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The Effect of Strict Agricultural Zoning on Agricultural Land Values: the Case of Ontario's Greenbelt

B. James Deaton and Richard J. Vyn

In 2004, the provincial government of Ontario passed legislation that imposed a moratorium on urban development of agricultural land within a "Greenbelt" boundary. This legislation, which became known as the Greenbelt legislation, has a direct effect on over 1.8 million acres of land located near one of the larger metropolitan areas in North America: the Greater Toronto Area. We use a hedonic model to examine 7760 farmland sales and we find evidence that the Greenbelt legislation influenced farmland property prices; the effect depends on the proximity of the farmland to the Greater Toronto Area.

Key words: farmland values, greenbelt, hedonic, Ontario, zoning.

JEL codes: Q14, Q24, R52.

Agricultural zoning is a widely used legal approach for controlling nonagricultural development in North America (Knaap and Nelson 1992; Henneberry and Barrows 1990; Vaillancourt and Monty 1985). When we use the term agricultural zoning we are referring to a relatively strict form of zoning which disallows the development of agricultural land for nonagricultural purposes such as residential housing developments. (Deaton, Hoehn, and Norris 2007 provide a discussion of the continuum of zoning regulations that may affect agricultural land use.) Agricultural zoning can be a contentious issue, and a primary question that confronts researchers, landowners, and government officials is what effect agricultural zoning will have on farmland property values.[1] This is of particular concern for agricultural land owners, considering that in the United States farmland accounts for nearly 80% of farm assets (Huang et al. 2006), while in the Canadian province of Ontario—the focus area of our study—farmland accounts for 63% of farm assets.[2]

The provincial government of Ontario recently imposed a strict form of agricultural zoning, referred to as the "Greenbelt," to prevent development of farmland for nonagricultural uses. (A detailed discussion of the Greenbelt legislation is provided in a later section.) The Greenbelt legislation affects 1.8 million acres of land (see figure 1) around one of North America's most populated urban areas: the Greater Toronto Area (GTA). Unsurprisingly, this legislation has generated considerable controversy among stakeholders regarding its potential effect on the value of farmland.

There is no clear consensus in the literature as to the nature of the effects of zoning or conservation easements on the value of agricultural properties. In some cases the effect on agricultural or vacant property values is found to be negative (Knaap 1985; Vaillancourt and Monty 1985; Nelson 1986; Beaton 1991).

B. James Deaton is an assistant professor in the Department of Food, Agricultural and Resource Economics, at the University of Guelph. Richard J. Vyn is an assistant professor in the Department of Food, Agricultural and Resource Economics, at the University of Guelph (Ridgetown Campus). The authors contributed equally to this manuscript.

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[1] There are a number of other contentious issues that surround the issue of agricultural zoning. A prominent issue is whether or not agricultural zoning actually achieves its objectives (for a review of this literature see Levine 2006). An additional issue, related to the concern about the property value effect, is the issue of property rights and compensation (see Knetsch 1983; Mercuro 1992).

[2] Based on 2005 farm asset values reported by Statistics Canada (Cansim Table 002-0020).

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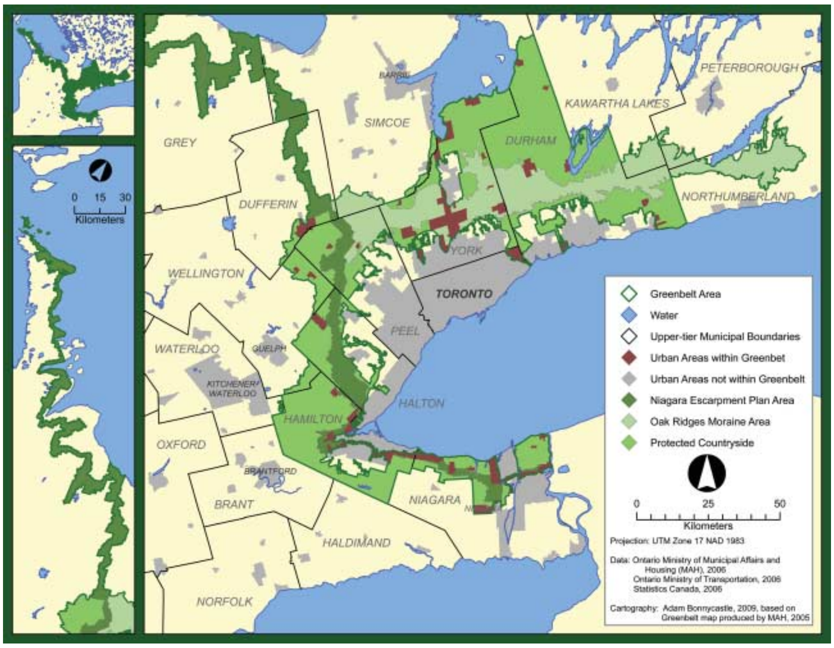

Figure 1. Map of the Greenbelt in southern Ontario. Note: This map is adapted by the authors (i.e., Toronto is identified) from a version of a map of the Greenbelt available from the Ontario Ministry of Municipal Affairs and Housing website (www.mah.gov.on.ca).

This negative effect is theoretically explained by the expectation that zoning will disallow future opportunities to develop agricultural land for urban uses (see Brueckner 1990). In contrast, studies by Beaton and Pollock (1992) and Nickerson and Lynch (2001) did not find evidence that conservation programs reduced the value of agricultural or vacant land. However, Lynch, Gray, and Geoghegan (2007) followed up on the study by Nickerson and Lynch using a much larger data set, and subsequently found that farmland preservation programs resulted in a significant reduction in farmland prices. A less common argument is that agricultural zoning may increase the value of some zoned farmland properties. Henneberry and Barrows (1990) suggested that the value of property less suited for nonagricultural development may appreciate if agricultural zoning reduces the risk of negative externalities associated with nonagricultural land uses, and ensures future land use patterns that are compatible with agricultural production. Their empirical analysis found evidence to support their hypothesis that the value of some farmland may increase as a result of zoning.

In this paper we examine the effect of the Greenbelt legislation on farmland property values in the Greenbelt. Our data set is extremely detailed and contains information on over seven thousand sales of farmland between 2002 and 2006. We find that Ontario's Greenbelt decreased the value of agricultural property in close proximity to urban areas: i.e., agricultural property with the greatest likelihood of development in the short term. Our paper adds an additional dimension to previous empirical studies on the effects of zoning by demonstrating that these effects vary with distance from urban areas.

Background on Ontario's Greenbelt

The concept of a Greenbelt was first publicly introduced by the premier of the province of Ontario, Dalton McGuinty, on November 20, 2003, who had promised during his campaign to establish a permanent greenbelt (www.premier.gov.on.ca/documents/ThroneSpeech112003En.pdf). The Minister of Municipal Affairs and Housing issued a Minister's Zoning Order under the Planning Act (O. Reg. 432/03) on December 16, 2003. On the same date as the Minister's Zoning Order, Bill 27 (the Greenbelt Protection Act, 2004) was introduced for First Reading and, after some debate, became law on June 24, 2004. The purpose of the Minister's Zoning Order and the Greenbelt Protection Act, 2004, was to create the Greenbelt Study Area and place a moratorium on certain types of land uses while the greenbelt plan was developed. The Ministry of Municipal Affairs and Housing established a Greenbelt Task Force in February 2004. The Task Force provided their final advice to the Government of Ontario in August 2004. Subsequently, Bill 135 (the Greenbelt Act, 2005) was introduced for First Reading on October 28, 2004, and it became law on February 24, 2005. The Greenbelt Act, 2005, provides permanent protection for the Greenbelt area.

The time between the announcement of the Greenbelt and the initial zoning order is remarkable: less than a month. Municipal governments, e.g., city, county, and township governments, were not involved in the development of the map (see figure 1) which was used to identify areas that would eventually be included in the Greenbelt. There were extensive discussions about the map after the initial announcement and before the Greenbelt was protected by law. In some cases the final boundaries were slightly changed, but for the most part, the final boundaries of the Greenbelt were not altered.

The Greenbelt legislation restricts urban municipalities, located outside the boundaries of the Greenbelt, from expanding urban development into areas within the boundaries of the Greenbelt. Moreover, the Greenbelt effectively eliminates the municipality's option to re-designate farmland for nonagricultural uses in "prime agricultural areas" (previously identified by municipalities) and "specialty crop areas," which include areas of the Niagara Peninsula and the Holland Marsh (just south of Lake Simcoe). Prior to the Greenbelt legislation, municipalities were able to alter agricultural zoning through zoning by-law amendments so long as these amendments were consistent with an Official Plan—an official document that provides a blueprint for future development within a municipality. Additionally, alternative uses of farmland in "Rural Areas" are now provincially restricted for most nonagricultural uses: e.g., multiple lots for residential dwellings are not permitted. These aforementioned areas—Prime Agricultural, Specialty Crops, and Rural Areas—comprise an area within the Greenbelt referred to as the "Protected Countryside (PC)."

The PC is distinct from two other areas within the Greenbelt: the Niagara Escarpment (NE) and the Oak Ridges Moraine (ORM). These two areas were, prior to the Greenbelt Act, 2005, already regulated by provincial legislation intended to preserve areas of environmental and ecological importance. Figure 1 identifies three areas that are now Greenbelt: (1) the Protected Countryside (PC); (2) the Niagara Escarpment (NE); and (3) the Oak Ridges Moraine (ORM). In these latter two areas—NE and ORM—agricultural protection was not a primary objective of the policy. Rather, restrictions on farmland development were primarily seen as a means to supporting the unique ecological features associated with both the Escarpment (a UNESCO World Biosphere reserve) and the Moraine. For example, in the NE all development on farmland (single dwellings, irrigation, etc.) requires a permit from the Niagara Escarpment Commission (NEC). In making decisions regarding development, the NEC's primary concern is to ensure the integrity of the Niagara Escarpment (see http://www.escarpment.org/About/planning.htm for a detailed discussion of the NEC's objectives). A common feature of all these policies (i.e., the Greenbelt, the NE, and the ORM) is that they resulted in an increased level of provincial oversight and regulation regarding the acceptable uses of all designated land, including farmland.

The Model

This paper examines the effect of agricultural zoning on the price of agricultural land. In theory we want to identify this *zoning effect* by comparing the *unrestricted* price (i.e., the sales price in the absence of zoning) of a parcel of agricultural land with the price of the same parcel under restrictions (Nickerson and Lynch 2001). The unrestricted price, V_u, is defined by the following equation:

$$(1)\qquad V_u = \int_0^T r_a(x,t)e^{-it}dt + \int_T^\infty r_u(x,t)e^{-it}dt - Ce^{-iT}.^3$$

In this equation, the sales price depends on the conversion date, T; agricultural rents, r_a, which are a function of an exogenous vector of factors, $\boldsymbol{x}$; time, t; a fixed interest rate, i; future urban rents, r_u; and the one-time costs, C, of converting agricultural land to urban

[3] Brueckner (1990) develops a similar model.

uses. The model assumes that agricultural land is expected to be developed for nonagricultural uses.

Restricting use of the parcel so that it remains only in agricultural use results in a sales price, $V_r = \int_0^\infty r_a(x,t)e^{-it}dt$. Hence, the change in sales price that results from prohibiting urban use—i.e., the zoning effect—is characterized by the following equation:

$$(2) \qquad V_r - V_u = \int_T^\infty \{r_a(x,t) - r_u(x,t)\}e^{-it}dt + Ce^{-iT}$$

where T indicates the time when land would have been converted in the unrestricted scenario. In the case of strict agricultural zoning, the zoning effect is expected to be negative if at some point the rent maximizing owner would have found it optimal to convert the land from agricultural to urban use.

Using sales price information, a hedonic approach can be used to measure the zoning effect. Following along the lines of Nickerson and Lynch (2001), we define the general empirical form of the hedonic property model as follows:

$$(3) \qquad V_j = x_j\beta + (d_j \times \delta_j)\sigma + \varepsilon_j$$

where V_j represents the log of the sales price of the jth parcel of agricultural land; $\boldsymbol{x}_j$ is an exogenous vector of parcel and structural characteristics[4] that affect returns in agriculture and developed uses; δ_j represents the presence of zoning ($\delta_j = 1$ if zoned; 0 otherwise); and $\boldsymbol{d}_j$ is a vector of dummy variables representing specific ranges for the distance between each parcel and the urbanizing center or central business district (CBD): e.g., $\boldsymbol{d}_j = 1$ if the parcel is between 0 and 5 km of the urban area. The use of such discrete distance measures allows for the zoning effect to vary nonlinearly with distance from urban areas. The sign and magnitude of σ represent the zoning effect within the distance range $\boldsymbol{d}_j$. In the absence of zoning, agricultural land in close proximity to urban areas is expected to be developed earlier than agricultural land located in more remote areas.[5] As a consequence of this timing, the zoning effect is expected to differ across the set of discrete distance ranges. Simply put, the value associated with the lost option to develop land for nonagricultural uses depends, in part, on when that option would have been exercised. Finally, the error term, ε_j, is assumed to be normally distributed.

If zoning reduces the sales prices of agricultural land within a specific distance range by restricting its capacity to be developed then we expect our estimate of σ to be negative. This zoning effect is expected to vary across distance ranges. Specifically, the magnitude of the negative zoning effect is expected to be greater in distance ranges closer to the CBD and diminish in distance ranges located further from the CBD. This is the hypothesized effect under the assumption of strict agricultural zoning. However, when zoning is not strict—e.g., when conversion to urban uses is merely delayed—the zoning effect is less certain (Brueckner 1990; Engle, Navarro, and Carson 1992). For example, Brueckner (1990) provides a model that identifies the potential for zoning to have either a positive or negative effect on land prices. In his model, the negative effect that results from a zoning policy that delays the development of farmland (for residential uses) may be offset (or partially offset) by the positive effect of simultaneous delays in negative externalities associated with population growth.

Previous literature argues that zoning may be endogenous, in which case unobserved characteristics in the error term may influence whether a parcel is zoned or not and, consequently, bias estimates of the parameters (Hardie, Lichtenberg, and Nickerson 2007). For example, zoning may be endogenous when municipalities engage in the decision to designate areas from one approved use to another. This issue, which has received little attention in the literature examining the effects of agricultural zoning on farmland values, may be a fruitful area of inquiry, particularly in situations like those discussed by Henneberry and Barrows (1990) where townships, "politically dominated by farmers" (p. 249), adopted exclusive agricultural zoning.

Zoning is unlikely to be endogenous in the situation analyzed here. First, as discussed

[4] Some of these variables appear in log form. Our initial choice of selecting which variables to log is based on a discussion of this issue in Wooldridge (2006). However, sensitivity analysis indicates that logging these variables did not affect the results from a qualitative standpoint.

[5] See Brueckner (1990) for a detailed treatment of the assumptions that govern his spatial and temporal model of land transformation. Some key assumptions of his model are that urban rents are assumed to fall as distance from the urban area increases, urban rents increase over time, and agricultural rents remain constant.

earlier, the provincial government of Ontario enacted zoning that limited the municipality's capacity to alter land use designations. Second, the length of time between the announcement of the proposed legislation and the application of zoning was extremely short. Third, the initial Greenbelt boundaries—which, for the most part, were consistent with the final boundaries—were announced prior to consultation with municipalities. To provide empirical evidence that zoning is not endogenous, a Hausman test was conducted. The zoning variable for this study was found to be correlated with a "ward" variable which was not used in our primary regression. The ward variable assigns a unique number to the municipal elector areas for election purposes. The zoning variable was regressed on the non-zoning variables identified in the following section (see table 1) and the residuals

Table 1. Dependent and Explanatory Variables, with Summary Statistics ($N = 7760$)

Variable	Definition	Mean	Std. Dev.	Min.	Max.
Dependent Variable					
Price	Sale price of the property (Cdn$)	536,854	1,112,106	5,000	24,491,484
Greenbelt Variables					
PC	= 1 if property is located in the Protected Countryside	0.1332	0.3399	0.00	1.00
ORM	= 1 if property is located in the Oak Ridges Moraine	0.0481	0.2139	0.00	1.00
NE	= 1 if property is located in the Niagara Escarpment	0.0290	0.1678	0.00	1.00
PC intermediate	= 1 if property is located in the PC and sold between November 2003 and June 2004	0.0206	0.1421	0.00	1.00
ORM intermediate	= 1 if property is located in the ORM and sold between November 2003 and June 2004	0.0081	0.0897	0.00	1.00
NE intermediate	= 1 if property is located in the NE and sold between November 2003 and June 2004	0.0055	0.0742	0.00	1.00
PC post-GB	= 1 if property is located in the PC and sold after June 2004	0.0528	0.2237	0.00	1.00
ORM post-GB	= 1 if property is located in the ORM and sold after June 2004	0.0214	0.1447	0.00	1.00
NE post-GB	= 1 if property is located in the NE and sold after June 2004	0.0090	0.0946	0.00	1.00
PC post-GB X 0–5 km	= 1 if property is 0–5 km from the GTA & PC post-GB = 1	0.0068	0.0824	0.00	1.00
PC post-GB X 5–10 km	= 1 if property is 5–10 km from the GTA & PC post-GB = 1	0.0098	0.0985	0.00	1.00
PC post-GB X 10–15 km	= 1 if property is 10–15 km from the GTA & PC post-GB = 1	0.0072	0.0846	0.00	1.00
PC post-GB X 15–20 km	= 1 if property is 15–20 km from the GTA & PC post-GB = 1	0.0063	0.0792	0.00	1.00
PC post-GB X 20–25 km	= 1 if property is 20–25 km from the GTA & PC post-GB = 1	0.0053	0.0725	0.00	1.00
PC post-GB X 25–30 km	= 1 if property is 25–30 km from the GTA & PC post-GB = 1	0.0063	0.0792	0.00	1.00
PC post-GB X 30–35 km	= 1 if property is 30–35 km from the GTA & PC post-GB = 1	0.0034	0.0578	0.00	1.00
PC post-GB X 35–40 km	= 1 if property is 35–40 km from the GTA & PC post-GB = 1	0.0015	0.0393	0.00	1.00
PC post-GB X 40–45 km	= 1 if property is 40–45 km from the GTA & PC post-GB = 1	0.0017	0.0409	0.00	1.00
PC post-GB X 45–50 km	= 1 if property is 45–50 km from the GTA & PC post-GB = 1	0.0024	0.0494	0.00	1.00

Continued

Table 1. Continued

Variable	Definition	Mean	Std. Dev.	Min.	Max.
PC post-GB X 50+ km	= 1 if property is 50+ km from the GTA & PC post-GB = 1	0.0021	0.0454	0.00	1.00
ORM post-GB X 0–5 km	= 1 if property is 0–5 km from the GTA & ORM post-GB = 1	0.0037	0.0610	0.00	1.00
ORM post-GB X 5–10 km	= 1 if property is 5–10 km from the GTA & ORM post-GB = 1	0.0048	0.0689	0.00	1.00
ORM post-GB X 10–15 km	= 1 if property is 10–15 km from the GTA & ORM post-GB = 1	0.0049	0.0698	0.00	1.00
ORM post-GB X 15–20 km	= 1 if property is 15–20 km from the GTA & ORM post-GB = 1	0.0034	0.0578	0.00	1.00
ORM post-GB X 20–25 km	= 1 if property is 20–25 km from the GTA & ORM post-GB = 1	0.0014	0.0376	0.00	1.00
ORM post-GB X 25–30 km	= 1 if property is 25–30 km from the GTA & ORM post-GB = 1	0.0006	0.0254	0.00	1.00
ORM post-GB X 30–35 km	= 1 if property is 30–35 km from the GTA & ORM post-GB = 1	0.0005	0.0227	0.00	1.00
ORM post-GB X 35–40 km	= 1 if property is 35–40 km from the GTA & ORM post-GB = 1	0.0000	0.0000	0.00	0.00
ORM post-GB X 40–45 km	= 1 if property is 40–45 km from the GTA & ORM post-GB = 1	0.0009	0.0300	0.00	1.00
ORM post-GB X 45–50 km	= 1 if property is 45–50 km from the GTA & ORM post-GB = 1	0.0001	0.0114	0.00	1.00
ORM post-GB X 50+ km	= 1 if property is 50+ km from the GTA & ORM post-GB = 1	0.0010	0.0321	0.00	1.00
NE post-GB X 0–10 km	= 1 if property is 0–10 km from the GTA & NE post-GB = 1	0.0032	0.0567	0.00	1.00
NE post-GB X 10–20 km	= 1 if property is 10–20 km from the GTA & NE post-GB = 1	0.0015	0.0393	0.00	1.00
NE post-GB X 20–30 km	= 1 if property is 20–30 km from the GTA & NE post-GB = 1	0.0006	0.0254	0.00	1.00
NE post-GB X 30–40 km	= 1 if property is 30–40 km from the GTA & NE post-GB = 1	0.0008	0.0278	0.00	1.00
NE post-GB X 40–50 km	= 1 if property is 40–50 km from the GTA & NE post-GB = 1	0.0000	0.0000	0.00	0.00
NE post-GB X 50–60 km	= 1 if property is 50–60 km from the GTA & NE post-GB = 1	0.0008	0.0278	0.00	1.00
NE post-GB X 60–70 km	= 1 if property is 60–70 km from the GTA & NE post-GB = 1	0.0004	0.0197	0.00	1.00

Continued

Table 1. Continued

Variable	Definition	Mean	Std. Dev.	Min.	Max.
NE post-GB X 70–80 km	= 1 if property is 70–80 km from the GTA & NE post-GB = 1	0.0003	0.0161	0.00	1.00
NE post-GB X 80–90 km	= 1 if property is 80–90 km from the GTA & NE post-GB = 1	0.0003	0.0161	0.00	1.00
NE post-GB X 90–100 km	= 1 if property is 90–100 km from the GTA & NE post-GB = 1	0.0004	0.0197	0.00	1.00
NE post-GB X 100+ km	= 1 if property is 100+ km from the GTA & NE post-GB = 1	0.0008	0.0278	0.00	1.00
Structural Variables					
Building value	Value of farm structures (e.g., barns), in dollars	30,049.4900	59,101.9800	0.00	1,157,111.00
Age	Age of the house, after accounting for renovations	45.8911	46.8479	0.00	191.00
Square feet	Total area of the house, in square feet	1,385.1600	1,153.1670	0.00	8,715.00
Bathrooms	Number of bathrooms	1.0334	0.9559	0.00	10.00
Bedrooms	Number of bedrooms	2.4841	1.9391	0.00	9.00
Fireplaces	Number of fireplaces	0.2630	0.5975	0.00	7.00
Land Quality Variables					
Farm size	Size of property, in acres	69.8004	46.7543	5.00	561.78
Class 1 land	Proportion of property in Class 1 land	0.2610	0.3820	0.00	1.00
Class 2 land	Proportion of property in Class 2 land	0.3452	0.3653	0.00	1.00
Wooded area	Proportion of property in wooded area	0.0928	0.1600	0.00	1.00.
Organic soil	Proportion of property with organic soil	0.0040	0.0604	0.00	1.00.
Heat units	Number of crop heat units	2,718.3510	189.7057	2,306.00	3,213.00
Horse	= 1 if property is a horse farm	0.0428	0.2024	0.00	1.00
Orchard/vineyard	= 1 if property has orchards or vineyards	0.0125	0.1111	0.00	1.00
Greenhouse	= 1 if property has greenhouses	0.0064	0.0800	0.00	1.00
Vacant land	= 1 if property has no structures	0.2494	0.4327	0.00	1.00
Neighbourhood and Amenity Variables					
Pop density	Township population density, number of people per km^2	108.0158	260.4598	3.06	2,317.97
Growth rate	Township population annual growth rate from 2001 to 2006	1.2245	1.9484	−1.26	14.28
Water/sewer	Accessibility to water and sewer services	0.7780	0.4156	0.00	1.00
Location Variables					
GTA	Distance to the GTA, in kilometers	62.5110	42.6550	0.01	209.79

Continued

Table 1. Continued

Variable	Definition	Mean	Std. Dev.	Min.	Max.
City	Distance to the nearest city, in kilometers	49.3326	31.4495	0.02	203.85
Town	Distance to the nearest town, in kilometers	17.2850	9.5368	0.84	99.06
Brant	= 1 if property is located in Brant County	0.0188	0.1359	0.00	1.00
Bruce	= 1 if property is located in Bruce County	0.0522	0.2224	0.00	1.00
Dufferin	= 1 if property is located in Dufferin County	0.0397	0.1952	0.00	1.00
Durham	= 1 if property is located in the Regional Municipality of Durham	0.0732	0.2605	0.00	1.00
Grey	= 1 if property is located in Grey County	0.0972	0.2962	0.00	1.00
Hald-Norfolk	= 1 if property is located in the Regional Municipality of Haldimand-Norfolk	0.0638	0.2444	0.00	1.00
Halton	= 1 if property is located in the Regional Municipality of Halton	0.0281	0.1652	0.00	1.00
Hamilton	= 1 if property is located in the City of Hamilton	0.0329	0.1783	0.00	1.00
Huron	= 1 if property is located in the City of Huron	0.0570	0.2318	0.00	1.00
Kawartha	= 1 if property is located in the City of Kawartha Lakes	0.0524	0.2229	0.00	1.00
Niagara	= 1 if property is located in the Regional Municipality of Niagara	0.0399	0.1959	0.00	1.00
Northumb	= 1 if property is located in Northumberland County	0.0293	0.1685	0.00	1.00
Oxford	= 1 if property is located in Oxford County	0.0482	0.2142	0.00	1.00
Peel	= 1 if property is located in the Regional Municipality of Peel	0.0357	0.1855	0.00	1.00
Perth	= 1 if property is located in Perth County	0.0441	0.2053	0.00	1.00
Peterborough	= 1 if property is located in Peterborough County	0.0424	0.2015	0.00	1.00
Simcoe	= 1 if property is located in Simcoe County	0.1058	0.3076	0.00	1.00
Waterloo	= 1 if property is located in the Regional Municipality of Waterloo	0.0260	0.1592	0.00	1.00
York	= 1 if property is located in the Regional Municipality of York	0.0451	0.2075	0.00	1.00
Other Variables					
Month	Month time trend	24.8259	14.7087	1.00	55.00
Speculative	= 1 if property was deemed a speculative sale	0.0072	0.0846	0.00	1.00

were added as an explanatory variable in the original hedonic regression. The coefficient on the residuals was not found to be statistically significant (p-value = 0.389), indicating that zoning is not endogenous in this case.

Data

The data set used to estimate the effect of the Greenbelt on property values consists of transaction records of all agricultural property sales in 21 counties across southern Ontario between 2002 and 2006, as recorded by the Municipal Property Assessment Corporation (MPAC).[6] This data set is unique and has not previously been made available for research purposes.

For this study, only sales that were "arm's length transactions" are included in the analysis.[7] The determination of arm's length transactions is based on MPAC's sale type coding, with sales coded as open market sales included in the analysis, while those coded as family sales, quit claim sales, government or exempt property transactions, and sales involving a single sale price for several properties

[6] MPAC is a not-for-profit organization, responsible for classifying and valuing all types of properties, in accordance with the Government of Ontario's Assessment Act. To accurately assess property values, MPAC collects detailed information for all properties in Ontario, including farm properties.

[7] Huang et al. (2006) defined arm's length as "a transaction arrived in the open market between unrelated parties, and attested by the seller to be unaffected by abnormal pressure or other related transactions that affect the stated price" (p. 463).

are omitted from the analysis. The data set we use in this paper consists of 7760 sales of farm properties that are at least 5 acres in size. These sales are analyzed using a hedonic approach, based on the double-log[8] empirical model outlined in equation (3).

We use geographic information systems (GIS) to develop a number of spatial variables for incorporation in the hedonic model, including whether or not an observation—farmland sale—was located inside or outside the Greenbelt. In total, there are 1632 property sales in the data that are located within the Greenbelt boundary. Table 1 provides summary statistics for all variables used in our regression analysis. In what follows, we focus our discussion on the key set of variables that enable us to assess the zoning effect. The remaining variables, which are numerous, are typically included in hedonic analyses and play the important role of enabling us to interpret our results holding other variables constant. For this reason we provide an expanded discussion of the key variables and an abbreviated discussion of the remaining variables.

The key Greenbelt variables, defined in table 1, address both spatial and temporal issues. As described in the background section, the Greenbelt comprises three distinct zones: the Protected Countryside (PC), the Oak Ridges Moraine Conservation Plan (ORM), and the Niagara Escarpment Plan (NE). The locations of these three zones are indicated in figure 1. Two of these zones, the ORM and the NE, had pre-existing provincial level regulations that restricted to some degree the development of farmland for nonagricultural uses. For this reason, we focus our analysis on the effect of the Greenbelt in the PC, an area where the development of farmland for nonagricultural uses had not previously been restricted by specific provincial regulations.

In addition to spatial issues there are a number of temporal issues to consider. Specifically, the Greenbelt Protection Act, 2004, was legislated in June 2004. However, the concept of the Greenbelt was first publicly announced in November 2003. Prior to November 2003, transacting parties (e.g., buyers and sellers of farmland) are assumed to be unaware of the potential for zoning restrictions. After November 2003 and up till June 2004—when the Greenbelt Protection Act became law—we assume that there was uncertainty as to the long term implications for buying in the Greenbelt area. An intermediate period is specified in table 1 to account for the price effect (announcement effect) that may have occurred in this period of uncertainty. After June 2004, we assume that all buyers would have been aware of the Greenbelt and therefore, the Greenbelt effect is expected to be more pronounced in this post-Greenbelt period. Table 1 defines the intermediate and post-Greenbelt variables in a spatial context: i.e., PC, ORM, and NE.

As discussed earlier, the zoning effect is expected to vary based on proximity to an urban area. The distance to urban areas may vary greatly because the area within the Greenbelt is significant; as evident in figure 1, the Greenbelt becomes quite wide in some places, particularly in the area northeast of the GTA. For example, the maximum distance to the GTA for properties in the PC is almost 70 kilometers. For this reason there may be considerable differences in the expected timing of development of farm properties for nonagricultural purposes. We use categorical measures of distance to allow the effects of the Greenbelt to vary by distance in an unrestricted manner. Distance bands have been used in a number of studies (Carroll, Clauretie, Jensen, and Waddoups 1996; Mikelbank 2005; Nelson, Genereux, and Genereux 1992; Smolen, Moore, and Conway 1992; Thayer, Albers, and Rahmatian 1992). Distance bands in these studies are specified in terms of equal distances (e.g., Mikelbank 2005; Thayer et al. 1992) or so that each band contains an equal number of observations, in which case each band has a different diameter (e.g., Smolen et al. 1992). We follow the first type of specification, an approach that is more prevalent in the literature.

Dummy variables are created to represent successive 5 km bands around the Greater Toronto Area. These variables are interacted with the post-Greenbelt variables for each of the three zones[9] to account for the effects of the Greenbelt within each distance band. For example, *PC post-GB X 0–5 km* represents the

[8] The use of the double-log functional form, which was supported by the Box-Cox test, is consistent with previous land value studies (Boxall, Chan, and McMillan 2005; Irwin 2002; Geoghegan, Wainger, and Bockstael 1997). However, we also assess the sensitivity of our results by using a linear functional form for the dependent variable.

[9] Due to the long and narrow shape of the Niagara Escarpment (see figure 1), the bands interacted with this zone are in 10 km increments to ensure that there are enough observations within each band.

interaction of the distance band variable that accounts for properties between 0 km and 5 km from the GTA with a set of farmland properties that were sold in the Protected Countryside after June 2004, when the Greenbelt Act was initially passed. These variables are used to measure the effects of the Greenbelt on properties within specific ranges of distances from the GTA. We also conduct sensitivity analysis on this approach by using a different width (10 km) for the bands.

The remainder of this section reviews the host of other variables that are included in the hedonic regression. These variables are also defined and summarized in table 1. Land quality attributes characterize differences in the agricultural productivity of farmland. These variables include farm size, proportions of Class 1 and Class 2 land (the most productive classes of land), proportion of wooded area (which can reduce the total productive capability of the farm), proportion of organic soil, and crop heat units.[10] In addition, categorical variables are included for farm types—orchard and vineyard, horse, and greenhouse operations—that tend to be higher in value. Greenhouse, orchard, and vineyard operations tend to generate much higher revenue as compared to more mainstream agricultural operations such as cash crop, beef, or swine farms, while horse farms are often purchased more for lifestyle reasons than for agricultural production, and thus the prices paid for these farms may not reflect the value derived from agricultural production. Finally, a categorical variable is included to account for properties with no structures.

Residential homes and farm structures influence the sales price of a farm. A number of variables are included to account for differences in residential housing attributes. These variables, which are consistent with variables used in previous hedonic studies, include the square footage, the age of the house, and the numbers of bathrooms, bedrooms, and fireplaces. In addition, the influence of farm buildings (e.g., barns, sheds, silos) on the sale price is accounted for through an assessed value of these buildings (this value does not include the value of residential buildings).

[10] Crop heat units, an indexing system developed by Agriculture and Agri-Food Canada, are based on the average daily minimum and maximum temperatures during the frost-free growing season. Thus, areas with higher temperatures and more frost-free days will have a higher level of heat units.

A set of neighborhood and amenity variables are also included in the regression. Population density and rate of population growth, derived from Statistics Canada's 2001 and 2006 Census data, are used to measure differences in urban influence and congestion across townships. In addition, we include a categorical variable to indicate whether or not water and sewer services, the vast majority of which are private, are available.

We account for additional differences across regions (e.g., municipal regulations, etc.) by including a categorical variable for each county or regional municipality. These counties are listed in table 1 (Wellington County is the omitted county). Distance variables (by road) are created using GIS to account for urban and amenity influences, including the distances to the GTA (measured as the minimum of the distances to the municipal boundaries of 14 cities located in close proximity to Toronto), to the nearest city with a population of greater than 50,000 (not including the cities that comprise the GTA), and to the nearest town.

Two additional variables described in table 1 are a monthly time trend variable and a categorical variable that identifies "speculative sales." The basis for determining a speculative sale involves a number of potential criteria. According to our communications with the assessing agency (MPAC), speculative sales are determined after an investigation of a sale indicates that the purchaser bought the land with expectations of high appreciation rates. This is determined in a number of ways, including: (1) prior knowledge of the purchaser; (2) location of the property relative to urbanizing activity; (3) underlying zoning that allows for development; and (4) if the sale price appears to be an anomaly when compared to other sales in the market area. (It is not necessary that all four of these criteria be met.) In our analysis we only use speculative sales that were considered by MPAC as arm's length transactions. The number of sales identified as speculative in our data set are relatively small (i.e., 0.7%), and their inclusion does not affect the primary results of our analysis.

Results

The results of the hedonic models for the analysis of the Greenbelt effect are presented in tables 2 and 3. The estimated coefficients for the land quality, structural, neighborhood and amenity, location, and other variables have, for

Table 2. Comparison of Estimated Coefficients for the Greenbelt Variables across Various Distance Band Models

	Distance Bands Model Results				
Greenbelt Variables	5 km (OLS)	10 Km	Quartiles	5 km (SAR)	5 Km (Linear)
PC	−0.2825***	−0.2786***	−0.2782***	−0.2632***	609,450***
PC intermediate	0.0664	0.0669	0.0662	0.0768	−5,833
PC post-GB X 0–5 km	−0.2428***			−0.2466***	−410,705***
PC post-GB X 5(0)–10 km	−0.0607	−0.1348***		−0.0837	−249,950***
PC post-GB X 10–15 km	0.0202			−0.0426	−53,340
PC post-GB X 15(10)–20 km	0.0954	0.0529		0.0422	109,164
PC post-GB X 20–25 km	0.0653			0.0519	55,975
PC post-GB X 25(20)–30 km	−0.0177	0.0170		−0.0111	30,681
PC post-GB X 30–35 km	0.0204			0.0542	49,295
PC post-GB X 35(30)–40 km	0.1244	0.0526		0.1312	−271,990
PC post-GB X 40–45 km	0.3764**			0.3212***	487,981***
PC post-GB X 45(40)–50 km	0.1550*	0.2439***		0.1565**	433,301***
PC post-GB X 50+ km	0.0596	0.0577		0.1990**	479,898***
PC post-GB X Q1			−0.1402**		
PC post-GB X Q2			−0.0114		
PC post-GB X Q3			0.0434		
PC post-GB X Q4			0.1161**		
ORM	−0.0772	−0.0731	−0.0731	−0.1491***	−613,823***
ORM intermediate	0.1312*	0.1300*	0.1304*	0.0420	147,745
ORM post-GB X 0–5 km	0.1649			0.2619*	873,146
ORM post-GB X 5(0)–10 km	−0.0706	0.0351		−0.1026	−193,559
ORM post-GB X 10–15 km	0.0158			−0.0907	−26,599
ORM post-GB X 15(10)–20 km	0.3323***	0.1448**		0.1255	392,250***
ORM post-GB X 20–25 km	0.2352			0.0092	415,734***
ORM post-GB X 25(20)–30 km	0.2164*	0.2278*		0.2152	341,905***
ORM post-GB X 30–35 km	0.2031			0.1542	367,643**
ORM post-GB X 35(30)–40 km	(dropped)	0.2025		(dropped)	(dropped)
ORM post-GB X 40–45 km	0.2311			0.2567*	527,946***
ORM post-GB X 45(40)–50 km	0.3647***	0.2460*		0.2361***	628,692***
ORM post-GB X 50+ km	−0.0176	−0.0219		−0.0998	476,213***
ORM post-GB X Q1			0.0015		
ORM post-GB X Q2			0.0831		
ORM post-GB X Q3			0.1668**		
ORM post-GB X Q4			0.1761**		
NE	−0.0212	−0.0200	−0.0200	−0.0240	−310,315***
NE intermediate	0.0768	0.0763	0.0779	0.0397	57,842
NE post-GB X 0–10 km	−0.4847***			−0.3778***	−718,644***
NE post-GB X 10(0)–20 km	0.0223	−0.3217***		−0.0403	−73,666
NE post-GB X 20–30 km	0.1742			−0.0045	355,252
NE post-GB X 30(20)–40 km	0.2412	0.2096		0.0834	425,355***
NE post-GB X 40–50 km	(dropped)			(dropped)	(dropped)
NE post-GB X 50(40)–60 km	0.8981***	0.8951***		0.7600***	827,413***
NE post-GB X 60–70 km	1.0217***			0.8442***	749,356***
NE post-GB X 70(60)–80 km	0.3609***	0.7546***		0.2489***	349,694***
NE post-GB X 80–90 km	1.0771***			1.0662***	574,247***
NE post-GB X 90(80)–100 km	0.8059***	0.9140***		0.5786***	580,783***
NE post-GB X 100+ km	−0.1091	−0.1108		−0.1942	248,170***
NE post-GB X Q1			−0.4749***		
NE post-GB X Q2			−0.2009		
NE post-GB X Q3			0.3499**		
NE post-GB X Q4			0.5146***		
R-squared	0.7139	0.7126	0.7116	0.7361	0.5092

Note: Asterisks (*,**,***) indicate that the coefficient is significantly different from zero at the 10%, 5%, and 1% levels, respectively. To address the issue of heteroskedasticity, robust standard errors are generated. Some distance band variables were dropped due to insufficient numbers of observations.

Table 3. Estimated Coefficients for the Control Variables in the 5 km Distance Band OLS Model (Dependent Variable: ln(Sale Price))

Variable	Coefficient	Std Error	Variable	Coefficient	Std Error
Land Quality Variables			Location Variables		
ln(Lot size)	0.4044***	0.0092	ln(GTA)	−0.2571***	0.0155
Class 1 land	0.4393***	0.0225	ln(City)	−0.0994***	0.0135
Class 2 land	0.2165***	0.0194	ln(Town)	−0.0641***	0.0115
Wooded area	−0.2131***	0.0401	Brant	−0.6206***	0.0521
Organic soil	−0.0838	0.1023	Bruce	0.0928***	0.0338
ln(Heat units)	2.0623***	0.2459	Dufferin	0.0437	0.0355
Horse	0.0647***	0.0241	Durham	−0.0511	0.0462
Orchard/vineyard	0.3132***	0.0541	Grey	0.0121	0.0271
Greenhouse	0.1307 **	0.0648	Haldimand-Norfolk	−0.6760***	0.0492
Vacant land	0.3296***	0.0397	Halton	−0.0928	0.0750
			Hamilton	−0.8516***	0.0623
Structural Variables			Huron	0.2088***	0.0379
ln(Building value)	0.0459***	0.0035	Kawartha Lakes	−0.3137***	0.0305
Age	−0.0008***	0.0002	Niagara	−0.7925***	0.0600
ln(Square feet)	0.0366***	0.0049	Northumberland	−0.3243***	0.0397
Bathrooms	0.0638***	0.0108	Oxford	0.0892 **	0.0387
Bedrooms	0.0059	0.0059	Peel	0.3665***	0.0578
Fireplaces	0.0882***	0.0106	Perth	0.3215***	0.0306
			Peterborough	−0.2634***	0.0324
Neighbourhood and Amenity Variables			Simcoe	−0.0199	0.0254
ln(Pop density)	0.1929***	0.0134	Waterloo	−0.1674***	0.0397
Growth rate	0.0280***	0.0060	York	0.1761***	0.0525
Water/sewer	0.0980***	0.0205			
			Other Variables		
			Month	0.0088***	0.0004
			Speculative	1.5518***	0.0823
			Constant	−5.4731***	1.9397

Note: Asterisks (*, **, ***) indicate that the coefficient is significantly different from zero at the 10%, 5%, and 1% levels, respectively. To address the issue of heteroskedasticity, robust standard errors are generated.

the most part, the expected signs (see table 3). In what follows, we focus our discussion of the results on those of the Greenbelt variables (see table 2 for a comparison of results across various specifications), in order to address the primary question of our research: What was the effect of the Greenbelt legislation on farmland property values in the Protected Countryside zone?

Our initial analysis estimates this effect across a set of successive 5 km distance bands around the GTA. The key variables that measure this effect are the distance band interaction variables for the Protected Countryside (i.e., *PC post-GB X 0–5 km*, *PC post-GB X 5–10 km*, etc). The nature of the effect within each band depends on the coefficient and level of significance for each interaction variable. The results are provided in the first column of table 2; the subsequent columns provide results from the sensitivity analysis.

The estimated parameters indicate that the Greenbelt legislation lowered property values in the Protected Countryside located within 5 km of the GTA by 24.3%. Prior to implementation of this legislation, the median per-acre price of farmland in the PC zone within 5 km of the GTA was $12,263 (Canadian), which implies an estimated loss in value for these properties of just under $3000 (Canadian) per acre. The estimated parameters indicate further that the Greenbelt legislation had no effect on the value of property located between 5 km and 40 km: the zoning effect is not statistically significantly different from zero for all seven distance bands that comprise this area. These results suggest that strict agricultural zoning affected the value of farmland under immediate development pressure but had no effect on the value of farmland not under immediate development pressure, as the theoretical analysis indicates.

The estimated parameters show that the value of properties located between 40 km and 45 km from the GTA increased after imposition of the Greenbelt legislation, while the values of properties located farther away (45–50 km and over 50 km) did not. This pattern is not consistent with the theoretical analysis. There were, however, relatively few observations—i.e., 13—in this distance band (after zoning was enacted). This result is examined more fully in the sensitivity analysis.

Two other zones, the Oak Ridges Moraine and Niagara Escarpment, were subject to restrictions on development prior to the Greenbelt legislation and were subsequently incorporated into the Greenbelt. The estimated parameters reported in table 2 indicate that the nature of the results for the NE are similar to those discussed above with respect to the Protected Countryside, with a significantly negative effect within 10 km of the GTA and significantly positive effects in the distance bands that are greater than 50 km from the GTA. The estimated parameters for the ORM do not show a negative effect in close proximity to the GTA, but do show positive effects for some distance bands at greater distances from the GTA.

Robustness Checks

We test the robustness of these results by using alternate specifications for the distance bands. For each of these specifications, the set of control variables (i.e., structural, land quality, neighborhood and amenity, location, and other variables) remains the same as in the primary model. One alternate specification used 10 km bands around the GTA rather than 5 km bands. A second alternate specification used four distance bands each of which contained a quarter of farmland sales in the PC in the post-Greenbelt period; the resulting four bands have distance limits of 0 to 8.0 km, 8.0 to 17.2 km, 17.2 to 27.9 km, and greater than 27.9 km from the GTA. The results of these models (see table 2, columns 2 and 3) are qualitatively the same as those of the 5 km band model: the Greenbelt legislation reduced the value of properties adjacent to the GTA and had no effect on the value of properties located farther away from the GTA except for those located in some more remote bands—e.g., 40–50 km from the GTA—which experienced an appreciation of property values.

We also examine the issue of spatial correlation, which can arise in property value studies, producing inefficient estimates in OLS models which can lead to incorrect hypothesis tests (Kim, Phipps, and Anselin 2003). A Moran's I test indicated the presence of spatial correlation, which we corrected for using a spatial autoregressive (SAR) model:

$$V_j = V_j W \rho + x_j \beta + (d_j \times \delta_j)\sigma + \varepsilon_j, \quad (4)$$

where ρ is the spatial autoregressive parameter and W is an $n \times n$ spatial weight matrix with elements w_{ij}. This row-standardized spatial weight matrix is specified based on the 15 nearest sales (which occur prior to the sale being observed) with geometrically declining weights which are inversely related to distance from the sale observation.[11] The results of the SAR model (see table 2, column 4) for the Greenbelt variables are again qualitatively and quantitatively the same as the results of our primary model.[12]

Next, we examine the sensitivity of our primary results to functional form by estimating a model with the dependent variable included linearly. The results, reported in the final column of table 2[13] are qualitatively the same as those of the primary model (i.e., negative effects in the distance bands close to the GTA and positive effects in the distance bands at greater distances from the GTA), indicating that the results discussed above are not sensitive to the choice of functional form.

We examine the influence of outliers by re-estimating the primary model omitting all properties with sale prices greater than the 99th percentile ($5.5 million). The results indicated only minimal quantitative differences in the coefficients of our primary variables of interest. For example, the negative effect in the 0–5 km band was 20.0% while the positive effect in the 40–45 km band was 34.0%. Since many of these high priced sales are speculative sales, we also tested the sensitivity of our results to these sales by removing them from the analysis.

[11] While the selection of the number of neighbors is arbitrary, it follows from similar specifications in previous studies (Pace et al. 2000; Pace et al. 1998). Alternate specifications (e.g., different numbers of neighbors, different decay rates for the geometrically declining weights) do not qualitatively affect the results.

[12] While the results for only the Greenbelt variables can be compared in table 2, the parameter estimates for all other variables are very similar, in both sign and magnitude, between the two models. For a complete set of results from the SAR model, please contact the authors.

[13] Again, the results for all other variables included are consistent with our primary model discussed earlier.

In this case, we found even smaller differences in magnitude from our primary model: i.e., the negative effect in the 0–5 km band was 24.6% while the positive effect in the 40–45 km band was 38.0%.

Finally, we examine the sensitivity of the results to an increase in the minimum parcel size of farmland properties included in the data set from 5 acres to 20 acres. The estimated negative effect for the 0–5 km band remains statistically significant at the 5% level, while the positive effect for the 40–45 km band is significant at only the 10% level.

Overall, the results of these exercises indicate that the results of the primary model are quite robust. In all cases, the results indicate that the Greenbelt legislation reduced the prices of farmland in close proximity to the GTA. Positive effects tended to be observed in some relatively remote areas (though this positive effect is sensitive to the choice of minimum farm size), while in all remaining areas no effect was found.

Conclusions

Our empirical analysis suggests that zoning influences property values, and that this "zoning effect" varies spatially depending on development pressure. Farmland within the Greenbelt, and in close proximity to the Greater Toronto Area (GTA), experienced a statistically significant decline in property values. More specifically, the negative effect occurs mainly at the urban–rural boundary: i.e., farmland within 5 km of the GTA. After this boundary area, the zoning effect diminishes and becomes, for the most part, statistically insignificant. Our finding that some relatively remote areas experienced a positive zoning effect was not consistent with our theoretical model, but has been observed elsewhere in the literature (Henneberry and Barrows 1990).

With respect to the negative zoning effect, our results are consistent with a great deal of literature (e.g., Vaillancourt and Monty 1985; Nelson 1986; Lynch, Gray, and Geoghegan 2007). In this context, our empirical approach adds an additional dimension to some of these studies by demonstrating spatial variation in the zoning effect with respect to the GTA: i.e., the distance effect.

Future empirical research can reassess the distance effect after more time has passed. The effect of zoning may be sensitive to a number of factors, including changes in development pressure and new information regarding long-term expectations about the Greenbelt: e.g., legal and political challenges. Moreover, while we have characterized the zoning effect in terms of land prices, zoning has a broader set of consequences. Agricultural zoning is often initiated with the stated goals of protecting open space, supporting local farming, reducing sprawl, and protecting the environment. Future research needs to assess these issues as well. In this broad context, analyses such as ours contribute to the ongoing debate concerning the net benefits of zoning, and the distribution of those benefits or losses.

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