The Effect of the Student Population of the University of Western Ontario on the London Housing Market: A Hedonic Analysis

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Introduction

Any city or town with a university or large post-secondary institution has had to accommodate a sizeable population of students living amongst its residents. Interactions between the two groups are sometimes confrontational, as their differing lifestyles can result frequently in social friction. This is of serious concern to many universities and the municipalities in which they are located. For example, the University of Western Ontario (UWO) takes student-resident relations seriously enough that it has established the Housing Mediation Service (HMS), whose purpose is to "assist in the speedy resolution of problems which may arise between students and landlords, students and London residents and/or students and students in the areas of housing and lifestyles" (HMS n.d. a.). According to a document released by HMS entitled "Western & Neighbourhood Relations," UWO is "acutely aware the actions of a small minority of students create problems for neighbours" (HMS n.d. b.).

One particularly harmful impact of having a university in close proximity to a neighbourhood is the formation of a student ghetto, which is a concentration of students living in a specific area near the university. A prime example of a student ghetto would be the Kingston student ghetto, which is defined generally as the area just north of Queen's University and south of Princess Street. Student ghettoes usually form because of insufficient residence space, steady growth in enrolment, and the convenient proximity to the university and student activities. Unfortunately, the presence of many students in one area can lead to a deterioration of living conditions. Several of the consequences of high student concentrations in neighbourhoods are highlighted in the City of London Department of Planning and Development's presentation, "Closing the Gap: New Partnerships for Great Neighbourhoods Surrounding Our University and Colleges" (2007). The presentation cites overcrowding of housing, poor maintenance, vandalism, deterioration of properties, rowdiness, lack of communication between students and long-term residents, and the migration of local residents away from the affected neighbourhood. In a London Free Press (LFP) article by Joe Belanger entitled "Lure of profits forcing families to flee," the author explains that as demand for housing close to the campus goes up, prices are also driven up. The higher prices, coupled with the increasing number of students living nearby, induce families to move and sell their properties to landlords, who proceed to rent the property to more students. According to Belanger, this is how entire neighbourhoods in the Old North of London are being transformed into student ghettoes. The LFP article also describes several violent incidents, notably in the area of Fleming Drive near Fanshawe College, where police in riot gear had to be deployed twice from 2002-2007 to quell disturbances. Clearly, the presence of students in neighbourhoods have numerous negative externalities, lowering the demand for housing in these neighbourhoods from local residents, and, theoretically, the prices they are willing to pay for it.

On the other hand, owning property close to a university can have spillover benefits. In "Land and Residential Property Markets in a Booming Economy: New Evidence from Beijing," Zheng and Kahn (2008) conclude that there is an upside to living close to a university. Since universities serve as clusters of human capital, potential home buyers may be willing to pay more to be located near other highly educated people. Nearby residents can also take advantage of the services a university offers, such as exercise facilities, libraries, health services, and scenery. As students generally live near their university for convenience, housing occupied by students would tend to benefit from these positive externalities.

Therefore, whether or not a student occupies a dwelling is affected by both positive and negative externalities. It is our hope that, using variables available from the Census of Canada individual datasets from 1981-2001, we can establish a correlation between student occupancy and the state of repair of a property. Finally, we will try to determine if student renters significantly reduce housing value. In order to conclude if student populations have an overall positive or negative effect on the real estate in a local market, we plan to conduct a hedonic analysis to determine the price function of housing in the real estate market for London, Ontario. By including variables that take into account undergraduate full-time enrolment and residence spaces each year at UWO, we aim to establish a positive correlation between enrolment, residence spaces, and housing value.

Relevant Past Studies

Researchers have compiled a large body of work in the field of real-estate economics. Since housing is a large good in the consumption bundle of most households, there is a significant motivation on the part of those in the real-estate industry to analyze the effect that different characteristics of a property may have on its value. The field of real-estate economics is well established, as are its methods of estimation for price functions. Any housing price function must be constructed hedonically, since there is little or no information concerning the value added of each individual component of housing. Another reason the housing market is well suited to hedonic analysis is that housing is relatively heterogeneous as a good. Therefore, it is important to take into account the different characteristics of each individual dwelling. Sheppard (1999) gives a useful overview of the theory behind the hedonic price function estimation and its application in empirical studies.

Hedonic analysis is used when the good is traded in a single explicit market, but the good is quite heterogeneous in nature, and there is no single price that can be applied to that good. Housing, for example, cannot be characterized by a single price for all houses, even across one regional market. One can assume, however, that the characteristics of housing such as rooms and square footage, if treated as goods themselves, are homogeneous and have a single price in their respective markets. Theoretically, the value of any house can be represented by: $value = P \cdot X$, where P is a (1 x N) vector containing the market equilibrium price of each of the N characteristics of housing, and X is a (N x 1) vector containing the amount of each characteristic of housing contained in the dwelling. Can (1992) explains that after the hedonic price function is constructed, its primary uses are to estimate consumer demand for that good and to create a price index. We will not be attempting either of these; we will simply be estimating the price function in order to ascertain the relative values of the individual components of housing.

Theoretically, the hedonic price function is obtained by solving the objective function for the suppliers of housing, which is: $\max_{Z,N} P(Z) \cdot N - C(Z, N, \gamma)$. $\pi = P(Z) \cdot N - C(Z, N, \gamma)$ is the profit of each producer, N is the number of houses built by that producer, P(Z) is the price of the houses sold given their characteristics Z, and $C(Z, N, \gamma)$ is the cost function for that producer, which depends on the number of houses built, their characteristics, and $\gamma \equiv$ vector of characteristics of that producer.

In order to estimate the hedonic price function, there have been traditionally two approaches: parametric and nonparametric. Sheppard (1999, 1614) explains the parametric approach as choosing a "functional form whose actual values are determined by a finite number of parameters." Traditionally, the functional form is a linear function. The logarithmic form is especially useful in estimating the price functions for housing as it narrows the range of values the estimate can take, reducing the effect of outlying observations (Wooldridge 2006). In addition, the logarithmic form has the advantage of having easy to interpret coefficients for its independent variables. Cropper, Leland, and McConnell (1988) compared several parametric estimations of the hedonic price function and found that, when one or more significant independent variables are omitted, the logarithmic forms tend to perform better than more complicated types of parametric estimation, such as the quadratic form. The logarithmic forms also tend to have the advantage of being the easiest to implement.

A nonparametric approach, on the other hand, attempts to estimate the individual components' prices without assuming any previous relationship between the components and the good itself. There are several advantages to utilizing a nonparametric approach. Parmeter, Henderson, and Kumbhakar (2007) claimed that by using nonparametric techniques instead of a linear approach, their ability to analyze the effect of *ceteris paribus* changes in variables is greatly enhanced. As an example, the authors found that, although the effect of adding one garage to a house with no garages had a significant effect on the value of the house, any subsequent additional garages had substantially smaller effects on value. Li and Racine (2004) also argue that nonparametric estimation is more robust to functional form specification, meaning that the estimated price function will more accurately approximate the actual price function. Unfortunately, nonparametric approaches have several major drawbacks. The technique requires much larger amounts of data than a parametric approach. The biggest obstacle to utilizing nonparametric estimation for our purposes, however, is its complexity in theory and implementation.

For our project, the complexity of nonparametric estimation eliminates it as a viable option. We will be utilizing the logarithmic form for our parametric estimation because our empirical model will be omitting several explanatory variables that are likely to be present in the actual price function. We specifically chose the logarithmic form because our dataset likely will contain a number of outlying observations in the total income and the value of housing. The logarithmic form will help to reduce the range of these variables.

Zietz, Zietz, and Sirmans (2007) claimed in their paper, "Determinants of House Prices: a Quantile Regression Approach," that consumers in different income brackets would value the characteristics of housing differently. They advocated using a quantile regression, which would divide the distribution of selling prices into several mutually exclusive sets and give the effect of each explanatory variable for each part of the distribution. Our empirical model likely will not encounter the problem described by Zietz et al. (2007) because we are examining only the lower end of housing values. Specifically, we will be looking at housing with values up to only 199999, since at 200000 and above, the Census reports the value of the house as 200000 for confidentiality reasons.

Finally, in order to determine which variables were appropriate to use in our parametric estimation, we referred to "The Value of Housing Characteristics: A Meta Analysis," by Sirmans et al. (2006). The authors, in their analysis of numerous past studies conducted on housing characteristics, listed the most common variables used in hedonic price functions of housing as square footage, lot size, age, number of bathrooms, and the presence of swimming pools, air conditioning, and garages. While we were unable to obtain a dataset that contained all of the above variables, our empirical model will contain other explanatory variables that will help increase the explanatory power of our function. In addition, the logarithmic form of our function will help minimize the effect of the bias caused by the omitted variables.

Empirical Model

The econometric model that we will be using is a logarithmic form estimation of the price function for housing in London, Ontario, and is given by:

$$\log value = \beta_0 + \beta_1 \log totinc + \beta_2 university + \beta_3 room + \beta_4 condwel + \beta_5 enroll + \beta_6 residence + \beta_7 period + \beta_8 repair \cdot university + u$$

The dependent variable, "$\log value$", was obtained by taking the log of the variable "$valuep$" in the Census of Canada Individual File. The variable "$valuep$" is the estimated value that the dwelling would be expected to sell for, if sold at the time of the census. While this number is not an exact assessed value of the dwelling, it should give a very good approximation of the price of the dwelling. We decided to exclude the values of 200000 and 999999 for "$valuep$", since the Census of Canada automatically groups values for "$valuep$" above 200000 into one category, and reports them all as 200000.

"$\log totinc$" and "$university$" are the first two dependent variables in the regression, and represent personal characteristics of the occupant which might affect the value of the dwelling. Since the Census of Canada data organizes people with incomes of $200 000 and above into the 200000 category, we decided to simply take *totinc* values of up to 199999. We also eliminated observations which reported total incomes of less than 0.

The variable "*university*" is a measure of whether the respondent is currently in university. This was not an actual question asked in the Census, except for the 1981 Census. We therefore had to construct the "*university*" variable from two other variables that were included in the Census data from 1991-2001. For these years, we constructed "*university*" as a dummy variable whose value for each observation depends on the reported values of SCHATTP, school attendance, and HLOSP, highest level of schooling. If an observation's value for SCHATTP was 2, meaning the respondent was attending school full-time, and if the value for HLOSP was 9, meaning the highest level of schooling of the respondent was some university without a degree or diploma, then the dummy variable took on a value of 1, meaning that the respondent was currently in university. We created the "*university*" variable in order to determine the effect that having a university student as an occupant has on the value of a dwelling. This will answer one of our primary research questions.

The variables "*condwel*" and "*room*" represent more variables that are normally included in hedonic estimation of price functions for housing. The variable "*condwel*" represents the condition of the dwelling and takes on values from 1 to 3. At 1, the dwelling requires only a normal number of repairs, while 3 represents the need for major repairs, such as repairs for structural damage or defective electrical wiring or plumbing. These two variables represent typical characteristics of housing that consumers in the housing market might find important. We included these variables so that our price function will approximate more closely the true price function of housing in London. Unfortunately, the limitations of the Census of Canada data prevented us from including more of the variables that should be included in an accurate model of the price function. The omission of several significant explanatory variables, however, should not prevent us from obtaining a relatively good measure of the direction and magnitude of the effects of the "*university*", "*enroll*", and "*residence*" variables on housing value.

The variables "*enroll*", "*residence*", and "*period*" are our time-dependent variables. "*period*" is our time variable in which an observation was given a value between 1 and 4, 1 being the earliest and 4 being an observation from 2001. "*enroll*" represents the number of full-time undergraduate students listed at UWO in the year that the observation was recorded. Similarly, "*residence*" is a variable that represents the number of residence spaces available to full-time undergraduate students in the year that the observation was recorded. The "*period*" variable was included to control for changes between Census takings which might affect housing value, but would not be accounted for in the model, such as inflation, fluctuations in the housing market, and changes in government policies that affect housing.

We included the variable "$repair \cdot university$" in order to determine whether having a university student occupy the dwelling has a significant effect on the condition of the dwelling. This is captured by the variable "$repair \cdot tenure$." In order to create these dummy variables, we used the term "$repair$" instead of "$condwel$," where we input a value of 0 for "$repair$" if a dwelling needs only regular maintenance. If a dwelling needs minor or major repairs, we input a value of 1 for "$repair$."

In addition to our time-series regression, which we used primarily to test for the effect of the number of residence spaces and the student enrolment over time, we conducted separate regressions using only observations from one specific year, for all the years that we had Census data. For these regressions, we used the following model:

$$\log value = \beta_0 + \beta_1 \log totinc + \beta_2 university + \beta_3 room + \beta_4 condwel + \beta_8 repair \cdot university + u$$

The purpose of these additional regressions is to observe how the effects of the individual characteristics on value of housing change over time. In particular, we would like to see how our university variable changes over the years, and whether it is significant in all years. In addition, running separate regressions for each individual year will provide better estimates for the housing price function in that year. The only drawback to running these separate regressions is that we will be unable to monitor the effect of variables that change only with time, but which are constant during any single year, such as enrolment rates and residence spaces. For this reason, we have decided to perform separate regressions with the data from individual years and a single time-series regression pooling all the observations we have from all years. Thus, we will be able to ensure that we can determine the significance of enrolment rates and residence spaces, as well as the significance of our other variables of interest such as "*university*" and "$repair \cdot university$." In addition, we will be able to produce a set of price functions per individual year that should be relatively accurate, despite the fact that there are likely to be several omitted variables due to data unavailability.

Data Description

Initially, we planned to put in a request for data from the Municipal Property Assessment Corporation (MPAC). MPAC, as the organization charged by the Government of Ontario with the task of property assessment, would have detailed information on a large number of properties in the London area. As part of their assessments, MPAC would have recorded the value of each property. It would have gathered data on square footage, lot size, number of bathrooms, heating, and a host of other useful variables we could have used as regressors. MPAC was also capable of organizing each observation geographically. We would have divided London into a number of neighbourhoods, allowing us to analyze the effect that being in a particular neighbourhood has on the value of housing. Unfortunately, because of the high fees that MPAC charges, as well as the indeterminate amount of time they required to collate the relevant data, we decided not to pursue the MPAC data and obtained alternative datasets.

In place of the data we were expecting from MPAC, we decided to use the Census of Canada Public Use Individuals File for the years 1981, 1991, 1996, and 2001, downloaded from the Internet Data Library System. The most important variable in the

Census of Canada data was the Census Metropolitan Area (CMA), which we used to select only observations that were taken in London. According to Statistics Canada, each CMA consists of an urban core (city of more than 100 000 people) coupled with a group of nearby, related census subdivisions, which are classified as either "urban fringes" or "rural fringes." We used only observations obtained from CMA 555, which has London as its urban core, but also includes a series of nearby townships, specifically Central Elgin, St. Thomas, Southwold, Strathroy-Caradoc, Thames Centre, Middlesex Centre, and Adelaide Metcalfe, as of the 2001 Census. Whether or not a subdivision located close to an urban core is included within the CMA is calculated using a complicated series of criteria, but essentially, a census subdivision is eligible for inclusion if there is a "high degree of integration with the central urban area, as measured by commuting flows derived from census place of work data." These calculations for inclusion in a CMA are conducted for every Census of Canada. In this way, the growth and influence of a city is taken into account.[1] Since the 1986 Census did not divide its observations into CMAs that included London, we were forced to conclude that the 1986 dataset was not useable.

The Census data provided us with variables concerning each respondent's housing, such as its value, number of rooms, state of repair, and whether the housing is rented or owned. Value of housing, which will form the dependent variable in our regression, is not the exact assessed value of a dwelling or the selling/buying price, but the expected dollar amount that the owner could anticipate if the dwelling were sold at the time of the census. From the Census data, we were also able to obtain personal information for each respondent. Variables that were relevant to us included age, total income, school attendance, and highest level of schooling attained. The variables for the value of housing and the total income were truncated at $200 000. Respondents who replied that their value of housing or total income was above $200 000 were simply assigned a value of $200 000 for that variable. Therefore, when we used these variables, we decided to exclude observations that had values of $200 000 or more for either the value of housing or total income.

In order to obtain data for UWO's student enrolment and residence space for the years 1981, 1991, 1996, and 2001, we contacted the university's Office of Institutional Planning & Budgeting (IPB) for data. IPB's website included a section called "Western Facts," which contained the relevant information, but held data from only 1999 onwards. The data we obtained was divided into academic years, or more specifically Fall/Winter sessions spanning two calendar years. We decided that we would use the academic year of 1980/1981 to correspond with our Census of Canada 1981 data, the academic year of 1990/1991 for Census of Canada 1991, and so on.

For a more detailed description of the data, please see Appendix 2, where we have included a summary of all our variables (mean, standard deviation, minimum and maximum values) broken down into separate years, as well as the number of observations per year.

[1] See Appendix for a map of the Census Metropolitan Area of London

Findings

STATA estimation of the econometric model described in the "Empirical Model" section produced a set of interesting results. As expected, our regression suggests that as enrolment at UWO increases, housing values tend to increase, due to higher demand for housing in London. Similarly, as residence spaces for full-time students increase, housing values tend to decrease, as the demands placed on off-campus housing decreases. Our results also indicate that having a university student as an occupant tends to have a significant positive effect on the housing value. This supports our initial hypothesis that housing prices tend to be higher in neighbourhoods in which student demand is relatively high, i.e., having more students off-campus will tend to increase housing value in London.

Variable	Coefficient	Std. Dev.	t-statistic
$\log totinc$	0.0129966	0.0018923	6.87
$room$	0.0639863	0.0014116	45.33
$condwel$	-0.0648537	0.0040726	-15.92
$university$	0.0551602	0.0245261	2.25
$enroll$	0.0047463	4.69e-06	1010.94
$residence$	-0.0057609	9.95e-06	-578.83
$period$	0.1390575	0.0062488	22.25
$repair \cdot university$	-0.0059368	0.0459075	-0.13
constant	-44.49897	0.068998	-644.93

At a 5% level of statistical significance, the variable "$repair \cdot university$" was not statistically significant, with a t-statistic of -0.13. This meant that (P > t) = 0.897. This result was unexpected, and ran counter to our hypothesis and the anecdotal evidence that having university students as occupants would lower the state of repair of a dwelling. One possible reason for this variable's insignificance is the low number of reported values of 1 for "$repair \cdot university$". This would suggest that there was insufficient variation in "$repair \cdot university$", which resulted in an underestimation of its magnitude. Our estimate of the coefficient for "$repair \cdot university$" was -0.0059368, which suggests that our theory concerning the statistical insignificance of "$repair \cdot university$" might be correct. The negative direction of the coefficient indicates that "$repair \cdot university$" has an inverse relationship with housing value. If the occupant is a university student and the dwelling is in poor condition, then housing value will decrease, *ceteris paribus*. This relationship seems to conform to our expectation that if having a university student as an occupant truly worsens the condition of the dwelling, then housing value should decrease due to the worsened state of repair. Since the direction of the coefficient was correct, the small magnitude of the coefficient was the only reason that we were forced to discount this variable as significant. The small coefficient, however, is likely due to a small number of reported values of 1 for "$repair \cdot university$," which resulted in an underestimation of its importance.

Another reason for the statistical insignificance of "$repair \cdot university$" could be that there is no relationship between "repair" and "university." This would contradict the anecdotal evidence presented in numerous newspaper articles. It would even contradict UWO's expectations of students living off-campus. HMS, through its document "Western & Neighbourhood Relations," clearly sees poor upkeep and maintenance of housing as one of the primary sources of contention between off-campus students and London residents. It is possible that anecdotal evidence consistently points out worst-case scenarios amongst student occupants, and that on average, student occupants treat their dwellings no worse than regular occupants. Our empirical evidence seems to support this statement.

As expected, our variables representing number of rooms, total income of the occupant, and condition of the dwelling were statistically significant in our regression. The direction of the coefficients confirms the results of past hedonic estimates of housing price functions. The positive coefficients of "log $totinc$" and "$room$" are in line with the findings of other economists. Zietz et al. (2007), in their summary of past hedonic studies of housing, found that the number of rooms had a positive coefficient the majority of times. The significance of the three variables above helps improve the accuracy of our model, and it should allow our coefficients for our university-related variables to approximate the true coefficients more closely.

The coefficients for the variables "$enroll$" and "$residence$" had t-statistic values of 1010.94 and -578.83 respectively. This means that they are both statistically significant at the 5% significance level. Their significance answers one of our primary research questions, which was whether or not the number of full-time undergraduate students enrolled and the number of available residence spaces had a significant effect on housing value. Our results clearly suggest that they are correlated with housing value. The coefficient for "$residence$", -0.0057609, means that we can derive the elasticity, ε, as $\varepsilon_r = 100 \cdot [e^{-.0057609} - 1]$. Therefore, $\varepsilon_r = -.57443$. In other words, an increase in residence spaces of one will decrease housing value by approximately 0.57443%. In a similar fashion, we can derive the price elasticity of "$enroll$" by $\varepsilon_e = 100 \cdot [e^{0.0047463} - 1]$. The price elasticity of "$enroll$," as estimated in our paper, is $\varepsilon_e = 0.4758$. Therefore, we conclude that an increase in undergraduate enrolment of one student would increase housing values by 0.4758%. The two elasticities confirm that the growth of UWO has a sizeable effect on the London housing market. The elasticities may seem to be exaggerated, but this may be because 1981-2001 was a period of growth for UWO. Several new residences were built, such as Elgin, Essex, and Alumni House. These three residences make up a total of 1155 residence spaces. The large increase in residence spaces during 1981-2001 may have resulted in the overestimation of the effect of "$residence$." The effect of "$enroll$" could have been similarly skewed by the aggressive growth of full-time undergraduate enrolment during the period 1981-2001, as enrolment jumped from 13615 in 1981 to 20577 in 2001. The overestimation of the effects of both variables does not indicate that the analysis failed to provide any meaningful correlation between enrolment rates, residence spaces, and housing values. The direction of the coefficients still suggests that as enrolment increases and residence spaces at UWO decrease, housing values in London will decrease.

Our "*university*" variable was also proven to be statistically significant at the 5% level, according to the t-test. The coefficient for "*university*", which was 0.0551602, suggests that being a university student has a strong and direct correlation to housing value. This strong correlation may be partially because of the locations where students tend to live. According to Zheng and Kahn (2008), there are a number of spillover benefits from living close to a university. These benefits were listed more extensively in the "Relevant Past Studies," but they include proximity to health services and gyms. Students naturally tend to prefer living closer to the university for a multitude of reasons: reliance on public transit to get to school, convenience, proximity to other students, and a more established network of landlords willing to rent to students are just some of these reasons. This tendency of students to locate close to UWO can result in a capturing of spillover benefits, resulting in a higher value of housing. Another reason for the positive correlation between the occupant's being a university student and higher housing values is referred to in a number of anecdotal sources. Since most students prefer to live close to campus, the demand for housing near UWO is higher, *ceteris paribus*, compared to other areas in London. This higher demand pushes the value of housing up. Therefore, because students tend to live in higher-demand areas, dwellings that have university students as occupants tend to have higher prices.

Our regression using only 1981 data indicated that, while all the control variables that typically were found in hedonic price functions were found to be statistically significant even at the 1% level, both the "*repair*university*" and "*repair*" variables were statistically insignificant at the 5% level for that year. The "*university*" variable, however, was significant at the 10% level, with a t-statistic of 1.68.

When running our regression using only 1991 data, we found that all the control variables were once again statistically significant at the 5% level. We found that for 1991, the "*university*" variable was found to be significant at the 5% level, while, as in our time-series estimation, "*repair*university*" was again insignificant, with a t-statistic of -1.17.

Our 1996 regression continued the trend of the previous two observation years. The control variables were reported as significant, while the "*university*" variable was once again significant at the 10% level. The "*repair*university*" variable, in keeping with our other results, was statistically insignificant at all levels.

Finally, our regression using the 2001 Census of Canada data also returned exactly the same results as our other years, in that the "*university*" variable turned out to be statistically significant, but only at the 10% level, while the "*repair*university*" variable was again insignificant. Since our one year regressions also returned the result that "*repair*university*" was insignificant, our time-series estimation results for "*repair*university*" is likely accurate. The reason for the insignificance in the time-series estimation was a lack of relationship between the state of repair of a dwelling and the occupant being a university student. Without the "*period*" variable, our regressions returned significantly lower R-squared values. For our 1981, 1991, 1996, and 2001 regressions, we achieved R-squared values of 0.1919, 0.1269, 0.1564, and 0.1232, respectively. Assuming that housing values are correlated with many time-dependent variables that are not included in this model, such as inflation and the state of the housing market, our single-year regressions should fit that year's data more accurately than our estimated price function using the pooled time-series data. It also seems that, although the "*university*" variable was insignificant even at the 10% level in the 1981 estimation, it gradually became significant at the 10% level, even reaching significance at the 5% level in the 1991 regression. This can be explained by the fact that from 1981 to 1991, student enrolment increased significantly, from 13615 to 16053. From 1991 through to 2001, full-time undergraduate student enrolment also increased by a significant amount, which may have contributed to the increasing significance of the "*university*" variable, as the increasing number of students living off-campus meant that the overall effect of student occupants increased over time. Although residence spaces increased by a large amount proportionally, from 3594 in 1991 to 4560 in 2001, the increase was not sufficient to cope with the larger absolute change in student enrolment.[2]

Due to concerns that some of our variables may be linearly dependent, we ran more regressions for each independent variable we had, running each independent variable as the dependent variable in that regression against the other independent variables. While we found some correlation between the variables, none of the regressions had an R-squared of 1, which meant that none of our independent variables could be expressed as an exact linear combination of the other independent variables. Therefore, we concluded that none of our independent variables was linearly dependent.

Conclusion

Our time-series regression allowed us to conclude that the enrolment rates and number of residence spaces available at the University of Western Ontario had a significant effect on the value of housing in London. It is possible that the estimated price elasticities for both of those variables is larger than in the actual price function because of the significant increases in enrolment and the construction of several large residences during the period of 1981-2001. The significance of these variables in our analysis, however, indicates that UWO does indeed have a big influence on the London real-estate market over time by affecting demand for housing, due to the need by students for off-campus housing.

The insignificance of the "*repair*university*" variable in both the time-series regression and the regressions run with data from only single years suggests that there is not a relationship between the effect of the condition of the dwelling and the effect of the occupant's being a university student. Therefore, our paper's results run counter to a plethora of anecdotal evidence that suggests that students treat housing a lot more poorly than regular residents do. While our results may be biased be due to issues of reporting in the Census itself, we hypothesize that the "*repair*university*" variable was insignificant because a real relationship does not actually exist between the two. One possible explanation for the lack of a relationship between the two is that the anecdotal evidence is

[2] For a complete table of all estimated results for each of these regressions, see Appendix.

incorrect in assuming that students treat housing worse than local residents do, and that local media tend to choose worst-case scenarios, report on them, and assume that most students behave in a similar manner. There is no reason to assume that the average student would treat housing any better or worse than an average local resident would. Hopefully, our paper's results will help dispel the commonly held perception that students are bad tenants and that students lead to the deterioration of the quality of the neighbourhood in which they live.

While it is likely that our estimated house value functions have omitted one or more significant variables that are normally present in hedonic price functions, our choice of the log-linear function means that under the circumstances, our function should perform the best compared with other functional forms. Therefore, we are confident that we have done everything within our power to minimize the omitted variables bias.

We would have liked to run regressions to estimate house price functions for a city of a size similar to London, which does not have a university or large post-secondary institution, as a means of comparison with the functions estimated for London. Unfortunately, the Census data we used did not separate the data into Census Metropolitan Areas that included cities which did not have universities. For example, Toronto, Ottawa, Hamilton, and Windsor all had large universities. It would be interesting if a future study explored this issue further by running comparison regressions, if a more complete dataset were available.

Finally, it is our hope that our estimated price functions will be of use to those interested in the London real-estate market, whether they are on the supplier or the consumer side of the market. In particular, the results of our paper may prove useful to municipal planners when they are trying to determine the extent of UWO's effect on the London housing market. Our paper could also be of use to purchasers of housing in London, who can estimate the value of a dwelling based on its characteristics and determine whether the asking price is too high relative to the characteristics of the dwelling. While we were not able to include more control variables, such as distance to the city core and the age of the dwelling, we are still confident that our estimated equations accurately represent the determination of value in the London housing market.

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Appendix
Summary of Data for 1981 (5389 Observations)

Variable	Mean	Standard Deviation	Minimum	Maximum
Room	6.437372	1.903291	1	10
Condwel	1.244201	0.5238611	1	3
University	0.0519577	0.2219622	0	1
Logtotinc	8.946083	1.256886	0	11.51292
Logvalue	10.99369	0.3991848	9.903487	11.73607
Repair*university	0.0105771	0.3995072	0	1

Summary of Data for 1991 (4306 Observations)

Variable	Mean	Standard Deviation	Minimum	Maximum
Room	7.374826	1.587775	2	10
Condwel	1.333024	0.5679075	1	3
University	0.0167209	0.1282384	0	1
Logtotinc	9.706461	1.181973	0	12.18556
Logvalue	11.77916	0.2781016	9.903487	12.20557
Repair*university	0.003948	0.0627161	0	1

Summary of Data for 1996 (4467 Observations)

Variable	Mean	Standard Deviation	Minimum	Maximum
Room	7.408552	1.705303	1	10
Condwel	1.383031	0.5939752	1	3
University	0.0156705	0.124211	0	1
Logtotinc	9.743198	1.234528	1.791759	12.12432
Logvalue	11.7684	0.2786138	9.903487	12.20106
Repair*university	0.0044773	0.06677	0	1

Summary of Data for 2001 (4771 Observations)

Variable	Mean	Standard Deviation	Minimum	Maximum
Room	7.395095	1.694129	1	10
Condwel	1.397611	0.6109986	1	3
University	0.0129952	0.1132651	0	1
Logtotinc	9.859456	1.242556	1.94591	12.15435
Logvalue	11.74536	0.3012141	9.903487	12.20607
Repair*university	0.0039824	0.062987	0	1

Coefficients for Regression using only 1981 Data

Variable	Coefficient	T-statistic
Room	0.1076274	22.04
Condwel	-0.0800268	-5.02
University	0.0503565	1.46
Logtotinc	0.0228179	3.97
Repair*university	0.1684706	1.85
Constant	10.10351	N/A

Coefficients for Regression using only 1991 Data

Variable	Coefficient	T-statistic
Room	0.0529394	20.66
Condwel	-0.0719406	-9.97
University	0.0829214	2.29
Logtotinc	0.0112401	3.24
Repair*university	-0.0846441	-1.17
Constant	11.37425	N/A

Coefficients for Regression using only 1996 Data

Variable	Coefficient	T-statistic
Room	0.0603869	25.72
Condwel	-0.060969	-8.98
University	0.0629533	1.68
Logtotinc	0.0106979	3.28
Repair*university	-0.0072149	-0.10
Constant	11.29985	N/A

Coefficients for Regression using only 2001 Data

Variable	Coefficient	T-statistic
Room	0.0569028	23.04
Condwel	-0.0646418	-9.37
University	0.0211458	0.46
Logtotinc	0.012547	3.70
Repair*university	0.0708866	0.88
Constant	11.29032	N/A

Preliminary 2006 CMA / RMR préliminaire de 2006: London, Ont.

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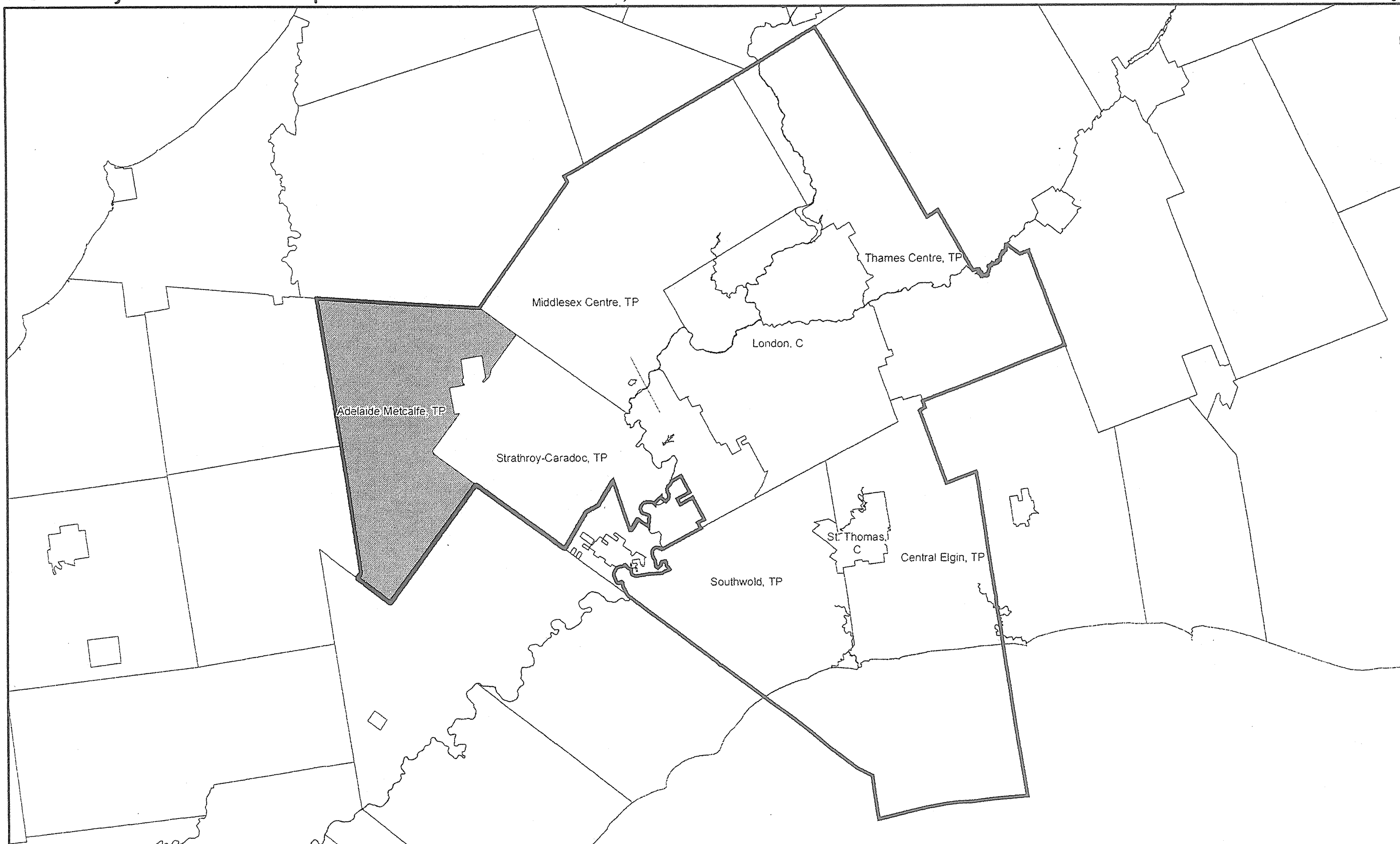

Notes / Nota:

Preliminary Census Metropolitan Area (CMA)
Région métropolitaine de recensement (RMR) préliminaire

Census Subdivision (CSD) included
Subdivision de recensement (SDR) incluse

CSD status quo
SDR statu quo

CSD excluded
SDR exclue

0 7 14 21 km

Statistics Canada Statistique Canada

Source: 2001 Census of Canada. Produced by the Geography Division, Statistics Canada, 2003.
Source : Recensement du Canada de 2001. Préparé par la Division de la géographie, Statistique Canada, 2003.

Canada