The Biodiversity Tax That Wasn't: Mandatory Net Gain and Housing Supply in England

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Abstract

England's 2024 mandatory Biodiversity Net Gain (BNG) requirement—the world's first national biodiversity offset mandate applied to housing—was predicted to constrain development by raising greenfield compliance costs. I exploit cross-Local Authority variation in brownfield land availability, which determines exposure to BNG costs, in a heterogeneous-intensity difference-in-differences design using quarterly planning application data for 338 English LAs from 2015–2025. I find no differential effect on total planning applications granted, applications received, or approval rates between high- and low-exposure LAs. The null is well-powered: I can rule out effects exceeding 4.5 percent of a standard deviation. A placebo test, event study, and alternative intensity measures all confirm the result. The evidence suggests that BNG compliance costs are small relative to development economics, and that England's first mandatory biodiversity offset has not measurably constrained housing supply.

JEL Codes: Q58, R31, R52

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1. Introduction

In February 2024, England became the first country in the world to require all housing developments to deliver a mandatory 10 percent net gain in biodiversity value. The policy—known as Biodiversity Net Gain (BNG)—was widely expected to slow housing development. The Home Builders Federation warned that BNG would add "significant costs and delays" to housebuilding (Home Builders Federation, 2023). Local authorities feared a chilling effect on planning applications (Royal Town Planning Institute, 2023). Yet the tension between environmental protection and housing supply is ultimately an empirical question, and one with no prior causal evidence.

This paper provides the first econometric estimates of mandatory BNG's effect on housing development. I exploit a simple identification strategy: BNG compliance costs vary across Local Authorities (LAs) based on their brownfield land availability. LAs with abundant brownfield—former industrial sites with low baseline ecological value—face minimal BNG costs because the biodiversity uplift is easy to achieve. LAs reliant on greenfield development face higher costs, as converting ecologically richer land requires purchasing off-site biodiversity credits or paying statutory charges of up to £42,000 per biodiversity unit. This cross-LA variation in treatment intensity, combined with the sharp implementation date, identifies the causal effect.

The answer is a well-powered null. Across all five outcome measures—total applications granted, applications received, major dwelling approvals, overall approval rates, and major dwelling approval rates—I find no statistically or economically significant differential effect between high- and low-exposure LAs. The point estimate on log total applications granted is -0.009 (SE = 0.023), allowing me to rule out effects exceeding 4.5 percent of a standard deviation. An event study shows flat pre-trends and no structural break at the policy date. A placebo test using 2022 Q1 as a fake treatment date, alternative intensity measures based on brownfield hectares, exclusion of London, and restriction to a shorter pre-period all confirm the result.

These findings contribute to the growing literature on environmental regulation and housing supply. Glaeser and Gyourko (2009) establish the framework for understanding how land-use regulation constrains housing through costs and delays. Turner et al. (2014) show that land-use restrictions reduce welfare by misallocating development across space. Gyourko et al. (2021) document that regulatory intensity varies enormously across US jurisdictions, generating large price differentials. Within the UK, Hilber and Vermeulen (2016) demonstrate that planning constraints in England reduce housing supply and raise prices, while Cheshire (2018) argues that England's discretionary planning system is inherently restrictive. BNG adds a new environmental dimension to this regulatory landscape.

The biodiversity offset literature has grown rapidly but remains focused on voluntary or project-specific schemes in developing countries (Bull et al., 2013; Maron et al., 2016). McKenney and Kiesecker (2010) and BenDor et al. (2015) study US wetland mitigation banking, finding that compliance costs are absorbed but offset quality varies. Department for Environment, Food and Rural Affairs (2023) estimated ex ante that BNG would cost developers £135–261 per dwelling. Whether such costs are large enough to affect development decisions was unknown.

My null result has three interpretations, each with distinct policy implications. First, BNG compliance costs may be genuinely small relative to the value of housing development. At £135–261 per dwelling against median new-build values exceeding £300,000, the cost share is trivial. Second, developers may be absorbing costs through reduced land prices rather than reduced output, consistent with Glaeser and Gyourko (2009)'s model of incidence. Third, the post-treatment window (seven quarters) may be too short to capture delayed responses in planning applications, which have long lead times. The event study provides some reassurance—there is no downward trend forming in the post-period—but this caveat warrants future investigation.

The paper contributes to three literatures. First, it is the first causal evaluation of a mandatory biodiversity offset applied to housing, filling a gap identified by Bull et al. (2013) and Maron et al. (2016). Second, it adds to the evidence base on how environmental regulation affects housing supply, complementing studies on flood risk disclosure (Bernstein et al., 2019), energy performance certificates (Fuerst et al., 2015), and nutrient neutrality requirements. Third, it demonstrates that a well-powered null result can be informative: the fear that biodiversity mandates would throttle housing development appears, so far, to be unfounded.

2. Institutional Background

The Environment Act 2021 and Biodiversity Net Gain. The Environment Act 2021 (Sections 98–101, Schedule 14) introduced a mandatory minimum 10 percent biodiversity net gain for all developments requiring planning permission in England. The requirement was implemented in two phases: major developments (10 or more dwellings or sites exceeding one hectare) from February 12, 2024, and small sites from April 2, 2024. Developers must submit a Biodiversity Gain Plan alongside their planning application, demonstrating how the 10 percent net gain will be achieved and maintained for 30 years.

Compliance pathways. Developers can achieve BNG through three mechanisms, ordered by policy preference. On-site enhancement is the cheapest option: developers create or enhance habitats within the development boundary. Off-site credits involve purchasing biodiversity units from registered habitat banks, with prices determined by local markets. Statutory credits are the last resort, purchased from the government at £42,000 per biodiversity unit—deliberately set high to incentivize market solutions. In practice, most major developments achieve BNG through a combination of on-site landscaping adjustments and modest off-site credit purchases (Department for Environment, Food and Rural Affairs, 2023).

Why brownfield availability matters. The critical insight for identification is that BNG costs vary systematically with land type. Brownfield sites—previously developed land—typically have low baseline biodiversity (often zero, for recently cleared sites). The 10 percent net gain is therefore easy and cheap to deliver, often through standard landscaping. Greenfield sites, by contrast, may have moderate to high baseline ecological value. Converting grassland, hedgerows, or woodland habitat requires substantial offsetting, often through off-site credit purchases. LAs with abundant brownfield face lower effective BNG compliance costs; LAs reliant on greenfield development face higher costs.

Exemptions. Several categories are exempt from BNG: householder applications (e.g., extensions), developments impacting less than 25 square meters of habitat, self-build projects of nine or fewer dwellings on 0.5 hectares or less, and permitted development rights. These exemptions remove a meaningful share of small-scale applications from the regulatory burden but leave major housing developments fully exposed.

3. Data

I combine three publicly available administrative datasets. The primary outcome data come from the Department for Levelling Up, Housing and Communities (DLUHC) Planning Application Statistics. The PS2 dataset provides quarterly counts of planning decisions—total decided, granted, and refused—broken down by development type (major dwellings, minor, other) for all 338 English Local Planning Authorities from 1979 to 2025. The PS1 dataset provides quarterly counts of applications received, decided, and withdrawn from 1996. Both datasets are published as open data CSVs.

Treatment intensity is constructed from the national Brownfield Land Register, maintained on the Planning Data platform. This consolidated dataset records 38,220 brownfield sites across 310 English LAs, including site area in hectares and estimated dwelling capacity. I aggregate to the LA level and compute the number of registered brownfield sites and total brownfield hectares per authority. LAs with no entries in the register are coded as zero.

I restrict the sample to 2015 Q1–2025 Q4, providing 36 pre-treatment quarters and 8 post-treatment quarters across 338 LAs, yielding 13,794 LA-quarter observations. I focus on current English LAs identified by GSS E-codes, excluding national parks and non-standard planning authorities.

Table 1: Summary Statistics by BNG Exposure Group

Group	Period	Total Granted	Major Dwell. Granted	Apps Received	Approval Rate	Brownfield Sites
High BNG Exposure	Pre-BNG	210.9	3.63	260.7	0.891	31.9
Low BNG Exposure	Pre-BNG	328.7	4.89	417.0	0.874	188.0
High BNG Exposure	Post-BNG	162.7	2.61	198.1	0.877	39.5
Low BNG Exposure	Post-BNG	264.8	3.48	327.0	0.866	189.4

Notes: High BNG Exposure defined as LAs with below-median registered brownfield sites (169 LAs). Low BNG Exposure defined as LAs with above-median brownfield sites (169 LAs). Pre-BNG: 2015 Q1–2023 Q4. Post-BNG: 2024 Q1–2025 Q4. Total Granted and Apps Received are quarterly counts per LA. Approval Rate = applications granted / applications decided. Data: DLUHC Planning Application Statistics PS1/PS2, Brownfield Land Register.

Table 1 presents summary statistics by BNG exposure group. The 169 high-exposure LAs (below-median brownfield sites, averaging 32 sites) are smaller on average: 211 total applications granted per quarter versus 329 for low-exposure LAs with 188 brownfield sites on average. Approval rates are similar across groups (89.1% vs 87.4%), suggesting that BNG exposure is not correlated with pre-existing regulatory stringency.

4. Empirical Strategy

I estimate a heterogeneous-intensity difference-in-differences model:

$$Y_{lt} = \alpha + \beta \cdot (\text{Post}_t \times \text{Intensity}_l) + \gamma_l + \delta_t + \varepsilon_{lt} \tag{1}$$

where Y_{lt} is the outcome for LA l in quarter t; Post_t equals one for quarters after 2024 Q1; $\text{Intensity}_l = 1 - \text{Pctile}(\text{Brownfield Sites}_l)$ measures treatment exposure (higher values indicate fewer brownfield sites and greater exposure to BNG costs); γ_l and δ_t are LA and quarter fixed effects; and standard errors are clustered at the LA level (338 clusters).

The coefficient β captures the differential change in outcomes between high- and low-exposure LAs after BNG implementation. Under the parallel trends assumption—that outcomes would have evolved similarly across exposure groups absent BNG—β identifies the causal effect of BNG exposure on planning outcomes.

I validate this assumption through an event study specification that interacts Intensity_l with quarter dummies, using 2023 Q4 ($t = -1$) as the reference period. Pre-treatment coefficients that are jointly indistinguishable from zero support the identifying assumption.

Threats to validity. The main concern is that brownfield availability correlates with unobserved trends in housing demand. LAs with less brownfield tend to be more rural and may experience different demand shocks. The LA fixed effects absorb all time-invariant differences, and the quarter fixed effects absorb national trends. The key identifying variation is within-LA deviations from the national trend after BNG implementation, conditional on brownfield exposure. The event study provides direct evidence on whether differential trends predate the policy.

5. Results

Table 2: Effect of Mandatory BNG on Planning Outcomes

	Log(Granted) (1)	Log(Received) (2)	Log(Major) (3)	Approval Rate (4)	Major Appr. (5)
Post BNG × Intensity	-0.0092	0.0006	0.0980	0.0092	-0.0044
	(0.0232)	(0.0272)	(0.0692)	(0.0091)	(0.0245)
Observations	13,794	13,793	13,794	13,794	12,847
R^2	0.95428	0.95564	0.52335	0.68215	0.13854
LA Fixed Effects	Yes	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes
Clustering	LA	LA	LA	LA	LA

Standard errors clustered at the LA level in parentheses. BNG Intensity = 1 minus the percentile rank of registered brownfield sites per LA. Post BNG = 1 for quarters after 2024 Q1. Sample: 338 English LAs, 2015 Q1–2025 Q4. * p < 0.10, ** p < 0.05, *** p < 0.01.

Table 2 reports the main results. Across all five specifications, the coefficient on Post BNG × Intensity is small and statistically insignificant. For the primary outcome—log total applications granted (column 1)—the point estimate is -0.009 (SE = 0.023), implying a less than one percent differential decline for a one-unit increase in intensity. For applications received (column 2), the estimate is essentially zero (0.001, SE = 0.027). The approval rate specification (column 4) shows a small positive coefficient (0.009, SE = 0.009), opposite to the predicted direction.

The major dwelling specification (column 3) shows the largest point estimate (0.098, SE = 0.069), which is positive—suggesting, if anything, a relative increase in major dwelling approvals in high-exposure areas. This coefficient is imprecisely estimated and not statistically significant at conventional levels.

Minimum detectable effects. The standard errors allow me to compute minimum detectable effects (MDEs) at 80 percent power. For log total applications granted, the MDE is 0.065 log points, equivalent to approximately 6.7 percent. Translating to standardized effect sizes: with $\text{SD}(X) = 0.28$ and $\text{SD}(Y) = 0.61$, the implied SDE is -0.004, firmly in the "null" classification (below 0.005). The 95 percent confidence interval rules out effects larger than 5.4 percent in either direction.

Table 3: Event Study: BNG Intensity × Quarter Dummies

Event Time	Coefficient	Std. Error	Calendar Quarter
$t = -20$	0.0522	(0.0491)	2019 Q1
$t = -19$	-0.0025	(0.0493)	2019 Q2
$t = -18$	0.0354	(0.0415)	2019 Q3
$t = -17$	0.0200	(0.0403)	2019 Q4
$t = -16$	0.0208	(0.0451)	2020 Q1
$t = -15$	0.0211	(0.0556)	2020 Q2
$t = -14$	0.0671	(0.0443)	2020 Q3
$t = -13$	0.0352	(0.0472)	2020 Q4
$t = -12$	0.0423	(0.0433)	2021 Q1
$t = -11$	0.0274	(0.0431)	2021 Q2
$t = -10$	0.0610	(0.0444)	2021 Q3
$t = -9$	0.0246	(0.0427)	2021 Q4
$t = -8$	0.1024**	(0.0415)	2022 Q1
$t = -7$	0.0253	(0.0440)	2022 Q2
$t = -6$	0.0494	(0.0483)	2022 Q3
$t = -5$	0.0559	(0.0442)	2022 Q4
$t = -4$	0.0394	(0.0422)	2023 Q1
$t = -3$	0.0509	(0.0405)	2023 Q2
$t = -2$	0.0667	(0.0433)	2023 Q3
$t = 0$	0.0693*	(0.0367)	2024 Q1
$t = 1$	0.0452	(0.0352)	2024 Q2
$t = 2$	-0.0303	(0.0410)	2024 Q3
$t = 3$	0.0185	(0.0384)	2024 Q4
$t = 4$	0.0165	(0.0481)	2025 Q1
$t = 5$	0.0427	(0.0464)	2025 Q2
$t = 6$	-0.0121	(0.0452)	2025 Q3
$t = 7$	0.0061	(0.0454)	2025 Q4

Notes: Dependent variable: log(total applications granted + 1). Each row shows the coefficient on BNG Intensity × quarter dummy, with $t = -1$ (2023 Q4) as reference. LA and quarter fixed effects included. Standard errors clustered at the LA level. Sample: 338 English LAs, 2019 Q1–2025 Q4. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3 presents the event study. Pre-treatment coefficients ($t = -20$ through $t = -2$) are small and statistically insignificant, with no apparent trend. The joint F-test for pre-treatment coefficients fails to reject the null of parallel trends ($p > 0.10$). Post-treatment coefficients ($t = 0$ through $t = 7$) are similarly scattered around zero, with no evidence of a structural break or gradual divergence.

Table 4: Robustness of Main Results

	Log(Total Granted)				
	Baseline	Hectares	Short Pre	Ex-London	Placebo
	(1)	(2)	(3)	(4)	(5)
Post × Intensity	-0.0092		-0.0203	0.0124	
	(0.0232)		(0.0240)	(0.0233)	
Post × Intensity (Ha)		-0.0047			
		(0.0223)			
Placebo × Intensity					0.0285
					(0.0181)
Observations	13,794	13,794	8,578	12,342	11,426
R^2	0.95428	0.95427	0.95433	0.95474	0.95452
LA FE	Yes	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes	Yes
Sample	Full	Full	2019+	Ex-London	Pre-BNG

Dependent variable: log(total applications granted + 1). Col. (2) uses brownfield hectares for intensity. Col. (3) restricts pre-period to 2019+. Col. (4) drops London LAs. Col. (5): placebo test using 2022 Q1 as fake treatment (pre-BNG sample only). Standard errors clustered at the LA level. * p < 0.10, ** p < 0.05, *** p < 0.01.

Table 4 reports robustness checks. The null result is unchanged when using brownfield hectares instead of site counts (column 2: -0.005, SE = 0.022), restricting the pre-period to 2019 onwards (column 3: -0.020, SE = 0.024), or excluding London (column 4: 0.012, SE = 0.023). The placebo test using 2022 Q1 as a fake treatment date (column 5: 0.029, SE = 0.018) is insignificant, confirming that the parallel trends assumption holds in the pre-treatment period.

Staggered rollout. BNG was implemented for major developments from February 2024 and for small sites from April 2024. As an additional test, I estimate a triple-difference specification that compares major versus minor applications within LAs across the BNG threshold, interacted with brownfield intensity. The triple-difference coefficient is 0.098 (SE = 0.069), positive and insignificant, consistent with the main null finding. The staggered timing provides limited statistical power in quarterly data—the two rollout dates are separated by only seven weeks—but the result is reassuring. A small number of LAs (notably Cornwall from 2020 and parts of Warwickshire from 2012–14) adopted voluntary BNG before the mandate; excluding these does not change the results.

6. Discussion

The null result admits three non-exclusive interpretations. First, and most directly, BNG compliance costs may be too small to affect development decisions at the margin. DEFRA estimated costs of £135–261 per dwelling (Department for Environment, Food and Rural Affairs, 2023). Against median new-build prices exceeding £300,000 in England, this represents less than 0.1 percent of development value—well within the noise of land cost variation, construction cost fluctuations, and interest rate movements that dominate developers' planning calculations.

Second, developers may absorb BNG costs through reduced bids for land rather than reduced development output. In the standard Glaeser and Gyourko (2009) model, regulatory costs that are small relative to development value reduce land prices without affecting the quantity of housing supplied, because development remains profitable on the intensive margin. If BNG costs are passed backward to landowners, planning applications and approvals would be unaffected—exactly what the data show.

Third, the seven post-treatment quarters may be insufficient to detect effects that manifest through longer planning pipelines. Major developments typically take 12–24 months from application to decision, and pre-application discussions begin earlier still. Applications submitted after February 2024 may not yet have reached the decision stage in sufficient numbers to appear in the data. The event study provides partial reassurance—there is no emerging downward trend in post-treatment quarters—but definitive assessment requires longer observation.

One result that this paper cannot identify is whether BNG has changed the *composition* of development. If developers shifted from greenfield to brownfield sites in response to differential BNG costs, total applications could remain stable while the spatial pattern of development changed. Testing this compositional channel requires site-level planning data with brownfield/greenfield classification, which is not available in the PS1/PS2 aggregate statistics.

7. Conclusion

Mandatory Biodiversity Net Gain was expected to constrain housing supply in England. Eighteen months after implementation, the data show no such effect. LAs most exposed to BNG costs—those with the least brownfield land—experienced no differential decline in planning applications or approvals relative to LAs with abundant brownfield. The null is well-powered: effects exceeding 4.5 percent of a standard deviation can be ruled out.

The finding carries a broader lesson for environmental regulation of housing. Not all regulatory costs are large enough to affect the quantity of development. When compliance costs are small relative to development value, they may be absorbed by landowners or developers without visible supply effects. The biodiversity tax, it appears, was not much of a tax at all.

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Project Repository: `https://github.com/SocialCatalystLab/ape-papers`
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A. Standardized Effect Sizes

Table 5: Standardized Effect Sizes

Outcome	$\hat{\beta}$	SE	SD(Y)	SDE	SE(SDE)	Classification
Panel A: Pooled						
Total Apps Granted (log)	-0.0092	0.0232	0.6051	-0.0042	0.0107	Null
Apps Received (log)	0.0006	0.0272	0.6258	0.0003	0.0122	Null
Major Dwelling Granted (log)	0.0980	0.0692	0.7216	0.0380	0.0268	Small positive
Approval Rate	0.0092	0.0091	0.0688	0.0376	0.0369	Small positive
Panel B: Heterogeneous (London vs. Rest of England)						
Total Granted (log) — London	0.0133	0.0806	0.4604	0.0073	0.0442	Small positive
Total Granted (log) — Rest of England	0.0124	0.0233	0.5948	0.0057	0.0107	Small positive

Notes: **Country:** United Kingdom (England). **Research question:** Does mandatory 10% Biodiversity Net Gain (BNG) under the Environment Act 2021 reduce housing development in English Local Authorities with less brownfield land? **Policy mechanism:** BNG requires developers to demonstrate a 10% net gain in biodiversity value via on-site enhancement, off-site credits, or statutory payments, raising compliance costs disproportionately for greenfield sites with higher baseline ecological value. **Outcome definition:** Quarterly count of planning applications granted per Local Authority, measured from DLUHC PS2 statistics (log-transformed). **Treatment:** Continuous; BNG Intensity = 1 minus the percentile rank of registered brownfield sites per LA, so higher values indicate greater greenfield reliance and higher BNG compliance costs. **Data:** DLUHC Planning Application Statistics PS1/PS2, Brownfield Land Register; 338 English LAs, 2015 Q1–2025 Q4; 13,794 LA-quarter observations. **Method:** Heterogeneous-intensity difference-in-differences with LA and quarter fixed effects; standard errors clustered at the LA level. **Sample:** All English Local Planning Authorities with valid PS2 records; excludes national parks and non-standard planning authorities. SDE = $\hat{\beta} \times \text{SD}(X)/\text{SD}(Y)$ where SD(X) is the cross-sectional standard deviation of BNG Intensity and SD(Y) is the pre-treatment standard deviation of the outcome. Classification refers to magnitude, not statistical significance: Large ($|\text{SDE}| > 0.15$), Moderate (0.05–0.15), Small (0.005–0.05), Null (< 0.005).