NIMBYs for the rich and YIMBYs for the poor:

Analyzing the property price effects of infill development

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ABSTRACT

A combination of strong urbanization and shortage of land in many European city areas prompts an impetus of infill development, with current residents often raising concerns that infill development leads to lower nearby property prices. The aim of this paper is to analyze how nearby property prices are affected by new construction projects in Stockholm, Sweden. We use a difference-in-difference specification in a hedonic model, and our sample consists of more than 40,000 observations over the period 2005–2013. Our results are robust and indicate that house prices in nearby areas increase following the completion of infill development. Our results also indicate that infill development only has a positive spillover effect on nearby house prices only in areas with lower incomes, more public housing units and more inhabitants born abroad.

Keywords: Residential construction, Infill development, NIMBY, YIMBY

1. Introduction

A combination of strong urbanization and incentives to use land more efficiently in many European and US city areas has led to arguments for infill development (see, for instance, Duany et al., 2010; Farris, 2001; McConnell and Wiley, 2010; Steinacker, 2003). However, current residents often raise concerns that infill development leads to lower nearby property prices. The Swedish capital of Stockholm is no exception. Research evidence thus far is mixed, with some studies showing that infill development projects lead to a positive impact on property prices (Ding et al., 2000; Ellen and Voicu, 2006; Simons et al., 1998) and others finding a negative impact (Du Preez and Sale, 2013; Wiley, 2009).

A housing shortage currently exists in many western European cities. If it is considered more profitable to develop land through the construction of taller and newer buildings, why are these buildings not being constructed? According to McConnell and Wiley (2010), the existence of land regulations that prevent new construction within urban areas represents a problem. Assembling land for infill development projects also becomes a problem if the present landowners are reluctant to sell. Perhaps the most well-known problem is the opposition from current residents against development, often referred to as Nimbyism (not in my backyard) as opposed to the less well-known contrarian view of Yimbyism (yes in my backyard). Community residents frequently argue that infill development will have negative effects owing to, among other things, more traffic and lost open space (Burningham, 2012; Esaiasson, 2014; Evans, 2004; Green and Malpezzi, 2003; Malpezzi, 1996; Wolsink, 1994).

The aim of this paper is to analyze how nearby property prices are affected by new construction projects in Stockholm (Sweden's capital city). If there is an impact on property prices, we endeavor to investigate whether the effects vary among different areas

within the municipality, for different groups of inhabitants and for different types of housing (i.e., public versus private housing). In contrast to earlier studies, the differences between public and private housing structures are explored.

Furthermore, like Ding et al. (2000), we analyze the differences between low-income and high-income areas. Unlike that study, however, our hedonic price model is combined with a difference-in-difference approach and a cluster design so as to identify the new development projects geographically. The data availability in this study is extensive, with approximately 40,000 observations between 2005 and 2013. By including the aspects of income and ethnic background, we are in a position to compare the effects on property prices from new housing projects in ethnically and economically segregated areas with areas with less segregation. In this way, the results of this study can potentially provide a foundation for policymakers in their decisions on urban planning.

The remainder of this paper is organized as follows: Section 2 provides a theoretical framework and a literature review. Section 3 discusses the hedonic pricing methodology, the difference-in-difference approach and the method of constructing clusters to identify new development projects geographically. Section 4 presents the arguments for choosing the municipality of Stockholm as our area of study, and Section 5 presents the data. The empirical results are presented in Section 6, and Section 7 concludes the paper.

2. Theory and literature review

In this section, we begin by identifying the most common definitions of the term *infill* and by clarifying the definition used in this paper. In the theoretical framework, we then provide arguments for and against infill. Furthermore, we review the literature on the

empirical evidence regarding the types of impact (i.e., negative impact, positive impact and no evidence of impact) of infill on property values.

2.1. Definitions of infill development

The broadest definition of infill, according to McConnell and Wiley (2010), is “development that occurs in underutilized parcels in already developed, urbanized areas” (Maryland Department of Planning [MDP], 2001; Municipal Research and Services Center of Washington, 1997; Northeast-Midwest Institute, 2001). Infill development is mostly associated with city centers, where the focus is often on carrying out revitalization projects and/or increasing density (Farris, 2001; Steinacker, 2003). However, infill can also occur in suburbs where there are underutilized parcels of land (McConnell and Wiley, 2010). Some definitions also include redevelopment and rehabilitation, wherein existing buildings are replaced by higher structures at higher density (Wheeler, 2002). Other aspects to take into consideration are the size of the infill development (Ding et al., 2000; Zahirovich-Herbert and Gibler, 2014), the type of family home – that is, single-family homes (cf. Galster et al., 2004) or multifamily homes – and the condition or state of the area (Ooi and Le, 2013).

In this paper, we define infill development as new construction of multifamily cooperative apartment buildings in urban areas with existing houses and/or existing multifamily cooperative apartment buildings. Hence, new construction of small houses is not included in our definition. We also make the distinction between small and large building projects. We do not include the rehabilitation of existing housing. Thus, in accordance with our definition, infill development projects consist of new apartment buildings only.

2.2. Theoretical framework

The focus of this paper is the impact of infill development projects on property values. Economic, sociological and ecological aspects could create positive spillover effects (i.e., higher property prices) and negative spillover effects (negative property prices owing to, for example, increased supply or increased traffic). In the remaining paragraphs of this subsection, we will elaborate on these theoretical aspects with regard to both positive and negative spillover effects.

From an economic perspective, undeveloped areas within mostly developed urban areas represent an economic opportunity for denser development in later time periods (see McConnell and Wiley, 2010). Higher land prices will cause developers to substitute structural capital for land, resulting in higher density (Ottensmann, 1977). By creating denser urban environments, efficiency can be improved through reduced sprawl and increased use of mass transit (Burchell and Mukheri, 2003; Danielsen et al., 1999). As infill expands homeownership to more residents, the community's tax base increases, resulting in the provision of more and better public services (Malpezzi, 1996). In addition, an increase in the number of residents leads to an increase in retail and commercial opportunities. The amenity effect of infill relates to the overall appeal of the neighborhood; for example, the construction of new buildings on vacant lots, which used to attract dumping, vandalism and crime, improves the esthetics of the area (Ellen et al., 2001; Ooi and Le, 2013).

In addition to the mainly economic theoretical arguments, movements pointing to sociological and ecological benefits have evolved (see Knaap and Talen, 2005). New Urbanism, an urban design movement promoting walkable and sustainable cities, argues that well-designed infill can create vibrant and revitalized communities (see webpage of

Congress for the New Urbanism at <https://www.cnu.org>). The Smart Growth movement – with its origin among land preservation groups – encourages urban infill and higher density housing to alleviate environmental and transportation concerns, in addition to increasing the quality of life (Danielsen et al., 1999; Duany et al., 2010). Today's demographics are characterized by growing numbers of smaller families, childless married couples and singles, and these people are in search of housing that reflects their lifestyle (Farris, 2001).

All or some of these economic, sociological and ecological benefits could create spillovers into higher property values. However, building new houses within existing urban communities can create both positive and negative externalities for private property owners and the general public. Although most of the costs are likely to be local, the benefits perceived by Smart Growth advocates are, for the most part, felt throughout a region (McConnell and Wiley, 2010).

The amenity effect, which proponents argue is positive, could be negative if, among other things, open space is lost, traffic increases locally and new construction leads to overcrowding and decreased services (McConnell and Wiley, 2010). Existing homeowners may not favor increased density, and according to Flint (2005), density has a bad reputation. Dye and Macmillan (2007) mention increased pollution and traffic noise, disruption to local traffic patterns and loss of neighborhood character as reasons why existing property owners fear infill. One aspect of neighborhood character can include the desire of people with certain interests and lifestyles to live with people who share these interests and lifestyles, and this, together with race- and income-based discrimination, could also explain opposition to new development (McConnell and Wiley, 2010). Furthermore, there could be a supply effect if the construction of new houses reduces the property values of nearby existing houses by increasing supply while demand remains constant (Simons et al., 1998). The supply effect could be either direct if the market

segment is the same or indirect if filtering through submarkets occurs. Together, the supply effect and the amenity effect could lead to reduced property values, thus resulting in a loss for the existing homeowners (Ooi and Le, 2013; Zahirovich-Herbert and Gibler, 2014).

Glaeser (2011) denounces the Nimbyism (rather than Yimbyism, the contrarian view that was formed in opposition to Nimbyism) that accompanies infill because it can hinder the construction of new houses, increase house prices and create cities that are available only to rich people. Nimbyism is the idea that citizens would oppose the establishment of facilities in their neighborhood for selfish reasons but would raise no opposition to similar developments elsewhere (Burningham, 2012; Esaiasson, 2014; Evans, 2004; Green and Malpezzi, 2003; Hermansson, 2007; Malpezzi, 1996; Wolsink, 1994). Glaeser (2011) discusses two powerful and interacting psychological tendencies behind the popularity of Nimbyism, the status quo tendency and the effect tendency. The status quo tendency is illustrated in an experiment by Kahneman et al. (1990) in which subjects are given coffee mugs and then presented with the option of either paying more to keep their coffee mugs or paying less to buy exactly the same coffee mugs. Kahneman et al. find that the subjects, preferring to maintain the status quo, are prepared to pay more to keep their coffee mugs. The effect tendency is illustrated in a study by Gilbert et al. (1998) in which people tend to overestimate how their happiness is affected by a negative shock. For example, the construction of a new building may make some people unhappy, but, in reality, they will adjust quickly to this new situation.

2.3. Literature review

There is a substantial amount of research on Nimbyism (see, e.g., Burningham, 2012; Esaiasson, 2014; Wolsink, 1994), as well as on the impact of a new construction or a rehabilitation project on nearby property prices. In the following subsections (Sections

2.3.1.–2.3.3.), we will review these impact studies based on the type and design of infill and the methodologies used. As we will show, the empirical evidence on price effects is mixed.

2.3.1. Negative impact

Studies that show negative effects mainly refer to social housing or other types of infill (e.g., the construction or the announced construction of office buildings, shopping centers and stadiums) rather than residential infill. Only one study involving classic residential infill (Wiley, 2009) shows negative effects.

Studies on the infill development of social housing (also referred to as public housing, affordable housing, supportive housing and low-income housing tax credit projects) have yielded mixed results. According to Nguyen (2005), most of the first wave of studies shows positive effects, whereas the second wave of studies, in which hedonic price models are used, show mixed results. She concludes that the likelihood of a decline in property values increases when the design quality of affordable housing is poor, affordable housing is located in dilapidated neighborhoods that contain disadvantaged populations and affordable housing residents are clustered. There appear to be no effects when affordable housing is located in vibrant neighborhoods, the structure of the housing does not change the character of the neighborhood, the housing management is responsive to problems and affordable housing is dispersed. When negative effects exist, they are found to be small.

An exception to the presence of small effects is reported in a study by Du Preez and Sale (2013). Using a hedonic price model, they find that the establishment of a social housing development in Walmer Township in South Africa produces large negative effects on nearby property prices. This township had earlier been designated to be in a “whites only”

area. A typical house in the neighborhood under investigation (located 500 m from the project site) would experience a 49% rise in value if it were located 3,200 m away.

Hedonic price models have been used in several studies to investigate various types of construction (other than residential housing) and their effects. For instance, Colwell et al. (1985), analyzing the construction of a shopping center, and Thibodeau (1990), analyzing the construction of an office building, find negative effects on prices of properties in close proximity to the new building, but a positive effect for those at a greater distance. More shopping options and new employment opportunities may increase the demand for homes in the surrounding area, but not in the immediate proximity. In addition, Dehring et al. (2007) find that announcements regarding the construction of stadiums have a negative impact on property prices.

In his study on the impact of an infill on property values, Wiley (2009) reports negative – albeit small (less than a 0.5% decline) – effects on property values for higher-income areas. However, Wiley also finds that infill development tends to benefit lower-income areas. Wiley uses a hedonic price model with a difference-in-difference analysis, thus attempting to account for other factors in the local area that had an effect on house prices but were unrelated to the infill.

2.3.2. No evidence of impact

Pollakowski et al. (2005) find no significant effects on single-family house prices related to the introduction of a large-scale, high-density mixed-income multifamily rental development in the Boston area. Using a case study approach, they identify seven development projects and select corresponding impact areas. They then use a hedonic model to construct an index for the impact area and the control area. Similarly, Blanchard et al. (2008) also use a case study approach (as well as postal survey methodology) in their

analysis of residential areas in Idaho. They find no evidence of a decline in property prices accompanying infill construction; however, without the hedonic price model and difference-in-difference specification, it is not possible to isolate the effects on prices from the infill.

2.3.3. Positive impact

Most studies using hedonic price models and difference-in-difference analyses have found that residential infill development produces a positive impact. Ding et al. (2000) and Simons et al. (1998) investigate residential development in cities based on the hypothesis that developments can have positive spillover effects on certain neighborhoods. Analyzing new and rehabilitation projects and their effects on single-family residential property values in Cleveland, Ohio, in two periods during the 1990s, both studies find a positive impact on nearby values. Ding et al. (2000) note that the effects diminish beyond 300 ft (or 91.5 meters) from the construction site and are the greatest for low-income areas and for large-scale projects. Simons et al. (1998) also find housing prices to increase with proximity, but in contrast to Ding et al., find that the effects diminish for large-scale projects.

In addition to using a hedonic model, Galster et al. (2004) employ a difference-in-difference approach to control for factors other than those generated by the supportive housing development project. They find a positive impact on single-family homes in the area between 1,000 and 2,000 ft (or 305 and 610 meters). from the project site. Similarly, Ellen et al. (2001) use a difference-in-difference design in their hedonic price model and find that properties near the construction site increase in value. Ellen and Voicu (2006) also find that the impact remains stable over time for nonprofit organizations but declines for profit organizations. For large projects, the impact from nonprofit and profit

organizations is the same, but for small projects, the impact from profit organizations is larger.

A recent article by Ooi and Le (2013) analyzes the price effect of mixed infill development on neighboring areas. They use a data set from Singapore consisting of more than 55,000 sales transactions of dwellings and 275 new developments between 1997 and 2011. They estimate a hedonic model with a difference-in-difference specification so as to better capture the causal effect, but they (like most others) do not control for spatial dependency. Their findings indicate that infill developments have a positive and persistent impact on housing prices in neighboring areas, with this impact being greater if the infill is built in teardown areas. The scale does not seem to be significant, but height has a negative impact.

In another recent article, Zahirovich-Herbert and Gibler (2014) show that new construction in the form of classic infill creates positive externalities. The strongest effects are found within one-quarter mile (or about 400 meters) and for new houses that are larger than average-sized houses and for houses with values lower than others. The construction of average-sized houses has little effect on existing house prices. They do not use a difference-in-difference specification of the hedonic price equation or the spatial effects model. Instead, they use fixed neighboring effects to capture spatial dependency, and they perform a quantile regression to capture the distribution of house prices. Their sample comes from Baton Rouge, Louisiana, and consists of single-family transactions data between 1984 and 2005.

3. Methodology

Our results are based on a difference-in-difference model using repeated cross-sectional data. The first cross-sectional data set contains transactions before the new infill

developments, and the second data set contains transactions after the developments. The implicit assumption is that the transactions are randomly drawn from the same population, which means that the transactions from the first cross-sectional data set can be used as proxies for the transactions in the treatment and the control groups in the second cross-sectional data set (see Stock and Watson, 2012, p. 535).

Our estimating process is based on the following five steps: (1) traditional hedonic model, (2) difference-in-difference (DiD) model, (3) quantile regression (QR), (4) spatial regression models and (5) spatial drift model (SD).

The main objective is to estimate the effect of infill development on property values. The basic framework is to estimate a hedonic price equation where the price of the property HP is a function of property P and apartment A characteristics and neighborhood N characteristics. The hedonic price equation can be described as

$$HP_{i,t} = b_0 + b_1P_{i,t} + b_2A_{i,t} + b_3IF_{i,t} + b_4N_{i,t} + b_5T_{i,t} + e_{i,t}, \quad (1)$$

where T is a matrix of (monthly) time binary variables and IF is a dummy that equals 1 if the house or apartment is near an existing infill development and 0 otherwise. For example, a house that was sold in the year 2008 and is near an infill development that was constructed that year will be given the value 1. However, a house that was sold in year 2008 and is near an infill development that was constructed later (e.g., year 2010) will have the value 0.

In Equation 1, subscript i is the transaction, t represents the time period and N is a vector of neighborhood fixed effects. We are mainly interested in b_3 ; that is, we are interested in the effect of infill developments.

The main problem with a traditional hedonic model is that it suffers from omitted variable bias and selection bias (Machin, 2011). By using pooled cross-sectional data (i.e., data before and after the infill construction), we are able to determine an infill development's effect on nearby house prices and reduce the selection bias (Wooldridge, 2006). In the literature, this method is called a natural experiment or a quasi-experiment.

To estimate a difference-in-difference hedonic model, we need to create two new variables measuring infill development (i.e., the previous variable *IF* cannot be used in a difference-in-difference estimation). The first variable that we create is *Near*, which indicates closeness to a new residential development regardless of whether or not the infill development is produced at the time of the transaction of a house or an apartment. It is a dummy variable equal to 1 if the transaction is within 200 m from the infill development (otherwise 0). Zahirovich-Herbert and Gibler (2014) define the rings around the new construction to be 90 m and 150 m, and Ooi and Le (2013) use a ring of 500 m. To test the robustness of the estimates, we also test 100 m and 300 m from a new infill development. If a house is close to several infill developments, only the closest infill development is regarded as a treatment (i.e., we do not model multiple treatments within a single year). However, if a house or an apartment is close to infill developments that occur in separate years, then that house or apartment can have several treatments.

Creating *Near* in the treatment period allows us to estimate a so-called difference-in-difference hedonic equation model (see, e.g., Galster et al., 2004; Kiel and McClain, 1995; Wooldridge, 2006; as well as Dehring et al., 2007; Dhar and Ross, 2012; Ooi and Le, 2013; Voicu and Been, 2008; Wiley, 2009).

The second variable that we create is *Treatment*, which is a dummy variable that equals 1 for transactions and time periods subject to infill developments. In other words, *Treatment*

equals 1 for transactions that are close to new residential development during the treatment period. An implicit assumption is that the treatment effect is equal for each year.

As a consequence, our model is now specified as follows:

$$HP_{i,t} = b_0 + b_1P_{i,t} + b_2A_{i,t} + b_3Near_{i,t} + \gamma_1Treatment_{i,t} + b_4N_{i,t} + b_5T_{i,t} + e_{i,t} \quad (2)$$

For our purposes, the difference-in-difference estimator of γ_1 , the interaction variable *Treatment*, is of special interest. It measures the causal treatment effect, which is the change in house and apartment prices attributed to being close to new development. The estimated treatment effect is valid as long as the assumption is correct that the prices of houses and apartments located both close and far from new developments do not change at different rates for other reasons (cf. Wooldridge, 2006).

The data set used for the estimation of the difference-in-difference model does not include infill developments constructed during the period 2008–2013 because these data are used to identify infill developments (and, consequently, transactions) that are near an infill development project.

The b_3 coefficient is interesting as it measures whether the infill development was built in an area with higher or lower house or apartment prices. The model will be estimated for cooperative apartments.

The estimations are based on a full sample and a so-called restricted sample. The restricted sample is defined as a radius of 1,000 m around an infill development. The treatment group consists of houses or apartments within 200 m from the infill development (see Fig. 1). The main reason for creating a restricted sample is to mitigate any potential problems with

spatial dependency, which can cause problems with biased standard errors. The restricted sample will likely make the treatment and control groups more homogenous.

[INSERT FIGURE 1 HERE]

The estimation of quantile regression models aims to examine whether house prices exhibit an asymmetric behavior across the price distribution (various quantiles) in the presence of infill development (for a description of the method, see an earlier work by Koenker and Bassett, 1978; for examples of recent applications of quantile regression models, see Ceccato and Wilhelmsson, 2011, and Zahirovich-Herbert and Gibler, 2014). An article by Zietz et al. (2008) was one of the first to use quantile regression in a hedonic modeling framework. They conclude that some of the variation in estimated hedonic implicit prices derives from the fact that housing attributes are not priced the same across the price distribution. Another reason put forward by Koenker (2005) is that quantile regression estimates are more robust against outliers when compared with ordinary least squares (OLS) regressions. The quantile regression model could be written as

$$HP_{i,t} = b_0 + b_1(\tau)P_{i,t} + b_2(\tau)A_{i,t} + b_3(\tau)Near_{i,t} + \gamma_1(\tau)Treatment_{i,t+4} + b_4(\tau)N_{i,t} + b_5(\tau)T_{i,t} + e_{i,t}, \quad (3)$$

where τ is the quantile of the dependent variable (Kostov, 2009). Quantile regression is based on the minimization of weighted absolute deviations (Zietz et al., 2008).

Spatial econometrics accounts for the influence of space in our hedonic model. Spatial effects can be classified as *spatial dependence* and *spatial heterogeneity*. Spatial dependence, on the one hand, is a consequence of the existence of spillover effects, omitted spatially correlated variables, measurement error and misspecification of the functional form. Spatial dependence means that an observation at one location depends on

observations at a number of other locations (Wilhelmsson, 2002). Spatial heterogeneity, on the other hand, concerns the uneven distribution of transactions (Anselin, 2010).

We adopt the estimation approach formulated by Elhorst (2010). We begin by estimating an OLS model. Next, we perform diagnostic tests on the residuals so as to compare different spatial models, such as the spatial autoregressive model (SAR), spatial error model (SEM) and spatial Durbin model (SDM). We then perform the Lagrange multiplier (LM) test, the robust LM test and the likelihood ratio (LR) test (Anselin, 1988; Anselin et al., 1996). The selection of a spatial weights matrix involves employing a goodness-of-fit measure, such as the log-likelihood value, so as to distinguish different weight matrices (see Stakhovych and Bijmolt, 2009).

The quantile regression generalization of the spatial lag model could be written as

$$\begin{aligned} HP_{i,t} = & b_0 + \lambda(\tau)WHP + b_1(\tau)P_{i,t} + b_2(\tau)A_{i,t} + b_3(\tau)Near_{i,t} \\ & + \gamma_1(\tau)Treatment_{i,t+4} + b_4(\tau)N_{i,t} + b_5(\tau)T_{i,t} + e_{i,t}, \end{aligned} \quad (4)$$

where W is the spatial weights matrix. Here, it is defined as a row-standardized, distance-based nearest neighbor weights matrix. We use 2 and 20 nearest neighbors.

We also estimate a so-called spatial drift model (Can, 1992), which means that we estimate a model for neighborhoods with different characteristics.

4. The study setting: Stockholm

We chose the municipality of Stockholm as the setting of the present study for the following four reasons: First, choosing a setting with the same political governance

throughout helps minimize differences in land policy that might affect observations differently. Second, the municipality of Stockholm has a great in-migration from other parts of Sweden but has limited land available, which leads to a demand for infill construction. By investigating this type of situation and presenting a debate on new construction in developed areas, this article may produce findings of relevance to policymakers in Stockholm and elsewhere. Third, the municipality of Stockholm is segregated in both economic and ethnic terms (see Musterd, 2005), which is one of the independent variables in our model. Finally, our local knowledge of Stockholm helps us in choosing independent variables and clusters (size and amount).

Like many other old Swedish cities, Stockholm is built around the core of an old town from the Middle Ages, which was later complemented with trees and stone buildings in a grid plan during the period 1600–1850. In the late 1800s, the grid plan was complemented with large boulevards as a way to limit the potential devastation caused by fires. From 1930 to 1970, the development of the city was based on modernist ideas and was largely influenced by the use of cars, which created the possibility of long-distance traveling, thereby lowering the density of Stockholm.

The population of the municipality of Stockholm is just over 900,000 inhabitants. The land area is 188 km², of which 40% constitutes park areas and green spaces. The population density is 4,786 inhabitants per square kilometer. The density of Stockholm is higher than the densities of the 50 largest cities in the Nordic countries and is a great deal higher than the densities of average-sized cities in the United States. Compared with the densities of the 100 largest cities in the world, the density of Stockholm is above the median value. In Table 1, descriptive statistics of the variables are presented for the entire Stockholm metropolitan area, as well as for the inner and outer areas of Stockholm.

[INSERT TABLE 1 HERE]

5. Data

The data (provided by Valueguard AB) are based on arm's-length transactions of single-family houses (almost 10,000 sales observations) and cooperative apartments (94,000 sales observations) over the period 2005–2013. In Table 2, descriptive statistics are presented for both the full period (2005–2013) and the treatment period (2008–2013).

[INSERT TABLE 2 HERE]

The estimation of the hedonic price equation uses six attributes to explain the price variation. We find that the average prices are slightly lower in the restricted sample than in the full sample. In addition, we find the average transaction price to be higher in the treatment group than in the control group, indicating that infill development has a positive effect. The first attribute used measures the fee to the management of the cooperative housing company. This fee is higher in the treatment group than in the control group, indicating that the monthly fee cannot explain the higher average transaction price in the treatment group. The second and third attributes measure the size of the apartment (measured as the number of rooms and square meters of living area). There is no difference in size between the treatment group and the control group. We also include the age of the property and the distance to the central business district (CBD) in the price equation. There is no difference between the groups in terms of the distance to the CBD, but there is a rather big difference in the average building year. The apartments in the treatment group are on average 10 years younger than those in the control group, which can potentially explain the price difference between the two groups. Finally, we use distance to infill as a treatment variable.

We identify infill developments by using the data set consisting of all transacted single-family houses and cooperative apartments in the Stockholm area from 2005 to 2013. Because we want to estimate the causal effect of proximity to new developments on house and apartment prices, it is important to define what is meant by an infill development. In this paper, an infill development is defined as the new construction of multifamily cooperative apartment buildings in urban areas with existing houses and/or other multifamily cooperative apartment buildings. Any new construction of small houses is not considered to be an infill development.

Because we lack information about where all new residential developments are located in Stockholm, we need to identify the new residential developments in areas with existing houses (our definition of infill developments). The data are divided into two separate cross-sectional data sets, 2005–2007 and 2008–2013. We use the second data set to identify the location of the infill developments. Sales with a building year of 2008 and sales in year 2008 are identified as infill developments. We do the same for each year from 2009 to 2013. Consequently, we construct six new data sets of infill developments, one for each year. For each data set, the x and y coordinates of the infill developments are included.

Because infill developments involve the new construction of multifamily apartment buildings, there will naturally be several transactions that can be regarded as belonging to the same infill development. By applying the clustering technique, we create boundaries around the individual transactions that belong to the same infill development. The next step is, therefore, to use cluster analysis in grouping all transactions of newly constructed houses and apartments into clusters (infill developments). We apply a partition clustering method to construct 50 clusters¹ for each year from 2008 to 2013. Transactions can belong

¹ We also perform a cluster analysis with 500 clusters; however, changing the number of clusters does not yield different estimation results.

to only 1 of the 50 clusters. The clusters can, of course, contain different numbers of transactions.

6. Econometric analysis

First, we present the estimates concerning the hedonic model with the difference-in-difference specification. In the second section, we present the results from the spatial drift model. In the final section, we show the results from the quantile regression model. The results from the cooperative condominium market and the results from the full sample and the restricted sample are presented in Table 3. All estimates are based on OLS, and only the treatment effect variables (*Near* and *Treatment*) are presented in the table. Each cluster is classified as either a large or a small infill development project. We do that by first counting the number of transactions in each cluster. If it is above average, we define it as a large project; if it is below average, we define it as a small project.

[INSERT TABLE 3 HERE]

The model uses 9,804 observations, and the model's goodness of fit is high (adjusted R^2). Around 60% of the price variation can be explained by the explanatory variables. The estimates concerning infill developments are robust (full sample versus restricted sample) and statistically significant. All estimated parameters are significant (except one) and positive, indicating that (1) areas with infill developments already had a positive effect on nearby apartments and (2) the effect after the completion of the infill was even higher. The variation of this price effect is around 2%, depending on the specification of the rings around the development and the number of clusters. The effect is almost the same as those reported in studies by Ooi and Le (2013) and Zahirovich-Herbert and Gibler (2014). The

treatment effect seems to be of the same magnitude regardless of the size of the project. The results concerning the spatial regression models are presented in Table 4.

[INSERT TABLE 4 HERE]

As our results show, the OLS estimates are of the same magnitude as the results from the SEM, SAR and SDM. The OLS results might be considered a little higher than the results from the spatial models. However, most of our results from the spatial regression models are statistically significant. The effect seems to vary from 1% to 2%.

For the spatial drift models, we estimate the models in different subsamples of the data. The subsamples are based on differences in income, the number of public housing units and the ethnic background of the inhabitants. The results are presented in Table 5.

[INSERT TABLE 5 HERE]

The results that emerge are very interesting. The results are robust in that the same pattern is shown in both the single-family housing market and the market for cooperative dwellings. Infill developments have a positive price effect on nearby properties/dwellings, but not in all submarkets. Infill developments have a positive effect only in low-income areas with more public housing units and more people born abroad. In high-income areas, infill developments have no effect at all (i.e., the effect is neither negative nor positive).

As in a previous study by Zahirovich-Herbert and Gibler (2014), we estimate a quantile regression so as to determine whether the effect is different in different portions of the price distribution. The results from the quantile regression model are presented in Table 6.

[INSERT TABLE 6 HERE]

The infill effect is rather robust across the price distribution. However, it seems that the effect is marginally higher in the higher portion of the price distribution and especially for large projects.

7. Conclusion and policy implications

A combination of strong urbanization and shortage of land in many European city areas prompts an impetus of infill development, with current residents often raising concerns that it leads to lower nearby property prices. The aim of this paper is to analyze how nearby property prices are affected by new construction projects in Stockholm, Sweden.

We use a difference-in-difference specification in a hedonic model, and our sample comprises approximately 40,000 observations over the period 2005–2013. We test for spatial dependency by estimating the following spatial models: SAR model, SEM, SDM and SD model. We also estimate quantile regression models so as to analyze whether the treatment effect varies across the price distribution.

Our results are robust and indicate that housing prices in nearby areas increase following the completion of infill developments. Our results are thus in line with those of other studies finding positive spillover effects (Ding et al., 2000; Ellen et al., 2001; Ooi and Le, 2013; Simons et al., 1998; Zahirovich-Herbert and Gibler, 2014). Our results also indicate that infill development has a positive spillover effect on nearby housing prices only in areas with lower incomes, more public housing units and more inhabitants born abroad. We have estimated the effect to be around 1% of the apartment price. The effect does not vary with the size of the infill development.

Our findings highlight several policy implications. Residents opposed to new multifamily construction projects owing to their perceived risk of lower nearby property prices lack scientific evidence for their concerns – a situation that policymakers need to be aware of. By contrast, there is support for Yimbyism in areas where incomes are low, more public housing units are available and more inhabitants are born abroad. At the same time, there is

no support for Nimbyism in areas where incomes are high and fewer inhabitants are born abroad, and there is only little support where there are fewer publically owned housing units. Policymakers' understanding of Nimbyism may thus be inaccurate, which could slow planning processes and lead to a low supply of housing.

In Sweden, many inhabitants with low incomes and foreign backgrounds live in the so-called million program— that is, areas where about 1 million dwellings were built between 1965 and 1974 but have not undergone modernization in recent years. According to our findings, infill developments in these areas will increase the property values of the existing multifamily buildings. This is line with findings from previous studies, for example, by Farris (2001) and by Steinacker (2003). New construction projects tend, among other things, to revitalize teardown areas, increase the tax base and increase the inhabitants' purchasing power, thereby improving private and public services, as well as the esthetics of the area (see also Ellen et al., 2001; Malpezzi, 1996; Ooi and Le, 2013).

The findings of this paper give support to the existence of positive price effects from increased infill development in certain areas. We are in agreement with Kim (2015) that policymakers need to expend greater efforts to better understand the nature of the neighborhood changes derived from infill development so as to promote infill as a way to alleviate segregation and increase income diversity.

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Table 1

Descriptive statistics of variables for Greater Stockholm and for inner and outer Stockholm. For each variable, the percentage (yearly average) is presented.

Variable	Area	Mean	Min	Max
Income 0*	Greater	7.56	4.78	16.31
	Inner	7.01	4.78	12.30
	Outer	8.15	5.46	16.31
Income 0.1–159.9*	Greater	27.84	23.50	37.84
	Inner	25.63	23.50	29.58
	Outer	30.22	23.53	37.84
Income 160–319.9*	Greater	34.75	26.28	42.10
	Inner	31.67	26.28	37.40
	Outer	38.09	30.55	42.10
Income 320–499.9	Greater	18.97	9.77	23.98
	Inner	21.43	17.73	23.98
	Outer	16.31	9.77	20.52
Income 500+	Greater	10.89	2.38	19.53
	Inner	14.26	8.68	19.08
	Outer	7.23	2.38	19.53
Immigrants all**	Greater	24.74	12.24	66.80
	Inner	18.15	15.34	25.33
	Outer	31.89	12.24	66.80
Immigrants born abroad	Greater	19.17	10.25	47.05
	Inner	14.85	12.27	21.85
	Outer	23.85	10.25	47.05
Immigrants born in Sweden	Greater	5.58	1.99	19.75

	Inner	3.30	2.47	3.93
	Outer	8.04	1.99	19.75
Municipal rental***	Greater	21.67	2.28	52.42
	Inner	8.71	2.28	20.36
	Outer	35.70	11.26	52.42
Private (other) rental	Greater	30.65	12.31	49.25
	Inner	32.98	24.65	49.25
	Outer	28.12	12.21	45.14
Cooperative	Greater	47.69	16.95	71.01
	Inner	58.31	36.86	71.01
	Outer	36.18	16.95	54.65

*Average values 200x–200z. **Average figures 200x–200z. ***Average figures 200x–200z.

Table 2

Descriptive statistics. Mean and standard deviation (within parenthesis) values.

	Full sample	Restricted sample	Treatment group	Control group
Transaction price	2,404,731 (1,429,721)	2,194,814 (1,202,450)	2,380,949 (1,220,196)	2,160,787 (1,196,067)
Fee	2,991 (1,304)	3,109 (1,319)	3,341 (1,322)	3,066 (1,314)
Number of rooms	2.25 (1.93)	2.27 (1.02)	2.30 (1.00)	2.27 (1.02)
Square meters, living area	60.64 (25.92)	60.74 (24.41)	61.79 (23.81)	60.55 (24.51)
Building year	1945 (34)	1952 (31)	1960 (34)	1951 (31)
Distance to CBD (meter)	4,079 (2,888)	4,441 (2,906)	4,592 (2,714)	4,414 (2,940)
Observations	94,351	42,283	6,535	35,748

Note. Standard deviation values within parentheses. CBD = central business district.

Fig. 1. Control group (restricted sample) and treatment group.

Table 3

The effect of new multifamily projects (DiD models).

		Multifamily	
		Full sample	Restricted sample
All projects	Near	0.0135 (4.52)	0.0161 (4.71)
	Treatment	0.0233 (6.02)	0.0192 (4.61)
Large projects	Near	0.0138 (3.04)	0.0065 (1.36)
	Treatment	0.0182 (2.94)	0.0215 (3.53)
Small projects	Near	0.0079 (1.84)	0.0188 (3.62)
	Treatment	0.0289 (4.79)	0.0131 (1.97)

Note. Restricted sample maximum = 1,000 m from the new project. *Near* and *Treatment* maximum = 200 m from the new project.

Table 4

Effects across price distribution (spatial regression models). Treatment effect. Restricted sample.

All projects.

	SEM	SEM	SAR	SAR	SDM	SDM
	n2	n20	n2	n20	n2	n20
Near	0.0133	0.0110	0.0135	0.0186	0.0121	0.0099
	(3.64)	(3.16)	(3.52)	(4.56)	(4.19)	(1.24)
Treatment	0.0233	0.0053	0.0172	0.0186	0.0085	0.0019
	(6.02)	(1.30)	(5.78)	(5.90)	(3.92)	(0.63)

Note. SAR = spatial autoregressive model; SDM = spatial Durbin model; SEM = spatial error model.

The notation n2 and n20 means two neighbors and 20 neighbors, respectively.

Table 5

Effects across space (spatial drift models). Treatment effect. Restricted sample.

	All		Large projects		Small projects	
	Coefficient	<i>t</i> value	Coefficient	<i>t</i> value	Coefficient	<i>t</i> value
Low income	0.0992	7.26	0.0270	0.10	0.1398	5.35
High income	0.0068	1.17	−0.0191	−1.56	0.0115	1.51
More public housing	0.0263	4.23	0.0233	3.09	0.0313	2.67
Less public housing	−0.0035	−0.81	−0.0164	−2.16	0.0040	0.66
More born abroad	0.0298	4.86	0.0262	3.20	0.0315	2.84
Fewer born abroad	−0.0057	−1.25	−0.0014	−0.17	0.0082	1.31

Note. Bold values are statistically significant on a 95% significance level.

Table 6

Effects across price distribution (quantile regression models). Treatment effect. Restricted sample.

	All		Large projects		Small projects	
Percentile	Coefficient	<i>t</i> value	Coefficient	<i>t</i> value	Coefficient	<i>t</i> value
0.1	0.0117	1.49	0.0109	0.93	0.0190	1.63
0.2	0.0148	2.61	0.0231	2.78	0.0127	1.30
0.3	0.0207	4.42	0.0307	4.34	0.0143	1.83
0.4	0.0197	4.24	0.0217	3.22	0.0189	2.64
0.5	0.0201	4.42	0.0197	3.01	0.0075	1.16
0.6	0.0205	4.65	0.0168	2.61	0.0060	0.77
0.7	0.0204	4.69	0.0148	2.12	0.0060	0.83
0.8	0.0166	3.67	0.0064	0.92	0.0078	1.06
0.9	0.0064	1.25	0.0142	1.62	−0.0007	−0.09

Appendix

Table A

The difference-in-difference hedonic model (multifamily with restricted sample).

	All projects		Large projects		Small projects	
	Coefficients	<i>t</i> value	Coefficients	<i>t</i> value	Coefficients	<i>t</i> value
Treatment	0.0192	4.76	0.0215	3.60	0.0131	2.03
Near	0.0161	5.11	0.0065	1.45	0.0187	4.03
Living area	0.8047	133.48	0.7794	98.58	0.8471	92.95
Rooms	0.1313	29.07	0.1401	23.47	0.1142	17.96
Fee	−0.1793	−43.46	−0.1676	−31.09	−0.2138	−31.26
Floor	0.0131	27.80	0.0139	23.15	0.0147	22.02
Building year	−3.0703	−36.93	−2.0631	−18.83	−2.2796	−19.57
Distance to CBD	−0.1239	−48.63	−0.1938	−48.92	−0.0993	−33.84
Constant	36.54	58.41	29.3358	0.01	29.5411	32.98
Observations	41,763		22,090		20,858	
R^2	0.8403		0.8497		0.8323	

Note. Coefficients concerning parish and time are not shown in the table. CBD = central business district.

Table B

Sensitivity analysis. Different sizes of treatment and control groups.

Control area		500 m		1,000 m		1,500 m	
Treatment area		100 m	300 m	100 m	300 m	100 m	300 m
All projects	Near	0.0064	0.0061	0.0040	0.0033	0.0013	0.0008
		(1.15)	(2.06)	(0.73)	(1.25)	(0.24)	(0.30)
	Treatment	0.0443	0.0165	0.0517	0.0177	0.0143	0.0192
		(6.26)	(4.87)	(7.43)	(5.76)	(1.85)	(6.23)
Large projects	Near	0.0093	0.0019	0.0096	-0.0016	0.0543	0.0044
		(1.20)	(-0.52)	(1.23)	(-0.50)	(7.71)	(1.41)
	Treatment	0.0546	0.0096	0.0643	0.0119	0.0581	0.0093
		(5.20)	(2.18)	(6.08)	(2.93)	(5.51)	(2.33)
Small projects	Near	-0.0018	0.0126	0.0035	0.0153	-0.0157	-0.0007
		(-0.17)	(2.96)	(0.35)	(2.05)	(-1.59)	(-0.20)
	Treatment	0.5003	0.0072	0.0553	0.0116	0.0700	0.0220
		(3.77)	(1.38)	(4.28)	(2.44)	(5.50)	(4.74)