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Adoption of Green Innovations on Office Markets in Poland

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ABSTRACT

Purpose – In recent two decades, several important innovations have emerged and been adopted in the built environment across the world. Amongst the most prolific technological innovations are green (sustainable) and intelligent (smart) buildings design. The adoption of that innovation was particularly visible in the commercial property market. In the case of sustainable design, the process has been facilitated by the emergence of independent third party governance institutions and the development of green building certification systems. In many cases, the process of innovation diffusion is a spatial phenomenon that manifests as hierarchical/cascade or contagious dispersion of given technological advancements..

Design/methodology/approach – We analyze the spatial diffusion of sustainable innovation across commercial property markets in major cities in Poland. Using a city-level panel data we trace the diffusion of green building innovation diffusion. We focus on major green building certification scheme - LEED developed in the US, In the empirical part, we investigate the adoption of new technologies by analyzing the fraction of innovative (green) office space in particular office markets.

Findings – The diffusion of green innovation was particularly fast between 2010 and 2020 in all selected cities. Nonetheless the explorative research suggest that the dynamics of adoption of green technologies is different in selected cities. The adoption rate was the highest in Wroclaw, and the lowest in Krakow.

Limitations – The study focuses on diffusion of LEED certificates, and as such it does not cover all sustainable buildings. Many office projects have different green building certificates (mainly BREEAM).

Keywords:	innovation; diffusion; smart buildings; green buildings; office market; real estate; Poland
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INTRODUCTION

In recent two decades, several important innovations have emerged and been adopted in the built environment across the world. Amongst the most prolific technological innovations are green (sustainable) and intelligent (smart) buildings design. The adoption of that innovation was particularly visible in the commercial property market. In the case of sustainable design, the process has been facilitated by the emergence of independent third party governance institutions and the development of green building certification systems.

In many cases, the process of innovation diffusion is a spatial phenomenon that manifests as hierarchical/cascade or contagious dispersion of given technological advancements. Since Hägestrands seminal contribution on the mechanisms of spatial diffusion of innovation (1953) the problem has been discussed theoretically and investigated empirically in regional economics as well economic geography. The diffusion of innovation has also been addressed in business and economic research.

We analyse the adoption of sustainable innovation across commercial property markets in major cities in Poland. Using a city-level panel data we trace the diffusion of green building innovation diffusion. We focus on the major green building certification scheme - Leadership in Energy & Environmental Design (LEED) developed in the US. In the empirical part, we investigate the adoption of new technologies by analysing the fraction of innovative (green) office space in particular office markets.

The paper is organized as follows. The following section discusses prior research concerning green building diffusion and adoption. Section Research methodology comments on green innovation adoption rates, as well as discusses data sources. We explain findings in Results and discussion section.

LITERATURE REVIEW

The sustainable (green) building may be defined as responsibly created and managed construction, complying with the guidelines of natural environment protection and the efficient use of natural resources (Eichholtz, Kok, & Quigley, 2008; Kibert, 2013). Typically, green buildings share some distinct attributes that make them environmentally and economically sustainable in the property life-cycle. The list includes, but is not limited to: use of ecological technologies in construction, maximum use of daylight, high

indoor air quality and climate control; high energy and water-use efficiency (Głuszak, 2015).

The higher economic utility of green buildings should translates into several benefits for their users and owners. Several empirical studies report economic premiums associated with green buildings. Empirical research shows that green buildings usually have higher rents, and lower vacancies, and are generally high-valued by potential investors (Fuerst & McAllister, 2011; Pivo & Fisher, 2010; Wiley, Benefield, & Johnson, 2010). Despite the economic benefits, the diffusion of green buildings was not eminent, as the quality of buildings is difficult to observe. The adoption of technology was fostered by the creation of independent third party governance institutions and the development of green building certification systems – such as LEED. It has been demonstrated that independent institutions have positive impact on multi-criteria building certification and diffusion of green innovation (Sedlacek & Maier, 2012).

The seminal empirical work on the diffusion of green innovation on commercial real estate market suggests that there are strong economic fundamentals foster the adoption of Energy Star and LEED certification in US (Kok, Mcgraw, & Quigley, 2011). The results are confirmed and further extended in another US study (Fuerst, Kontokosta, & McAllister, 2014). Empirical evidence shows that adoption of LEED-certified commercial buildings is higher in densely populated cities with dynamic economic growth. Similar patterns are found in residential real estate markets. Diffusion of LEED certificates is faster in economically strong markets, with high household incomes, and facilitated by ecological policy measures. (Rakha, Moss & Shin, 2018) Ma and Cheng (2017) used clustering analysis to identify the local markets with high rate of green building adoption and factors that affect diffusion of green innovation. The research suggest that US based research findings may as well translate to other countries, including China (Ma & Cheng, 2017). Due to data limitations empirical results are scarce outside of US or Europe, but there are also papers addressing green building adoption in emerging markets (Anzagira, Duah & Badu, 2019).

RESEARCH METHODOLOGY

We investigate the diffusion of green technologies in office buildings using the data on LEED registered office projects in Poland. LEED system created in 1998 by the United States Green Building Council (USGBC) is the global leader in green building assessment and one of the most popular certification systems in Europe - second only to Building Research Establishment

Environmental Assessment Methodology (BREEAM) created in 1990 in UK (Głuszak, 2015). Other important green building European certification systems Haute Qualité Environnementale (HQE) created in 1992 by Association pour la Haute Qualité Environnementale (ASSOHQE) or Deutsche Gesellschaft für Nachhaltiges Bauen (DGNB) created in 2007 by Deutsche Gesellschaft für Nachhaltiges Bauen e.V has not achieved similar popularity in Poland based on the number of certified projects.

We track the adoption of green building innovation in three major office markets in Poland – Warsaw, Krakow, and Wroclaw from 2009 to 2020. Warsaw is a capital of Poland and by far the biggest commercial real estate market in the country. It is also the biggest office market in the Central and Eastern Europe. Krakow and Wroclaw are the biggest regional office markets in Poland ranked as second and third based on the office stock available.

There are several measures of market penetration of green innovation in built environment. The most simple measure is the fraction of green buildings (k_i) in total number of office buildings (n_i) in study area (metropolitan area, city, country). It is given by following equation (Eq1):

$$K_i = \frac{k_i}{n_i}, \qquad (1)$$

Another simple measure of adoption of green technologies in built environment is a share of green buildings area in total building area in question. The fraction of green office space can be calculated in accordance with the following equation (Eq2):

$$F_i = \frac{z_i}{x_i}, \qquad (2)$$

where:
z_i is the stock of LEED-certified office space in a city i
x_i is the total office stock in a city i.

This particular measure was used in the seminal work on green building adoption in US (Kok et al., 2011). It can be argued that simple measures of technology adoption may lead to biased estimates - for discussion see Fuerst et al. (2014). In general the formulae based on the number of green buildings may overestimate the market penetration rate in cities with a significant number of small green projects, whereas the formulae based on the area may overvalue the markets with big green projects (in extreme case one

certified building may account for a big share of commercial area in small town).

Fuerst et al. (2014) suggested a new green building adoption measure based on the proportion of sustainable space in given area normalized by the overall sustainable space. The G index is derived from spatial Gini coefficient and has a following form (Fuerst et al., 2014) (Eq3):

$$G = \sum_{i=1}^{N} \frac{z_i}{Z} - \frac{x_i}{X}, \qquad (3)$$

where:
z_i, x_i are as in Eq 2,
Z is the sum of LEED-certified office space in all cities
X is a total office stock in all cities.

The data on LEED registered projects are taken from LEED Projects Directory administred by USGBC (https://www.usgbc.org/projects). The data on office stocks are from Cushman & Wakefield market reports on regional commercial real estate in Poland. The exploratory analysis of adoption of green building technologies on regional office markets in Poland is presented in the following section.

RESULTS & DISCUSSION

In the beginning of the study, we explored the data on LEED building registration and certification in Poland. According to LEED project directory as of 31 October 2020 there were 200 office projects registered and 127 already certified in LEED in selected cities in Poland. The average number of points received in LEED certification by office projects was 71.1, with the median of 69. Minimum number of points received was 30 and maximum was 92. The number of points is associated by the label – silver (up to 59 points), gold (60 to 79 points), and platinum (80 points and more). The number of points achieved b certification label is presented in Figure 1.

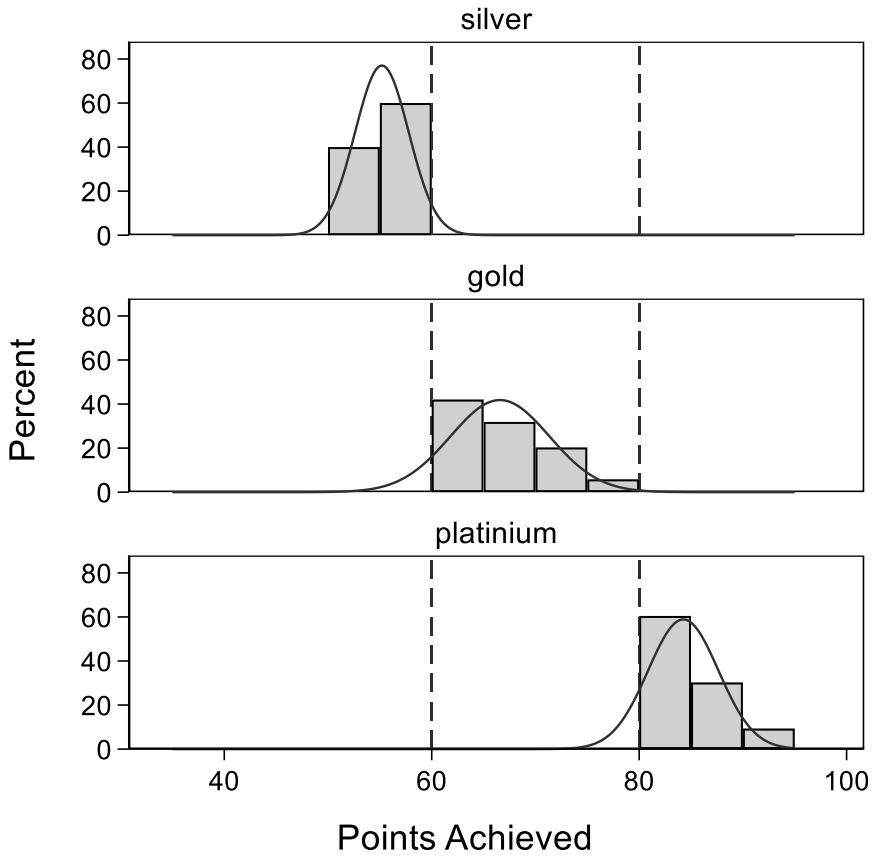

Figure 1. Points received in LEED certification and label achieved
Source: own elaboration.

The research is based on a registration data rather than certification for one fundamental reason. Data shows that certification in LEED system is a lengthy process (median time to achieve certification is 856 days), and registration is a valid signal of a green quality of the building. The situation is even more complicated when we account for a certification type (Fig. 2).

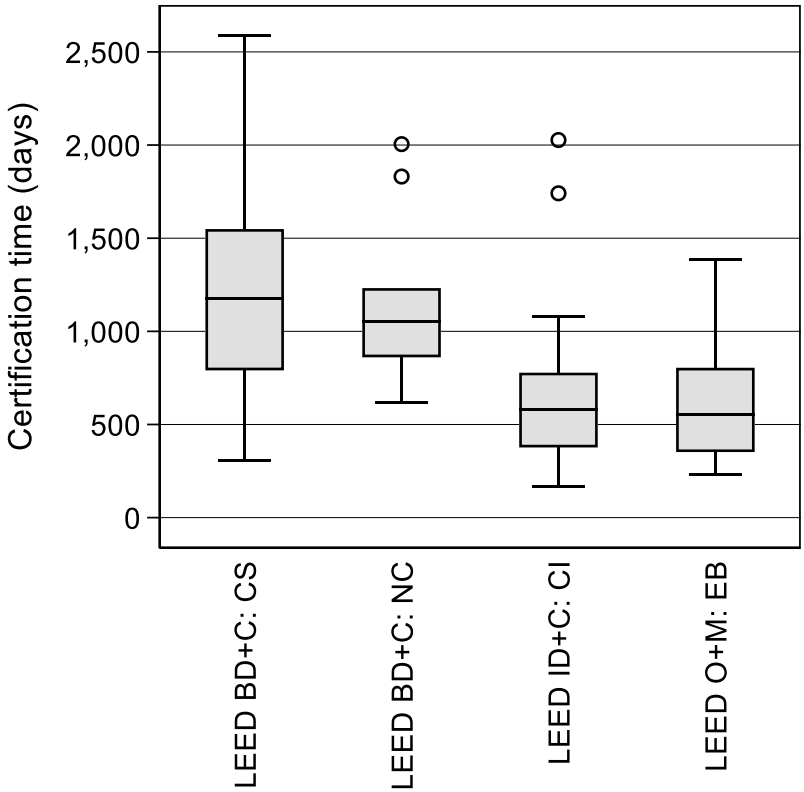

Figure 2. Time between registration and certification by certificate type in Poland

Source: own elaboration.

Certification time is the longest in case of Building Design and Construction (BD+C) LEED rating system (intended for buildings that are new construction or major renovations) – median of 1179 and 1055 for Core and Shell and New Construction respectively. On average getting certification in Interior Design and Construction (ID+C) LEED system (created for interior spaces that are a complete interior fit-out) takes considerably less time (median equal to 579 days). The registration time is similar in case of Building Operations and Maintenance (O+M) LEED system (for buildings that are fully operational and occupied for at least one year).

In the second step of the research we focused on the number of office projects registered in LEED certification scheme. We tracked adoption of green technologies in Krakow, Warsaw and Wroclaw. The Figure 3 shows the cumulative number of LEED registered projects in these three cities from 1 Jan 2009 to 31 Oct 2020.

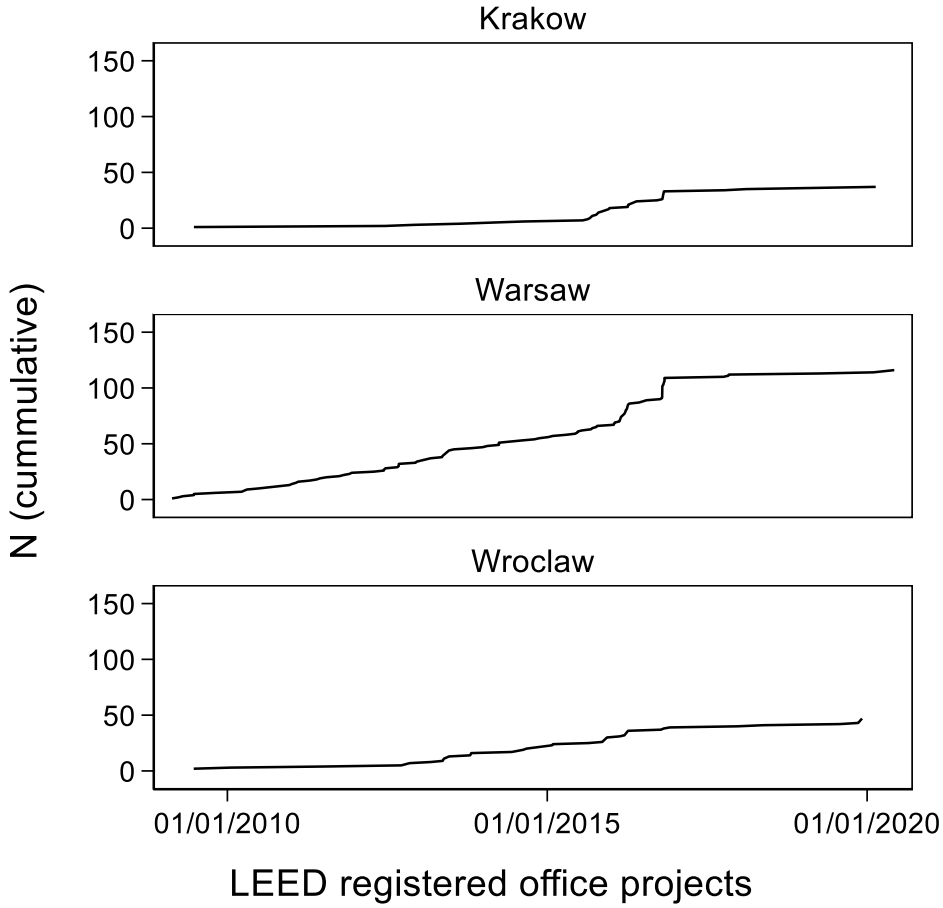

Figure 3. The number of LEED registered office projects in selected cities in Poland

Source: own elaboration.

We explore the adoption of green technologies using a simple measure suggested by Kok et al (2011). The fraction of LEED registered office space changed significantly in the study period in all three cities (Fig. 4).

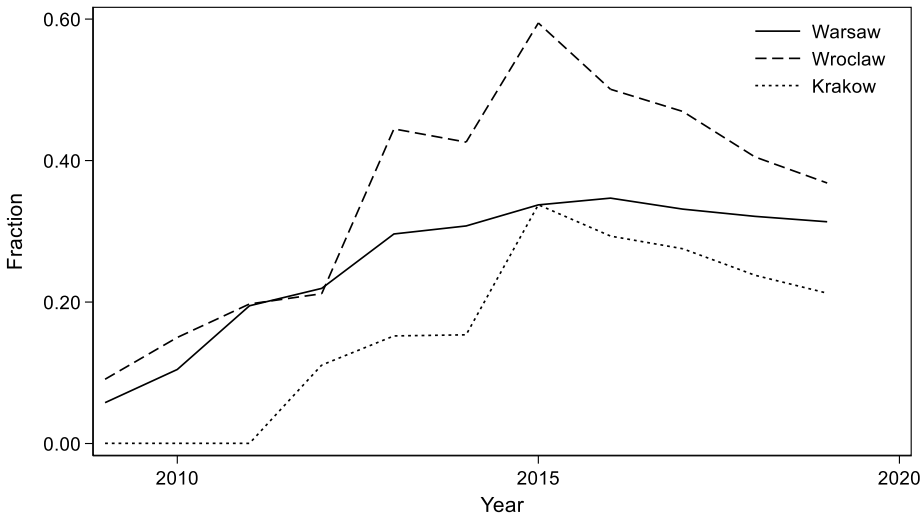

Figure 4. Fraction of LEED buildings in selected cities in Poland
Source: own elaboration.

The data analysis suggest that the fraction of LEED registered office space steadily increased in Warsaw, Wroclaw and Krakow from 2009 to 2015. The share was the smallest in Krakow and generally the highest in Wroclaw. In both regional cities the measure was more volatile than in Warsaw, mainly due to lower amount of office stock. The share of LEED registered space decreased from 2015 to 2020, following the significant increase in overall office stock. It is worth noting that the decrease of the share of LEED registered office space can be at least partially attributed to the competition from other green building certification scheme. Especially BREEAM system has a strong competitive position in Poland, and particularly in Krakow.

To explore penetration of LEED certification system on office market in Poland we used G-index as suggested by Fuerst et al (2014), and tracked it in all three cities from 2009 to 2020. The results are shown in Figure 5.

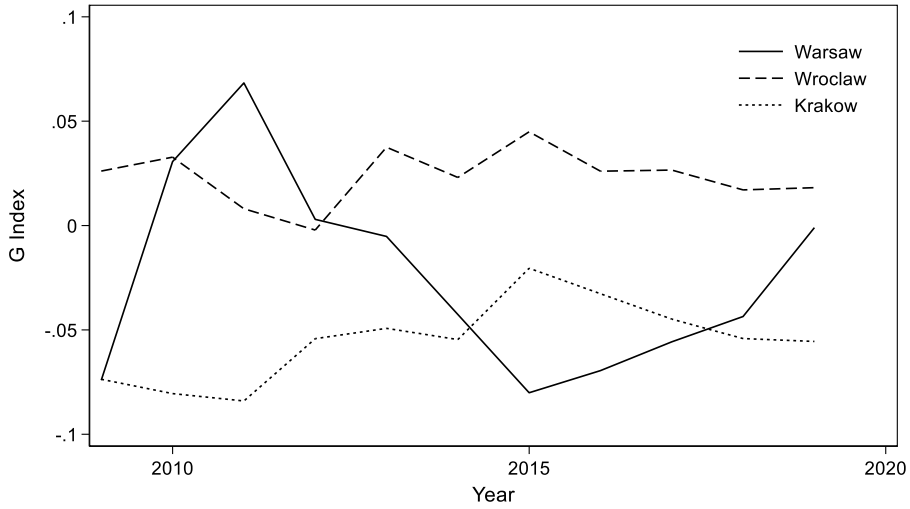

Figure 5. G index of LEED building adoption in selected cities in Poland
Source: own elaboration.

G-index captures the difference between a proportion of all LEED-certified office stock and a proportion of all modern office stock in a given city. In three major office markets in Poland the G-scores changed dynamically during the study period. In Warsaw G-index increased from 2009 to 2011 to reach its peak in 2011. In the following period it decreased, and for the most of the period remained negative. The G-index was more stable in Krakow, albeit its values were negative in the study period. The results suggest that despite its importance as a major Polish regional office market, Krakow was not a centre of green buildings diffusion, at least when we measure it by LEED adoption.

The simple measures of market penetration based on a fraction of LEED registered projects must be treated with caution. The office area registered in LEED in a given year is linked both with existing space and space under construction – thus high share in a given year may be misleading. Also considerable share of green office space is certified in other schemes – mostly in BREEAM. The complex study of green building certification in European countries is thus more complicated than in US.

CONCLUSION

In the paper we tracked the adoption of green building innovation in three major cities in Poland – Warsaw, Wroclaw and Krakow. We focus on the major green building certification scheme LEED developed in the US, and

popular in Poland. The diffusion of green innovation was particularly fast between 2010 and 2020 in all selected cities. Nonetheless the explorative research suggest that the dynamics of adoption of green technologies is different in selected cities. The adoption rate was the highest in Wroclaw, and the lowest in Krakow. The study, albeit explorative, contributes to the understanding of green building adoption in emerging markets. The results could be useful for market participants (commercial property developers and investors). Following studies could investigate factors affecting green building adoption rate on a regional and country level.

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