

Analysis of Green Scarcity Value Capitalization: Empirical Evidence from Metropolitan Lyon (France)

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December 16, 2020

The Challenges in the Building Sector

- Buildings **account for 39% of final energy consumption** in Europe and **20% of GhG emissions** (European Commission, 2017).
- Energy **renovation process** is a necessary consideration in dealing with climate change.
 - **"Energy-Efficiency Gap"** is the unexploited potential for energy-efficiency of the technically feasible energy-efficiency **measures that are cost-effective but are not being deployed**" (Hirst and Brown, 1990; Jaffe and Stavins, 1994; Allcott and Greenstone, 2012).
 - There are different explanations for the EEG, however a better understanding of the motives for renovation are still necessary.

Previous Research

- Economic motives for investments in renovation:
 - Decrease in value of energy bills.
 - **Increase of patrimonial value of houses.**
- Previous research focusing on patrimonial value has shown:
 - **A positive effect of renovations and of energy performance on the housing prices** for most studies (Gilmer, 1989; Brounen and Kok, 2011; Hyland et al., 2013; Cajias and Piazzolo, 2013; Fuerst et al., 2016; de Ayala et al., 2016; Kholodilin et al., 2017; DINAMIC, 2013; Leboullenger et al., 2018; Civel, 2019, etc.).
 - **Heterogeneity** of the implicit prices for energy performance found on different **studied periods and spatial units** (Baumont et al., 2019).
- To the best of our knowledge, there are few studies using the temporal dimension.

Structural Modeling

- We develop a **canonical model of Hedonic Prices** (Rosen, 1974) for the energy-efficiency performance for the rental market.
 - Matching equilibrium for **composite goods**.
 - The service of the house depends on a vector H of attributes.
 - We focus on the attribute "energy performance".

Structural Modeling

- Two kinds of Agents: **Landlords and Tenants**
- Tenants choose their housing in order to maximize their utility.

$$U_i^n = \alpha_i * H_n + X \quad (1)$$

- The condition for preferring the house with level ($H_n > H_m$) of energy service is:

$$\alpha_i > \frac{P_n - P_m}{H_n - H_m} \quad (2)$$

- Where α is bounded by $[\alpha_{min}; \alpha_{max}]$ with F, its cumulative distribution function.

Structural Modeling

- Landlords seek the highest rent from the property.
- There is an equilibrium if the proportion of tenants asking for a house H_N amounts exactly to θ_N , with:

$$n = [1, 2, 3 \dots N] \quad (3)$$

- The equilibrium prices equation for H_1 is:

$$P_1 = \alpha_{min} H_1 \quad (4)$$

Equilibrium

- We show that the equilibrium market is determined by the following expressions:

$$(P_n^* - P_{n-1}^*) = (H_n - H_{n-1})F^{-1} \left[\sum_{i=1}^{(n-1)} \Theta_n \right] \quad (5)$$

- Were θ_n ($\theta_n > 0$) corresponds to the share of houses with a given energy performance H_n .
- The premium of class "n" is a decreasing function of the share of housings of lower class.
- Say in another way, **the capitalization is driven by the scarcity of energy performance in the housing market.**

Spatio-Temporal Approach

- Apartments (Condo Units)
- EPC as proxy of houses' energy performance.
- Categorical information (Civel and Cruz, 2018)

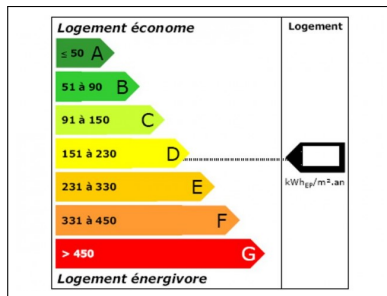


Figure: French Energy Performance Certificate

Data

- Notarial Data-Base including **transactions** between January 2013 and December 2018 in the Metropolis of Lyon (9948 observations)
 - Surface, construction period, number of floors, energy rating, **price**, taxes, **longitude and latitude**, **day of the transaction**, etc.
- GIS
 - **Distances** to parks, rivers, banks, schools, forests, hospitals, police stations, etc.
- **Socio-demographic** information on the neighborhood (IRIS).
 - Rate of social diversity, age of population, distribution of wages, rate of vacancy, rate of occupation, level of education, etc.

Metropolis of Lyon

- **Growing market.**
- Higher prices for **urban and central locations.**
- Different distributions of prices according to the EPC. However, we need to control for other characteristics of housing.

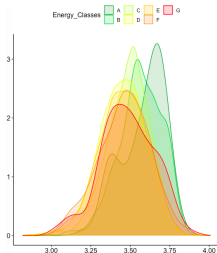


Figure: Distribution of Energy Prices by Energy Performance Category

Spatio Temporal Autocorrelation

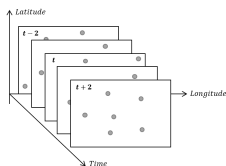


Figure: Spatio-Temporal Neighborhood

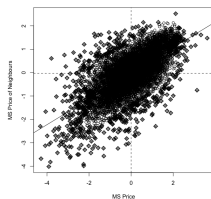


Figure: Moran Plot for Spatio-Temporal Dependence

Econometric Model

$$Y = X\beta + u \tag{6}$$

$$u = \lambda W_{ST} + \epsilon \tag{7}$$

$$X = [x_1, x_2, \dots, x_n, EPCscarcity] \tag{8}$$

- Where the **EPC scarcity variable** is defined as the rate of houses with a lower level of performance **in the neighborhood of each house**.
- We use twelve kinds of **neighborhoods defined by a circle of different radii around the house** (in the spatial and temporal dimensions).

Econometric Results

EPC	Specifications Matrix 800M 6months		
	(Classic STEM)	(scarcity)	(scarcity STEM)
A	0.086464 (1.376e-05)	0.1185 (3.05e-07)	0.099375 (2.125e-06)
B	0.090082 (< 2.2e-16)	0.1142 (7.63e-16)	0.11048 (< 2.2e-16)
C	0.021560 (1.886e-05)	0.06132 (3.83e-09)	0.053926 (8.447e-10)
D	(REF)	0.08808 (2.46e-05)	0.062070 (0.0004790)
E	-0.0084940 (0.0775752)	0.2740 (0.000533)	0.15304 (0.0268857)
F	-0.017966 (0.0353890)	0.5923 (0.218436)	-0.095016 (0.8212721)
G	-0.012401 (0.4251590)		
AIC	-5191 (lm:-2427.3)		-5193 (lm:-2424.5)
LR	2655.518		2655.489
R2		0.613	
F		(< 2.2e-16)	

Conclusions

- **Positive effect of scarcity** for the classes A, B, C, and D ("Scarcity Patrimonial Effect" or "Rare Gem Effect") for the different types of neighborhoods.
 - The patrimonial value for scarcity indicates an expected evolution on the market with a **decreasing Green Energy Value.**

Thank you for your attention

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