of a systematic lock-in between firms and majority party politicians, some are testable while others are consistent with findings in existing literature.

From an officeholders’ perspective, a structural alignment with firms could solidify the incumbency advantage and diminish political competition: existing officeholders will have advantages in tapping firms, their executives, and employees for campaign contributions and other electoral benefits. Whether having more firms in a district increases the incumbency advantage is a testable implication of our results that is left for future research.

From a firms’ perspective, alignment with politicians may reduce the need to lobby. Their long-term ties with firms gives politicians strong incentives to oblige firms’ interest even when they don’t lobby, helping to explain a long-standing puzzle in the literature that asks why only approximately 10% of firms ever lobby (deFigueiredo & Richter 2014; Kerr et al. 2014).\footnote{Far more firms are gerrymandered than lobby: recall that as many as 52% of firms for which a possibility to be gerrymandered exists in our sample are, in fact, gerrymandered, while the benchmark from the literature is that only 10% of publicly-traded firms lobby.} By contrast, firms not drawn into majority party districts may have to spend more on lobbying, lacking a natural ally in power who is predisposed to listen. This is a second testable implication of our paper.

From a citizen’s perspective, both the diminished political competition and politicians’ incentives to focus on policies that benefit firms in their district may have implications for the quality of representation. It may lead both parties to act in more pro-business ways at the expense of labor-oriented voters. Out-party voters located near firms the majority party has
captured, in particular, may not have a member of Congress advocating for them. This is a third testable implication of our paper.

Our results point to gerrymandering extending far beyond voters. Politicians will seek to incorporate into their districts anything that gives them advantages or status--and this may stretch well beyond firms as well to things like universities, military bases, ports, airports, stadiums, national parks, and hospitals. Likewise, politicians may also seek to keep undesirable things like waste facilities or troublesome constituents outside of their districts. Politicians gain power from all the contents of their districts, and future research could benefit from peeling back the onion a bit further as gerrymandering might not be only about maximizing seats, but rather maximizing structural power of the party derived from districts.

6.2. Limitations and Opportunities for Future Research

Recognizing the assumptions and simplifications we made in this work, will provide ways to deepen a new literature on firm gerrymandering, in addition to providing entry points to contribute separately to the existing literatures on (i) partisan gerrymandering, and (ii) firms and politics.

First, we treat all publicly traded firms as homogeneous and of equal value. Reality is more nuanced with: (i) variability between firms, (ii) some undesirable firms (or combinations of firms), and (iii) differential value to politicians and parties in acquiring clusters of firms over single (valuable) firms. Some firms may be more valuable to politicians in credit claiming, for example, if they have strong reputations among voters or are perceived as being bedrocks of the district’s economy; other firms, by contrast, may be toxic to politicians (McDonnell & Werner 2016). Politicians may also extract more value from having a coherent set of firms by industry. This allows a representative to focus their advocacy, build expertise, and improves their chances of joining desired committees. By contrast, an incoherent set of firms, say the pairing of petroleum and green energy firms, might make it more difficult for a representative to take consistent policy positions which may weaken their standing with some voters. Alternatively, there may be some value to having a diverse industry profile in a political district to weather common economic shocks.

Second, not all firms are equally possible to gerrymander. While our analysis estimates whether and how many firms are gerrymandered, we cannot account for which firms are gerrymandered in practice. Flipping the unit of analysis to the firm could help reveal the consequences to firms of being drawn into an unexpected district, and yield insights into which firms politicians choose to capture when given the flexibility.

43 Larger employee bases and more active firm Political Action Committees (PACs) may also make certain firms more valuable to politicians.
Third, we focus on firm gerrymandering at a state-level rather than within specific districts, but individual districts may have been gerrymandered even if the allocation of firms (and/or seats) is not extreme at the state-level. For example, we might expect the majority party incumbents to compete or cooperate such that firms are reallocated to more powerful politicians or to incumbents under threat. A district level analysis also could reveal things about the mechanisms for firm gerrymandering (e.g. are firms more likely to be gerrymandered if they are located near borders of existing districts). Finally, there may be characteristics of individual districts that are indicative of the presence of firm gerrymandering (e.g. non-compact districts).

Fourth, our test statistic attempted to capture party-wellbeing rather than that of individual politicians: redistricting battles within parties may explain some of the more idiosyncratic state outcomes, for example why we don’t see many states selecting the most extreme seat and firm gerrymanders available. Explanations may come from individual politicians’ priorities, including district safety over firm count, having their residence in the same district as a desired firm, or preferred constituencies more granular than simply party registration. Relatedly, parties may reallocate firms from disloyal incumbents to those seen as rising stars, a pattern our analysis cannot observe.

Fifth, we do not consider how mapmakers choose to trade off between firms and seats, in particular safe seats, and how that decision may be shaped by their expectations about demographic changes. For instance, how many outparty voters will an incumbent accept to gain an additional firm? Are incumbents willing to accept a slimmer margin if they anticipate favorable demographic changes in the future, or does myopia prevent more long-term optimal districts? All of these approaches could yield insights useful to build a more complete and comprehensive theory of gerrymandering.

Sixth, this research focused on firm allocation outcomes, rather than the process of allocating firms by mapmakers beyond postulating that firms would be considered an object of desire by self-interested partisan mapmakers. Future research may explore the map creation process and factors weighed in it in more detail. Most maps (of any sort) are created in an endogenous and path dependent process (Nagaraj & Stern 2020); however, the nuances could be interesting and could inform our understanding of the political geography of firms further. For instance, to what degree is deference on particular firms’ allocation to specific politicians’ districts honored if the pair had a prior geographic tie. To what extent do firms lobby to be included in specific districts--and do they typically do so when they want to stay in the same politician’s district or when they want to move to another politician’s or another party’s? Finally, to what extent do firms select their headquarters locations based on likely electoral district map outcomes? Answers to all of these questions could help us better understand the mechanisms leading to a disproportionate allocation of firms to the party that draws the lines.
6.3. Implications: Judiciating Gerrymandering

When a metric becomes a target, it ceases to be a useful metric. Mapmakers have extensive experience in gaming many of the metrics that courts use to assess gerrymanders, diminishing their use as legal criteria to detect unconstitutional redistricting plans (Cain et al. 2017, Grofman and King 2007, Stephanopoulos and McGee 2015, Kaufman et al. 2021). Courts, legislatures, and advocates might consider firm balance when examining maps for such partisan advantage since these metrics are not (yet) targets and can reveal gerrymanders that courts have missed.

The 2012 redistricting plan enacted in Texas did not appear to be a partisan gerrymander on the basis of seats allocated to Republicans using simulation methods favored by courts. Yet we show that the enacted map is a clear conditional firm gerrymander. Republican mapmakers created an inconspicuous but potent partisan advantage. If the media, nonprofit observers, courts, or the law considered firms (and/or other source of political power) in evaluating redistricting outcomes, then Republican mapmakers may not have been able to enact such a map in Texas in 2012.

Redistricting reform and restrictions on gerrymandering may be both more urgent and more complicated than advocates realize. Broadening the definition of partisan gerrymandering beyond voters exposes that the phenomenon infects the structural roots of democratic institutions in the United States in deeper and more subtle ways than previously recognized. Gerrymandering ties not only voters, but also firms and other sources of political power, to electoral districts in the interest of politicians and political parties.

7. CONCLUSION

In this paper, we contribute to the theory of gerrymandering by incorporating firms. We present a stylized example showing that partisan gerrymandering goes well beyond seats into less obvious features electoral districts. While we focus on firms, our theorizing and empirical approach generalizes to other objects of desire to political mapmakers. In short, we expose how gerrymandering is an even more complicated and widespread problem than previous research demonstrated.

Empirically, we demonstrate that firm gerrymandering is prolific. By simulating counterfactual allocations of firms to districts, and comparing enacted plans to those null distributions, we show that majority parties drawing the lines capture more firms than would have occurred by chance. Courts and commissions, by contrast, allocate firms to parties’

44 Note the 2012 Texas Redistricting plan might have been considered a partisan gerrymander using a compactness criteria; however, there is no such requirement in Texas law.
districts more neutrally. Such allocations could improve the function of democracy by eliminating a structural alignment between firms and state majority parties.

Our results are also important for the literature on firms and politics. We show that the relationship between firms and politicians is at the heart of the redistricting process. Political mapmakers determine which politician each firm must rely on as their gatekeeper to the political process, exposing that the relationship between firms and politicians goes both ways: firms not only capture politicians, but also politicians capture firms.

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