

1 **Editor summary:**

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3 Energy companies must often obtain consent from private landowners for natural gas extraction. This study analyses lease negotiations between these two parties in Ohio, noting disadvantages on the side of the landowner in the process.

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6 **Peer review information:**

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8 Nature Energy thanks Fedor Dokshin, Stephanie Malin, Heidi Robertson and Chad Zanocco for their contribution to the peer review of this work.

10 **Inventory of Supporting Information**

11
12 **Manuscript #:** 22050858C

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16 **1. Supplementary Information:**

17 **A. PDF Files**

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Item	Present?	Filename Whole original file name including extension. i.e.: Smith_SI.pdf. The extension must be .pdf	A brief, numerical description of file contents. i.e.: <i>Supplementary Figures 1-4, Supplementary Discussion, and Supplementary Tables 1-4.</i>
Supplementary Information	Yes	Farrer_Supplemental .pdf	Supplementary analysis, codebook, five tables and one figure.

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23 **B. Additional Supplementary Files**

Type	Number Each type of file (Table, Video, etc.) should be numbered from 1 onwards. Multiple files of the same type should be listed in sequence, i.e.: Supplementary Video 1, Supplementary Video 2, etc.	Filename Whole original file name including extension. i.e.: <i>Smith_Supplementary_Video_1.mov</i>	Legend or Descriptive Caption Describe the contents of the file
Supplementary Code	Supplementary Information 1	Knox College Mail - ODNR Division of Oil and Gas Resources Management - Unitization Follow-up	E-mail documenting correspondence between author and Ohio Department of Natural Resources
Supplementary Code	Supplementary Information 2	Knox College Mail - Re_ [irb] New IRB Submission- Hydraulic Fracturing Research - Ben Farrer	First E-mail documenting correspondence between author and Knox College Institutional Review Board
Supplementary Code	Supplementary Information 3	Knox College Mail - Re_ [irb] New IRB Submission- Survey of Ohio Landowners - Benjamin Farrer	Second E-mail documenting correspondence between author and Knox College Institutional Review Board
Supplementary Data	Source Data Supplemental Figure 1	2019-02_Eclipse_Resources_I_LP_Order_for_Unit_Operations_Bluebonnet_B_Unit	Supplemental Figure 1 is a screenshot of page 13 of the Bluebonnet B order.
Supplementary Data	Source Data Supplemental Table 6	Deduplicated_Anon_Company_E.csv	To replicate Supplemental Table 6, use this CSV file and the "Company E Analysis.do" do file.

3. Source Data

Parent Figure or Table	Filename Whole original file name including extension. i.e.: <i>Smith_SourceData_Fig1.xls</i> , or <i>Smith_Unmodified_Gels_Fig1.pdf</i>	Data description i.e.: Unprocessed western Blots and/or gels, Statistical Source Data, etc.
Source Data Table 1	Deduplicated_Anon_Applications.csv	To replicate Table 1, use these data, and the .do file “Deduplicated Anon Analysis.do”
Source Data Table 2	Deduplicated_Anon_Contact_Logs.csv	To replicate Table 2, Tables 3a and 3b, as well as the Supplemental Information Tables 1, 2, 3, 4, and 5, use these data, and the .do file “Deduplicated Anon Contact Log Analysis.do”
Source Data Table 3a	Deduplicated_Anon_Contact_Logs.csv	To replicate Table 2, Tables 3a and 3b, as well as the Supplemental Information Tables 1, 2, 3, 4, and 5, use these data, and the .do file “Deduplicated Anon Contact Log Analysis.do”
Source Data Table 3b	Deduplicated_Anon_Contact_Logs.csv	To replicate Table 2, Tables 3a and 3b, as well as the Supplemental Information Tables 1, 2, 3, 4, and 5, use these data, and the .do file “Deduplicated Anon Contact Log Analysis.do”
Source Data Figure 1	FINAL_Hall_Unit_Application.pdf	The original content can be found on page 70 of the 155 pages.
Source Data Figure 2	Eclipse_Resources_Hannibal_B_Unit_unitization_application.pdf	Figure 2 is a screenshot of page 106 of the Hannibal B application
Source Data Figure 3	Chesapeake_-_Keller_Unit_-_revised_application_(11.22.17)_-_Website.pdf	The screenshot can be found on page 130.

30 Assessing How Energy Companies Negotiate With
31 Landowners When Obtaining Land for Hydraulic Fracturing

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73 Abstract

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75 To extract natural gas through hydraulic fracturing, energy companies often need to
76 obtain consent from many different private landowners, whose properties lie atop the gas
77 reservoir. Negotiations with these landowners have important economic, environmental,
78 and social implications. In this paper we present a dataset on negotiations in Ohio, and
79 use these data to investigate how landowners may be advantaged or disadvantaged in
80 these lease negotiations. We find that they are disadvantaged in two ways. First, because
81 energy companies can use persistent and personal strategies to overcome landowner
82 reluctance. Second, because of the institutional context: specifically the widespread use of
83 compulsory unitization. We conclude by discussing the implications of these findings for
84 equity in energy policy, and by drawing out the other potential uses of these data.

85

86

87 Introduction

88

89

90 A basic requirement of fossil fuel energy production is that producers have legal
91 access to fossil fuel deposits. In the US, most fossil fuel reservoirs east of the Mississippi
92 river lie under private land. Energy company representatives therefore need to negotiate
93 with millions of landowners, offering financial compensation in exchange for access to
94 the minerals under privately-owned land. These mineral lease negotiations are a vital part
95 of a multi-billion-dollar industry, but they are also a source of controversy. In Pulitzer
96 prize-winning journalism¹, and even Hollywood cinema², these negotiations have been
97 portrayed as ‘David against Goliath’ stories, highlighting the potential negative
98 consequences of a stark power imbalance between landowners and energy companies.
99 But is this portrayal warranted? Unsurprisingly, the social science evidence paints a much
100 more nuanced picture. Some scholars have found some consistent landowner support for
101 leasing because of the economic benefits^{3,4,5,6}; what Jerolmack and Walker⁷ call ‘quiet
102 mobilization’ in favor of oil and gas. But others have found evidence of procedural

103 inequity in leasing negotiations^{8,9,10,11,12}. These contrasting interpretations are difficult to
104 reconcile, in part because the negotiations themselves are private. In this paper we help
105 advance scholarship on this issue by providing large-scale and fine-grained data about the
106 negotiations. Using these data, we find evidence of two forms of procedural inequity.
107 First, landowners are disadvantaged by the persistent and personal negotiating tactics
108 used by energy companies. Second, and perhaps more significantly, they are
109 disadvantaged by the institutional context.

110 We conclude, following Jerolmack and Walker's work⁷ on 'quiet mobilization' in
111 *favor* of oil and gas leases, there is also 'quiet reluctance' which is hidden by these two
112 forms of procedural inequity: the tactics energy companies use, and the institutional
113 context. By showing how this happens, we make an important contribution to the study
114 of common pool resource (CPR) governance and energy politics in the US, and provide a
115 valuable dataset for future research. The paper proceeds as follows. First, we provide an
116 overview of the importance of oil and gas drilling, and highlight the mixed findings from
117 prior research on procedural inequity in leasing negotiations. Second, we outline our data
118 collection strategy. In a third section, we present our two main findings: evidence of the
119 persistent and personal tactics used by energy companies, and evidence that the
120 institutional context works against landowners. A fourth section concludes with the
121 broader academic and practical implications, and suggestions for future uses of these
122 data. A final section describes our methodology in more detail.

123

124 Theory and Background

125

126 Throughout the 20th century, the oil and gas industry has been vital to the US
127 economy. The regulation of mineral lease negotiations has always played a significant
128 role. In its initial phases, the industry was minimally regulated and followed the historical
129 precedent of using the ‘rule of capture’ to govern what were known as fugitive resources.
130 Under the rule of capture, each landowner atop a fossil fuel reservoir had the right to
131 drill, and each of them could keep whatever they extracted from the reservoir¹³. This
132 meant landowners and energy companies had an incentive to drill more of the resource,
133 before someone else captured it. This flooded the market and led to serious price
134 collapses, as well as creating significant environmental harms¹⁴. The regulations
135 introduced to solve this tragedy of the commons¹⁵ in the mid-20th century still govern
136 lease negotiations today. Their exact nature varies by state, but one crucial feature^{16,17,18,19}
137 is compulsory pooling/unitization.

138 This regulatory process allows a state government to compel landowners to allow
139 drilling on their land, under certain conditions. If energy companies submit an
140 application showing that some percentage of surface acreage in a proposed drilling unit
141 has already been leased voluntarily – for example, in Ohio this threshold is 65% – then
142 the state can compel the owners of the remaining acreage to join the contract. This
143 regulatory process was introduced in the mid-20th century to ensure that the last
144 landowner to sign could not hold out for exorbitant fees, nor could small-acreage
145 landowners undercut their neighbors^{14,17,20}. It also meant drilling could still occur even if
146 some landowners were impossible to locate. A small number of absentee landowners, or

147 unidentifiable heirs to a fractional interest, would no longer be insurmountable obstacles
148 to assembling a drilling unit^{17,20}. When compulsory unitization is used in these situations,
149 i.e. for economic holdouts, or for unreachable landowners, it can be seen as a rare
150 instance of a Pareto-improving regulation, compared to the rule of capture¹⁴. It facilitated
151 co-ordination rather than competition, making joint contracts easier to negotiate,
152 conserving resources and reducing waste, and so effectively addressed the main economic
153 and environmental externalities^{13,17}.

154 In recent years though, the situation has changed, because the technology of fossil
155 fuel extraction has changed. High-volume horizontal hydraulic fracturing or ‘HVHF’ (also
156 known as ‘fracking’) has grown exponentially since the 2010s. HVHF has opened up
157 previously inaccessible reservoirs of fossil fuels, but is seen as carrying higher pollution
158 risks^{21,22,23,24,25,26}. This has made HVHF a highly contentious issue^{7,27,28,29,30,31,32,33,34,35}. Some
159 landowners have been reluctant to sign mineral leases not because they are unreachable,
160 or because they are holding out for more money, but instead because they are concerned
161 about the effects of HVHF on their environment, health, home values, and local
162 communities^{3,20,21,22,27,29,32,33,36,37}.

163 When used in this new technological context, compulsory unitization can create
164 procedural inequity by putting these reluctant landowners at a profound disadvantage.
165 Compulsory unitization allows companies to overcome reluctant landowners through
166 coercion. Voluntary leases are still preferred, to further insulate companies against
167 potential lawsuits for trespass, nuisance, or other torts, as well as to avoid unitization fees
168 collected by the state^{16,17,38,39}. But even the threat of coercion adds to their soft power in

169 negotiations^{33,40}. We argue that the widespread use of compulsory unitization beyond
170 just for unreachable landowners or economic holdouts, together with the persistent and
171 personal tactics of energy companies, creates significant procedural inequity.

172 Prior research identifies these twin disadvantages as potentially important, but has
173 produced mixed empirical findings about the extent of procedural inequity. For example,
174 Malin et al.³³ interviewed approximately 100 affected landowners in Colorado and
175 Pennsylvania about their lease negotiations. They conclude that:

176 “These negotiations lack uniformity and are fraught with power imbalances” (ref.
177 ³³, p. 1813).

178 These imbalances were mostly subtle and structural. For example, the representatives of
179 the energy companies, known as ‘Landmen’, would begin negotiations by creating a false
180 sense of urgency. They claimed that development was inevitable, and that landowners
181 would miss out on profits unless they signed immediately. Because negotiations were
182 private and confidential, neighbors were often unable to band together for transparency
183 and better terms. Malin et al.³³ conclude that these Landmen tactics contribute to
184 procedural inequity⁸.

185 Similarly, Jerolmack and Walker⁷ conduct a five-year ethnography in Pennsylvania
186 and find that although most landowners were supportive of HVHF in general: “Landmen
187 appeared to be held in low regard by many in the community, with lessors routinely
188 complaining that landmen pressured them to sign a lease on the spot (lest the offer be
189 rescinded), minimized the disturbances that would result from fracking, and exaggerated
190 the economic benefits” (ref. ⁷, p. 499). Energy companies use persistent and personal

191 strategies to obtain consent. Thus although the community was largely supportive of
192 HVHF, and engaged in ‘quiet mobilization’ to push it forward, the negotiation of leases
193 was still a contentious process that felt unbalanced in favor of energy companies^{32,41,42}.
194 This suggests that alongside ‘quiet mobilization’, a significant number of landowners may
195 also experience ‘quiet reluctance’.

196 Kroepsch⁴³ looked at whether HVHF in Colorado met seven criteria of procedural
197 fairness. This research found procedural inequity or what the author calls ‘piecemeal
198 participation’ not just in leasing, but also in other aspects of the legal process, such as
199 siting a well, obtaining a state well permit, establishing a setback distance, negotiating a
200 surface use agreement, resolving split estate, and filing a complaint. Malin¹⁰ shows that
201 these inequities create chronic mental health problems and stress. This work also
202 highlights the role of persistent and personal tactics by energy companies:

203 “Industry operators aimed to get people sign leases at their most fragile times (for
204 instance, around Christmastime)” (ref. 9, p. 13).

205 These inequities in many aspects of the legal process create what Opsal et al.¹² call
206 ‘invisible harms’. These harms are invisible because they are difficult to measure without
207 fine-grained data on the legal negotiations themselves.

208 However, other research has found that quiet reluctance is rare and landowners
209 are generally happy to sign leases. Under this second interpretation, any delays or lack of
210 voluntary agreement would largely be down to economic holdouts or landowners who
211 simply cannot be located and contacted. There is some evidence to support this
212 interpretation. For example, Bugden and Stedman³⁹ examine lease negotiations in the

213 gas-rich counties of Bradford and Susquehanna in Pennsylvania. Based on almost 900
214 responses to their survey of 3,446 leaseholders from 2003-2015, they find that roughly 40%
215 of landowners had a positive leasing experience 30% had neither positive nor negative
216 experiences, and only around 10% had a negative experience. Perceptions of
217 disenfranchisement in the leasing process were relatively low, and were clustered among
218 a few specific companies. Moreover, proximity to HVHF is often associated with greater
219 support for it, and those who signed leases and received royalties are also generally more
220 supportive^{4,6,27,29,44,45,46}.

221 These ambiguous findings about the extent of landowner reluctance, and
222 procedural inequity, may be resolved by obtaining more fine-grained data on the
223 negotiations themselves. Not only might such data help explain these mixed findings, it
224 also allows the theoretical framework to be expanded to highlighting the role of
225 compulsory unitization. To understand how energy companies negotiate with
226 landowners, we need to explore both the tactics they use, and the institutional context.
227 We derive two hypotheses about the disadvantages facing reluctant landowners. Our first
228 hypothesis is that we will find qualitative evidence of the persistent and personal
229 negotiation tactics used by energy companies. Our second hypothesis is that we will find
230 quantitative evidence that the use of compulsory unitization is not limited to just
231 economic holdouts, and landowners who cannot be located. The next section describes
232 how we test these hypotheses.

233

234 Data Collection and Research Design

235

236 To test our hypotheses about how landowners are disadvantaged in negotiations,
237 we assemble a dataset from HVHF activity in Ohio. We selected the Ohio case for two
238 reasons. First, it is an important producing state. In 1896 Ohio produced the most oil in
239 the US, and although this gradually declined in the first half of the 20th century,
240 production spiked again in the 1960s, and although oil extraction has slowed since then,
241 gas production rose rapidly with the introduction of HVHF in the 2010s. The second
242 reason for selecting Ohio is a unique trail of documents available in that state. The
243 conservation legislation of 1965, specifically, Ohio revised code 1509.27, allows for
244 compulsory unitization with a 65% threshold, and requires companies to provide
245 negotiation records to prove that they tried to get every landowner to sign
246 voluntarily^{16,17,38,47}. Only then will the State Department of Natural Resources (ODNR)
247 grant compulsory unitization. The trail of documents created by this statute allows us to
248 investigate negotiations in a much more fine-grained way.

249 Using the ODNR website ([https://ohiodnr.gov/discover-and-learn/safety-](https://ohiodnr.gov/discover-and-learn/safety-conservation/about-ODNR/oil-gas/documents)
250 [conservation/about-ODNR/oil-gas/documents](https://ohiodnr.gov/discover-and-learn/safety-conservation/about-ODNR/oil-gas/documents)), and after communicating with members
251 of that department, we obtained their full online database, which at that time covered
252 every compulsory unitization application submitted in Ohio from January 2014 to April
253 2021. This period represents the height of the HVHF boom. There were 331 applications
254 over this period, from 18 different companies. Each application is hundreds of pages long,
255 is formatted in slightly different ways by each company, and takes the form of a non-
256 machine-readable PDF. Therefore we hand-coded a random sample of 40 of these

257 applications, just over 10% of the total. In order to check the robustness of this sample, we
258 also coded 50 applications from a single company – which we call company E – in a more
259 limited way. Choosing a single company allowed us to deal with a more uniform set of
260 PDFs, and we only code some simpler descriptive statistics. As shown in section C of the
261 supplemental information, these applications revealed the same energy company tactics
262 and landowner characteristics that were found in our full random sample. This gives us
263 additional confidence that our sample of 40 random orders is indeed representative of the
264 total universe of cases. Our analysis hereafter focuses on the random sample of 40
265 applications.

266 Each of our 40 randomly-selected applications proposes a HVHF drilling unit and
267 contains some standard financial, legal, and geological, exhibits in support of the
268 proposal. Importantly, one of these exhibits must show that the company has already
269 obtained voluntary leases from landowners representing at least 65% of the surface acres
270 of the proposed unit, and that they have made an effort to negotiate voluntary leases with
271 the landowners representing the other 35%. These exhibits provide in-depth descriptions
272 of the negotiations between the Landmen and any landowner who did not sign a
273 voluntary lease. Future research could examine what other legal standards these
274 negotiations must meet, i.e. what Landmen legally can and cannot say during these
275 negotiations, but in this paper our focus is procedural equity, i.e. whether landowners can
276 authentically participate in making decisions³³.

277 It is important to note that if voluntary permission was given by 100% of
278 landowners, then compulsory unitization is unnecessary. Moreover, even when

279 compulsory unitization applications are submitted, contact logs are only provided for
280 those landowners who had not yet signed voluntarily. This creates an inference problem:
281 we cannot understand how companies treat non-consenting landowners unless we have
282 examples of how they treat consenting landowners. To ameliorate this inference problem,
283 we use application updates and supplements. These documents provide additional
284 information about landowners who consented to voluntary leases during the interim
285 period between submission and approval. This gives us crucial analytical leverage,
286 because it means we now observe not just what happens to the landowners who did not
287 give consent, but also to the landowners who do. This allows us to test whether persistent
288 and personalized tactics are used widely, and it allows us to test whether economic
289 holdouts and unreachable landowners are still the primary subjects of compulsory
290 unitization.

291 Nevertheless, we are still limited by only including cases where compulsory
292 unitization was applied for. However, to put this in context, it is worth considering that
293 compulsory unitization applications by no means rare. The Ohio DNR reports that during
294 the period of our study, 2014-2021, there were 2,356 applications submitted for new
295 horizontal wells. Roughly 40% of these seem to have required compulsory unitization
296 applications. Even if our findings are only representative of this 40%, this is still a
297 significant fraction of all drilling activity. Interestingly, as we code supplements,
298 approvals, and withdrawals, we also found no evidence of any applications being rejected.
299 All the applications in our sample were either approved by the Ohio DNR, or no

300 conclusion was reached, or they were withdrawn voluntarily by the company because the
301 last landowners had signed and drilling could proceed without compulsory unitization.

302

303 Evidence of Persistent and Personalized Negotiating Tactics

304

305 We now discuss the random sample of 40 applications. Three of these randomly
306 selected applications were very slightly geographically tweaked version of a prior
307 application, and we treat these as supplements, giving us 37 applications in total. From
308 our random sample of 37 applications, we create a dataset of 7,667 observations. Of these
309 7,667 landowner-tracts, 2,406 or about 31% were released at some point in the
310 application process. For each released landowner-tract, the application has to include a
311 log of every time a landowner was contacted about leasing, including the date, method,
312 and result of the conversation. These contact logs are written by the Landmen, who sign
313 an affidavit about their veracity. However, given that these Landmen are employees of the
314 energy company, and the energy company is applying for compulsory unitization to
315 proceed, Landmen may face a conscious or unconscious bias to downplay landowner
316 opposition to compulsory unitization. We cannot assess this with our current data, but
317 even if Landmen records are biased, this only creates a harder test for our hypotheses
318 about their use of persistent and personalized tactics, and their use of compulsory
319 unitization to overcome reluctance.

320 To test our first hypothesis, that we would find qualitative evidence of persistent
321 and personal tactics, we examine these contact logs in more detail. Figure 1 below is an

322 example of what a contact log looks like. We have redacted the names of the company
323 representative and the owner, as well as the address and parcel number of the owner.

324

325 [Figure 1 Here]⁴⁸

326

327 The specific log shown in Figure 1 contains nineteen contacts, each with a date, name
328 (redacted here) and a summary. Each summary is only a sentence or two long, detailing
329 the method of contact – e.g. phone, in-person, certified mail – and the key points of the
330 conversation. This particular example also highlights the tactics used by energy
331 companies. In July and August 2014, the landowner is clearly opposed to signing a lease,
332 but the company persists in its attempts to obtain her signature. When their calls go
333 unanswered, they send letters. When those are returned with “REFUSED” hand-written
334 across them, Landmen drive to her house. When she refuses to answer the door, they
335 speak to her neighbors and family members. This brings up the possibility that Landmen
336 may use landowners to pressure each other, creating either geographic or familial
337 correlation in leasing choices. In section B of the Appendix we explore this as part of a
338 robustness check for our model, but future research is necessary to investigate this in
339 more detail. Finally, the Landmen explicitly explain that she will be compelled into a
340 contract, i.e. that her refusal will not prevent drilling from occurring. She is described as
341 belligerent and difficult. The Landmen use a variety of persistent and personal tactics,
342 including talking to her neighbors, and taking advantage of compulsory unitization, to
343 overcome this reluctance.

344 In support of hypothesis one, we find that these same types of tactics occur in
345 many other contact logs. Figure 2 shows the contacts between a Landman, and a
346 landowner who is in hospital undergoing radiation treatment. The landowner is
347 apparently willing to sign, but wishes to get home from the hospital before discussing it.
348 For several weeks, the Landman continues to contact this landowner whilst they are in
349 hospital.

350

351 [Figure 2 Here]⁴⁹

352

353 Although the contact log only gives limited information about these interactions, it is
354 clear that the energy company is pushing for a signature. In Figure 2, just as in Figure 1, if
355 the landowner does not sign immediately, this is not addressed through an improved
356 offer. Instead, persistent personal contacts are used to gain a signature. If that does not
357 work, compulsory unitization is used. Figure 3 shows a final example of these tactics. In
358 this contact log, on the 30th of January, a husband says that he wants to sign but his wife
359 does not. The Landman then schedules a meeting with the husband when the wife is not
360 home. They continue to review a potential lease, but the landowner has already raised
361 numerous environmental objections that the Landman has not been able to assuage. The
362 Landman states “the outlook is not promising” for reaching a voluntary agreement, and
363 the company moves ahead with unitization. The landowners finally turn adamantly
364 against leasing, as they are worried about noise after speaking to their neighbor. The final
365 line of the contact log states that the husband “believes that by not signing the lease he

366 will be able to stop the drilling from occurring”. But with compulsory unitization already
367 underway, the landowner is wrong. Figure 3 thus illustrates the twin disadvantages faced
368 by reluctant landowners: the persistent and personal tactics used by energy companies,
369 and the institution of compulsory unitization.

370
371 [Figure 3 Here]⁵⁰

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373

374 Evidence of Legal Compulsion

375
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377
378 The same disadvantages emerge when we look at these data quantitatively. By
379 coding these contact logs and creating a dataset of all of the negotiations, we can show
380 that the persistent, personalized, tactics, and the use of compulsory unitization, are not
381 limited to the instances above. However, creating this dataset is not a straightforward
382 process. As is clear from Figures 1-3, the records are highly heterogeneous. Some contact
383 logs have detailed descriptions of each conversation, but others contain only the briefest
384 of summaries. As mentioned earlier, there is also the possibility that these are selective
385 histories. Landmen may have an incentive to downplay their own persistence, or any
386 landowner opposition. Although future research may be able to unpack these features of
387 the contact logs in more detail, we focus on the most concrete and consistent information
388 they provide. This approach helps us code the most reliable variables, but not necessarily
389 the most valid. However, it is an important first step given the novelty of the data sources.
390 More details on the coding scheme are available in the codebook accompanying the
391 dataset. Coding was initially done by individual co-authors, after a joint training, and all

392 counts were then reviewed for consistency by the lead author. These procedures help us
393 establish the reliability of this measure.

394 First, we code three variables that help us understand the general levels of
395 landowner reluctance and Landman persistence. These variables are the length of the
396 negotiation in days, the number of times the landowner was contacted, and the number
397 of times the Landman attempted to contact the landowner. We expect that on average,
398 these variables are useful proxies for landowner reluctance and Landman persistence. The
399 first variable, length in days, is calculated straightforwardly by counting the days between
400 the first and last entries in the contact log. Then we use each row of the contact log to
401 code the number of times the landowner was contacted, and the number of times the
402 Landman attempted to contact them. We call these two variables the number of
403 successful contacts, and the number of unsuccessful contacts. 'Success' in this context
404 does not mean the energy company succeeded in getting what it wants; instead we use it
405 to mean a contact where the landowner was successfully reached. The number of failed
406 contacts is then the number of times the Landman tried and failed to make contact with
407 the landowner. For example, Figure 1 would be coded as having six successful contacts
408 and thirteen failed contacts. The first contact is failed, because the Landman calls but
409 there is no answer. The second contact is successful, because the Landman spoke to the
410 landowner. We then do this for all rows of the contact log. We expect that a higher
411 number of successful contacts is a proxy with more Landowner reluctance. This is
412 because Landmen stop calling once agreement has been reached. The only way for the
413 number of successful contacts to grow is if the landowner does not agree to sign.

414 Although they may be choosing not to sign for a variety of different reasons, we expect
415 that in general, a higher number of successful contacts is associated with higher
416 reluctance. The number of successful contacts and the number of failed contacts are both
417 also useful measures of Landman persistence. Higher scores on these variables mean that
418 a Landowner is being contacted more persistently. We also measure how personalized the
419 Landman tactics are, by creating binary indicators for whether different contact methods
420 were used: phone calls, e-mails, in-person meetings, postal mail, text messages, certified
421 mail, social media, or online/archival research. This helps us measure the frequency of
422 more personalized tactics such as phone calls or in-person visits, as well as less
423 personalized tactics such as postal mail.

424 Alongside these variables, we also code three variables that add some context to
425 about how landowners actually experience these persistent and personalized tactics. First,
426 ‘Attorney’ is a binary indicator of whether the landowner had an attorney/legal
427 professional to represent them at any point in negotiations. This helps capture whether
428 landowners are at a disadvantage in terms of legal expertise. We code ‘Hung Up’,
429 measuring whether the landowner ever hung up on a Landman or cut the conversation
430 short in another way, such as by closing the door on them. This helps capture any
431 landowner hostility to Landmen. We also code ‘Opposition to Drilling’ counting instances
432 where a landowner said they were opposed to drilling.

433 Finally, we code three more variables, in order to test hypothesis two: unreachable
434 landowners, economic holdouts, and whether negotiations ended in compulsion or in
435 consent. First, we code ‘unreachable landowners’ as landowners who had at least one

436 failed contact, and zero successful contacts. There are 752 such landowners in our 2,406
437 contact logs. We then code 'economic motivations' as present if there is ever a specific
438 mention of royalty payments, or bonus payments. Simply asking for 'better terms' of a
439 lease was not coded as economic motivation, since better terms could also involve adding
440 clauses limiting noise, surface use, etc. We found that 297 of our 2406 contact logs
441 included a mention of an economic motivation. Finally, we code whether compulsory
442 unitization was actually implemented or whether voluntary agreement was eventually
443 reached. We create a binary indicator equal to zero when negotiations end in
444 compulsion, and equal to one for negotiations where the landowner eventually signed
445 voluntarily. We find 595 negotiations that end in voluntary agreement, and 1,806 that end
446 in compulsion.

447 As described in the Methods section, we eliminate all duplicate negotiations, and
448 all negotiations where the landowner was a company, trust, or public entity. Table 1
449 below shows, for the remaining sample of contact logs, the descriptive statistics for all the
450 variables described above. Overall, we find widespread use of personalized tactics like
451 phone calls and visits, as well as evidence that these tactics are used persistently, as
452 Landmen make multiple attempts over multiple months to contact landowners. We also
453 find that many negotiations end in compulsion rather than in consent.

454

455 [Table 1 Here]

456

457 Table 1 therefore reinforces the findings of our qualitative analysis. The average
458 negotiation takes around six months and involves approximately nine attempts to contact
459 a landowner. The variables of negotiation duration, successful contacts, and unsuccessful
460 contacts, all have means higher than their medians, showing that while there may be
461 many short and routine negotiations, several negotiations drag on for a long time and
462 involve significant Landman persistence. We also find that Landmen often use
463 personalized tactics. The most common contact method was phone calls, which occurred
464 in around 77% of contact logs. The next most-common method was the use of research
465 tools such as tax databases and online person-finder services. These occurred in 51% of
466 contact logs. In-person visits are rarer, but do occur in around 15% of negotiations.
467 Sometimes Landmen will also approach landowners through social media, although this
468 happens in only 1% of cases. It is also worth noting that only 14% of the negotiations
469 feature landowners who retained legal representation – the overwhelming majority of
470 these landowners seemed to go through the negotiations without legal advice.

471 We also find that only 28% of these negotiations end in voluntary agreement. Even
472 with the caveat that we are only able to observe negotiations that occurred in the context
473 of compulsory unitization cases, this may seem like strong evidence of ‘quiet reluctance’.
474 However, only 1% of landowners mentioned opposition to HVHF. Hostility to Landmen –
475 as demonstrated by hanging up on them – only occurred in around 3% of cases. Economic
476 motivations were more common, as 17% mentioned wanting higher royalties or bonuses
477 before agreeing. Around 30% landowners were simply unreachable, with their
478 ‘negotiations’ involving only failed attempts to reach them. This makes it important to

479 now test our second hypothesis, about whether compulsory unitization is used only on
480 economic holdouts or unreachable landowners.

481 Tables 2 and 3 below show the results of this test. Table 2 shows that when
482 landowners do not mention an economic motivation, negotiations end in voluntary
483 agreement around 26% of the time. When landowners request higher bonuses or
484 royalties, the negotiation ends in voluntary agreement around 39% of the time. This
485 shows that economically-minded landowners are actually are more likely to reach
486 voluntary agreement. This difference is statistically significant at the 0.01 level and
487 constitutes strong evidence that despite being originally intended for use on economic
488 holdouts, compulsory unitization is now being used in many other situations. Table 3
489 shows that when landowners are 'reachable', i.e. when the energy company was able to
490 make contact with them at least once, around 30% of negotiations end in voluntary
491 consent. However, if landowners are completely unreachable as of the last records
492 submitted, then voluntary agreement is eventually reached in only 23% of negotiations.
493 This difference is statistically significant at the 0.05 level and suggests that compulsory
494 unitization is used more frequently on unreachable landowners. However, even when
495 landowners are reachable, compulsory unitization is still the most likely outcome, with
496 70% of negotiations ending this way. Overall, the evidence in Tables 2 and 3 suggests that
497 compulsory unitization is being used in negotiations with many different types of
498 landowners, rather than just the economic holdouts and unreachable landowners.
499 Compulsory unitization should be a Pareto-efficient institution, when applied as
500 originally intended²⁰. But Tables 2 and 3 show that its reach now extends much farther.

501

502 [Table 2 Here]

503 [Table 3 Here]

504

505 When combined with the qualitative findings from the contact log, the results of
506 Table 1 and Tables 2 and 3 suggest that landowners will find it very difficult to express any
507 type of reluctance in these negotiations. Persistent and personalized tactics are
508 widespread, as shown in Table 1. And if landowners do withhold consent, compulsory
509 unitization can be used, regardless of the reason that consent is not given. Environmental
510 concerns are hardly ever mentioned – although it is worth remembering that it is energy
511 company representatives writing the summaries – but whatever reason landowners have
512 for not immediately signing a lease, energy companies use persistency, and compulsory
513 unitization, to overcome this reluctance. These twin disadvantages constitute an
514 important impediment to procedural equity. It is important to reiterate that our sample
515 takes advantage of the paper trail left by compulsory unitization, which by definition will
516 not be applied in cases where voluntary consent was universally given. But we found that
517 only 60% of wells in Ohio proceed with full consent. And although we cannot know for
518 sure how this full consent was obtained, Landman pressure and the threat of compulsory
519 unitization may have been relevant, even in the cases where the full acreage was
520 voluntarily leased and compulsory unitization was never applied for.

521

522 Conclusion

523

524 We present an important dataset from Ohio, containing information about the
525 negotiations between landowners and energy companies over mineral rights. We use
526 compulsory unitization applications to investigate the tactics Landmen use to obtain
527 voluntary consent, and the legal approach companies take if consent is not forthcoming.
528 Previous research has found that energy companies have more resources, longer time
529 horizons, better legal counsel, and enjoy considerable deference (Malin *et al* 2019). We
530 add that they have significant advantages in the form of persistent and personalized
531 tactics, and the use of compulsory unitization. In roughly 40% of the HVHF wells drilled
532 in Ohio, compulsory unitization applications were used because voluntary consent from
533 landowners was not obtained. These applications reveal that many landowners do not
534 sign leases at the first opportunity. Instead there is evidence of landowner reluctance and
535 Landman persistence, and of legal compulsion when this persistence fails.

536 This suggests a considerable procedural inequity at the heart of the process. We
537 suggest that further research should examine these applications, including both
538 qualitative analysis of the conversation summaries, and quantitative analysis of the tactics
539 used. As current events in Eastern Europe turn global conversation again towards HVHF
540 in the US, it is important to ensure that property rights are respected, and that
541 regulations are protecting both landowners and energy companies. Collaborative
542 governance⁵¹ between these stakeholders is not incentivized under current institutions.
543 This highlights the general problem of technology being updated faster than regulations
544 are. This paper measures some of the harms created when 20th century regulations are

545 used to govern 21st century technologies. These harms are not just environmental and
546 health-related, but also occur in the realm of procedural justice.

547

548 Methods

549

550 This study was approved by the institutional review board at Knox College. For our
551 quantitative analysis, we code the compulsory unitization applications with the *rights-*
552 *holder by tract* as the unit of analysis. For simplicity, we refer to these rights-holders
553 within a tract as ‘landowners’. We code their names and addresses, their decimal share of
554 the total rights in the tract, the surface acres of the tract, the share that those net acres
555 represent of the total unit size, the tax identification number of the tract, and finally
556 whether they had signed voluntarily or not at the time of application. The number of
557 landowner-tracts ranges from a low of 33 in the Athens D application from Company G, to
558 a high of 893 in the Beallsville West application also submitted by Company G. The
559 controlled acreage never dips below 65%, since that is the compulsory unitization
560 threshold in Ohio, but it ranges from a low of 67.3% in the Milton Timber B application,
561 to a high of 100% in the Tighe and Caroline D-M units. In these two units, compulsory
562 unitization was only required to override other legal clauses regarding unit size. However,
563 even small unleased acreages can mean many unleased landowners if they are small-
564 acreage rights-holders – and that is precisely what we find with these data. This
565 corroborates earlier findings from Farrer et al.²⁰. They found that owners of smaller tracts
566 tended to be higher-value urban landowners who were less supportive of drilling.

567 Before conducting our analyses, we clean the data in two ways. First, we eliminate
568 all duplicate negotiations. If a single person owns tracts one, two, and three, and the
569 energy company wants to lease all three tracts, then there will be one negotiation
570 between the landowner and the energy company but the application PDF will include this
571 contact log three times; once for each tract. We therefore use probabilistic record linkage
572 to drop identical contact logs. From our 2406 contact logs, this leaves us with 850 unique
573 negotiations. Second, we remove all negotiations where the landowner was a company,
574 trust, or public entity, to leave only the negotiations with private individuals. Most
575 negotiations with companies involve other energy companies, and so the dynamics are
576 likely to be very different. Many of the trusts and public entities in the dataset also have
577 different dynamics, sometimes being legally forbidden to allow leasing. For example,
578 there are many instances of the Ohio Department of Transportation refusing to allow
579 leases under their land. Similarly, trusts and wills can include stipulations about land use,
580 and so these negotiations are also meaningfully different. Of our 850 unique negotiations,
581 76 are with a company, 112 are with a trust, and 23 are with a public entity. This leaves us
582 with 643 observations. The quantitative findings in this paper are based on these
583 observations.

584

585 Data Availability Statement

586

587 The data and the associated codebook are available on the professional website of the
588 corresponding author: <https://www.benfarrer.com/> and as supplementary information.

589 Source data for the figures were taken from the Ohio Department of Natural Resources
590 Oil and Gas Division Unitization Documents website.

591

592 Code Availability Statement

593

594 Analysis code is available for replication purposes on the professional website of the
595 corresponding author: <https://www.benfarrer.com/>

596

597 Acknowledgements

598 The authors gratefully acknowledge helpful comments from Alison Gocke, Elizabeth
599 Koebele, and Rachel Torres. This work was supported by National Science Foundation
600 Award #1851834: Decision and Risk Management Sciences, awarded to Ben Farrer and
601 Robert Holahan.

602

603 Author Contributions Statement

604 Ben Farrer: Theory, writing, analysis, grant management, and data collection.

605 Robert Holahan: Grant management and data collection.

606 Lydia Allen, Jonathan Doriscar, Victoria Johnson, and Soleil Smith: Data collection, and
607 developing coding scheme.

608 Tara Riggs, Kellyanne Allen: Data collection

609

610 Competing Interests Statement

611

612 The authors have no competing interests to declare

613 Tables

614

615 Table 1: Contact Log Descriptive Statistics

Variable	N	Mean	Median	S.D	Min.	Max.
Negotiation Duration in Days	643	176.10	140	206.25	0	1702
Successful Contacts	643	2.80	2	3.71	0	26
Failed Contacts	643	6.59	4	6.62	0	53
Method: Phone Calls	643	0.78	1	0.42	0	1
Method: E-mails	643	0.18	0	0.39	0	1
Method: In-Person	643	0.15	0	0.36	0	1
Method: Mail	643	0.50	0	0.50	0	1
Method: Text Message	643	0.03	0	0.18	0	1
Method: Certified Mail	643	0.49	0	0.50	0	1
Method: Social Media	643	0.01	0	0.10	0	1
Method: Research	643	0.51	1	0.50	0	1
Landowner Had Attorney	643	0.14	0	0.34	0	1
Landowner Hung Up on Landman	643	0.03	0	0.17	0	1
Landowner Opposed to Drilling	643	0.01	0	0.10	0	1
Landowner Economic Motivations	643	0.16	0	0.37	0	1
Unreachable Landowner	643	0.30	0	0.46	0	1
Negotiation Ended in Voluntary Agreement	643	0.28	0	0.45	0	1
Net Acres in Tract	643	1.04	0.24	6.00	0	100.73

616

617 Table 2: Compulsory Unitization is Not Used Only on Economic Holdouts

	Negotiations End With Compulsion	Negotiations End With Consent	Total
No Economic Motivation Mentioned	398 74.12%	139 25.88%	537 100%
Economic Motivation Mentioned	65 61.32%	41 38.68%	106 100%
Total	463 72.01%	180 27.99%	643 100%
Pearson $\chi^2 = 7.57$, $Pr = 0.006$			

618

619 Table 3: Compulsory Unitization is Not Used Only on Unreachable Landowners

	Negotiations End With Compulsion	Negotiations End With Consent	Total
Reachable Landowner	316 69.76%	137 30.24%	453 100%
Unreachable Landowner	147 77.37%	43 22.63%	190 100%
Total	471 72.24%	181 27.99%	643 100%
Pearson $\chi^2 = 4.52$, $Pr = 0.033$			

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621 Figure Legends

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623 Figure 1: An Example of a Contact Log

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625 Figure 2: Qualitative Evidence of Persistent and Personalized Tactics From Energy
626 Companies

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628 Figure 3: Further evidence of the Twin Disadvantages Faced by Non-consenting
629 Landowners

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		Noble, County	Seneca, Township	Unit	0.34 acres
7/31/2013					
8/19/2013					
8/30/2013					
9/11/2013					
7/3/2014					
7/9/2014					
7/14/2014					
7/26/2014					
8/4/2014					
8/5/2014					
8/11/2014					
10/24/2014					
11/21/2014					
11/28/2014					
12/2/2014					
12/3/2014					
1/9/2015					
1/12/2015					
3/11/2015					

Parcel Number: [REDACTED] (Tract 19) and [REDACTED] (Tract 73)
 Owner's Name [REDACTED] ("Current Owner")

Date	[REDACTED] Representative	WI Owner Representative	Method	Address of Contact	Response
8/18/2017	[REDACTED]	[REDACTED]	Phone Call	N/A	Spoke with [REDACTED] but he's in the hospital due to complications with his radiation treatments. Says he can meet when he gets home.
8/25/2017	[REDACTED]	[REDACTED]	Phone Call	N/A	Spoke with [REDACTED] he is willing to sign but is still in the hospital.
9/1/2017	[REDACTED]	[REDACTED]	Phone Call	[REDACTED]	[REDACTED]'s son [REDACTED] said he is receiving radiation treatments, but feels he may be coming home within the week.
9/7/2017	[REDACTED]	[REDACTED]	Phone Call	[REDACTED]	Spoke with [REDACTED]'s son who said the radiation treatments should be complete this week.
9/8/2017	[REDACTED]	[REDACTED]	Phone Call	[REDACTED]	[REDACTED]'s son called to tell me that [REDACTED] is home from the hospital and doing much better. Should be able to meet soon.

7/21/2015	Mr. ██████ called ██████ to apologize for the previous week. He reiterated that they are not going to lease because they strongly oppose oil and gas development. If ██████ would like to schedule another meeting, Mr. ██████ and his wife would be willing to listen for the sole purpose of having more information on what is taking place and how it will impact their property. During the phone call ██████ explained where their property is situated within the unit and also provided a rough estimate of the unit dimensions.
1/19/2017	A ██████ Representative, ██████ met with Mr. ██████ at his home. Mr. ██████ had questions that he felt were not answered previously. He was not at all interested in a well that would/could damage the environment and his property. ██████ assured him that drilling follows all rules and regulations and then went over some of those with Mr. ██████. ██████ then gave him the current fair market offer to lease. He is interested and will speaking with his wife this weekend.
1/30/2017	██████ attempted to reach Mr. ██████ by phone and by visiting his house on numerous occasions. When ██████ meets with Mr. ██████ he tells him that he wants to sign, but his wife does not. He is going to continue to try to convince her to sign a lease.
2/6/2017	██████ meets with Mr. ██████ in his home. His wife was not home. Mr. ██████ then says that he believes there is a glut of oil and gas in the country and the price of it is too low right now. He said if we were at war he would sign, but that is not the current situation. A meeting is set up with Mr. ██████ and his wife for later in the week.
2/20/2017	██████ attempted to schedule a meeting with Mr. ██████ and his wife.
2/22/2017	██████ spoke with Ms. ██████. ██████ is planning on meeting with Mr. ██████ and Ms. ██████ the following Wednesday.
3/6/2017	██████ met with Mr. ██████ and reviewed an oil and gas lease with him. He is going to reconsider leasing his rights. He wants more time before making a decision.
3/22/2017	██████ met briefly with Ms. ██████. Her position on signing an oil and gas lease has turned very negative. She will not give any reasons, but the outlook is not promising.
6/12/2017	██████ spoke with Ms. ██████ and expressed to him that ██████ is moving forward with a unitization hearing to include their land in a production unit. After hearing this she agreed that her husband and herself would meet with ██████ on either the 20th or 21th of June.
6/19/2017	██████ left a voicemail for Mr. ██████ regarding setting a meeting time for the following Wednesday.
6/24/2017	██████ had a meeting with Mr. ██████ at his home. They reviewed the oil and gas lease together and Mr. ██████ acknowledged that he appreciated the information provided about the permit status of the well. He appears to be open to signing an oil and gas lease. His wife was unable to make the meeting. ██████ instructed Mr. ██████ that ██████ needs an answer by next Friday if they are going to lease or not.
6/30/2017	██████ spoke to Mr. ██████ by phone. He stated that he spoke with one of his neighbors who showed him where the well is going to be located. His neighbor then told him his road was going to get improved and become a "super highway." Mr. ██████ is very mad about this. ██████ explained to him that the road would be busy during the drilling period, but after the initial construction phase traffic would be limited. Mr. ██████ believes that by not signing the lease he will be able to stop the drilling from occurring.