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Infill Development: Perspectives and Evidence from Economics and Planning

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Abstract

This paper explores the different perspectives on infill development and its role in urban growth. Despite the intense debate about the potential for and effects of infill development, there is very little empirical evidence about whether policies to promote it have been effective, about the amount and type of infill development and its effect on surrounding communities. This paper first reviews arguments from both the planning and economics literature on the possible benefits and costs of infill development and the effectiveness of policies to promote it. Then, we summarize the different approaches to measuring infill and provide evidence about the amount of infill that has occurred relative to other development. We also investigate infill characteristics and how its density and size may be different from the development in existing neighborhoods where it is located. Finally, we review the empirical literature on the effects of infill on property values in receiving communities, drawing out implications for policy and suggesting directions for future research.

Key Words: infill development, smart growth, urban development, urban sprawl, development density

JEL Classification Numbers: R11, R12, R14

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Virginia McConnell and Keith Wiley*

I. Introduction

Many in both the policy community and in urban planning have hailed infill development as a possible solution to sprawl that will both increase density and revitalize depressed neighborhoods (Farris, 2001; Haughey, 2001; Robinson and Cole LLP, 2002; and Urban Land Institute 2001). It is argued that infill, or new development in existing urban areas, at relatively high densities would prevent additional dispersed, low density development at the periphery that claims many acres of forested and agricultural lands. And a host of recent state and local policies now promote or at least facilitate new infill development as an answer to urban sprawl. In this chapter we examine the arguments from the economics and planning literature about both the advantages of infill development, and the barriers to it. We also review the empirical evidence about the amount and type of infill, government policies to promote it, and the effect it may have on surrounding communities.

There are many opportunities for infill development in U.S. cities because development tends to be dispersed. The rights of private property owners to develop their land, and local control of land use regulations allow for "leap-frog" development, creating opportunities for later infill. And, changes in zoning rules can allow for redevelopment in some central urban areas, allowing for increasing density with time. Changes in land use policies designed to limit sprawl and restrict development in rural areas not only encourage infill but seek to increase density in already developed urban areas.

Infill development has the potential to have dramatic effects on urban density and urban form. But the role for future infill development depends on the interplay of complex economic, political and regulatory forces. In this chapter we first review the arguments from the economics, policy and planning literatures on the possible benefits of infill development, the range of policies to promote infill that have been passed or proposed, and the reasons why there may be

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opposition to infill. We then examine ways to measure infill development and look at some of the evidence about the proportion of development that has been infill. Characteristics of infill are also important and we review issues that influence the extent and trends in the density of infill development. Finally, because there is so much opposition to infill development based on its potential costs to local residents, we review the literature on the effect of urban projects, including infill, on local property values. To conclude, we draw out implications for policy, and suggest directions for future research on infill.

II. Overview of the Issues

Infill as a Solution

Both smart growth and new urbanist advocates push for "smart growth" policies and provide much of the underlying rationale for their use. Smart growth advocates seek to change current patterns of low-density dispersed development (Downs 2001). They stress the need for planned growth which concentrates development in and near current communities because such projects take advantage of existing infrastructure and increase investment in current neighborhoods (Burchell et al., 2000; Cooper 2004; and Downs 2005). Uncontrolled, exurban expansion, on the other hand, is viewed as leading to increased infrastructure costs and duplication of facilities along with draining resources from existing neighborhoods.

Smart growth advocates also emphasize that planned growth reduces the conversion of open space areas with public benefits, reduces traffic volumes, and prevents other such external costs associated with sprawl (Burchell et al. 2000; Cooper 2004: and Young 1995). This view holds that low-density subdivisions scattered at the exurban fringe exacerbate traffic congestion because of longer commutes and increase land consumption due to more people living on large individual lots in previously undeveloped areas. The argument is that only better planned, higher density development located in and around existing communities, as promoted by smart growth policies, can effectively address these problems. Many of these perceived benefits, like decreased congestion and air pollution, are regional in impact.

The New Urbanists, who include architects, urban planners, and developers, emphasize many of these same advantages in support of infill development. In addition, they pay particular attention to how well-designed infill can create vibrant and revitalized communities (Duany 2002; Judd and Swanstrom 2006; and Meyers and Kitsuse 1999). New urbanists believe "good planning and design make it possible to create dense, walkable neighborhoods [that] provide a high quality of life partly by reducing vehicle use" (pg. 2 Congress for New Urbanism 2001).

For new urbanists, low-density, exurban development, which isolates housing from retail and office development and requires constant automobile travel, not only creates increased infrastructure and environmental costs, but also results in a diminished quality of life and sense of community.

Economic analysis suggests that undeveloped parcels within mostly developed urban areas will become economic to develop more densely in later time periods. In fact, leapfrog development that leaves some parcels undeveloped may result in more efficient land use over time than development that occurs in a more uniform pattern (Ohls and Pines 1975; and Peiser 1989). Vacant parcels in an existing community will become more valuable, reflecting both better relative access to services and a limited supply of land in the area. The higher land prices will tend to cause developers to want to substitute structural capital for land, resulting in higher density, or more housing per unit of land area (Pendall 1999; Ottensmann 1977; and Mills 2002). Another reason for increasing value to infill development is that transportation costs rise as the urban area expands. One study which surveyed city managers found such higher transportation prices resulting from longer commutes explained the increased infill development in the late 1990s and early 2000s in a number of cities (Nassar 2007).

Economists have also suggested that there could be potential positive externalities associated with residential development (Malpezzi and Green 2003; and Malpezzi 1996). For example, infill may expand homeownership to more residents while increasing a community's tax base and potentially expanding retail and commercial opportunities associated with the larger resident population.

Government Policies Related to Infill

Because of these potential advantages, many state and local planning policies have attempted to increase the amount of higher density infill development. For instance, Maryland state policy guidelines assert that infill will "fill in gaps in existing communities and play a critical role in achieving community revitalization, resource and land conservation, and alternatives to sprawl development" (MDP 2001 pg. 4). Federal government policies have also encouraged such projects. For example, there is a current program sponsored by several Federal agencies "Partnership for Sustained Communities" which has as a key principle targeting federal funding toward existing communities, and seeks to do this by promoting transit oriented, mixed-use development, and land recycling (EPA 2010). In addition, non-policymaking institutions now actively promote infill. The University of California, Berkeley's California Infill Parcel

Locator website enables the general public to locate vacant, potential infill properties throughout the state of California (CIP Locator 2005).

According to a survey article by Cooper (2004), more than twenty states have passed legislation promoting anti-sprawl, so-called "smart growth" policies. State smart growth policies, such as those establishing an urban growth boundary (UGB) in Oregon and priority funding areas (PFAs) in Maryland, attempt to shift development away from the rural, exurban fringe into designated areas that include existing communities both suburban and central city. By definition then, these policies seek to promote infill development. However, there is mixed evidence about how well these approaches have worked.

Urban growth boundaries, such as the one in Oregon, restrict residential development to areas within a designated urban boundary. The Oregon UGB was established in 1977 with one of its major goals to increase density of development within the designated urban region. Song and Knaap (2004), in a study of one of the counties within the boundary, find some evidence that neighborhood densities increased since the 1960s, but it is not clear how much of that is actually a result of the boundary policy. Another study by Jun (2004) attempted to control for a range of factors that influence development, finds that density has not increased in Portland relative to other cities, and that growth in the Portland area may have been pushed into other adjacent low density areas that were not subject to the restrictions.

The PFA policy in Maryland took a less prescriptive approach, and relied on providing economic incentives to developers to induce them to choose to build in more urbanized locations (Priority Funding Areas). The incentives were that infrastructure costs such as schools, roads and parks would be subsidized by state government when building occurred within designated PFA areas. There are mixed findings about how well this approach has worked to direct development toward such urbanized areas. Shen and Zhang (2007) find some empirical evidence that development within the PFAs increased relative to the outlying areas after the policy was passed. However, Lewis et al (2009) find that the PFA designation have had little effect on development choices.

Aside from these specific policies to target development to urbanized areas, many local governments attempt to use zoning rules that set maximum allowable density levels, to influence density in different areas. Often, outlying areas are zoned for very low density in an attempt to make development uneconomic, or at least consistent with very low density, rural uses. In addition, urban locations are zoned to higher density in an attempt to increase building and density in those areas. These efforts have not been entirely successful. For example, in

Montgomery County, rural areas that have been down-zoned to very low density have still been developed with big houses on large lots, and urban central areas are not being developed at density levels allowed by revised zoning rules (McConnell et al. 2007). There are many reasons for the latter result, as we discuss in more detail below.

Obstacles to Infill

It is clear that despite policy efforts to encourage infill, significant obstacles still exist. One issue is that local land use regulations can also serve as barriers to development. Urban area permitting processes often require multiple hearings and various building/zoning requirements which increase construction costs. Each requirement and hearing adds time and costs to a project, which can reduce a developer's profits. For example, Wheeler (2001) explains how onerous parking requirements can push an otherwise viable infill project into no longer being financially feasible.

Developers also face difficulties when assembling parcels in an urban setting. A small number of land owners can refuse to sell, which can dramatically drive up costs (Farris 2001). Exurban developments, on the other hand, regularly involve a single owner and therefore avoid such problems and related costs. In addition, the more parcels being assembled the greater likelihood of legal problems, such as liens of properties, which can endanger a project. These types of problems can in turn make it difficult for infill projects to obtain financing.

Current resident opposition posses the biggest concern to an infill developer. That is, some community residents argue that infill projects will result in adverse effects on the surrounding neighborhoods. These costs may include such negative externalities as increased traffic congestion or lost open space associated with infill (Evans 2004; Malpezzi and Green 2003; and Malpezzi 1996). For example, residents opposing a downtown Columbia, Maryland development stated that, in addition to the lost open space, the increased population generated would mean more congestion, more crime and more stress placed on community infrastructure (Cadiz 2004).

Many of these local concerns ultimately relate to a fear that more people mean greater demand for local services that are either paid for directly through increased taxes or indirectly by decreased service quality due to overcrowding. In particular, this worry is greatest with development that occurs at higher densities than current resident homes. The classic line from planners comes to mind: "if there is one thing people hate more than sprawl it is density" (Flint 2005). The smaller homes associated with increased density, may generate lower tax revenues

for a community per resident, yet the new residents still use services. Also, people associate the increased density with inner-city blight, poor service quality, and other problems (Flint 2005). These perceived negative externalities could result in lower housing prices, as we discuss in more detail below.

Economic theory suggests other reasons for opposition to infill even if there were no adverse effects on local housing prices. The first comes from a behavioral argument that households may experience an "endowment effect," or "status quo bias" with respect to the current state of their neighborhoods. They may see the undeveloped areas, whether they be forested or open space, as an integral and valued part of where they live. This may lead current residents to be particularly unwilling to give up these areas to development. Because local residents are often able to control development through zoning rules, there will be less infill development than would be efficient (Fischel 1999). In a related paper, McConnell and Cinyabuguma (2009) argue that local residents have the incentive to block new development because they bear all of the costs of that new development due to congestion and loss of open space, while the urban area as a whole receives the benefits of a growing population. There will tend to be less than the efficient amount of infill development in existing neighborhoods.

Another argument is that there could be an incomplete market in home insurance that facilitates residents' opposition to infill development. Fischel (2001a, 2001b) suggests that although increased neighborhood development is unlikely to negatively affect current resident home values, the risk that it might, no matter how remote, leads people to oppose infill. Since a home is the largest asset most people own and they cannot insure the home against this risk, people try to lessen this risk via land-use policy and development opposition.

One final point from the economics literature is that infill development may not be less costly than dispersed development at the periphery, as urban planning and smart growth advocates have argued. The planning literature has focused on infrastructure costs, and has analyzed development costs associated with different types and designs of development (Burchell 2006; Humstone 2004; Young 1995; and Muro 2004). These estimates are often based on hypothetical designs, and do not take account of the costs of expanding infrastructure in crowded urban areas. In fact, at least one careful study has found that infrastructure costs can increase with increased density (Ladd 1992).

There are other arguments about local residential opposition to infill projects and how local government structure perpetuates sprawl (Danielson 1976; Carruthers 2003; and Carruthers and Ulfarsson 2002). Homeowners may be pursuing what they believe to be their own interest

using zoning boards and local land use authority to limit infill, especially when they feel it will be costly (if the infill development uses more in services than pays in taxes) (Carruthers 2003; and Downs 2000). The result should be a reduced amount of infill, restricted to projects most likely to have a positive impact. Evidence supporting these claims, beyond documenting opposition and political fragmentation, is limited at best. It should also be noted that a desire of like people to live with like people (Norris 2001) and racial and income based discrimination (Ihlanfeldt 2004; Mills 2002; and Harris 1999) are also potential reasons for opposition to development.

III. Defining and Measuring Infill Development

How much of development in urban areas can be considered infill development? Defining and measuring infill is difficult because there is no single accepted definition of what constitutes infill versus other development. The broadest and most common definition for infill is development that occurs in underutilized parcels in already developed, urbanized areas (Municipal Research Services Center 1997; MDP 2001; and Northeast Midwest Institute 2001). Two terms standout in this definition. First, "underutilized" means that the property was at least in part undeveloped. The parcel could initially be entirely vacant or partially undeveloped. Second, the term urbanized means the receiving area is a previously developed neighborhood. The infill then "fills in" an unused part of a community.

Infill is often associated just with central city development, where such projects are seen as a policy tool to revitalize existing central city neighborhoods. For example, a recent issue of the Department of Housing and Urban Development Breakthroughs (2009) highlighting local government efforts to promote infill mentioned only central city policies and projects in Miami, San Diego and Phoenix. Because of this association, it should come as no surprise that most infill research explores central city redevelopment. For example, Steinacker (2003) and Farris (2001) both define and measure infill trends over time, focusing exclusively on central city development as infill. Individual case studies have also concentrated primarily on central city infill revitalization projects (Urban Land Institute 2005; and Deitrick and Ellis 2004).

However, infill need not be restricted to central city areas. Development occurring in established communities in suburban jurisdictions in the broader MSA regions certainly meets the general definition of infill given above, and also provides many of the touted advantages of infill including less development in the undeveloped periphery. There has been much less focus on measuring or documenting this type of infill. Some efforts have attempted to identify possible infill sites and their potential for residential housing units. For example, the California

Infill Pilot project documents potential infill sites throughout the state of California (The Future of Infill Housing in California 2005). It is important here to note that most efforts at measuring infill, similar to the California study, explore an area's capacity for new development not how much has occurred. The difference between the potential for development and the actual number of units built can be quite different as we explain below in section IV.

Finally, there is the issue about whether infill development should include redevelopment efforts, in which existing building is replaced with new structures at higher density or mixed uses.[1] New infill development and redevelopment are often considered together in some analyses, but there is also a separate literature that addresses the fundamentally different opportunities and underlying economic conditions faced in redevelopment projects. While it seems reasonable to consider redevelopment or renovation of buildings on previously developed lots as a type of infill, particularly if it increases the number of units built, in this chapter we will focus primarily on infill as new development occurring on previously unused or underutilized lots.

Measuring Infill

Following from the definition of infill development discussed above, the measurement of the amount of infill occurring in an urban area involves a number of different steps. There must be estimates of both the amount and location of land that is vacant and developable, and how much of that land is in urbanized areas where development would be considered infill. Both of these types of estimates can be time consuming and difficult to estimate. In addition, as discussed above, some analyses of infill look at potential infill development while others look at the actual amount of infill. We briefly review the different approaches and estimates from the planning and policy literature.

In exploring how best to measure infill, land use planning provide some guidance. As part of smart growth efforts in states like Maryland, Washington, and Oregon, planners need to identify developable land and monitor any change in that land's supply (National Center for Smart Growth Research and Education, 2005). Many of these vacant, developable parcels are

[1] For example, Wheeler (2001) clearly considers rehabilitation and expansion of existing buildings to be infill while Knaap and Moore (2000) consider them as separate. We see this differences in the policy world as well where the Maryland "Model and Guidelines for Infill Development" (2001) refers to infill as including redevelopment while the Denver Regional Councils of Governments "Regulatory Strategies for Encouraging Infill and Redevelopment"(2006) views them separate.

located in already existing communities and in turn constitute potential infill. The planning literature details these activities, often called capacity estimates.

Knaap and Moore (2001) provide an excellent overview of how planners measure land inventory, estimate development demand and monitor consumption rates. Of particular interest here is the discussion on identifying developable lands. While site inspection may be the most accurate method, it may be prohibitively expensive. On the other hand, less costly approaches, such as using assessment records, mean increased error rates. A multi-tool approach is suggested as best. Once identified, vacant parcels must be assessed as to whether they are developable. The amount of developable land consists of all identified vacant parcels minus land where development is restricted due to environmental and service constraints. It is the supply of this land which constitutes the development capacity.

Following the techniques identified in the planning literature, the most thorough way to identify infill would be to execute a case-by-case investigation assessing each potential development. This method would involve reviewing developments, primarily concentrating on the receiving neighborhoods, both through data analysis and visual site-by-site inspection. The key idea is to determine whether or not an area surrounding a project is sufficiently developed to allow the project to be considered infill. For example, in a study of low-income apartment affects on receiving suburban residential neighborhood property values, Pollakowski et al. (2005) used a site selection process which involved closely inspecting new developments to determine whether they were part of a receiving neighborhood or more isolated project. Such inspection of specific areas is already used in the form of site-by-site surveys to determine potential development and infill inventories (The Future of Infill Housing in California, 2005).

A review of all possible infill sites is not practical when analyzing large areas, or to determine how infill has changed over time. An alternative approach is to use statistical analysis to determine areas that could be considered urbanized. Any development that occurs in these urbanized areas is then infill. Unfortunately, there is no agreed upon way to define what is an urbanized area. Wiley (2009) identifies urbanized areas of Montgomery County, Maryland by applying uniform assumptions to small gridded areas at the periphery of existing development in the County over time. Any area within the periphery that is developed is considered infill, and development in areas on the edge that have average lot size below a certain level and are at least 70% or more developed, for example, would also be considered infill in his analysis.

The various studies of the amount of infill development are summarized in Table 1. The Landis et al. (2006) study provides an example of a capacity analysis. There are countless other

examples in the literature, but the Landis study is highlighted because they attempted to inventory all infill development in California, both in and outside of central cities. The authors measure the level of development in a given area and then label it as urban if it meets a set level of development. Once urban areas are identified, the authors then estimate the amount of developable land within those areas. Although this approach does not address the amount of infill, it highlights how capacity analyses are done and shows how one might go about identifying urbanized areas from which built infill could be estimated.

The Farris (2001) and Steinacker (2003) studies provide estimates of the amount of infill across urban areas in the U.S. In both cases, the researchers defined infill in extremely general terms: all residential development occurring within a central city. They then compared infill to residential development taking place in the remainder of the metropolitan region. Both studies analyzed development occurring in the 1990s and included most major metropolitan areas. The authors did take slightly different analytical approaches. Farris compared differences between the percentages of residential building permits awarded in central cities to those in the remainder of a metropolitan region (suburbs). He aggregated all of the data looking at the overall level that occurred during the 1989 to 1998 period. The results for every region were that most new residential construction was occurring outside the central city—there was very little infill. His analysis, however, does not include as infill any development in suburban areas of the MSAs of these cities.

Steinacker (2003) first creates a ratio of central city residential permits (infill) to all MSA residential permits (non-infill). Similar to the Farris findings, the ratios reveal that less than 20% of MSA development would be defined as infill. Steinacker then adjusted her development measure to account for land area.[2] She shows that development in the central city areas is more dense that the development in non-central city areas, and therefore a primary reason for the small share of infill development in the central city is the small share it is of the total land area in an MSA.

[2] She creates a concentration ratio is as follows: (Central city Permits/All MSA Permits) / (Central City Land Area/All MSA Land Area). This ratio measures whether or not a MSAs central city residential development is proportionate to its share of the MSAs land. The ratio tends to be greater than 1 because the share of land in the center city is less than the share of new housing units built (infill).

Table 1. Studies Measuring the Amount of Infill Development

Study	Location	Method Used	Findings
Landis, John D., Heather Hood, Guangyu, Li, Thomas Rodgers, and Charles Warren. 2006. The Future of Infill Housing in California: Opportunities, Potential Feasibility. *Housing Policy Debate*. 17(4)	California	Measure potential residential infill sites by first identifying counting (urban) areas from which they then identified potential infill parcels	The author identifies substantial numbers of parcels, 500,000 potential infill sites, with the potential to take on 4 million housing units. The author notes that many other factors that likely serve to limit the total amount of units built.
Farris, J. Terrence. 2001. The Barriers to Using Urban Infill Development to Achieve Smart Growth. *Housing Policy Debate*. 12(1):1-29.	22 older cities	Infill defined as residential projects built in central cities and non-infill as suburban development	The author finds that over the decade of the 1990s only 5.2 % of all housing permits went into central cities and only 2.2% of single family dwelling permits.
Steinacker, Annette.2003. Infill Development and Affordable Housing: Patterns from 1996 to 2000. *Urban Affairs Review*, 38(4):492-509.	50 largest MSAs	Infill defined as residential projects built in central cities and non-infill as suburban development	The author finds that looking at building permits alone, central city development or infill is less than 20% of total development. However, once land size is accounted for, residential infill density is higher than non-infill.
Wiley, Keith. 2009. An Exploration of the Impact of Infill on Neighborhood Property Values.	Montgomery County, MD	Measures infill occurrence by first identifying an urbanized area, similar to Landis, from which infill is defined.	The author estimates that infill accounts for roughly two-thirds of residential development in Montgomery County, Maryland. Over time the proportion of infill has been roughly constant.

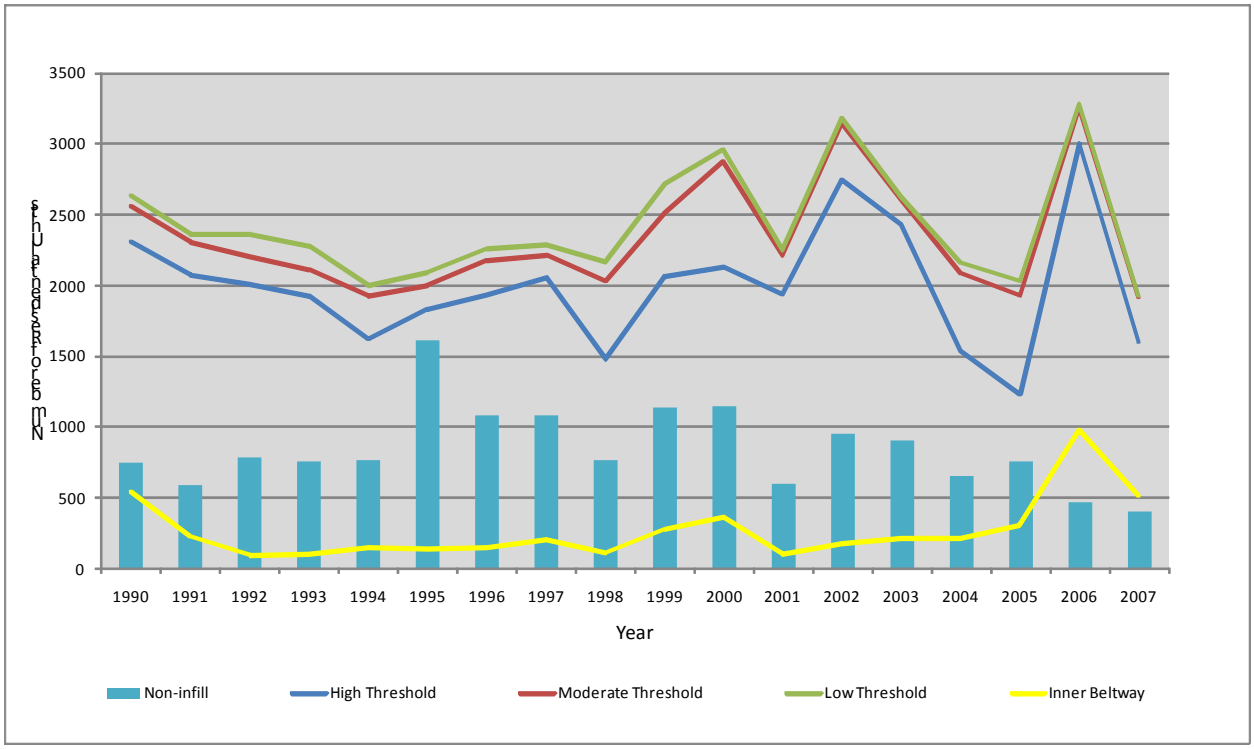
Wiley (2009) carefully identifies urbanized areas where development would be considered infill at the edge of the developed city. He establishes an urban boundary by identifying areas that are on the outer fringe of an urbanized area, and then evaluates which of these marginal areas should be considered urbanized using two different criteria, as described above. The defined urbanized area changes over time as the region develops.

Figure 1 presents several estimates of new residential infill from Wiley's analysis (detached, attached and multi-unit condominiums) in suburban Montgomery County, Maryland.. Three of the trend lines reflect different estimates for establishing the urban boundary (high, moderate and low threshold). The fourth trend line (inner beltway infill) uses a central city boundary (Capitol beltway separates old inner ring suburbs from newer developed areas).

The solid line at the year 1997 shows when Smart Growth legislation in Maryland was passed that attempted to promote more infill development. The amount of infill remains roughly constant at about 1,500 to 2,000 units a year over time in the County, but the variation in infill

becomes greater after the Smart Growth legislation is initiated. This is likely due to larger infill development projects that became more common late in the period as discussed below.

Figure 1. Estimates of Infill Trends in Montgomery County, Maryland 1990–2007

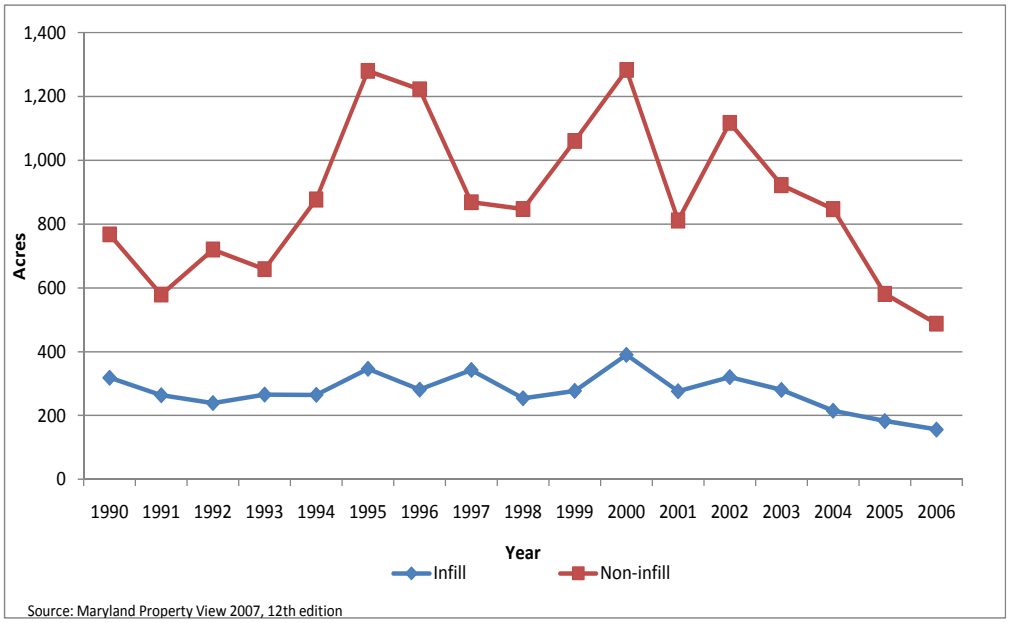


Note: Non-infill bars show the amount of development in the County that was not in the infill area as defined under the moderate threshold for the urbanized areas. To find the urbanized areas, Wiley divided the county tax grid into 6,000 by 4,000 foot blocks. After subtracting out open space areas (golf courses, etc.), he then measured the density and amount of development in each block. Many interior blocks were considered urbanized. For the blocks at the edge of existing development, assumptions were made to determine if the areas would be considered urbanized. The level of development was evaluated every two years and the status as urban determined. The moderate threshold for urbanized was defined as one acre or less residential lot sizes and 70% of land developed. Sensitivity analysis was performed where the low threshold equates to 1.25 acres residential lot size and 65% developed. The High Threshold estimate thresholds are: .75 acres mean residential lot size and 75% developed. The data source was tax assessor records using ARCGIS.

Figure 1 also includes an estimate of non-infill. This estimate reflects all development outside the urbanized area using the moderate threshold assumption to define what is urbanized. The total amount of non-infill residential infill represents much less than 50% of all new units built in almost all years. However, although there are many more infill units built, the amount of land used in the non-infill development is much greater. Figure 2 shows the amount of land used by non-infill and infill development as defined by the moderate assumptions about what is an urbanized area from Figure 1 above. Clearly, much less land is consumed for infill development

compared to non-infill. A relatively small number of residential subdivisions in an exurban/rural area may consume more land than several hundred infill units, which is why there is such a focus on the density of infill as a way of conserving land at the periphery. The following section explores infill density and zoning issues in more detail.[3]

Figure 2. Land Consumption by Development Type Montgomery County, MD 1990-2007



In summary, the amount of infill relative to other types of development depends very much both on how infill development is defined and also on how what is considered an urbanized area is defined. While there are a number of efforts to determine "urban capacity" or the amount of potential infill, there have been very few studies that have tried to actually measure the amount of infill development. Estimates of infill development that include only central city development as infill find that very little of an overall MSAs new development has occurred as infill.. Most of the development over the past 20 years has been in suburban and even exurban areas of MSAs. Which of this development is infill? Only one study has looked at

[3] It is important here to note that infill is being measured by assessor records of built units but one could also look at number of building permits. Farris (2001) and Steinaker (2003) both use building permits. If one wanted to consider renovations they would likely want to look at building permit data.

the evidence of infill development in an urban/suburban county of a large metropolitan area – the Wiley (2009) study of Montgomery County in the Washington D.C. metropolitan area. In that study, infill development makes up slightly more than half of the overall development that has occurred, and there is some limited evidence there that infill may be increasing. But, it is worth noting that the land areas used for non-infill development are much greater than that for infill. Below we discuss the issue of infill density, which may be a key element in whether infill development achieves the hoped-for land use goals.

IV. Density of Infill Development

A major focus of the infill capacity studies described above is to determine how much of future growth could be accounted for by infill development, at least in principle (The Future of Infill Housing in California 2005; and Moundon 2001). The argument by Smart Growth advocates is that the more development can occur through infill, the greater will be the regional benefits as described in section II above. The density of the infill development is, of course, the key issue for making such estimates of infill capacity. But density of infill development is the complex outcome of economic, regulatory and political factors, which we explore in this section.

One of the arguments in favor of infill development as described in section II above is that leapfrog development and then infill at higher densities can actually be more efficient than development patterns that use all land sequentially over time (Ohls and Pines 1975, Peiser 1989 and Ottensmann 1977). Higher densities would result from higher land prices in infill areas, as housing capital is substituted for land in the housing bundle. As Peiser noted, though, this outcome assumes no opposition from current residents to the increased density. This view also overlooks the potential for developers to substitute larger homes and/or more amenities in place of more units as a way to recoup the increased costs associated with the now more expensive land (Lichtenberg et al. 2007). Developers might seek to increase home amenities rather than fight local zoning boards.

Local land use authority and either public support or opposition for a project greatly shape development levels. Johnston et al. (1984) studied such factors and the impact they had on growth management and infill promotion efforts in Sacramento County, California in the late 1970s and early 1980s. In this study, the authors reviewed zoning actions and general plan amendments assessing the impact these changes had on development. They found that by and large growth phasing changes were successful. The amendments to protect agricultural land helped limit leap frog development and preserve undeveloped areas. Infill promotion efforts were more difficult. The authors documented resistance to infill and in particular high density

multi-family buildings. Density reductions inside the urban service boundaries reduced the area's planned population holding capacity by about 18,000. The authors estimated that this could mean an additional 1,200 acres would be developed since those resident have to go outside of the urban area to live. These results are similar to those noted by Kopits et al (2007) and Wiley (2007) in that planned or desired densities were not achieved in practice (see below).

There may also be low demand for homes on small lots if households have strong preferences for lot size (McConnell et al. 2005). Ellman refers to this when she recalls a Phoenix developer's claim that there is only a "sliver" of demand for infill in the form of townhomes or other moderate density projects (1997). In particular, families with children, a primary group of home buyers, do not prefer high density development even in new urbanist designed projects (Lee and Ahn 2003). However, demographic trends suggest these preferences could change in the future due to smaller family sizes and an aging population which may be more inclined to live in more compact, walkable neighborhoods (Meyers and Gearin 2004).

Kopits et al. (2007) assessed the role of household preferences in lot and structure size in their suburban Maryland study. They constructed a hedonic model and analyzed home sales in two of the three suburban counties. Findings point toward higher consumer demand for large lot sizes. This is particularly the case in heavily developed Montgomery County. These findings are consistent with work done by Lichtenberg et al. 2007. Lichtenberg finds that developers instead provide greater open space amenities in place of more units. These studies demonstrate that consumers are willing to pay extra for increased amenities such as open space.

Zoning and Infill Development: Potential vs. Actual Density

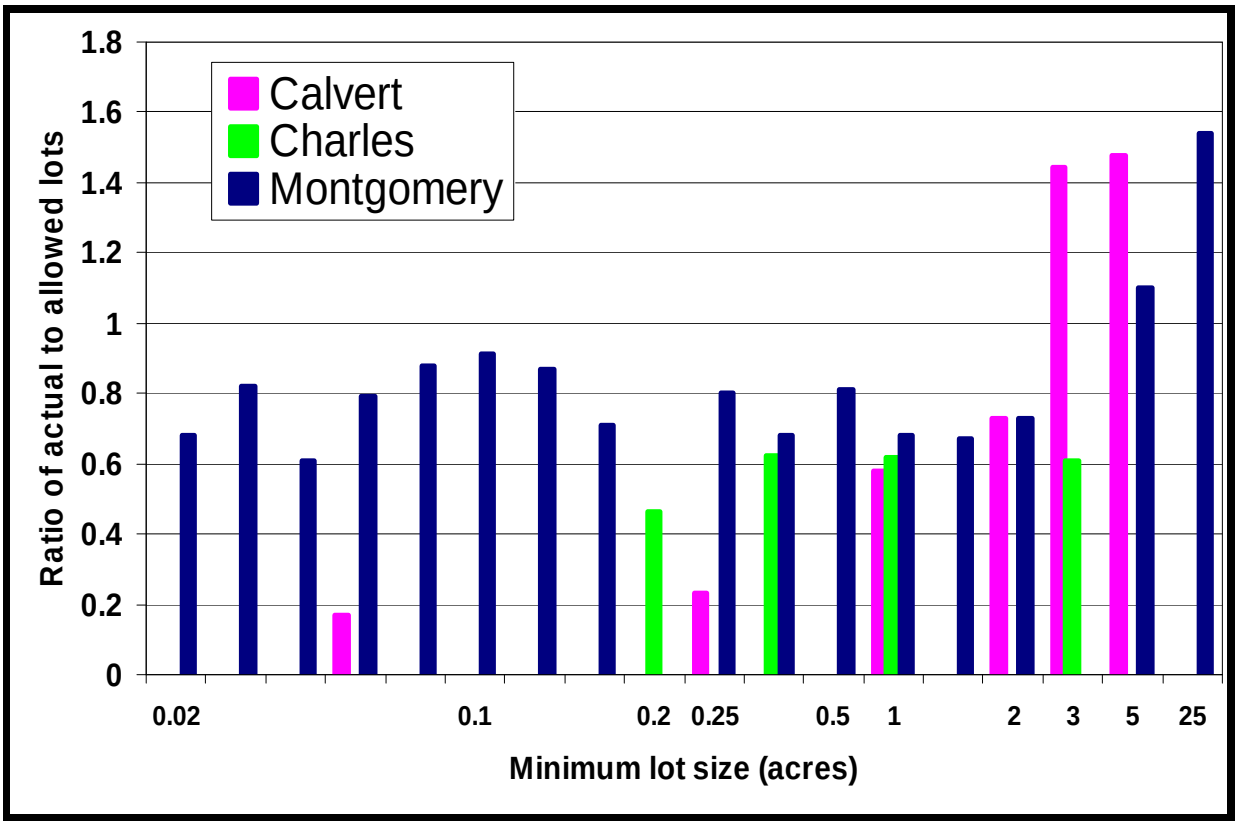
Local zoning rules may also have a big impact on the density levels at which infill can be built. Residential zoning rules specify either a minimum lot size or maximum number of housing units per land area, thus creating an upper limit on density levels. Zoning levels can be set to reflect the underlying demand for density in different parts of the urban area, or they can be set to try to influence density levels (Levine, 2006). However, zoning regulations establish only the maximum density; the actual density of new building is determined by the complex interaction economic and political factors, and the physical features of the landscape.

There have been several recent economic studies which directly explore actual density levels relative to potential density that could be achieved according to zoning allowances. Kopits, McConnell and Miles (2009) explored lot sizes, land-use zoning and consumer preferences in three suburban Maryland counties located in the Washington DC metropolitan

area. As part of their study, the authors evaluate actual and zoned subdivision densities for all three counties over a three decade period. The analysis includes calculated ratios of actual to zoned density for each jurisdiction. The data ratios are then broken down by zoning limits from smallest to highest maximum allowed levels.

The findings show that the actual number of units that could be built was seldom reached in any of the three jurisdictions, except in those with very low density (lot sizes larger than 5 acres). The difference ratio of actual to allowed residential density by zoning is less than 1 in all of the residentially zoned areas, as shown in Figure 3. Infill occurs in these high density urban areas, where actual density tends to fall below what is allowed by zoning.

Figure 3. Ratio of Actual Lots to Allowed Lots for Three Counties in Maryland



Calculated from subdivision data, 1980 to 2005.
Source: Kopits, McConnell and Miles, *Lot Size, Zoning and Household Preferences: Impediments to Smart Growth?* 2009.

Wiley (2007) also explored housing density in select residential infill subdivisions in suburban Montgomery County which borders Washington, DC. The author looked at actual density for 13 small developments (4 to 17 units), maximum allowed density according to

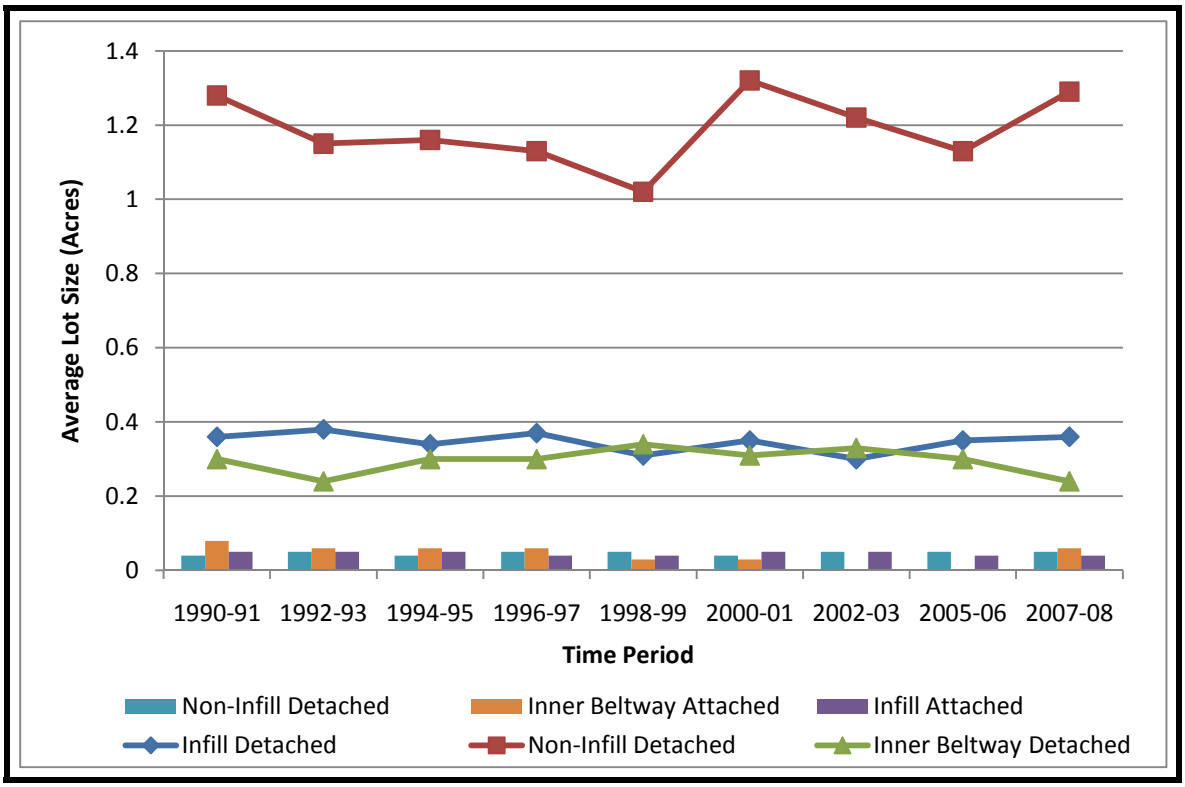
zoning, and the surrounding area parcel sizes. In none of the cases did a project meet the zoned density limit. For example, if zoning allowed up to 11 units only five or six might have been built. Circumstances such as setbacks and lot shape were not accounted for in the analysis; nevertheless, the data suggest infill actual density may be lower than potential density.

In addition, Wiley's research found that the infill lot sizes were larger than the surrounding lots in 9 of the 13 cases. It appears the lot difference may be related to the fact that receiving neighborhoods were built in a time period when lot sizes were smaller. Still, it is important to note that the infill did not increase density, as theory predicts. There are a number of reasons why higher density is difficult to achieve, including opposition from local residents, consumer references and local zoning rules. We discuss each of these below.

Evidence of Infill and Non-Infill Density Levels

To provide some sense of the differences in lot sizes in different part of the urban area, we again draw on data from the study of Montgomery County (Wiley, 2009). Figure 4 below shows the trends in lot size over time for different types of residential infill development and compares those to average lot sizes for non-infill development that occurred outside the urbanized areas. As expected, non-infill development has low density, with average lot sizes of just over 1 acre per housing unit. Infill development tends to have smaller lot sizes, but development is not as dense as might be expected for urbanized areas. Average single family lot sizes are only about half of those in the outlying areas, at about 0.4 acres. And, inner beltway single family houses have only slightly smaller lots than all infill housing. Town houses have roughly the same lot size no matter where they are built, with very small lot sizes of roughly one tenth acre or less.

Figure 4. Average Lot Size by Type, Montgomery County, Maryland



Note: Detached structures are single-family detached homes. Attached structures are townhomes only. Information on condominium structure size is missing in many cases so this measure is not included here. Definition of infill is all development in urbanized areas defined as those with at least 75% developed land, and average density of more than 1 home units per acre.
Source: Wiley (2009). Data is from Maryland Property View.

Table 2 breaks down the infill and non-infill areas more finely for single family detached housing units. For this table, the non-infill area is defined as just those areas that are adjacent to urbanized area, and specifically designated for future urban growth.[4] First, it is noteworthy that average lots sizes in central city and suburban infill areas and in the non-infill adjacent areas all have very similar lot sizes. We would expect central city locations to have much higher density levels, but they do not.. It is also interesting that lot sizes of the units in the non-infill growth areas (bottom row) tend to be somewhat smaller than those in the infill areas. This suggests that

[4] The border area is defined as the area that is outside of the area defined as "urbanized" but within the Priority Funding Area, which is the region designated by the County for future growth.

it may be easier to target somewhat higher density development to the boundary of the urbanized area than to more central locations.

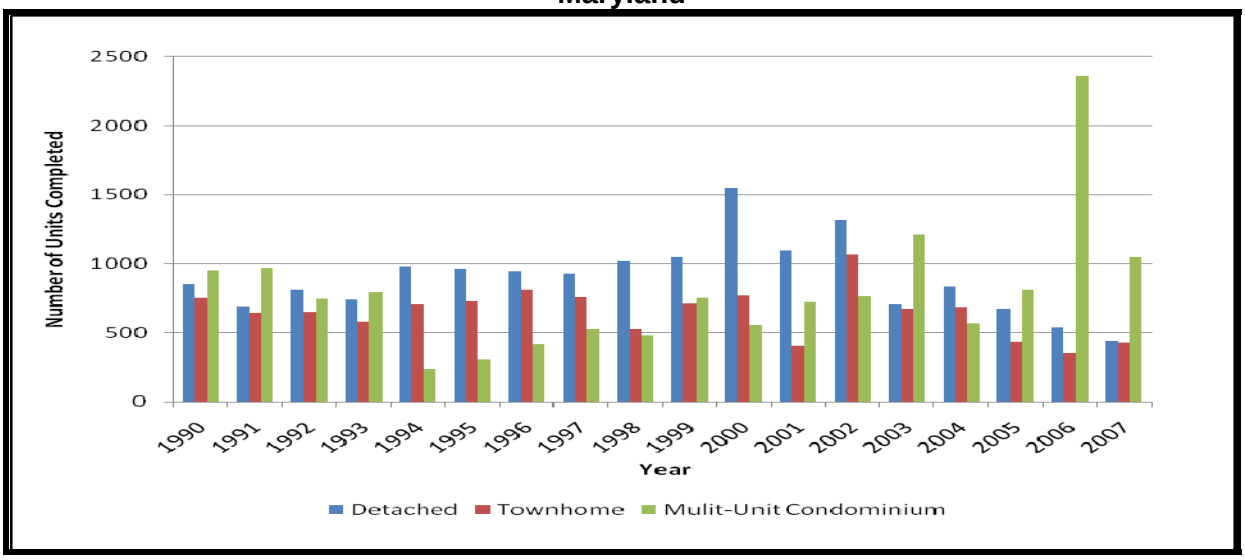
Table 2. Mean lot Sizes for Single Family Residential Housing, Montgomery County, Maryland Development 1990-2007

Detached Dwellings	Time Period								
	1990-1991	1992-1993	1994-1995	1996-1997	1998-1999	2000-2001	2002-2003	2004-2005	2006-2007
Infill (Primarily Suburban Type)	0.36	0.38	0.34	0.37	0.31	0.35	0.30	0.35	0.36
Inner-Beltway Infill (Central City Type)	0.30	0.24	0.30	0.30	0.34	0.31	0.33	0.30	0.24
Non-Infill but inside designated growth area	0.27	0.27	0.28	0.28	0.29	0.27	0.25	0.22	0.38

Finally, it is important point out that the real changes in infill density are likely to come about as a result of much higher density construction, as condominiums would provide.[5] Figure 4 above included information on lot size for only new single family and townhouse housing. Condominiums were not included because their lot sizes are so small, at roughly 0.05 of an acre on average. There has been an effort in recent years in Montgomery County and in other urban areas around the country to allow for higher density through planned development and mixed use zoning projects, especially in central urban areas that may serve as a transportation nexus. Figure 5 shows the number of units by type of infill development. While the number of condominium units declined in the 1990s, their prevalence has increased dramatically since 2002. They make up by far the largest share of units built as infill in the later period. This may explain why land used for infill development (Figure 2 above) is declining over this period, even though there was a spike in infill building in 2006 (this spike is from large condominium projects as Figure 5 shows).

[5] Apartments are another higher density housing type, but the data for Montgomery County does not have accurate spatial information about apartment units.

Figure 5. Types of Infill Units Built Montgomery County, Maryland



We conclude that the evidence on infill density is mixed. There is clearly a great deal of opposition to high density development that must be better understood before policies to increase density will be more successful. Zoning changes alone will not lead to targeted density levels because actual density is often lower than allowed density under zoning. And for single family detached and townhouse units, lot sizes are surprisingly similar across the urban area even for infill and non-infill areas. There is some evidence, at least in one of the urban areas we examined, that recent regulatory changes may be leading to higher density condominium development in recent years, and less land consumed for development throughout the region.

V.Effects of Infill on Surrounding House Prices

While there are likely to be regional smart growth benefits from greater infill development, there may also be actual or perceived localized costs of such development, as discussed above. These local costs can include increased traffic congestion, lost open space and crowded services. Whether there are benefits or costs to local areas of infill development, these effects can be expected to be incorporated into local housing prices. There have been some recent attempts in the literature to estimate the extent and magnitude of these effects on local prices. These studies build on an earlier and parallel literature that examines the effects of urban redevelopment on local housing prices. We review all of this empirical literature here that bears on the costs of infill development.

Much of the earlier economic research focuses on the effect of non-conforming buildings, central-city redevelopment projects, and rental properties on nearby housing prices. Using hedonic pricing methods, studies by Simons et al. (1998), Rabiega et al. (1984), and Grether and Mieskowski, (1980), found that this urban redevelopment either no impact or a positive effect on redevelopment on nearby housing values. This research focused on distressed inner city neighborhoods and used distance from the redevelopment site in a simple hedonic framework.

In the last five to ten years, several new studies have analyzed the effects of various types of infill development on nearby property values in central city and suburban jurisdictions. Of note, these studies did greatly improve analysis by adding new research design elements to the hedonic model. Previous research on home values had used basic hedonic models alone (Simons, et al. 1998; Ding, et al. 2000; Wang et al. 1991; Thibodeau 1990, Colwell et al. 1985; Rabiega et al. 1984 and Grether and Mieskowski 1980).

Table 3 on the following page lists the most recent and relevant studies which explore how development affects nearby property values. The first two studies presented in Table 3 address the issue of how non-conforming development is likely to be different from the surrounding land uses, and may increase traffic and service flows into and out of the local area. Thibodeau (1990) explores the effect of a newly constructed high-rise office building on a surrounding residential area in Dallas, Texas, and Colwell et al. (1985) analyze the impact of a newly constructed shopping center on nearby property values in Urbana, Illinois. Both used the hedonic approach to measure the development impact by estimating the change in residential property values. The other important design element was that the studies had pre- and post-infill project home sales data making it possible to use the hedonic model to assess how proximity to the infill site changed post-development.

Both the Thibodeau and Colwell studies found a negative impact for those properties in close proximity to the new building, but a positive impact for those at a greater distance. The positive effect at greater distance may reflect more shopping options or increased demand for homes by new workers employed at the office complex. Both of these studies suggest that there may be concentrated, localized costs of such development, but dispersed benefits. Thibodeau attempts to compare total benefits and costs to ascertain an overall value for the development, which he finds to be positive overall. He also puts forth the possibility of a compensation scheme for compensating the nearby residents who are adversely affected (1990).

The Ding, et al.(2000), Simons et al (1998), and Ellen and Voci (2006) studies all three explore residential development in central city settings and the possibility that development can

have positive externalities in certain neighborhoods. Both Ding et al. (2000) and Simons et al. (1998) assess the impact of new and rehabilitative development on nearby single-family residential property values in Cleveland for the 1996-1997 and 1991-1992 periods respectively. These studies use a hedonic pricing model to estimate the home value impact associated with proximity to construction.

Ding et al and Simons et al both find that new housing development has a positive impact on nearby values. Ding et al estimate that, on average holding other factors constant, a house will sell for about $5,000 more if it is near a new home construction. This effect diminishes rapidly once one gets beyond 300 feet from the new construction. In addition, Ding et al. estimates this positive effect to be greatest for low-income receiving areas and large sized projects. Simons et al also find that housing prices increase with proximity to new house construction. Their study finds, in contrast to the Ding et al study, that this effect diminishes with large scale projects.

The Ellen and Voicu (2006) study of the New York City's Ten Year Capital Plan renovation efforts effect on nearby property values also sought to explore the possibility of positive externalities like Ding et al and Simons et al. The study also uses a hedonic pricing model, but Ellen and Voicu's methodology includes the difference-in-difference econometric design which makes it possible to account for overall changes in the local area or region that might affect property values but that are unrelated to the development in question. Their study also finds a positive spillover effect from the redevelopment site in that home values increase in the surrounding areas. There are some differences in effects if the projects are built non-profit or by private developers. In both cases, the increased home values decrease with distance from the redevelopment site, but the decline is smaller for non-profits than for private developers. They also found that scale did matter for non-profits with larger projects being more positive.

In a study which employs a similar research approach, an hedonic model with a difference-in-difference design, Galster et al. explore the home price impact associated with sitting supportive housing facilities in the Denver metropolitan areas (2004). The Galster et al. (2004) research found that being near a supportive facility had a positive impact on residential home values overall. They suspect this occurs because although negative externalities might exist, such as increased traffic, they are offset by even greater positive externalities, like increased tax revenues. However, a Colwell et al. study of the impact group homes have on nearby residential properties in DuPage County, Illinois found the opposite, a negative impact (2000). The Colwell et al. study employs a event study approach instead of the difference in difference used by Galster et al. (2004).

Table 2. Evidence of the Effects of Infill Development on Local Property Values

Study	Location	Development Type	Findings/Results
Colwell, Peter F., Surrinder S. Gujral and Christopher Coley. 1985. The Impact of a Shopping Center on the Value of Surrounding Properties. *Real Estate Issues* (Summer/Spring)	Urbana, Illinois	Shopping Center	Properties values nearby the development declined after its construction was announced but beyond 1,500 feet values increased.
Thibodeau, Thomas G. 1990. Estimating the Effect of High-Rise Office Buildings on Residential Property Values. *Land Economics*, 66(4): 402-408.	Dallas, Texas	Office Building	Properties within 1,000 ft. of infill suffer price declines after construction. Properties 1,001 to 2,500 ft. away. experienced positive price impacts and those further out were unaffected
Simons, Robert A., Roberto G. Quercia, and Ivan Maric. 1998. The Value of New Residential Construction and Neighborhood Disinvestment on Residential Sales Prices. *Journal of Real Estate Research*, 15(1/2): 147-163.	Cleveland, Ohio	Rehabilitation and New Residential Construction	Properties near new neighborhood construction increase in value. A negative home value impact is associated with being near large projects as opposed to small ones.
Ding, Chengri, Robert Simons, and Esmail Baku. 2000. The Effect of Residential Investment on Nearby Property Values: Evidence from Cleveland, Ohio. *Journal Real Estate Research*, 19(1/2):23-47.	Cleveland, Ohio	Rehabilitation and New Residential Construction	Properties near new neighborhood construction increase in value. Large projects and those in lower-income areas are associated with higher home values.
Ellen, Ingrid Gould and Ioan Voicu. 2006. Nonprofit Housing and Neighborhood Spillovers. Journal of Policy Analysis and Management, 25(1): 31-52.	New York, New York	Residential Rehabilitation projects	Properties near the new construction increased in values. Impacts vary by type of provider: nonprofit and for profit.
Galster, George C., Peter Tatian and Kathryn Pettit. 2004. Supportive Housing and Neighborhood Property Value Externalities. *Land Economics*, 80(1): 33-54.	Denver, Colorado	Supportive Housing Facilities	Properties located nearby the supportive facilities increased in value after sitting. The facilities are built in depressed areas which might explain the positive effect.
Pollakowski, Henry O., David Ritchay, Zoe Weinrobe. 2005. Effects of Mixed-Income, Multi-Family Rental Housing Developments on Single Family Housing Values. Cambridge, MA: Massachusetts Institute of Technology-Center for Real Estate Research.	Boston, Massachusetts	Low-income Apartment Bldg.	Case studies of 8 projects found no evidence the apartment building caused home values to decline or vary in any way from what was occurring in the overall jurisdiction.
Blanchard, Christopher and Clegg, Elaine and Martin, Leslie (2008). *The Consequences of Residential Infill Development on Existing Neighborhoods in the Treasure Valley*. Project Report. Urban Land Institute, Idaho/Smart Growth, Idaho.	Boise, Idaho	Residential: Single Family & Townhomes	Case studies of 12 projects found no evidence infill created increased neighborhood traffic and home price decline. Residents did perceive negative impact from lost open space.
Wiley, Keith. 2009. *An Exploration of the Impact of Infill on Neighborhood Property Values*. (Doctoral dissertation). Available from Dissertations and Theses database. (UMI No. 10221)	Montgomery County, MD	Residential: Single Family & Townhomes	Analysis of pre-post change in property values for 28 residential infill sites in suburban jurisdiction finds negative home price impacts.

Pollakowski et al.'s research explores the impact of newly constructed mixed-income apartment developments on nearby, single-family houses through changes in sales prices. The study encompasses seven projects in suburban Boston built during the 1983-2003 period. In each case, the new development consisted of much higher densities than the surrounding areas and at least 25% of the units were deemed affordable. Changes in state housing laws designed to expand housing opportunities for lower-income residents allowed these projects to over-ride local opposition. By looking at cases mandated by the law, the authors were able to analyze new infill at higher densities which otherwise might have been decreased in zoning board negotiations. The analysis also was careful to restrict the treatment or impact area only to those homes which either abutted or were immediate neighbors of a project (within sight). This was done to ensure the study dealt with only those cases most likely to be impacted.

Pollakowski then compared home prices changes in the impact area to those in the remainder of the political jurisdiction (municipality). That is, home sales prices in the form of a housing price index, were compared for treatment and control areas before, during, and after construction. The study found no discernable change in the treatment area home price indexes that varied from those found in the overall community. The authors conclude such developments do not depress property values as many fear.

The Idaho Smart Growth and Urban Land Institute take the analysis one step further. These two groups teamed up to study residential infill in the Boise Idaho metropolitan area (2008). The researchers studied 12 projects which were built on vacant parcels within city limits in areas where 80% of the property within 300 feet was considered developed. The authors looked at pre- and post-development trends to assess the effects of each project. In addition, the analysis included traffic counts were done in the affected areas before and after development, home sales price trends pre and post were constructed, and residents were surveyed about their view on the projects.

The findings identified three of the twelve sites with a post-development traffic increase, no neighborhoods with changes in property value trends that dramatically varied from overall area, and no correlation between survey scores on views of infill and density. The survey found that there were some negative perceptions about the loss of open space associated with the development. Respondents also had higher views of projects that provided public amenities which were accessible to all residents.

Finally, a recent study by Wiley (2009) had a different focus than many of the above studies, and finds different results than most of them. Wiley examined the effects of infill

development consisting of single-family detached or townhome dwellings that were built in residential neighborhoods on local housing prices. Specifically, the author explored the effects of 28 residential infill subdivisions built during the 1980-2004 period in Montgomery County, Maryland on sales prices of surrounding homes. The author also used hedonic pricing models and estimated change pre and post development using a difference-in-difference framework.

Wiley's results across the various models identified a consistent negative price effect associated with the infill, though the effect is small---less than 0.5% decline in property values. In addition, Wiley also explored how effects of infill might vary by either the receiving neighborhood characteristics or by the type of infill development. He found that lower-income areas tend to benefit and higher income areas had property values decline as a result of infill. Also, larger projects generated greater negative effects than smaller projects. This study used detailed property level data, and attempted to isolate the effects of the infill from other factors that could affect property values. It is the only statistical analysis that focuses on residential infill, and the results may suggest small negative effects, that can help explain why there is so much opposition to infill.

VI. Conclusions

There are many reasons planners and public policy analysts give for why new development patterns that include more high density, mixed-use infill development would achieve improved social outcomes. Infill development is often seen as an opportunity to address sprawl and its associated problems while at the same time revitalizing and growing existing communities. Nevertheless, such new infill development has proven difficult to achieve in practice, for a host of economic, political and regulatory reasons. We have reviewed the arguments from the planning and economics literature that support more infill development and associated policies to achieve it. We have also reviewed the literature on why infill development has not occurred and the nature of the opposition to it. One important argument that has been overlooked in recent years suggests that policies to promote infill may even be counter-productive in the long-run. If policies that promote infill today are successful, this may preclude or at least make more difficult, higher density infill in the future.

There is very little empirical work examining how much infill has actually occurred in U.S. cities and whether it is increasing or decreasing over time. The amount of infill depends critically on the definition of urbanized areas. Beyond inventory and capacity analyses which evaluate potential development, most of the studies that have been done assume infill is only development that occurs in central cities, not in surrounding metropolitan jurisdictions. This is

clearly a very limited view of infill, and one that will tend to underestimate the amount of development occurring in built-up areas of cities. At least one study has looked at infill in both suburban and inner city locations, and found that infill has been an important part of the new development and may have been increasing in recent years. There is a tendency for new residential development to be built at densities similar to the surrounding neighborhoods, which is contrary to what economic principles would suggest – that new infill should be built at higher densities due to the increased value of vacant land at close-in locations. The reasons appear to be linked to preferences of existing residents, zoning limits and other regulatory constraints. There are, however, some infill development projects that are of high density, and in some areas, the opportunities for those may be increasing.

A key issue then is how, where and under what circumstances can high density infill development be built? There may be opportunities for infill with relatively high density, but the locations, types and approaches to these are still not well understood. Can these occur only in locations where there are few close neighborhoods, or where there are already high densities? Or, can high density be built at the periphery with zoning designed for high density from the beginning? Infill may be most effective right at the edge of the built up urban area, or in "new towns" created in relatively suburban locations. Farris summarizes these views: "the primary goal of smart growth advocates should be to encourage higher-density quality development at the metropolitan edge and exurbia while selectively choosing those relatively limited infill opportunities." (Farris, 2001).

In a further look at existing evidence on infill, we find that there is not strong evidence that policies implemented to promote infill, such as Urban Growth Boundaries and Priority Funding Areas, have worked. The combination of local government control over land use, economic costs, household preferences for housing types, and neighborhood opposition, presents formidable obstacles to any such policy. Economic incentive policies with more teeth than the PFAs, and that could be applied on a regional scale may be effective but difficult to put into practice.

Finally, a review of the arguments about the benefits of infill and possible reasons for opposition to it suggests a major reason why there is not more high density infill development. Most of the costs are likely to be local, while the benefits perceived by smart growth advocates are, for the most part, felt throughout a region. So, for example, local residents view the development of an open space area in their neighborhood as a cost, while smart growth advocates view this as a benefit in that it prevents the loss of an even larger amount of open space further out at the exurban fringe. This suggests that policies that attempt to distribute the costs of new

development more broadly could be effective. The PFA policy attempts to do that by having the state pay for all new development infrastructure costs in infill areas. But, for the most part, this policy has not provided enough of an incentive to direct more development into higher density more central urban locations in the state of Maryland. Communities may need to more carefully weigh the benefits of more compact urban form, and if they are large enough, find politically acceptable ways to distribute the costs.

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