Real estate market as a dynamical system from a physical perspective

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The paper deals with time series of housing prices recorded on local real estate markets in Warsaw, Krakow and Poznan in the period from 2006 to 2013 to study the mechanisms underlying observed dynamics. In that time the two concurrent processes have occurred, namely rapid price changes in 2007 (housing bubble), followed by long-lasting fall down to the equilibrium state (relaxation). Presented work is aimed at finding out essential similarities between real estate markets and physical systems in order to implement the theory of dynamical systems. Thus, time series of housing prices are first analyzed in terms of critically damped harmonic oscillations, which resulted in estimation of the relaxation time for each housing market. Obtained best-fitting curves and the fit quality measures show reasonable matching of the model with housing prices in Warsaw and Poznan, but not in Krakow. The latter data, however, are found to agree well with the model of underdamped harmonic oscillations, which actually suggests that in Krakow there is a trembling housing market. To confirm such assumption, time series of housing prices were plotted in the form of evolution paths in phase space. Obtained phase portraits (being actually Poincare sections) allow us to reconstruct vector fields, and potential functions in which the markets are immersed. Having that, the structure of equilibrium points is studied that brings information about stability of the system. Apart from that, however, the marks of possible chaotic behavior are also considered. To this end, time series are re-plotted in the form of return maps, and the Lyapunov exponents are determined.