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The impact of earthquakes on housing prices in Groningen. A hedonic approach.

After a noticeable earthquake occurred in 2012 in the province of Groningen, in the North of the Netherlands, several (smaller ones) followed. These earthquakes were 'induced', resulting from gas extraction in the region. Earthquakes are likely to influence the local housing market as houses suffer from material damage and the demand for housing in the area declines (if for example people leave the area due to these earthquakes).

This research tries to answer the question if and to what extent earthquakes and the (future) risk of earthquakes are influencing housing prices in Groningen. Moreover the goal is to test which underlying mechanisms or 'events' are causing this possible negative effect: the (location of the) actual earthquakes themselves, the damage (causes by these earthquakes) or the impact on the region as a whole due an overall image effect. Using data on earthquakes and damage several indicators are constructed and tested in the empirical analysis.

The empirical approach is based on a hedonic price model, based on the idea that housing prices reflect the value that people attach to a house and all of its location characteristics including the possible negative impact of earthquake. The goal of the application of a hedonic price model in this regard is to isolate the impact of earthquakes from other factors that may influence housing prices. Ideally one would compare similar houses at locations that are similar with the exception of one aspect: (the risk of) earthquakes. This is important as the part of Groningen where earthquakes occurring also suffers (at leasts part of the area) from population decline for over many years (before 2012) which in turn can be partly related to, amongst others things, a low level of economic activity and jobs.

In order to try to come as close as possible to this situation we used *'propensity score matching'* to match each house sold in the Groningen region with a risk of earthquakes with another house sold at a location that is most comparable with the exception of earthquakes. The selection of the most comparable locations are based on a wide range of location characteristics (ranging from the number of accessible jobs to the safety and nuisance levels in the direct surroundings of the house and from different amenities such as culture to the presence of nature in the area) that bear a significant statistical relation with the price of (the land below) houses.

The result is a subset of sold houses consisting of houses in the Groningen region with a risk of earthquakes and houses sold that at locations that are (almost) identical with these houses when it comes to location characteristics. In order to test for the presence of a price effect of earthquakes and the (future) risk of earthquakes it is necessary to control for possible differences between the characteristics of the houses as well. This is done using detailed data characteristics based in the national association of Realtors. This database contains a wide range of variables of the characteristics of the houses sold (by members of this association): size, the type of the house, building period, quality of the house and so on. This allows to control in detailed way for housing characteristics.

While controlling for housing characteristics, different indicators for (the risk of future) earthquakes and earthquake related damage are tested. Based on these results more insights are gained with regard

to the presence and magnitude of a negative price effect and the mechanisms through which they occur.