# Why does local control constrain the housing supply?*

David Foster† Joseph Warren†

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Local control over housing policy is widely held responsible for constraints on new housing development. Yet while local residents who fear negative externalities may be expected to oppose new housing, why is it that developers with large potential profits apparently cannot compensate residents? We use a formal model to investigate the role of transaction costs in bargaining between developers and local residents. Such transaction costs arise when regulatory institutions effectively require developers to expend resources that cannot be used to compensate residents. Our model shows that when transaction costs are high, voters consistently oppose new development, regardless of compensation from developers. But when transaction costs are low, developers are able to compensate residents, and local support for new housing increases. We extend the baseline bargaining model to show that when benefits of developers internalizing negative externalities of new development outweigh the transaction costs associated with local control, then local control improves social welfare relative to centralized authority over land use.

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†Graduate student, Department of Political Science, University of California, Berkeley.
Corresponding author: `jwarren@berkeley.edu`

High housing prices in major metropolitan areas in the United States have severe social and economic consequences (see, e.g., Ganon and Shoag 2017, Chetty et al. 2014, Hsieh and Moretti 2015).[1] In turn, an inelastic housing supply is an important cause of high housing prices (Gyourko et al. 2013), with land-use regulations forming a powerful constraint on the housing supply. One measure of the effect of land-use regulations on housing prices is provided by the difference between prices and construction costs. In 2013, about one in ten American households lived in houses with prices more than double construction costs (Glaeser and Gyourko 2018). On the California coast, in the same year, the median home price was about three times construction costs (Taylor 2015). Since the cost of building new houses is so much lower than housing prices, developers should be expected to build more housing in the absence of regulatory supply constraints.[2] Indeed, studies have found an empirical relationship between increasing land-use regulations and higher housing prices (Albouy and Ehrlich 2018, Ihlanfeldt 2007). Given the link between housing prices and land-use regulations, effective policies to address high housing prices require addressing the political causes of housing supply constraints arising from land-use regulations.

Both policymakers and scholars have ascribed responsibility for housing supply constraints to the high degree of local control over housing policy in the United States. One example of such a proposal, introduced in the California State Legislature in the 2018 session, was Senate Bill (SB) 827. Though this bill failed to pass, it proposed to increase housing development around transit stops by overriding local regulations. Consistent with this, the bill's author emphasized that housing production cannot be increased without giving up some local control over housing policy (Levin 2018). In Massachussets, a related proposal to mandate multifamily zoning was based on similar logic (Yglesias 2016).

Such sentiment among policymakers is mirrored in arguments presented by scholars of land-use policy. In a statement of support for SB 827, a collection of urban planning professors argued that

[1] Glaeser and Gyourko (2018) distinguish three categories of housing markets in the US. (1) expanding markets with plentiful new construction, such as Atlanta, where housing prices have generally tracked construction costs, (2) declining markets, such as Detroit, where an existing housing stock means that lower demand decreases housing prices and there is little new construction, and (3) expanding markets with limited new construction, such as the San Francisco Bay Area, where housing prices have risen far beyond construction costs. This paper focuses on the third type of housing market.

[2] This measure of regulatory constraints is analogous to Tobin's $q$ (the ratio of a firm's market value to replacement cost), which can be greater than 1 due to capital adjustment costs (Glaeser and Gyourko 2018).

local governments incorporate local opposition to new housing, but not the wider social benefits (Manville et al. 2018). Other scholars (e.g., Hankinson 2018, Schleicher 2013) concur that a collective action problem arises when neighborhood groups that would bear the concentrated costs of new housing pressure local governments against development, but no groups exert opposed pressure in favor due to the diffuse benefits of new housing. Moreover, potential new residents who would benefit from housing do not even vote in the relevant jurisdiction (Glaeser and Gyourko 2018). For such reasons, local governments fail to build housing, necessitating intervention by state-level policymakers.

But there is a theoretical puzzle. On one hand, we may expect local residents to be wary of new housing development out of self-interest, and empirical evidence supports this. Homeowners concerned about home values, renters worried about rising rents, or commuters facing high traffic are more likely to oppose new housing development (Marble and Nall 2018, Hankinson 2018, Dubin et al. 1992). Where land values are already high for exogenous (geographic) reasons, regulations protecting land values are also higher, which is consistent with voters seeking to protect property values through land-use regulation (Saiz 2010). On the other hand, the substantial gap between housing prices and the costs of new construction shows that there is a large surplus available for developers to share with neighbors. While developers sometimes negotiate with local residents to obtain support for new projects, offering goods to the community in exchange for resident acceptance of the proposed project, the success of such negotiations is clearly incommensurate with the demand for new housing.[3] If it is truly the case that there are such huge potential profits from building more housing, why are developers incapable of negotiating with neighbors in order to overcome local opposition?[4]

Oftentimes, public portrayals of local opposition to new housing focuses on small groups of neighbors who consistently appear at planning hearings to oppose new development—classically labeled "Not In My Backyard" (NIMBY) voters—and who are presented as perceiving the costs of

[3]See Been (2010) for a discussion of community benefits agreements.

[4]Others have observed the unrealized potential for transfers from developers to reduce local opposition to new housing (e.g., Glaeser and Ward 2009, 278). Albouy et al. (2018) show that a market with competitive developers in which site-owners can exchange transfers with potential new residents results in an optimal population distribution for the society as a whole. Yet to our knowledge, prior research has not analyzed the bargaining problem that we argue is central to explaining the absence of such transfers in practice.

new housing to be extremely high, if not infinite. Yet a variety of empirical evidence shows that such residents are unrepresentative of the broader population (Einstein et al. 2017b, Ornstein 2017). While local residents appear to experience new housing as a cost in many cases, local opposition to new housing is neither overwhelming nor invariant. Local voters are willing to support new developments when the negative externalities are sufficiently small or developers also provide local public goods (Gerber and Phillips 2003, 2004).

In this paper, we explain local opposition to new housing as arising due to transaction costs in the project-approval process, which eliminate potential bargains between developers and local residents. Existing land-use institutions require developers to expend large quantities of resources that then cannot be used to compensate current residents for the local costs of new housing. The costs to developers for project approval can be substantial. Quigley et al. (2008) survey housing developers in the San Francisco Bay Area to ask for "the all-inclusive cost of the entire entitlement process," finding that the approval process for single-family developments cost Bay Area developers an average of \$1.3 million per project (\$22,600 per new unit) and other developments average a cost of \$2.3 million per project (\$9,100 per new unit). These regulatory expenses arise from fees such as for permitting, but also minimum lot size requirements, maximum density limits, minimum parking requirements, community benefits arrangements, mandatory environmental reviews, management of public relations campaigns to forestall city council pressure, and more generally, the expense of lawyers and experts needed to navigate regulatory obstacles (Einstein et al. 2017a, Glaeser and Ward 2009, Quigley and Rosenthal 2005).[5]

We present a model to analyze this bargaining problem between developers and local residents. In the model, voters select a degree of strictness for development regulations, conceived of as an application fee that developers must expend in order to secure project approval. Developers consider the total size of this fee when deciding to build a potential project. Yet for voters, there are

[5]The cost expended by opponents of new development can be substantial too, but these high costs for developers are central to the theory we present below because such costs constrain potential bargains between developers and local residents.

A classic vein of land-use theorizing conceives of zoning regulations as a form of property rights, such as Nelson (1977) and Fischel (1985), who draw the Coasean implication that the allocation of rights does not matter for efficient development as long as transaction costs are low. Commenting on this view, Schleicher (2013, 1714) responds that transaction costs in land-use regulation are often high. However, Schleicher does not focus policy considerations on reducing transaction costs (such as reforms to facilitate bargaining between developers and local residents).

two distinct components of this developer expense. Some of this expense goes directly back to voters in the form of public goods, community benefits agreements, or (in principal) cash transfers. Another portion is unable to be transferred to voters and instead goes to lawyers, consultants, organizing counter-protesters, or any other expenses necessary to navigate the regulatory process. This latter portion constitutes the transaction costs associated with regulatory approval for new housing development.

Our model abstracts from the specifics of the project-approval process to focus on voter preferences for the overarching regulatory regime. A number of theories of land-use regulation (e.g., Einstein et al. 2017a; Glaeser et al. 2005) highlight the ability of neighbors to exert pressure through the planning process. Our modeling strategy is complementary to these theories. Because our model features a representative voter, we do not consider conflicts among local residents or the problems associated with developers attempting to satisfy a small number of neighbors holding effective veto power. Instead, these features of the project-approval process enter our model through a single parameter representing the transaction costs of development.[6] By reducing many features of the land-use regulatory process to a single transaction-cost dimension, we are able to focus on the importance of this dimension for housing policy outcomes.

In our model, decreasing transaction costs of development increases electoral support for new housing, and this effect is non-linear. When voter compensation remains low due to high transaction costs, increasing compensation will not necessarily increase electoral support for more housing. Thus, one cannot look at the failure of many negotiations between developers and current residents to win neighbor approval to conclude that community benefits of sufficient magnitude will have the same outcome. This threshold on transaction costs, above which voters consistently oppose new housing, represents the NIMBY problem in our model. Bargains are unavailable because the portion of developer profits remaining after transaction costs are expended is lower than the negative externality experienced by voters, despite the project being a net social benefit in the absence of transaction costs. But when transaction costs are below this threshold, then increasing resident compensation leads to more project approval, which increases total social welfare.

[6] Two examples of formal bargaining papers showing how asymmetric information and veto power result in inefficiency are Mailath and Postlewaite (1990) and d'Aspremont and Gérard-Varet (1979).

However, as long as local residents charge an application fee greater than zero, then local control continues to restrict the housing supply relative to a land-use regime in which new developments are automatically approved. Do such restrictions represent a problem in terms of reducing overall social welfare, or do fees set by local residents incorporate socially relevant information? To analyze this question, we extend the baseline bargaining model to compare the allocation of new housing projects across heterogeneous districts when the application fee for developers is set either by local residents or a higher-level government official. While local voters set district-specific fees, the higher-level policymaker is constrained to set the same fee across both districts (due to informational or administrative constraints). Thus, if the higher-level policymaker chooses to allow housing development, then the developer builds in the district with the most profitable project, regardless of the cost to local residents. In contrast, if local residents set fees, then they receive compensation for new developments, and the relative size of these fees shift developments to locations where the net cost of new development is lower. The model shows that when transaction costs for development are sufficiently low, local control increases both total social welfare and the welfare of local residents.

This paper contributes to existing theories of land-use regulation by examining the institutional basis for the (net) cost that homeowners experience from new development, rather than taking such cost as given. With the theoretical possibility of transfers from developers, local opposition to new housing becomes puzzling rather than obvious. Our argument holds important policy implications. Two ideas often viewed to be in conflict—reducing inefficient delays by simplifying the approval process, and incorporating the preferences of local residents into land-use decisions—are actually consistent goals. By making land-use institutions more majoritarian (removing veto points that can be exploited by only a small number of residents, but maintaining veto power by a local majority), it is possible to facilitate new housing development while preserving local resident participation in the project-approval process. Moreover, reducing transaction costs while maintaining local control should increase electoral support for a regulatory regime that increases housing development.

Multiple existing models analyze the relationship between housing development, prices, and land-use regulations. In the model of Ortalo-Magné and Prat (2014), the median voter selects the number of building permits to issue. An exogenous fee paid by developers is then distributed evenly among voters. Similar to our results, as this fee increases (meaning that voters capture more of the surplus from new development), voters approve more housing, which increases social welfare. In a related model, Hilber and Robert-Nicoud (2013) analyze decisions by a planning board lobbied by owners of developed and undeveloped land. The planning board sets a regulatory tax that raises the cost of developed land. In their model, current residents are unable to share in the profits from new developments that would be possible from lowering the regulatory tax; instead, it is reflected in land prices. Our model differs from these models of land-use regulation in our focus on alternative regulatory regimes. In particular, we conceptually distinguish the overall regulatory expense that a developer must pay from the transfer that is available to voters.

In the model of Albouy et al. (2018), a NIMBY problem arises because city governments maximize the average welfare of the city population. City governments take into account congestion costs of increasing city size, but not the productivity gains that could be secured by residents of smaller cities moving to larger cities. Our analysis differs from this explanation of NIMBYism due to the possibility of transfers between new and current residents. In the version of their model with competitive developers, Albouy et al. show that when transfers can be exchanged between existing site-owners and potential new residents, then the society-wide optimum occurs. Their "developers" or "site-owners" are isomorphic to the current residents of our model. With this theoretical possibility in mind, we investigate the apparent bargaining failures at the root of real-world outcomes.

The paper proceeds as follows. The first section presents a baseline model in which a representative voter chooses how strict to set land-use regulations. The second section analyzes this baseline model to show that the greater the portion of developer expense going to the voter, the more willing the voter is to set regulations with lower costs of new developments, which increases social welfare. The third section compares a local-control policy regime to one in which land-use policy is set at a higher level of government, showing that local control is social welfare-improving when transaction costs are sufficiently low. The final section concludes.

# 1 A model of voter selection of land-use regulations

We present a complete-information game in which a representative Voter $V$ and a Developer $D$ are engaged in distributive conflict over potential new housing developments. $D$ obtains profit from building new housing, but doing so imposes costs on $V$. To mitigate these costs, $V$ selects a level of stringency for the land-use regulatory regime, to be represented by an application fee that $D$ must pay to proceed with development. In this section, we first present the formal definitions and setup of the model. Then we relate specific features of our model to the empirical literature on land-use regulation.

## 1.1 Formal setup

$V$ determines a level of cost that $D$ must pay in order to be allowed to proceed with a project. We represent this cost to $D$ as $\phi \in [0, \bar{b}]$, where $\bar{b}$ represents the maximum potential value of a project. This application fee $\phi$ represents more than literal money transferred to a government agency. Rather, it stands in for any costs imposed on developers through the political process. This includes two different conceptual categories of expense. In one category are expenses that accrue to the voter, such as community benefits or development impact fees. In another category are expenses of effort expended to gain approval that are essentially lost, such as time spent organizing a public forum or money paid to consultants.[7] To capture the difference between these two categories, we conceive of transaction costs $t \in (0, 1)$ as the fraction of the fee that does not accrue to $V$'s benefit. Thus, $V$ receives the portion $1 - t$ of the application fee as compensation for new development.

$V$ has the following utility:

$$U_V = \psi[\phi(1-t) - \beta b]$$

where $\psi \in \{0, 1\}$ indicates whether $D$ decides to develop the project. The parameter $b$ measures project size or gross social benefit. The welfare of non-residents enter the model through this parameter, in that people not yet living in a neighborhood are the main beneficiaries of new housing

[7] In the social welfare analysis of Section 2.1, we introduce a parameter to allow a portion of transaction costs (potentially the entirety) to be included in aggregate welfare, representing the social value of the welfare of government officials, lawyers, or consultants. The assumption of the model is only that transaction costs are lost to voters.

and the source of $D$'s revenue. $V$'s utility thus depends on the project benefit, a relationship governed by the parameter $\beta$. We assume that $0 < \beta < 1$. Assuming $\beta > 0$ means that $V$ perceives projects as bad, and the larger a project is, the more disutility it provides $V$.[8] Assuming $\beta < 1$ means that while a project may displease $V$, the project nonetheless generates more benefit to society than costs to the Voter. Some projects may indeed be a social bad, imposing social costs that exceed social benefits, and these should fail. Here we are interested in when and why projects that provide a net social benefit are blocked.

$D$ has the following utility function:

$$U_D = \psi(b - \phi)$$

where $\psi$ is as above, $b$ denotes $D$'s benefit from the project, and $\phi$ is the application fee set by the Voter. The parameter $b$ represents profit net of any costs exogenous to the political process we explore, such as construction and building materials. The fact that $b$ appears in utility functions of both $V$ and $D$ is a simply way to encode a distributive conflict between current residents and developers. Again, because potential new residents will be paying developers for housing when doing so makes new residents better off, we interpret developer profit to incorporate the benefits of development to current non-residents.

The order of moves in the game is as follows:

1. The representative voter $V$ selects an application fee $\phi$.
2. The benefit of a project $b$ is drawn $U[0, \bar{b}]$ and the developer $D$ observes it
3. $D$ decides whether to pay the application fee and build the project.
4. Payoffs are realized and the game ends.

While $b$ is drawn from a uniform distribution in the version of the model presented in the main text, Appendix A shows that our results hold with a more general probability distribution as well.

The exogenous parameters are $\bar{b}$, $\beta$, and $t$. The random variable is $b$. The endogenous choices are $\psi$ and $\phi$. Since this is a sequential game of complete information, subgame perfect Nash equilibrium (SPNE) is the natural equilibrium concept. We focus exclusively on pure-strategy SPNE.

[8] We do not explore the case in which $\beta \leq 0$, since voters who see projects as goods do not pose a NIMBY problem.

## 1.2 Discussion

Our model analyzes circumstances in which voters experience new housing development as bad, and empirical evidence attests to the range of costs local residents often perceive in new housing. Monkkonen and Livesley-O'Neill (2018) examine concerns expressed by local residents in neighborhood council meetings in Los Angeles and find that residents identified harms arising from changes to the built environment and "neighborhood character." Examples of these included environmental impacts, traffic, aesthetics, and historic preservation. In San Diego, Dubin et al. (1992) show that voters who live near traffic congestion tend to be more opposed to new development. In a national survey, Marble and Nall (2018) show that when homeowners are reminded of home values, they become less accepting of new housing. Similarly, renters who are fearful of rising rents are also more likely to oppose development in their neighborhoods.

Anticipating such costs of future developments, the Voter in our model moves first to select the development regime, i.e. the application fee. Voter attitudes toward development, given the institutional environment they face, are taken as the starting point for what developers can do. Other scholars, such as Glaeser et al. (2005), have modeled development decisions by a zoning board or city council as resulting from competitive lobbying by homeowners and developers. In contrast, we focus on voter preferences for strictness of the land-use regulatory regime overall. As Ornstein (2017) observes, essentially all development decisions are ultimately derived from the preferences of elected officials such as mayors or city councils, or ballot measures that sometimes directly set features of land-use institutions, such as the zoning code. Therefore, our formulation derives a development environment directly from the preferences of the Voter, and then the Developer makes a profit-maximizing decision within the constraints of this environment.[9]

The application fee represents a wide variety of regulatory features, from environmental reviews to parking requirements to literal permitting fees. An important premise here is that this diversity of regulations in fact reflects a single dimension of regulatory strictness or leniency. This assumption aligns with the empirical literature showing that different types of land-use regulations tend to be

[9]However, if we allow the Developer to move first, so that the Voter approves or vetoes potential projects, then the threshold on transaction costs above which voters reject all projects (the NIMBY problem in the model) remains identical. This will be explained further in the next section.

highly correlated with each other across cities (Gyourko et al. 2008, Einstein et al. 2017a).

Transaction costs of the project-approval process are assumed to move independently of the total application fee. Since a primary cause of regulatory expenses for developers is delay associated with multiple approval stages (Einstein et al. 2017a), one can imagine substituting the regulatory expense of delays for direct transfers or public goods as a theoretical means by which transaction costs can be decreased while the total application fee remains constant. This could be achieved, for instance, through a structured process for residents and developers to negotiate over community benefits, followed by a simple majority up-or-down vote. In fact, there is some empirical evidence that procedures along these lines facilitate bargains (Gerber and Phillips 2003, 2004).[10] However, we deem it unlikely in practice that transaction costs could be entirely eliminated within a local control land-use regime; a trade-off created by this fact will be explored in Section 3.

Finally, two features of the model are included for ease of analysis. First, the project's benefit is drawn randomly. This can be interpreted literally: $D$ and $V$ may be unsure what development opportunity might arise in the future. Yet because they both have risk-neutral preferences over $b$, this device merely serves to average over the different levels of benefit to $D$ that are expected in the future. Second, the fee chosen by $V$ is restricted to be fixed regardless of project size. This is of course not literally true, but having $V$ choose a single fee-level captures the coarseness with which regulation can be tailored relative to project benefit. Inevitable limits to bureaucratic capacity make it difficult for local planning offices or other policymakers to write regulations that anticipate all possible scenarios. As we explain in the next section, our qualitative results are the same whether $b$ is drawn randomly or not and whether or not $V$ chooses a fixed fee across projects or sets a fee for a specific project after it arises.

[10]In San Diego and a sample of other California municipalities that require voters to approve new housing development through referendums, Gerber and Phillips find that local neighborhood groups and the Sierra Club would negotiate with developers to secure public goods (such as open-space guarantees) and then subsequently endorse the project. Voters often approved developments that received interest group endorsements.

## 2 Analysis

We proceed by backward induction. It is clear that if and only if $b > \phi$, $D$ builds the project, selecting $\psi = 1$. The expected value of $\psi$ given $\phi$, denoted $\mathbb{E}(\psi|\phi)$, therefore corresponds to the probability that the project is built given that the $V$ sets a fee of $\phi$. Knowing this, $V$ must select $\phi$ to maximize expected utility, which is given by

$$EU_V(\phi) = \mathbb{E}(\psi|\phi) \int_{\phi}^{\overline{b}} U_V(b) f(b|\psi = 1) db + (1 - \mathbb{E}(\psi|\phi))0$$

This expression states that $V$'s expected utility equals the probability that the project is built given $\phi$, multiplied by $V$'s expected value of the project. (If the project is not built, then $V$'s utility is zero.) To find $V$'s expected value from the project, we integrate over $V$'s utility given possible project values that are built, where the realized value of $b$ is greater than $\phi$, with $f(\cdot|\psi = 1)$ representing the cdf of $b$ given that $\psi = 1$. Substituting in and applying the fact that $b \sim U[0, \overline{b}]$, we have

$$\begin{aligned} EU_V(\phi) &= \frac{\overline{b} - \phi}{\overline{b} - 0} \int_{\phi}^{\overline{b}} [\phi(1-t) - \beta b] \frac{1}{\overline{b} - \phi} db \\ &= \frac{\overline{b} - \phi}{\overline{b}} \left( \phi(1-t) - \beta \frac{\phi + \overline{b}}{2} \right) \end{aligned}$$

Intuitively, this is simply the probability that a sufficiently large project benefit is drawn, times the portion of the fee not lost to transaction costs minus the average cost incurred.

Having established $V$'s expected utility as a function of $\phi$, we can find $V$'s optimal choice of $\phi$. Let $\phi^{(*)}$ denote the zero of the derivative of an unbounded version of the expected utility function. The first-order condition for $V$'s choice of $\phi$ is

$$\frac{d}{d\phi} EU_V(\phi) = \frac{\phi[\beta + 2(1-t)] - \overline{b}(1-t)}{\overline{b}} = 0 \implies \phi^{(*)} = \frac{\overline{b}(1-t)}{2(1-t) + \beta}$$

For there to be an interior solution (that is, for $0 < \phi < \overline{b}$), it must be the case that $0 < \frac{1-t}{2(1-t)+\beta} < 1$. This condition holds when $t < 1 - \beta$. Substantively, this means that transaction costs must be smaller than the available social surplus (per unit of project size). If this is not true, then projects will always harm $V$ and thus $V$ is better off prohibiting all projects by setting $\phi = \bar{b}$. For the part of the parameter space in which $t < 1 - \beta$, the second-order condition is met.

$V$'s equilibrium selection of $\phi$, which we denote $\phi^*$, is stated in the following proposition:

**Proposition 1.** *In any SPNE, V's optimal selection of the application fee is as follows:*

$$\phi^* = \begin{cases} \bar{b} & t \geq 1 - \beta \\ \frac{\bar{b}(1-t)}{2(1-t)-\beta} & t < 1 - \beta \end{cases}$$

*Proof.* In text. □

The condition on transaction costs ($t \geq 1 - \beta$) represents the problem of NIMBYism in our model: when transaction costs are too high, $V$ is unresponsive to potential compensation and consistently opposes projects. Whether $V$ recovers nothing or some small positive amount of a project's value in fees, the entire project is expected to incur more disutility from its existence than utility from fees recovered, and $V$ responds with maximal opposition. Only when transaction costs are low and fees recovered (either in the form of public goods, cash, or otherwise) reach a sufficiently high threshold does $V$'s selection of a development regime change smoothly with shifts in model parameters. This result implies that we cannot extrapolate from observed failures of community benefits agreements at low levels to conclude that high levels would also fail to increase public support for new development.

Importantly, the bargaining failure that arises when $t$ is too large does not rely on the order of moves in the game or $V$'s uncertainty over the future value of the project benefit $b$. We can amend the game so that the project benefit is certain. Suppose the Developer moves first by offering a value of $\phi$ that the Voter chooses to accept or reject. The condition for $V$ to accept the $D$'s offer is $\phi(1 - t) - \beta b \geq 0 \Rightarrow \phi \geq {}^{\beta b}/_{(1-t)}$. Hence, $D$ needs to offer $\phi = {}^{\beta b}/_{(1-t)}$ in order to induce $V$ to approve the project. $D$ wants to build if and only if $b > \phi$, so the condition for the project to be built is $b > {}^{\beta b}/_{(1-t)} \Rightarrow 1 - \beta > t$. This condition is the same as that of Proposition 1.

What happens if $V$ moves first and offers $\phi$ for $D$ to accept or reject, but with a known value of project benefit $b$? Since $D$ accepts if and only if $b \geq \phi$ (assuming in this case that $D$ accepts when indifferent), $V$ offers $\phi = b$. Now the condition for $V$ to want the project to be built with $\phi = b$ is

$b(1-t) - \beta b > 0 \Rightarrow 1 - \beta > t$. As above, this is also the same condition as in Proposition 1. Thus, the existence of uncertainty and the order of moves in the game alter the equilibrium value of $\phi$, but the threshold value of transaction costs that results in a bargaining failure (what we characterize as the NIMBY problem in our model) is identical across these variations of the game.

The following proposition summarizes the comparative statics of the original game:

**Proposition 2.** *As transaction costs $t$ decrease, the space of $\beta$ in which the Voter charges the maximum fee decreases. Where $t < 1 - \beta$, $V$'s optimal fee $\phi^*$ increases in the maximum project benefit $\overline{b}$, transaction costs $t$, and $V$'s cost of projects $\beta$.*

*Proof.* See Appendix B. □

These comparative statics have clear intuition. As the potential value of a project increases, $V$ responds by imposing a stricter regime. This aligns with empirical results showing an association between housing demand in a metropolitan area and the stringency of land-use regulations (Hilber and Robert-Nicoud 2013, Saiz 2010). Next, as transaction costs diminish, $V$ takes a more lenient approach to development. While $V$ continues to see projects as a bad on their own, $V$ is able to share in more of the surplus generated by $D$. Finally, unsurprisingly, as projects impose less cost on $V$, $V$ accepts more development.

## 2.1 Welfare effects

Having established $V$'s optimal choice of $\phi$ as a function of transaction costs, we can now explore how total social welfare changes with transaction costs for development. This section shows that social welfare is strictly decreasing in transaction costs. This result holds even if we allow some portion of transaction costs to be lost only to $V$ and $D$ and still be reflected in total social welfare. Since if $t \geq 1 - \beta$ then total welfare is zero, in the proceeding analysis we assume that $t < 1 - \beta$.

To compute total welfare, we first compute the equilibrium expected utilities for both $V$ and $D$. $V$'s equilibrium expected utility is

$$EU_V^* \equiv EU_V(\phi^*) = \frac{\overline{b} - \phi^*}{\overline{b}} \left( \phi^*(1-t) - \beta \frac{\phi^* + \overline{b}}{2} \right) = \frac{\overline{b}[(1-t) - \beta]^2}{2[2(1-t) - \beta]}$$

Next, $D$'s equilibrium expected utility is

$$EU_D^* \equiv EU_D(\phi^*) = \mathbb{E}(\psi|\phi^*) \int_{\phi^*}^{\bar{b}} U_D(b) f(b|\psi = 1) db + (1 - \mathbb{E}(\psi|\phi^*))0$$

$$= \frac{\bar{b} - \phi^*}{\bar{b} - 0} \int_{\phi^*}^{\bar{b}} (b - \phi^*) \frac{1}{\bar{b} - \phi^*} db = \frac{\bar{b} - \phi^*}{\bar{b}} \left( \frac{\phi^* + \bar{b}}{2} - \phi^* \right) = \frac{\bar{b}[(1-t) - \beta]^2}{2[2(1-t) - \beta]^2}$$

These two values provide the first two components of expected total welfare. For the third component of total welfare, we must first introduce a new parameter.

We assumed above that a portion $t$ of the application fee $\phi$ is lost, while $V$ obtains the remainder. One could argue, though, that welfare calculations should include some share of this portion $t$. Although $V$ may not benefit from fees paid to lawyers, for instance, lawyers' welfare might be considered part of total social welfare. Therefore, we allow a fraction $s \in [0, 1]$ of transaction costs to enter social welfare.

In equilibrium, expected total fees are found by multiplying the value of fees paid by the probability that a project that will be approved arises, as follows

$$E\Phi^* = \phi^* \frac{\bar{b} - \phi^*}{\bar{b}} = \frac{\bar{b}(1-t)(1-t-\beta)}{[2(1-t) - \beta]^2}$$

Thus, expected fees lost to transaction costs are $tE\Phi^*$. We can now define $E\Phi^*_{\mathbf{W}}$ to be expected transaction costs counting toward expected total welfare, so that $E\Phi^*_{\mathbf{W}} = stE\Phi^*$. Hence, expected total welfare is

$$E\mathbf{W} = EU_V^* + EU_D^* + E\Phi^*_{\mathbf{W}}$$

The following proposition summarizes how expected total welfare changes with transaction costs:

**Proposition 3.** *Expected total welfare is strictly decreasing in transaction costs.*

*Proof.* See Appendix B. □

When transaction costs diminish, welfare increases in part because fees previously lost now accrue to $V$ instead. But the proposition requires no restriction on $s$ (other than the fact that $s$ is a share and thus $0 \leq s \leq 1$). In other words, even if all transaction costs lost to $V$ are counted in total welfare, total welfare still increases as transaction costs decrease. This is due to two effects of decreasing transaction costs: a direct effect in which the Voter receives more compensation from developers, plus an indirect effect of incentivizing development of socially beneficial projects.

This can be seen through a simple argument. Regard $E\mathbf{W}$ as a function of $t$, both directly as well as indirectly through $t$'s effect on $\phi^*$. Then, the total derivative of $E\mathbf{W}(\phi^*(t), t)$ is

$$\frac{d}{dt} E\mathbf{W}(\phi^*(t), t) = \overbrace{\frac{\partial E\mathbf{W}}{\partial \phi^*} \cdot \frac{\partial \phi^*}{\partial t}}^{\text{indirect effect}} + \overbrace{\frac{\partial E\mathbf{W}}{\partial t}}^{\text{direct effect}}$$

We know that the direct effect is

$$\begin{aligned}\frac{\partial E\mathbf{W}}{\partial t} = \frac{\partial EU_V^*}{\partial t} + \frac{\partial EU_D^*}{\partial t} + \frac{\partial E\Phi_{\mathbf{W}}^*}{\partial t} &= -\phi^* \frac{\bar{b} - \phi^*}{\bar{b}} + 0 + s\phi^* \frac{\bar{b} - \phi^*}{\bar{b}} \\ &= -(1-s)\phi^* \frac{\bar{b} - \phi^*}{\bar{b}} \leq 0\end{aligned}$$

Because in equilibrium $\phi^* < \bar{b}$, under the previous assumption that $t < 1 - \beta$, the direct effect is guaranteed to be less than or equal to zero, and strictly negative if and only if $s < 1$. This represents the increase in total welfare associated with decreasing $t$ arising from the fact that a portion of $D$'s fees are no longer completely lost but rather are paid as cash or public benefits to $V$. But notice that if $s = 1$ and no portion of fees are actually lost (benefiting lawyers, consultants, or bureaucrats), this direct effect is zero. Yet Proposition 3 tells us that expected total welfare is strictly decreasing in transaction costs. This is because the benefits from decreasing transaction costs are not limited to $V$'s ability to receive fee payments directly.

Expected total welfare also increases because $V$ is incentivized to decrease the application fee, which consequently increases welfare. This is captured by the indirect effect, which is

$$\frac{\partial E\mathbf{W}}{\partial \phi^*} \cdot \frac{\partial \phi^*}{\partial t} = \left( \overbrace{\frac{\partial EU_V^*}{\partial \phi^*}}^{=0} + \frac{\partial EU_D^*}{\partial \phi^*} + \frac{\partial E\Phi_{\mathbf{W}}^*}{\partial \phi^*} \right) \cdot \frac{\beta \bar{b}}{[2(1-t)-\beta]^2}$$

$$= \overbrace{\left( -\frac{\bar{b}-\phi^*}{\bar{b}} + \frac{st(\bar{b}-2\phi^*)}{\bar{b}} \right)}^{<0} \cdot \overbrace{\frac{\beta \bar{b}}{[2(1-t)-\beta]^2}}^{>0} < 0$$

The left component of the above expression is negative when $\phi^* > \frac{\bar{b}}{2}$, and we know that $\phi^* > \frac{\bar{b}}{2-\beta}$ from Proposition 1. Hence, the expression as a whole is negative. This corresponds to the fact that increasing $t$ reduces the incentive for $V$ to approve development, causing an increase in $\phi^*$. This in turn limits new development and diminishes social welfare.

Thus, reducing transaction costs and thereby increasing $V$'s compensation improves expected total welfare both by shrinking potential benefits that are lost to $V$ given project approval, as well as through the incentive it creates for $V$ to approve projects that have a net social benefit. As this section has shown, high transaction costs in the project-approval process limit housing supply due to the consequent inability of developers to compensate local residents for the costs of new housing. The next section argues that if we can reduce transaction costs associated with new development, then empowering local residents in the development process can increase total social welfare as well as the welfare of local residents.

# 3 The allocation of projects across districts

The previous section considered the problem of a single neighborhood or municipality negotiating with a developer. However, as long as transactions costs are non-zero under a local control land-use regime, then some amount of development will be restricted under local control relative to a regime in which a higher-level government official mandates localities to allow new development, as a number of policy prescriptions propose. To speak to such proposals, we analyze the impact of transaction costs on project location across multiple cities or neighborhoods and how this changes with whichever level of government holds land-use authority.

We start by assuming that higher levels of government have less information or administrative capacity to make fine-grained decisions about project location than do local residents. Thus, if more housing is to society's overall benefit, then a central authority maximizing social welfare will grant developers a right to build housing even if a specific neighborhood or municipality is opposed. In contrast, a local-control regime enables neighborhoods to force developers to internalize negative externalities of new development. This means that under local control, developers balance both the cost to local residents and the profitability of a potential project in choosing where to locate new housing developments. This trade-off, between the benefits of developers internalizing negative externalities and the transaction costs associated with local control, determines whether local control or centralized authority over land use improves social welfare.[11]

The model in this section shows how local control over development provides an important mechanism for incorporating local resident preferences into project location decisions, even in the presence of non-zero transaction costs. As long as transaction costs are not too high, then the region in which local control increases social welfare relative to centralized authority is increasing as the heterogeneity of externalities increases across districts. Additionally, the welfare of local residents is weakly greater under local control.

### 3.1 Model setup

There are two possible policy regimes. Under a Local Control regime, two Voters in two different Districts bid against one another for a Developer to build a project in one District or the other. Under a Centralized Authority regime, a benevolent Central Authority sets a single price to develop in either District. The generic term "District" represents any lower level of government, such as a neighborhood, municipality, or even region (when compared to the state or national level).[12]

[11]This trade-off can be understood in terms of the Coase Theorem. We are essentially concerned with how a property right—the right to develop—should be allocated. To achieve an economically efficient result, the Coase Theorem tells us that it does not matter whether developers or local residents hold this right in the absence of transaction costs or externalities. Yet first, there exist transaction costs specifically when local residents hold this right (since the social-welfare-maximizing central authority sets development fees to zero). And second, there exist externalities that local residents face. While neighbors holding the right to develop increases transaction costs, it also forces developers to internalize externalities of new housing. Which land-use regime is preferable depends on the relative weight of these two violations of the Coase Theorem.

[12]The substantive contrast we draw is between any higher and lower levels of government. Within each governing unit, one imagines an inevitable diversity of preferences being averaged over; thus, the benefits of local control in

Under both policy regimes, we have a Voter in District 1, $V_1$, a Voter in District 2, $V_2$, and a Developer, $D$. Districts and corresponding Voters are indexed by $i \in \{1, 2\}$. The utility functions for these players are analogous to those in the baseline model. Thus, let

$$U_{V_i} = \psi_i[\phi_i(1-t) - \beta_i b_i]$$

$$U_D = \sum_i \psi_i(b_i - \phi_i)$$

The value $b_i$ represents the social benefit of a project, as before. But we assume that the two values of $b_i$ are contingent on building a project only in a single district, because the potential projects are (imperfect) substitutes for consumers. If the Developer builds in one District, then the project benefit in the other district falls a sufficient degree that the Developer no longer wants to build in the latter. Thus the Developer chooses at most a single District in which to build a project, selecting at most one $\psi_i = 1$. This creates an allocation problem that must be solved through some policy regime.

Analogous to the baseline model, we define total welfare to be

$$\mathbf{W} \equiv \sum_i U_{V_i} + U_D + \sum_i \psi_i s t \phi_i$$

Under the Centralized Authority regime, we introduce a fourth player: a benevolent Central Authority $C$ whose utility coincides with total welfare $\mathbf{W}$.

The order of moves in the game is as follows:

1. The policymaker chooses an application fee $\phi_i$.
2. $D$ decides in which District, if any, to pay the District's application fee and build the corresponding project.
3. Payoffs are realized and the game ends.

The identity of the policymaker who moves at step 1 differs according to the policy regime. Under Local Control, each $V_i$ simultaneously selects a District-specific application fee. Under Centralized

determining the locations of new developments may increase with smaller districts. However, the smaller the districts, the more one would be concerned with costs of new development spilling over to neighboring districts. The optimal size of decision-making bodies over new development is clearly an important issue for policy implementation, which we leave to future research.

Authority, $C$ chooses a single region-wide application fee $\phi_1 = \phi_2$ to apply to both Districts. In contrast to the baseline model of the previous section, decision-making in this section concerns a single project rather than regulation over a stream of projects.

The exogenous parameters are $b_1$, $b_2$, $\beta_1$, $\beta_2$, $t$, and $s$. The endogenous choices are $\psi_1$, $\psi_2$, $\phi_1$, and $\phi_2$. This is a sequential game of complete information, and thus SPNE is the natural equilibrium concept. We focus exclusively on pure-strategy SPNE.

#### 3.1.1 Discussion

The basic conceptual distinction between Local Control and Centralized Authority in our model is two-fold. First, $C$ is assumed to value total social welfare. Second, $C$ is restricted from setting a District-specific application fee. This restriction is interpreted to arise from either administrative or informational constraints on higher levels of government. Even in circumstances in which a state-wide policymaker attempts to distinguish between types of neighborhoods through quantitative metrics, such as SB 827 proposing to up-zone within a half-mile of certain transit stops, substantial variation remains that a state-level policymaker cannot effectively take into account. Examining the location of projects across two districts is a simple way to incorporate the idea that a higher-level policymaker is less able—to some degree—to make fine-grained location decisions than are local residents.

### 3.2 Analysis

We assume throughout that $0 < \beta_1 < \beta_2 < 1$ and $0 < b_1 < b_2$. As in the baseline model, neither Voter experiences so great a negative externality from new developments that projects decrease overall welfare. The cost of a project for District 2 is assumed to be greater than that for District 1. Yet when $D$ does not have to internalize this cost, it finds the potential project in District 2 to be more profitable than that in District 1. Examining this case focuses the analysis on circumstances in which a tension is present between preferences of local residents and potential profits for the Developer.

We use the superscript $\ell$ to denote outcomes specific to Local Control, and we use the superscript

$c$ to denote outcomes specific to Centralized Authority.

### 3.2.1 Local Control

We proceed by backward induction. $D$ builds in District $k$, with $k = \arg\max_i(b_i - \phi_i)$. Given this, each Voter $i$ bids against one another in selecting a $\phi_i$ until each Voter $i$ offers $D$ an equal amount of surplus (project benefit minus fee) and the Voter with less overall surplus to offer has set a price equal to its cost. We assume in this case that the other Voter wins the bidding, as it could have offered any $\epsilon > 0$ in additional surplus to obtain the project.

For this analysis, we first find what $V_i$'s cost of allowing a project is. This corresponds to the value of $\phi_i$ such that $U_{V_i} = 0$, which we denote $\underline{\phi_i}$. We can see that $U_{V_i} = [\underline{\phi_i}(1-t) - \beta_i b_i] = 0$ implies that $\underline{\phi_i} = b_i \frac{\beta_i}{1-t}$. Thus, $V_i$ can offer surplus to the Developer of at most $\max\{b_i(1 - \frac{\beta_i}{1-t}), 0\}$, which is positive whenever $t < 1 - \beta_i$. Moving through possible values of $t$ from high to low, cases are defined in Table 1 below.

| Case | Condition |
|---|---|
| I | $1 - \beta_1 < t$ |
| II | $1 - \beta_2 < t < 1 - \beta_1$ |
| III | $t < 1 - \beta_2$ & $b_1(1 - \frac{\beta_1}{1-t}) > b_2(1 - \frac{\beta_2}{1-t})$ |
| IV | $t < 1 - \beta_2$ & $b_1(1 - \frac{\beta_1}{1-t}) < b_2(1 - \frac{\beta_2}{1-t})$ |

Table 1: Cases for different values of $t$.

Because $t \geq 0$, while it is always possible to decrease $t$ sufficiently to be in Case III, it is not always possible to do so to be in Case IV. This is because of the assumed relationship that $\beta_1 < \beta_2$ and $b_1 < b_2$. Figure 1 gives an example of regions corresponding to these cases.

In Case I, since $t > 1 - \beta_1$ and $t > 1 - \beta_2$, Voter $i$ in both Districts experiences a negative externality from Project $i$ that exceeds the maximum $\phi_i$ that $D$ is willing to pay. No development occurs anywhere and all players receive zero payoff. However, once $t$ decreases just enough such that $t < 1 - \beta_1$ (but still $t > 1 - \beta_2$), we enter Case II and $V_1$ is willing to build Project 1. $V_2$ still experiences a cost of Project 2 that exceeds the maximum $\phi_2$ that $D$ is willing to pay. Thus,

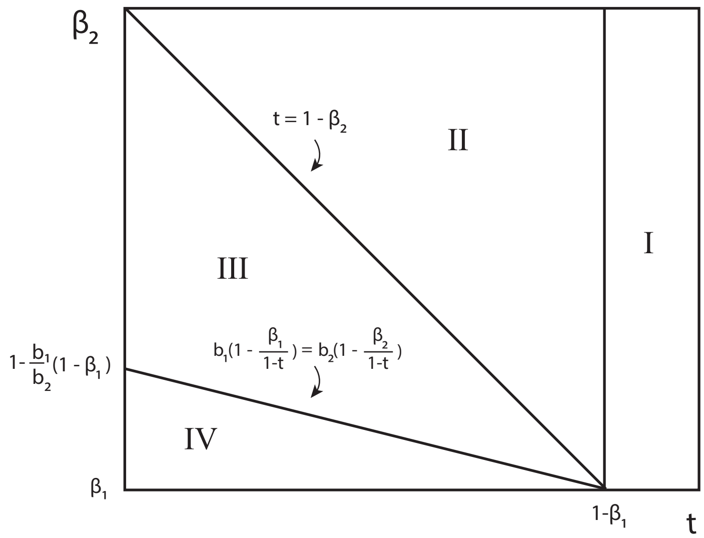


Figure 1: The four cases for different values of $t$ and $\beta_2$. Shown are all possible values of $t$ and values of $\beta_2 > \beta_1$ since $\beta_2$ is restricted to be greater than $\beta_1$.

without any competition, $V_1$ sets $\phi_1 = b_1$, extracting all of $D$'s surplus.

In Cases III and IV, both Voters are willing to charge interior fees. The difference between these two cases is the relative size of either Voter's available surplus. In Case III, $V_1$'s available surplus is larger, while in Case IV, $V_2$'s available surplus is larger. In Case III, $V_1$ sets $\phi_1$ just to the point where to offer an equal amount of surplus, $V_2$ would need to set $\phi_2 = \underline{\phi_2}$. In Case IV, $V_2$ sets $\phi_2$ just to the point where to offer an equal amount of surplus, $V_1$ would need to set $\phi_1 = \underline{\phi_1}$. Figure 2 illustrates the bidding process for Case III.

For each of these cases, we calculate total social welfare. Doing so obtains the following result.

**Lemma 1.** *Total welfare under the Local Control regime is invariant to transaction costs when $t > 1 - \beta_1$ (Case I) and is strictly decreasing in transaction costs otherwise (Cases II-IV).*

*Proof.* See Appendix B. □

In Case I, nothing is built, so decreasing $t$ has no effect except eventually to bring us into a different case. Within any other specific case, though, the project is assured to be built in a specific District; decreasing $t$ reduces wasted effort expended by $D$ while leaving the distribution and amount

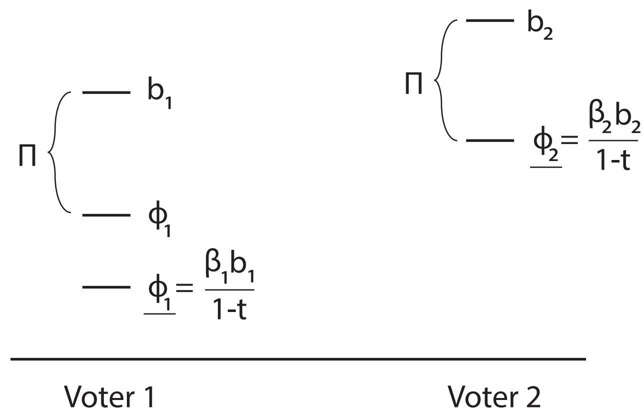


Figure 2: An illustration of the bidding process in Case III, in which $b_1(1 - \frac{\beta_1}{1-t}) > b_2(1 - \frac{\beta_2}{1-t})$. The value $\Pi$ represents the portion of the surplus that goes to $D$. Because the surplus available to Voter 1, $b_1(1 - \frac{\beta_1}{1-t})$, is greater than that available to $V_2$, $b_2(1 - \frac{\beta_2}{1-t})$, $V_1$ is able to offer a fee $\phi_1$ that provides a benefit to $D$ just large enough for $D$ to build the project in District 1.

of surplus otherwise unchanged. Furthermore, this District is the "correct" one in which to build, in the sense that it is the District with the larger difference between benefit to $D$ and cost to $V$. Throughout the balance of the paper, we refer to the "correct" District in this sense.[13]

We now analyze the Centralized Authority regime, followed by a comparison of total welfare and Voter utility under either policy regime.

#### 3.2.2 Centralized Authority

Again, we proceed by backward induction. $D$ builds in District $k$, with $k = \arg\max_i(b_i - \phi_i)$. Since $\phi_1 = \phi_2$ under Centralized Authority, this is equivalent to $\arg\max_i b_i$, and thus $k = 2$ by our prior assumption that $b_2 > b_1$. That is to say, with a single fee across both Districts, the project is built in whichever District the project is most profitable to $D$, regardless of the externality it imposes on the Voter in that District (and by assumption, this is District 2).

Total Welfare, which by assumption coincides with the utility of $C$, is

$$\mathbf{W}^c(\phi) = U^c_{V_2} + U^c_D + st\phi = b_2(1 - \beta_2) - (1 - s)t\phi$$

[13]We will see later that moving from a Local Control regime to a Centralized Authority regime, while holding parameter values fixed, often changes the location in which the project is built, causing inefficiency.

Then

$$\frac{d\mathbf{W}^c}{d\phi} = -(1-s)t \leq 0$$

indicating that $C$ has a corner solution of $\phi^* = 0$ as long as $\mathbf{W}^c(\phi^*) > 0$, which is true whenever $\beta_2 < 1$ and $b_2 > 0$ and thus always holds under prior assumptions. This is stated in the following result:

**Lemma 2.** *In any SPNE in which $s > 0$, $C$ sets the application fee to zero.*

*Proof.* In text. □

Intuitively, the assumptions that $\beta_1 < 1$ and $\beta_2 < 1$ imply that projects are net social goods, as long as fees are sufficiently small. In other words, the negative externality of new developments is less than their entire value to $D$. Since charging a fee only shifts surplus from $D$ to Voters imperfectly efficiently (transaction costs being non-zero) and without creating any incentives for $D$, the best $C$ can do is to set the fee to zero.[14] It follows that $U^c_{V_1} = 0$, $U^c_{V_2} = -b_2\beta_2$, $U^c_D = b_2$, and $\mathbf{W}^c = b_2(1-\beta_2)$.

Since $t > 0$, there is an inherent inefficiency in charging positive fees. Yet this can be outweighed by the inefficiency of $D$ choosing to build in the incorrect District. In fact, we will see that the social welfare outcome is often worse than allowing Voters to choose District-specific fees. We now turn to a comparison of the outcomes under the two policy regimes.

#### 3.2.3 Comparison of policy regimes: Total welfare

Notice first that if fees are very inefficient, that is, $t > 1 - \beta_1$ (corresponding to Case I), the Local Control regime's outcome will always be worse than the outcome under Centralized Authority. This is because, despite the social efficiency of projects, Voters will experience an externality greater than what they can recover in fees. Their solution is to charge sufficiently high fees such that development is effectively prohibited. One fix to this problem, then, is to impose Centralized Authority, force

[14] One might wonder if residents of a wealthy or politically powerful district could organize to stop $C$ from setting $\phi$ to zero. While this is not a possibility in our model, this would strengthen our subsequent results regarding the benefits of Local Control when transaction costs are sufficiently small.

development, and effectively expropriate Voters. However, if $t$ could instead be decreased sufficiently, this would guarantee weakly greater social welfare.

Recall that while total welfare under Centralized Authority, $\mathbf{W}^c$, is always constant in $t$, total welfare under Local Control, $\mathbf{W}^\ell$, is only constant in $t$ as long as $t > 1-\beta_1$ and is strictly decreasing otherwise. The following result states conditions under which an interior threshold value of $t$ exists such that we can guarantee that $\mathbf{W}^\ell$ crosses $\mathbf{W}^c$.

**Proposition 4.** *Whenever $b_1(1-\beta_1) > b_2(1-\beta_2)$, for every value of $\beta_2$, there exists a unique $\tilde{t}$, where $0 < \tilde{t} < 1$, such that $t < \tilde{t}$ implies $\mathbf{W}^\ell > \mathbf{W}^c$ and $t > \tilde{t}$ implies $\mathbf{W}^\ell < \mathbf{W}^c$.*

*Proof.* See Appendix B. □

The condition $b_1(1-\beta_1) > b_2(1-\beta_2)$ simply captures that if fees were perfectly efficient, District 1 would be the correct place to build, taking into account both profitability of new projects and their cost to local residents. Because Centralized Authority induces an outcome with zero fees (and perfect efficiency in that respect), it performs better than Local Control as long as District 2 is actually the correct place to build. Because we have assumed that District 2 offers the more profitable project for the Developer, the Developer thus builds in District 2 when both fees are zero.

Given that District 1 is the correct location in which to build the project, then for any level of District 2's externality, we can always find an interior threshold of transaction costs (or compensation for voters) below which (above which) the Local Control regime produces greater social welfare than Centralized Authority.

This threshold $\tilde{t}$ is increasing in $\beta_2$, as stated in the following proposition:

**Proposition 5.** *The value of transaction costs $\tilde{t}$, below which the Local Control regime provides greater social welfare than Centralized Authority and above which the reverse holds, is increasing in Voter 2's marginal externality $\beta_2$ when $t < 1-\beta_1$ and invariant otherwise.*

*Proof.* See Appendix B. □

Holding $\beta_1$ constant, as $\beta_2$ increases (moving farther from $\beta_1$), then the range of possible levels of transaction costs under which Local Control yields superior social welfare outcomes compared to Centralized Authority increases. Simply put, the worse the consequences of building in the incorrect District due to high negative externalities, the higher the value of transaction costs there is that allows for superior total welfare under the Local Control regime. When $t \geq 1 - \beta_1$, then no project is built in either district, so a change in $\beta_2$ has no effect on welfare.

Corresponding to the cases shown in Figure 1, Figure 3 illustrates the region in which the Local Control regime yields an outcome with greater total welfare than that of Centralized Authority.

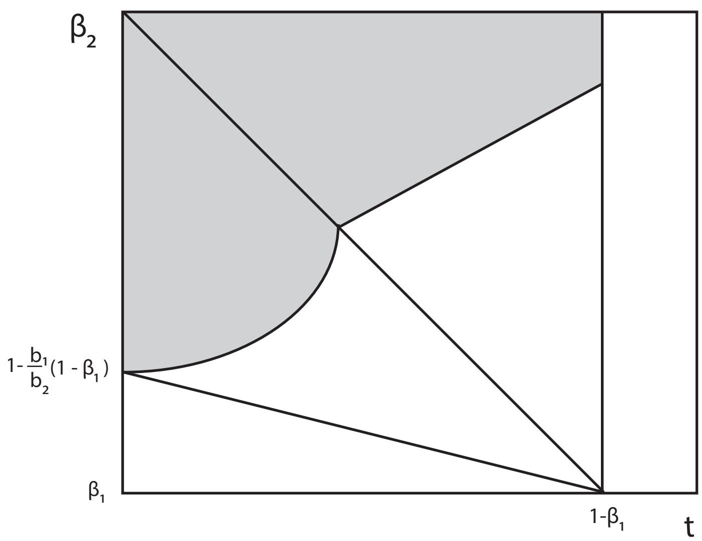


Figure 3: The region in which $\mathbf{W}^{\ell} > \mathbf{W}^{\mathbf{c}}$. Notice that even when $t = 0$, Local Control does not generate greater social welfare than Centralized Authority when $\beta_2 < 1 - \frac{b_1}{b_2}(1 - \beta_1)$. This is because in Case IV the correct location for the project (District 2) is the outcome under either policy regime.

#### 3.2.4 Comparison of policy regimes: Welfare of local residents

One might be concerned not just with general social welfare, but specifically for the welfare of existing residents in a city or neighborhood. In our model, under the Local Control regime, if a Voter accepts a project, that implies that from their perspective, compensation must have exceeded harm. In contrast, under Centralized Authority, local residents lack any choice and cannot refuse a project that a Developer finds profitable. Furthermore, even if local residents would have accepted a project under either policy regime, under Centralized Authority, residents receive zero compensation and therefore experience a net harm.

In fact, we can establish the following result:

**Proposition 6.** *Voter utility is weakly greater under Local Control than it is under Centralized Authority.*

*Proof.* In text. □

This holds across all Cases. Recall that under Centralized Authority, a project is built in District 2, which is assumed to be the District with the more profitable project. Thus, when $t > 1 - \beta_1$, under Local Control, nothing is built in either District, $V_1$'s utility is the same under either regime. When $t < 1 - \beta_2$ and $b_1(1 - \frac{\beta_1}{1-t}) < b_2(1 - \frac{\beta_2}{1-t})$ (Case IV), $V_2$ has greater available surplus, meaning that under Local Control the project is built in District 2. Thus, $V_1$'s utility is again unchanged between Local Control and Centralized Authority. In all other combinations of Voter and Case, the Voter is strictly worse off under Centralized Authority than under Local Control.

In moving from Local Control to Centralized Authority, choices by $D$ harm Voters in two ways. First, with the exception of Case IV (in which the project always goes to District 2), a project that was profitable for $V_1$ to allow is eliminated and replaced with a project in District 2, reducing $V_1$'s utility from positive to 0. Second, $V_2$ no longer has the potential to receive fee revenue and is fully expropriated by $D$, reducing $V_2$'s utility from 0 to negative. For these reasons, local residents never gain from transforming land-use authority from Local Control to a Centralized Authority policy regime.

This section has analyzed a model in which new housing developments are located across districts under two different policy regimes: a Local Control regime in which local residents approve projects in exchange for compensation from developers, and a Centralized Authority regime in which a benevolent Central Authority maximizes total social welfare by setting application fees to zero in both Districts. We have shown that while Centralized Authority eliminates inefficiencies caused by transaction costs of development, total social welfare under Local Control is higher than that under Centralized Authority when transaction costs are sufficiently low. This is because incorporating local resident preferences into the approval process results in a more efficient location for new developments. Additionally, local residents are never worse off under Local Control, and are often better off because they obtain compensation upon approving new housing development.

## 4 Conclusion

Given recent research linking high housing prices and regulatory supply constraints, we have investigated underlying political causes of restrictions on new housing development. We analyzed a bargaining problem between developers and local residents, in which transaction costs associated with the project-approval process eliminate mutually beneficial bargains. Such transaction costs provide an explanation for local opposition to new housing, despite the theoretical possibility of transfers from developers. This analysis indicates an alternative to the frequent policy recommendation that land-use authority be transferred to a higher level of government. Rather than disempowering local residents by centralizing housing policy, our argument indicates the potential to restructure local institutions to reduce transaction costs for developers and thereby enable developers to compensate local residents for the costs of new housing.

While prior research has focused on inherent features of localism, such as who is empowered to vote in local jurisdictions, our model shows that once one incorporates the potential for bargaining, the underlying cause of local opposition to new housing is specific features of local land-use institutions, rather than localism per se. In our model, increasing the portion of developer expense that directly compensates current residents alters local resident behavior so that residents lower the costs demanded of developers and thereby allow more housing development, which increases social welfare. Moreover, the non-linear effect of transaction costs, in which exceeding a certain threshold entirely precludes bargains, indicates that the existing absence of observed successful negotiations should not be taken to imply that bargains would be impossible with lower transaction costs.

We extended the baseline bargaining model to directly compare local versus centralized land-use authority. The model extension showed that when transaction costs are sufficiently low, local control enables more efficient project location, since developers are forced to account for the preferences of local residents in additional to the profitability of a potential project. Local residents also benefit through their ability to secure public goods or other compensation in exchange for approving new development, as well as the power to veto truly harmful developments.

While economic analyses provide strong evidence that the stringency of existing land-use regulations cannot be justified based on the magnitude of negative externalities imposed by new developments, few observers deny the existence of such externalities. Despite the deleterious impact of environmental regulations on new housing construction, for example, septic system regulation or wetlands protection are vital measures for public health and ecosystem preservation.

Yet the goals of increasing the housing supply and incorporating local resident preferences into development decisions need not be in conflict. Prior reform strategies have been premised on the entanglement of two conceptually distinct institutional elements. While mechanisms for local residents to express their preferences over development approval tend to coincide empirically with manifold opportunities for delay and thus high transaction costs for new development, we demonstrate that by reducing transaction costs in the project-approval process while maintaining local control, policymakers could safeguard local resident interests, increase electoral support for new development, facilitate new housing construction, and consequently reduce housing prices.

## Appendix A

In this appendix, we prove analogous results to Propositions 1-3 in the main text for a version of the model in which $b$ is drawn from a general distribution fulfilling Assumption 1, rather than a uniform distribution $U[0, \bar{b}]$. Before doing so, it is useful to present a couple definitions:

**Definition 1.** *A cdf $F$ has the* ***Monotone Hazard Ratio Property*** *(is MHR) if $\frac{1-F(x)}{f(x)}$ is well-defined and increasing in $x$.*

**Definition 2.** ***Domain multiplication of a distribution****, notated $a \circ G$, takes a distribution $G$ and a real number $a$ as inputs and outputs a distribution $F$ such that $F(\phi) = G\left(\frac{1}{a}\phi\right)$.*

The operation set out in Definition 2 generalizes the parametric model's sense of increasing the upper bound of a probability distribution to all possible distributions with support on nonnegative values, regardless of whether an upper bound on the support actually exists. We additionally set the following conditions on the distribution of $b$.

**Assumption 1.** *$b$ is distributed according to a twice-continuously differentiable, strictly monotonic cdf $F$ that is MHR and with associated density $f$ that is strictly positive on $(0, \bar{b}]$, with $\bar{b} \in (0, \infty]$, such that $f(\phi) > \frac{-\phi - \phi f'(\phi)((1-t)-\beta)}{2(1-t)-\beta}$ for all $\phi$.*

The restriction on $f(\phi)$ corresponds to the second-order condition of the Voter's optimization problem. When $\beta < 1-t$, a sufficient condition for this to be satisfied is $f'(\phi) \geq 0$, as in the special case of the uniform distribution.

We are now able to establish the following results, which correspond to and are more general versions of in-text Propositions 1 through 3, respectively:

**Proposition 1A.** *In any SPNE, the Voter's optimal selection of the application fee is $\bar{b}$ when $\beta \geq 1-t$. Otherwise, there exists a unique interior optimum $\phi^*$ that satisfies the following implicit condition:*

$$\phi = \frac{1-t}{1-t-\beta}\frac{1-F(\phi)}{f(\phi)}$$

*Proof.* The Voter's expected utility is

$$\int_{\phi}^{\bar{b}} ((1-t)\phi - b\beta) f(b) db$$

The First Order Condition for an interior optimum of $\phi$ is therefore

$$\int_{\phi}^{\bar{b}} (1-t) f(b) db - ((1-t)-\beta)\phi f(\phi) = 0$$

which is equivalent to

$$\phi = \frac{1-t}{1-t-\beta}\frac{1-F(\phi)}{f(\phi)}$$

Because $\phi \geq 0$ and $1-t > 0$, this equation has a solution only if $\beta < 1-t$. Furthermore, if this holds, the solution exists and is unique because $F$ is MHR. Finally, by Assumption 1, the Second Order Condition holds when $\beta < 1 - t$.

Therefore, if and only if $\beta \geq 1 - t$, there does not exist an interior optimum. We are left to compare utility from $\phi = 0$ to utility from $\phi = \bar{b}$. Utility from $\phi = 0$ is clearly negative, while utility from $\phi = \bar{b}$ is clearly 0. $\square$

**Proposition 2A.** *As transaction costs $t$ decrease, the space of $\beta$ in which the Voter charges the maximum fee decreases. Where $t < 1-\beta$, the Voter's optimal fee $\phi^*$ strictly increases in transaction costs $t$ and strictly decreases in the Voter's cost of projects $\beta$. Furthermore, suppose $b$'s distribution $F = a \circ G$ with $a > 0$. The Voter's optimal fee $\phi^*$ is increasing in $a$.*

*Proof.* Because the condition to charge the maximum fee is $\beta \geq 1 - t$, that the space in which this holds is decreasing in $t$ is immediate.

Now suppose $t < 1 - \beta$. Consider again the implicit condition that $\phi^*$ must satisfy. $\phi$ is clearly strictly increasing in itself. Define the multiplicative inverse of the hazard function of $F$ as $h^{-1}(\cdot; F)$. Because $F$ is MHR, $h^{-1}(\phi; F)$ is (weakly) decreasing in $\phi$. Then because the leading factor $\frac{1-t}{1-t-\beta}$ is positive, increasing it strictly increases the value of $\phi^*$. The leading factor is increasing in $t$ and decreasing in $\beta$.

Next, it is evident that if $a' \circ G(\phi)$ is MHR, $a'' \circ G(\phi)$ is also MHR. Observe next that $h^{-1}(\phi; a'' \circ G) \geq h^{-1}(\phi; a' \circ G)$ whenever $a'' > a' > 0$, with the inequality strict whenever $\phi > 0$. Because the optimum is interior, this implies that if $\phi' = \frac{1-t}{1-t-\beta} h^{-1}(\phi; a' \circ G)$ and $\phi'' = \frac{1-t}{1-t-\beta} h^{-1}(\phi; a'' \circ G)$, we must have $\phi'' > \phi'$. $\square$

**Proposition 3A.** *Assume that $t < 1-\beta$. Expected total welfare is strictly decreasing in transaction costs.*

*Proof.* We recall that the Voter's expected utility is

$$\int_{\phi}^{\bar{b}} ((1-t)\phi - b\beta) f(b) db$$

The Developer's expected utility is

$$\int_{\phi}^{\bar{b}} (b-\phi)f(b)db$$

Expected transaction costs counting in welfare are

$$\int_{\phi}^{\bar{b}} st\phi f(b)db$$

The total derivative of expected total welfare with respect to $t$ is

$$\frac{d}{dt}E\mathbf{W}(\phi^*(t),t) = \overbrace{\frac{\partial E\mathbf{W}}{\partial \phi^*}\cdot\frac{\partial \phi^*}{\partial t}}^{\text{indirect effect}} + \overbrace{\frac{\partial E\mathbf{W}}{\partial t}}^{\text{direct effect}}$$

We know that the direct effect is

$$\frac{\partial E\mathbf{W}}{\partial t} = \frac{\partial EU_V^*}{\partial t} + \frac{\partial EU_D^*}{\partial t} + \frac{\partial E\Phi_{\mathbf{W}}^*}{\partial t} = -\phi^*\big(1-F(\phi^*)\big) + 0 + s\phi^*\big(1-F(\phi^*)\big)$$

$$= -(1-s)\phi^*\big(1-F(\phi^*)\big) \leq 0$$

Consider the indirect effect. By Proposition 2A, $\frac{\partial\phi^*}{\partial t} > 0$. The indirect effect is

$$\frac{\partial E\mathbf{W}}{\partial \phi^*}\cdot\frac{\partial \phi^*}{\partial t} = \left(\overbrace{\frac{\partial EU_V^*}{\partial \phi^*}}^{=0} + \frac{\partial EU_D^*}{\partial \phi^*} + \frac{\partial E\Phi_{\mathbf{W}}^*}{\partial \phi^*}\right)\cdot\frac{\partial \phi^*}{\partial t}$$

$$= \Big(-\big(1-F(\phi^*)\big) + st\big(1-F(\phi^*)-\phi^* f(\phi^*)\big)\Big)\cdot\frac{\partial \phi^*}{\partial t}$$

$$= \underbrace{\big(-(1-st)\big(1-F(\phi^*)\big) - st\phi^* f(\phi^*)\big)}_{<0}\cdot\underbrace{\frac{\partial \phi^*}{\partial t}}_{>0} < 0$$

Because the direct effect is weakly negative and the indirect effects is strictly negative, we conclude that expected total welfare is strictly decreasing in transaction costs. □

## Appendix B

*Proof to Proposition 2.* The Voter charges the maximum fee as long as $t \geq 1 - \beta$. Because the right-hand side is decreasing in $\beta$, we conclude that $t = 1 - \tilde{\beta}$ and $t' < t$ imply that if $t' = 1 - \beta'$, we must have $\beta' > \tilde{\beta}$. Next, noting that the initial condition can be rearranged as $\beta \geq 1 - t$ and observing that this condition will therefore be satisfied at or above a threshold on $\beta$, we conclude that decreasing $t$ results in a smaller space of $\beta$ in which the condition for the Voter to charge the maximum fee is satisfied.

Next, under the assumption that $t < 1 - \beta$ (which implies $\beta < 1 - t$), $\frac{\partial \phi^*}{\partial \bar{b}} = \frac{1-t}{2(1-t)-\beta} > 0$, $\frac{\partial \phi^*}{\partial t} = \frac{\bar{b}\beta}{(2(1-t)-\beta)^2} > 0$, and $\frac{\partial \phi^*}{\partial \beta} = \frac{\bar{b}(1-t)}{(2(1-t)-\beta)^2} > 0$. □

*Proof to Proposition 3.* From the in-text discussion, it follows that

$$E\mathbf{W} = \frac{\bar{b}(\beta + t - 1)\left(-\beta^2 + (t-1)(2(s-1)t + 3) + \beta(4 - 3t)\right)}{2(\beta + 2t - 2)^2}$$

and thus

$$\frac{\partial E\mathbf{W}}{\partial t} = \frac{\bar{b}\left(\beta^2(s(2t-1) - t) + \beta(t-1)(3s(t-1) - 3t + 2) + 2(1-s)(1-t)^3\right)}{(\beta + 2t - 2)^3} < 0$$

□

*Proof to Lemma 1.* **Case 1.** Voter $i$ in both Districts experiences a negative externality from Project $i$ that exceeds the maximum $\phi_i$ that $D$ is willing to pay. No development occurs anywhere and every player's utility is 0. Therefore, clearly $\mathbf{W}^\ell = 0$. Then $\frac{\partial \mathbf{W}^\ell}{\partial t} = 0$.

**Case 2.** In District 2, $V_2$ would experience an externality from Project 2 that exceeds the maximum $\phi_2$ that $D$ is willing to pay. Without any competition, $V_1$ is able to set $\phi_1 = b_1$, extracting all of $D$'s surplus. Then $U^\ell_{V_1} = b_1(1 - t - \beta_1)$, $U^\ell_{V_2} = 0$, $U^\ell_D = 0$, and $\mathbf{W}^\ell = b_1(1 - t - \beta_1 + st)$. Then $\frac{\partial \mathbf{W}^\ell}{\partial t} = -b_1(1 - s) < 0$.

**Case 3.** Both Voters are willing to charge interior fees. Yet $V_1$ has more surplus to offer and sets $\phi_1$ just to the point where to offer an equal amount of surplus, $V_2$ would need to set $\phi_2 = \underline{\phi_2}$.

Specifically, $V_1$ sets $\phi_1 = b_1 - (b_2 - \underline{\phi_2}) = b_1 - b_2\left(1 - \frac{\beta_2}{1-t}\right)$. Then $U^{\ell}_{V_1} = b_1(1-t-\beta_1) - b_2(1-t-\beta_2)$, $U^{\ell}_{V_2} = 0$, $U^{\ell}_{D} = b_2\left(1 - \frac{\beta_2}{1-t}\right)$, and $\mathbf{W}^{\ell} = b_1(1-t-\beta_1+st) + \frac{b_2(1-s)t(1-t-\beta_2)}{1-t}$. Then $\frac{\partial \mathbf{W}^{\ell}}{\partial t} = -\frac{(1-s)\left(b_2\beta_2-(b_2-b_1)(1-t)^2\right)}{(1-t)^2} < 0$.

**Case 4.** Both Voters are willing to charge interior fees. Yet $V_2$ has more surplus to offer and sets $\phi_2$ just to the point where to offer an equal amount of surplus, $V_1$ would need to set $\phi_1 = \underline{\phi_1}$. Specifically, $V_2$ sets $\phi_2 = b_2 - (b_1 - \underline{\phi_1}) = b_2 - b_1\left(1 - \frac{\beta_1}{1-t}\right)$. Then $U^{\ell}_{V_1} = 0$, $U^{\ell}_{V_2} = b_2(1-t-\beta_2) - b_1(1-t-\beta_1)$, $U^{\ell}_{D} = b_1\left(1 - \frac{\beta_1}{1-t}\right)$, and $\mathbf{W}^{\ell} = b_2(1-t-\beta_2+st) + \frac{b_1(1-s)t(1-t-\beta_1)}{1-t}$. Then $\frac{\partial \mathbf{W}^{\ell}}{\partial t} = -\frac{(1-s)\left(b_1\beta_1+(b_2-b_1)(1-t)^2\right)}{(1-t)^2} < 0$. □

*Proof to Proposition 4.* First observe that $\beta_2 \leq 1 - \frac{b_1}{b_2}(1-\beta_1)$ is contradicted by assumption. Then we define three cases:

| Case | Condition |
|---|---|
| A | $1 - \frac{b_1}{b_2}(1-\beta_1) < \beta_2 \leq \frac{b_1(\beta_1-s)+b_2}{b_1(1-s)+b_2}$ |
| B | $\frac{b_1(\beta_1-s)+b_2}{b_1(1-s)+b_2} \leq \beta_2 \leq 1 - \frac{b_1}{b_2}s(1-\beta_1)$ |
| C | $1 - \frac{b_1}{b_2}s(1-\beta_1) \leq \beta_2$ |

**Case A**. Given our requirement that $0 < t < 1$, $\mathbf{W}^{\ell} = \mathbf{W}^{c}$ when

$$t = \hat{t} \equiv \frac{b_1(\beta_1+s-2) + b_2(\beta_2-1)(s-2)}{2(s-1)(b_1-b_2)} + \sqrt{R}$$

where

$$R \equiv (b_1(\beta_1+s-2) + b_2(\beta_2-1)(s-2))^2 - 4(s-1)(b_1-b_2)(b_1(\beta_1-1) - \beta_2 b_2 + b_2)$$

By the initial assumption of the Case, we conclude that $0 < \hat{t} < 1-\beta_1 < 1$. From Lemma 1 it follows that $\mathbf{W}^{\ell}$ strictly increases as $t$ decreases at $t = \hat{t}$, and at least weakly increases over the entire domain, while Lemma 2 implies that $\mathbf{W}^{c}$ remains constant. This implies that $\tilde{t} = \hat{t}$.

**Case B**. $\mathbf{W}^{\ell} = \mathbf{W}^{c}$ when $t = \frac{b_1(1-\beta_1)-b_2(1-\beta_2)}{b_1(1-s)}$. By the initial assumption of the Case, we conclude that $0 < \frac{b_1(1-\beta_1)-b_2(1-\beta_2)}{b_1(1-s)} \leq 1-\beta_1 < 1$. From Lemma 1 it follows that $\mathbf{W}^{\ell}$ strictly increases as $t$ decreases at $t = \frac{b_1(1-\beta_1)-b_2(1-\beta_2)}{b_1(1-s)}$, and at least weakly increases over the entire domain, while Lemma 2 implies that $\mathbf{W}^c$ remains constant. This implies that $\tilde{t} = \frac{b_1(1-\beta_1)-b_2(1-\beta_2)}{b_1(1-s)}$.

**Case C**. $\mathbf{W}^\ell > \mathbf{W}^c$ when $t \leq 1-\beta_1$ and $\mathbf{W}^\ell < \mathbf{W}^c$ when $t > 1-\beta_1$. From Lemma 1 we also know that $\mathbf{W}^\ell$ at least weakly increases as $t$ decreases over the entire domain, while Lemma 2 implies that $\mathbf{W}^c$ remains constant. It follows that $\tilde{t} = 1-\beta_1$. □

*Proof to Proposition 5.* Examining the expressions for $\tilde{t}$ given in the proof to Proposition 4, it is apparent that $\frac{\partial \tilde{t}}{\partial \beta_2} > 0$ in Cases A and B and $\frac{\partial \tilde{t}}{\partial \beta_2} = 0$ in Case C. Observe also that the overlap in the Cases implies that $\tilde{t}$ is continuous across the entire domain; it follows that $\tilde{t}$ is at least weakly increasing in $\beta_2$ not only within each Case but also across Cases. □

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