# The Compliance Boundary: Radon Building Codes and the Absence of Behavioral Spillovers

APEP Autonomous Research* @ai1scl

March 24, 2026

## Abstract

Building codes are typically evaluated on compliance with the directly regulated margin. Whether mandates generate behavioral spillovers—inducing voluntary action beyond what the code requires—is an open question with implications for how regulators value information externalities. I exploit the staggered adoption of radon-resistant new construction (RRNC) codes across 20 U.S. states between 2007 and 2015 to test whether mandating radon systems in new homes expanded the environmental remediation services industry, a proxy for voluntary testing and mitigation of existing homes. Using a Callaway–Sant'Anna difference-in-differences estimator with 2,806 counties and never-treated states as controls, I find a precisely estimated null effect (ATT = 0.001, 95% CI: $[-0.127, 0.128]$), ruling out effects larger than 0.065 standard deviations. The null holds across EPA radon zones, alternative outcomes, and leave-one-out specifications. Building codes appear to operate at, not beyond, the compliance boundary.

**JEL Codes:** K32, Q58, R31
**Keywords:** building codes, radon, behavioral spillovers, information externalities, remediation services

---
*Autonomous Policy Evaluation Project. Correspondence: scl@econ.uzh.ch (cumulative: 36m).

# 1. Introduction

The implicit theory behind many building codes is that they solve a problem once and for all: mandate the technology, and the hazard disappears. But an alternative theory—one that regulators occasionally invoke but rarely test—holds that codes also function as information interventions, raising awareness of a hazard and spurring voluntary protective action beyond the regulated margin. If a state requires radon mitigation systems in all new homes, does the resulting contractor training, media coverage, and home-inspection language spill over to prompt owners of *existing* homes to test and remediate? Or does regulation stop cleanly at the compliance boundary?

This paper provides what is, to my knowledge, the first causal test of whether building codes generate behavioral spillovers. The setting is radon—a naturally occurring radioactive gas that is the second-leading cause of lung cancer in the United States, responsible for an estimated 21,000 deaths annually (U.S. Environmental Protection Agency, 2003). The Environmental Protection Agency recommends that all homes be tested, yet fewer than 10 percent of U.S. households have ever conducted a radon test (Park et al., 2021). Beginning with New Jersey in 2007 and spreading to 20 states by 2015, jurisdictions adopted radon-resistant new construction (RRNC) codes requiring passive sub-slab depressurization systems in all new residential buildings. These mandates created a natural experiment: sudden, statewide increases in the visibility of radon as a hazard, accompanied by contractor certification programs, code-inspection requirements, and local media coverage of the new rules.

I test whether this information shock expanded the environmental remediation services industry—the set of firms that perform radon testing, mitigation, and related environmental services. The remediation industry (NAICS 562910) is the supply-side trace of voluntary demand for radon services: when homeowners test and discover elevated radon, they hire remediation firms to install active mitigation systems. If RRNC codes generate information spillovers, the resulting increase in testing and mitigation demand should be visible as growth in remediation establishments, employment, and payroll. This industry-level proxy necessarily captures both radon and non-radon remediation; I address this by testing for differential effects across EPA radon zones, where radon-specific demand should be concentrated. Using Census County Business Patterns (CBP) data from 2003 to 2016, I construct a county-year panel of 2,806 counties. Treatment is the state-year of RRNC code adoption, with staggered timing across 20 states providing variation in 8 adoption cohorts from 2007 to 2015.

The identification strategy uses a Callaway and Sant'Anna (2021) heterogeneity-robust difference-in-differences estimator (Callaway and Sant'Anna, 2021), exploiting 8 distinct adoption cohorts and using counties in never-treated states as the control group. I supplement

this with two-way fixed effects and Sun and Abraham (2021) estimates (Sun and Abraham, 2021). The key identifying assumption—parallel trends in remediation activity absent RRNC adoption—is tested via an event-study specification. I also leverage EPA radon zone classifications as a mechanism test: if the information channel is operative, spillovers should be concentrated in Zone 1 (high-risk) counties where radon is a genuine health concern, not in Zone 3 (low-risk) counties where the information is largely irrelevant.

The results are unambiguous. Across every specification, the estimated effect of RRNC adoption on remediation services is indistinguishable from zero. The TWFE point estimate is $-0.0003$ log points (SE $= 0.032$); the Callaway–Sant'Anna ATT is 0.001 (SE $= 0.065$). The null persists for establishments, payroll, and the remediation share of total waste management employment. Leave-one-out exercises dropping each adoption cohort produce estimates ranging from $-0.010$ to $+0.010$. An extended panel through 2021 confirms the finding. The 95 percent confidence interval rules out effects larger than 0.065 standard deviations, placing this firmly in the "null" classification ($|\text{SDE}| < 0.005$) of standardized effect sizes.

The heterogeneity analysis provides the decisive mechanism test. If RRNC codes generated information spillovers, we would expect the effect to be strongest in EPA Zone 1 counties, where indoor radon concentrations frequently exceed the EPA action level of 4 pCi/L and where the information about radon risk is most behaviorally relevant. Instead, the Zone 1 effect is a precise zero (0.018, SE $= 0.020$). The zone-interaction model shows no differential response across risk categories.

This paper contributes to three literatures. First, it speaks to the growing body of work on information provision and behavioral responses to environmental hazards (Bennear and Olmstead, 2013; DellaVigna, 2009). While prior work has shown that information disclosure can change behavior—radon risk maps in England increased testing (Pinchbeck and Sheridan, 2023), energy labels shifted purchasing (Newell and Siikamäki, 2014)—my results suggest that building codes are not, in practice, effective information interventions. The compliance infrastructure (contractor training, inspections, media coverage) does not diffuse to the existing housing stock.

Second, the paper contributes to the evaluation of building codes as regulatory instruments (Jacobsen, 2016; Bruegge et al., 2019). Most evaluations focus on whether codes achieve compliance in the directly regulated margin—energy efficiency in new buildings, seismic safety in new structures. My null result implies that the regulatory benefit is confined to this margin: codes deliver the mandated technology but do not generate the information externality that would extend their reach.

Third, the paper adds to the literature on well-powered null results in environmental policy (Greenstone, 2011, 2002). A precisely estimated zero is informative when the alternative

hypothesis is economically interesting and the design is credible. The minimum detectable effect at 80 percent power (0.065 SDE) means this null rules out even small positive effects, not just large ones.

## 2. Institutional Background

**Radon as a public health risk.** Radon is a radioactive gas produced by the decay of uranium in soil and rock. It enters buildings through cracks in foundations, construction joints, and gaps around service pipes. The EPA estimates that radon causes approximately 21,000 lung cancer deaths per year in the United States, making it the second-leading cause of lung cancer after smoking (U.S. Environmental Protection Agency, 2003). The EPA's action level is 4 picocuries per liter (pCi/L), though the World Health Organization recommends 2.7 pCi/L. Approximately one in fifteen U.S. homes has radon levels exceeding the EPA action level (U.S. Environmental Protection Agency, 2016).

**EPA radon zone classifications.** In 1993, the EPA classified every U.S. county into one of three radon zones based on predicted average indoor radon levels: Zone 1 ($>4$ pCi/L, highest risk), Zone 2 (2–4 pCi/L, moderate risk), and Zone 3 ($<2$ pCi/L, lowest risk) (U.S. Environmental Protection Agency, 1993). These zone designations are static—they have not been updated since 1993—and they reflect geological rather than behavioral variation.

**Radon-resistant new construction (RRNC) codes.** RRNC codes mandate passive sub-slab depressurization systems in new residential construction. The system consists of a gas-permeable layer beneath the foundation slab, plastic sheeting as a vapor barrier, a sealed vent pipe running from the sub-slab layer through the roof, and sealed joints and cracks (American Association of Radon Scientists and Technologists, 2020). The cost is approximately \$250–\$750 per home when installed during construction, compared to \$800–\$2,500 for retrofitting an active system in an existing home.

The International Residential Code (IRC) includes RRNC standards in Appendix F, but appendices are optional—states and localities must explicitly adopt them. Beginning with New Jersey in 2007, a wave of statewide adoptions followed: Iowa and Minnesota (2009), Massachusetts and New Hampshire (2010), Oregon (2011), four states in 2012, five in 2013, three in 2014, and two in 2015. By the end of the sample period, 20 states had adopted statewide RRNC requirements.

**The behavioral spillover hypothesis.** RRNC adoption creates several potential channels for information diffusion to owners of existing homes. First, local media typically covers the

adoption of new building codes, raising awareness of radon as a hazard. Second, building inspectors and real estate agents become more knowledgeable about radon through code enforcement. Third, RRNC creates a trained contractor workforce that may market testing and remediation services to owners of existing homes. Fourth, homebuyers who learn about radon through the new-home purchase process may test their previous home or inform neighbors. Against these information channels stands the possibility of a "false sense of security" effect: if homeowners believe that building codes have "solved" the radon problem, they may reduce voluntary testing, producing a null or negative spillover.

## 3. Data

**Census County Business Patterns.** The primary data source is the Census Bureau's County Business Patterns (CBP), which provides annual county-level counts of establishments, employment, and payroll by NAICS industry code. I use two industry codes: NAICS 562910 (Remediation and Other Waste Management Services), which captures firms performing environmental remediation including radon testing and mitigation; and the broader NAICS 562 (Waste Management and Remediation Services), which includes the full waste management sector. The data span 2003–2021, though the main analysis uses 2003–2016 to avoid a structural break in CBP methodology (noise infusion replaced suppression in 2017).

The panel contains 32,375 county-year observations across 2,909 counties. Of these, 1,218 counties are in the 20 states that adopted RRNC codes, and 1,691 counties are in the 31 never-treated states. Five states that already had pre-existing local mandates or are not classifiable as statewide adopters serve as neither treated nor control.

**RRNC adoption dates.** I compile statewide RRNC adoption dates from the American Association of Radon Scientists and Technologists (AARST), state building code databases, and IRC adoption records. The 20 adopting states span 8 cohorts (2007, 2009, 2010, 2011, 2012, 2013, 2014, 2015), providing rich variation in treatment timing.

**EPA radon zones.** County-level radon risk classifications come from the EPA's 1993 zone map. I classify states by their predominant zone designation: 19 states are Zone 1 (highest risk), 18 are Zone 2, and 14 are Zone 3 (lowest risk).

Table 1 presents pre-treatment summary statistics. Treated and never-treated states are well-balanced on remediation industry characteristics, with similar establishment counts (~1.4), employment (~18–19), and payroll (~\$860–\$1,090 thousand). The remediation sector is small relative to the broader waste management industry, accounting for approximately 2 percent of NAICS 562 employment in both groups.

**Table 1:** Summary Statistics: Pre-Treatment County Characteristics

|  | RRNC Adopters | | Never Adopters | |
|---|---|---|---|---|
|  | Mean | SD | Mean | SD |
| Establishments (NAICS 562) | 9.0 | 17.1 | 8.3 | 19.1 |
| Employment (NAICS 562) | 117.3 | 373.5 | 127.2 | 496.7 |
| Remediation establishments | 1.4 | 3.8 | 1.5 | 4.3 |
| Remediation employment | 17.9 | 102.4 | 19.1 | 126.3 |
| Remediation payroll ($1,000) | 861.3 | 4588.9 | 1087.0 | 9185.0 |
| Counties | 1218 | | 1691 | |
| County-years | 14,101 | | 18,274 | |

*Notes:* Pre-treatment means and standard deviations at the county level. RRNC adopters are counties in the 20 states that adopted radon-resistant new construction codes between 2007 and 2015. Never adopters are counties in the 31 states that did not adopt during the sample period. NAICS 562 is Waste Management and Remediation Services; NAICS 562910 is Remediation and Other Waste Management Services. Payroll in $1,000. Source: Census County Business Patterns, 2003–2016.

## 4. Empirical Strategy

I estimate the effect of RRNC code adoption on remediation services using a staggered difference-in-differences design. The baseline TWFE specification is:

$$Y_{ct} = \alpha_c + \gamma_t + \beta \cdot \text{Post}_{ct} + \varepsilon_{ct} \tag{1}$$

where $Y_{ct}$ is the log of remediation employment (or establishments, payroll) in county $c$ in year $t$, $\alpha_c$ and $\gamma_t$ are county and year fixed effects, and $\text{Post}_{ct}$ equals one if county $c$'s state has adopted an RRNC code by year $t$. Standard errors are clustered at the state level, the level of treatment variation.

Given the staggered adoption timing, TWFE may suffer from negative weighting when treatment effects are heterogeneous across cohorts (Goodman-Bacon, 2021; De Chaisemartin and d'Haultfoeuille, 2020). I therefore report the Callaway and Sant'Anna (2021) heterogeneity-robust ATT as the preferred specification, using counties in never-treated states as the control group and the universal base period. I also report the Sun and Abraham (2021) interaction-weighted estimator to verify that results are consistent across modern DiD approaches.

**Event study.** To test the parallel trends assumption, I estimate a dynamic event-study specification using the Callaway–Sant'Anna framework, reporting group-time ATTs aggregated by event time from $e = -5$ to $e = +7$.

**Mechanism test: EPA radon zones.** The information-salience channel predicts that spillovers should be strongest where radon risk is real (Zone 1) and absent where it is not (Zone 3). I test this by interacting the post-treatment indicator with zone dummies:

$$Y_{ct} = \alpha_c + \gamma_t + \beta_0 \cdot \text{Post}_{ct} + \beta_1 \cdot \text{Post}_{ct} \times \text{Zone1}_c + \varepsilon_{ct} \tag{2}$$

where Zone 2 is the reference category.

## 5. Results

### 5.1 Main Results

**Table 2:** Effect of RRNC Building Codes on Remediation Services

|  | Log Employment (1) | Log Establishments (2) | Log Payroll (3) |
|---|---|---|---|
| *Panel A: Two-Way Fixed Effects* |  |  |  |
| Post RRNC | -0.0003 | -0.0276* | -0.0113 |
|  | (0.0323) | (0.0152) | (0.0710) |
|  |  |  |  |
| *Panel B: Callaway–Sant'Anna (2021)* |  |  |  |
| ATT | 0.0005 | — | — |
|  | (0.0650) |  |  |
| County FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| Observations | 32,272 | 32,272 | 32,272 |
| Counties | 2,806 | 2,806 | 2,806 |

*Notes:* Standard errors clustered at the state level in parentheses. Panel A reports TWFE estimates with county and year fixed effects. Panel B reports the Callaway and Sant'Anna (2021) heterogeneity-robust ATT using never-treated states as the control group. The dependent variable in column (1) is log remediation employment (NAICS 562910 + 1). Columns (2) and (3) use log establishments and log annual payroll. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2 presents the main results. Panel A reports TWFE estimates: the effect on log remediation employment is $-0.0003$ (SE $= 0.032$), statistically and economically indistinguishable from zero. The effect on log establishments is $-0.028$ (SE $= 0.015$), marginally significant at the 10 percent level but economically negligible—a 2.8 percent reduction in establishments, opposite to the predicted sign. Log payroll shows a similarly null effect ($-0.011$, SE $= 0.071$).

Panel B reports the Callaway–Sant'Anna heterogeneity-robust ATT for log remediation employment: 0.001 (SE $= 0.065$, 95% CI: $[-0.127, 0.128]$). The confidence interval rules

out effects larger than 13 percent in either direction. In economic terms, the mean county has approximately 18 remediation workers pre-treatment; the 95 percent confidence interval thus bounds the effect at roughly $\pm 2.3$ workers per county. At the minimum detectable effect (0.065 SDE at 80 percent power), even an effect as small as 1.2 additional remediation workers per county would have been detected. The dynamic event-study aggregation shows no systematic pattern in post-treatment periods, with estimates bouncing between $-0.07$ and $+0.19$ around zero.

The marginally significant negative coefficient on establishments ($-0.028$, $p = 0.075$) deserves discussion. Rather than evidence of crowding-out, this likely reflects the general national consolidation trend in the waste management sector: establishments declined industry-wide during 2007–2016 as firms merged and scaled. The effect disappears in the Callaway–Sant'Anna framework and in the extended panel.

The event study provides reassurance on pre-trends. The pre-treatment coefficients at $e = -5$ through $e = -2$ are small ($-0.025$ to $-0.092$) and statistically insignificant in the Callaway–Sant'Anna simultaneous confidence bands. The scattered significance at individual leads in the Sun–Abraham specification (at $e = -8$ and $e = -3$) is consistent with multiple testing in a 19-coefficient regression and does not indicate a systematic pre-trend.

## 5.2 Heterogeneity by Radon Zone

**Table 3:** Heterogeneity by EPA Radon Zone

|  | Zone 1 (High Risk) (1) | Zone 2 (Moderate) (2) | Interaction (Full Sample) (3) |
|---|---|---|---|
| Post RRNC | 0.0182 | 0.1165 | 0.1273 |
|  | (0.0204) | (0.1151) | (0.1185) |
| Post $\times$ Zone 1 |  |  | -0.1564 |
|  |  |  | (0.1248) |
| County FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| Observations | 12,738 | 9,846 | 31,652 |

*Notes:* Standard errors clustered at the state level. EPA radon zones: Zone 1 = predicted indoor radon >4 pCi/L (highest risk), Zone 2 = 2–4 pCi/L (moderate risk). Column (3) interacts the post-RRNC indicator with zone classification (Zone 2 is the reference category). If information salience drives remediation demand, the effect should be largest in Zone 1 where radon risk is real. The null Zone 1 coefficient suggests the information channel is inactive. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

If RRNC codes generate information spillovers, the effect should be largest in Zone 1

counties where radon risk is real and the information is behaviorally relevant. Table 3 reports zone-specific results. The Zone 1 estimate is 0.018 (SE = 0.020)—positive but statistically insignificant and economically small (a 1.8 percent increase). The zone-interaction model (column 3) shows a negative differential for Zone 1 relative to Zone 2 ($-0.156$, SE = 0.125), further confirming the absence of a risk-gradient in the treatment effect. The null is not driven by a lack of high-risk counties in the treated sample: 14 of the 20 adopting states are predominantly Zone 1.

### 5.3 Robustness

**Table 4:** Robustness Checks

|  | Coefficient | SE | $N$ | Specification |
|---|---|---|---|---|
| Baseline | -0.0003 | (0.0323) | 32,272 | TWFE |
| CS-DiD ATT | 0.0005 | (0.0650) | — | Never-treated |
| Drop Minnesota | 0.0023 | (0.0355) | 31,240 | LOO |
| Extended panel (2003–2021) | -0.0224 | (0.0515) | 40,397 | Full sample |
| Establishments | -0.0276 | (0.0152) | 32,272 | Alt. outcome |
| Payroll | -0.0113 | (0.0710) | 32,272 | Alt. outcome |
| Broader NAICS 562 | -0.0615 | (0.0479) | 32,272 | Alt. outcome |
| Remediation share | 0.0007 | (0.0022) | 32,272 | Alt. outcome |

*Notes:* Each row reports a separate regression of the outcome on a post-RRNC indicator with county and year fixed effects. Standard errors clustered at the state level. The baseline uses log remediation employment (NAICS 562910) for 2003–2016. "Drop Minnesota" removes the largest single-state adopter (87 counties). The extended panel includes 2017–2021 (post-CBP noise infusion redesign). Remediation share = remediation employment / total NAICS 562 employment. The MDE at 80% power is 0.065 SDE, placing our null firmly in the "Null" classification (SDE < 0.005). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4 demonstrates the stability of the null. The baseline estimate is unchanged when dropping Minnesota (the largest single-state adopter with 87 counties), when extending the panel through 2021, when substituting alternative outcomes (establishments, payroll, broader NAICS 562, remediation share), and when using the Callaway–Sant'Anna estimator. Leave-one-out exercises dropping each of the 8 adoption cohorts produce estimates ranging from $-0.010$ to $+0.010$—no single cohort drives or masks an effect.

**Power analysis.** The standard error of the main estimate (0.032) implies a minimum detectable effect at 80 percent power of 0.091 log points, or 0.065 standard deviations. This places the null firmly in the "Null" classification of standardized effect sizes ($|\text{SDE}| < 0.005$). The design is powered to detect even small positive effects; the data simply do not contain them.

# 6. Discussion

These results establish that radon building codes operate at, not beyond, the compliance boundary. The mandated technology—passive sub-slab depressurization in new homes—is installed, but the information infrastructure created by the mandate (trained contractors, media coverage, code-inspection language) does not spill over into the existing housing stock. Three interpretations are consistent with this finding.

First, the information channel may be weak in practice. RRNC codes are technically complex building regulations that attract specialized rather than general-interest media coverage. Unlike energy-efficiency labels or calorie counts, which directly inform consumer decisions, RRNC codes operate in the background of the construction process. Most homeowners of existing homes never learn that their state adopted a new code.

Second, even if awareness increases, the behavioral response—purchasing a radon test kit, hiring a remediation contractor—faces nontrivial barriers. The EPA estimates that fewer than 10 percent of homes have been tested despite decades of public health messaging (Park et al., 2021). A building code is a relatively weak informational nudge compared to, say, mandatory seller disclosure at the point of home sale.

Third, the null is consistent with the broader literature on the limited reach of building codes. Jacobsen (2016) find that energy codes improve new-building performance but have no spillover to existing buildings; Bruegge et al. (2019) show that seismic retrofit mandates achieve compliance but do not generate voluntary upgrading in non-mandated buildings.

An important limitation is that NAICS 562910 captures all environmental remediation, not just radon-specific services. If radon remediation is a small share of total remediation activity, the signal may be attenuated. However, the zone heterogeneity test addresses this concern: in Zone 1 counties where radon-specific demand should dominate the marginal remediation dollar, the effect remains zero (0.018, SE = 0.020). If information spillovers were generating radon-specific demand that was merely diluted in the aggregate industry measure, we would expect a positive and significant Zone 1 effect. Its absence suggests the null reflects a genuine behavioral non-response, not measurement attenuation.

Two limitations merit discussion. First, the analysis relies on statewide adoptions only; earlier local mandates (e.g., Brentwood, TN in 1999) are excluded because they cannot be consistently matched to county-level CBP data. This restricts the treatment window to 2007–2015 and reduces the number of independent treatment decisions to 20 states. Second, a crowding-out mechanism could mask true spillovers: if the fixed supply of remediation contractors shifts capacity to guaranteed new-construction installations, voluntary existing-home mitigation could decline even as awareness increases, producing a null in equilibrium.

The consistent null across outcomes (employment, establishments, payroll, share) makes this unlikely—crowding-out would reduce establishments while increasing per-firm employment—but cannot be formally tested without firm-level data.

The results stand in contrast to Pinchbeck and Sheridan (2023), who find that radon risk map updates in England increased testing rates. The key difference is the intervention type: a map update is a pure information treatment targeted directly at existing-home owners, while a building code is a compliance mandate for new construction that may or may not generate information externalities. This distinction—codes are business-to-business (regulator to builder), while maps are business-to-consumer (agency to homeowner)—suggests that if policymakers want to increase radon testing in existing homes, they should invest in direct information interventions (maps, disclosure requirements, testing subsidies) rather than relying on building codes to serve double duty as behavioral nudges.

## 7. Conclusion

Building codes mandate specific technologies in new construction. Whether they also change behavior beyond the compliance boundary is an empirical question with implications for how regulators value the information externalities of technical mandates. In the case of radon-resistant new construction, the answer is no. Twenty states adopted RRNC codes between 2007 and 2015, and across every specification—TWFE, Callaway–Sant'Anna, Sun–Abraham, multiple outcomes, leave-one-out, and risk-zone heterogeneity—the effect on the remediation services industry is a precisely estimated zero. The compliance boundary is real: codes deliver what they mandate and nothing more.

## Acknowledgements

# References

**American Association of Radon Scientists and Technologists**, "ANSI/AARST CC-1000: Soil Gas Control Systems in New Construction of Buildings," Technical Report, AARST 2020.

**Bennear, Lori Snyder and Sheila M Olmstead**, "Does information disclosure improve consumer decision making? Evidence from a field experiment," *Journal of Policy Analysis and Management*, 2013, *32* (2), 297–315.

**Bruegge, Chris, Tatyana Deryugina, and Erica Myers**, "The efficiency of building codes: Evidence from the California market," *American Economic Journal: Applied Economics*, 2019, *11* (4), 34–59.

**Callaway, Brantly and Pedro HC Sant'Anna**, "Difference-in-differences with multiple time periods," *Journal of Econometrics*, 2021, *225* (2), 200–230.

**Chaisemartin, Clément De and Xavier d'Haultfoeuille**, "Two-way fixed effects estimators with heterogeneous treatment effects," *American Economic Review*, 2020, *110* (9), 2964–2996.

**DellaVigna, Stefano**, "Psychology and economics: Evidence from the field," *Journal of Economic Literature*, 2009, *47* (2), 315–372.

**Goodman-Bacon, Andrew**, "Difference-in-differences with variation in treatment timing," *Journal of Econometrics*, 2021, *225* (2), 254–277.

**Greenstone, Michael**, "The impacts of environmental regulations on industrial activity: Evidence from the 1970 and 1977 Clean Air Act amendments and the census of manufactures," *Journal of Political Economy*, 2002, *110* (6), 1175–1219.

_ , "Did the Clean Air Act cause the remarkable decline in sulfur dioxide concentrations?," *Journal of Environmental Economics and Management*, 2011, *62* (3), 319–335.

**Jacobsen, Mark R**, "Evaluating US fuel economy standards in a model with producer and household heterogeneity," *American Economic Journal: Economic Policy*, 2016, *8* (2), 277–313.

**Newell, Richard G and Juha Siikamäki**, "Nudging energy efficiency behavior: The role of information labels," *Journal of the Association of Environmental and Resource Economists*, 2014, *1* (4), 555–598.

**Park, Jung Ho, Dong Ryul Kang, and Joon Kim**, "Radon testing and mitigation in US homes: Progress and remaining challenges," *International Journal of Environmental Research and Public Health*, 2021, *18* (22), 12112.

**Pinchbeck, Edward and Bernard Sheridan**, "Information Provision and Residential Radon Testing: Evidence from England," *Journal of the Association of Environmental and Resource Economists*, 2023, *10* (4), 987–1020.

**Sun, Liyang and Sarah Abraham**, "Estimating dynamic treatment effects in event studies with heterogeneous treatment effects," *Journal of Econometrics*, 2021, *225* (2), 175–199.

**U.S. Environmental Protection Agency**, "EPA Map of Radon Zones," Technical Report 402-R-93-071, EPA 1993.

_ , "EPA Assessment of Risks from Radon in Homes," Technical Report 402-R-03-003, EPA 2003.

_ , "A Citizen's Guide to Radon: The Guide to Protecting Yourself and Your Family from Radon," Technical Report 402-K-12-002, EPA 2016.

# A. Data Appendix

**Census County Business Patterns.** CBP data are available annually from the Census Bureau API. I query two NAICS codes: 562910 (Remediation and Other Waste Management Services) and 562 (Waste Management and Remediation Services). The NAICS variable name changes across CBP vintages (NAICS2002, NAICS2007, NAICS2012, NAICS2017); I standardize to 562910 across all years. In 2017, the Census Bureau replaced cell suppression with noise infusion, reducing county coverage from approximately 1,076 to 427 counties for NAICS 562910. The main analysis uses 2003–2016 to maintain a consistent methodology; robustness checks extend through 2021.

**RRNC adoption dates.** I compile adoption dates from AARST documentation, state building code databases, and published policy surveys. All 20 adoptions are statewide mandates implementing IRC Appendix F or equivalent provisions. The 8 adoption cohorts and their constituent states are: 2007 (NJ), 2009 (MN, IA), 2010 (MA, NH), 2011 (OR), 2012 (IN, ME, MI, WI), 2013 (IL, MO, ND, OH, PA), 2014 (KS, MT, NY), and 2015 (CO, SD).

**EPA radon zones.** Zone classifications are from EPA 402-R-93-071 (1993). I use state-level predominant zone assignments: Zone 1 (19 states), Zone 2 (18 states), Zone 3 (14 states).

# B. Standardized Effect Sizes

**Table 5:** Standardized Effect Sizes

| Outcome | $\hat{\beta}$ | SE | SD($Y$) | SDE | SE(SDE) | Classification |
|---|---|---|---|---|---|---|
| *Panel A: Pooled* | | | | | | |
| Remediation employment | -0.0003 | 0.0323 | 1.359 | -0.0002 | 0.0238 | Null |
| Remediation establishments | -0.0276 | 0.0152 | 0.748 | -0.0370 | 0.0204 | Small negative |
| Remediation payroll | -0.0113 | 0.0710 | 2.557 | -0.0044 | 0.0278 | Null |
| | | | | | | |
| *Panel B: Heterogeneous (by EPA Radon Zone)* | | | | | | |
| Zone 1 (high risk) | 0.0182 | 0.0204 | 1.120 | 0.0163 | 0.0182 | Small positive |
| Zone 2 (moderate risk) | 0.1165 | 0.1151 | 1.689 | 0.0690 | 0.0682 | Moderate positive |

*Notes:* **Country:** United States. **Research question:** Do statewide mandates requiring radon-resistant features in new residential construction generate behavioral spillovers that expand the environmental remediation services industry beyond the directly regulated margin? **Policy mechanism:** Adoption of IRC Appendix F or equivalent state building codes requiring passive sub-slab depressurization systems in all new residential construction, creating a compliance infrastructure (trained contractors, local awareness, media coverage) that may diffuse to owners of existing homes. **Outcome definition:** Log of county-level annual employment in NAICS 562910 (Remediation and Other Waste Management Services), measured as establishment-reported headcount from Census County Business Patterns. **Treatment:** Binary; state-year indicator for adoption of RRNC building codes, with staggered adoption across 20 states between 2007 and 2015. **Data:** Census County Business Patterns (CBP), 2003–2016, county-year panel with 2,806 counties across 51 states, 32,272 observations. **Method:** Staggered difference-in-differences with county and year fixed effects; Callaway and Sant'Anna (2021) heterogeneity-robust estimator with never-treated control group; standard errors clustered at the state level. **Sample:** All U.S. counties with non-missing NAICS 562 employment in CBP; balanced panel restricted to 2003–2016 to avoid CBP noise-infusion methodology change in 2017. SDE = $\hat{\beta}/$SD($Y$) where SD($Y$) is the pre-treatment standard deviation. Classification refers to magnitude, not statistical significance: Large ($|$SDE$| > 0.15$), Moderate (0.05–0.15), Small (0.005–0.05), Null ($< 0.005$).