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# Did the Land Transfer Tax Reduce Housing Sales in Toronto?

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Ryerson University and Cape Breton University



UNIVERSITY OF  
TORONTO

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*By*

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# Did the Land Transfer Tax Reduce Housing Sales in Toronto?

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## **Abstract**

The City of Toronto implemented a land transfer tax on real estate transactions in February 2008. We explore the impact of the tax on housing sales in the City of Toronto and the rest of the Greater Toronto Area (GTA). Previous research has shown that housing sales declined in Toronto once the City imposed the land transfer tax. This study, however, concludes that the negative impact of the tax on housing sales was statistically insignificant. Our approach differs from earlier studies in three ways. First, we highlight other influences on housing sales, in particular, the impact of the Great Recession, which overlapped with the imposition of the land transfer tax in Toronto, and the tightening of mortgage regulations in Canada that prevented lenders from issuing subprime mortgages. Second, we analyze the sale of both freehold and condominium properties in the GTA; previous research restricted analysis to freehold properties. Third, we take a regional perspective by contrasting any decline in housing sales in Toronto against an increase in sales in the suburban municipalities.

**Keywords:** land transfer tax, housing sales, housing market, consumer behavior, Toronto, Greater Toronto Area

**JEL codes:** H76, H31, R31

## Did the Land Transfer Tax Reduce Housing Sales in Toronto?

### **I. Taxes and their impact on consumption**

In this paper, we estimate the impact on housing sales of a new land transfer tax (LTT) that was imposed in February 2008 in the City of Toronto.<sup>1</sup> In the first year of implementation, the tax generated roughly \$150 million dollars. In 2013, it generated \$356.8 million and another \$432 million in 2014. In 2015, the tax generated \$517.1 million. The property tax, in comparison, generated in excess of \$3.8 billion in 2013 and almost the same amount in 2014.<sup>2</sup>

Municipal revenues (property taxes, grants, and user fees) have not kept pace with the costs of maintaining municipal infrastructure in a state of good repair (Côté and Fenn, 2014). The LTT offers an alternative source of revenue to support municipal services. Without the additional revenue from the LTT, either other taxes, including property taxes, would have to be raised or municipal services would have to be cut. However, if the effect of the tax is to dampen housing sales and/or prices, then the land transfer tax might not be an appropriate way to raise the needed revenue.

The impact of taxes on consumer behaviour has been the subject of extensive research. Research shows that the imposition of (or an increase in) taxes raises the price of the item being taxed, which should reduce the demand for the item.

Two divergent views have emerged about the impact of the LTT in Toronto. Dachis (2012) and Dachis, Duranton, and Turner (2012) found that the LTT caused a 15 to 16 percent decline in housing sales. They further observed that the decline in housing prices equalled the revenue generated by the new tax. On the other hand, Nowlan (2007), using a theoretical model of housing markets, estimated that if a buyer were to own a house for 10 years, the present value of the otherwise increased property taxes (implemented in the absence of the LTT) would equal what the buyer would have paid for the LTT. In other words, for buyers who pay the LTT and hold on to the property for at least 10 years, the financial impact of the LTT would be the same as the present value of the increased property taxes, making the choice revenue-neutral between the LTT and the increase in property taxes.

The impact of land transfer taxes on real estate prices and the volume of transactions have been studied in several other jurisdictions:

1. The municipal LTT levied in February 2008 was in addition to a provincial land transfer tax, which has been in effect for much longer.
2. Data from Financial Information Returns compiled by the Ontario Ministry of Municipal Affairs and Housing.

- Benjamin, Coulson, and Yang (1993) compared housing sales in Philadelphia, which were subject to a higher ad valorem real estate transfer tax (3.5 percent), with those in other non-taxed municipalities. The authors found that housing prices declined in Philadelphia after the increase in the land transfer tax relative to the non-taxed neighbouring municipalities.
- In New York City, properties that sell for more than a million dollars are subject to an additional 1 percent tax, commonly known as the “mansion tax.” A predictable consumer response would be to engineer transactions slightly below the million-dollar mark, which would result in a \$10,000 reduction in taxes (Kopczuk and Munroe, 2014). Not surprisingly, the authors observed a higher frequency of sales just under the million-dollar mark.
- In the United Kingdom (U.K.), where the land transfer tax is called a stamp duty, Davidoff and Leigh (2013) observed that an increase in the tax was accompanied by lower turnover and a decline in housing transactions.
- Comparatively, a decline in transaction costs resulted in higher housing transactions in the U.K. (Besley, Meads, and Surico, 2014). The government introduced a stamp duty holiday in 2008–2009, which equalled a decline in after-tax prices of approximately £900. The resulting reduction in transaction taxes was associated with an 8 percent increase in housing sales.
- An increase in transaction costs has been shown to lower the probability of moving in Holland. Van Ommeren and Leuvensteijn (2005) found that a percentage increase in property transaction costs decreased mobility rates by 8 percent. Hilber and Lyytikäinen (2012) reported similar findings for Great Britain. However, the authors found that the impact was stronger for relocations of 10 kilometres or less.

The literature on land transfer taxes reveals that an increase in transaction costs is associated with a decline in sales volume. There are, however, two important caveats. First, most studies confine the analysis to the short-term effects of taxes. The long-term effects, which could include a higher sales volume in subsequent years, are not considered. Second, the decline in sales is assumed to be the result of only one factor – the new land transfer tax. Other possible contemporaneous factors, such as a recession, are ignored.

## **2. Earlier findings on the effect of the land transfer tax in Toronto**

Earlier research on the effect of the LTT on housing markets in Toronto concluded that the tax caused a statistically significant decline in the number of housing sales in the City of Toronto (Dachis, 2012; Dachis, Durantou, and Turner, 2012).

In this study, we build upon this research in a number of ways. First, we explicitly highlight the influence of other factors, such as the overlapping impact of the Great Recession of 2008, on housing sales. We also recognize the impact of the tightening of mortgage regulations that occurred at the same time. In 2008, the Canadian government raised the down payment requirement for residential mortgages from 0 percent to a minimum of 5 percent of the house price. Meanwhile, the government lowered the maximum allowable amortization period from 40 years to 35 years. Alexander, Burleton, and Petramala (2012) have estimated that lowering the amortization period to 35 years had an adverse impact on housing affordability equivalent to a 0.4 percentage point increase in interest rates.

Second, we highlight the impact of prior knowledge of the new tax on homebuyers' decisions to advance their house purchase. If consumers have prior notice of a new tax being imposed on a certain date, they may advance their purchase to benefit from lower transaction costs, a process known as "forward buy" in the supply chain literature. An example of forward buy is documented by Mian and Sufi (2009) who analyzed the impact of cash subsidies to trade older polluting vehicles for new ones. They found that the sale of cars in countries that registered higher car sales when the program was in effect declined after the program expired. In other words, "most vehicle purchases induced by the program were borrowed from purchases that would have otherwise occurred in the very near future." Those who advance their car purchase to take advantage of the fiscal stimulus are not likely to buy another car the following year.

Third, earlier research on the LTT in Toronto excluded condominium sales from the analysis. Dachis (2012) and Dachis, Duranton, and Turner (2012) were of the view that condominiums were often sold directly by developers, and not through the Multiple Listing Service (MLS). They argued that condominium sales were systematically underrepresented in the MLS database. We, however, discovered that condominiums, on average, accounted for more than 40 percent of all housing sales recorded by the MLS in the City of Toronto. We have therefore included condominium sales in our analysis because they constitute a sizeable chunk of the market.

Condominiums are significantly cheaper than single-family detached housing and are therefore subject to a lower LTT. In 2007, the average sales price for a condominium in Toronto was \$274,000 compared with \$623,000 for a single-family detached housing unit.

We hypothesize that condominium sales should have increased as a fraction of total housing sales in Toronto after the implementation of the LTT for two reasons. First, being cheaper, condominiums are likely subject to a lower LTT rate because the municipal LTT rate for properties selling for between \$55,000 and \$400,000 is 1 percent. Properties sold at more than \$400,000 are subject to a



rate of 2 percent. Furthermore, first-time homebuyers received a rebate of up to \$3,725. This means that first-time homebuyers received a 100 percent rebate for the municipal LTT if the value of their purchase was under \$400,000.<sup>3</sup>

Fourth, we expand the study area to include all suburban municipalities, which were not subject to the LTT but are part of the Toronto Real Estate Board's market area. In order to estimate a region-wide impact, we do not restrict our analysis to neighbourhoods near the boundaries of the City of Toronto.

### 3. Data and methodology

We based our empirical analysis on monthly housing sales data recorded between July 2002 and June 2011 in the Greater Toronto Area. We extracted data from *Market Watch*, the Toronto Real Estate Board's monthly statistical bulletin on housing sales.<sup>4</sup> *Market Watch* reports summary statistics on housing sales, which are further differentiated by structural housing types and more than 85 local sales districts (Figure 1). We analyzed the entire market area covered by the Toronto Real Estate Board (TREB), because the Greater Toronto Area serves as a single integrated housing market. We assert this because a large number of workers who live in the outer suburbs travel daily to the City of Toronto for work<sup>5</sup> and a smaller, yet significant, number of City of Toronto residents commute to work in the outer suburbs.

Since all TREB districts within the boundary of the City of Toronto (Figure 1) were subject to the LTT, we aggregated the data from those districts into one regional market and called it Toronto. We aggregated the remaining TREB districts into three mutually exclusive regions: West, North, and East (Figure 1). By aggregating the data into four regions, we were able to compare the impact of the LTT on housing sold in the City of Toronto with that on housing sold in the three suburban regions.

In the language of case-control studies, Toronto served as the “treated” group because it is subject to the LTT tax, and the three suburban regions served as “controls” to determine whether the impact of the LTT was uniquely different in Toronto from its “untreated” suburban counterparts.

Table 1 provides summary statistics for the data analyzed in this report.

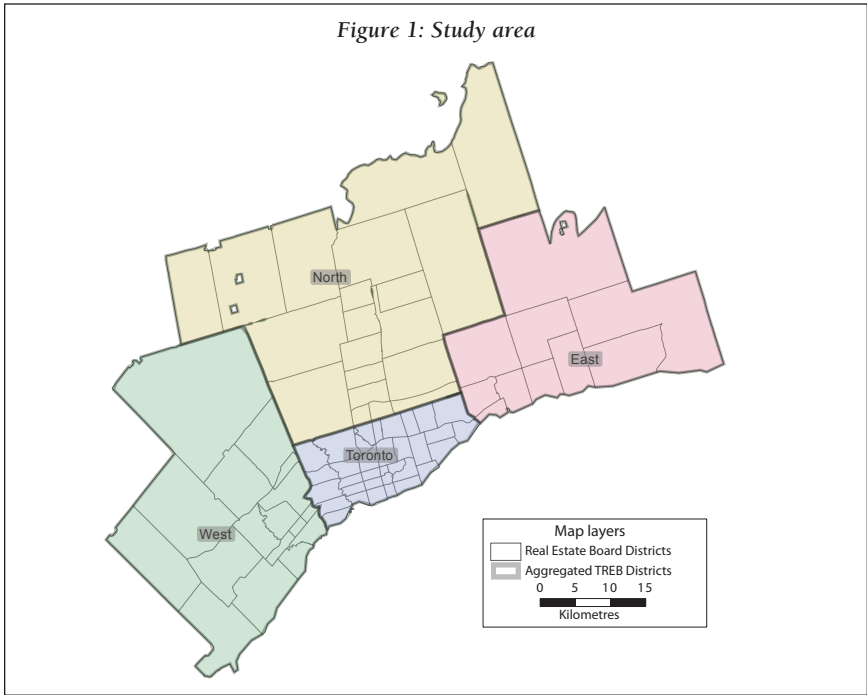
We used interrupted time series analysis (ITSA) to determine the effect of the land transfer tax on housing sales in the Greater Toronto Area. ITSA is suited to

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3. Municipal Land Transfer Tax, first-time home purchaser, rebates. <http://www.toronto.ca/311/knowledgebase/77/101000050177.html>

4. Toronto Real Estate Board. *TREB Market Watch March 2016*, [http://www.trebhome.com/market\\_news/market\\_watch/2016/mw1603.pdf](http://www.trebhome.com/market_news/market_watch/2016/mw1603.pdf)

5. The regional travel demand survey for 2011 showed that commuters living outside the City of Toronto constituted 32 percent of the morning peak-period trips to downtown Toronto.



analyzing the impact of large-scale interventions (such as media campaigns) or public policy changes (such as new laws or taxes) because it explicitly addresses the impact of interventions while accounting for the overall trend over time in sales volume and/or price. Furthermore, ITSA makes it possible to determine the impact of the intervention in the pre- and post-intervention periods. The dependent variable in an ITSA “is observed over multiple equally spaced time intervals before and after the introduction of an intervention which is then expected to ‘interrupt’ the level and/or trend of the dependent variable” (Linden, 2014). ITSA can incorporate one or multiple control and treated groups and can accommodate multiple interventions or triggers.

Since the sales data are longitudinal with monthly observations for each of the four regions, we needed to account for heteroskedasticity and serial autocorrelation. We therefore report Newey-West standard errors, which are robust to heteroskedasticity and serial autocorrelation. The technical formulation of the model is documented in the Appendix.

We studied the long-run impact of the LTT. Restricting the analysis period to monthly sales recorded from July 2002 to December 2008 would exaggerate the adverse impact of the LTT, because households could have advanced their

Table 1: Summary statistics

Results reported for monthly transactions for the four regional markets	Observations	Mean	Std. Dev.	Min	Max
Number of all sales	432	1,772	932	265	4,578
Number of active listings	428	5,018	2,409	1,088	10,656
Number of new listings	432	3,065	1,642	406	8,577
Number of detached sales	432	855	330	172	1,784
Number of semi-detached sales	432	213	149	13	608
Number of condominium sales	432	388	457	11	1,781

home purchases before February 2008 to avoid paying the LTT. Those advance purchases would contribute to a decline in sales in the months immediately after the tax was implemented. Therefore we covered a longer time period – July 2002 to June 2011 – to capture the long-term trends in housing markets. Dachis (2012) also adopts a long-term approach, covering the sales between January 2005 and June 2012.

Dachis, Duranton, and Turner (2012) restrict their analysis to housing sales recorded in TREB districts on the City of Toronto’s municipal boundary. This restriction may exaggerate the impact of the land transfer tax, especially if one generalizes the findings from sales along the City’s boundary to the entire housing market in the GTA. Buyers interested in housing near the municipal boundary are likely to be indifferent to their choice of municipality in the absence of the LTT. When the LTT is imposed in one municipality, these buyers can cross the street (and the municipal boundary) and purchase a house in the adjoining municipality where the LTT is not levied. On the other hand, households interested in purchasing smaller houses (especially condominiums) near the city centre are demographically distinct from those searching for larger homes near the City’s municipal boundary. Generalizing findings from the City’s boundary to the entire housing market while mixing multiple cohorts with distinct preferences, tastes, and housing needs would lead one to exaggerate the impact of the LTT. For this reason, we did not restrict the analysis to properties changing hands along the City of Toronto’s municipal boundary.

Since we extended the study area to include the real estate markets covered by the local real estate board, we could still observe homebuyers’ expected preference

for suburban housing over housing in the City of Toronto in their desire to avoid the LTT. Our model specifications account for the difference in sales between Toronto and its suburbs before and after the LTT was implemented. Furthermore, we differentiated between the rates of sales appreciating over time for Toronto and its suburbs.

#### **4. Findings**

In this section, we answer the questions posed earlier about the effect of the LTT on housing markets in the Greater Toronto Area. First, we present evidence as tabulations and graphics in support of our hypotheses. Later, we test our hypotheses using ITSA to determine the significance of the LTT on housing sales in the GTA.

##### *4.1 Impact of the Great Recession and tightening of mortgage rules on housing sales*

As we mentioned earlier, the LTT was implemented at the same time that other macroeconomic forces and changes in mortgage regulation were at play. Canada experienced a negative GDP growth rate in the first quarter of 2008.<sup>6</sup> Starting in the fourth quarter of 2008, Canada recorded three consecutive quarters of negative GDP growth rate. The U.S. economy was already experiencing the Great Recession. The negative economic news and declining consumer confidence<sup>7</sup> were associated with a decline in consumer spending in Canada.<sup>8</sup> Housing was no exception. At the same time, Canadian regulators tightened mortgage rules (Alexander, Burleton, and Petramala, 2012). The federal government announced tightening of mortgage rules on July 9, 2008, which came into effect on October 15, 2008.

One way to explore our contention is to compare the change in the rate of housing sales in jurisdictions in which the LTT was imposed with jurisdictions in which the tax was not levied. For the GTA, we compare housing sales in the City of Toronto (the treated group) with those in the surrounding suburban municipalities (the control group).

If the LTT were the sole or primary influence on housing sales, the sales recorded in tax-exempted municipalities should not show a decline. We present the results in Table 2. Housing sales in the GTA (relative to 2007) declined by 20 percent in 2008. The City of Toronto led the decline with 23.3 percent fewer sales in 2008 than in 2007. However, municipalities located immediately to the north of the City of Toronto *also* experienced a 22 percent decline in 2008 over 2007. Similarly, housing sales in the western municipalities declined by 15 percent and in the eastern municipalities by 14 percent. If the LTT is the cause for declining

6. Statistics Canada. Real Gross Domestic Product. <http://www.statcan.gc.ca/daily-quotidien/121130/dq121130a-eng.htm>

7. Trading Economics, Canada Consumer Confidence. <http://www.tradingeconomics.com/canada/consumer-confidence>

8. Trading Economics, Canada Consumer Spending. <http://www.tradingeconomics.com/canada/consumer-spending>

sales in 2008 in the City, what is causing the decline in housing sales in the suburban municipalities?

The results in Table 2 offer evidence of the influence of the Great Recession and the Canada-wide tightening of mortgage regulations on housing transactions. The decline in housing sales in the suburban municipalities in the GTA was caused by regulatory and macroeconomic factors other than the LTT.

Year	East	North	Toronto	West	Total
2004	8.77	7.69	5.17	8.32	6.95
2005	-7.45	1.85	1.37	2.6	0.79
2006	2.98	-1.68	0.59	-3.63	-0.82
2007	9.24	12.63	13.65	10.95	12.21
2008	-13.98	-21.63	-23.38	-15.09	-19.75
2009	6.1	25.97	18.08	13.16	16.83
2010	1.56	-3.28	-1.8	0.24	-1.19

Source: Toronto Real Estate Board. Calculations by the authors.

#### 4.2 Did “forward buy” increase sales in 2007?

Table 2 also suggests the presence of “forward buy” – that consumers advanced their housing purchases to 2007 in anticipation of the LTT in 2008. A scan of news media revealed that the LTT was mentioned in 473 news items in 2007, suggesting wide coverage of the proposed tax. In contrast to 2006, when housing sales declined by 0.82 percent in the GTA, regional housing sales rose unexpectedly by 12.2 percent in 2007. Again, the City of Toronto led the charge and reported a 13.7 percent increase in sales in 2007 over 2006. Municipalities to the North followed with a 12.6 percent increase in year-over-year sales in 2007. If it were not for the LTT, what explains the rise in sales in 2007?

Another question is why we see an increase in sales in 2007 in the suburban municipalities where the tax was not levied. Our consultation with real estate brokerages suggests that consumers were slightly confused about the jurisdictional extent of the LTT and erroneously assumed that it would apply to suburban jurisdictions and hence advanced their purchases to 2007. However, we lack data that would support this hypothesis.

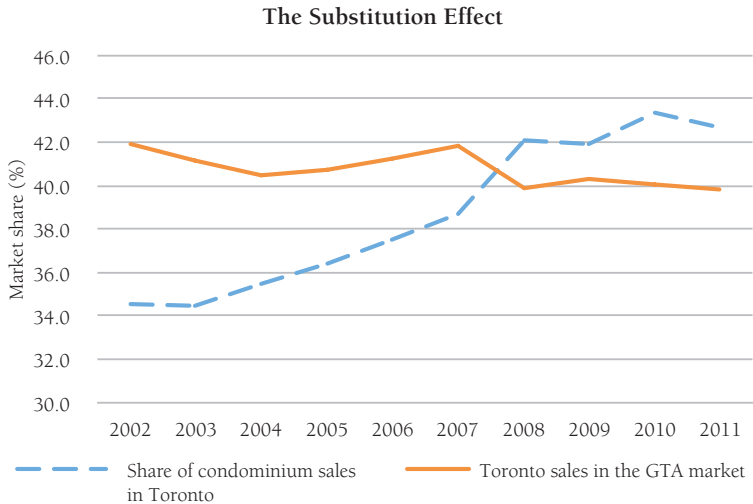
### 4.3 The regional effects

We expect the LTT to induce two substitution effects in the GTA's housing markets. Because condominiums are significantly cheaper (and smaller) than most freehold properties, they are subject to a lower LTT rate. Furthermore, condominium buyers are more likely to benefit from the first-time homebuyer rebate, which reduces the tax to zero dollars for units under \$400,000. Therefore, we expect consumers to increase their preference for condominiums or cheaper housing units in the City of Toronto to limit their exposure to the LTT.

We have earlier argued that the GTA is one integrated housing market in which the LTT affects housing sales only in the City of Toronto. This should mean that homebuyers will prefer housing in suburban municipalities that are not subject to the LTT. We provide evidence for both assertions in Figure 2, which shows a sudden upward shift in the slope in 2008 for the condominium market share in the City of Toronto. At the same time, Figure 2 shows a sudden decline in 2008 for the City of Toronto's share in the GTA housing market.

Figure 2 leads us to conclude that consumer preferences evolved because of the LTT so that buyers increasingly preferred condominiums to freehold housing and suburban municipalities to the City of Toronto. We explore these trends further using ITSA in the following section.

Figure 2: Increase in condominium share in the City of Toronto and a decline in Toronto's share in the GTA housing market



#### 4.4 Interrupted time series analysis of housing sales in the GTA

Essentially, we have estimated ordinary least squares (OLS) regression models with housing sales as the dependent variable. We report Newey-West standard errors, which are heteroskedasticity and serial autocorrelation consistent. The explanatory variables are typical of an ITSA model and include *Time Trend*, *LTT*, and *Toronto*.

*Time Trend* is effectively a counter that starts at 1 for July 2002 and adds increments of 1 each month to reach 108 by June 2011. *Time Trend* controls for the overall trend in housing sales until the intervention in February 2008.

*LTT* is a dichotomous variable that takes the value of 1 for Toronto starting February 2008 and 0 otherwise. *LTT* accounts for the immediate effect of the tax. *LTT\*Time Trend* is the interaction between the two variables, controlling for the time trend after the imposition of the tax; that is, time trend effects as of March 2008.

*Toronto* is a dichotomous variable that serves as a constant for Toronto and controls for Toronto-specific effects. *Toronto\*Time Trend* controls for the time trend in advance of the intervention in February 2008. *Toronto\*LTT* is the interaction between the two variables and accounts for the immediate effect of the tax in Toronto, which in a case-control study is in addition to the impact of the variable *LTT* that would account for the impact of the tax in the suburban communities. *Toronto\*LTT\*Time Trend* accounts for the post-intervention time trend for Toronto, which in a case-control study is in addition to the time trend effect controlled for by *LTT\*Time Trend* for the suburban municipalities.

We differentiate the analysis by the structural type of housing. We first report aggregated results for housing of all types (Table 3). We then present separate models for the three housing types (detached, semi-detached, and condominiums). The first column does not differentiate between the treated (City of Toronto) and control (suburban municipalities) groups and reports the results for the entire region. The second column reports the results for a specification that captures the impact of the LTT on the treated and control groups separately. Both models report statistical significance using Newey-West standard errors that are heteroskedasticity and autocorrelation consistent.

The results presented in the first column of Table 3 indicate that the immediate effect of the LTT was 618 fewer transactions. However, the coefficient is not statistically significant at the 5 percent level. We also see that after the imposition of the tax, housing sales increased by 4.7 per month; however, the coefficient is statistically insignificant.

The second column shows that the immediate effect of the LTT was 182 fewer transactions in the suburban municipalities, but the coefficient is not statistically significant. A positive coefficient for *Toronto* (the dummy variable controlling for the City of Toronto) suggests that the sales volume in the City of Toronto was

statistically higher than that in the suburban municipalities. In other words, in any given time period, more sales are recorded in Toronto than in the suburban municipalities.

However, the negative, yet again statistically insignificant, coefficient for *Toronto\*LTT* suggests that although the City of Toronto recorded 436 fewer sales (in addition to 182 fewer sales in the suburban municipalities) immediately after the LTT was imposed, the coefficient was statistically insignificant.

The positive coefficient for *Toronto\*LTT\*Time Trend* in the second column suggests that after the LTT was imposed, housing sales in the City of Toronto increased more rapidly over time than in the suburban municipalities. However, the coefficients are statistically insignificant at the 5 percent level.

Table 3: ITSA results, all housing types

	Single Group Analysis	Multiple Group Analysis
Variable	Detached Sales	(Newey-West standard errors)
Time Trend until the introduction of the LTT	10.43*	3.99
LTT: Immediate effect of the LTT on sales	-618.33	-182.05
Interaction of (Time) and LTT	4.68	2.54
Treated group (1 for Toronto and 0 otherwise)		1284.68***
Interaction of Toronto and Time Trend		6.44
Interaction of Toronto and LTT		-436.28
Interaction of Toronto, Time Trend, and LTT		2.15
Cons	2517.77***	1233.09***
N	108	432

Legend: \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$

The impact of the LTT on single-family detached housing indicates similar results in Table 4 to those reported in Table 3. We do not find statistically significant evidence of a decline in single-family detached housing sales resulting from the LTT. We conclude the same for semi-detached housing (Table 5).

We observe interesting results for condominium sales in the GTA (Table 6). We find statistically significant evidence for higher condominium sales in Toronto, which implies that condominium sales were 727 units higher in Toronto than in



the suburban municipalities. Furthermore, we observe that housing sales increased at a higher rate (5.6 units per month) before the imposition of the tax in Toronto compared with the suburban municipalities. However, we still did not find a statistically significant effect of the LTT on condominium sales.

Table 4: ITSA results, single-family detached housing

	Single Group Analysis	Multiple Group Analysis
Variable	Detached Sales	(Newey-West standard errors)
Time Trend until the introduction of the LTT	2.28	2.32
LTT: Immediate effect of the LTT on sales	-273.52	-104.09
Interaction of (Time) and LTT	2.31	1.70
Treated group (1 for Toronto and 0 otherwise)		326.56***
Interaction of Toronto and Time Trend		-0.04
Interaction of Toronto and LTT		-169.44
Interaction of Toronto, Time Trend, and LTT		0.60
Cons	1015.09***	688.53***
N	108	432

Legend: \* p<0.05; \*\* p<0.01; \*\*\* p<0.001

## 5. Interpreting the results

That correlation cannot be confused with causation is perhaps the primary lesson drawn from the results presented in this study. Housing sales declined immediately after the LTT was imposed in the City of Toronto. It may be convenient to hold the LTT responsible for the decline, but in this study, we find little evidence to support the assertion that the LTT alone was responsible for the decline.

The impact of the Great Recession and the tightening of mortgage regulations in Canada in 2008 on housing markets cannot be ignored. If the LTT were the only factor at play, we would not have observed a decline in housing sales of similar magnitude in the suburban housing markets that were not subject to the LTT. We provide empirical evidence to establish that the housing markets elsewhere in the GTA experienced declines in sales as well.

We also highlight the fact that consumers advanced their housing purchases to 2007 to avoid the LTT and the newer, more stringent mortgage regulations, which raised the minimum down payment threshold and reduced the maximum

	Single Group Analysis	Multiple Group Analysis
Variable	Detached Sales	(Newey-West standard errors)
Time Trend until the introduction of the LTT	0.76	0.48
LTT: Immediate effect of the LTT on sales	-84.72	-22.78
Interaction of (Time) and LTT	0.27	-0.17
Treated group (1 for Toronto and 0 otherwise)		200.50***
Interaction of Toronto and Time Trend		0.28
Interaction of Toronto and LTT		-61.94
Interaction of Toronto, Time Trend, and LTT		0.44
Cons	348.66***	148.16***
N	108	432

Legend: \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$

	Single Group Analysis	Multiple Group Analysis
Variable	Detached Sales	(Newey-West standard errors)
Time Trend until the introduction of the LTT	6.33***	0.72
LTT: Immediate effect of the LTT on sales	-182.77	-16.03
Interaction of (Time) and LTT	1.42	0.43
Treated group (1 for Toronto and 0 otherwise)		727.01***
Interaction of Toronto and Time Trend		5.61***
Interaction of Toronto and LTT		-166.75
Interaction of Toronto, Time Trend, and LTT		0.99
Cons	833.76***	106.75***
N	108	432

Legend: \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$

amortization period for mortgage loans. We believe that the tightening of mortgage rules would have a lesser impact in advancing housing purchases to 2007 because the changes were implemented much later in 2008. The rapid increase in housing sales in 2007 makes sense if one were to acknowledge the consumers' intent to avoid the impending additional taxes and stricter mortgage regulations. Since these changes in policy overlapped in time, we are limited in our ability to differentiate between the effects of the two policy changes or to isolate their impact from that of the LTT.

We find evidence in support of our assertion that even though housing sales declined in one part of the regional housing market (the City of Toronto), the sales picked up in other parts (the suburban markets). Dachis, Duranton, and Turner (2012) also highlight the distortionary impact of the LTT. This substitution in housing location was motivated by the consumers' desire to avoid the LTT. From the perspective of the regional housing market in the GTA (and not just in the City of Toronto), the impact of the LTT may not be as drastic, because the suburbs picked up some sales that were lost in the City of Toronto. Similarly, the sudden increase in condominium sales in 2008 in the City of Toronto offers further proof of the substitution effect in the housing market where consumers opted for cheaper housing units, especially condominiums, which were subject to a lower LTT rate (or to rebates for first-time home buyers).

## **6. Conclusions**

The GTA and other large urban centres in Canada experienced declines in housing sales in 2008. Previous research suggested that the LTT caused the decline in housing sales in the City of Toronto. In this study, we show that other macro-economic factors and market regulations also contributed to the decline in sales. The Great Recession and stricter mortgage regulations, introduced in 2008, also depressed housing sales and were felt all across Canada.

Since consumers were aware of the imposition of the LTT in the City of Toronto, we believe that many buyers advanced their housing purchases to 2007, a phenomenon referred to as forward buy, to avoid paying higher taxes and mortgage costs. These factors explain at least part of the extraordinary increase in housing sales in 2007 in the GTA and the subsequent decline in housing sales in 2008.

We also find evidence for two separate substitution effects. Realizing that the LTT increased transaction costs in Toronto, we found that consumers in 2008 increasingly purchased housing in the suburban municipalities, which were not subject to the LTT. At the same time, consumers increased their purchase of cheaper housing units, predominantly condominiums, which are subject to a lower LTT rate, to minimize their transaction costs.

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## 8. Appendix

ITSA is uniquely powerful for analyzing outcomes resulting from quasi-experiments where the data is available to test the impact of interventions, even when the outcomes being analyzed were not part of a controlled experiment. For instance, Li et al. (2013) used ITSA to explore a decline in burglaries associated with the enforcement of no-cold-calling restrictions, which reduced unsolicited visits by vendors.

Lagarde (2011) illustrates the use of ITSA for applications in health research where the focus is on determining the impact of policy changes, such as eliminating user fees at hospitals, after controlling for the treated and control groups. Catalano et al. (2000) used ITSA to determine the increase in psychiatric emergencies among those who receive income supplements from the government. Commonly referred to as the “check effect,” the authors found an immediate increase in psychiatric emergencies after the disbursement of income support.

Humphreys, Eisner, and Wiebe (2013) used ITSA to determine changes in the frequency of violence after time restrictions on serving alcohol were eliminated. They found support for an increase in violence in the early morning hours. A similar study of changes in drunk driving laws in California revealed an ex-post decline in death rates involving automobile collisions (Ray, 1989).

We implement ITSA using an ordinary least squares estimation routine. However, we report the Newey-West standard errors, which are heteroskedastic and serial correlation consistent. We account for first-order auto-regressive process in the Newey-West regressions. Following Linden (2015), the basic model formulation is presented in the following equation:

$$Sales_t = \beta_0 + \beta_1 T + \beta_2 LTT_t + \beta_3 T * LTT_t + \varepsilon_t \quad (1)$$

$Sales_t$  reports housing sales in the Greater Toronto Area (GTA).

$T$  represents the time in months (1, 2, 3, ...) since the start of the study period (July 2002).

$LTT_t$  is a dummy variable representing the intervention (Land Transfer Tax) and is 0 for the pre-intervention period (from July 2002 to January 2008), and 1 otherwise.

$T*LTT_t$  is an interaction term.

$\beta_0$  is the intercept representing the starting level of the outcome variable.

$\beta_1$  is the slope or trajectory for sales until the introduction of the LTT in February 2008.

$\beta_2$  accounts for the immediate treatment effect of the LTT on sales.

$\beta_3$  determines the difference in slopes before and after the implementation of the LTT.

We also implement the treatment and control version of the model by implementing the multiple group strategy. The baseline model for multiple groups is presented below.

$$Sales_t = \beta_0 + \beta_1 T + \beta_2 LTT_t + \beta_3 T*LTT_t + \beta_4 Z + \beta_5 Z*T + \beta_6 Z*LTT + \beta_7 Z*T*LTT + \epsilon_t \quad (2)$$

$Z$  is a dummy variable representing the treated group (1 for Toronto and 0 otherwise).

$Z*T$ ,  $Z*LTT$ , and  $Z*T*LTT$  are all interaction terms and are interpreted the same way as we have described for Equation 1.

Coefficients  $\beta_0$  to  $\beta_3$  represent the control group (suburban districts in East, West, and North regions).

$\beta_4$  to  $\beta_7$  are the coefficients for the treated group (the City of Toronto).

$\beta_4$  represents the difference in the level (intercept) of sales between the City of Toronto (treated) and the other regions (control groups) prior to the implementation of the LTT.

$\beta_5$  represents the difference in the slope (trend) of sales between the City of Toronto and the other regions prior to the intervention.

$\beta_6$  controls for the difference in the level of sales between the City of Toronto and the other regions immediately after the introduction of the LTT.

$\beta_7$  accounts for the difference in the slopes of sales between the City of Toronto and the other regions (control groups) post LTT.  $\beta_7$  can be interpreted as the difference-in-difference of the slopes (Linden, 2015).

The resulting data structure is presented in the following table.

Table A1: Structure of the data set in the case-control setup

Region	Time trend (T)	LTT	LTT * Time	Toronto (Z)	Toronto * LTT	Toronto * LTT * Time
Toronto	1	0	0	1	0	0
Toronto	2	0	0	1	0	0
Toronto	3	1	0	1	1	0
Toronto	4	1	1	1	1	1
Toronto	5	1	2	1	1	2
Toronto	6	1	3	1	1	3
North	1	0	0	0	0	0
North	2	0	0	0	0	0
North	3	1	0	0	0	0
North	4	1	1	0	0	0
North	5	1	2	0	0	0
North	6	1	3	0	0	0

Baum (2006: 139) recommends that when faced with heteroskedasticity and autocorrelation (HAC), one should rely on variance covariance estimators that are heteroskedastic and autocorrelation-consistent. One such estimator is the Newey-West estimator that adjusts for heteroskedasticity and autocorrelation. Baum (2006: 199) recommends another HAC-consistent estimator (*ivreg2* in Stata) for standard errors using the instrumental variable and Generalized Method of Moments (GMM) approach. The *ivreg2* routine, using GMM, offers more efficient estimates if the estimated equation is over-identified.

We estimated our models using the user-written command, *itsa*, in STATA 13. The methods are described in detail in Linden (2015).

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