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The Maple Bubble: A History of Migration among Canadian Provinces[1]

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[1] *Disclaimer: The findings, recommendations, interpretations and conclusions expressed in this paper are those of the authors and not necessarily reflect the view of the Banco de la Republica or its Board of Directors.*

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Abstract

This study reports evidence of the existence of house price bubbles in several Canadian provinces around the recent global financial crisis. Using a wealth of monthly data for about a thirty-year period we find evidence supporting the hypothesis that the bubble in Quebec transmitted to four other Canadian provinces. Using a recently developed migration test, we show evidence of time-varying transmission intensities. In all cases an inverted U-shape is encountered, suggesting that initially migrations gain strength and then decrease after a maximum point is reached. Interestingly, intensities increase significantly around the maximum point of the bubble in Quebec. Our results have important implications for the design of housing market policies.

JEL Classification*:* G01; G12; C22.

Keywords*: Housing bubbles; Bubble transmission; Recursive right-tailed unit root tests; Canada.*

1 Introduction

Several analysts coincide that Canadian house price growth during the last decade has been excessive. In fact, in the second semester of 2016 the Bank of Canada ramped up its concerns regarding heavily indebted households and the unreasonable expectations driving the continuous price increases in the housing market. Warnings about a possible bubble have been raised. According to the latest Organization of Economic Cooperation and Development (OECD) statistics, current prices in Canada relative to economic fundamentals such as household income or rent are on record high levels, being comparable only to those in Australia and Belgium.

Surprisingly, while the case of Canada has received important attention in policy circles and in the news, only a small number of papers have studied the housing price bubble in this country (see, for instance, Macdonald, 2010; Walks, 2014; and, Head and Lloyd-Ellis, 2016). While they coincide in the excessive growth of the price-to-rent ratio in the country, they also emphasize in the heterogeneous behavior of this ratio among Canadian provinces. For instance, Head and Lloyd-Ellis (2016) point-out that while Quebec, Vancouver and Victoria present the highest overvaluations, other provinces such as Calgary and Edmonton exhibit certain degree of undervaluation. Additionally, these papers show that there ia also important heterogeneity in the periods of price exuberance.

In this paper we use the bubble identification and date-stamping methods proposed by Phillips et al. (2011, PWY hereafter) and Phillips et al. (2015, PSY hereafter) to study the existence of bubbles in Canadian housing markets. Instead of focusing in the aggregate house price index of the country, we use data from several Canadian provinces. This strategy has the advantage of recognizing the heterogeneous nature of local housing markets and allows us to test for possible bubble transmissions within provinces.

The issue of regional transmission of housing bubbles within a given country has received little attention in the literature. Few papers in the topic have focused in the cases of China (Shih et al., 2014, and Deng et al., 2017) and New Zealand (Greenaway-McGrevy and Phillips, 2017 GP hereafter). Notably, up to our knowledge bubble transmission within Canadian provinces has not been studied at all. We contribute to the literature by studying the existence and regional transmission of housing market bubbles among Canadian provinces. Using monthly housing price and rent data for a set of nine provinces for the period comprised between January 1986 and September 2016, we encounter at least one bubble for all but one of these provinces (New Brunswick). Following the center-periphery literature, we consider transmissions originating in a bubble in Quebec, and find evidence of four episodes of bubble transmission (to Alberta, British Columbia, Newfoundland and Labrador, and Saskatchewan).

Using a recently developed method, we study the dynamics of bubble contagion and find a diversified behavior of intensities. In some cases, as for Alberta and Saskatchewan, an inverted U-shape relation is encountered with maximum values located around the end of the global financial crisis. In other cases, as for British Columbia, the same shape is found but with a maximum value in the beginning of the subprime financial crisis. Other provinces exhibit flat shapes, corresponding to no transmission. In all cases, the intensity of transmission has been decreasing for the last few months, probably predicting the end of the bubbles in the Canadian housing markets.

Our results have important policy implications. We encounter that the formation of bubbles coincides with a period of time in which historically low interest rates persisted in Canada. This finding coincides with the predictions of several studies that show that prolonged periods of monetary policy easing increase financial vulnerability (see, for instance, Maddaloni and Peydro, 2011; Dell'Ariccia et al., 2013; Jimenez et al., 2014; and, Cecchetti et al., 2017). In that sense, our results provide further evidence of the important collateral effects that monetary policy relaxation may have on credit, asset prices and overall financial stability. Central banks should account for these collateral effects when designing interest rate policies.

Additionally, we provide evidence that housing price bubbles may migrate. In that sense, our results go in line with those of Gomez-Gonzalez et al. (2017a, GG hereafter) who show that the United States housing bubble that gave origin to the subprime financial crisis was transmitted to other OECD countries, and those of GP who find that bubbles migrate within regions in New Zealand. Altogether, the findings of these papers call for policy actions focused in preventing contagion. In the context of international transmission of bubbles, capital controls may be an effective prudential measure of reducing the intensity of transmission. In the case of local migrations, other tax policies and caps on the maximum levels of household leverage may prove useful in controlling contagion.

The remainder of this paper is organized as follows. Section 2 presents a brief literature review. Section 3 shows the methodological framework in which our empirical analysis is based. Section 4 describes the data used in this paper. Results are shown in Section 5, and finally Section 6 concludes.

2 Literature Review

House price bubble detection has been widely studied in the literature. The first detection methods follow the present value model under the assumption of rational bubbles. Early proposals include Shiller's variance bound test (Shiller, 1981), and West's two-step test (West,1987). Campbell and Shiller (1987) and Diba and Grossman (1988) introduced the (perhaps) most commonly used methods for detecting asset price bubbles in the literature, namely the right-tailed unit root test and the co-integration test.

Standard right-tailed unit root tests, however, suffer from a serious limitation pointed-out by Evans (1991), who shows that they lose significant power to detect explosive bubbles when the sample data includes multiple bubbles that emerge and collapse. Different alternative approaches have appeared in the literature to deal with Evans' critique. In a recent paper, PSY propose an Augmented Dickey-Fuller (ADF) test that improves power significantly with respect to the conventional unit root and co-integration tests, and allows estimating the origination and final dates of the bubble.

The PSY test has been extensively used recently for detecting bubbles in different financial markets, including stock markets (Lee and Phillips, 2016; Deng and Xie, 2017; Chuliá et al., 2017, among others), commodity markets (for instance, Etienne, 2016; Alexakis et al., 2017), energy markets (Narayan and Narayan, 2017), exchange rates (Maldonado et al., 2016), and housing prices (for example, Anundsen et al., 2016 and Gomez-Gonzalez et al, 2017b). Almost all of these papers have encountered several episodes of bubbles in different markets, many of them related to the recent international financial crisis.

A lower amount of papers have studied the phenomenon of bubble migration. However, regarding the housing market there is a growing literature suggesting the interdependence between national and global house prices (Vansteenkiste, 2009 and Cesa-Bianchi, 2011). Moreover, regarding the regional transmission of shocks, Vansteenkiste (2007) shows that house price shocks in California are an important factor driving prices in other US states. Up to our knowledge, there are only three papers in the literature studying the regional migration of house price bubbles in the context of a single country. Two of them study the case of China (Shih et al., 2014, and Chen et al., 2017), while the other studies the case of New Zealand (GP). All three papers report evidence of regional transmission of housing bubbles.

3 Model Specification and Econometric Approach

3.1 Baseline model

Our starting is point a standard asset-pricing equation, given by

$$P_t = \sum_{i=0}^{\infty} \left(\frac{1}{1 + r_f} \right)^i E_t(D_{t+i}) + B_t, \tag{1}$$

where P_t is the after-dividend price of the asset at time t, the payoff received from the asset at time $t + i$ is D_{t+i} (i.e. dividend, housing rent), B_t is the bubble component and r_f is the risk-free interest rate.

The quantity $P_t^f = P_t - B_t$ is called the the market fundamental price, with B_t satisfying a submartingale property,

$$E_t(B_{t+1}) = (1 + r_f)B_t. \tag{2}$$

The condition for the absence of bubbles is $B_t = 0$, which means that the asset price is equivalent to its fundamental value $P_t = P_t^f$. Meanwhile, if $B_t \neq 0$, $P_t \neq P_t^f$ which embodies an explosive behavior caused by the submartingale property of the bubble component. This explosive property is different to the unit root process that can be present in the P_t^f given that D_t is a martingale, as it is commonly assumed in the literature. The run-up rate of the bubble component is greater than the fundamental price, giving origin to an explosive behavior of the asset price.

3.2 Testing for Bubbles

PWY show that a sufficient condition for the existence of a bubble consists in the detection of an explosive behavior in the price-to-dividend ratio. They propose the application of recursive right-tailed unit root tests using the price-to-dividend ratio P_t/D_t (the price-to-rent ratio in our case) as the dependent variable. The implementation is based in the augmented Dickey Fuller (ADF) unit root test. PSY argue that the PWY procedure is affected by the existence of multiple bubbles and fails to be consistent. PSY (2013) then propose a generalized version of the sup ADF test of PWY (*GSADF*). They demonstrate that the GSADF test improves the discriminatory power and has a better treatment of multiple bubbles.

The GSADF statistic is used for testing the existence of at least one bubble in the entire sample. It is computed as the global supremum ADF statistics of the form:

$$GSADF(r_0) = \underset{r_2 \in [r_0,1], r_1 \in [0, r_2 - r_0]}{sup} ADF_{r_1}^{r_2}, \tag{3}$$

and the empirical regression is,

$$\Delta p_t = \alpha_{r_1,r_2} + \beta_{r_1,r_2} p_{t-1} + \sum_{i=1}^{k} \psi_{r_1,r_2}^{i} \Delta p_{t-i} + \epsilon_t \tag{4}$$

where p_t stands for the price-dividend ratio, k is the lag order and $\epsilon_t \overset{\text{i.i.d}}{\sim} N(0, \sigma_{r_1,r_2}^2)$. r_1 and r_2 are fractions of the whole sample. The regression is computed using a window size given by $r_w = r_2 - r_1$. Notice that in the SADF the start point r_1 is fixed while in the GSADF both, the beginning and ending of the sample is changing for a recursive estimation.

3.3 Date stamping

When the GSADF rejects the null hypothesis, there is evidence of the existence of at least one bubble in the sample. To determine the origination and collapse of each bubble, we follow the date stamping strategy of PSY (2013) who suggest a *Backward sup ADF test* (BSADF). The BSADF test performs an SADF test on a backward expanding sample,

$$BSADF_r(r_0) = \sup_{r_1 \in [0, r-r_0]} ADF_{r_1}^r. \tag{5}$$

Then, the origination date is estimated as the first time the BSADF statistic exceeds the critical values sequence, and the end is estimated as the first chronological observation after $\delta * log(T)$ periods whose BSADF statistic goes below critical values.

3.4 Migration tests

For analyzing bubble transmission we follow the approach of Phillips and Yu (2011, PY hereafter) and the extension presented by GP. In PY, the coefficient measuring bubble transmission is time-invariant, and it is used to construct a t-type test with a null hypothesis of no transmission. GP extend the PY model allowing the migration coefficient to be time-varying. Considering that PW is a particular case of the latter, we briefly expose the GP approach. A similar approach is proposed by GG. In our particular case, we analyze bubble transmission between Canadian provinces.

Let $\hat{\beta_{i,s}}$ be the slope coefficient of equation (4) for province i at an ending date of the subsample $s = S, ..., T$, and $\hat{\beta_{core,s}}$ the same slope coefficient but for the province in which the initial bubble originated. We fit the following regression for each province:

$$\hat{\beta}_{i,s} = \delta_i + \gamma_i \left(\frac{s}{T-S+1} \right) \hat{\beta}_{core,s-d} + error_s, \quad \forall\ i \neq core,\ for\ s = S, ..., T. \tag{6}$$

where S is the initial date. In this paper *core* is the province of Quebec (QC) and d is a delay parameter which is chosen for the equation 6 with the highest R^2.
It is important to note that under the GP approach the parameter γ_i is time-varying. This approach has the advantage of capturing the transition dynamics. We expect that bubble migration process exhibits an inverted U-shape, consistent with an initial strengthening up to a maximum point after which the intensity of migration diminishes.

4 Data

In this paper we study a province-level housing bubble migration in Canada. Following center-periphery models, we focus on migrations originating in Quebec, which is the province in which the first bubble appeared according to our date-stamping results. Additionally, Quebec is one of Canada's most important provinces[1], and several reports point-out that the current bubble might have originated there. Our dataset consists of nominal house price indexes for each Canadian province ($P_{i,t}$) as well as the rent component of CPI as a proxy of the housing dividend ($D_{i,t}$). Similar data has been used in the related literature (see, for instance, Shi et al., 2016, GP and GG). Data is obtained from the Canadian agency

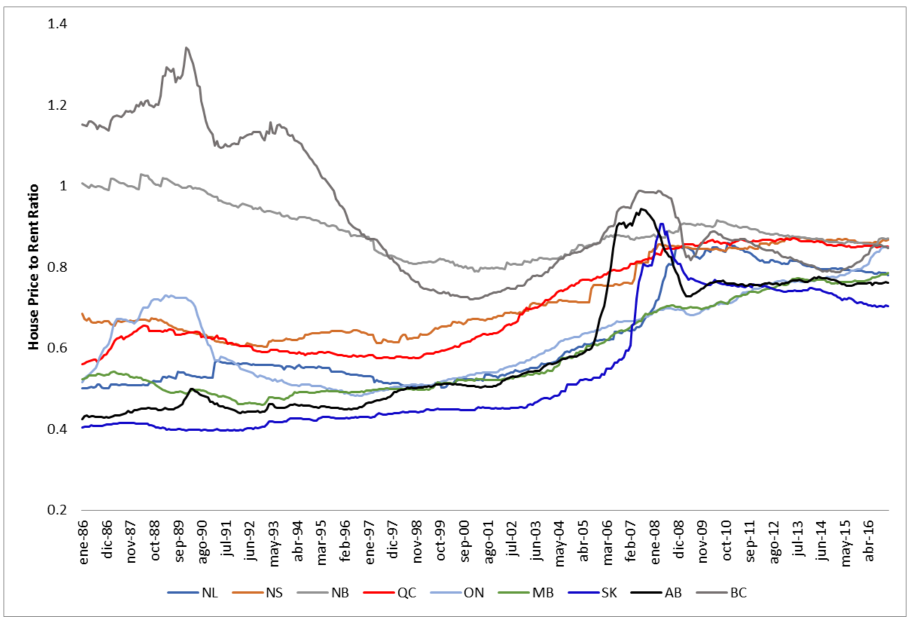

Figure 1: House Price-to-Rent ratio by Province

of statistics (Statistics Canada) on a monthly basis from January 1986 to January 2017 (over 30 years of data). The house price index is measured by the *New Housing Price Index* for house only [2] We have information for the following ten provinces: Newfoundland and Labrador (NL), Prince Edward island (PE), Nova Scotia (NS), New Brunswick (NB), Quebec (QC), Ontario (ON), Manitoba (MB), Saskatchewan (SK), Alberta (AB) and British Columbia (BC). PE information

[1]Quebec is the second province in terms of population in 2016, as well as participation of the National GDP in 2015, only surpassed by Ontario

[2]Land and Total are disposable too in the Statcan web page.

begins in January 1995, for that reason it is excluded of our analysis. For the 9 remaining provinces we computed the price-to-rent ratio and applied the methodology described before.
Figure 1 shows the behavior of the price-to-rent ratio in these nine provinces. Two different periods of exuberant behavior can be eye-inspected. The first occurs around 1988, and is particular of British Columbia. This explosive increase in the price-to-rent ratio ends by the end of 1989. The second episode begins around 2000, and is general to most Canadian provinces. Interestingly it appears to start first in Quebec and also to be more enduring in this province.

5 Results

5.1 Bubble detection and date-stamping

We apply the methodologies described in sections 3.2 and 3.3 for the price-to-rent of each of the nine provinces. In order to compute the GSADF and the BSADF statistics we use a minimum window size of 40 periods (more than 3 years). [3] We find evidence of at least one episode of exuberance in each province except for New Brunswick, as it is shown in Table 1.[4] Figure 2 illustrates the GSADF test results. Provinces are colored in different tones of blue, depending of the value of their GSADF. The darkest the province is colored the highest its GSADF statistic.[5]
Confirming our eye-inspection, it is noticeable that Quebec is the first province in which a bubble emerged. It is also quite important that most bubbles burst around the peak of the Global Financial Crisis, although for some cases (Ontario and Manitoba) the bubble phenomena has not stopped yet.

[3] It is consistent with the strategy proposed by PSY in which the window length must be a proportion $r0 = 0.01 + \frac{1.8}{\sqrt{T}}$ of the total sample T.

[4] Table 1 presents additionally the dates for which bubbles were encountered.

[5] Date-stamping figures are showed in the Appendix A

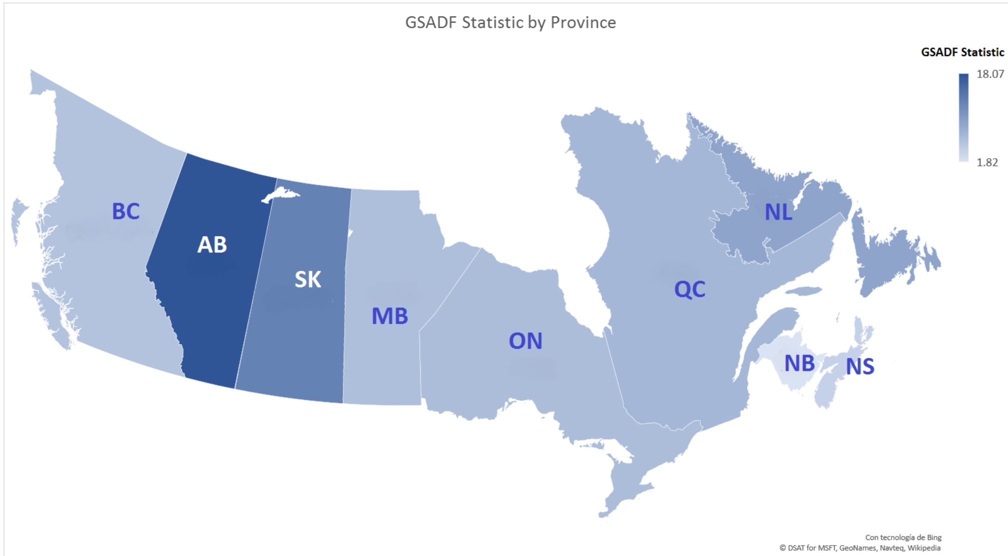

Figure 2: GSADF Test by Province

Province	GSADF stat	Period
Canada	12.7459***	Feb-2002 - Mar-2009
Newfoundland and Labrador	9.0779***	Aug-2007 - Aug-2011
Nova Scotia	3.8359***	May-2007 - Mar-2009
New Brunswick	1.816	NA - NA
Quebec	6.8768***	Jan-2001 - Aug-2012
Ontario	6.1659***	Oct-2002 - Jan-2017
Manitoba	5.9775***	Dec-2004 - Jan-2017
Saskatchewan	12.9268***	Mar-2004 - Apr-2009
Alberta	18.0747***	Oct-2003 - Jun-2008
British Columbia	5.5011***	Jan-2004 - Jun-2008

Significance at 1%(***), 5% (**) and 10% (*)

Table 1: GSADF Test

Note also that the episode of exuberance reported in BC in the late 1980s is not identified as a bubble. Probably, the reason is that this period of high house price inflation was not long enough. Recall that our minimum window size is of 40 months.

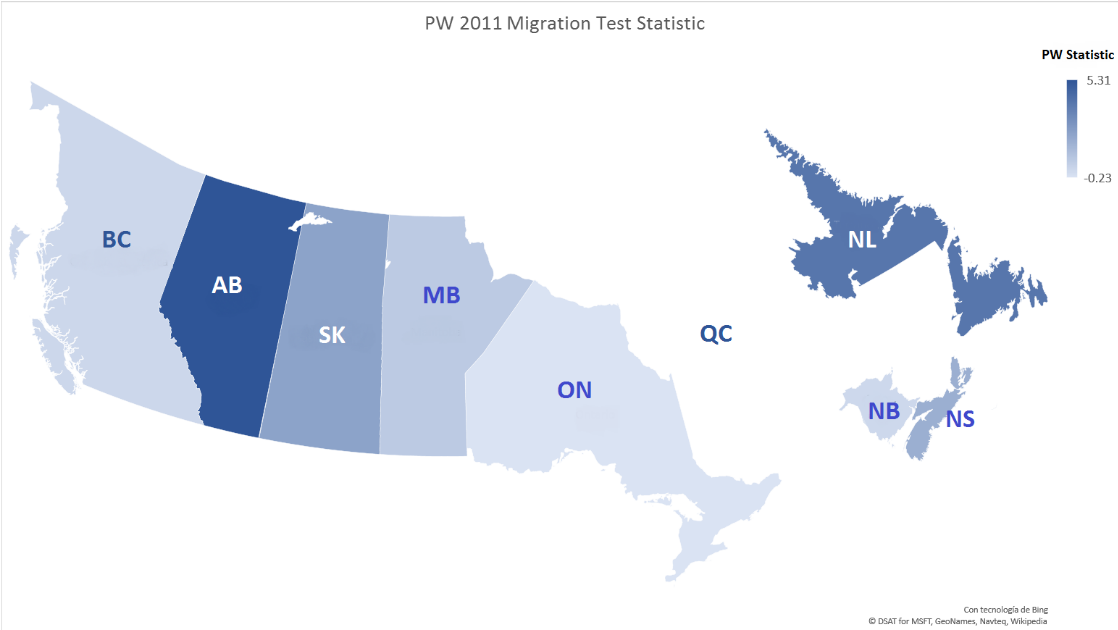

Figure 3: Migration Test by Province

5.2 Migration tests

We now emphasize on housing bubble migration between provinces. After identifying bubble periods for each province, we test for possible migrations of the housing bubble originated in Quebec to the remaining provinces. In order to account for this issue, Figure 3 shows the test statistic developed by PY for each province, while Table 2 presents the statistic significance and the period for which migration is tested. We find bubble migration from Quebec to Alberta (darkest zone in the map), Newfoundland and Labrador, Saskatchewan and Nova Scotia, while there is no evidence of transmission to other provinces. Regions for which migration is significant are also those with the highest GDP per capita, except for New Scotia.

Province	PY Stat	Period
Alberta	5.31***	May-2004 - Aug-2006
Saskatchewan	2.29**	May-2004 - Jun-2007
Nova Scotia	1.80**	May-2004 - Mar-2008
Newfoundland and Labrador	4.02***	May-2004 - Nov-2008

Significance at 1%(***), 5% (**) and 10% (*)

Table 2: Phillips and Yu Migration Test: Quebec is the origin

As we mentioned before, we also adopt the approach proposed by GP. Figure 4 shows the time-varying migration coefficient for provinces in which the PY tests exhibits migration. The shaded area corresponds to the whole duration of the Quebec's bubble. Dotted lines refer to peaks in the bubble. Particularly important, the red line corresponds to the peak of the Quebec bubble. In this case notice that each of the time-varying coefficients became steeper after this point for the four provinces for which evidence of transmission is obtained. All of these provinces present an inverted U-shape graphs, consistent with the expected result.

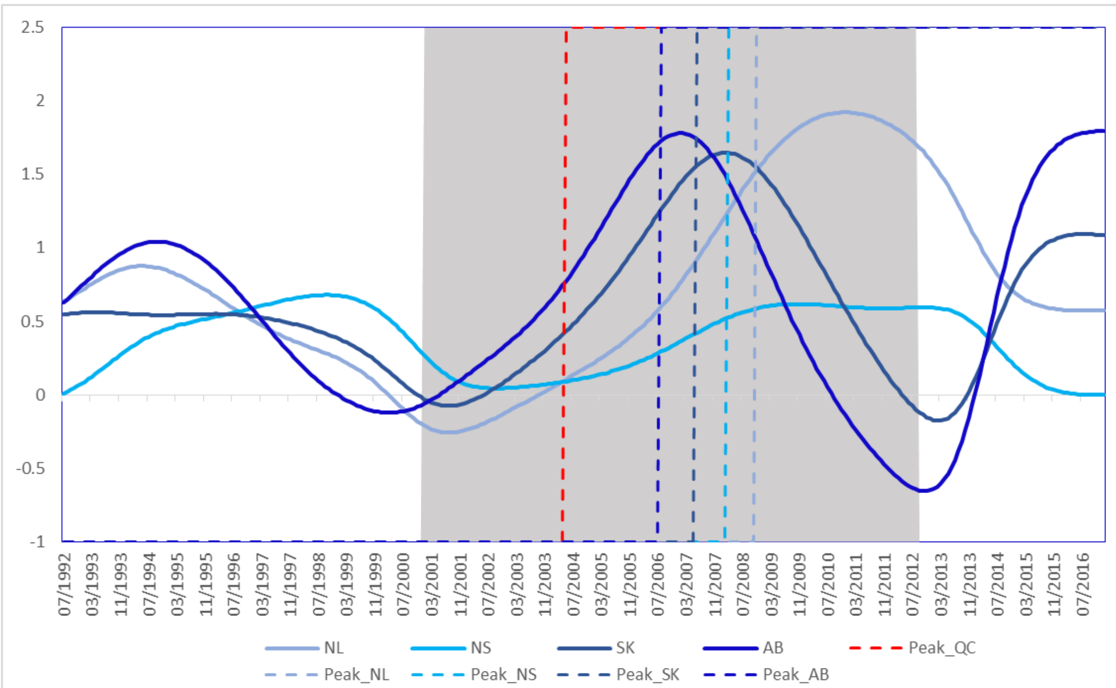

Figure 4: Time-varying contagion coefficients

On the other hand, Figure 5 shows the time-varying coefficients for those provinces for which migration from Quebec is not detected. Although the PY-test suggests there is no evidence of migration, these provinces also exhibit a high relation with the Quebec persistence coefficient. It can be seen that Manitoba's contagion coefficient reaches a value of almost one, and for Ontario of almost 1.5 by the end of the duration of Quebec bubble.

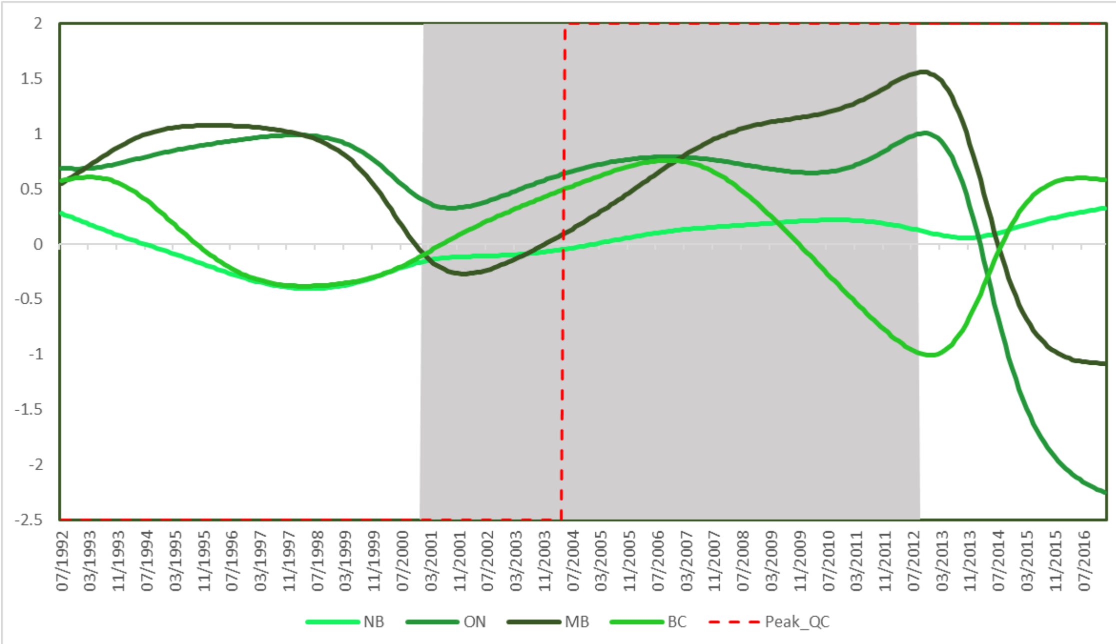

Figure 5: Time-varying contagion coefficients

6 Conclusions

In this paper we test for the existence and migration of house Price bubbles within Canadian provinces. Using monthly data spanning a three-decade period, and various bubble detection and migration tests developed recently, we encounter at least one period of exuberant behavior in the price-to-rent ratio in all of the nine provinces included in our sample, except for New Brunswick. All of these bubbles originate before the beginning of the recent global financial crisis, and most of them end on or before 2010. However, two bubbles are still in place, one in Ontario and another one in Manitoba. According to our bubble detection results, the first province in which a bubble appeared is Quebec, with a starting date in January 2001. Our bubble migration tests suggest that this bubble migrated to four other provinces, namely Alberta, Saskatchewan, Nova Scotia, and Newfoundland and Labrador. We identify a smooth migration process from the bubble in Quebec to these other four provinces. However, we find that the intensity of migration increased around the point in which the bubble in Quebec encounters its maximum BSADF value. This finding suggests that housing bubble migrations are more intense when housing prices exhibit their maximum growth rates. As expected, transmission intensities present an inverted-U shape, consistent with the findings of related studies such as GG. Interestingly, although formal migration tests do not identify transmissions from Quebec to Manitoba and British Columbia, our time-varying contagion test suggest the existence of inverted U-shapes for these two provinces, and high transmission coefficients for the time period near the end of the Quebec bubble. Hence, we consider there is weak evidence of migration to these two Canadian provinces as well. Our results suggest the importance of developing policies for avoiding the undesired negative effects of house price bubble migrations. For instance, tax policies or the imposition of maximum debt-to-value or debt-to income ratios.

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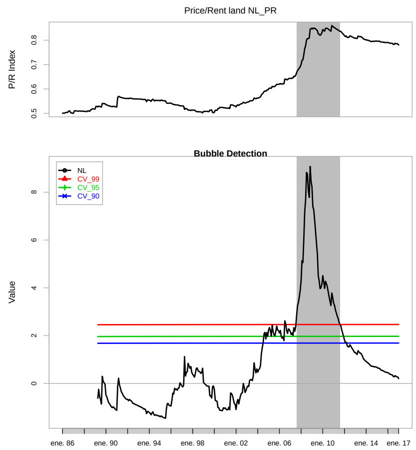
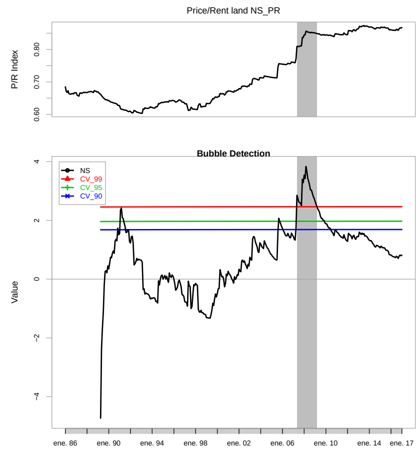
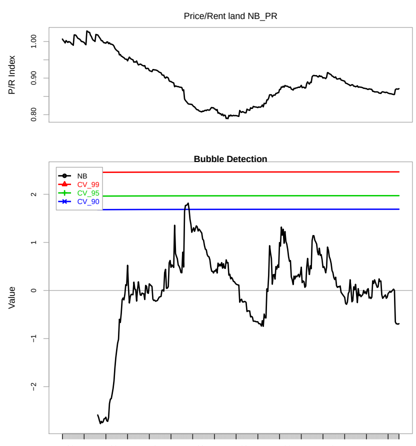
Appendix A Bubble detection and date-stamping



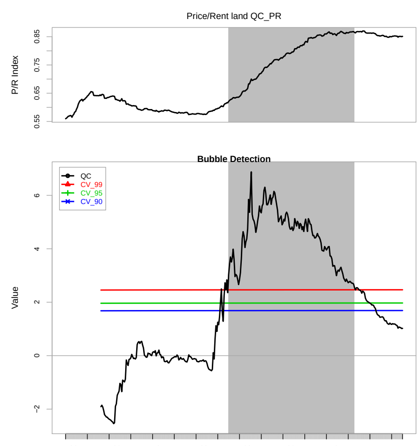
(a) Newfoundland and Labrador



(b) Nova Scotia

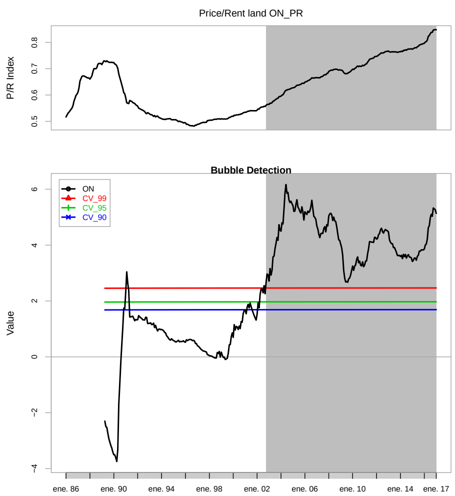


(c) New Brunswick

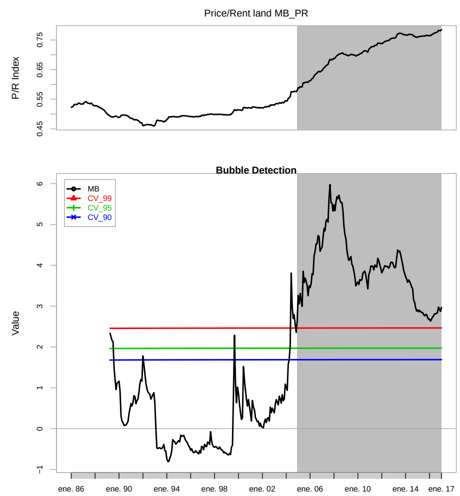


(d) Quebec

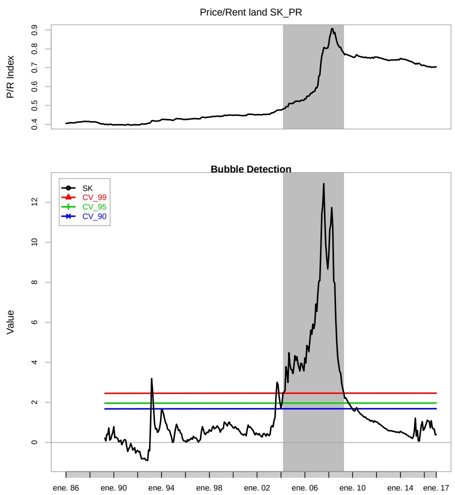
Figure 6: Housing Bubbles Date-Stamping (part 1)



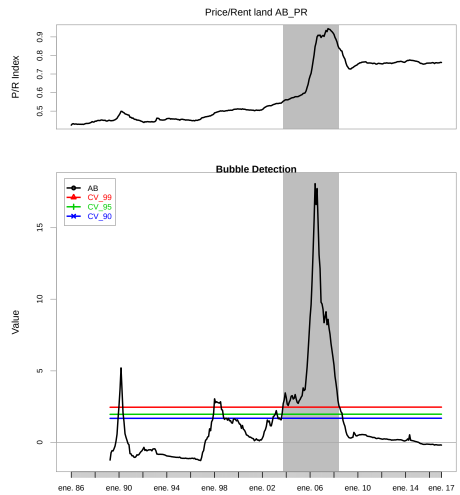
(a) Ontario



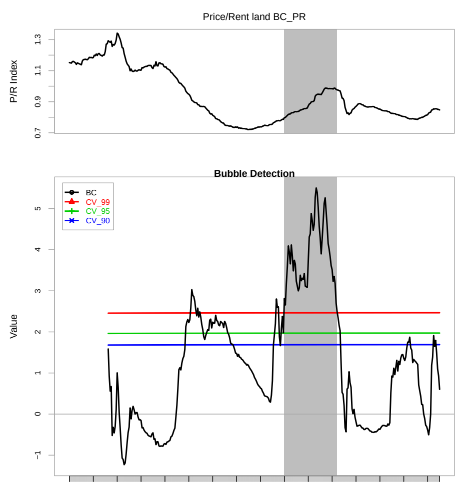
(b) Manitoba



(c) Saskatchewan



(d) Alberta



(e) British Columbia

Figure 7: Housing Bubbles Date-Stamping (part 2)


BANCO DE LA REPÚBLICA
COLOMBIA