Can Development Impact Fees Help Mitigate Urban Sprawl?

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ABSTRACT

Problem, research strategy and findings: Many local governments have reacted to sprawl by adopting urban containment policies to limit fringe growth and encourage core development. An alternative is to design impact fee programs that account for the higher costs of providing services to remote locations. Zone-based impact fee programs carry this potential, but there is no empirical work investigating their effects on residential development.

We explored the effects of a zone-based impact fee program on residential permits issued across the Albuquerque MSA using 21 years of data, identifying countervailing influences on density. We found the program mitigated sprawl by reducing the share of construction occurring near the urban fringe and increasing the share in more centrally located areas. However, we found no evidence the program increased core development. During a brief period when Albuquerque had impact fees but an adjacent community did not, spill-over effects that exacerbated sprawl were observed.

Takeaway for practice: Planners managing sprawl can use zone-based impact fee programs that account for the higher costs of fringe development to effectively increase the density of residential construction. However, it may be necessary to use regional programs or coordinated efforts to prevent spill-over to adjacent communities.

Keywords: urban sprawl, infill, impact fees, residential permits

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INTRODUCTION

Urban sprawl creates a range of social problems including degraded air and water quality, increased reliance on fossil fuels and automobiles, poor health outcomes such as higher rates of obesity and diabetes, increased traffic congestion and accidents, disparities in educational quality across inner cities and their suburbs, and increased costs of providing public services (Freemen, 2001; Lopez, 2004; Speir and Stephenson, 2002). In response, local governments have implemented corrective policies including urban growth boundaries and permit caps.

An ongoing debate is whether these policies are more effective than price-based alternatives like development impact fees, which help offset the cost of infrastructure expansions necessitated by growth. First seen in the 1970s, over 1,000 communities in the United States now have impact fee programs (Nelson et al., 2008). There is limited research on the relative merits of impact fees versus alternative sprawl policies. While studies have demonstrated that growth boundaries increase urban density, no investigation has verified that impact fee programs can do the same.

We address this deficiency by investigating the effects of impact fees on residential permitting activity in Albuquerque, New Mexico and surrounding areas over a 21 year period that pre- and post-dates the adoption of the city's program in 2005. Albuquerque joined a relatively small group of communities that incentivized infill and redevelopment by varying rates across geographic zones to account for the higher costs of adding infrastructure in fringe locations,. We found that by redirecting construction towards northern interior areas, Albuquerque's program increased MSA density by lowering the share of development in more remote western locations. However, we also found that the program encouraged development in adjoining jurisdictions and had no effect on permitting activities in the urban core.

In the sections that follow we discuss existing research on impact fee programs, outline our research approach and data, and describe our findings. We close with two recommendations for planners seeking to control sprawl and promote infill development. First, we recommend that zone-based impact fee programs be implemented at a regional level to prevent "spillover," developments jumping to adjacent jurisdictions with lower impact fees. Second, communities can justify zone-based impact fee programs by noting the long term cost savings they generate.

BACKGROUND

Local governments have implemented various polices to control sprawl; here we describe what is known about the relative effectiveness of development impact fees and their alternatives. Since empirical evidence that impact fees can influence urban density has been elusive, we review the findings from a small theoretical literature and discuss three studies that considered the related question of how impact fees affect overall residential construction rates.

Impact Fees and Urban Density

Altshuler and Gomez-Ibáñez (1993) predicted impact fees would increase urban density if they were set at high levels in suburban areas and low levels in the urban core, but otherwise would have little to no effect on the geographic distribution of residential permitting. While seminal, their contribution did not provide any formal theoretical or empirical evidence to support their claim.

Brueckner (1997) developed a theoretical model evaluating the production of a composite local public good through three different methods of infrastructure financing: impact fees, current cost-sharing, and perpetual cost-sharing. In the model, local governments are assumed to raise revenues entirely through impact fees and/or property taxes; the model ignores the costs of maintaining the public good, as well as differences between categories of local public services. Of the three approaches Brueckner considered, impact fees result in the highest urban densities and enhance efficiency by lowering the overall costs of public service provision.

Turnbull (2004) compared the dynamic growth effects of impact fees and urban growth boundaries in models qualitatively similar to those advanced by Brueckner. He investigated what happened when communities used average cost pricing for services (e.g., proportional property taxes or user fees that do not vary by location) but faced increasing costs of providing services as residential locations sprawled. He concluded that accurately priced impact fees, defined to be rates that accounted for the location of development, efficiently corrected for the public service infrastructure externalities associated with sprawl. However, when urban growth boundaries were drawn to replicate the same efficient long run outcome (i.e., where the final land conversion produces no negative externality), the decreased supply of developable parcels raises the rate of return obtained by converting undeveloped land into improved parcels, encouraging inefficiently rapid levels of development and sprawl in the short run.

Impact Fees and Aggregate Residential Construction Rates

Skidmore and Peddle (1998) analyzed data from 29 cities in Dupage County, Illinois, between 1977 and 1992, finding that impact fee programs were associated with a 25%-30%

decline in residential construction. While pioneering, their data do not address our question of interest for two reasons. First, they observed only whether a city had an impact fee program in place or not, not the actual dollar amount of fees charged. Second, their impact fee variable only changed when moving from one city to another, not between different portions of the same city. Finally, the 29 cities in their study were all suburbs of Chicago.

Burge and Ihlanfeldt used panel data from Florida over an 11 year (1993-2003) period, investigating construction effects for single-family homes (2006a) and multifamily housing (2006b). They constructed separate models for central cities, inner and outer suburban areas, and rural areas. They found that non-water/sewer impact fees increased the construction of smaller homes and multi-family housing within inner suburban areas. However, they found no effect on construction rates (for either type of housing) in central city, outer suburban or rural areas. They argued that in those regions the non-pecuniary benefits of impact fee programs are large enough to avoid a reduction in new housing. A difference between Burge and Ihlanfeldt's work and ours is that the impact fee program in Albuquerque exhibited variable rates, whereas programs in Florida generally did not exhibit variation in fee amounts across locations within the same implementing jurisdiction. The environment we consider may be more relevant to planning officials interested in the extent to which zone-based impact fee programs can mitigate sprawl.

Growth Boundaries and Urban Development Patterns

It is generally accepted that the overall restrictiveness of land-use zoning, framed in general terms (since precise measurement can be challenging), influences the composition of development and residential density (Knaap and Nelson, 1992; Peiser, 1989). Traditionally, restrictive zoning has resulted in low-density development that inefficiently raises environmental and fiscal costs (Burchell et al., 2005). Urban containment policies and development impact fees represent two commonly suggested ways to improve the efficiency of development patterns in the presence of pre-existing restrictive zoning and other land-use regulations.

Urban containment policies (i.e., growth boundaries in their various forms) are used to limit the outward expansion of residential development, thereby encouraging dense residential development and higher levels of infill and redevelopment (Nelson, Dawkins, and Sanchez, 2004; Nelson et al., 2004). However, in cities with growing populations and expanding economic opportunities, the overall demand for new housing remains strong, even when remote locations are placed off limits. Scholars have argued this pressure for growth rebounds to interior portions of the implementing city, as well as outwardly beyond the growth boundary in the form of spillovers to neighboring communities.

All told, the literature on this relationship contains interesting but inconclusive overall evidence that urban containment policies lead to denser development outcomes, and may increase the likelihood of re-zoning approval or the modification of pre-existing density requirements (Knaap and Nelson, 1992; Ingram et al., 2009; Nelson, Dawkins, and Sanchez, 2008). However, there is very little evidence regarding the relationship between the method of infrastructure financing and urban density. Carruthers and Ulfarsson (2003) found that density, urbanized land area, property value, and political fragmentation all influenced the cost of providing public services. However, they did not investigate how changes in infrastructure financing methods affected development outcomes.

Our study fills the voids in these related literatures by investigating the relationship between urban form and a zone-based development impact fee program. The choice of a zone-based system over more traditional programs is critical; it establishes a direct link to urban density and reflects the desirability of programs that separately consider the marginal and average costs of infrastructure finance (Nicholas, 1988). Previous studies have argued that when development confronts its full marginal cost of infrastructure provision, long run patterns of urban development are more efficient (Lee, 1988; Brueckner, 1997). Development impact fees help achieve this, since they are designed to impose a monetary fee on development, equal in size to the proportionate-share costs of providing the new or expanded infrastructure that will serve the facility (Nicholas, Nelson, and Juergensmeyer, 1992).

In practice though, most impact fee programs are average cost mechanisms that result in lower cost interior developments being charged more than their true marginal cost while higher cost fringe projects are subsidized. The predictable result of this fiscal subsidization is urban sprawl – inefficiently high levels of growth near the fringe and lower levels of construction near the core (Nelson, Dawkins, and Sanchez, 2008). We investigated the effects of a program that was designed according to the efficiency principles outlined above, rather than the more commonly seen average-cost design

Albuquerque and its Innovative Program

Albuquerque underwent a scenario planning process in search of a "preferred alternative," from the early 1990s through the early 2000s, after several decades of pervasive development and population growth. Prior to the 1960s, most building took place in the central and eastern portions of the city as shown in Figure 1.[1] [Figure 1 about here] These areas had natural limits, as they were bordered by the Rio Grande River on the west and the Sandia Mountains and Cibola National Forest on the east. Since both provide valuable amenities, these neighborhoods commanded a location premium. During the 1960s and 1970s, most residential development moved towards the northern portions of Albuquerque, including along the I-25 corridor and surrounding areas. During the 1980s and 1990s, most construction took place in the western portions of the MSA. This last wave of growth largely drove the concerns regarding increased sprawl and higher costs of public service that led to the scenario planning process.

Albuquerque developed an impact fee program to support their 2004 Planned Growth Strategies (PGS) plan which created three geographic tiers – fully served, partially served, and unserved locations. The tiers recognized that some areas of the city already had most (or all) of the infrastructure needed to serve new development, while others did not. Furthermore, the city recognized that, due to valuable location-based amenities and access to employment, infill and redevelopment projects were most likely in fully served areas. City officials designed an impact fee schedule that encouraged development in fully served areas by levying charges that were small (or zero), while at the same time asking new construction in partially and unserved areas to pay higher rates that accounted for their impacts on various services.[2]

The program was implemented on July 1, 2005, with fees phased in over the next 18 months.[3] While innovative, Albuquerque's program is subject to the same legal standards affecting other programs, meaning levies could not exceed a proportionate share of the cost of new facilities. To impose varying rates based on location, the city needed convincing evidence to support the idea that some projects created larger impacts than others.

For this reason, Albuquerque estimated the net cost characteristics for different service areas. In this context, “net cost” meant total costs less available revenues, including other taxes and fees expected to be generated by the facility over time. Net costs reflected the impact of density and location on the costs of service provision. Greater density lowers the cost of providing water, sewer, solid waste, transportation, and other public services. These savings, combined with the higher preexisting levels of service already present in many centrally located areas, meant that impact fees would be minimal (or zero) in service areas where existing facilities were already sufficient to meet reasonable levels of future growth. Finally, because impact fees have been criticized for adversely effecting housing affordability, Albuquerque’s program allowed fees to be waived if a project is located in one of the city’s planned development zones, and is affordable to residents living in that area.[4]

In late 2009, when the housing crisis was in full force, Albuquerque cut their impact fee rates in half. Perhaps the significant fee differentials across locations gave opponents of the program ammunition to attack it during a recession. On the other hand, like other impact fee programs that experienced similar rate reductions around the same time, it may have faced political backlash regardless of its design.

RESEARCH APPROACH

We explored how the Albuquerque impact fee program influenced development patterns in centrally located areas, relative to the current urban fringe, using time series regressions. While the impact fee rates that varied over time and across PGS zones were our primary variables of interest, we also accounted for changing macroeconomic conditions over time as well as several factors that have been shown by previous studies to influence levels of permitting activities. We explored extensions that validated our findings, that is, our findings are not merely an artifact of the recent housing crisis affecting many parts of the U.S. Finally we investigated the possibility that Albuquerque's impact fee program may have pushed growth to more remote areas outside city boundaries, and found spillover effects were experienced.

We designated the fully served, partially served, and unserved zones in Albuquerque's PGS program as the ***core, interior***, and ***fringe*** portions of the Albuquerque MSA, respectively (consistent with the city's reporting practices for building permits). Figure 2 shows the MSA segmented into these three zones, along with a visual summary of the location of building permits during the investigated period. [Figure 2 about here] Table 1 provides the impact fee levels for transportation, parks and recreation, drainage, and public safety impact fees [5] for each zone following the initial phase-in period, but prior to the City lowering their rates during the recession (i.e., January 2007 through September 2009) [Table 1 about here]

Each PGS zone (core, interior, and fringe) contained multiple impact fee zones, but no impact fee zone crossed PGS zone borders. The simplest design was for public safety fees, where only two zones charged similar fees. Other categories displayed more variation. Transportation fees followed an eight-zone system where three core zones - Near North Valley, Northeast

Heights, and Downtown – had no fees. Since we aggregated multiple impact fee zones into each PGS zone, our impact fee variables were constructed by weighting the fees from each impact fee zone by the expected growth rates found in Albuquerque's Roadway Facilities Report (2004).

The parks and recreation program had seven zones, with fees ranging from $390 to $1,630. We weighted each by the expected housing unit growth reported in the city's Amended Parks and Recreation Report (2004). The drainage impact fees were $0 in the core, $2,042 in the interior zone, and ranged from $2,567-$2,810 in the fringe. From January 2007 through September 2009, when impact fees were at their highest observed levels, a developer would have paid roughly $1,022 for a core permit, $5,537 for an interior permit, and $6,912 for a fringe permit.

Tables 2 and 3 describe our data sources. [Table 2 and Table 3 about here] Table 2 indicates whether each variable is measured as a level, a percentage, or as a categorical variable. It also provides the timing of observation (e.g., monthly, quarterly, yearly) and the source we obtained the variable from. Table 3 contains relevant summary statistics. Our primary dependent variables came from monthly Albuquerque building permit data by PGS zone (i.e., core, interior, and fringe) that we obtained through the city's website. They span 21 years of residential permits approved between January 1990 and December 2010, yielding 252 (21 x 12) observations, for each of the three separate zones. We also examined monthly permitting for the bordering city of Rio Rancho in a regression that investigated the possibility of growth spillovers (residential development pushed outside areas subject to Albuquerque's impact fee program).

The independent variables fall into two groups: impact fee variables and additional control variables. Following the design of the impact fee program, we calculated the dollar amount of impact fees a developer would have paid for a permit obtained in each PGS zone, during each month of the period we investigated.

Our control variables were factors that had been identified by previous studies as important determinants of permitting levels. We used short-term (Federal Reserve Bank loan rate) and long-term (Freddie Mac's thirty year rate) interest rates, since they reflect the financing costs paid by builders and eventual homebuyers. To account for demand fluctuations, Albuquerque's population growth rate and unemployment rate were also included in all our estimated models. Importantly, we expected local unemployment rates to exhibit a close connection to the recent recession and housing crisis. Also related to the housing crisis, we included two variables that respectively captured the residential construction materials cost index and the Albuquerque constant quality house price index reported by the Federal Housing Finance Agency. Since monthly data were not available for some of these measures, we followed a common practice and estimated monthly time series, where only quarterly or annual data were otherwise available. We also respected the seasonal nature of the housing market by including eleven monthly dummy variables (i.e., January was the reference category) in all estimations.

We included severable variables based on their significance in previous studies; they were expected to help control for the effects of the recent housing crisis. However, we doubt those factors were exhaustive. Figures 3 and 4 provide some visual evidence regarding the timing of changes in permitting activity in the Albuquerque MSA during the recent housing crisis, compared to permit levels nationwide. [Figure 3 and Figure 4 about here] Residential permitting peaked in Albuquerque and neighboring Rio Rancho in early 2005, whereas nationwide monthly permitting peaked later in the spring of 2006. Interestingly, all three peaks occurred well before the start of the recent housing crisis (Follian and Giertz, 2011).

Still, all three permit series clearly experienced significant reductions during several months immediately before and after the start of the recent recession. As such, additional control variables capturing the timing and intensity of the recession were merited. Our estimated models used a binary variable equal to 1 if the month fell within the recession as defined by the National Bureau of Economic Research, and the monthly growth rate in nationwide permitting, to accomplish this.

DID ALBUQUERQUE'S PROGRAM MITIGATE URBAN SPRAWL?

The simple answer is 'yes'. However, our findings suggest the effects of Albuquerque's zone-based impact fee program were complicated. We identified countervailing effects that, in combination, reduced pressures driving urban sprawl. The discussion that follows is built in layers; we provide the simplest evidence first and then add additional rigor along the way.

The decline in overall permitting following implementation of the program was severe. Figure 4 shows that nearly 900 permits were issued in June 2005 (the last month prior to impact fees applying) while only about 350 permits were issued in July. After rebounding over the next few months, permits further declined over the next three years, reaching their lowest levels in 2009. Figure 3 also shows a mild increase in permitting levels in late 2009, right after impact fee rates were cut in half. Our data confirm that, on average, new residential developments are less densely located that existing structures. This suggests that reducing the overall rate of new construction can be interpreted as slowing the rate of increase in urban sprawl. This provides one initial piece of evidence that urban sprawl was mitigated by the program, relative to a counterfactual environment with no impact fee program and higher rates of construction.

Of course, several problems are associated with stopping at this point. First, we have not linked the geographic variation in Albuquerque's impact fee rates across the PGS zones to permit levels in interior and fringe locations. Second, we have not controlled for other factors that may have influenced construction activity and may be overstating the effect of the impact fee program. Third, we have not said anything about the issue of spillover growth into neighboring communities that may *exacerbate* sprawl. Fourth, we have not given policy makers anything of value – only pointing out that sprawl is mitigated when construction falls.

The first shortcoming is addressed by examining the visual evidence presented in Figure 5. [Figure 5 about here] Between 2000 and the start of the impact fee program in July of 2005, roughly three-fourths of residential construction in Albuquerque was in the fringe zone. After the program was adopted, the share of residential construction in the fringe declined sharply. In fact, during the two and a half year period where impact fees were at their highest levels, fringe development fell to about fifty percent of total residential construction in Albuquerque. This suggests that, at least for the type of zone-based program we examined, reductions in remote locations were far more extensive than reductions in core and interior locations with lower costs of service – a result consistent with the stated goals of Albuquerque's program. Still, this conclusion is not based on analysis that controls for other influential factors.

Our regression models (described in the Appendix) show that Albuquerque's impact fee program did influence the overall pattern of residential growth within the MSA. Our discussion follows the City's system of three PGS zones and then moves beyond Albuquerque's borders, to neighboring Rio Rancho.

The Fringe, the Interior, and the Core

We found Albuquerque's impact fee program significantly reduced permitting in fringe locations that carried higher costs of service provision. We found that a $1,000 increase in fees is associated with a decline of about 28 permits per month. During the five years prior to the implementation of Albuquerque's program, roughly 18,000 residential permits were issued in the fringe. Our estimates suggest almost forty percent of that growth would not have taken place had Albuquerque adopted the same program five years earlier.

However, the impact fee program affected the northern interior portions of the city differently. Our results show that impact fee levels had no effect on permitting in the interior zone, while the fraction of growth going to the interior zone rose significantly. The two are consistent due to the overall reduction in permitting levels. We initially found this result to be surprising. The impact fees charged in the interior were three-fourths as large as those charged at the fringe – why no reduction in permits? The explanation can be seen through the concept of opportunity cost, which focuses on how the cost of an action compare to the cost of the next best alternative to that action. If homebuyers view the northern portions of the city as substitutes to locations west of the Rio Grande, then a developer may view building a new home in either area as representing the opportunity cost of building the home in the other. In this case, even though the absolute cost of developing in the interior zone was higher after the impact fee program, the opportunity cost of developing in the interior was lower. Even a $1,400 savings in impact fees accrued from shifting away from the fringe towards the interior, in fee rates (i.e., the largest differential we observed in our data) could enhance a developer's profit margin significantly.

We found no evidence that the impact fee program redirected growth into the urban core although the share of permits going to the core increased during the years Albuquerque's impact fee program was in place. Our regression analysis indicated that factors other than the impact fee program were the primary drivers of that result. Variables including interest rates, unemployment rates, the Albuquerque House Price Index, and the intensity of the economic recession all displayed statistical significance in the expected directions.

On the other hand, the impact fee program registered no effect on the share of core permits. The model exploring permit levels suggests that the number of permits issued in the core zone actually dropped slightly due to the program. Our analysis indicates that each dollar of impact fees in the core had about half as large an effect on core permitting levels as it did in the fringe. Since impact fee rates were more than six times higher in the fringe zone than they were in the core, the ratio of permit reduction comparing the fringe to the core was roughly 12 to 1. Therefore it seems that households did not view new homes built in the core as close substitutes to those built in the fringe and northern interior regions. We therefore concluded the program led to more dense patterns of urban development within city limits over the period we examined, but that this effect was driven by declining permit activity in the fringe combined with increasing shares of construction going to the northern interior, rather than by increasing density by raising construction in the urban core. Therefore, it seems the program was successful in mitigating the rate of increase in sprawl, but not in expanding core development.

Spillovers into Rio Rancho

A countervailing effect on density was also identified by investigating the potential for spillover growth to an even more remote northern part of the MSA – Rio Rancho.[6] The Rio Rancho border was very active during the period we investigated – both in terms of residential permitting and changes in the relative magnitude of impact fees on either side. From Albuquerque's July 2005 adoption through May of 2006, fees were higher on Albuquerque's side of the border. This was reversed during 2007, when Rio Rancho carried higher fees. From January 2008 through October 2009, both sides carried nearly identical impact fees.[7] Finally, following Albuquerque's rate reduction in October 2009 and through the end of our data, impact fees were again higher on the Rio Rancho side of the border.

The results of this regression, which are provided in the appendix, indicated that Albuquerque's program had no effect on permitting in Rio Rancho during months where impact fees on both side of the border were comparable in size. However, when fees were higher on Albuquerque's side of the border, an additional 59 permits per month were seen in Rio Rancho, while Rio Rico experienced a decline of 73 permits per month during months when their fees were higher. Both of these effects represent considerable movements in overall Rio Rancho permitting levels. This suggests about 650 residential permits (59 permits each month multiplied by the 11 months fees were higher on the Albuquerque side of the border) spilled across the municipal boundary. The easiest way to frame the magnitude of spillover is to note that for every 2 permits eliminated from Albuquerque's fringe during this period, approximately one represented a true reduction while the other was redirected as a spillovers. The former can be viewed as mitigating the intensity of sprawl in the Albuquerque MSA, while the latter has an exacerbating effect (i.e., Rio Rancho is even further away from the central city than the Albuquerque fringe). If the offsetting effects are viewed as comparable, which is reasonable given the location of each zone within the greater context of the Albuquerque MSA, no significant effect on urban density was observed during these 11 months. Therefore, the evidence that Albuquerque's impact fee program mitigated urban sprawl comes entirely from the 55 months following the Adoption of Rio Rancho's impact fee program, and should be viewed as linked to this progression of events.

CONCLUSIONS AND IMPLICATIONS FOR PLANNING

We were driven by a desire to learn whether or not development impact fees that varied with location specific costs could be viewed as a viable approach to mitigating urban sprawl. To do so, we considered the effects of Albuquerque's innovative zone-based program on residential permitting levels across different portions of the MSA. Albuquerque's commitment to a price based approach led them to explore impact fees as an alternative to the kinds of urban containment policies adopted by other cities to control sprawl. The City designed a program that rejected the conventional average-cost based approach, instead using a zone-based scheme where location-driven cost of service differentials translated into location based impact fee differentials.

We examined the effects of Albuquerque's program on permitting activity in each of their three service driven zones, as well as in the bordering city of Rio Rancho. Our findings suggest that variable impact fees can influence the pattern of development in ways that encourage construction in low-cost service areas, dissuade projects in high-cost locations, and lead to greater density over time. However, we also found that Albuquerque's program redirected nearly 700 permits to more remote locations across jurisdictional borders, as activity in nearby Rio Rancho increased sharply during the eleven months when Albuquerque's fees exceeded those charged by Rio Rancho. While these countervailing effects are intuitive, our study provides the first direct support that they occurred.

We highlight two key implications for planning practice. First, zone-based impact fee programs meant to reflect cost of service differentials should be implemented at a regional level. At the very least, municipal programs should be appropriately integrated across jurisdictions in the same MSA. This is based on our finding that impact fees in Albuquerque's fringe locations had countervailing effects on the density of development; they pushed some projects back into the northern portions of the city, but others across city borders to Rio Rancho. In our application, the spillover effect was actually larger in size than the number of permits pushed back into the interior northern region, but occurred for a relatively short period of time.

Fortunately, Rio Rancho adopted their own impact fee program soon after Albuquerque's so the spillovers working against higher density only persisted for a short period. Second, our results suggest zone-based impact fee programs may carry long term cost savings. By encouraging development in locations that are already well served, programs of this nature can reduce the overall costs of adding new infrastructure.

Our work suggests zone-based impact fees can be effectively used to encourage cost efficient, sustainable urban development patterns, and to mitigate the intensity of urban sprawl. We believe that our study demonstrates that development impact fee programs with variable pricing based on true costs of service are a viable tool for infrastructure finance that may represent a preferable alternative to growth boundaries to fight urban sprawl.

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[1] We thank the City of Albuquerque and their planning department for giving us the information we used to construct Figure 1, as well as the permit data shown in Figure 2.

[2] Three of the authors (Juergensmeyer, Nelson, and Nicholas) helped design the program.

[3] Prior to 2006, the city charged only one-third of the eventual rates. During 2006, this increased to two-thirds. The highest rates took effect January 1st, 2007 and remained in place for the next 33 months. Finally, in October of 2009, rates were halved and remained at that level through the end of our data. After we collected our data, Albuquerque modified their impact fee program again. The modifications adopted in November of 2012 are (to our knowledge) still in place. For the most part, they replaced the zone-based marginal cost pricing approach with the more commonly seen average cost pricing approach.

[4] Vicki Been synthesized this complex relationship in "Impact Fees and Housing Affordability", *Cityscape: A Journal of Policy Development and Research*, 8(1), 139-185 (2005).

[5] Certain components of the impact fees levied on an individual permit were based on the interior square footage of the structure or the size of the lot. However, Albuquerque's permit data did not reflect these individual traits. We calculated impact fee rates using a standardized property of 1,000 square feet and a fifth of an acre lot. We came to this decision after considering several alternative sizes. While 1,000 square feet is an admittedly small figure, the use of larger sizes only magnified the eventually estimated gap between the effect of impact fees in the fringe zone relative to the estimated effect in the core and interior zones. Since the relationship between Albuquerque's program and the density of development was our primary interest, we viewed this as an appropriately conservative choice.

[6] Rio Rancho represents the only other active permitting area in the region. While unincorporated portions of Bernalillo County surround Albuquerque, our data reveal only 93 residential building permits were issued in the unincorporated area during our sample (compared to over 35,000 within the city).

[7] Impact fees were defined as comparable if they fell within 5% of one another.

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Figure 1: Albuquerque, New Mexico: Geographic Features (impact fee zones provided and approved by the Albuquerque Planning Department).

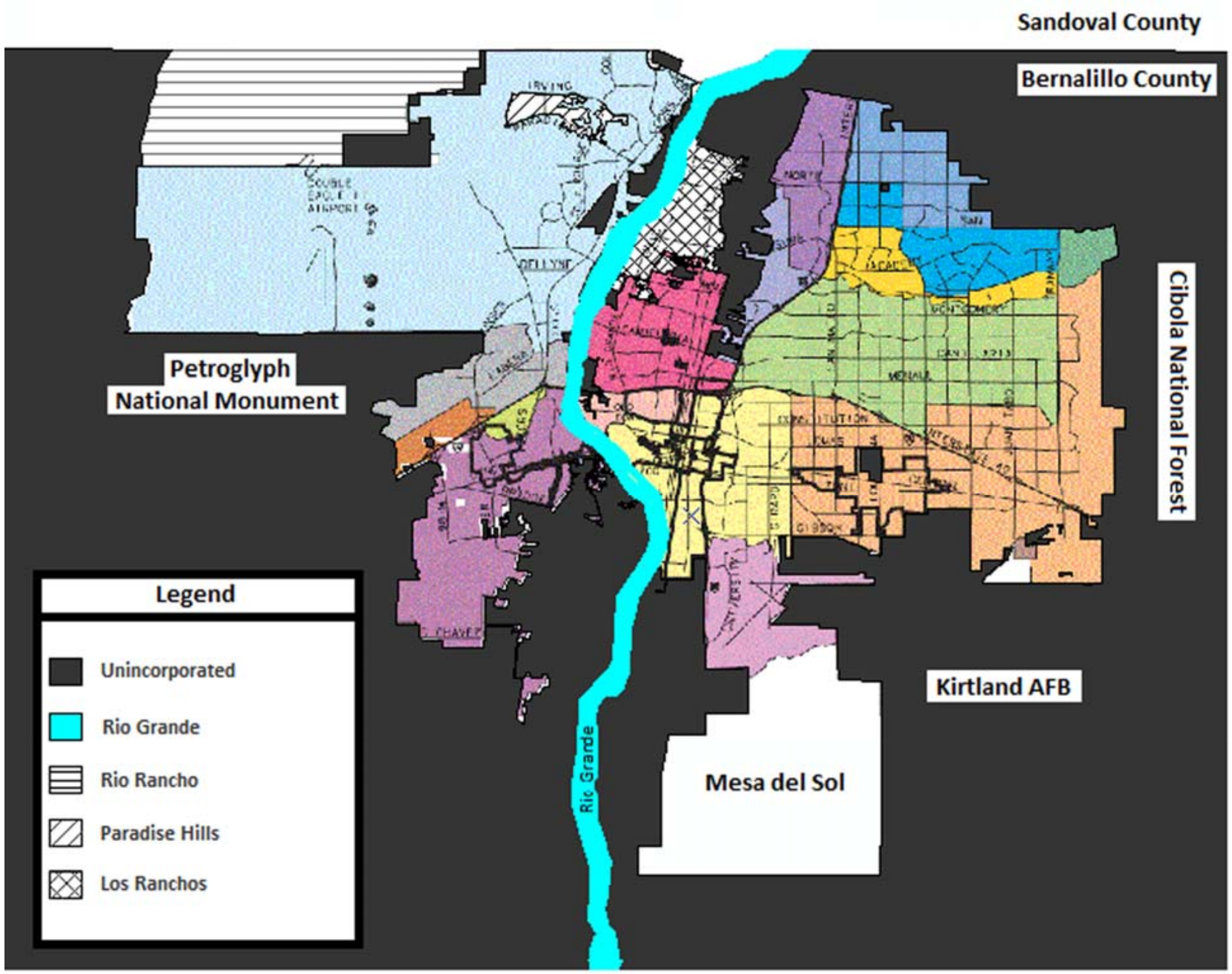

Figure 2: Albuquerque's Permit Reporting System: Core, Interior, and Fringe.

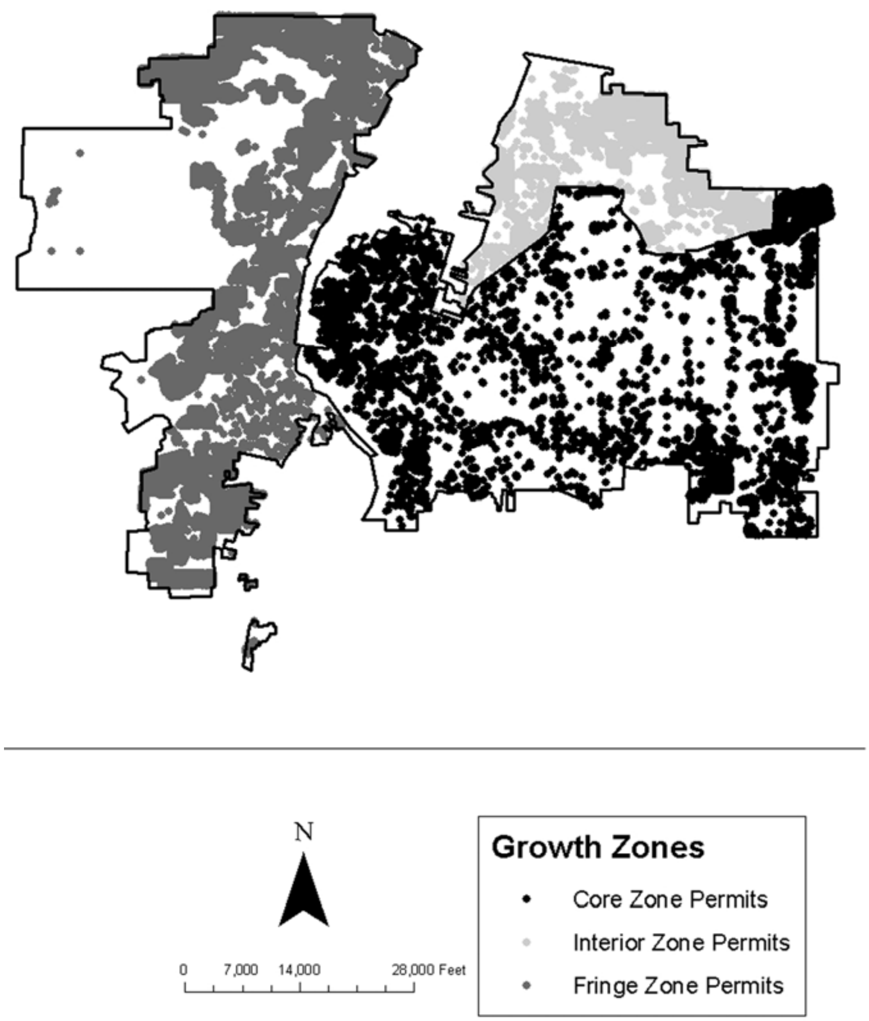

Figure 3: Albuquerque and Comparison Series Quarterly Residential Permits

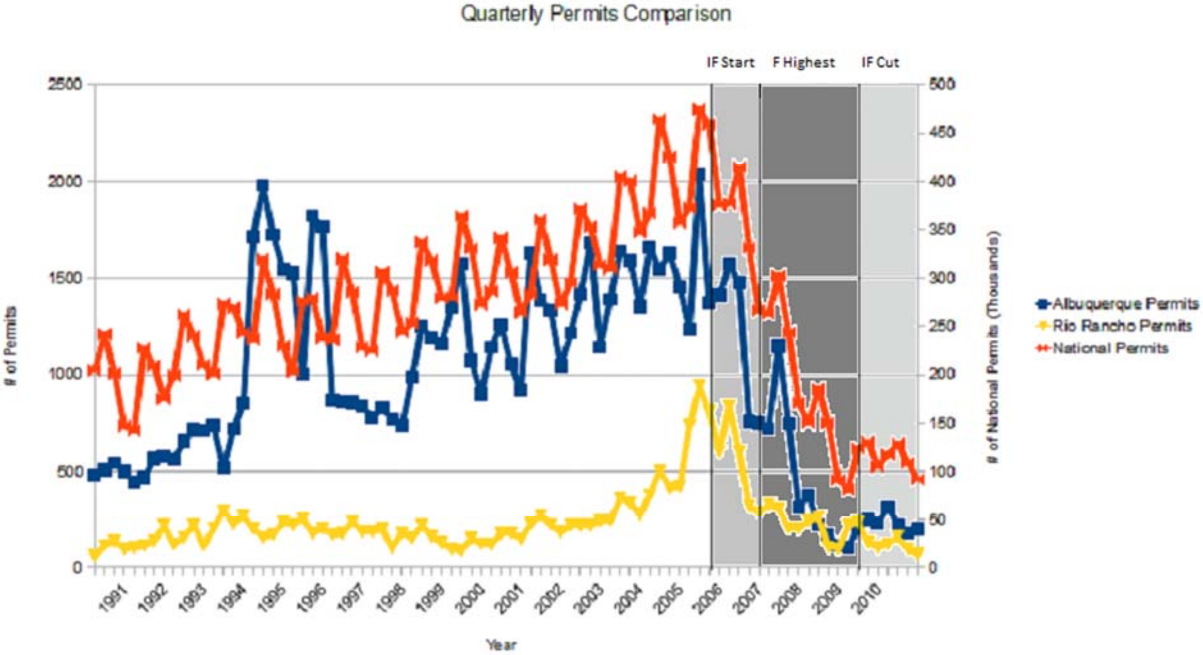

Figure 4: Albuquerque and Comparison Monthly Residential Permits

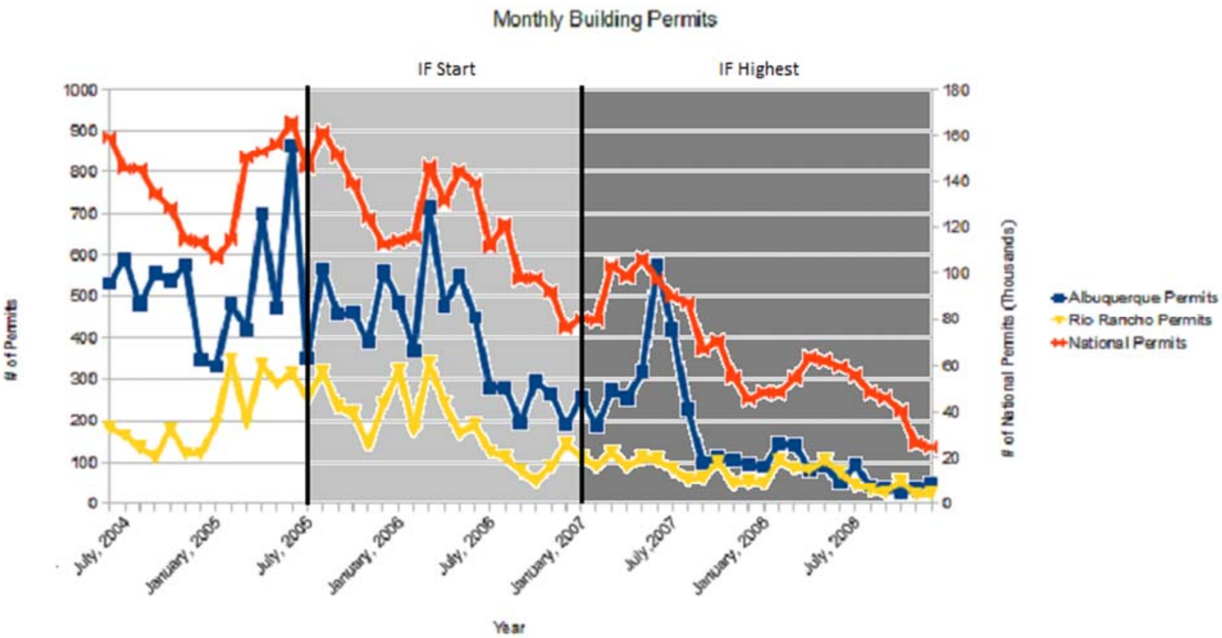

Figure 5: Share of Albuquerque Residential Permits by Zone: Full Sample.

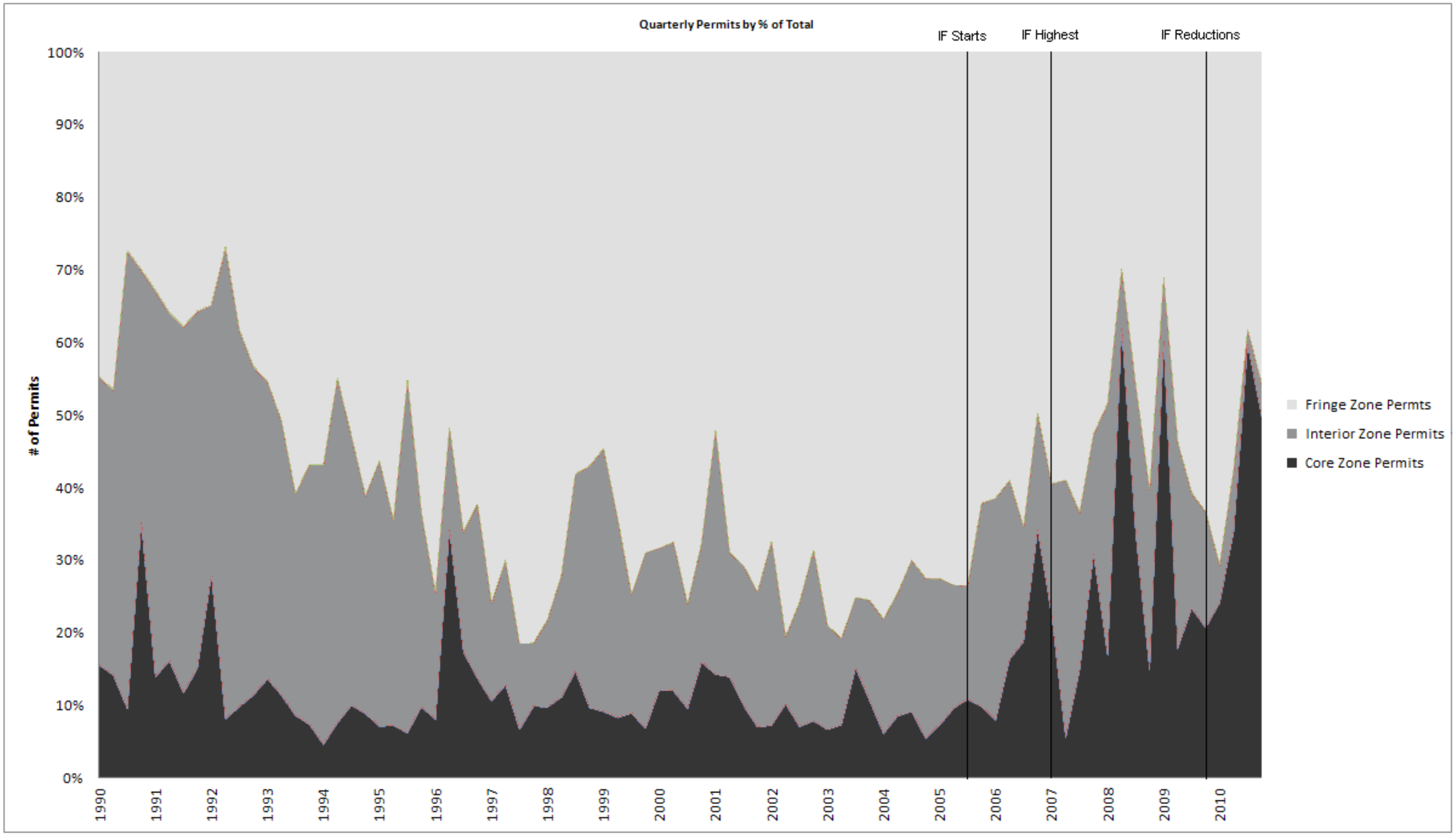

Table 1. Impact Fee and Building Permit Reporting Zones: Standardized Unit Fee Levels

Impact Fee Zone	**Core Zone (Pre 1960)**	**Interior Zone (1960-1979)**	**Fringe Zone (1980-2009)**
Transportation Fees			
Near North Valley	$0		
Downtown	$0		
NE Heights	$0		
I-25 Corridor		$2,113	
Far NE Heights		$1,069	
SW Mesa			$2,702
NW Mesa			$2,683
West Mesa			$2,683
Recreation Fees			
NE / Academy	$1,220		
Central / University	$390		
North Albuquerque		$1,550	
SE / Foothills		$520	
I-25 / North Valley		$1,630	
SW Mesa			$1,610
NW Mesa			$1,210
Drainage Fees			
Central City	$0		
Far NE		$2,042	
Tejaris			$2,658
NW Mesa			$2,810
SW Mesa			$2,567
Public Safety Fees			
East	$276	$276	
West			$207

Table 2. Variables

Variable Name	**Type**	**Aggregation (Timing)**	**Data Source**	**Variable Description**
permits core	level	Core zone (monthly)	Albuquerque Planning	Building permits in core areas of Albuquerque
permits interior	level	Interior zone (monthly)	Albuquerque Planning	Building permits in interior areas of Albuquerque
permits fringe	level	Fringe zone (monthly)	Albuquerque Planning	Building permits in fringe areas of Albuquerque
share core	percent	Albuquerque (monthly)	Generated	Percentage share of building permits in core areas
share interior	percent	Albuquerque (monthly)	Generated	Percentage share of building permits in interior areas
share fringe	percent	Albuquerque (monthly)	Generated	Percentage share of building permits in fringe areas
rr permits	level	Rio Rancho (Monthly)	Rio Rancho Planning	Building permits in Rio Rancho
if core	level	Core Zone (Monthly)	Albuquerque Planning	Impact fee rate (dollars) in core areas of Albuquerque
if interior	level	Interior Zone (Monthly)	Albuquerque Planning	Impact fee rate (dollars) in interior areas of Albuquerque
if fringe	level	Fringe Zone (Monthly)	Albuquerque Planning	Impact fee (dollars) in fringe areas of Albuquerque
interest long	percent	National (Monthly)	Freddie Mac	Long-term [30-year] interest rate
interest short	percent	National (Monthly)	Federal Reserve	Short-term [prime loan] interest rate
construction PPI	level	National (Monthly)	U.S. BLS	Residential construction materials production price index
unemployment	percent	Albuquerque (monthly)	U.S. BLS	Unemployment rate for Albuquerque
population	percent	Albuquerque (Yearly)	U.S. Census Bureau	Percentage growth in population in Albuquerque
HPI	percent	Albuquerque (Quarterly)	U.S. FHFA	FHFA Housing price index for Albuquerque MSA
permits national	level	National (Monthly)	U.S. Census Bureau	National building permits (in thousands)
rr pop	percent	Rio Rancho (Yearly)	U.S. Census Bureau	Percentage growth in population in Rio Rancho
vested rights	dummy	Albuquerque (monthly)	Generated	Denotes the period of possible vested rights usage
abq if start	dummy	Albuquerque (monthly)	Generated	Denotes Albuquerque impact fee initial implementation
abq if high	dummy	Albuquerque (monthly)	Generated	Denotes Albuquerque impact fees reaching their peak value
abq if cut	dummy	Albuquerque (monthly)	Generated	Denotes Albuquerque impact fees being reduced
rr if start	dummy	Albuquerque (monthly)	Generated	Denotes when impact fees were implemented in Rio Rancho
rr if high	dummy	Albuquerque (monthly)	Generated	Denotes Rio Rancho impact fees reaching their peak value

housing crisis	dummy	Albuquerque (monthly)	Generated	Months within the official designation of the recent recession

Table 3. Summary Statistics

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Dependent variables					
permits_core	252	22.98	12.92	1	63
permits_interior	252	57.27	41.51	1	220
permits_fringe	252	165.71	109.49	8	532
share_core	252	10.91	5.90	2.30	52.00
share_interior	252	24.61	13.04	1.41	59.57
share_fringe	252	64.49	14.24	29.79	94.37
rr_permits	252	80.23	59.67	7	347
Independent variables					
if_core	252	195.76	362.69	0	1021.74
if_interior	252	1060.90	1965.64	0	5537.42
if_fringe	252	1324.20	2453.42	0	6911.55
interest_long	252	7.23	1.50	4.23	11.05
interest_short	252	6.64	2.12	3.25	10.11
construction_PPI	252	145.18	24.06	107.60	193.90
unemployment	252	5.13	1.28	3.00	9.40
population	252	0.3092	1.0679	-1.4633	5.7397
HPI	252	3.73	5.06	-5.67	17.18
permits_national	252	88.89	31.54	22.10	166.20
rr_pop	252	0.8309	0.0758	0.7355	0.9700
vested_rights	252	0.09	0.29	0	1
abq_if_start	252	0.07	0.25	0	1
abq_if_high	252	0.13	0.33	0	1
abq_if_cut	252	0.06	0.23	0	1
rr_if_start	252	0.08	0.27	0	1
rr_if_high	252	0.14	0.34	0	1
housing_crisis	252	0.07	0.26	0	1

Appendix

Diagnostic tests considering the results of OLS regressions indicated our models suffered from autocorrelation. Therefore, all of our presented models used Newey-West OLS corrected standard errors, a technique used to mitigate bias associated with this condition. Estimation of Newey-West OLS requires specification of a lag length. Since certain variables were interpolated from annual data using a cubic spline technique, we selected a lag length of 12 months. Modifications of this choice produced results highly similar to those reported. We thank an anonymous reviewer for pointing out our decision to estimate separate models for each PGS zone should be defended using a Chow test from a regression that pooled the data from all three zones. The results of the Chow test suggested the presence of zone-specific regression slope coefficients for several variables – most notably the impact fee variables – indicating the estimation of separate time series regressions for each zone was appropriate.

Our regression models took the following form:

$$permits\_core_t = \alpha_t + \beta 1 \cdot if\_core_t + \beta 2 \cdot vested\_rights_t + \beta 3 \cdot housing\_crisis_t + \beta 4 \cdot interest\_long_t + \beta 5 \cdot interest\_short_t + \beta 6 \cdot construction\_PPI_t + \beta 7 \cdot unemployment_t + \beta 8 \cdot population_t + \beta 9 \cdot HPI_t + \beta 10 \cdot permits\_national_t\ \varepsilon_t \quad (1)$$

Progressing across the other dependent variables *permits_interior*, *permits_fringe*, *share_core*, *share_interior*, and *share_fringe* using similar independent variables, save the zone-based impact fee rates which varied according to which PGS zone was being considered. We also estimated models that used the national permit data to detrend Albuquerque's permit data directly, as well as models that used only pre-recession months. Both led to qualitatively similar results. Finally, the significant spike observed in permits issued in June of 2005 (i.e., the last month where no fees were applied) led us to run estimations that excluded the two months immediately before and after each change in impact fee rates. Those extensions also produced very similar results.

Table 4. Full Sample Results: Dependent Variable - Permit Levels by Zone

Variable	Newey-West OLS Regressions Core Zone	Interior Zone	Fringe Zone
if_core	-0.014*** (0.002)		
if_interior		0.000 (0.002)	
if_fringe			-0.028*** (0.005)
vested_rights	2.961 (4.200)	-36.412 (28.813)	-9.857 (32.864)
housing_crisis	-3.627** (1.501)	-7.313 (8.635)	-17.231 (15.733)
interest_long[1]	0.986 (1.194)	-2.045 (4.908)	-41.872*** (13.289)
interest_short[1]	-0.258 (0.548)	3.288 (3.055)	-7.540 (5.373)
construction_PPI[2]	0.365*** (0.097)	-0.224 (0.320)	1.242 (1.214)
unemployment[2]	-4.345*** (0.612)	-2.430 (3.198)	-39.894*** (6.878)
population[2]	-0.444 (0.451)	-0.274 (1.681)	2.078 (2.450)
HPI[2]	0.410 (0.310)	4.576** (1.771)	5.677*** (2.071)
permits_national[3]	0.146* (0.074)	-0.102 (0.201)	0.215 (0.352)
constant	-15.041 (21.283)	72.387 (81.878)	533.594** (265.208)
Observations	250	250	250
R-squared	0.48	0.44	0.72

* p < .10, ** p < .05, *** p < .01

[1] First lagged value

[2] Three month moving average of growth rate

[3] Growth rate

Table 5. Full Sample Results: Dependent Variable - Permit Shares by Zone

Variable	Newey-West OLS Regressions		
	Core Zone	Interior Zone	Fringe Zone
if_core	-0.001 (0.002)		
if_interior		0.004*** (0.000)	
if_fringe			-0.003*** (0.000)
vested_rights	1.281 (2.105)	0.029 (2.570)	-1.310 (2.639)
housing_crisis	2.758 (3.330)	6.389*** (2.490)	-9.147*** (3.411)
interest_long[1]	3.459*** (0.618)	2.258** (0.969)	-5.717*** (1.104)
interest_short[1]	-0.285 (0.191)	0.167 (1.094)	0.117 (0.532)
construction_PPI[2]	0.206*** (0.057)	-0.620*** (0.071)	0.413*** (0.086)
unemployment[2]	0.382 (0.381)	3.405*** (0.542)	-3.787*** (0.635)
population[2]	-0.411*** (0.160)	0.090 (0.387)	0.321 (0.395)
HPI[2]	-0.181 (0.080)	0.652*** (0.203)	-0.470** (0.212)
permits_national[3]	0.007 (0.043)	-0.056 (0.064)	0.049 (0.075)
constant	-44.987*** (12.106)	71.733*** (16.483)	73.254*** (19.206)
Observations R-squared	250 0.32	250 0.64	250 0.62

* p < .10, ** p < .05, *** p < .01
[1] First lagged value
[2] Three month moving average of growth rate
[3] Growth rate

Table 6. Border Spillovers Results: Dependent Variable - Rio Rancho Permits Levels

Variable	Newey-West OLS Regressions
alb_if_higher	58.633** (29.493)
alb_if_lower	-73.098** (31.197)
alb_rr_if_same	-12.295 (33.150)
housing_crisis	-46.540* (27.754)
interest_long[1]	-1.881* (1.050)
interest_short[1]	3.977*** (1.505)
construction_PPI[2]	0.821*** (0.314)
rr_pop[2]	218.762** (102.962)
HPI[2]	5.676*** (1.904)
permits_national[3]	0.348* (0.186)
constant	-229.760* (124.239)
Observations R-squared	252 0.68

* p < .10, ** p < .05, *** p < .01

[1] First lagged value

[2] Three month moving average of growth rate

[3] Growth rate