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The Association of Housing Supply Growth and Housing Prices in Paris

A quantitative approach from 2021 - 2023

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COLOFON

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Bachelor Program	HGP, Pre-master Real Estate Studies (RES)
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Author	G. Lenting
Student number	S5388724
Supervisor	M. van Duijn
E-mail	g.w.lenting@student.rug.nl
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Abstract

This study explores the relationship between housing prices and housing supply growth in Paris from 2021 to 2023 through a hedonic multiple regression model. The results show a significant positive linear relationship between the addition of housing supply and house prices in Paris. Findings show that adding 100 dwellings per square kilometre leads to a 1.91% increase in transaction prices. This highlights the impact of additional housing stock on the neighbourhood attractiveness. Additionally, no significant relationship is found between housing density and housing prices. However, this study is conducted using a limited dataset, which may include multicollinearity, and inaccuracies in data. Despite these limitations, the research illustrates the complexity of housing markets and the need for policymakers to recognize that increasing housing supply may not lower prices. This follows the theory of DiPasquale and Wheaton (1992), which suggests that excessive demand can cause prices to increase even when housing stock is added. Future research should expand the dataset and improve data accuracy to show the impact of specific government policies on housing supply.

Key words: Affordable housing, housing prices, housing supply, government policies

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1. Introduction

1.1 Motivation

Housing affordability has been decreasing worldwide in recent decades, particularly in the advanced economies. Since 1990, there has been a significant rise in the ratio of median house sales prices to median household incomes in countries such as Australia, Canada, Ireland, New Zealand, the United Kingdom, and the United States. This trend is being even more prominent in major cities within these nations (Cox, 2022).

A report from a United Nations expert sounds an alarming note on the escalating global affordable housing crisis. The findings reveal that approximately 1.6 billion individuals currently lack adequate housing. This situation is projected to worsen, potentially affecting up to 3 billion people by 2030 (United Nations General Assembly, 2023). Housing affordability in advanced economies is driven by factors such as rising house prices, a weakening housing market and a shift in household incomes towards homes in a higher price segment (Lee et al., 2022).

Within this global housing crisis, France serves as an illustrative example of how housing affordability issues are impacting the most developed Western countries. The average house price in France has doubled in the last 20 years (2003 to 2023), making homeownership increasingly difficult. Figure 1 shows the increase of the France house price index. Showing a significant increase in house prices within the last years (2018-2023).

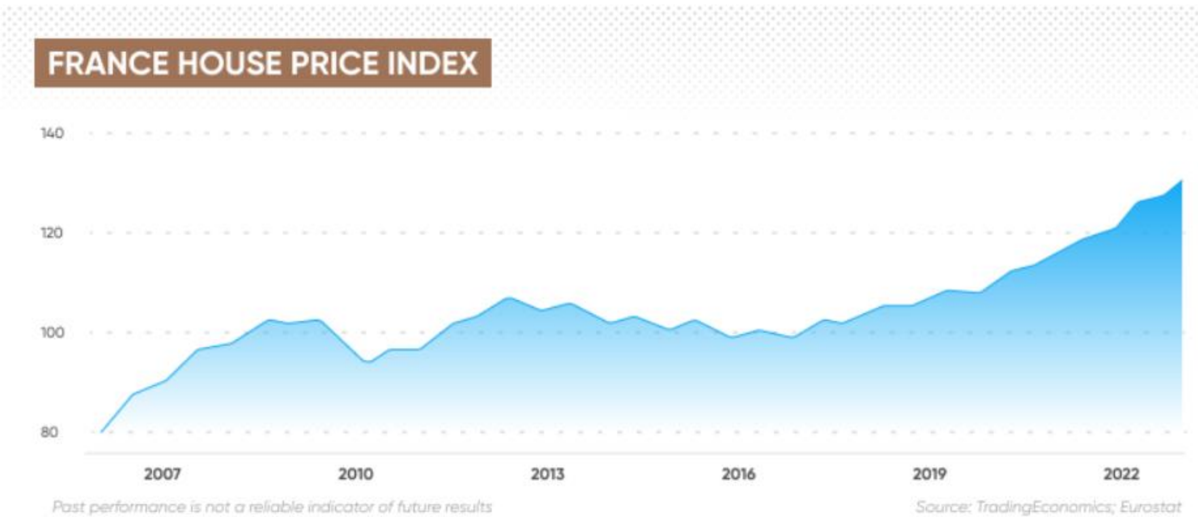

Figure 1. France House Price Index (Housing crisis in France: Is there a housing shortage?, 2023)

To combat the escalating housing affordability issues, governments search for innovative initiatives to increase supply and regulate market prices effectively. The increase in housing prices is an important factor of the affordable housing crisis. Especially in large cities such as Paris the affordable housing crisis is significant. To underline the current housing shortage, according to Jehangir (2023) 14% of the households in the Paris metropolitan area are awaiting affordable homes. Table 1 shows an overview of French policies which seeks to stimulate the housing market. Each policy is marked with an 'X' in the 'Demand' and/or 'Supply' column to illustrate its area of impact. A detailed description of the housing policies (Table 1) relevant to this study and their references are provided in Appendix II.

TABLE 1. FRENCH AFFORDABLE HOUSING POLICIES AND THEIR AREA OF IMPACT

Policy	Demand	Supply
First-Time Homebuyer Programs (Prêt à Taux Zéro - PTZ)	X	
The real joint lease (BRS) - Bail réel solidaire"	X	X
The loi ELAN (Evolution of Housing, Urban Planning and Digitalization Law)		X
The Loi Duflot / Loi Pinel		X

Almost all the above mentioned policies play an important role in boosting housing construction, whether through direct or indirect influence. Saiz (2023) provides an analysis of different policies used in worldwide nations. This study highlights the varied effects of government policies on the housing market. By offering financial assistance to first-time homebuyers, promoting the construction of new housing units or introducing new approaches to property ownership, these policies all contribute to expanding the availability of housing supply. Understanding the relationship between housing policies and their impact on housing affordability is a complex issue. Due to the lack of specific data on how individual policies directly contribute to changes in housing supply, this thesis does not attempt to isolate the effects of particular housing policies. While it acknowledges the role of supply-side policies, the analysis is primarily focusing on available statistics on housing stock and transaction prices.

1.2 Academic relevance

Multiple studies (Kim, 2005; Yu and Lee, 2010) explore the impact of government housing policies on the housing market, often with mixed findings. A central theme in these policies is the strategy of increasing housing stock to improve housing affordability. While this approach is aimed at making homes more accessible and affordable, it can also trigger a market response which boosts demand, which can worsen affordability in certain regions (Fingleton, 2008).

There remains an active discussion on whether adding housing stock contributes to affordable housing. Been et al. (2018) examine the idea that increasing housing supply solely can improve affordability. They address multiple key arguments made by those who doubt this approach. The study concludes that while adding new homes can moderate price increases and therefore improve affordability for low- and moderate-income families. It highlights that government intervention is essential to ensure that housing remains accessible to various income levels.

Despite the available existing literature, there remains a lack of understanding of how changes in housing stock specifically affect local housing affordability. This thesis focuses on this by examining the Parisian housing market from 2021 to 2023 across the different neighbourhoods (arrondissements). It seeks to bridge the gap in understanding how additions to housing stock influence affordability in Paris.

1.3 Research problem

The main goal of the research is to gain insights into the relationship between the change in housing stock and housing affordability in Paris. It is important to know if adding housing supply leads to changes in housing prices, and if so, the direction and magnitude of these changes. The research focuses on housing policies that impact the supply side of the real estate market. A key example is the loi ELAN (Table 1). This law includes various measures aimed at increasing housing availability and affordability. This policy, among others (appendix II), provides a practical context in which to examine how government interventions may affect housing stock and, consequently, prices. This is crucial for guiding policymakers in their decisions on whether to continue or redirect housing policies. If increasing housing stock does not significantly improve affordability, policymakers might need to consider alternative strategies to combat housing affordability issues.

The central question that comes with this research is:

"*What is the relationship between housing stock and housing affordability per arrondissement in Paris over the period from 2021 to 2023?*"

The following sub-questions have been formulated:

1. *What factors influence housing prices according to the academic literature?*
2. *What is the relationship between changes in housing stock and housing prices in Paris over the period from 2021 to 2023?*

1.4 Reading Guide

This study is divided into five distinct chapters, followed by references and appendices. Chapter one introduces the subject and elaborates the social and academic relevance of the research. In chapter two, the central concepts and theories relevant to the study are discussed. In addition to this, the first sub-question is answered in this chapter. The background of the data and used methodology is detailed in chapter three. This provides the foundation for the study. In chapter four the results derived from the multiple linear regression are analysed and discussed. Chapter five concludes the findings and implications of the research. Lastly, the reference list and appendices support the research and offer additional context.

2. Theoretical framework

2.1 Theories of housing market dynamics

Real estate prices are the signals that indicate changes in the conditions of demand and supply (Harvey and Jowsey, 2003).

Perfect competition

The central characteristic of the model of perfect competition is the fact that price is determined by the interaction of demand and supply; buyers and sellers are price takers. In the classical theory of perfect competition, the following assumptions are made to simplify the complex interactions within real-world markets: Identical properties, meaning there are no differences in quality or features between properties; a large number of buyers and sellers, preventing any individual from influencing prices; minimal barriers to entry and exit in the market; perfect information about the market; and all participants acting as price takers (Koutsoyiannis, 1975).

Real property markets

However, the efficiency of real property markets are reduced by their own special characteristics. These characteristics distinguish them from the classical perfect competition model. Significant characteristics are heterogeneity and inelasticity. The uniqueness of each property makes the real estate market highly heterogeneous. This differentiation leads to market segments where finding comparable properties and pricing them accurately becomes challenging. The slow supply adjustment in real estate contributes to its market inelasticity, as the lengthy processes involved in development hinder the quick response of supply to changing demand (Harvey and Jowsey, 2003).

Four-Quadrant Model

The Four-Quadrant Model, elaborated and popularized by DiPasquale and Wheaton (1992), provides a framework for understanding the interactions within real estate markets. This model integrates the economic dynamics between the construction and the space markets, showing how variables such as rents, construction costs, and investment decisions influence property prices and the overall real estate stock.

Figure 2 illustrates the Four-Quadrant model, with the asset market displayed on the left side and the space market on the right side. The red line in the diagram indicates the point of market equilibrium within each quadrant, occurring where the supply meets the demand. This line is crucial as it implies that there is no incentive for prices to change given the current conditions.

If all other quadrants remain constant (market is in equilibrium) and additional housing stock is introduced, changing Q* to Q1, the interaction between supply and demand shifts. The new supply curve, resolving from Q1, meets the demand curve at a lower point than the original equilibrium, illustrated by the blue line. This adjustment leads to a reduced rental price, R1. Continuing along the blue line to where it meets the valuation curve results in a decrease in property prices, now indicated as P1. Concluding, following the theory of Dipasquale and Wheaton (1992), a positive change in the quantity of housing stock results in a lower price.

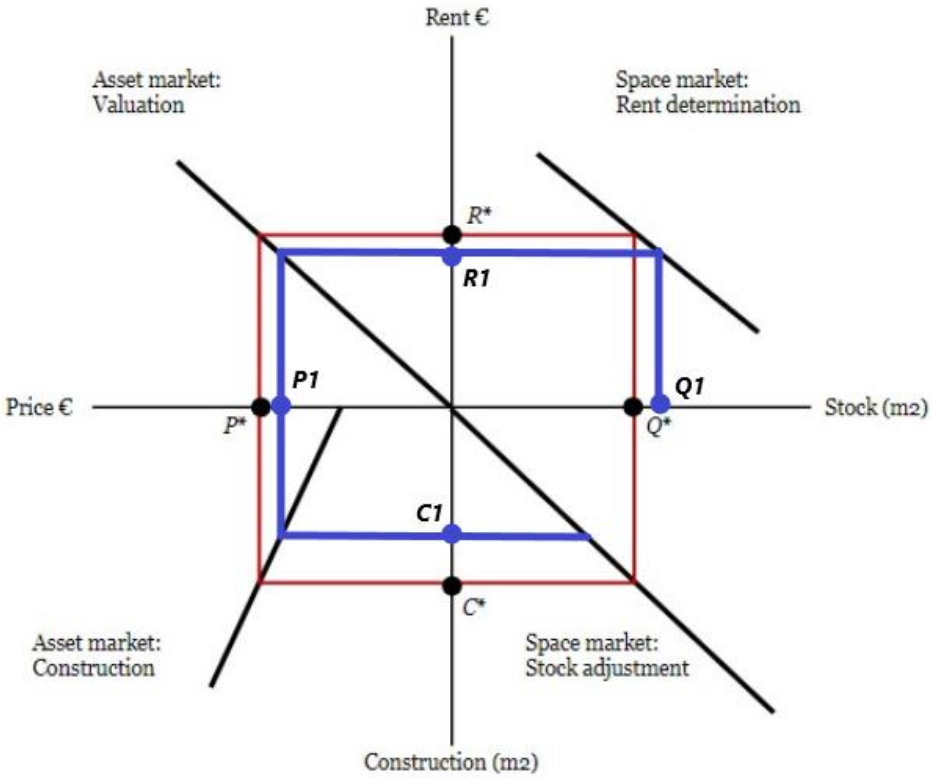

Figure 2. The Four-Quadrant model (DiPasquale and Wheaton, 1992)

However, the housing market in Paris is not in equilibrium, experiencing excessive demand (Paris Perfect, 2024). Therefore, the demand curve (rent determination line) moves to the right. Figure 3 illustrates that even when housing stock is added, the price (P1) will increase.

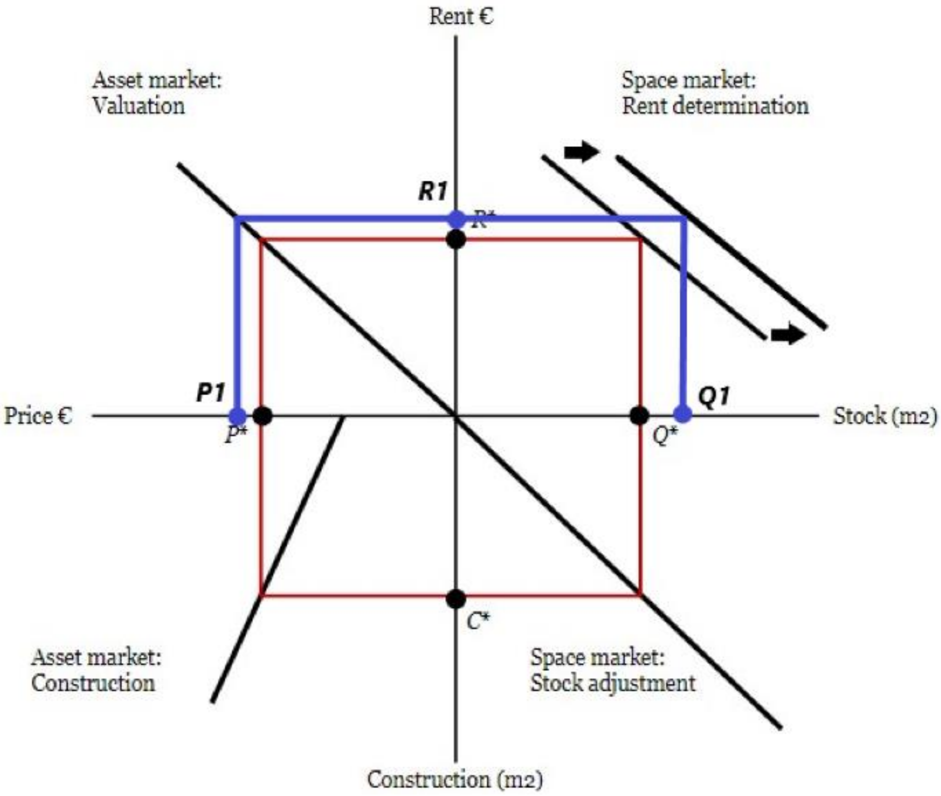

Figure 3. The Four-Quadrant model, excessive demand (DiPasquale and Wheaton, 1992)

2.2 The influence of housing stock on housing prices

Price effects of expanding housing supply

Been et al. (2018) analyse key arguments about housing supply and its effect on affordability. The study concludes that increased supply generally leads to lower housing prices in the long run (Been et al., 2018, p.30). They found that if the increase in housing supply caused a corresponding increase in demand, the overall effect on prices would be neutral. However, empirical evidence indicates that this scenario does not occur. Results of Meen (2011) are consistent with this finding. They find that increasing housing construction in England can improve long-run housing affordability.

De Vries and Boelhouwer (2005) also found results that are in line with this. However, their study showed that the relationship between (local) housing supply and (local) house price developments differed within regions in the Netherlands. Within the four main cities an increase in supply triggered a fall in house prices on the long run (1989-2002). For the other regions the correlation coefficients are close to zero, which suggests that the expansion of the housing stock is market-compliant.

Fingleton et al. (2018) also found that local supply has little impact on housing affordability. Local house prices turned out to depend crucially on conditions in neighbouring housing markets. Adding to this, increasing housing supply is not sufficient for reducing prices as the corresponding demand also needs to be considered.

While multiple studies (Been et al., 2018; Meen, 2005; de Vries and Boelhouwer, 2005) indicate that increasing housing supply lowers house prices, some research suggests that adding housing stock results in higher prices. A notable illustration of this is the emergence of new construction within a neighbourhood. This phenomenon positively impacts the value of existing housing due to the association of new construction with an appealing environment (Simons et al., 1998).

This is in line with the findings of Zahirovich-Herbert and Gibler (2014). They also find hat new residential constructions do not negatively impact the prices of existing houses. Instead, new constructions, especially those larger than average in their neighbourhoods, can have a small positive effect on the prices of existing homes. Ooi and Le (2011) support these results in the context of the Singaporean housing market. Contrary to the 'competition' hypothesis prediction of a negative reaction, they found that marginal supply of housing stock influences existing house prices in a positive manner. The observed positive effect remains strong and reliable when accounting for external demand influences.

Price effects of housing density (housing stock level per square kilometre)

In addition to the price effects of increasing housing stock, housing density also impacts house prices. To fully understand the relationship between housing stock and housing affordability, it is essential to examine the literature on housing density. Increasing housing stock naturally raises housing density, influencing the real property market.

Dong and Hansz (2019) find that higher density in Portland generally leads to higher single-family home prices because of the willingness to pay a premium to live in denser neighbourhoods. Canesi (2022) finds similar results suggesting that housing density is a feature that positively affects land prices (and therefore house prices). Higher density leads to higher values per buildable square feet. Densification policies (strategies and regulations implemented by local governments to increase the density of development) significantly increase land transaction prices because communities and developers value density and show a greater willingness to pay for it. They recognize its economic and social benefits.

In contrast, Lee (2016) finds that consumers in Seoul do not favour increased housing density. They do prefer populated areas, but they do not favour increased housing density. There is a willingness to pay higher premiums for housing in areas with high population growth and limited housing supply. As a result of this, higher housing densities tend to decrease housing prices in Seoul.

2.3 Other controls (housing price drivers)

According to the literature there are multiple factors that influence house prices. In Rosen's research (1974) the hedonic pricing model is introduced. It is explained how changes in individual attributes within a bundled product affect its overall value. In the context of house prices, the price of a property is determined by its characteristics, which can be broken down into various attributes This perspective helps understanding consumer behaviour and market pricing by highlighting how specific features impact perceived value.

Based on the research of Rosen (1974), Goodman (1978), Simons et al. (1998) and Dubin (1992) the following categories can be classified: housing (property) characteristics, neighbourhood characteristics and locational characteristics.

The following property-specific features are seen to influence housing prices: surface area of the property, number of rooms (specific bedrooms and bathrooms) and the size of the lot (Allen et al., 2017; Baltagi et al., 2014, Dubin, 1992). The following outdoor space features have a positive influence on house prices: presence of a terrace, balcony or garden (Baltagi et al., 2014, Dubin, 1992). Lastly, the construction age also influences the house price significantly (Allen et al., 2017; Baltagi et al., 2014, Dubin, 1992).

Certain neighbourhood characteristics also influence house prices. The features determine the attractivity of the neighbourhood. Median income is included by Halvorsen & Pollakowski (1981). Also, Choudhury & Hartman, 2015 found that higher median home values are associated with higher household income, suggesting that wealth factor positively impacts house value across different regions. Sequeira and Filippova (2020) found that the concentration of social housing negatively impacts residential property values in New Zealand. Been et al. (2018) found that adding housing supply leads to lower house prices. Therefore housing stock difference and housing stock difference per square km are added. Brueckner et al. (1997) found that natural amenities have a positive influence on house prices.

Location also plays a role in the price of housing. According to Baltagi et al. (2014) the distance to centre arrondissement, centre quartier & city centre has a negative influence on house prices. The findings of Iacono and Levinson (2011) indicate that locational factors such as proximity to highway access points positively influences property values, while being close to the highway itself negatively affects prices.

Derived from the literature and following van Haften (2021) Table 2 provides an overview of house value drivers.

TABLE 2. HOUSE VALUE DRIVERS FROM EXISTING LITERATURE

House value drivers	Findings	Sources
Property characteristics		
Size (surface in square meters)	+	Allen et al., 2017; Baltagi et al., 2014, Dubin, 1992
Number of rooms	+	Allen et al., 2017
Presence of terrace, balcony or garden	+	Dubin., 1992
Construction age	-	Baltagi et al., 2014
Neighbourhood characteristics		
Median income	+	Halvorsen & Pollakowski, 1981; Choudhury & Hartman, 2015
Concentration of social housing	-	Sequeira & Filippova, 2020
Housing supply (difference)	+/-	Simons et al., 1998; Been et al., 2018
Natural amenities	+	Brueckner et al., 1997
Locational characteristics		
Distance to centre arrondissement, centre quartier & city centre	-	Baltagi et al., 2014
Proximity to highway access	+	Iacono and Levinson, 2011
Distance to highway	+	Iacono and Levinson, 2011

2.5 Conceptual model

The conceptual model which is shown in figure 3 provides an overview of the variables that needs to be investigated when conducting the research. The research aims to investigate a possible relationship between housing supply growth and housing prices across different regions in Paris over the period from 2021 to 2023. The dependent variable, house prices, is influenced by both housing demand and housing supply. The right side of the model illustrates how housing policies contribute to the key independent variable: an increase in housing supply.

In addition to the independent and dependent variable, several control variables will be used to ensure that the relationship between housing prices and housing supply (growth) are not based on other variables. Based on the research of Rosen (1974) and Simons et al. (1998) the following control variables will be added: Housing characteristics, neighbourhood attributes and location.

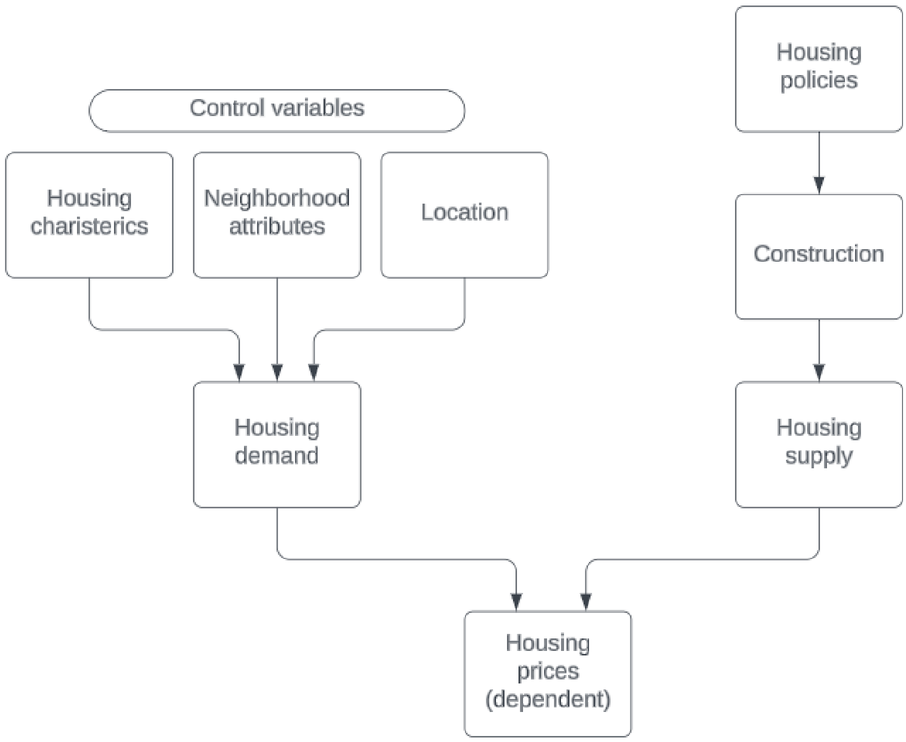

Figure 4. Conceptual model of research

2.5 Hypotheses

Based on the theoretical framework, several expectations could be explained. Firstly, housing supply growth can attribute to lowering housing prices. When controlling demand-factors, simply adding to supply could reduce housing prices if the new supply is a close substitute for existing housing. However, when there is excessive demand, as discussed in section 2.1 and shown in Figure 3, house prices still increase even with the addition of housing stock.

H1: *There is a positive linear relationship between housing supply and house prices.*

This is line with the results of Simons et al. (1998) and supporting literature (Zahirovich-Herbert and Gibler, 2014; Ooi and Le, 2011) in which construction positively impacts the value of existing housing due to the association of new construction with an appealing environment. Moreover, new developments often bring with them upgraded infrastructure and services, such as better transportation links, more green spaces, and enhanced commercial facilities, which can make the area more attractive to potential buyers and investors, thereby pushing up house prices.

H2: *There is a positive linear relationship between housing density and house prices.*

To better understand the relationship between housing stock and housing affordability, it is important to examine the influence of housing density. Based on the literature (Dong and Hansz, 2019; Canesi, 2022) we expect that higher density leads to higher house prices, as people pay a premium for denser neighbourhoods. We expect that higher density increases land and house prices due to its added social and economic value.

3. Methodology and data

3.1 Background and data collection

This study includes housing transactions and neighbourhood characteristics within the central area of Paris. Paris is divided into 20 different neighbourhoods (arrondissements). By analysing data from all 20 arrondissements, this study aims to examine the association between housing stock and transaction prices, providing insights into the housing market trends and dynamics across the central city of Paris.

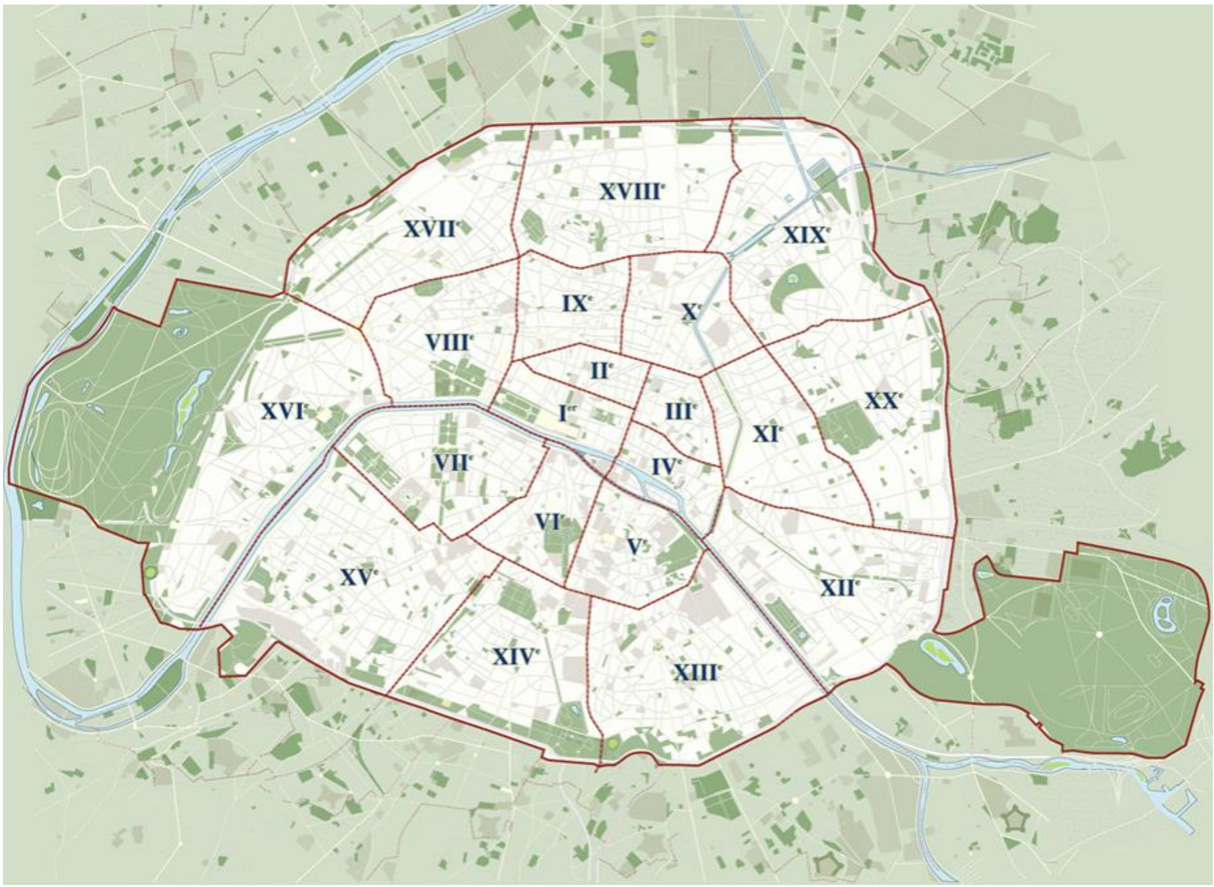

Figure 5. Map of Paris (Paris arrondissements & districts, no date)

The used data can be segmented into two distinct parts. The first dataset used is sourced from the French government. This dataset includes extensive information regarding properties sold in France during the period of 2018 to 2023. Through the "Demande de valuer fonciere" (DVF) platform, users can access details of property sale transactions. The information that is available includes sales prices, dates of sales, property sizes, number of bedrooms, land area, and plot number. The database safeguards the anonymity of both buyers and sellers, preserving privacy (News Archive: Access to French Property Sale Prices | French-Property.com, 2021).

The second part of the used data is from ADIL de Paris (L'Agence Départementale d'Information sur le Logement de Paris). The Paris Departmental Housing Information Office provides legal, financial, and tax-related advice on all housing matters. The operations and functions of ADIL are defined in

Article L 366-1 of the Housing and Construction Code. It is approved by the ministry responsible for housing and operates within the framework of the national ANIL/ADIL network (ADIL, 2023).

ADIL (2023) published reports called "fiches territoriales - Les principaux indicateurs," which contain data on population figures, housing stock, percentage social housing and average prices per square meter across all 20 arrondissements (districts) of Paris. This information is only available for the years 2021, 2022, and 2023.

Given the available data, it is not possible to investigate specific housing policies as there is no precise information on where supply is added due to specific policies. Therefore, as a second best, this study investigates the relationship between total housing supply growth per arrondissement and house prices.

Ethical considerations

As all data obtained for this study are publicly available, there are no concerns regarding data privacy or informed consent. However, it is essential to maintain integrity in data analysis and reporting to avoid misinterpretation or misrepresentation of findings. Furthermore, ethical guidelines regarding academic honesty and proper citation of sources will be strictly adhered to throughout the research process. The database of French property sales prices safeguards the anonymity of both buyers and sellers, preserving privacy.

When transferring information, as with any such system, it is likely that some errors will occur, and thus there is no guarantee of 100% accuracy. This is acknowledged by the source discussing the accessibility of French property sale prices (News Archive: Access to French Property Sale Prices | French-Property.com, 2021).

Given this statement, it is crucial to explore outliers when analysing the data. Such differences can potentially lead to incorrect statistical significance. Therefore, when utilizing this data, it is crucial to compare data from multiple sources to validate its accuracy.

3.2 Descriptive statistics

The dataset encompasses all residential property sales throughout the 20 arrondissements of Paris from 2021 to 2023, including 2023. Variables such as housing supply, median income, and the number of social housing units will be extracted from the territorial fiches. Both datasets provide detailed information for all 20 arrondissements, allowing for the analysis of transactions specific to each arrondissement.

Data management

The dataset of DVF contains a total of 337.548 observations across the 20 arrondissements in Paris. After cleaning the dataset by removing the missing values for the transaction price, gross floor area and number of rooms there remain 201.981 observations.

The data is filtered in several steps: initially, only the years 2021, 2022, and 2023 are selected. Subsequently, only transactions involving sold properties are included. Finally, the dataset is refined to include only apartments and houses. This process ensures that only the relevant cases are selected for analysis.

To control for outliers a boxplot was plotted. Any data points that lie beyond the whiskers are considered outliers. In a boxplot, the Interquartile Range (IQR) is calculated as the difference between the third quartile (Q3, 75th percentile) and the first quartile (Q1, 25th percentile). Whiskers extend from the quartiles to include data within 1.5 times the IQR. Specifically, the lower whisker reaches the smallest value greater than Q1 - 1.5 * IQR, and the upper whisker reaches the largest value less than Q3 + 1.5 * IQR (Quartiles and box Plots - Data Science Discovery, n.d.). After calculating the whiskers, all observations outside 0 and 1.802.466 are removed. As a result, an additional 11.260 observations are removed from the dataset. According to Morgan (2007), transaction prices below or above a threshold may be excluded. All observations below € 15.000 are excluded, these observations are not realistic. A total of 84.926 observations are used in the data analysis.

The data of fiches territoriales is merged into the DVF dataset, incorporating arrondissement-specific variables from the territorial fiches dataset into the original transaction dataset of Paris. This integration will enhance the comprehensiveness and utility of the data for analysis.

The following arrondissement-specific data is merged with the DVF dataset: total population; population density (people per km^2); dwellings per km^2; median household income (€/year); percentage social housing; housing stock difference (dwellings per year); housing stock difference per km^2 (dwellings per year).

TABLE 3. DESCRIPTIVE STATISTICS (N=84.926)

Variable	Mean	Std. Dev.	Min	Max
Transaction price (€)	541465,20	366031,349	15000	1802050
Gross floor area (m²)	48,41	30,106	1	518
Number of rooms	2,29	1,148	0	34
Population density (km²)	25816,34	8650,604	8535	39756
Average # of dwellings per km²	17620,426	4342,467	7007,215	27596,017
Median household income (€/year)	30014,71	6122,400	20900	44490
Percentage social housing (%)	19,002	10,959	1,30	40,30
Housing stock difference (dwellings per year)	127,99	233,718	-113	855
Housing stock difference km² (Average # dwellings per km² per arrondissement per year)	22,626	39,394	-52,461	126,830
Year 2021	,389	,487	0	1
Year 2022	,414	,493	0	1
Year 2023	,197	,398	0	1
Apartment or house (1=apartment, 0=house)	,997	,054	0	1
Arrondissement number	13,47	4,870	1	20

3.3 Methodology

To examine the relationship between housing prices and housing supply, a hedonic multiple regression will be employed. The hedonic pricing model is chosen for its efficiency in studying housing prices, where different characteristics contribute to property values (Rosen, 1974; Goodman, 1978; Simons et al., 1998). In this model the dependent variable is the transaction price. The variable is measured in euros per transaction and is determined by housing (property) characteristics, neighbourhood characteristics and locational characteristics. By analysing the relationship between transaction prices and housing supply and hedonic control variables, we aim to understand the key determinants driving fluctuations in housing prices.

To analyse the relationship between housing prices and the various variables, the following regression model is used:

Ln(Price) = β0 + β1(Housing Stock Difference Per Km²) + β2(Ln(Gross Floor Area)) + β3(Number Of Rooms) + β4(Population Density) + β5(Median Household Income) + β6(Dwellings Per Km²) + β7(Percentage Social Housing) + + β8(Housing Stock Difference Per Km²) + Σβ9(Transaction Year) + Σβ10(Property Type) + Σβ11(Arrondissement Number) + ε

Where:

- β0 represents the intercept term. It represents the expected value of Ln(Price) when all other independent variables are equal to zero.
- ε is the error term. It represents the difference between the observed values and the values predicted by the model.

The use of logarithmic transformations, such as Ln(Price) and Ln(Gross Floor Area), helps normalize the data distribution and reduce the influence of outliers (extreme values), which is particularly beneficial in real estate where property values can have a large price range. First "housing stock difference per km²" is added, providing insights into how increases or decreases in housing stock impact prices. This aligns with the methodology from Simons et al. (1998) and Ooi and Le (2011), which indicate that an increase in housing stock can positively impact property values by enhancing neighbourhood appeal. "Housing stock per km²" offers a clear picture of the influence of housing density on house prices within specific areas. For instance, higher densities may indicate well-developed areas with numerous amenities, potentially driving up property prices due to higher demand, as supported by studies like those of Dong and Hansz (2019) and Canesi (2022).

To assess temporal variations, dummy variables were incorporated for the years 2022 and 2023, using 2021 as the reference year. Regarding property type, a binary variable was used where apartments are coded as 1, and single-family homes as 0. Additionally, to account for geographic differences within the dataset, 20 dummy variables were included, each representing one of the 20 arrondissements, thereby controlling for locational effects.

Scatterplots

The scatterplot illustrated in figure 6 is a tool for visualizing the relationship between housing stock changes and the mean transaction price per arrondissement within the 20 arrondissements. It

highlights a potential negative correlation, the higher the housing stock difference per square kilometre, the lower the mean transaction price of the arrondissement. indicating that increasing housing stock might slightly lower property prices.

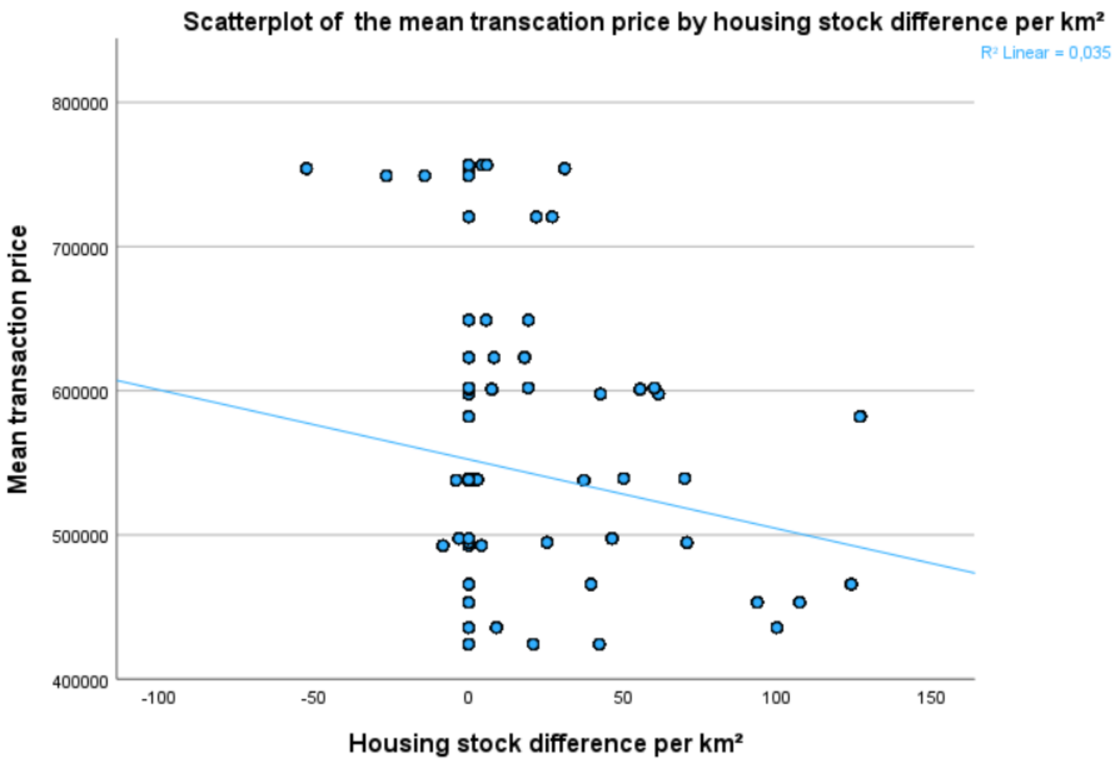

Figure 6. Scatterplot of the mean transaction price by housing stock difference per km²

Figure 7 shows a scatterplot illustrating the relationship between the mean transaction price per arrondissement and housing stock density per km². The blue regression line, with an R^2 value of 0.232, indicates a potential moderate negative correlation, suggesting that as housing stock density increases, mean transaction prices tend to decrease. However, since we do not control for other variables, this relationship should be interpreted only as an indication rather than conclusive evidence.

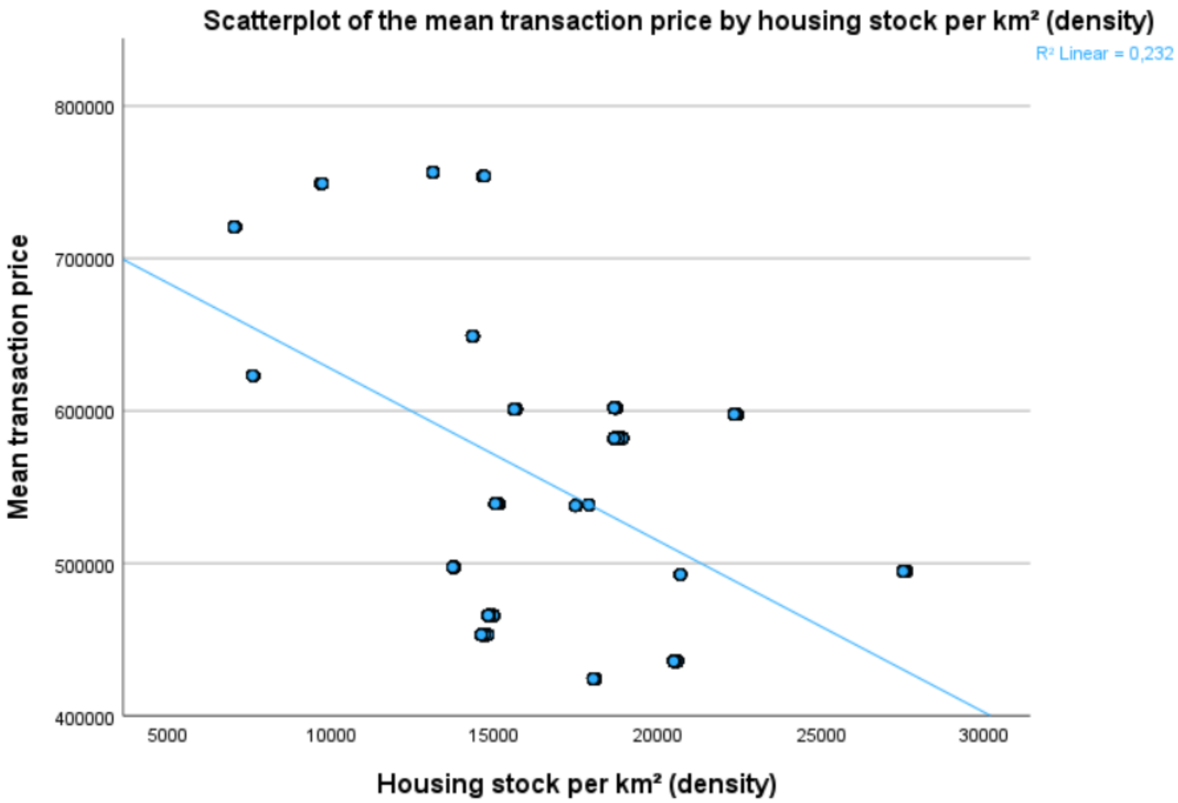

Figure 7. Scatterplot of the mean transaction price per arrondissement by housing stock per km²

Testing assumptions

The research tests the assumptions underlying the multiple regression analysis to ensure the validity of our findings. These assumptions include linearity, homoscedasticity, normality of the residuals. Tests such as the Kolmogorov-Smirnov to test for normality are performed. Lastly, multicollinearity is tested for in the model using the Variance Inflation Factor (VIF) to ensure the accuracy of the regression results. The test for normality and an explanation of all other regression assumptions are provided in Appendix I.

4. Results and discussion

4.1 Results

This section presents the analysis and discussion of the results obtained from the hedonic multiple regression models developed to assess the determinants of transaction prices. The models gradually include different predictors to understand their distinct contributions to explaining price variability. The base model consists of the most direct and influential predictors of transaction prices. These variables were selected based on their theoretical relevance and empirical evidence suggesting their significant impact on house values.

TABLE 4. REGRESSIONS ESTAMATING THE LOG(TRANSACTION PRICE)

	(1)	(2)	(3)	(4)	(5)
Housing stock difference per km² (per 100 dwellings)		-0,0642***	0,0109**	0,0212***	0,0189**
		(0,0516)	(0,0553)	(0,00763)	(0,00744)
	(0,00483)	(0,00487)	(0.00483)	(0.00482)	(0.00482)
Log gross floor area (m²)	0,777***	0,789***	0,777***	0,780***	0,780***
	(0,00483)	(0,00487)	(0.00483)	(0.00482)	(0.00482)
Number of rooms	0,0223***	0,0229***	0,0222***	0.0231***	0.0231***
	(0,00262)	(0,00265)	(0,00262)	(0,00261)	(0,00261)
Population density (people/km²)	4,171E-7***		2,6514E-7	3,305E-6**	3,520E-6
	(2,8497E-7)		(2,9514E-7)	(0,00000158)	(0,00000156)
Median household income (€/year)	-0,011***		1,013E-5***	9,101E-6	
	(0.00313)		(7,348E-7)	(0,0000128)	
Percentage social housing (%)	0,564***		-0,00300***	-0,0134	
	(0,00872)		(0,000356)	(0,0117)	
Year 2021 (reference)					
Year 2022	0,0131***	0,0338***	0,010**	0,0130***	0,00666
	(0,00384)	(0,00416)	(0,00415)	(0,00550)	(0,00453)
Year 2023	-0,0366***	-0,0137**	-0,0422***	-0,0347***	-0,0466***
	0,00478	(0,00557)	(0,00556)	(0,00895)	(0,00644)
Apartment (1=yes, 0=single-family home)	-0,306***	-0,229***	-0,307***	-0,305***	-0,305***
	(0,0319)	(0,0324)	(0,0319)	(0,0318)	(0,0318)
Control for location (arrondissement)	NO	NO	NO	YES	YES
Observations	84.926	84.926	84.926	84.926	84.926
R-squared	0,524	0,510	0,525	0,529	0,529

Note: Dependent variable is log of transaction price. Standard errors in parentheses with *** , **, *indicating significant at 1%, 5% and 10%, respectively.

In this model, control variables for location at the arrondissement level have not been included. Each variable added to the model is significant, with statistical significance at the 1% level. For instance, when analysing the gross floor area, it is evident with a significance at 1% that a 1% increase in gross floor area leads to a 7.8% increase in transaction price.

In the second model the key explanatory variable is added. First, the model does not control for neighbourhood characteristics or location to assess the impact of the difference in housing stock per km² (per 100 dwellings). In this model the key explanatory is significant at a 1% level. With a unstandardized of beta of -0,0642 the variable turns out to have a negative influence on the transaction price. With every 100 dwellings added per square kilometre in Paris the transaction price descends with 6.2%. However, this model does not control for location and neighbourhood characteristics.

In model 3 the neighbourhood variables are added again. In this way the model controls for the effect of neighbourhood characteristics on the transaction price. At a 5% significance level the key explanatory variable positively influences the transaction price. A remarkable shift from negatively influencing the transaction price to a positive unstandardized Beta. We see that adding 100 dwellings per square kilometre results in a 1.09% rise of the transaction price.

In the fourth model every variable is added to the regression. After also controlling for the location at arrondissement level the coefficient of the housing stock difference per square kilometre (per 100 dwellings) rises with 0,0103. This means that at a 1% significance level for every 100 added dwellings per kilometre the transaction price of houses in Paris now rises with 2.14%.

However the fourth model may lead to overfitting due to a high variance inflation factor (VIF). The median household income and percentage social housing both are removed due to a significantly low tolerance (<0,01). In this final model while not controlling for a part of the neighbourhood characteristics the key explanatory variable is significant at a 5% level. The adding of 100 dwellings per kilometre now results in a 1.91% increase in transaction price of houses in Paris.

Although house prices are rising, the results of the regression show a nuanced trend. The beta coefficient for the 2023 dummy variable is -0,0466 and significant at a 1% level, suggesting a relative decline in transaction prices during this period. When interpreting this coefficient in the context of a model where the dependent variable is the natural logarithm of the transaction price, it translates to a decrease of approximately 5.56% in house prices for 2023 compared to the reference year 2021. In contrast to the decrease in house prices during 2023, the regression analysis indicates that the year 2022 does not show a statistically significant impact on house prices.

Lastly, the beta coefficient for the apartment dummy variable, set at -0,305, indicates that apartments are associated with transaction prices that are lower than those of single-family homes. Specifically, the model suggests that apartments sell for approximately 26.3% less than single-family homes when all other factors are held constant. This finding is particularly insightful, as it highlights the premium attached to single-family homes.

Housing density (housing stock per km²)

The hedonic multiple regression analysis (Table 5) reveals that housing stock density is not a statistically significant predictor of the log of transaction prices when controlling for the other variables in the model. This indicates that housing density does not have a statistical significant impact on transaction prices when controlling for other variables.

TABLE 5. REGRESSION ESTIMATING THE LOG(TRANSACTION PRICE)

	(1)
Housing stock per km²	6,168E-7
	(4.728E−6)
Control for time effects	YES
Control for neighbourhood characteristics	YES
Control for property characteristics	YES
Control for location (arrondissement)	YES
Observations	84.926
R-squared	0,528

Note: Dependent variable is log of transaction price. Standard errors in parentheses with *** , **, *indicating significant at 1%, 5% and 10%, respectively.

4.2 Discussion

The results suggest that there is a significant relationship between housing supply growth and house prices in Paris. The data supports one of the two hypotheses. We find significant positive coefficients for the housing stock difference per km² (per 100 dwellings). This suggests that new housing developments may bring added value to neighbourhoods, which increases transaction prices. This in line with the findings of Simons et al. (1998), Zahirovich-Herbert and Gibler (2014) and Ooi and Le (2011), who also found that new constructions can have a small positive effect on the prices of existing homes. The evidence from the regression when controlling for neighbourhood characteristics results in a positive shift of the relationship between the key variables. By adding the arrondissement dummies indeed we see an even larger relationship between the two variables.

The shift from a negative to a positive influence on the prices when adding neighbourhood characteristic variables highlights the importance of considering the broader context. By including these controls, the coefficients illustrate that new housing developments are associated with higher property values. They are likely mediated by factors such as the quality of the developments, associated amenities, and overall neighbourhood appeal.

Despite initial findings (Dong and Hansz, 2019; Canesi, 2022) suggest that housing density has a positive impact on house prices, the results of this study indicate that this relationship is more complex. The data does not support the hypothesis of a positive linear relationship between housing density and house prices. When controlling for various neighbourhood, property and locational variables, housing stock density does not significantly predict transaction prices. The differing results could be attributed to the different geographical contexts of the studies, which may have distinct market dynamics compared to Paris. This demonstrates the complexity and heterogeneity of housing markets.

5. Conclusion

This study aims to explore the relationship between housing prices and housing supply in Paris from 2021 to 2023. More specifically, it investigates how changes in housing stock and housing density affect housing prices during this period. Using a hedonic multiple regression model, we assess the impact of various factors on transaction prices, including property characteristics, neighbourhood features, and locational specifics.

Firstly, we derived the house value drivers from existing academic literature. This provided a solid foundation for our analysis. Separately, the dynamic relationships between housing supply and house prices are examined. This approach provided a clear understanding of the relationship between house prices and the change in housing supply.

The results indicate a significant relationship between housing supply growth and transaction prices. The models show that increasing the housing stock by 100 dwellings per square kilometre results in a 1.91% increase in transaction prices. This suggests that while an increase in housing supply might typically be expected to lower prices due to supply and demand dynamics, in Paris, it appears to enhance neighbourhood attractiveness, thus driving prices up. This aligns with the theory of DiPasquale and Wheaton (1992), which suggests that even when housing stock is added in the presence of excessive demand, prices can still increase. It is also consistent with existing literature of Simons et al (1998) and Zahirovich-Herbert and Gibler (2014).

Additionally, when examining the effect of housing density on house prices, we found no significant relationship. This contrasts with the findings of Dong and Hansz (2019) and Canesi (2022), who found positive relationships in their studies.

Despite these insights, there are limitations to this study. The dataset spans only three years, which is a relatively short period for analysing such trends. Variations in transaction prices can be influenced by numerous factors beyond the scope of this model. Furthermore, the use of arrondissement-specific data introduces issues of multicollinearity, complicating the model's accuracy. Additionally, the data from DVF also contributes to inaccuracies. Many large projects with multiple apartments are recorded as being sold for 40 times the price of the entire project, rather than as individual apartments.

Overall, while the study provides valuable insights into the dynamics of housing prices and supply in Paris, future research with a more extended dataset and refined data accuracy is necessary to confirm these findings and further elucidate these relationships. Also, this study focuses on government policies boosting housing supply. While this research delves into the general impact of housing supply growth, it does not provide a clear overview of the specific contributions of housing policies. This is due to the complexity of the effects of such government policies. For this to examine, a deeper and understanding of various government policies and their direct impact on the housing stock is necessary.

References

ADIL (2021). *Nouvelle édition des Fiches territoriales*. https://www.adil75.org/2022/09/21/nouvelle-edition-des-fiches-territoriales-2022/.

Allen, M.T., Rutherford, J., Rutherford, R. and Yavas, A. (2017). Impact of Investors in Distressed Housing Markets. *The Journal of Real Estate Finance and Economics*, 56(4), pp.622–652. https://doi.org/10.1007/s11146-017-9609-0.

Baltagi, B.H., Bresson, G. and Etienne, J. (2014). Hedonic Housing Prices in Paris: An Unbalanced Spatial Lag Pseudo-Panel Model with Nested Random Effects. *Journal of Applied Econometrics*, 30(3), pp. 509–528. https://doi.org/10.1002/jae.2377.

Been, V., Ellen, I.G. and O'Regan, K.M. (2018). Supply skepticism: housing supply and affordability. *Housing Policy Debate*, 29(1), pp. 25–40. https://doi.org/10.1080/10511482.2018.1476899.

Brueckner, J. K., Thisse, J. F., & Zenou, Y. (1997). Why is central Paris rich and downtown Detroit poor? An amenity-based theory. *European Economic Review*, 43(1), 91-107.

Burt, J.E., Barber, G.M. and Rigby, D.L. (2009). *Elementary statistics for geographers*. Guilford Press.

Canesi, R. (2022). Urban Policy Sustainability through a Value-Added Densification Tool: The Case of the South Boston Area. *Sustainability*, 14(14), p. 8762. https://doi.org/10.3390/su14148762.

Chalencon, G. and Pavageau, G. (2023). Le bail réel solidaire, une propriété comme les autres?. *Paris - Tribune*, no. 288785, 12 May. https://cities.newstank.fr/article/view/288785/bail-reel-solidaire-propriete-comme-autres-g-chalencon-g-pavageau-espacite.html.

Choudhury, A., & Hartman, N. (2015). Regional differential wealth effect on home value: a cross-sectional analysis. *Journal of Economics and Economic Education Research*, 16, pp. 273..

Cox, W. (2022). *Demographia International Housing Affordability – 2022 Edition released*. https://urbanreforminstitute.org/2022/03/demographia-international-housing-affordability-2022-edition-released/.

De Vries, P. and Boelhouwer, P. (2005). Local house price developments and housing supply. *Property Management*, 23(2), pp. 80–96. Https://doi.org/10.1108/02637470510589968.

DiPasquale, D. and Wheaton, W.C. (1992). The Market for Real Estate Assets and Space: A Conceptual Framework. *Journal of the American Real Estate and Urban Economics Association*, Vol. 20, pp. 181-197.

DiPasquale, D. and Wheaton, W.C. (1994). Housing market dynamics and the future of housing prices. *Journal of Urban Economics*, 35(1), pp. 1–27. https://doi.org/10.1006/juec.1994.1001.

Dong, H. and Hansz, J.A. (2019). Zoning, density, and rising housing prices: A case study in Portland, Oregon. *Urban Studies*, 56(16), pp. 3486–3503. https://doi.org/10.1177/0042098018813251.

Dubin, R.A. (1992). Spatial autocorrelation and neighborhood quality. *Regional Science and Urban Economics*, 22(3), pp. 433–452. https://doi.org/10.1016/0166-0462(92)90038-3.

Effects of land and housing policies on market performance | Lincoln Institute of Land Policy (no date). https://www.lincolninst.edu/publications/articles/effects-land-housing-policies-market- performance.

Fingleton, B. (2008). Housing supply, housing demand, and affordability. *Urban Studies*, 45(8), pp. 1545–1563. https://doi.org/10.1177/0042098008091490.

Fingleton, B., Fuerst, F. and Szumilo, N. (2018). Housing affordability: Is new local supply the key?. *Environment & Planning. A*, 51(1), pp. 25–50. https://doi.org/10.1177/0308518x18798372.

French-Property.com (no date). *Mortgages for first time buyers*. https://www.french-property.com/guides/france/finance-taxation/mortgages/first-time-buyers.

Goodman, A.C. (1978). Hedonic prices, price indices and housing markets. *Journal of Urban Economics*, 5(4), pp. 471–484. https://doi.org/10.1016/0094-1190(78)90004-9.

Halvorsen, R. and Pollakowski, H.O. (1981). Choice of functional form for hedonic price equations. *Journal of Urban Economics*, 10(1), pp. 37–49. https://doi.org/10.1016/0094-1190(81)90021-8.

Harvey, J. and Jowsey, E. (2003*). Urban Land Economics*. Red Globe Press.

Housing crisis in France: Is there a housing shortage? (2023). https://www.studapart.com/en/inside-the-culture/housing-crisis-france-there-housingshortage#:~:text=Housing%20crisis%20in-%20France%3A%20Is,difficult%20to%20find%20affordable%20housing.

Iacono, M. and Levinson, D. (2011). Location, regional accessibility, and price effects. *Transportation Research Record*, 2245(1), pp. 87–94. https://doi.org/10.3141/2245-11.

Jehangir, M. (2023). Social housing crisis: 14% of households in Paris Metro area awaiting affordable homes. *BNN*. https://bnnbreaking.com/world/france/social-housing-crisis-14-of-households-in-paris-metro-area-awaiting-affordable-homes/

Kim, J.H. (2005). Housing price hike and price stabilization policy in Korea. *KDI School of Public Policy and Management*.

Koutsoyiannis, A. (1975). Perfect competition. *Palgrave Macmillan UK eBooks*, pp. 154–170. https://doi.org/10.1007/978-1-349-15603-0_5.

Lee, J.-S. (2016). Measuring the value of apartment density?. *International Journal of Housing Markets and Analysis*, 9(4), pp. 483–501. https://doi.org/10.1108/ijhma-08-2015-0047.

Lee, Y., Kemp, P.A. and Reina, V.J. (2022). Drivers of housing (un)affordability in the advanced economies: a review and new evidence. Housing Studies, 37(10), pp. 1739–1752. https://doi.org/10.1080/02673037.2022.2123623.

LOI n° 2018-1021 du 23 novembre 2018 portant évolution du logement, de l'aménagement et du numérique (1) - Légifrance (2018). https://www.legifrance.gouv.fr/loda/id/JORFTEXT000037639478.

Meen, G. (2011). A Long-Run model of housing affordability, *Housing Studies*, 26(7-8), pp. 1081–1103. https://doi.org/10.1080/02673037.2011.609327.

Morgan, A. (2007). The impact of Hurricane Ivan on expected flood losses, perceived flood risk, and property values. *Journal of Housing Research*, 16(1), pp. 47–60. https://doi.org/10.1080/10835547.2007.12091977.

News Archive: Access to French property sale prices | French-Property.com (2021). https://www.french-property.com/news/french_property_market/land_registry_cadastre_records

Ooi, J., & Le, T. (2012). New Supply and Price Dynamics in the Singapore Housing Market. *Urban Studies*, 49, pp. 1435 - 1451. https://doi.org/10.1177/0042098011415718.

Paris arrondissements & districts (no date). https://parismap360.com/paris-arrondissement-map.

Paris Perfect (2024). *Paris Real Estate: Insights from 2023 and Forecasts for 2024*. https://www.parisperfect.com/blog/2024/03/paris-real-estate-insights-from-2023-and-forecasts-for-2024/#:~:text=There%20is%20a%20housing%20-shortage,how%20far%20prices%20can%20fall.

Quartiles and box Plots - Data Science Discovery (no date). https://discovery.cs.illinois.edu/learn/Exploratory-Data-Analysis/Quartiles-and-Box-Plots/.

République Française (2024). *Impôt sur le revenu - Investissement locatif Loi Pinel/Duflot (réduction d'impôt).* https://www.service-public.fr/particuliers/vosdroits/F31151.

Rosen, S. (1974). Hedonic prices and implicit markets: product differentiation in pure competition. *Journal of Political Economy*, 82(1), 34–55. https://doi.org/10.1086/260169

Saiz, A. (2023). The Global Housing Affordability Crisis: Policy options and Strategies. *Social Science Research Network*. https://doi.org/10.2139/ssrn.4402329.

Savva, C. (2018). Factors Affecting Housing Prices: International Evidence. *Cyprus Economic Policy Review*, 12, pp. 87-96

Sequeira, V. and Filippova, O. (2020). Does concentration of social housing influence house prices? Evidence from New Zealand. *International Journal of Housing Markets and Analysis*, 14(4), pp. 720–744. https://doi.org/10.1108/ijhma-04-2020-0032.

Simons, R.A., Quercia, E.G. and Maric, I. (1998). The value impact of new residential construction and neighborhood disinvestment on residential sales price. *Journal of Real Estate Research*, Vol.15 Nos1-2, pp.147-61.

UIPI (2018). *Under the microscope – The New French Housing Law.* https://www.uipi.com/under-the-microscope-the-new-french-housing-law/.

United Nations General Assembly (2023). *Adequate housing as a component of the right to an adequate standard of living, and on the right to non-discrimination in this context*. Seventy-eighth session, item 73(b) of the provisional agenda. A/78/192, 15 August.

van Haften, H.J. (2021). *The relationship between institutional investors and house prices: The case of Paris*. August 20.

White, M. and Allmendinger, P. (2003). Land-use planning and the Housing Market: A Comparative review of the UK and the USA. *Urban Studies*, 40(5–6), pp. 953–972. https://doi.org/10.1080/0042098032000074263.

Yu, H.J. and Lee, S. (2010). Government housing policies and housing market instability in Korea. *Habitat International*, 34(2), pp. 145–153. https://doi.org/10.1016/j.habitatint.2009.08.005.

Zahirovich-Herbert, V., & Gibler, K. (2014). The effect of new residential construction on housing prices. *Journal of Housing Economics*, 26, pp. 1-18. https://doi.org/10.1016/J.JHE.2014.06.003

Appendix I. Assumption testing

Testing assumptions in statistical modeling is essential to ensure the validity, reliability, and accuracy of model results. Following Burt et al. (2009) the following must be checked for:

- Linearity: The errors have a mean of 0.
- Homoscedasticity: Constant variance of errors across all levels of the independent variables.
- Normality: The residuals of the model are normally distributed.
- Multicollinearity: Independent variables are not too highly correlated.

Linearity and homoscedasticity

In figure I.2 the unstandardized predicted value is plotted against the unstandardized residual. For the plot to meet the assumption, the residuals should scatter randomly around the horizontal line at zero without any pattern or systematic deviation. A non-random pattern (like a curved line or a funnel shape) suggests problems with linearity. In the used dataset where the dependent variable varies significantly across different arrondissements, some level of heteroscedasticity might be expected. Each arrondissement might have a different variance in house prices due to unique characteristics influencing prices differently across regions

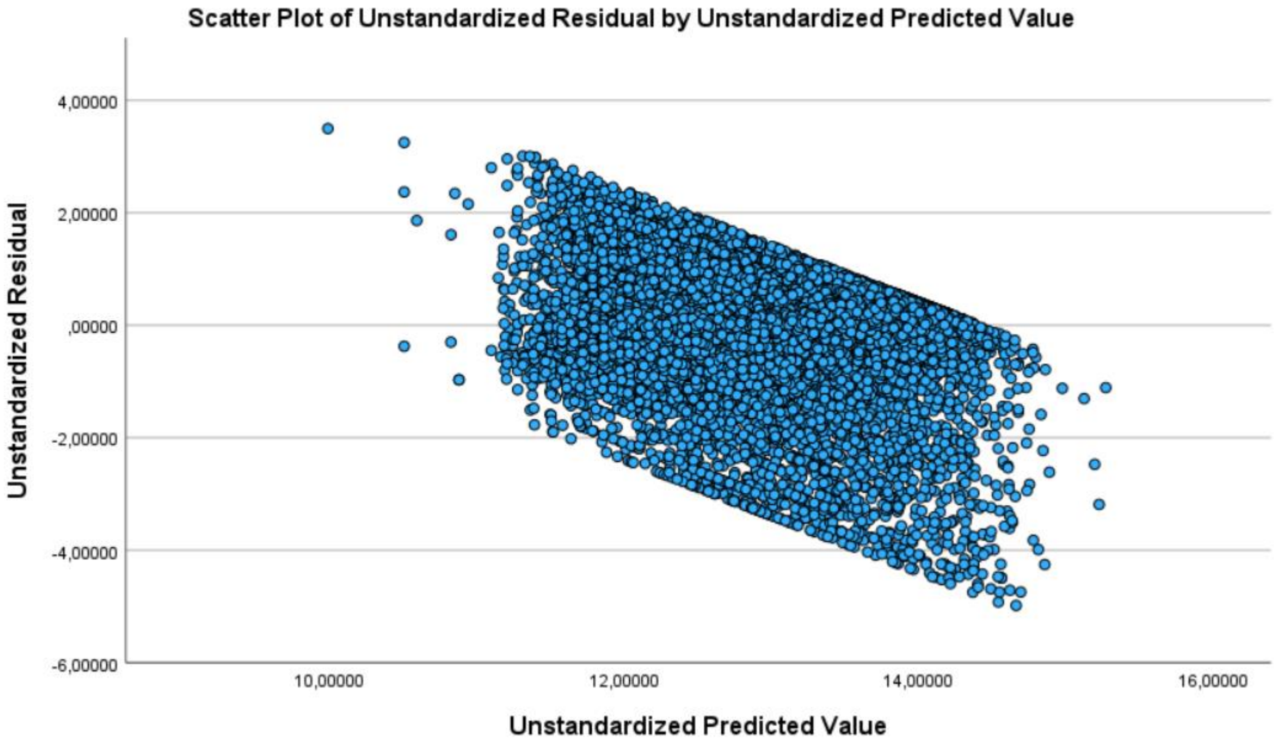

Figure I.1

Normality

In this section, we check for normality by assuming that the residuals of the model are normally distributed. Looking at figure I.2, the data looks normally distributed. A Kolmogorov-Smirnov test is conducted to determine whether the residuals are normally distributed. The output includes a test statistic and a significance value (p-value) for the Kolmogorov-Smirnov test. A significant result (typically $p < 0.05$) indicates that the data do not follow a normal distribution. The result is significant, therefore the null hypothesis of normal distribution of the error terms is rejected. However, with larger samples, the Central Limit Theorem suggests that the distribution of the residuals may approximate normality more closely (Burt et al., 2009).

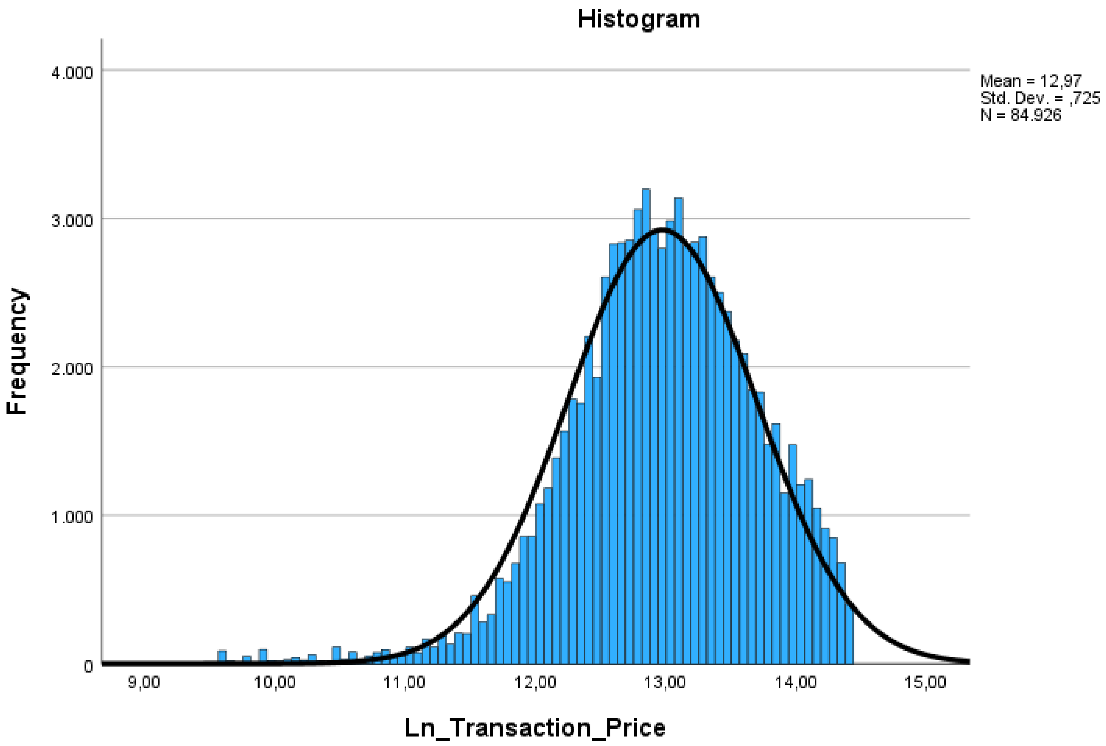

Figure I.2

Multicollinearity

Multicollinearity is the statistical phenomenon in which two or more predictor variables in a multiple regression model are highly correlated. When multicollinearity is present, the precision of the estimate coefficients decreases, which can lead to unreliable and unstable estimates of coefficients in the regression model. In figure I.3 the collinearity statistics are projected for every variable of the final used model. A Variance Inflation Factor (VIF) value of 10 or higher strongly suggests that the corresponding predictor is highly collinear with one or more of the other predictors. This can impair the regression model's ability to distinguish between the independent effects of collinear variables.

In figure I.3 multiple high VIF values (above 10) can be distinguished. The following variables turn out to have a high VIF value:

- Population density (per km²)
- Arrondissement 9, 10, 11, 13, 14, 15, 17, 18, 19 and 20 (dummy)

However, the primary interest is in estimating the effect of certain key explanatory variables. In this study, the key explanatory variable is the difference in housing stock per square kilometre. The VIF value of this variable is acceptable at a level of 2,943. Control variables are included primarily to adjust for potential confounding influences. If the VIFs of these key variables are within acceptable limits (typically VIF < 10), it suggests that the estimates for these variables are likely reliable, even if the control variables are highly collinear.

		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	10,513	,042		252,867	<,001		
	Number_of_rooms	,023	,003	,037	8,827	<,001	,324	3,089
	Population_density_(per km2)	-3,520E-6	,000	-,042	-2,251	,024	,016	62,778
	Year2022	,007	,005	,005	1,470	,141	,585	1,711
	Year2023	-,047	,006	-,026	-7,244	<,001	,445	2,249
	Dummy Variable for Apartments (1=Apartment, 0=House)	-,305	,032	-,023	-9,590	<,001	,990	1,010
	ArrDummy2	-,038	,030	-,006	-1,269	,205	,213	4,694
	ArrDummy3	,033	,038	,006	,866	,387	,104	9,642
	ArrDummy4	,101	,027	,017	3,819	<,001	,270	3,708
	ArrDummy5	,073	,030	,017	2,461	,014	,118	8,497
	ArrDummy6	,204	,026	,042	7,760	<,001	,189	5,298
	ArrDummy7	,134	,025	,028	5,316	<,001	,198	5,059
	ArrDummy8	-,060	,022	-,011	-2,756	,006	,357	2,804
	ArrDummy9	-,029	,035	-,008	-,837	,403	,063	15,851
	ArrDummy10	-,115	,038	-,037	-3,002	,003	,036	27,793
	ArrDummy11	-,011	,051	-,004	-,209	,835	,014	69,635
	ArrDummy12	-,183	,019	-,058	-9,682	<,001	,155	6,432
	ArrDummy13	-,160	,032	-,048	-5,073	<,001	,061	16,432
	ArrDummy14	-,095	,031	-,023	-3,082	,002	,096	10,444
	ArrDummy15	-,075	,034	-,032	-2,186	,029	,026	38,092
	ArrDummy16	-,060	,019	-,022	-3,229	,001	,122	8,214
	ArrDummy17	-,060	,036	-,024	-1,665	,096	,027	36,617
	ArrDummy18	-,140	,040	-,061	-3,467	<,001	,018	55,768
	ArrDummy19	-,216	,034	-,074	-6,382	<,001	,041	24,116
	ArrDummy20	-,212	,041	-,078	-5,130	<,001	,024	42,041
	LN_Gross_Floor_Area	,780	,005	,673	161,780	<,001	,320	3,121
	dwellings_difference_perkm2_100	,019	,007	,010	2,544	,011	,340	2,943

a. Dependent Variable: Ln_Transaction_Price

Figure I.3

Appendix II. French housing policies

TABLE II.1. FRENCH HOUSING POLICIES

Policy	Description	Demand	Supply
First-Time Homebuyer Programs (Prêt à Taux Zéro - PTZ)	Instrument that encourages home ownership. This program offers a government-backed interest-free loan to eligible buyers (French-Property.com, no date).	X	
The real joint lease (BRS) - Bail réel solidaire"	Non-profit entity retains ownership land and sells only the buildings to individuals at below-market prices. Also encourages development of affordable housing (Chalencon and Pavageau, 2023).	X	X
The loi ELAN (Evolution of Housing, Urban Planning and Digitalization Law)	The primary focal points of the ELAN (Évolution du Logement, de l'Aménagement et du Numérique) encompass several key objectives, namely: The reform of the social housing sector; Adaptation of rental lease contracts to societal changes; Simplification of urbanistic and building rules. (UIPI, 2018)		X
The Loi Duflot / Loi Pinel	These initiatives allow investors to purchase new properties with the intention of renting them out at controlled prices for a fixed period, typically nine years. In exchange for adhering to these conditions, investors benefit from substantial tax reductions (République Française, 2024).		X