Population Growth and Farmland Option Value in Alabama

By Sunjae Won and Mykel R. Taylor

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Abstract

This study investigates how short-run population growth influences the development option value of agricultural land, defined as the per-acre gap between market and current use values. Using parcel-level Alabama data (2016-2020), we quantify how both own and neighboring population density changes affect farmland valuation. Results show that changes in population density—particularly within a 10-mile radius—are positively associated with the development option value, with robust spatial spillovers (i.e., effects from nearby population growth). These effects vary by land use type. The findings highlight how dynamic development pressure, rather than static conditions, drives valuation gaps, informing farmland appraisal, tax policy, and land use planning.

INTRODUCTION

The concept of development option value—the hidden value due to future development potential, which is embedded in land prices due to the potential for future conversion to non-agricultural uses—has become increasingly relevant in agricultural and rural land economics. As urban expansion intensifies and land markets evolve, understanding how development pressure is capitalized into farmland values is critical for appraisers, policymakers, and landowners. This study investigates the relationship between population growth and the development option value of farmland, using parcel-level data from Alabama.

In agricultural appraisal contexts, the development option value is often inferred from the gap between market value and appraised value (or current use value). Market value is the price farmland would likely sell for in an open and competitive market, where both buyer and seller are informed, willing, and acting without forced sale pressure or unusual financing concessions. It reflects typical conditions where all relevant information, including development potential, soil quality, location, and market demand, is known to both parties. In contrast, appraised value under current use valuation is based on the parcel's productivity in agriculture, excluding speculative or alternative use considerations. This gap—intentionally created in many states through differential tax assessment policies—is designed to mitigate tax burdens and slow farmland conversion. However, the size and responsiveness of this gap to development pressure remain underexplored at the parcel level.

Recent studies have shown that farmland values are influenced not only by agricultural returns but also by non-agricultural factors such as urban proximity, natural amenities, and zoning restrictions (Borchers, Ifft, and Kuethe, 2014; Eagle et al., 2015; Plantinga, Lubowski, and Stavins, 2002). In regions experiencing rapid population growth, these factors may significantly inflate market values relative to appraised values, creating a measurable wedge that reflects development expectations. This wedge is particularly salient in states like Alabama, where current use valuation is widely applied but urban expansion continues to exert pressure on agricultural land.

We hypothesize that population growth—both own area and neighboring areas—will be positively associated with the development option value and that this relationship will vary by land use type. To test this, we construct a parcel-level panel dataset for Alabama that combines annual property assessment records from CoreLogic with gridded population data from the Gridded Population of the World (GPW) from 2016 to 2020. The development option value is measured as the per-acre difference between market value and appraised value by county (i.e., current use value), reflecting the premium attributed to future development potential. We link this valuation gap to both the level and change in population density at multiple spatial scales (5-, 10-, and 20-mile buffers), lagged to account for the temporal delay in market response.

Our contribution is threefold. First, we analyze development pressure at the parcel level using high-resolution appraisal and population data. Second, we distinguish between short-run changes in population density and long-run baseline conditions, allowing us to isolate short- and long-term effects. Third, we compare how development pressure plays out across different land uses—such as crop, forest, pasture, and mixed-use parcels—and across surrounding areas.

BACKGROUND

The development option value of farmland refers to the portion of a parcel's market value that reflects its potential for future conversion to non-agricultural uses. This concept is rooted in real options theory, which views land as an asset with embedded flexibility—landowners can delay conversion until market conditions become favorable (Capozza and Helsley, 1990). A real option value treats farmland as something more than its current use, namely, that it's an asset that gives its owner flexibility: the owner can keep farming today while retaining the option to convert the land later. This option becomes more valuable when conditions (i.e., development potential) are changing because the owner can wait and choose the most favorable moment to switch to development. When population growth increases development pressure, the value of having this flexibility rises, creating a larger gap between the land's market value and its current use value. In practice, this value is often latent and difficult to observe directly. However, in appraisal contexts, it can be inferred from the gap between market value and current use value, especially in jurisdictions that apply differential tax assessment policies.

Under current use valuation, farmland is assessed based on its productivity in agriculture, excluding speculative or alternative use considerations. This approach is designed to reduce property tax burdens and discourage premature conversion. However, as Eagle et al. (2015) and Siu, Li, and Caplan (2023) showed, the effectiveness of such policies depends on the credibility of zoning restrictions and the intensity of development pressure. In regions with weak enforcement or high urban demand, the development option value may still be capitalized into market prices, creating a persistent wedge between the market value of land and its value for farming use.

Theoretical models of farmland valuation (Plantinga, Lubowski, and Stavins, 2002; Livanis et al., 2006) decompose land value into agricultural and development components. These models suggest that proximity to urban centers, infrastructure, and population growth can significantly increase the development component, even if the land remains in agricultural use. Empirical studies using hedonic pricing and spatial econometric models have confirmed that farmland near urban areas commands higher prices due to its conversion potential (Delbecq, Kuethe, and Borchers, 2014; Borchers, Ifft, and Kuethe, 2014).

A key mechanism through which development pressure affects land value is population density. As density increases, especially in peri-urban areas, the likelihood of land conversion rises. This pressure is not limited to the parcel itself; spatial spillovers from neighboring development can influence market expectations. For example, infrastructure expansion or residential growth in adjacent areas may signal future conversion potential, even if the parcel's own use remains unchanged. Eagle et al. (2015) found that farmland within protected zones depreciated over time due to the perceived permanence of zoning restrictions, while unimproved parcels retained or gained value, driven by expectations of future development.

To capture these dynamics, our study distinguishes between baseline population density and short-run changes. Baseline density reflects long-standing structural conditions, while short-run changes capture recent shifts in demand. Lagging both measures allows us to account for the temporal delay between demographic change and its capitalization into land values, a delay often driven by regulatory inertia, infrastructure planning, or speculative holding. This approach aligns with the logic of Eagle et al. (2015), who modeled the impact of zoning over a 35-year period using hierarchical linear models.

Land use heterogeneity further complicates the relationship between development pressure and valuation gaps. Forest parcels may be held for conservation or speculation, while crop and pasture lands are more readily converted. Zoning regulations, conservation easements, and market expectations vary across land types, influencing how development pressure is reflected in valuation gaps. Our empirical strategy accounts for these differences by estimating stratified models and testing robustness across spatial buffers.

In summary, the development option value of farmland is a critical but underexplored component of land valuation. By linking parcel-level appraisal data to spatially explicit measures of population growth, this study provides new insights into how development pressure is capitalized into farmland values. It also contributes to the broader literature on land use policy, appraisal accuracy, and the economics of farmland preservation.

DATA AND EMPIRICAL STRATEGY

To examine the relationship between farmland valuation and development pressure, we construct a set of parcel-level variables based on two data sources: farmland valuation data from CoreLogic and population density data from GPW. We construct a parcel-level panel dataset covering Alabama from 2016 to 2020.

Parcel-Level Farmland Valuation Data

Parcel-level property assessment data are sourced from CoreLogic, which provides annual assessments and farmland characteristics (farm acreage and type) in Alabama. Each parcel record contains both the market value—defined as the estimated price at which the property would sell under fair market conditions—and the current use value, which reflects the valuation based on the property's existing use as of October 1 of the taxable year.

In Alabama, current use value is computed under a statutory formula established in §40-7-25.1 of the Code of Alabama (Code of Alabama, 1975). The Department of Revenue determines annual standard values by capitalizing the 10-year weighted average of net returns to land for the state's three most harvested crops excluding hay—cotton, soybeans, and peanuts—adjusted for soil productivity ratings. Net returns are calculated by subtracting USDA-estimated production costs from gross returns and dividing by the average effective interest rate on Federal Land Bank loans over the past decade. Soil productivity ratings modify these values by +20% for good, -30% for poor, -75% for nonproductive, and no change for average. While this approach reflects agricultural income potential, it relies on statewide averages and omits certain crops, which may cause current use values to understate parcel-specific productivity. Consequently, the option value—defined as the gap between market value and current use value—may be biased if current use assessments are systematically different from true agricultural returns. Upward bias may occur when the statutory formula is conservative or omits high-value crops, causing parcels with above-average productivity to appear undervalued. Conversely, downward bias can occur in areas with low market value or on parcels with poor soils, where current use assessments may be relatively high compared to market value. This limitation should be considered when interpreting the magnitude of the valuation gap, as it reflects both development pressure and statutory adjustments intended to provide tax relief.

The difference between market value and current use value, normalized by parcel acreage, is defined as the development option value (*Option Value*). This measure serves as a proxy for the hidden value due to future development potential associated with potential land conversion, excluding speculative or alternative use considerations. Figure 1 illustrates the spatial distribution of per-acre farmland value gaps across Alabama in 2020, highlighting regional variation in development option value that aligns with urban proximity and population growth patterns.

To account for scale effects, we include parcel acreage as a control variable. The dataset also contains parcel identifiers, land use classifications (e.g., crop, forest, pasture), and assessment year, allowing for stratified analysis and the inclusion of fixed effects.

Population Density Data

The GPW dataset provides globally harmonized, georeferenced population counts at approximately 1 km^2 resolution for benchmark years 2000, 2005, 2010, 2015, and 2020. Developed by the Center for International Earth Science Information Network (CIESIN), GPW integrates Census data into a consistent global grid, ensuring comparability across space and time. For intermediate years, population values are interpolated to capture gradual demographic changes.

In this study, the 1-km grid cells are aggregated to the county level to construct population totals and population density measures that match the geographic units used in the empirical analysis. And aggregated values are converted from square kilometers to square miles to maintain consistency in units. This procedure retains the fine spatial detail of the underlying raster while producing county-level measures that align with socioeconomic and environmental datasets, thereby strengthening the reliability of the population variables included in the statistical models.

For each parcel, we construct two measures of population density: own population density (*Own Density*) and neighboring population density (*Adjacent Density*), calculated within alternative buffer distances (5, 10, and 20 miles). These spatial buffers are designed to capture both localized development pressure and spillover effects from surrounding areas. The primary specification employs a 10-mile radius to define neighboring population density, which balances the need to capture localized development pressure while minimizing noise from distant population centers. The 10-mile buffer used to define neighboring population density serves as a proxy for the urban fringe, an area where agricultural land values are influenced by proximity to urban centers and potential conversion to non-agricultural uses. This operationalization aligns with empirical findings from Delbecq, Kuethe, and Borchers (2014), who estimated the urban fringe to extend approximately 33 miles from major metropolitan areas, and with prior studies suggesting that development pressure dissipates within 40 miles (Guiling, Brorsen, and Doye, 2009). A 10-mile radius thus captures the core of this transition zone while minimizing noise from more distant population centers. Figure 2 shows the spatial distribution of Alabama population density in 2020, which serves as the primary proxy for development pressure in our analysis.

To reflect the temporal dynamics of land markets, we decompose short-run and persistent development pressure by distinguishing between changes in density and baseline density. Baseline density, measured at time t–1, reflects longer-run structural conditions such as persistent demographic concentration, urban form, and other slow-moving features of the local economy. In contrast, changes in density, defined as the difference between density at t–1 and t–2, capture short-run demand pressures generated by recent growth in population, which often reflects sudden shifts such as new residential development. Specifically, we compute these changes as:

$$\Delta\ Own\ Density_{t-1} = Own\ Density_{t-1} - Own\ Density_{t-2}$$

$$\Delta\ Adjacent\ Density_{t-1} = Adjacent\ Density_{t-1} - Adjacent\ Density_{t-2}$$

This two-year difference approach captures recent growth dynamics while smoothing annual fluctuations. Both baseline density and change measures are lagged by one year in the regression specification to account for delayed market response.

Lagging both baseline and change measures recognizes the temporal delay between demographic change and its capitalization into land values. Development pressure typically builds gradually (Shih et al., 2022), while responses in land markets may be slowed by regulatory processes, infrastructure planning, or speculative holding. By including both lagged baseline density and lagged changes in density, our specification separates the influence of long-standing population conditions from short-run growth dynamics, thereby identifying distinct channels through which demographic shifts affect development option value.

Summary statistics for the key variables used in the empirical analysis are presented in Table 1, which provides context for the variation in development option value and population density across parcels.

Empirical Model

Our core empirical strategy involves estimating a fixed effects panel regression of the form:

$$Option\ Value_{ijt} = \beta_0 + \Delta\ Density_{ijt-1}\,\beta_1 + Density_{ijt-1}\,\beta_2 + \beta_3\, Acres_{ijt} + \alpha_j + \gamma_t + \varepsilon_{ijt} \quad (1)$$

where $Option\ Value_{ijt}$ is the per-acre gap between market value and current use value for parcel i in county j and year t; $\Delta\ Density_{ijt-1} = (\Delta\ Own\ Density_{ijt-1}\ \ \Delta\ Adjacent\ Density_{ijt-1})$ captures changes in own and neighboring population density between $t-1$ and $t-2$; $Density_{ijt-1} = (Own\ Density_{ijt-1}\ \ Adjacent\ Density_{ijt-1})$ includes own and neighboring population density in year t–1; $Acres_{ijt}$ is the parcel acreage; the county fixed effect (α_j) and the year fixed effects (γ_t) are incorporated to control for time-invariant regional such as differences in appraisal practices or land market conditions and temporal shocks including macroeconomic fluctuations and policy changes; and ε_{ijt} is the idiosyncratic error term. Standard errors are clustered at the county level to correct for spatial correlation in the error structure.

The parameter of primary interest, β_1, captures the extent to which growth in own and neighboring population density—interpreted as shifts in development demand—affects parcel-level development option value. By including both density changes and baseline density, the specification separates short-run demand pressures from longer-run population conditions, while controlling for parcel size and unobserved heterogeneity across counties and over time. The specification allows us to identify whether development demand—proxied by changes in population density—is associated with increases in development option value, while controlling for parcel size, baseline population conditions, and unobservable county-fixed effects and year-fixed effects.

RESULTS

Main Empirical Specification Results

Table 2 presents parameter estimates from the fixed effects panel regression model using a 10-mile buffer to define neighboring population density. The model includes county and year fixed effects and controls for parcel size and baseline population conditions. The "Overall" column includes land use controls via categorical indicators for parcel type (Crop, Forest, Pasture, Mix), while the remaining columns present stratified results by land use type.

Across all specifications, changes in own population density ($\Delta\, Own\, Density_{t-1}$) are positively and significantly associated with the development option value. For the overall model, a one-unit increase in own density change corresponds to a $280 increase in the development option value per acre. Stratified results show similarly strong effects for crop parcels ($278) followed by pasture and forest parcels, while mixed-use parcels exhibit a small and statistically insignificant effect. These findings suggest that recent population growth within a parcel's immediate vicinity is a strong predictor of latent development pressure in most land use types. This is consistent with the policy rationale behind current use valuation, which aims to reduce development incentives by lowering property tax burdens on agricultural land.

A one-unit increase in own population density change is associated with an increase in development option value equivalent to about 46% of the sample mean per-acre gap ($608.16/acre from Table 1), while a one unit increase in adjacent density change corresponds to 117% of the sample mean. Although these elasticities indicate substantial localized development pressure, they are unusually large relative to patterns documented in a prior study. Salois et al. (2011), for example, found that farmland values tend to be more strongly linked to movements in agricultural returns than to shifts in population growth. This broader evidence implies that profitability typically dominates as the primary driver of farmland values, with demographic forces playing a more limited role. The comparatively large marginal effects in our setting likely capture pronounced spillover dynamics operating at fine spatial scales rather than the regional adjustments emphasized in earlier work.

These effects are consistent with empirical findings that farmland value reflects not only agricultural returns but also nonfarm factors, including expected returns from potential development (Borchers et al., 2014; Hardie et al., 2001; Livanis et al., 2006; Ma & Swinton, 2012; Plantinga & Miller, 2001; Plantinga et al., 2002; Vyn & Shang, 2021; Zhang & Nickerson, 2015). For example, Zhang and Nickerson (2015) showed that farmland parcels closer to city centers sell for higher prices, with the urban premium accounting for about 40% of Ohio farmland prices before 2008 and falling to 20% after the housing market crash. Ma and Swinton (2012) found that appraised values in Michigan often understate market prices because appraisal formulas emphasize agricultural factors while ignoring nonfarm influences, a gap that widens in areas where cities are expanding. Livanis et al. (2006) demonstrated that urban proximity raises farmland values by enabling farmers on the urban fringe to produce higher-value crops such as fruits and vegetables. Plantinga et al. (2002) reported stark regional differences: development potential explains more than 80% of farmland value in New Jersey and Connecticut but less than 5% in rural Midwestern states. This contrast reflects variation in urban pressure—densely populated states face strong demand for housing and commercial development, which capitalizes into land prices, while rural Midwestern states have limited development prospects, so farmland values remain tied primarily to agricultural returns. Hardie et al. (2001) showed that in the mid-Atlantic region, nonfarm factors—such as housing prices—have a greater impact on farmland values than farm revenue. Plantinga and Miller (2001) argued that development potential is better captured by expected population growth than current population levels, as urban expansion reflects future demand. Borchers et al. (2014) noted that non-agricultural determinants extend beyond development potential to include amenities such as golf courses and college campuses. Similar patterns emerge in Canada (Turvey, 2003; Vyn and Shang, 2021).

Changes in neighboring population density ($\Delta\, Adjacent\, Density_{t-1}$) also show strong positive effects, indicating spatial spillovers. In the overall model, a one-unit increase in adjacent density change within a 10-mile radius is associated with a $713 increase in the valuation gap. Crop parcels show the largest effect ($1,154), followed by forest and pasture parcels. This suggests that development pressure in nearby areas contributes to the perceived conversion potential of a parcel, even if its own grid has not yet experienced population growth.

Taken together, these results provide strong empirical evidence that both direct and spillover effects of population growth are capitalized into farmland valuation gaps. The magnitude of these effects is economically meaningful and consistent with theoretical expectations from land economics and urban development literature. The findings also highlight the importance of distinguishing between short-run changes in population density and long-run baseline conditions, as the former appears to be a more powerful predictor of development option value.

The coefficients on lagged population density levels, particularly adjacent population density, are generally negative and modestly significant. It can suggest that areas with already high nearby population density may face zoning constraints or infrastructure saturation that limit further development potential. These results underscore the importance of capturing dynamic changes in population rather than relying solely on static density measures. Parcel acreage is negatively associated with development option value in most specifications, with statistically significant effects for overall parcels and pasture parcels. This may reflect higher transaction costs or reduced feasibility of converting larger parcels, particularly in fragmented or peri-urban landscapes.

DISCUSSION

The empirical results provide strong evidence that both direct and spillover effects of population growth are capitalized into farmland valuation as a development option value. The magnitude of the estimated coefficients is economically meaningful. For example, a one-unit increase in adjacent population density change within a 10-mile radius corresponds to a $1,154 increase in the development option value for crop parcels. This substantial effect highlights how even modest demographic shifts can significantly alter market expectations about land conversion potential.

These valuation gaps serve as early signals of development pressure in land markets. The responsiveness of market value to recent population growth suggests that appraisers and policymakers can use these gaps as indicators of emerging urban expansion. This is particularly relevant for regions undergoing rapid demographic change, where traditional appraisal methods may lag behind market dynamics.

From a policy standpoint, the findings underscore the importance of revisiting property tax assessment systems that rely on current use valuation. While these systems aim to preserve agricultural land by reducing the financial incentive to sell, the strong capitalization of population growth into market value suggests that they may be insufficient in high-growth areas. Zoning regulations and infrastructure planning should also account for the spatial spillover effects identified in this study, as development pressure is not confined to individual parcels but radiates across neighboring areas.

Our findings have direct relevance for appraisal professionals and valuation standards. A large body of literature shows that non-agricultural determinants such as urban proximity and demographic trends significantly influence farmland prices (Ma and Swinton, 2012; Zhang and Nickerson, 2015; Deaton and Lawley, 2022; Vyn and Shang, 2021). Appraisers should move beyond traditional approaches that rely primarily on historical sales or static productivity measures, as these often understate development pressure in rapidly urbanizing regions. For example, Ma and Swinton (2012) found that appraised values based on tax assessment formulas tend to emphasize physical and agricultural attributes while underrepresenting non-agricultural components (i.e., option value), which leads to biased interpretations of land value determinants when land use is changing. Similarly, Zhang and Nickerson (2015) demonstrated that the urban premium, the portion of farmland value attributable to proximity to urban areas, can fluctuate with housing market cycles. In Ohio, they found the urban premium accounted for 40% of per-acre farmland prices before 2008. These findings underscore the importance of incorporating spatial metrics and demographic indicators into appraisal models to improve accuracy and maintain consistency with market realities. Doing so can help appraisers anticipate emerging development pressure, support fair taxation, and guide landowners in making informed decisions about conversion timing. Ignoring these factors risks misestimating the contribution of development potential to market value, particularly in peri-urban areas where land conversion expectations are strong.

While the results are robust and consistent across specifications, several limitations should be acknowledged. First, the analysis does not directly observe land conversion events; instead, the development option value is inferred from the gap between market and current use values. Ideally, access to actual sales prices would allow for a more precise estimation of development option value. However, the lack of comparable sales records is a common challenge in farmland appraisal, making it unlikely that such data could be reliably obtained for a large sample.

Second, potential endogeneity may arise if population growth is influenced by land market dynamics. For example, rising land values may attract residential development, which in turn increases population density—creating a feedback loop between valuation and demographic change. Additionally, unobserved factors such as infrastructure investment, zoning changes, or local economic shocks could simultaneously affect both population growth and land values. Although county and year fixed effects help mitigate these concerns by controlling for time-invariant and region-specific characteristics, future research could explore instrumental variable approaches or spatial econometric models to address endogeneity more directly.

Third, the study focuses on short-term development pressure by using one-year lagged changes in population density. This approach is reasonable for capturing recent shifts in demand, especially in fast-growing regions where land markets respond quickly to demographic changes. However, mid- to long-term population trends (e.g., three- to five-year changes) may also influence development option value, particularly in areas with slower planning cycles or long-term infrastructure investments. Incorporating longer-term measures could provide a more comprehensive view of development dynamics.

Fourth, the generalizability of the findings may be limited to regions with similar land use policies, demographic trends, and appraisal systems. While all U.S. states have laws that tax agricultural land differently from other land uses to reduce property tax burdens for producers, the specifics of these "differential tax assessment" laws vary widely across states (National Agricultural Law Center, 2019). States differ in how they define qualifying land, calculate agricultural value, and impose penalties for conversion. Therefore, extending the analysis to other states or incorporating zoning and infrastructure data could improve external validity and enhance the policy relevance of the findings.

While our analysis focuses on development pressure as the primary driver of option value, we recognize that coastal areas, particularly around Mobile Bay, may reflect heterogeneous influences. In these regions, high market value premiums likely incorporate amenity-based factors such as waterfront access, scenic views, and recreational opportunities, alongside urban expansion effects. Because our model does not explicitly separate amenity value from development potential, the estimated option value in coastal parcels may overstate the role of population-driven development pressure. Future research could address this by introducing a coastal dummy or interaction terms to isolate amenity effects and better distinguish between urban growth and natural amenity contributions to farmland valuation.

Despite these limitations, the study provides a strong empirical foundation for understanding how demographic change influences farmland valuation. It also offers practical insights for appraisers, planners, and policymakers seeking to manage development pressure and preserve agricultural land.

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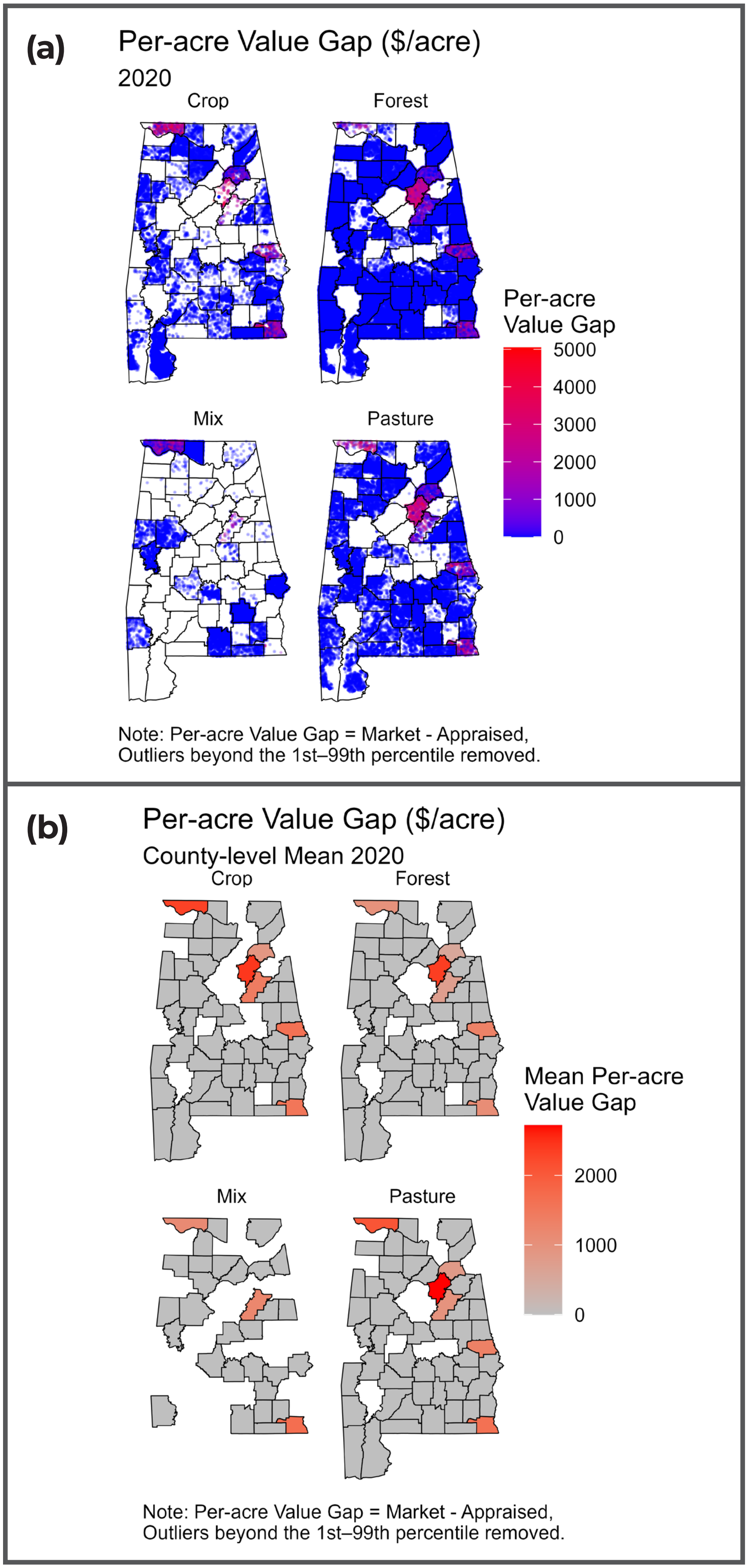

Figure 1. Spatial distribution of per-acre farmland value gaps by land type in Alabama, 2020 ($/acre): (a) parcel level and (b) county level, mean

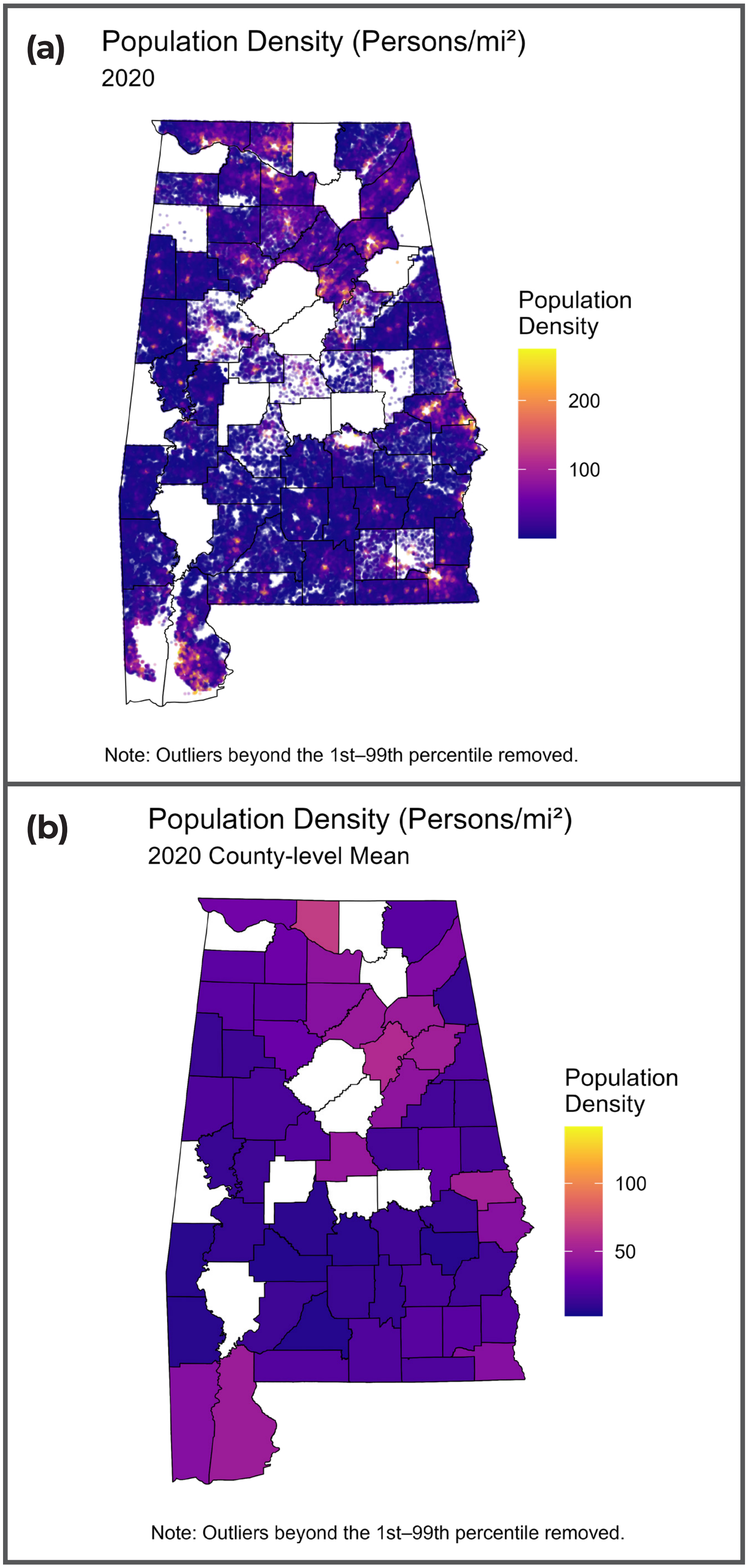

Figure 2. Spatial distribution of population density in Alabama, 2020 (Persons/mi²): (a) parcel level and (b) county level, mean

Table 1. Summary Statistics of Variables Used in the Baseline Empirical Models, 2016-2020					
Variable	**Unit**	**Mean**	**Std. Dev.**	**Min**	**Max**
Option Value	$ / acre	608.16	4336.86	-255337.42	796488.24
ΔOwn Density, t-1	Persons per square mile	0.54	2.50	-19.61	76.24
ΔAdjacent Density (5-mile), t-1	Persons per square mile	0.65	1.95	-3.55	25.29
ΔAdjacent Density (10-mile), t-1	Persons per square mile	0.70	1.66	-0.93	13.73
ΔAdjacent Density (20-mile), t-1	Persons per square mile	0.76	1.40	-0.31	9.42
Own Density, t-1	Persons per square mile	67.88	156.46	0	5103.68
Adjacent Density (5-mile), t-1	Persons per square mile	74.78	114.75	1.15	1625.89
Adjacent Density (10-mile), t-1	Persons per square mile	78.46	91.91	3.28	979.8
Adjacent Density (20-mile), t-1	Persons per square mile	86.61	84.01	7.05	646.03
Acres	Acre	57.47	91.25	0.01	7300

Note: The number of observations used in the baseline empirical models is 907,488.

Table 2. Fixed-Effects Panel Regression Results: Impacts of Population Density on Option Value (Dependent Variable: Option Value ($/acre), 10-Mile Radius Population Buffer)					
Independent variable	**Overall**	**Crop**	**Forest**	**Pasture**	**Mix**
Δ Own Density, t-1	280.40*** (38.09)	278.47*** (26.20)	232.77*** (42.69)	260.36*** (58.32)	12.74 (9.13)
Δ Adjacent Density (10-mile), t-1	712.58*** (252.95)	1153.99*** (228.18)	479.85*** (130.73)	404.07** (172.13)	-166.91** (67.60)
Own Density, t-1	-0.58 (0.67)	-0.33 (0.68)	0.49 (0.34)	0.27 (0.57)	-0.20 (0.13)
Adjacent Density (10-mile), t-1	-3.98* (2.23)	-7.96* (4.28)	-1.96** (0.87)	-1.71* (0.95)	2.73** (1.13)
Acres	-1.03* (0.61)	-5.26 (3.59)	-0.39 (0.24)	-0.84** (0.36)	-0.29 (0.30)
No. of observations	907488	121057	538387	164458	83586
Adjusted R^2	0.16	0.14	0.19	0.32	0.26

Note: The "Overall" column includes land use controls via categorical indicators for parcel type (Crop, Forest, Pasture, Mix); all columns include county and year fixed effects; errors are clustered by county; standard errors are shown in parentheses; *p < 0.1, **p < 0.05, ***p < 0.01

APPENDIX

Robustness Checks: Sensitivity to Spatial Definitions

To assess the sensitivity of our findings to spatial definitions and model specifications, we re-estimate the model using alternative spatial buffers of 5 miles and 20 miles. The 5-mile radius captures more immediate neighborhood effects, potentially reflecting short-run development spillovers, while the 20-mile radius tests whether broader regional population dynamics exert influence on parcel-level valuation gaps. Across these specifications, the direction and significance of key coefficients remain consistent, suggesting that the observed relationship between population change and development option value is not overly sensitive to the choice of spatial radius.

Tables A1 and A2 present parameter estimates from alternative specifications using 5-mile and 20-mile buffers to define neighboring population density. These robustness checks test the sensitivity of the main findings to the spatial definition of "adjacent" development pressure. All models include county and year fixed effects, and the "Overall" column includes land use controls. Across both alternative specifications, alternative spatial buffers (5-mile and 20-mile) confirm the stability of the main findings. In Table A1 (5-mile buffer), the coefficients of $\Delta\ Own\ Density_{t-1}$ remains positive and significant for all land use types. Their magnitudes are slightly lower than those in the 10-mile buffer model, which is expected given the narrower spatial scope of development pressure. The effect of $\Delta\ Adjacent\ Density_{t-1}$ in the 5-mile buffer is also positive and significant. These results suggest that even short-range population growth in neighboring areas is capitalized into farmland valuation.

As shown in Table A2 (20-mile buffer), the direction and magnitude of coefficients remain consistent across specifications, although the 20-mile buffer introduces more noise, particularly for forest and pasture parcels, where the changes in neighboring population density ($\Delta\ Adjacent\ Density_{t-1}$) becomes insignificant while positive. This suggests that broader regional population dynamics may be less relevant for certain land types, or that the signal becomes noisier at larger spatial scales.

Across all robustness checks, the direction and significance of the key coefficients remain consistent, reinforcing the interpretation that parcel-level valuation gaps are responsive to recent and localized changes in population density. These findings support the robustness of the main empirical results and highlight the importance of spatial scale in modeling development pressure.

Robustness Checks: Urban Influence Measures

The development option value likely reflects accessibility and proximity to both in-state and nearby out-of-state metropolitan areas (e.g., Atlanta) as well as major transportation corridors (e.g., interstate highways). To test the association, we re-estimated the baseline model (Table 2) by adding two accessibility variables employed as urban influence measures in Zhang and Nickerson (2015): distance to the nearest city center with population greater than 40,000 (Alabama and adjacent states), distance to the nearest highway on-ramp (Alabama and adjacent states). City population data were obtained from U.S. Census population estimates, and all interstate on-ramp locations were extracted from OpenStreetMap (2025). Table A3 provides the summary statistics of those two variables while Figure A1 illustrates the spatial distribution of development-relevant accessibility across Alabama.

As shown in Table A4, the inclusion of the variables that potentially explain the development option value confirms the stability of the main findings. Including accessibility variables does not materially change the coefficients on population density changes; they remain positive and significant, with only marginal shifts in magnitude. This confirms that development pressure—captured by short-run changes in population density—is the dominant driver of option value. Unlike static measures such as distance to cities or highways, which reflect long-term locational advantages, population change signals recent inflows of residents and emerging development demand, making it a more precise indicator of conversion pressure. While accessibility measures show expected signs in some cases, their inclusion does not alter the interpretation of development pressure effects, likely because fixed effects already absorb much of their influence. Overall, these results indicate that our main findings are robust to controls for metropolitan accessibility and transportation infrastructure.

Robustness Checks: Placebo Test Using Slope

Our baseline model controls for county-level heterogeneity but does not explicitly include parcel-level characteristics such as slope, soil quality, or floodplain status. These factors can affect both agricultural returns and conversion feasibility, potentially influencing development option value. Incorporating them could refine estimates and strengthen causal interpretation because these attributes can affect both agricultural returns and conversion feasibility, potentially influencing the magnitude of development option value.

We implemented a placebo test comparing parcels with steep slopes (high development constraints) to those with favorable physical conditions. Slope was calculated from NASA Digital Elevation Model (DEM) data at parcel centroids. Consistent with planning guidelines and prior literature (Saiz, 2010), slopes above 15% significantly limit residential development potential. In reality, many zoning ordinances restrict development on slopes greater than 10%, and some allow up to 15% (Southern Tier Central Regional Planning and Development Board, 2012).

Based on these norms, we created slope categories (≥10%, ≥15%, ≥20%, ≥25%) and defined binary less-developable (LD) indicators using parcel centroid slope. While centroid-based slope may not capture internal variation within parcels, we assume slope heterogeneity is minimal for most parcels. For example, = 1 if a parcel's centroid slope is larger than 10%. We re-estimated the model stratified by LD status and test sensitivity across thresholds.

Results indicate that population-driven effects diminish in less developable parcels across all slope thresholds: the influence of recent population growth within a parcel's immediate area weakens substantially on steep-slope parcels, and the effect of growth in surrounding areas disappears. This supports the interpretation that development pressure operates primarily where conversion is feasible. These findings provide additional evidence that observed valuation gaps reflect development pressure rather than unobserved physical limitations. Figure A2 shows the distribution of slopes in Alabama, and Table A5 presents regression results.

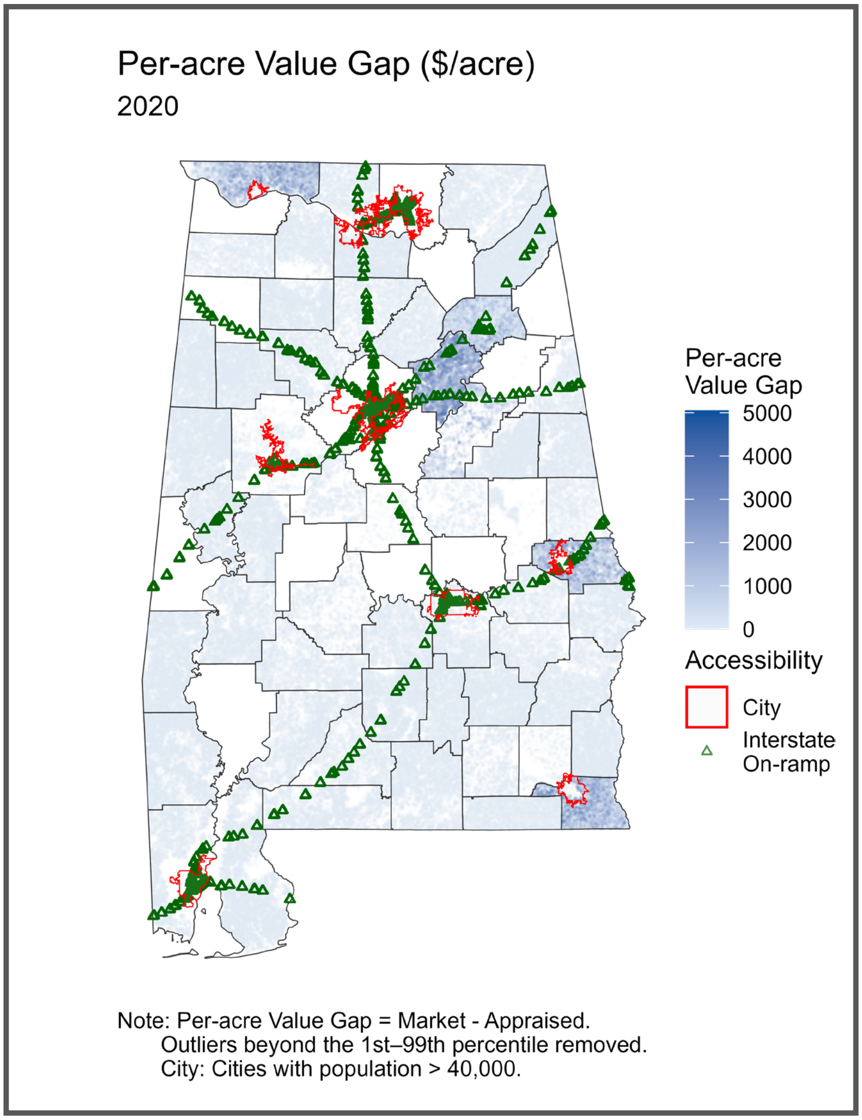

Figure A1. Spatial distribution of per-acre farmland value gaps (all land types) and development-relevant accessibility (proximity to cities and highway on-ramps) in Alabama, 2020 ($/acre)

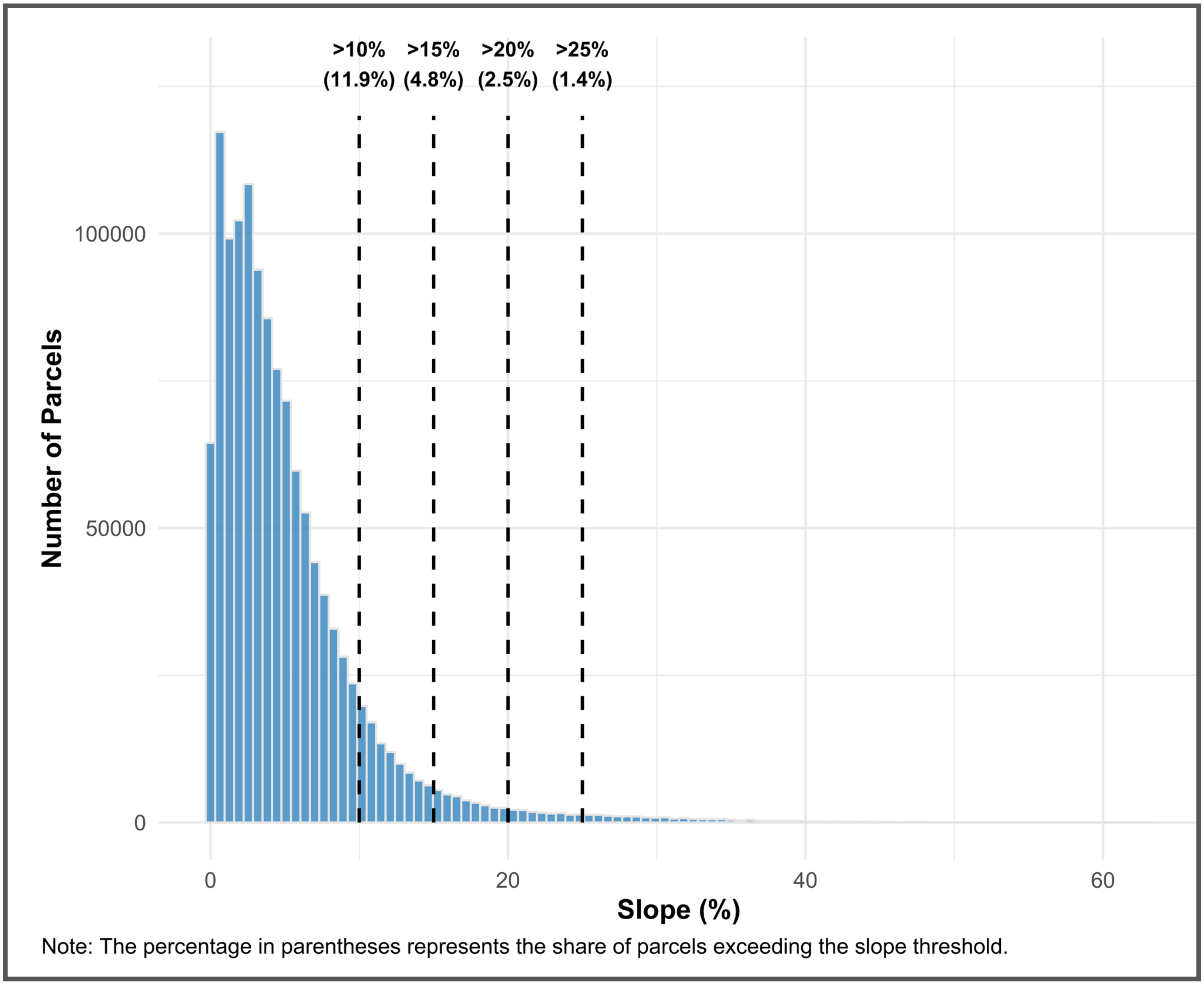

Figure A2. Distribution of parcel slopes in Alabama

Summary statistics, 2016-2020					
Variable	**Unit**	**Mean**	**Std. Dev.**	**Min**	**Max**
Slope	%	5.32	5.34	0.00	62.98

Table A1. Robustness Check: Fixed-Effects Panel Regression Results Using 5-Mile Radius Population Buffer (Dependent Variable: Option Value, $/Acre)

Independent variable	Overall	Crop	Forest	Pasture	Mix
Δ Own Density, t-1	191.72*** (33.28)	200.39*** (26.88)	135.88*** (17.20)	178.86** (77.27)	10.73 (9.64)
Δ Adjacent Density (5-mile) , t-1	623.10*** (171.93)	862.77*** (104.51)	493.75*** (102.12)	457.86** (185.90)	-70.97* (35.36)
Own Density, t-1	-0.51 (0.54)	-0.31 (0.65)	0.31 (0.25)	0.24 (0.44)	-0.28 (0.22)
Adjacent Density (5-mile), t-1	-2.80* (1.53)	-4.32** (2.11)	-0.96 (0.70)	-1.31 (0.86)	1.26 (0.79)
Acres	-1.09 (0.65)	-5.50 (3.79)	-0.43* (0.25)	-0.86** (0.34)	-0.29 (0.32)
No. of observations	907488	121057	538387	164458	83586
Adjusted R^2	0.16	0.14	0.21	0.33	0.26

Note: The "Overall" column includes land use controls via categorical indicators for parcel type (Crop, Forest, Pasture, Mix); all columns include county and year fixed effects; errors are clustered by county; standard errors are shown in parentheses; $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table A2. Robustness Check: Fixed-Effects Panel Regression Results Using 20-Mile Radius Population Buffer (Dependent Variable: Option Value, $/Acre)

Independent variable	Overall	Crop	Forest	Pasture	Mix
Δ Own Density, t-1	348.07*** (58.38)	394.79*** (37.32)	275.82*** (54.50)	292.32*** (54.96)	-1.74 (2.34)
Δ Adjacent Density (20-mile), t-1	562.36* (298.76)	1037.97*** (172.36)	219.70 (157.38)	86.60 (122.84)	-123.05*** (31.66)
Own Density, t-1	-0.67 (0.70)	-0.91 (1.01)	0.47 (0.36)	0.18 (0.60)	0.01 (0.04)
Adjacent Density (20-mile), t-1	-2.81** (1.09)	-1.89 (1.30)	-1.71* (0.88)	-0.38 (0.76)	2.64*** (0.93)
Acres	-1.08* (0.64)	-5.54 (3.58)	-0.45* (0.26)	-0.86** (0.36)	-0.28 (0.29)
No. of observations	907488	121057	538387	164458	83586
Adjusted R^2	0.15	0.13	0.18	0.31	0.26

Note: The "Overall" column includes land use controls via categorical indicators for parcel type (Crop, Forest, Pasture, Mix); all columns include county and year fixed effects; errors are clustered by county; standard errors are shown in parentheses; $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table A3. Summary Statistics of Distance Variables Used in the Empirical Models, 2016-2020

Variable	Unit	Mean	Std. Dev.	Min	Max
Distance to nearest city center	miles	38.31	18.79	0.26	90.35
Distance to nearest highway on-ramp	miles	41.53	19.76	0.25	100.82

Note: The number of observations used in the baseline empirical models is 907,488.

Table A4. Robustness Check: Fixed-Effects Panel Regression Results with the Inclusion of Accessibility-Relevant Variables (Dependent Variable: Option Value ($/acre), 10-Mile Radius Population Buffer)

Independent variable	Overall	Crop	Forest	Pasture	Mix
Δ Own Density, t-1	279.51*** (37.61)	277.87*** (25.88)	232.53*** (42.32)	259.63*** (58.21)	12.30 (9.04)
Δ Adjacent Density (10-mile), t-1	720.34*** (253.69)	1141.90*** (210.62)	486.29*** (129.61)	402.45** (170.19)	-159.66** (69.99)
Own Density, t-1	-0.57 (0.66)	-0.32 (0.66)	0.49 (0.34)	0.29 (0.57)	-0.19 (0.14)
Adjacent Density (10-mile), t-1	-3.70* (2.10)	-6.68* (3.70)	-1.84** (0.82)	-1.50 (0.91)	2.58** (1.14)
Acres	-1.03* (0.60)	-5.29 (3.58)	-0.39 (0.23)	-0.84** (0.36)	-0.29 (0.30)
Distance to nearest city center	9.05 (6.00)	29.84** (14.76)	3.85 (2.31)	3.09 (3.76)	-1.67* (0.84)
Distance to nearest highway on-ramp	3.31 (3.18)	-5.40 (6.76)	2.25 (2.57)	6.92* (4.02)	1.48 (3.31)
No. of observations	907488	121057	538387	164458	83586
Adjusted R^2	0.16	0.14	0.19	0.32	0.26

Note: The "Overall" column includes land use controls via categorical indicators for parcel type (Crop, Forest, Pasture, Mix); all columns include county and year fixed effects; errors are clustered by county; standard errors are shown in parentheses; *p < 0.1, **p < 0.05, ***p < 0.01

Table A5. Placebo Test: Fixed-Effects Panel Regression Results by Slope Threshold (Dependent Variable: Option Value ($/acre), 10-Mile Radius Population Buffer)

(a) Threshold: 10% Slope			**(b) Threshold: 15% Slope**		
Independent variable	**Slope>10%**	**Slope≤10%**	**Independent variable**	**Slope>15%**	**Slope≤15%**
Δ Own Density, t-1	386.52*** (109.97)	733.12*** (96.06)	*Δ Own Density, t-1*	295.87** (130.02)	733.21*** (99.05)
Δ Adjacent Density (10-mile), t-1	166.88 (164.39)	1945.25*** (635.32)	*Δ Adjacent Density (10-mile), t-1*	127.22 (212.15)	1881.86*** (651.35)
Own Density, t-1	-1.50* (0.89)	-1.41 (1.75)	*Own Density, t-1*	-0.84 (1.10)	-1.57 (1.75)
Adjacent Density (10-mile), t-1	1.25 (1.76)	-10.43** (4.96)	*Adjacent Density (10-mile), t-1*	1.58 (1.25)	-10.04* (5.04)
Acres	-0.53** (0.26)	-1.10 (0.69)	*Acres*	-0.46* (0.27)	-1.08 (0.66)
No. of observations	113793	809230	No. of observations	45851	877172
Adjusted R^2	0.25	0.16	Adjusted R^2	0.14	0.16
(c) Threshold: 20% Slope			**(d) Threshold: 25% Slope**		
Independent variable	**Slope>20%**	**Slope≤20%**	**Independent variable**	**Slope>25%**	**Slope≤25%**
Δ Own Density, t-1	179.55*** (55.09)	732.03*** (99.39)	*Δ Own Density, t-1*	182.84*** (50.58)	730.99*** (99.45)
Δ Adjacent Density (10-mile), t-1	38.62 (81.69)	1858.82*** (655.11)	*Δ Adjacent Density (10-mile), t-1*	41.95 (108.89)	1847.21*** (656.83)
Own Density, t-1	-1.20** (0.59)	-1.56 (1.75)	*Own Density, t-1*	-1.58*** (0.57)	-1.55 (1.74)
Adjacent Density (10-mile), t-1	2.62* (1.53)	-9.88* (5.03)	*Adjacent Density (10-mile), t-1*	3.26** (1.27)	-9.77* (5.01)
Acres	-0.29 (0.24)	-1.07* (0.64)	*Acres*	-0.25 (0.22)	-1.07* (0.63)
No. of observations	23545	899478	No. of observations	13311	909712
Adjusted R^2	0.44	0.16	Adjusted R^2	0.48	0.16

Note: All columns include county and year fixed effects; errors are clustered by county; standard errors are shown in parentheses; *p < 0.1, **p < 0.05, ***p < 0.01