Does Belgian residential property offer a hedge against inflation?

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DOES BELGIAN RESIDENTIAL PROPERTY OFFER A HEDGE AGAINST INFLATION?

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Master Thesis by
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List of abbreviations

AI	Actual Inflation
EI	Expected inflation
UI	Unexpected Inflation
CPI	Consumer Price Index
HPI	House Price Index
HICP	Harmonised Index of Consumer Prices
OLS	Ordinary Lest Squares
GLS	Generalized Least Squares
ADF	Augmented Dicky-Fuller

1 Introduction

Property is often seen as a safe investment, a refuge from the vagaries of the economy, particularly inflation. This deep-seated popular belief is based on the idea that property values tend to appreciate over time, thereby preserving investors' purchasing power even when prices are rising. In this context, property is often seen not only as a means of housing, but also as a tool for managing wealth and protecting against inflation.

However, this optimistic view of property as a hedge against inflation has not been uniformly confirmed by academic research. While some international studies have explored the relationship between inflation and the property market, few have looked specifically at the Belgian property market. After a thorough review of the literature, it appears that there are almost no studies that examine in detail the link between inflation and residential property in Belgium. This gap in the literature is all the more surprising given the importance of property in the Belgian economy and the central role that inflation plays in economic stability.

Given this lack of research, this thesis aims to fill the gap by exploring the ability of Belgian residential property to provide a hedge against inflation. The aim of this research is to analyse whether, and to what extent, property prices in Belgium can protect investors against both expected and unexpected inflation. The study also aims to explore regional variations within the Belgian property market, as well as the impact of economic cycles, such as recessions, on property performance during periods of inflation.

In addition, in order to better understand the functioning of the property market in Belgium, this thesis also outlines the differences in tax regimes between regions. Although this research does not specifically aim to study the impact of these tax policies, it is essential to recognise that these differences can influence the dynamics of the property market. Exposing these regional tax regimes therefore provides a necessary context for understanding the diversity of the Belgian property market.

This dissertation is structured into eight main chapters. It begins with a review of the literature, analysing previous studies on the relationship between inflation and real estate, and discussing regional differences in tax regimes in Belgium. The research objectives and main hypotheses are then presented, followed by a chapter detailing the methodology, data, and econometric tests used. The dissertation continues with an analysis of the empirical results obtained for the periods 1992-2010 and 2011-2023, compared with the existing literature. Robustness tests are also conducted to validate these results, including the use of different indices and cointegration tests to assess long-term relationships. A discussion of the implications of the results, the limitations of the study, and suggestions for future research precedes the conclusion, which summarises the main contributions of this work to the economic literature.

In short, this study aims not only to test the hypothesis that Belgian real estate can serve as a hedge against inflation, but also to make a significant contribution to the economic literature by elucidating the complex dynamics between inflation and real estate in the Belgian context.

2 Literature review

In this section, we begin with a detailed overview of the property market in Belgium, exploring its current characteristics and recent developments. We then present the methods used to measure inflation in Belgium, highlighting historical and contemporary trends. We then explain the concept of inflation hedging, a crucial aspect in understanding the dynamics between inflation and the property market. Finally, we review the existing literature on the ability of the property market to provide a hedge against inflation, examining the main studies and their conclusions in this area.

2.1 Overview of the Belgian property market

In a press release dated 22 December 2023, the National Bank of Belgium (NBB) reports on trends in the property wealth of individuals. In 2022, the property assets of private individuals in Belgium were valued at €1,876 billion, an increase of 7.7% on the previous year. This is divided into land, worth €1,157 billion (62% of the total), and buildings, worth €719 billion (38% of the total). In comparison, the net financial assets of private individuals amounted to €1,142 billion, marking a 7.8% decline on 2021 due mainly to stock market volatility and rising interest rates. This information highlights robust growth in the real estate sector in Belgium, contrasting with a fall in financial wealth, which may influence investment decisions and inflation hedging strategies. Moreover, in 2020-2021, 72% of Belgian households own their own home (de Sola Perea and Van Belle, 2022).

In their analysis Artige and Reginster (2017) examined the evolution of the residential property market in Belgium and Wallonia from 1995 to 2015. They found that during this period, house prices rose faster than the consumer price index, despite slowing down following the 2008 financial crisis. The authors explored several potential factors responsible for this rise in prices. Firstly, they considered the impact of demographic pressure on housing demand, but did not consider this factor to be sufficient on its own to explain the spectacular rise in prices. They then assessed the attractiveness of property yields as a possible cause, but this hypothesis was also dismissed. The examination of an insufficiently responsive property supply on the part of the construction sector was recognised as partially responsible for the rise in prices, but insufficient to explain the continuing increase in demand. Finally, the authors concluded that easier access to mortgage credit, coupled with lower interest rates and more flexible credit conditions, while facing an inelastic supply from the construction sector, played a key role in the sharp rise in house prices observed in Belgium over the period studied. Mortgage credit is still the main way for the majority of Walloon households to buy a home (Anfrie et al, 2023).

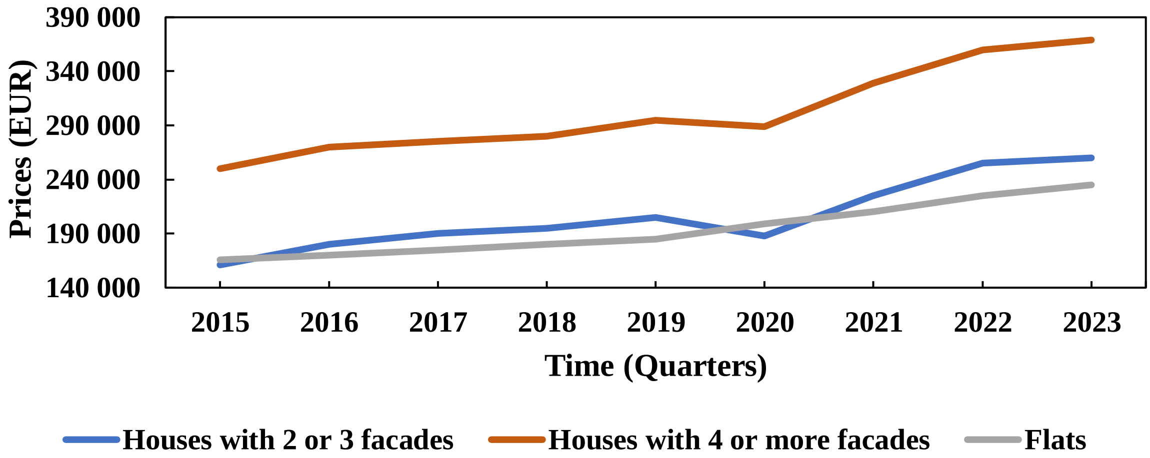
Although property prices in Belgium have seen positive growth over the last few years, outstripping the increase seen in the eurozone as a whole, they have grown even faster in several European countries, including Spain, Ireland, the UK and the Netherlands (Reusens and Warisse, 2018). In their research, the authors also identify the factors responsible for this price increase. According to them much of the rise in house prices over the last 45 years has been due to the significant increase in land prices, particularly in the Flemish region where the shortage of building land has intensified, especially since the early 2000s. In addition to demographic factors, exacerbated by the gradual reduction in average household size, the escalation in house prices has also been fuelled by various macroeconomic factors. Among these, the sharp fall in mortgage interest rates has played a major role, combined with rising household incomes, making property acquisition more affordable. In addition, changes in property taxes have often facilitated access to mortgage credit and stimulated demand for housing. These findings reinforce the conclusions of Artige and Reginster (2017).

Since the studies mentioned above, property prices have continued to rise. According to the latest available data, house prices continued to rise without interruption except for 2020 (see Figure 1). During this period, the median price of houses with 4 or more facades rose from 250,000 euros to

370,000 euros, an increase of 48%. The median price of flats rose from 165,750 euros to 240,000 euros, an increase of 44.78%. Houses with 2 or 3 facades saw the most significant increase, with a jump of 64,6%, with the median price rising from 165,750 euros to 240,000 euros. It is important to note a fall in prices in late 2019 and early 2020 for houses, coinciding with the emergence of Covid-19 and the first lockdown, which has slowed the global real estate market (Balemi et al, 2021). Flats, meanwhile, have held up well in the crisis. After this period of slowdown, the property market is now on the up, and more so than before. On average, median house prices rose by 6.26% between 2020 and 2022, compared with 3.26% between 2015 and 2019. According to a report published on 6 June 2024 by ImmoWeb, during this period, interest rates reached a historically low level, offering very favourable financial conditions for property purchases. As a result, demand has been strong enough to keep pace with growing supply, while the number of properties put up for sale has risen by +8.8%, the total volume of properties available on the market has fallen by -5%.

In addition, for these 3 types of property in Q4 2023, Wallonia is the least expensive, followed by Flanders and Brussels (Table 1). Flemish Brabant and Walloon Brabant are the provinces with the highest prices. Houses fetch the highest prices in Ixelles, while the cheapest houses are found in Colfontaine and Chimay. As for flats, the most expensive are in Knokke-Heist, while the cheapest are in Charleroi.

Figure 1 : Change in median prices, by property type, in Belgium between 2015 and 2023



Source: own construction based on Stabel data

Table 1

Median price by property type and region in Q4 2023.

	Wallonia	Flanders	Brussels
Houses with 2 or 3 facades	180.000€	300.000€	490.000€
Houses with 4 or more facades	300.000€	410.000€	1.372.000€
Flats	180.000€	247.000€	260.000€

Source: own construction based on Statbel data

Although 2023 saw positive growth in property prices in Belgium, it was also marked by a slowdown in this growth, as shown in Table 2. In addition, the notaries' barometer for 2023 reveals a 15% fall in sales transactions compared with 2022. Their report also notes a fall in real estate activity of 1.1% compared with the previous year. This slowing trend is confirmed in 2024, in the first quarter, the notaries'[1] barometer reports a 7.3% reduction in sales transactions compared with the same quarter of the previous year. This downturn can be attributed to the rise in interest rates, which has made access to credit more difficult and led to a fall in demand for housing. According to the latest statistics from the National Bank of Belgium[2], the number of new mortgage loans in 2022 and 2023 is lower than in 2021. Whereas 433.487 new loans were granted in 2021, there were only 325.795 in 2022, representing a fall of 24.84%, and only 215.755 in 2023, a fall of 50.22% compared with 2021.

Table 2

Percentage change in the median price in euros by type of property in Belgium in Q4.

	% change 2022 (Q4) /2021 (Q4)	% change 2023 (Q4) /2022 (Q4)
Houses with 2 or 3 facades	9,57%	5,16%
Houses with 4 or more facades	7,46%	2,78%
Flats	5,00%	3,90%

Source: own construction based on Statbel data

In the 3 regions, the picture is broadly the same, as shown in table 3. Comparing the two periods, it is clear that there is a general slowdown in the growth of property prices in all regions. In Wallonia and Brussels, median price increases have slowed significantly in 2023 compared to 2022, with the exception of houses with 4 or more facades in Brussels, which show extreme volatility. In Flanders, although price growth remains positive, the trend also shows a slowdown, especially for flats. This may indicate a moderation in demand or other economic factors influencing the property market in these regions.

[1] https://www.notaire.be/nouveautes/barometre-des-notaires

[2] https://www.nbb.be/doc/cr/ccp/publications/bro_ckpstat2023f_23012024.pdf

Table 3

Percentage change in the median price in euros by type of property in the three regions in Q4.

	% change 2022 (Q4) /2021 (Q4)	% change 2023 (Q4) /2022 (Q4)
Wallonia		
Houses with 2 or 3 facades	4,12%	1,69%
Houses with 4 or more facades	8%	1,01%
Flats	3,55%	3,42%
Brussels		
Houses with 2 or 3 facades	4,43%	0,60%
Houses with 4 or more facades	-8,14%	14,11%
Flats	6,25%	1,96%
Flanders		
Houses with 2 or 3 facades	7,55%	5,26%
Houses with 4 or more facades	3,84%	4,87%
Flats	6,22%	3,64%

Source: own construction based on Statbel data

2.1.1 Regional analysis of tax systems

An analysis of regional tax systems in Belgium reveals significant disparities in the taxation of residential property, which can influence buyer behaviour and the dynamics of the property market. This chapter looks at the main tax components that vary from region to region, namely registration fees, property tax reduction for mortgage interest. These tax differences, which are rooted in the specific policies of each region, have a direct impact on the cost of acquiring and holding a property and, consequently, on the attractiveness of the residential property markets in different parts of the country. However, it is important to note that the information presented here reflects the current tax conditions in force in July 2024. These conditions have evolved over time and are likely to change in the future. The purpose of this analysis is to highlight regional differences that may potentially impact the residential property market. However, it is essential to specify that this study does not seek to assess whether these differences have a significant impact on the property market, but rather to illustrate the current tax disparities between regions.

Registration fees

Firstly, in the Flemish Region[3], the general rate of registration duty is set at 12%. However, there is a significant reduction for the purchase of a principal residence, where the rate is lowered to 3%, provided certain requirements are met. In addition, to encourage major energy renovations, the rate can be reduced to 1%, reflecting a regional desire to promote energy efficiency in the residential sector.

Secondly, in the Walloon Region[4], although the general rate of registration fees is slightly higher at 12.5%, the region offers specific tax benefits to support buyers on modest incomes. For the purchase of a modest dwelling, defined by value criteria, the rate of registration duty is reduced to 6%, providing a significant incentive for low-income households to become homeowners.

Finally, in the Brussels-Capital Region[5], the general rate of registration duty is also 12.5%. However, the region stands out for the introduction of a substantial allowance on the first €200,000 for the

[3] https://www.vlaanderen.be/belastingen-en-begroting/vlaamse-belastingen/registratiebelasting/verkooprecht/tarieven-in-het-verkooprecht
[4] https://finances.belgium.be/fr/particuliers/habitation/acheter-vendre/droits-enregistrement/wallonie
[5] https://finances.belgium.be/fr/particuliers/habitation/acheter-vendre/droits-enregistrement/bruxelles

purchase of a principal residence. This allowance is designed to lighten the tax burden on buyers, making the purchase of a property more accessible in a region where prices are often high.

Property tax

Property tax, which is an annual tax on property ownership, varies from one Belgian region to another, with calculation mechanisms specific to each entity. In the Flemish Region[6], the basic rate of property tax is set at 3.97% of indexed cadastral income. This rate may be reduced under certain conditions.

In the Walloon Region[7], the basic rate of property withholding tax is significantly lower, at 1.25%. However, in addition to this basic rate, there is a provincial rate and the additional centimes imposed by the municipalities, which can increase the total tax burden for the homeowner. As in Flanders, specific reductions are available for certain categories of taxpayer, which means that the impact of this tax can be modulated according to the individual situation of property owners.

Similarly, in the Brussels-Capital Region[8], the basic rate of withholding tax is also 1.25%, plus the provincial rate and additional municipal centimes. Reductions also apply in this region, offering a degree of tax flexibility for eligible homeowners.

Tax reduction for mortgage interest

As far as tax relief on mortgage interest is concerned, tax policies vary considerably between Belgian regions, reflecting distinct approaches to supporting homeowners.

In the Flemish Region[9], mortgages taken out from 1 January 2020 can no longer benefit from the "housing bonus", a measure that previously offered significant tax reductions for homeowners.

In the Walloon Region[10], homeowners can still benefit from tax reductions in the form of the "chèque habitat", a scheme introduced for mortgages taken out from 2016. Under this scheme, income tax is reduced according to the repayments made.

In the Brussels-Capital Region[11], the tax benefits associated with mortgage loans have been phased out. For loans taken out from 2017 onwards, there is no longer any specific tax reduction linked to mortgage interest. Instead, the Region has introduced a rebate on registration fees for the purchase of a principal residence, which reduces acquisition costs from the outset rather than offering a tax advantage spread over the term of the loan.

2.2 Inflation in Belgium

2.2.1 Measurement of inflation

Inflation in Belgium is measured using the consumer price index (CPI). The definition provided by the Belgian statistics office[12] (Statbel) is as follows: "The consumer price index is an economic indicator

[6] https://www.vlaanderen.be/belastingen-en-begroting/vlaamse-belastingen/onroerende-voorheffing/onroerende-voorheffing/berekening-van-de-onroerende-voorheffing#q-98fad5ce-5103-4e93-998d-d9bd983170d2

[7] https://finances.wallonie.be/home/fiscalite/precompte-immobilier.html

[8] https://fiscalite.brussels/fr/le-precompte-immobilier

[9] https://www.minfin.fgov.be/myminfin-web/pages/public/fisconet/document/d99c6c75-913c-433b-a6b9-92ee0a1b9508#_1._Habitation_propre

[10] https://www.minfin.fgov.be/myminfin-web/pages/public/fisconet/document/77ea2b3b-4936-4955-a7e9-84aaa943d6a0#_1.1._Emprunts_hypoth%C3%A9caires

[11] https://www.minfin.fgov.be/myminfin-web/pages/public/fisconet/document/f78e3373-0cf7-457f-9e44-558f8b2bd783#_1._Habitation_propre

[12] https://statbel.fgov.be/fr/themes/prix-la-consommation/indice-des-prix-la-consommation

whose main task is to objectively reflect the price evolution over time for a basket of goods and services purchased by households and considered representative of their consumer habits." This index is divided into several sub-categories according to the COICOP nomenclature, developed by the United Nations to classify household expenditure. The weighting represents the importance of the products and services included in the CPI in relation to household purchasing habits, and is established on the basis of the household budget survey. According to the Belgian statistics office, "Inflation is defined as the ratio between the value of the consumer price index of a given month and the index of the same month the year before. Therefore, inflation measures the rhythm of the evolution of the overall price level."

2.2.2 Historical trends and current situation

As shown in Figure 2, from 2000 to 2019, the inflation rate in Belgium has gone through several cycles with moderate fluctuations and occasional peaks. The years 2008 and 2009, marked by the global financial crisis, saw significant rises in inflation followed by periods of disinflation. In 2008, inflation peaked at 5.90% in July, before falling back to -1.68% in July 2009, reflecting the severity of the economic crisis and the contraction in demand. Average inflation over this period was 1.95%.

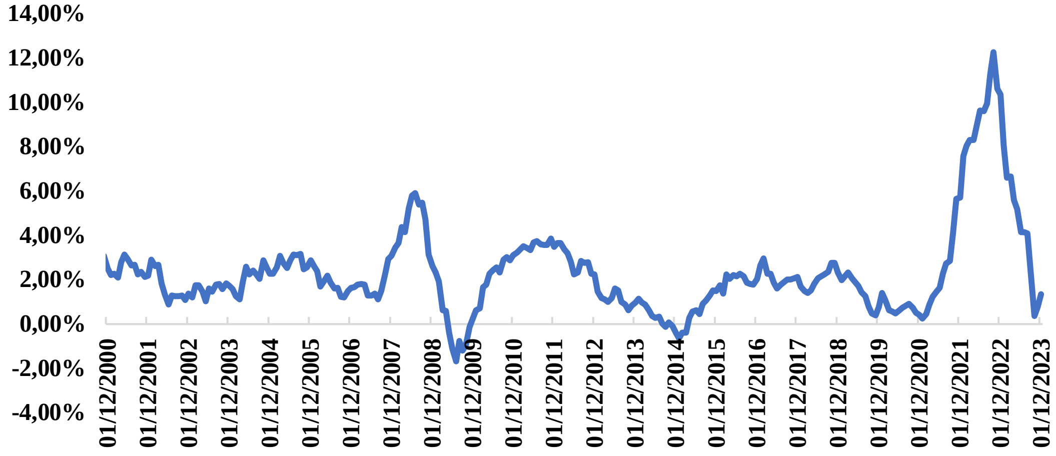
Since 2020, inflation in Belgium has shown a marked upward trend, especially in 2021 and 2022, reaching historic highs. This period was heavily influenced by the COVID-19 pandemic, which disrupted global supply chains. In October 2022, inflation peaked at 12.27%, before starting to fall gradually in 2023. In November 2023, inflation stood at 0.76%. For the period from 2020 to 2023, inflation averaged 4.25%.

This high inflation was widespread in the European Union, with an average rate of 9.3% in 2022 (Statista, 2024)[13]. To deal with this situation, the ECB decided in 2022 to change its monetary policy by gradually raising its key rates in order to slow down the economy and, consequently, reduce inflation (ECB, 2024)[14]. In response to this change, the banks also raised their rates, making access to credit more difficult.

As Artige and Reginster (2017) explained in their study, easy access to credit led to a rise in property prices between 1995 and 2015. Between 2015 and 2022, ECB rates did not change significantly, remaining close to zero for some and even negative for others, which facilitated access to credit. With the change in the ECB's monetary policy and the rise in rates, access to credit has become more difficult. It will be interesting to see whether this situation has an impact on the property sector in the future. For the time being, according to the latest published figures, house prices do not seem to be falling, while, as explained above, the number of mortgages is falling.

[13] https://fr.statista.com/statistiques/570461/taux-d-inflation-dans-l-ue-et-la-zone-euro-en-2020/#:~:text=En%202022%2C%20le%20taux%20d,euro%20de%208%2C38%25.
[14] https://www.ecb.europa.eu/stats/policy_and_exchange_rates/key_ecb_interest_rates/html/index.en.html

Figure 2 : Monthly inflation rate in Belgium from 2000 to 2023



Source: own construction based on Statbel data

2.3 What's Inflation Hedging?

In his study Bodie (1976) describes the concept of inflation hedging through several definitions that capture different perspectives on how investments can be shielded against the effects of inflation.

Bodie begins by describing hedging against inflation as a process where one starts with a default-risk-free nominal bond and uses other securities to reduce as much of the variance of its real return as possible. This approach highlights the pursuit of stability in inflation-adjusted returns, underscoring the importance of diversifying a portfolio to minimize the risks associated with inflation rate fluctuations.

He then proposes an alternative definition, whereby a security constitutes an inflation hedge if it offers "protection" against inflation, which means it eliminates or at least reduces the possibility that the real rate of return on the security will fall below a certain threshold, such as zero. This perspective is particularly relevant for investors seeking to maintain a minimum level of real return, regardless of inflation movements.

Lastly, Bodie advances that "a security is an inflation hedge if and only if its real return is independent of the inflation rate." This independence implies that a ceteris paribus change in the inflation rate should be accompanied by an equal change in the nominal rate of return on the security. This definition suggests a direct and proportional correlation between nominal returns and inflation rates, highlighting an ideal form of protection where returns adjust perfectly in response to inflation changes.

Bodie concludes by emphasizing that each of these definitions provides a different approach to what it means to hedge against inflation, ranging from reducing variations in real returns to the perfect alignment of nominal returns with inflation rates. This plurality of perspectives highlights the complexity of inflation hedging and the necessity for investors to clearly understand their specific objectives and the characteristics of various financial instruments when designing strategies to hedge against inflation.

The scholarly consensus suggests that an effective inflation hedge is characterized by a consistent positive correlation between inflation rates and the returns from the hedging instrument. A perfect hedge occurs when increases in housing prices completely counterbalance increases in consumer prices, typically measured by the Consumer Price Index (CPI) and similar metrics (Tang et al., 2019; Arnold & Auer, 2015; Bodie, 1976).

2.4 Residential property's ability to hedge against inflation

Numerous studies have already been conducted to explore whether there is a connection between inflation and residential real estate prices. However, there is no consensus among researchers, as conclusions vary. The results depend on various factors, including the region studied, the time frame (long-term and short-term), the type of real estate (commercial, industrial, residential), the data used, and the methodologies employed. To bring structure and clarity, this section will be divided by geographical area to clearly highlight the differences. In addition, in order to obtain the most relevant studies and to best reflect current economic conditions, this section will focus on research conducted from the 2000s onwards.

2.4.1 North America

In examining real estate as a potential hedge against inflation in North America, several foundational studies have been conducted, each contributing to a nuanced understanding of this dynamic. The seminal research in this field was notably carried out by Fama and Schwert (1977), who analyzed multiple assets including U.S. government bonds and bills, private residential real estate, and stocks to assess their ability to provide a good hedge against inflation. The authors used the OLS (ordinary least squares) model. Their study revealed that only the residential market was a perfect hedge against expected and unexpected inflation over the period from 1953 to 1971, setting the stage for numerous subsequent studies.

Anari and Kolari (2002) continued this exploration by focusing on the long-term impact of inflation on homeowner equity, examining the relationship between house prices and the prices of non-housing goods and services from 1968 to 2000. The author excluded housing costs from the consumer price index to avoid potential bias. The study employs autoregressive distributed lag (ARDL) models. Their research concluded that house prices consistently hedged against inflation over the long term, thus corroborating the findings of Fama and Schwert (1977).

A few years later, Le Moigne and Viveiros (2008) studied the Canadian real estate sector from 1973 to 2007. The study employs time-series regressions and correlation analyses across various Canadian provinces and property types. They found that while real estate served as a hedge against inflation during high inflation years (1973-1984), it did not maintain this capacity in a low inflation climate (1985-2007), with changes in monetary policy possibly explaining this loss of hedging capability.

Wu and Pandey (2012) focused on the U.S. market from 1987 to 2010. The research utilizes data from the S&P/Case-Shiller city-level and composite indices, examining 22 indices in total, to assess the performance of residential real estate over a significant duration. Their study finds that while residential real estate can offer some diversification benefits, its ability to hedge against inflation is modest against both expected and unexpected inflation, contradicting previous studies (Fama and Schwert, 1977; Anari and Kolari, 2002). This difference may be due to the different methodology used.

Lastly, Christou et al. (2018) delved into the long-run relationship between U.S. house prices and the non-housing Consumer Price Index (CPI) from 1953 to 2016. By excluding housing costs, the authors took the same approach as Anari and Kolari (2002). The authors used a quantile cointegration method. The research demonstrates that house prices and non-housing CPI are mainly cointegrated at lower quantiles. At these lower quantiles, house prices tend to over-hedge against inflation, suggesting they offer more protection against inflation when inflation rates are relatively high. This is in line with the conclusion of Le Moigne and Viveiros (2008).

2.4.2 Asia

In their study, Chu et Sing (2004) focus on urban centers in China during two distinct periods, 1996-2002 for short-term effects and 1988-2002 for long-term effects. The authors used the OLS (ordinary least squares) model to test the short-term relationship and the cointegration method to test the long-term relationship. The analysis indicates a lack of consistent inflation hedging by Chinese real estate for both expected and unexpected inflation. A few years later, Zhou et Clements (2010) conducted a similar study in China focusing on the period from 2000 to 2008 this is a timeframe post-real estate privatization. Using an autoregressive distributive lag (ARDL) model. The results reveal no substantial long-term equilibrium between real estate price variations and the inflation rate, indicating that real estate may not serve as an effective asset class for inflation hedging in China. The conclusions drawn by the two authors are similar to those of Chu and Sing (2004). However, these two studies contradict the results of Fama and Schwert (1977). This shows the heterogeneity of the results. However, it should be noted that the period studied in Zhou and Clements (2010), which spans eight years, appears too short to reliably establish whether or not a long-term relationship exists. This brief timeframe does not allow for an accurate examination of price and inflation fluctuations.

In another very serious study Wu et Twidell (2015) offers another conclusion for the Chinese market. They used data from 35 cities across Eastern, Middle, and Western China, from 2000 to 2010. The study employs panel vector autoregressive (PVAR). They conclude that while real estate in some parts of China can hedge against inflation, this is not a universal property across all regions. The Middle Chinese markets show the most robust results in using real estate as an inflation hedge, suggesting regional variability and the influence of local economic policies on these dynamics. In the same year, Kuang and Liu (2015) conducted a similar study from 1996 to 2010 using generalized method of moments (GMM) and concluded that housing prices can act as a hedge against inflation, as housing prices generally rise with inflation. 4 years later using and ARDL Tang et al. (2019) did the study on 29 Chinese cities from 2003 to 2013 and concluded that there is no long run link between housing prices and inflation. These three authors conducted similar studies in terms of the periods and regions examined, but they did not reach a consensus, the main difference being in the methodologies used. This highlights the complexity of selecting the appropriate model for this type of research.

Glascock et al. (2008) evaluate the efficacy of Hong Kong’s real estate market in mitigating inflation from 1998 to 2006 using both short-term and long-term methods. They apply the Fama and Schwert framework for the short-term analysis and a combination of Cointegration method and Granger Causality test for the long-term analysis. The paper concludes that the Hong Kong real estate market's ability to hedge against inflation is limited and highly dependent on external economic factors and the specific characteristics of property types. This challenges the traditional view of real estate as a reliable inflation hedge. However, the same criticism that applies to the study by Zhou and Clements (2010) can also be raised here, namely that studying this type of relationship over a duration of eight years seems quite brief.

The same year Wen-Shwo et al. (2008) explores the real estate in Taiwan as a hedge against expected and unexpected inflation from 1991 to 2006. Utilizing an exponential generalized autoregressive conditional heteroskedasticity model (EGARCH). Unlike previous studies such as Glascock et al. (2008), which suggested variability in inflation hedging across different property types in Hong Kong, this study presents a generalized ineffectiveness of real estate as an inflation hedge in Taiwan. This contrasts with broader findings from other regions such as the US, where real estate is often considered a viable inflation hedge. Following this study Kuan-Min et al. (2008) explore the asymmetric relationship between housing returns and inflation in Taiwan using a nonlinear vector error correction model (VECM) from 1991 to 2006. The research identifies how different states of inflation (high vs. low) impact the ability of housing returns to hedge against inflation. The study concludes that the inflation-hedging ability of real estate is significantly influenced by the state of inflation, with effective hedging occurring only in higher inflation environments which confirms the results of Le Moigne and Viveiros (2008).

Amonhaemanon et al. (2013), this empirical investigation explores whether Thai real estate can serve as a hedge against both ex post and ex ante inflation from 1987 to 2011 using the Fama and Schwert framework. The study concludes that while Thai real estate has some potential as an inflation hedge, its effectiveness is highly variable and influenced by economic conditions. This variability suggests that real estate may not be a reliable hedge against inflation in all circumstances.

Now from a Malaysian perspective, through its studies Lee (2014) aimed to assess the short-term and long-term inflation-hedging capacities of Malaysian residential properties, differentiating among property types from 1999 to 2012. The Fama and Schwert model is applied to measure short-term hedging abilities, while Dynamic Ordinary Least Squares (DOLS) assesses long-term attributes. The study includes a comprehensive analysis based on Malaysian housing data from 1999 to 2012. They concluded that in the short term, Malaysian housing provides a variable hedge against expected inflation, differing by property type. Long-term results indicate a robust hedge against expected inflation for all property types analysed, though no significant hedging is observed against unexpected inflation this contradict Fama and Schwert (1977). Yeap and Lean (2017) carried out a similar study in Malaysia using a Nonlinear Autoregressive Distributed Lag (NARDL) model. the study analyses both the short-run and long-run inflation hedge abilities of housing across various residential types from 1999 to 2015. In the long run, housing prices show a consistent response to consumer inflation, suggesting a potential as a hedge. The result is in line with Lee (2014). However, the short-term results differ from Lee (2014), housing prices react asymmetrically to inflation.

In their study of the Singapore residential property market from 1978 to 1988, National and Low (2000) assess the ability of property to act as a hedge against inflation. Their analysis reveals that, over the entire period studied, residential property is not an effective hedge against inflation, whether expected, unexpected or actual. However, the authors distinguish between the performance of property in low and high inflation environments. They find that in periods of low inflation, residential property offers some protection against unexpected inflation. On the other hand, in periods of high inflation, real estate shows no effectiveness as a hedge against inflation. This distinction highlights the importance of the economic context in valuing real estate as a tool for inflation hedging.

The most recent study in this region from Lee (2021) explores the inflation hedging potential of residential properties in China, India, and Russia using various econometric models, including the Fama and Schwert (1977) framework and ARDL cointegration techniques. The study spans multiple decades up to 2019 and contrasts findings across these major emerging markets (EMs). The authors concludes that while residential property can hedge against inflation in the long run in all three studied markets, the effectiveness is inconsistent in the short term, particularly in India. These results confirm those of other studies (e.g., Anari and Kolari, 2002; Stevenson, 2000).

2.4.3 Europe

Given the focus on Belgium, it is essential to understand the relationship between property prices and inflation in our neighbouring countries. Indeed, neighbouring countries share an economic context similar to Belgium, unlike the USA, Canada, or Asian countries which operate in different economic environments. This section will concentrate on the Netherlands, specifically Amsterdam, the United Kingdom, Poland, and France.

Stevenson (2000) examines the relationship between inflation and residential property markets over a 30-year span across the United Kingdom from 1968 to 1997 using OLS and Engel-Granger cointegration models. The study concludes that residential property exhibits potential as a long-term hedge against inflation, although this capability varies significantly across different UK regions. This finding highlight that even within a single market, geographical differences can influence inflation hedging capabilities, a theme that resonates across various European studies.

In the Netherlands, a study by Brounen et al. (2013) evaluates the inflation hedging capabilities of private homes with a comprehensive dataset spanning from 1814 to 2008 in Amsterdam. The research focuses on the long-term relationship between house prices, rents, and inflation, concluding that homeownership can provide a reliable hedge against both expected and unexcepted inflation over long investment horizons. However, the effectiveness of this hedge is influenced by the duration of the investment and the economic context, being notably stronger in environments where inflation is persistent. This conclusion regarding the duration of the investment aligns with many studies that have found real estate to be capable of hedging against inflation in the long term but not necessarily in the short term (Fama and Schwert, 1977; Anari and Kolari, 2002; Lee, 2014; Yeap and Lean, 2017; Henry Koon Nam Lee, 2021; Stevenson, 2000).

From Poland's perspective, three recent studies offer updated views. Wolski (2023) assesses the relationship between real estate prices and inflation in Poland, using data from the first quarter of 2009 to the fourth quarter of 2021. Wolski employs cointegration analysis with the Engle-Granger test to examine the linkage between residential real estate prices. The analysis concluded that there is no significant relationship between real estate prices and inflation levels during the study period, contradicting the popular belief that real estate serves as an effective inflation hedge. Conversely, Dittmann (2024) concludes that residential real estate in Poland, particularly when including rental income, offers a robust hedge against inflation across six major local markets from 2006 to 2022. As mentioned above for the Chinese market this discrepancy highlights how methodological approaches can significantly impact conclusions, even within similar market conditions.

Lastly, focusing on France, a study by Zouari and Nasreddine (2023) examines the ability of residential real estate in the communes of the "Grand Paris" from 1996 to 2017. By utilizing hierarchical clustering, the research divides the area into five homogeneous groups of communes to analyze their hedging capabilities. The findings suggest that while residential real estate in the Greater Paris area can act as an effective hedge against certain aspects of inflation, its performance is not uniform across all sectors and locations within the metropolis. This supports the notion that location plays a crucial role in an asset's ability to hedge against inflation, a concept also underscored by Stevenson (2000).

2.4.4 Africa

The African residential market has not been widely studied, however, two fairly recent research by Inglesi-Lotz and Gupta (2013) and Dabara (2015) looks at the South African and Nigerian markets. Given that Nigeria represents Africa's largest economy, it is particularly relevant to examine this country.

The study by Inglesi-Lotz and Gupta (2013) analyses the long-term relationship between house prices and inflation, excluding housing costs like Christou et al. (2018) and Anari and Kolari (2002), across various segments of the South African housing market from 1970 to 2011. Using the autoregressive distributed lag (ARDL) model. They concluded that real estate in South Africa, particularly over long periods, can serve as a hedge against inflation, though its effectiveness varies across different housing market segments. This conclusion is in line with several of the studies mentioned above.

The second study Dabara (2015) analyses the ability of residential property investments in Gombe metropolis, Nigeria. Conducted between 2003 and 2012 using Ordinary Least Squares (OLS) regression. The study concludes that residential properties in Gombe, Nigeria, can serve as an effective hedge against expected inflation but are less effective against unexpected inflation shocks. The authors draw the same conclusion as Lee (2014).

2.4.5 Oceania

The study conducted by Zhou et al. (2005) explores the inflation-hedging capabilities of various asset classes, focusing on real estate and financial assets within New Zealand. This research employs a quantitative approach, analysing the quarterly data from December 1979 to December 2003. The study uses the consumer price index as a proxy for inflation and examines the relationship between asset returns and inflation using correlation and regression analysis. The findings revealed that all four types of real estate assets provide a partial hedge against actual inflation.

In Australia Ma and Liu (2010) investigates the correlation between house price indices and consumer price indices in Australia's capital cities from 1998 to 2008. Utilizing autoregressive distributed lag (ARDL) models and error correction models (ECM), the study seeks to discern the short-run and long-run relationships between these indices. In the short term, there is no significant correlation between house prices and consumer prices, indicating that real estate does not serve as an effective hedge against inflation in this timeframe. Conversely, in the long term, the relationship between house prices and consumer prices is evident in most capital cities, suggesting that real estate may serve as a viable inflation hedge over extended periods. Although the 10-year period seems too short to establish the reliable existence of a long-term relationship, this conclusion is in line with many of the studies cited above. (Fama and Schwert in, 1977; Anari and Kolari, 2002; Lee, 2014; Yeap and Lean, 2017; Henry Koon Nam Lee, 2021; Stevenson, 2000; Brounen et al. 2013)

2.5 Conclusion

Studies in all region generally support the notion that real estate can serve as a long-term hedge against inflation. This is evidenced by the consistent findings across different time periods and market conditions in these regions (Fama and Schwert in, 1977; Anari and Kolari, 2002; Lee, 2014; Yeap and Lean, 2017; Lee, 2021; Stevenson, 2000; Brounen et al. 2013, Le Ma and Liu, 2010; Inglesi-Lotz and Gupta, 2013). However, when the period studied is shorter, the conclusions are mixed. Some researchers conclude that real estate is not a good instrument for protecting against inflation. (Chu and Sing, 2004; Zhou and Clements, 2010; Tang et al. 2018; Glascock et al. 2008; Fang 2008), while others argue the opposite (Wang et al. 2008; Amonhaemanon et al. 2013; Wu et Twidell 2015; Kuang and Liu, 2015; Lee, 2014). This difference highlights the impact of the period studied. It should also be mentioned that the methodology used can also lead to different results (Wu et Twidell, 2015; Kuang and Liu, 2015; Tang et al. 2018)

Across various studies, different methodological approaches were employed to assess the inflation-hedging capabilities of real estate. Notably, the Autoregressive Distributed Lag (ARDL) model was frequently used, as seen in Anari and Kolari (2002), Zhou and Clements (2010), and Inglesi-Lotz and Gupta (2013). The ordinary least squares (OLS) model proposed in the seminal study by Fama and Schwert (1977) is also very popular in the literature. In addition, cointegration tests, including Engle-Granger and Johansen, were also commonly employed, as in studies by Chu and Sing (2004) and Stevenson (2000). These methodologies are crucial in long-term studies examining the relationship between real estate prices and inflation across different segments and geographical areas.

3 Research objectives

3.1 Objectives

The main objective of this research is to examine whether Belgian residential property offers a good hedge against different types of inflation. Given the significant economic implications, understanding the relationship between house prices and inflation is crucial for all Belgian homeowners.

This study also aims to assess whether the relationship between inflation and house prices varies between the different regions, Wallonia, Flanders and Brussels. This regional analysis is essential to uncover local market dynamics and any disparities that may exist. Such granularity will enable us to better understand how inflation affects property prices in different ways in different regions, providing valuable information for future homeowners.

Furthermore, it is also crucial to analyse how the property market is impacted by specific economic periods such as periods of high inflation or recession. By studying these particular economic cycles, we can understand how these events influence property prices and yields, and thus anticipate the future effects of such periods on the Belgian property market.

Finally, this study aims to fill an important gap in the existing literature. To date, no in-depth research has been carried out to analyse the ability of Belgian residential property to provide a hedge against inflation. By providing new and detailed insights into this subject, this study hopes to fill this gap and provide valuable knowledge to researchers.

3.2 Hypothesis to test

To analyse the impact of different economic conditions on property yields, we have constructed two linear regression models, the first of which includes actual inflation in equation 1, followed by expected inflation, unexpected inflation, a binary variable for periods of high inflation and another for periods of recession in equation 6. The hypotheses we are going to test are formulated to assess the impact of each of these variables on property returns. The hypotheses are based on equations 1 and 6.

Hypothesis 1: Does residential property offer a hedge against actual inflation?

Actual inflation represents the immediate change in the prices of goods and services, directly affecting consumers' purchasing power. Property, as a tangible asset, is often seen as a means of preserving value in the face of this erosion. The aim of this hypothesis is to test whether residential property returns are sensitive to actual inflation and whether these properties can effectively compensate for losses in purchasing power by maintaining or increasing their value. The aim is to determine whether residential property in Belgium can be considered an effective hedge against immediate inflation.

- $H_0: \delta = 0$ (Residential property does not provide a hedge against actual inflation)
- $H_1: \delta \neq 0$ (Residential property provides a hedge against actual inflation)

Hypothesis 2: Does residential property offer a hedge against expected inflation?

Expected inflation is that which is anticipated by economic players and can influence investment decisions. If investors expect prices to rise, they may turn to assets such as property to protect their capital. This hypothesis assesses whether residential property prices react positively to expected inflation, thereby offering protection against anticipated changes in purchasing power. The analysis will focus on the relationship between inflation expectations and property yields, to ascertain whether property in Belgium is perceived as a safe haven against future inflation.

- $H_0 : \beta_1 = 0$ (Residential property does not provide a hedge against expected inflation)
- $H_1: \beta_1 \neq 0$ (Residential property provides a hedge against expected inflation)

Hypothesis 3: Does residential property offer a hedge against unexpected inflation?

Unexpected inflation, by definition, is not anticipated by investors and can therefore cause significant economic disruption. This hypothesis explores whether residential property is capable of adapting to these unexpected inflationary shocks. In other words, it seeks to test whether residential property can not only protect against anticipated inflation but also absorb the impact of sudden and unexpected price rises, thus providing a robust hedge against economic uncertainty.

- $H_0 : \beta_2 = 0$ (Residential property does not provide a hedge against unexpected inflation)
- $H_1 : \beta_2 \neq 0$ (Residential property provides a hedge against unexpected inflation)

Hypothesis 4: Do periods of high inflation have a significant impact on residential property yields?

Periods of high inflation can have varying effects on the property market, depending on the ability of properties to appreciate sufficiently to compensate for inflation. This hypothesis examines whether, beyond average inflation, periods of high inflation have a discernible effect on property returns. The analysis will determine whether residential properties in Belgium react differently during these critical periods and whether these moments exacerbate or mitigate their potential role as a hedge against inflation.

- $H_0 : \beta_3 = 0$ (Periods of high inflation have no significant impact on residential property)
- $H_1 : \beta_3 \neq 0$ (Periods of high inflation have a significant impact on residential property)

Hypothesis 5: Do periods of recession have a significant impact on residential property yields?

Economic recessions are often accompanied by a fall in property demand and a devaluation of assets. This hypothesis assesses the impact of recessionary periods on residential property returns, by analysing whether residential properties are particularly vulnerable to economic cycles. The aim is to determine to what extent recessions can weaken the value of property investments and whether they continue to play a protective role during periods of economic uncertainty.

- $H_0 : \beta_4 = 0$ (Periods of recession have no significant impact on residential property)
- $H_1 : \beta_4 \neq 0$ (Periods of recession have a significant impact on residential property)

4 Methodology

This section details the methodology used to examine the relationship between inflation and residential property returns in Belgium. We begin by establishing the theoretical framework for our analysis, presenting the Ordinary Least Squares models that will be used to test our hypotheses. We then develop the concept of expected and unexpected inflation, which are crucial to our study, and explain how these measures will be incorporated into our models. We then discuss the concept of stationarity and the tests we will perform to verify the stationarity of our time series, thereby guaranteeing the validity of our analyses. Finally, we present a cointegration test to study the long-term dynamics between the variables.

4.1 Theoretical framework

The first model used is the Ordinary Least Squares, which will enable us to study the ability of residential property to provide a hedge against actual inflation. This model, proposed by Stevenson (2000), is as follows:

$$R_{ret} = \alpha + \delta(Actual\ Inflation) + \varepsilon, \quad (1)$$

where R_{ret} is the return on different properties in different region. δ is the coefficient to be estimated. This model assumes that inflation forecasts are always correct.

The second model used is still the Ordinary Least Squares method, this time proposed by Fama and Schwert in 1977. Based on the work of Irving Fisher (1930) Fama and Schwert (1977) give a model in order to study the relationship between asset returns and inflation. This model is used in the majority of previous studies (e.g., National and Low, 2000; Chu and Sing, 2004; Lee, 2021). According to Fisher (1930), the nominal interest rate is the sum of an expected real return and an expected inflation rate. This means that the nominal return on an asset is influenced by the market's assessment of the expected rate of inflation. Any asset's price in an efficient market will be adjusted so that the expected nominal return on the asset from t-1 to t is the sum of the expected equilibrium real return and the expected inflation rate for that period. This equation can be written as follows:

$$E(\tilde{R}_{jt}|\phi_{t-1}) = E(\tilde{\imath}_{jt}|\phi_{t-1}) + E(\tilde{\Delta}_t|\phi_{t-1}), \quad (2)$$

where:

$\tilde{R}_{jt}$ = Nominal Return on asset j

$E(\tilde{\imath}_{jt}|\phi_{t-1})$ = Expected real return

$E(\tilde{\Delta}_t|\phi_{t-1})$ = Expected inflation rate

ϕ_{t-1}= Information available at t – 1

~ = random variables

Fisher proposes that, assuming that the real factors in the economy remain constant, the relationship between asset returns and inflation can be expressed as a linear function of the inflation rate as follows:

$$\tilde{R}_{jt} = \alpha_j + \beta_j E(\tilde{\Delta}_t|\phi_{t-1}) + \tilde{\varepsilon}_{jt}, \quad (3)$$

Fama and Schwert (1997) then joined the unexpected component of inflation in the model, thus (2) can be extended as follows:

$$E(\tilde{R}_{jt}|\phi_{t-1}, \Delta_t) = E(\tilde{\imath}_{jt}|\phi_{t-1}) + E(\tilde{\Delta}_t|\phi_{t-1}) + \gamma_j[\Delta_t - E(\tilde{\Delta}_t|\phi_{t-1})], \quad (4)$$

where:

$[\Delta_t - E(\phi_{t-1})]$ = Unexpected inflation rate

We can now estimate (3) based on the following regression model:

$$\tilde{R}_{jt} = \alpha_j + \beta_j E(\tilde{\Delta}_t|\phi_{t-1}) + \gamma_j[\Delta_t - E(\tilde{\Delta}_t|\phi_{t-1})] + \tilde{\eta}_{jt}, \quad (5)$$

where α_j, β_j, and γ_j are the coefficient to be estimated and $\tilde{\eta}_{jt}$ is the error term. Based on this model if the coefficient $\beta_j = 1$, the asset is considered to offer a complete hedged against expected inflation and when $\gamma_j = 1$ the asset is considered to offer a complete hedged against unexpected inflation. Furthermore, the signs of the regression coefficients indicate whether an asset serves as a positive or negative hedge against inflation. If the coefficient is less than 1.0 but significantly different from zero, the asset provides a partial hedge against inflation. Conversely, an asset with a coefficient significantly greater than 1.0 not only hedges inflation on a one-to-one basis but also offers additional protection against the inflation risks associated with other assets in the portfolio.

However, this model can be improved by adding variables to analyse the impact of different economic conditions on property yields. Two dummy variables will be added to this model. The first dummy variable introduced is designed to identify periods of high inflation. In line with the objectives of the European Central Bank (ECB)[15], which aims to maintain inflation close to 2%, we have defined a period of high inflation as any period when inflation exceeds 2%. A value of 1 for this variable indicates a period of high inflation and 0 in the opposite case. The second dummy variable is used to identify periods of recession. We use the methodology of the Federal Reserve Bank of St. Louis (FRED)[16], which provides a binary time series indicating periods of recession for Belgium. According to this methodology, a value of 1 indicates a period of recession and 0 the opposite. The data in this series is only available up to August 2022. We therefore assume that periods after this date are not considered to be recessionary. By simplifying our equation 5 and adding the two dummy variables, our linear regression model is formulated as follows:

$$R_{ret} = \alpha + \beta_1(Expected\ Inflation) + \beta_2(Unexpected\ inflation) + \beta_3(High\ Inflation) + \beta_4(Recession) + \varepsilon \quad (6)$$

4.2 Measure of the expected and unexpected inflation

As previously shown by Fama and Schwert (1977) the actual inflation (AI) can be subdivided into expected inflation (EI) and unexpected inflation (UI). Expected inflation is the level of inflation that market participants anticipate for a given period, based on the information available at the end of the previous period. Unexpected inflation, on the other hand, represents the difference between the inflation actually observed during a period and the inflation forecast at the start of that same period. This part of inflation is considered to be the real inflationary risk, as it indicates a deviation from expected inflation, resulting from new information not previously available on the market (Le Moigne and Viveiros, 2008).

[15]https://www.ecb.europa.eu/ecb/orga/tasks/monpol/html/index.fr.html#:~:text=Nous%20visons%20un%20taux%20d,qu'une%20inflation%20trop%20%C3%A9lev%C3%A9e.

[16] https://fred.stlouisfed.org/series/BELREC

In the literature many methods have been presented to illustrate the expected and unexpected inflation. For expected inflation, we will use the OECD's[17] quarterly figures. Regarding unexpected inflation we use the approach of Fama and Schwert (1977), which is defined as the difference between the actual and expected inflation as shown in equation (5).

4.3 Augmented Dicky-Fuller test

According to Chu and Sing (2004) a significant drawback of the Fama and Schwert (1976) methodology is its disregard for the stationarity issue in time series data. In their book, Hill et al (2011) propose the following definition, a time series y_t is considered stationary if its mean and variance remain constant over time, and if the covariance between two values in the series depends only on the time interval between them, and not on the specific times at which these values are observed. In other words, a time series y_t is stationary if the following properties hold for all values and all periods:

$$E(y_t) = \mu \; (constant\ mean) \tag{6}$$

$$var(y_t) = \sigma^2 \; (constant\ variance) \tag{7}$$

$$cov(y_t, y_{t+s}) = cov(y_t, y_{t-s}) = \gamma_s \; (covariance\ depend\ on\ s, not\ t) \tag{8}$$

It is crucial to test the stationarity of time series data before using them in econometric analyses, as highlighted by the seminal study of Granger and Newbold (1974). The authors demonstrate that regressions using non-stationary data (i.e. they have a unit root) can lead to spurious results. In particular, the errors in such regressions often exhibit strong autocorrelation, invalidating standard statistical tests and misleading the interpretation of results. Moreover, even in the absence of a causal relationship, regressions between non-stationary series can produce significant R^2 values and apparently significant coefficients. These errors lead to incorrect conclusions and inappropriate economic decisions. Phillips (1986) drew conclusions that align with those of Granger and Newbold (1974).

Numerous tests exist to determine if a series is stationary or nonstationary, the most widely used in the literature is the augmented Dickey-Fuller test (Dicky and Fuller, 1979, 1981) (e.g. Chu and Sing, 2004; Le Moigne and Viveiros, 2008; Glascock et al, 2008; Zhou and Clements, 2010; Brounen et al, 2014; Lee, 2014, Yeap and Lean, 2021; Wolski, 2023; Lee, 2021). It tests the null hypothesis that a series has a unit root (i.e. that it is not stationary) against the alternative hypothesis that it is stationary.

Thus, if a series is found to be nonstationary (i.e., it has a unit root), it is necessary to transform the series to make it stationary. This is where the concepts of differencing and order of integration become essential. Differencing is a method used to stabilise the mean of a time series by removing changes in the level of a series, thus eliminating trends and seasonality. When a series y_t is nonstationary, we take the first difference of the series, which is defined as: $\Delta y_t = y_t - y_{t-1}$. If the differenced series Δy_t is stationary, then the original series y_t is said to be integrated of order 1, denoted as $\mathrm{I}(1)$. If Δy_t is still nonstationary, further differencing is required until stationarity is achieved (Dicky and Fuller, 1979, 1981).

To choose between the three possible versions of the test, we will follow the methodology proposed by Hill et al (2011). This method is based on the visual analysis of the time series after its graphical representation:

- If the series seems to wander or fluctuate around a sample mean of zero, we use the test with no constant and no trend. (Example in appendix 1)

[17] https://www.oecd.org/en/data/indicators/inflation-forecast.html

- If the series seems to wander or fluctuate around a sample mean which is nonzero, we use the test with constant but no trend. (Example in appendix 2)
- If the series seems to wander or fluctuate around a linear trend, we use the test with constant and with trend. (Example in appendix 3)

Gretl software was used to carry out the various unit root tests.

5 Data

This section presents the data used for our analysis, as well as the methodologies for calculating inflation and property yields. We describe the sources and characteristics of the data on residential property prices in Belgium. We also explain the methods used to calculate house prices, based on an old methodology for older data and a new methodology for recent data. Finally, we provide descriptive statistics for the key variables, offering an overview of the trends and distributions observed.

5.1 Inflation

The consumer price index is commonly used as an indicator of the actual inflation rate. This index is preferred because it is the most frequently used in previous research (e.g., Fama and Schwert, 1977; Wu and Tidwell, 2015; Brounen et al. 2013). The data are available for the period 1920 to 2024 and are taken from the Belgian statistical office, Statbel[18]. The index is available on a monthly basis but in order to match property prices, the CPI will be used on a quarterly basis. Inflation is defined as the ratio between the value of the consumer price index for a specific month and the index for the same month in the previous year. It is therefore a way of quantifying the speed of change in the general price level. The actual rate of inflation (Δ_t) is calculated as follows:

$$\Delta_t = \frac{(CPI_t - CPI_{t-1})}{CPI_t} - 1, \qquad (10)$$

Given that data on expected inflation has been available since 1992, our study will be divided into 2 main periods to match the methodologies used to calculate property yields, as we will see in the next section. The two periods will run from 1992 to 2010 and from 2011 to 2023 respectively.

The statistics for these different periods are summarised in Table 4. We can see that property yields are higher over the period 2011 - 2023 with an average yield of 2.52% but volatility is also higher with a volatility of 2.51%.

Table 4

Quarterly inflation Rate

	Mean	Median	Min	Max	Std. Dev
1992 – 2010					
AI	0.0200	0.0198	-0.0121	0.0558	0.0101
EI	0.0196	0.0196	-0.0109	0.0561	0.0101
UI	0.0004	0.0008	-0.0072	0.0049	0.0023
2011-2023					
AI	0.0252	0.0189	-0.0048	0.1108	0.0251
EI	0.0247	0.0191	-0.0066	0.1123	0.0265
UI	0.0004	-4.4390e-05	-0.0116	0.0237	0.0064

Source: our own calculations with Gretl

[18] https://statbel.fgov.be/fr/themes/prix-la-consommation/indice-des-prix-la-consommation#figures

5.2 Housing returns

Statbel[19] provides two separate time series, the first one is based on an old method of calculating property prices. This method uses a classification of property categories based on the cadastral map and includes the sale of new properties. The three categories of housing are "ordinary dwellings", "villas, bungalows and country houses" and "flats. The nature of a building is fixed once it has been built, and is not systematically updated if there is a change of use. The distinction between “ordinary dwellings” and “villas, bungalows and country houses” is based on the subjective assessment of the Land Registry expert. These two approximations can distort the statistics. The list covers the period from 1973 to 2017.

The second list, based on the new methodology, covers the period from 2010 to 2023. This optimised methodology aims to provide a more accurate picture of residential property prices in Belgium. Since 2017, detailed data on properties has been available, including two new variables, the type of property according to the deed of sale and the building code. From now on, to identify the type of building, the nature specified in the deed of sale is used rather than that shown on the cadastral map. This information, which is checked by the notary at each transaction, is more recent and reliable. Houses are now classified objectively according to the number of facades, with a distinction made between houses with 2 or 3 facades and those with 4 or more. As a result of the new methodology, the designations “houses with 2 or 3 facades”, “houses with 4 or more facades” and “flats” have replaced the designations “ordinary dwellings”, "villas, bungalows and country houses” and “flats and studio”. In addition, the new methodology does not include new builds. In 2016, Statbel obtained more detailed data from the Land Registry, revealing that not all new buildings were included in the databases and that information on those included was not always accurate. As a result, the new methodology focuses exclusively on the secondary property market, excluding all new build transactions.

In the old methodology, the results included average prices, median prices, percentile prices, number of transactions, total prices and total surface areas. The new optimised methodology focuses on median prices, percentile prices and number of transactions. For this study, median prices will be used because, according to Statbel (2017), the impact of extreme values on this indicator is virtually nil, the median does not vary, or varies very little, when an extreme value is included or excluded from the calculation, unlike the mean. The median price is therefore a more reliable and stable indicator than the average price.

As we can see, the two periods overlap between 2010 and 2017. We are therefore going to analyse this period. This analysis has several key objectives. One of the main objectives of this analysis is to verify the consistency between the two methodologies used to calculate property yields. By comparing the results of the two series over this overlap period, we can determine whether the two methodologies produce similar results. Consistency between the two series would indicate that the methodological differences do not significantly affect the conclusions of the study.

In order not to overload the text, all the results concerning the analysis of this overlap are available in the appendices from 4 to 11. Analysis of property yields in Belgium and at regional level reveals significant differences between the results obtained from the two methodologies used by Statbel to calculate residential property prices, despite significant correlations. The differences in results between the two-time series can be attributed to fundamental differences in the data collection and classification methodologies. The old methodology includes biases related to the subjective valuation of properties and the inclusion of new builds, while the new methodology uses more objective criteria and data verified by notaries, excluding new builds. These differences lead to significant variations in the regression results, making it impractical to merge the series.

[19] https://statbel.fgov.be/fr/themes/construction-logement/prix-de-limmobilier#figures

To ensure the consistency and validity of the conclusions, we have chosen to use the time series based on the old methodology for the period 1992 to 2010, and then switch to the time series based on the new methodology for the period 2011 to 2023. This approach allows us to take advantage of the best available data for each period, while recognising the inherent limitations of each method, thus ensuring a rigorous and reliable analysis of property yields in Belgium.

Finally, prices are organised by year, half-year or quarter, depending on the type of property and location (municipalities, boroughs, provinces, regions and countries). For this study, quarterly returns based on housing prices at national and regional level will be used to test the various hypotheses. The calculation of the property yield based on housing prices follows a similar methodology to that used to calculate the inflation rate in equation 10.

The statistics for the period 1992 to 2010 are summarised in table 5. For the period 1992 to 2010, ordinary residential properties in Belgium show the highest average yield at 7.39%, with a volatility of 4.82%. Flats show an average return of 6.11% and a lower volatility of 4.44%. Villas, on the other hand, have the lowest average yield at 2.97%, but also the highest volatility at 5.34%. In terms of correlation with current inflation (AI), ordinary residential property has a correlation of 0.185, although this is not significant.

Comparing the three regions of Wallonia, Brussels and Flanders for the period 1992 to 2010:

- In Wallonia, ordinary residential properties also offer the highest average yield at 7.16%, with a volatility of 4.03%. Flats follow with an average yield of 6.23% and a volatility of 5.96%. Villas show an average yield of 3.12%, with a relatively high volatility of 8.13%. None of the correlations with current inflation (AI) is significant for this region.
- In Brussels, ordinary residential properties are the most profitable, with an average yield of 7.82% and a high volatility of 11.65%. Flats have an average yield of 5.85% and a volatility of 6.45%. Villas, although less profitable at 7.06%, show extremely high volatility at 14.80%.
- In Flanders, ordinary residential properties have an average yield of 7.41% with a volatility of 4.76%. Flats follow with an average yield of 6.28% and a volatility of 4.25%. Villas, although with an average yield of 3.30%, have a volatility of 5.43%. It is important to note that the only significant correlation with current inflation (AI) in the whole table is observed for ordinary residential properties in Flanders, with a correlation of 0.2639**, indicating a moderate positive relationship with inflation.

Table 5

Quarterly property returns as a function of property type from 1992 to 2010

	Mean	Median	Min	Max	Std. Dev.	Correlation with AI
Belgium						
R (ordinary)	0.0739	0.0688	0.0000	0.2440	0.0482	0.1850
R (villas)	0.0297	0.0357	-0.1291	0.1267	0.0534	-0.0977
R (Flats)	0.0611	0.0562	0.0000	0.1659	0.0444	0.03451
Wallonia						
R (ordinary)	0.0716	0.0706	0.0000	0.1647	0.0403	0.0794
R (villas)	0.0312	0.0349	-0.2112	0.2000	0.0813	-0.0887
R (Flats)	0.0623	0.0562	-0.1199	0.2727	0.0596	0.0314
Brussels						
R (ordinary)	0.0782	0.0606	-0.0666	0.5425	0.1165	0.1100
R (villas)	0.0706	0.0540	-0.3295	0.4684	0.1480	0.2085
R (Flats)	0.0585	0.0499	-0.0599	0.2094	0.0645	0.1282
Flanders						
R (ordinary)	0.0741	0.0652	0.0000	0.2319	0.0476	0.2639**
R (villas)	0.0330	0.0400	-0.1250	0.1295	0.0543	-0.0797
R (Flats)	0.0628	0.0524	-0.0476	0.1637	0.0425	0.0043

Note:
**Significant at the 5% level

Source: our own calculations with Gretl

The statistics based on the new methodology are summarised in table 6. In Belgium, property yields vary according to the type of property. Houses with 2 or 3 facades have the highest average yield at 3.88%, followed by flats at 3.70%, and houses with 4 or more facades at 3.37%. In terms of volatility, houses with 2 or 3 facades have the highest volatility at 4.64%, while flats have the lowest at 2.14%. In terms of correlation with real inflation, flats show the strongest correlation at 0.3914**, indicating a significant relationship with inflation, followed by houses with 2 or 3 facades at 0.2872**, while houses with 4 or more facades have no significant correlation.

Comparing the three regions of Wallonia, Brussels and Flanders for the period 2011 to 2023:

- In Wallonia, flats have the highest average yield at 3.41%, followed by houses with 4 or more facades at 3.02%, and houses with 2 or 3 facades at 2.88%. Houses with 4 or more facades show the highest volatility at 2.94%, while houses with 2 or 3 facades have the lowest at 2.41%. In terms of correlation with actual inflation, flats have the highest correlation at 0.3404**, followed by houses with 2 or 3 façades at 0.3132**, and houses with 4 facades or more at 0.3062**, all showing significant relationships with actual inflation.
- In Brussels, flats have the highest average yield at 3.63%, followed by houses with 2 or 3 facades at 3.55%, and houses with 4 or more facades at 3.41%. Houses with 4 or more facades show the highest volatility at 19.80%, while flats show the lowest at 2.97%. However, none of the property categories in Brussels show a significant correlation with actual inflation.
- In Flanders, houses with 2 or 3 facades show the highest average yield at 4%, followed by flats at 3.85%, and houses with 4 or more facades at 3.16%. Houses with 2 or 3 facades show the highest volatility at 3.24%, while flats have the lowest at 2.30%. The strongest correlation with actual inflation is observed for flats at 0.4065***, followed by houses with 2 or 3 facades at 0.3535**, and houses with 4 facades or more at 0.3500**, all indicating significant relationships with inflation.

Comparing property types between the different regions, flats in Flanders are the most profitable, with an average yield of 3.85% and a significant correlation with real inflation of 0.4065***. This puts them ahead of flats in Wallonia and Brussels, with average yields of 3.41% and 3.63% respectively. In Wallonia, houses with 4 or more facades follow with a yield of 3.02%, while in Brussels, houses with 2 or 3 facades offer a yield of 3.55%. All in all, flats in Flanders are the best performers in terms of average yield and relationship with inflation, making them the most profitable property type among the regions studied.

Table 6

Quarterly property returns as a function of property type from 2011 to 2023

	Mean	Median	Max	Min	Std. Dev.	Correlation with AI
Belgium						
R (2 or 3)	0.0388	0.0303	0.1968	-0.0829	0.0464	0.2872**
R (4 or more)	0.0337	0.0250	0.1384	-0.0203	0.0322	0.2153
R (Flats)	0.0370	0.0332	0.0855	-0.0090	0.0214	0.3914**
Wallonia						
R (2 or 3)	0.0288	0.0317	0.0897	-0.0079	0.0241	0.3132**
R (4 or more)	0.0302	0.0250	0.1155	-0.0130	0.0294	0.3062**
R (Flats)	0.0341	0.0357	0.0967	-0.0175	0.0280	0.3404**
Brussels						
R (2 or 3)	0.0355	0.0424	0.1511	-0.0572	0.0439	0.1678
R (4 or more)	0.0341	-0.0016	0.5113	-0.3102	0.1980	-0.1695
R (Flats)	0.0363	0.0298	0.1000	-0.0277	0.0297	0.0590
Flanders						
R (2 or 3)	0.0400	0.0369	0.1555	-0.0379	0.0324	0.3535**
R (4 or more)	0.0316	0.0327	0.0980	-0.0178	0.0245	0.3500**
R (Flats)	0.0385	0.0369	0.0890	-0.0171	0.0230	0.4065***

Notes:
R (2 or 3) = returns of houses with 2 or 3 facades
R (4 or more) = returns of houses with 4 or more facades
**Significant at 5% level
***Significant at 1% level

Source: our own calculations with Gretl

6 Empirical results

Firstly, our preliminary tests have shown, using the Durbin-Watson statistics, that the residuals of most of our OLS regressions are autocorrelated with low values of the Durbin-Watson statistics. The Durbin-Watson statistics, which varies between 0 and 4, is used to detect the autocorrelation of the residuals, a value close to 2 indicates no autocorrelation, while a value significantly different from 2 indicates autocorrelation (Durbin and Watson, 1950, 1951). If there is any doubt about the autocorrelation based on the Durbin-Watson statistic, we use the Durbin-Watson p-value. Autocorrelation violates the fundamental assumption of error independence in the regression model, rendering the estimates inefficient. To correct this problem, we will use the GLS regression (Generalized least squares) (Glascock et al., 2008).

6.1 Stationary test

To ensure the validity of our econometric analysis, it is crucial to test the stationarity of the data. Stationarity is a fundamental property of time series data, ensuring that the statistical characteristics such as mean, variance, and autocorrelation remain constant over time. Therefore, we first tested the stationarity of our data using the Augmented Dickey-Fuller (ADF) test. This test helps determine whether the series has a unit root, indicating nonstationary, or if it is stationary, which is essential for reliable model estimation. We begin by testing the stationarity of the different inflation periods. We will then assess the stationarity of property yields, firstly for the period 1992 to 2010, and then for the period 2011 to 2023. All the decisions concerning the ADF test method are available in appendices 29 to 32.

6.1.1 Inflation

Table 7 presents the results of the Augmented Dickey-Fuller (ADF) test for the quarterly inflation rate over two periods, 1992-2010 and 2011-2023, distinguishing between actual inflation (AI), expected inflation (EI) and unexpected inflation (UI). For the period 1992-2010, actual inflation and expected inflation become stationary after differentiation, while unexpected inflation is stationary at the level. For the period 2011-2023, actual inflation becomes stationary after differentiation, while expected inflation and unexpected inflation are stationary at the level. This suggests that the components of inflation need to be treated differently depending on their nature and the period considered in the econometric analysis.

Table 7

ADF test for quarterly inflation rate

	At level	1st difference
1992-2010		
AI	0.1716	0.0000***
EI	0.282	0.0000***
UI	0.0000***	
2011-2023		
AI	0.5956	0.0000***
EI	0.0002***	
UI	0.0000***	
Notes *** Significant at 1% level		

Source: our own calculations with Gretl

6.1.2 Residential property returns from 1992 to 2010

Table 8 presents the results of the ADF test for quarterly property returns in Belgium and its regions for the period 1992 to 2010. The results show that, for the period 1992-2010, the yields of many properties in Belgium and its regions are stationary after the first differentiation, indicating that they are integrated of order 1. In Wallonia all property types have stationary returns at the level. Ordinary houses and villas in Belgium, as well as villas in Brussels and Flanders, are stationary at their initial level. These series are integrated of order 0.

Table 8

ADF test for quarterly property returns as a function of property type from 1992 to 2010

	At level	1st difference
Belgium		
R (ordinary)	0.0100**	
R (villas)	0.0010***	
R (flats)	0.0730	0.0000***
Wallonia		
R (ordinary)	0.0012***	
R (villas)	0.0001***	
R (flats)	0.0000***	
Brussels		
R (ordinary)	0.2477	0.0000***
R (villas)	0.0000***	
R (flats)	0.1671	0.0000***
Flanders		
R (ordinary)	0.2206	0.0000***
R (villas)	0.0010***	
R (flats)	0.2538	0.0000***
Notes		
** Significant at 5% level		
*** Significant at 1% level		

Source: our own calculations with Gretl

6.1.3 Residential property returns from 2011 to 2023

Table 9 shows the results of the ADF test for quarterly property returns in Belgium and its regions for the period 2011 to 2023. Over the period, the yields of half the properties in Belgium and the regions are stationary after the first or second differentiation, indicating that they are integrated of order 1 or order 2. In Brussels, all yields are integrated of order 1. Houses with 2 or 3 facades in Belgium and Flanders are also integrated of order 1, as are houses with 4 or more facades in Wallonia.

Table 9

ADF test for quarterly property returns as a function of property type from 2011 to 2023

	At level	1st difference	2nd difference
Belgium			
R (2 or 3)	0.0000***		
R (4 or more)	0.0863	0.0000***	
R (flats)	0.2833	0.0011***	
Wallonia			
R (2 or 3)	0.3183	0.0000***	
R (4 or more)	0.0027***		
R (flats)	0.4792	0.0000***	
Brussels			
R (2 or 3)	0.0000***		
R (4 or more)	0.0000***		
R (flats)	0.0181**		
Flanders			
R (2 or 3)	0.0000***		
R (4 or more)	0.1144	0.0022***	
R (flats)	0.4549	0.4588	0.0000***

Notes
R (2 or 3) = returns of houses with 2 or 3 facades
R (4 or more) = returns of houses with 4 or more facades
** Significant at 5% level
*** Significant at 1% level

Source: our own calculations with Gretl

6.2 Regression results for the period 1992 to 2010

6.2.1 Actual inflation

Table 10 shows the results of the actual inflation regression from 1992 to 2010 for Belgium, the different regions and the different property types (ordinary houses, villas and flats). Analysis of the coefficients reveals that of all the property categories studied, only flats in Brussels show a significant coefficient of 1.0879, significant at 5% level. We can therefore reject the null hypothesis that residential property offers no hedge against actual inflation. This result means that for every 1% increase in actual inflation, flat prices in Brussels increase by 1.0879%. This shows that flats in Brussels provide more than proportional hedge against inflation, increasing in value at a higher rate than inflation. In contrast, the other property types in the different regions do not show significant coefficients, so we cannot reject the null hypothesis, which suggest that they do not provide a reliable hedge against inflation over the period studied.

Table 10

Results for actual inflation from 1992 to 2010

Dependant variable	Constant	Actual Inflation	Adjusted R^2	DW Statistics
Belgium				
R (ordinary)	0.0700***	−0.1485	0.5206	2.0631
R (villas)	0.0282**	0.3029	0.3902	1.9417
R (flats)	0.0002	−0.1544	0.0390	1.9363
Wallonia				
R (ordinary	0.0690***	−0.0956	0.3802	2.2117
R (villas)	0.0250*	1.0707	0.2085	2.1322
R (flats)	0.0607***	1.3515	0.2151	2.0464
Brussels				
R (ordinary)	−0.0009	−0.3051	0.0254	1.9662
R (villas)	0.0743***	1.5069	0.1292	2.0568
R (flats)	0.0000	1.0879**	0.2597	2.0835
Flanders				
R (ordinary)	−0.0014	0.4412	0.0444	1.8005
R (villas)	0.0333**	0.2160	0.4072	1.9849
R (flats)	0.0004	−0.5092	0.1415	2.1739

Notes:
* Significant at 10% level
** Significant at 5% level
*** Significant at 1% level
DW denotes Durbin-Watson statistics

Source: our own calculations with Gretl

6.2.2 Expected vs. Unexpected inflation and Economics Cycles

The results of equation 6 are shown in Table 11. For the period 1992 to 2010, analysis of the coefficients for Belgium as a whole show that villas suffer a sharp fall in yield in response to unexpected inflation, with a coefficient of -4.7160, significant at 10% level. We can therefore reject the null hypothesis that residential property does not hedge against unexpected inflation. However, this result indicates a negative hedge, meaning that for every 1% increase in unexpected inflation, villa returns fall by 4.7160%.

In Wallonia, villas offer a more than proportional hedge against expected inflation, with a coefficient 2.4017, significant at 10% level. We can therefore reject the null hypothesis that residential property does not hedge against expected inflation. This means that for every 1% increase in expected inflation, villa yields increase by 2.4017%. However, these same properties suffer a sharp fall in yield of 11.7018% in response to unexpected inflation, with a coefficient -11.7018, significant at 1% level, indicating a negative hedge against unexpected inflation.

In Brussels villas suffer a significant fall in yield during periods of recession, with a coefficient of -0.0830, significant at 5% level. We can therefore reject the null hypothesis that periods of inflation have no significant impact on residential property. This means that during recessions, villa yields fall by 8.30%.

Table 11

Results for expected vs. unexpected inflation and economic cycles from 1992 to 2010

Dependant variable	Constant	Expected inflation	Unexpected inflation	High inflation	Recession	Adjusted R^2	DW Statistics
Belgium							
R(ordinary)	0.0695***	−0.1211	0.01825	0.0004	0.0008	0.4996	2.0665
R(villas)	0.0333**	0.4391	−4.7160*	−0.0042	−0.0029	0.3970	1.9628
R(flats)	0.0000	0.0100	1.1941	−0.0014	0.0008	0.0112	1.9387
Wallonia							
R(ordinary)	0.0726***	−0.0878	−1.0682	0.0015	−0.0106	0.3631	2.1951
R(villas)	0.0396**	2.4017*	−11.7018***	−0.0326	0.0163	0.3128	2.1365
R(flats)	0.0660***	1.5465	2.8914	−0.0047	−0.0114	0.2000	2.0670
Brussels							
R(ordinary)	0.0009	−0.5714	4.9831	−0.0056	−0.0035	0.0089	1.9836
R(villas)	0.0895***	0.8376	11.8196	0.0239	−0.0830**	0.1643	2.0479
R(flats)	0.0032	1.3772	2.3286	−0.0086	−0.0009	0.2826	2.16488
Flanders							
R(ordinary)	−0.0022	0.3834	2.0711	0.0005	−0.0011	0.0301	1.8133
R(villas)	0.0385**	0.0734	−2.3072	0.0006	−0.0123	0.3930	1.9727
R(flats)	−0.0001	−0.3923	0.0950	0.0009	0.0002	0.0983	2.1867

Notes:
*Significant at 10% level
** Significant at 5% level
*** Significant at 1% level
DW denotes Durbin-Watson statistics

Source: our own calculations with Gretl

6.2.3 Summary of the results

Table 12 summarises the main results. Over the period 1992 to 2010, the residential market in Belgium generally did not offer any hedging against the various types of inflation, with a few exceptions. Villas in Wallonia were hedged against expected inflation, while flats in Brussels also offered some protection against actual inflation. Conversely, some property types even showed negative hedging against unexpected inflation, notably villas nationally and in Wallonia when looking at the regions in more detail.

Table 12

Summary of the results of the regression against all types of inflation from 1992 to 2010

	Belgium			Wallonia			Brussels			Flanders		
	AI	EI	UI	AI	EI	UI	AI	EI	UI	AI	EI	UI
Ordinary	X	X	X	X	X	X	X	X	X	X	X	X
Villas	X	X	–	X	V	–	X	X	X	X	X	X
Flats	X	X	X	X	X	X	V	X	X	X	X	X

Notes:
X = No hedge
– = Negative hedge
V = Positive hedge

Source: our own construction

6.3 Regression results for the period 2011 to 2023

6.3.1 Actual inflation

Table 13 shows the results of equation 1 over the period 2011 - 2023. The results of this period indicate that only houses with 2 or 3 facades in Brussels offer more than proportional hedge against actual inflation, with a coefficient of 1.2075, significant at 5% level. We can therefore reject the null hypothesis. This means that these houses in Brussels not only protect against actual inflation, but also increase in value at a higher rate than inflation. In contrast, the other property types in the different regions do not show significant responses to inflation, suggesting that they do not provide a reliable hedge against actual inflation for the period 2011 to 2023.

Table 13

Results for actual inflation from 2011 to 2023

Dependant variable	Constant	Actual Inflation	Adjusted R^2	DW Statistics
Belgium				
R (2 or 3)	0.0388***	0.8344	0.0148	1.9692
R (4 or more)	−0.0001	0.0549	0.2936	2.1913
R (flats)	0.0000	0.0667	0.1058	2.0814
Wallonia				
R (2 or 3)	−0.0003	0.1035	0.1587	2.2718
R (4 or more)	0.0276***	−0.1622	0.4613	2.4161
R (flats)	−0.0002	−0.0045	0.2389	2.3112
Brussels				
R (2 or 3)	0.0349***	1.2075**	0.1378	2.0865
R (4 or more)	0.0193	4.0578	0.1418	1.8406
R (flats)	0.0361***	0.1844	0.4120	2.2579
Flanders				
R (2 or 3)	0.0395***	0.3110	0.0142	2.0435
R (4 or more)	-0.0000	0.0367	0.2089	2.2404
R (flats)	−0.0002	0.0855	0.4380	2.9752

Notes
R (2 or 3) = returns of houses with 2 or 3 facades
R (4 or more) = returns of houses with 4 or more facades
** Significant at 5% level of significance
*** Significant at 1% level significance
DW denotes Durbin-Watson statistics

Source: our own calculations with Gretl

6.3.2 Expected vs. Unexpected inflation and Economics Cycles

The results of equation 6 are shown in Table 14. For Belgium as a whole, none of the coefficients is significant for houses with 2 or 3 facades, houses with 4 or more facades, and flats. This suggests that neither expected inflation, unexpected inflation, periods of high inflation nor recessions have a statistically significant impact on property yields at national level for the period studied.

In Wallonia, the returns on houses with 2 or 3 facades are significantly influenced by several economic factors. Expected inflation has a coefficient of -0.2868, significant at the 1% level, and unexpected inflation has a coefficient of -0.6730, also significant at the 1% level. We can therefore reject the null hypotheses that residential property does not provide a significant hedge against expected and unexpected inflation, even though the coefficient is negative. These results indicate that both expected and unexpected increases in inflation have a negative impact on the returns of these properties, suggesting that houses with 2 or 3 facades in Wallonia do not offer a positive hedge against inflation. For every 1% increase in expected inflation, yields fall by 0.2868% for expected inflation and by 0.6730% for unexpected inflation. Furthermore, high inflation has a coefficient of 0.0095, significant at 10% level. We can therefore reject the null hypothesis, suggesting that period of high inflation have a positive impact on returns. The coefficient for recessions is negative, -0.0085, significant at 5% level. We can therefore reject the null hypothesis, suggesting that periods of recession have significant negative impact on returns. For houses with 4 or more facades, unexpected inflation has a significant negative effect with a coefficient of -1.5924, significant at 5% level, also indicating a lack of positive hedging against unexpected inflation.

In Brussels, none of the inflation coefficients is significant, so we cannot reject the null hypotheses. On the other hand, periods of recession have a negative impact on houses with 2 or 3 facades, as well as on those with 4 facades or more. For houses with 2 or 3 facades, the coefficient is -0.0307, significant at 10% level, suggesting that in a recession, the yield on these houses decreases by around 3%. For houses with 4 or more facades, the coefficient is -0.1260, significant at 10% level, indicating a decreasing of around 12.6% in yield during a recession.

In Flanders, only houses with 2 or 3 facades present a partial hedge against expected inflation, with a coefficient of 0.4638, significant at 10% level. We can therefore reject the null hypothesis. This means that for every 1% increase in expected inflation, the yield on these properties rises by 0.4638%.

Table 14

Results for expected vs. unexpected inflation and economic cycles from 2011 to 2023

Dependant variable	Constant	Expected inflation	Unexpected inflation	High inflation	Recession	Adjusted R^2	DW Statistics
Belgium							
R (2 or 3)	0.0308***	0.4368	−0.9818	0.0030	−0.0185	0.0944	1.9494
R (4 or more)	0.0033	0.0582	0.1590	−0.0136	0.0045	0.2991	2.2750
R (Flats)	0.0019	−0.02822	−0.1557	−0.0032	0.0011	0.0930	2.0956
Wallonia							
R (2 or 3)	0.0046*	−0.2868***	−0.6730**	0.0095*	−0.0085**	0.2932	2.4497
R (4 or more)	0.0220***	0.2212	−1.5924**	0.0085	0.0029	0.2381	2.1758
R (Flats)	0.0004	−0.1516	−0.3704	0.0054	0.0032	0.2119	2.3407
Brussels							
R (2 or 3)	0.0370***	0.0651	−1.9187	0.0106	−0.0307*	0.1619	1.9939
R (4 or more)	0.0972*	−2.1173	−8.5428	0.0324	−0.1260*	0.1672	1.9682
R (Flats)	0.0308**	0.0930	0.1107	−0.0021	0.0131	0.3890	2.3175
Flanders							
R (2 or 3)	0.0319***	0.4638*	−0.3517	−0.0033	−0.0091	0.1002	1.9849
R (4 or more)	0.0026	−0.1726	−0.1681	0.0043	−0.0013	0.2001	2.3097
R (Flats)	−0.0001	−0.0232	−0.1147	0.0011	0.0002	0.3992	2.9853

Notes:
R (2 or 3) = returns of houses with 2 or 3 facades
R (4 or more) = returns of houses with 4 or more facades
*Significant at 10% level
** Significant at 5% level
*** Significant at 1% level
DW denotes Durbin-Watson statistics

Source: our own calculations with Gretl

6.3.3 Summary of the results

Table 15 summarises the results for the period 2011-2023. We observe a general trend of no inflation hedging, with most coefficients being insignificant, indicating that we cannot reject the null hypotheses. This conclusion is similar to the previous period. However, houses with 2 or 3 facades in Wallonia show a significant but negative hedge against expected and unexpected inflation. A similar observation is made for houses with 4 or more facades in Wallonia regarding unexpected inflation. Finally, houses with 2 or 3 façades in Brussels show positive coverage against current inflation, and those in Flanders against unexpected inflation.

Table 15

Summary of the results of the regression against all types of inflation from 2011 -2023

	Belgium			Wallonia			Brussels			Flanders		
	AI	EI	UI	AI	EI	UI	AI	EI	UI	AI	EI	UI
Housing with 2 or 3 facades	X	X	X	X	–	–	V	X	X	X	V	X
Housing with 4 or more facades	X	X	X	X	X	–	X	X	X	X	X	X
Flats	X	X	X	X	X	X	X	X	X	X	X	X

Notes:
X = No hedge
– = Negative hedge
V = Positive hedge

Source: our own construction

6.4 Robustness tests

Robustness tests are essential to assess the reliability and validity of the results of our regression model. The main purpose of these tests is to check whether our conclusions remain consistent under different specifications and conditions. By carrying out these tests, we can reinforce the credibility of our results by demonstrating that they are not sensitive to variations in the data or methods used. To carry out the robustness tests, we will modify certain components of our data and our model, and observe how these changes affect our results. We will first use the harmonised consumer price index as a proxy for actual inflation, then again use the health index as a proxy for actual inflation, and then include a lagged variable for the dependent variables. Finally, we will use the house price index to calculate housing returns and to perform the cointegration test. For all the robustness tests, we consider the period 2011-2023 on the basis of the data available to us. As before, autocorrelation is tested using the Durbin-Watson statistic and corrected where necessary using a GLS regression.

6.4.1 Harmonised Index of Consumer Prices (HICP)

The Harmonised Index of Consumer Prices[20] (HICP) is a statistical indicator developed to assess and compare inflation between the different countries of the European Union. Unlike the national CPI, the HICP follows a harmonised methodology that ensures comparability of data between countries. It is used in particular by the European Central Bank (ECB) to monitor price stability and guide monetary policy.

All the statistics and calculations relating to this variant are available in appendices 12 to 15. Comparing the results of our regressions with the CPI and the HICP, we found some significant differences as well as some significant similarities. For actual inflation and unexpected inflation, none of the results show significant similarities between the two indices. This suggests that the impact of these inflation measures on property yields is sensitive to the definition of inflation used.

On the other hand, for expected inflation certain significant similarities emerge:

- Houses with 2 or 3 facades in Wallonia, in both models using CPI and HICP, show a negative hedge against expected inflation, indicating that increases in expected inflation reduce their returns.

[20] https://statbel.fgov.be/fr/themes/prix-la-consommation/indice-des-prix-la-consommation-harmonise-ipch

- Houses with 2 or 3 fronts in Flanders show partial hedging against expected inflation in both models, suggesting that yields increase somewhat with expected inflation.
- Regarding the impact of recessions, periods of recession negatively affect the returns of houses with 2 or 3 fronts in Wallonia and Brussels in both models. This indicates that these types of properties are particularly vulnerable to adverse economic cycles, regardless of the inflation measure used.

These results highlight the importance of justifying the choice of inflation indices in economic analyses and indicate that the specific components of inflation can have a significant impact on property returns. Our conclusions must therefore take this sensitivity into account in order to offer a more nuanced and accurate interpretation of the relationships studied. By providing a comparable measure of inflation across European countries, the use of the HICP also paves the way for future comparisons with similar studies in other countries.

6.4.2 Health index

The Health Index[21] is a variant of the CPI that excludes certain products, such as tobacco, alcohol and fuels (with the exception of LPG), to provide a more representative measure of inflation for essential goods and services. Using the Health Index allows us to check whether the conclusions remain robust when using a more restrictive measure of inflation.

All the statistics and calculations relating to this variant are available in appendices 16 to 19. Once again, using the health index, some conclusions significantly diverge, while others remain significantly the same as with the basic model. For Belgium as a whole, the conclusions remain the same, with none of the coefficients being significant. If we look at the regions in more detail, significant similarities emerge:

- In Wallonia houses with 2 or 3 facades show a negative hedge against expected and unexpected inflation. In addition, periods of recession have a negative impact on the returns on these same houses.
- In Brussels, for houses with 2 or 3 facades we observe more than proportional hedge against actual inflation. Periods of recession have a negative impact on returns for houses with 2 or 3 facades, as well as houses with 4 or more facades, indicating greater sensitivity to unfavourable economic cycles.
- In Flanders houses with 2 or 3 facades offer partial and positive hedge against the inflation expected in both models.

Once again, by changing the inflation proxy, some conclusions no longer hold while new ones emerge, indicating that our model may be sensitive to the method of calculating inflation. However, some conclusions remain robust.

6.4.3 Lagged Variables

As our inflation data is quarterly, we have chosen to use a lag of one quarter. Inflation and economic cycles can have delayed effects on property returns. By including a one-quarter lag, we capture these lagged effects and obtain a more complete picture of the impact of these variables on property yields.

All the statistics and calculations relating to this variant are available in appendices 20 to 23. Comparing the results for actual inflation between the two models, it appears that the inclusion of a lagged variable alters the conclusions significantly. In the basic model, only houses with 2 or 3 facades in Brussels offered a hedge against actual inflation. However, with the addition of a lagged variable, new observations emerge.

[21] https://statbel.fgov.be/fr/themes/prix-la-consommation/indice-sante#documents

Nationally, houses with 2 or 3 façades now offer cover against actual inflation. In addition, when we look at the different regions, we find that houses with 2 or 3 facades in Flanders also offer protection against actual inflation. In Wallonia, houses with 4 or more facades show a similar ability to protect against actual inflation. In particular, houses with 2 or 3 facades in Brussels continue to offer protection against actual inflation, confirming the conclusions of the basic model.

With regard to equation 6 of our basic model, new conclusions emerge with the integration of lagged variables. At national level, periods of high inflation have a negative impact on houses with 4 or more facades, indicating that these properties suffer a deterioration in their returns during periods of high inflation.

In Wallonia, flats offer a partial hedge against expected inflation. In addition, periods of recession have a slightly positive impact on flat yields, suggesting that these properties may benefit from a slight resilience in times of economic crisis. However, houses with 2 or 3 facades continue to offer a negative hedge against expected inflation, confirming previous results. Similarly, houses with 4 or more fronts in Wallonia offer a negative hedge against unexpected inflation, indicating continued sensitivity to this variable.

In Brussels, the results show that houses with 2 or 3 facades offer a negative hedge against unexpected inflation. Furthermore, houses with 4 or more facades offer a negative hedge against expected inflation. Finally, periods of high inflation have a negative impact on flat yields, highlighting the vulnerability of these properties in periods of high inflation.

In Flanders, houses with 2 or 3 facades continue to provide a hedge against unexpected inflation, confirming the robustness of this relationship in the new model with lagged variables.

These results suggest that inflation and economics cycles have lagged effects on property returns, which may reflect market adjustments that take longer to occur. The inclusion of lagged variables in the model shows a more extensive hedge against inflation, which was not visible in the baseline model. These observations highlight the importance of taking time effects into account when analysing the impact of inflation.

6.4.4 House Price Index (HPI)

The HPI[22] measures changes in residential house prices, providing a direct measure of house price trends. By using HPI instead of house prices based on old and new methodologies, we aim to verify the robustness of our findings with an alternative measure of house prices. This test will give us an overall view of trends in Belgium and in the different regions, but we will not be able to compare the results in detail with the basic models, since the HPI does not allow us to distinguish between the different types of property.

All the statistics and calculations relating to this variant are available in appendices 24 to 27. The results of equation 1 show that property yields in Belgium, Wallonia, Brussels and Flanders do not provide a significant hedge against actual inflation. None of the coefficients are significant in the regions and periods studied, indicating that property have failed to protect against the erosion of purchasing power due to actual inflation.

The results for equation 6 shows that at national level, none of the coefficients for expected inflation, unexpected inflation, high inflation or recession is significant. In Wallonia, residential property offers

[22] "The house price index measures the price evolution of real estate prices on the market of private property. The index follows price changes of new or existing residential real estate purchased by households, irrespective of their purpose (letting or owner-occupying). Only market prices are taken into account. Houses built by their owners are therefore not included. The price of the building plot is included in the house price." (Stabel, 2017)

a negative hedge against expected and unexpected inflation. In Brussels and Flanders, none of the coefficients is significant.

This robustness test confirms the general trend that residential property does not provide a hedge against the various forms of inflation.

6.4.5 Cointegration test

Ordinary least squares (OLS) methodology is commonly used to test the inflation hedging characteristics of various financial assets. However, according to Chu and Sing (2004), this method may underestimate the long-term hedging capacity of residential property and other assets. To address this limitation, we employ the two step Engel-Granger (1987) cointegration methodology, which allows us to examine long-term return relationships in the real estate market (Stevenson, 2000; Chu and sing, 2004; Glascock et al. 2008)

The first step is to test the stationarity of the property returns time series and the inflation series using the Augmented Dickey-Fuller (ADF) test. The time series must satisfy the $I(1)$ stationarity condition in order to be used in the cointegration test.

Once the stationarity of the time series is confirmed, the second step is to estimate the cointegration regressions of asset returns on inflation, according to the following equation:

$$y_t = \alpha + \beta x_t + \varepsilon_t, \tag{9}$$

The residuals (ε_t) obtained from the regression are then tested for stationarity using the ADF test again. If the residuals are $I(0)$ stationary, this indicates that the two series are cointegrated, meaning that there is a stable long-term relationship between them.

The tests carried out previously revealed that the actual inflation figures over the period 2011 to 2023 are integrated of order 1. For property returns, the results are more varied, some series are integrated of order 0 and others of order 1. However, returns based on the house price index (HPI) for the period 2011-2023 are all integrated of order 1.

To ensure a clear analysis of the situation, we decided to focus our study on the HPI-based property yield time series between 2011 and 2023, which are all integrated of order 1. Glascock et al (2008) argue that since we are looking to determine whether there is a long-term relationship between returns and actual inflation, it is not necessary to distinguish between expected and unexpected inflation.

The second step is to estimate the cointegration regression. In equation (9), y_t represents the residential property yields in the different regions and x_t represents actual inflation. Next, the residuals are extracted and tested for stationarity. The results are presented in appendix 28.

These results in appendix 28 indicate that there is no long-term relationship between inflation and residential property returns, since none of the p-values is below the decision threshold. These results reconfirm the general trend in the Belgian residential market, which offers no hedging against inflation.

7 Discussion

The aim of this section is to summarise and analyse the various hypotheses studied, presenting the results obtained and comparing them with the existing literature. We begin by examining each hypothesis, comparing our findings with those of previous studies. We will then discuss the robustness tests carried out to assess the reliability of our results. We will also discuss the limitations of our study, highlighting methodological constraints and possible biases. Finally, we will offer suggestions for future research on this topic, identifying issues that merit further investigation.

7.1 Hypothesis

The main objective of this study is to assess the ability of Belgian residential property to act as a hedge against inflation. More specifically, this research aims to determine whether residential property can protect against the decline in purchasing power associated with inflation, by examining the relationship between residential property yields and inflation rates. This study also seeks to understand how periods of high inflation and recession impact residential property. To achieve this objective, several hypotheses were formulated and tested.

Does residential property offer a hedge against actual inflation?

For the period 1992-2010, the results show that only flats in Brussels provide an effective hedge against actual inflation. For the period 2011 to 2023, only houses with 2 or 3 facades have shown hedge against actual inflation. By contrast, other types of property in the various regions of Belgium do not provide a significant hedge against actual inflation for the two periods studied. The results are partly in line with those of Stevenson (2000). In his study, the author shows that the ability of residential property to provide a hedge against inflation depends on the region studied.

Does residential property offer a hedge against expected?

The results show that, for the period 1992-2010, only villas in Wallonia offer a significant hedge against expected inflation. By contrast, the other types of property in Belgium do not show any significant hedge against expected inflation. Our results are partly in line with studies by Fama and Schwert (1977) and Anari and Kolari (2002), who found that residential property in the United States could hedge expected inflation. However, the regional specificity observed in our study shows that villas in Wallonia have effective hedge against expected inflation, which contrasts with the more generalised results of North American studies. This regional variability is also observed in the study by Stevenson (2000) in the United Kingdom, who emphasised that the ability of real estate to cover inflation can vary significantly depending on the region. Wu and Twidell (2015), Zouari and Nasreddine (2023) also made the same observation.

For the period 2011-2023, the results show that no type of property in Belgium offer a significant hedge against expected inflation, with the exception of houses with 2 or 3 facades in Flanders, which are only partially hedged. In addition, houses with two or three façades in Wallonia show negative hedging. These results are at odds with several previous studies, including Fama and Schwert (1977) and Lee (2014), who found that real estate could provide a hedge against expected inflation. However, they are consistent with the results of Zhou and Clements (2010) in China, who found that real estate was not an effective hedge against expected inflation over a similar period.

Does residential property offer a hedge against unexpected inflation?

For the period 1992-2010, if we look at Belgium as a whole, the results indicate that villas suffer a significant decrease in return in response to unexpected inflation, indicating a negative hedge against unexpected inflation. If we zoom in on the regions, we see that it is villas in Wallonia that are suffering this significant decrease. The other types of property in the region do not show a significant response to unexpected inflation. Our results regarding the inability of real estate to hedge unexpected inflation are in line with the study by Wu and Pandey (2012), who found that residential real estate provided a limited hedge against unexpected inflation in the US. This observation is also supported by the findings of Lee (2014) in Malaysia, who found that real estate does not provide a significant hedge against unexpected inflation in the short run, although it may offer some protection in the long run.

For the period 2011-2023, the conclusions are similar, with the results indicating that residential property in Belgium does not offer a significant hedge against unexpected inflation. In Wallonia, houses with 2 or 3 facades and those with 4 or more facades even show a significant negative response to unexpected inflation. These results reconfirm the findings of Wu and Pandey (2012) and other studies that found a limited ability of real estate to hedge unexpected inflation. The regional variability observed in our study is also in line with the findings of Brounen et al. (2013) and Stevenson (2000), who showed that the effectiveness of real estate as an inflation hedge may depend on the specific location and economic context. Furthermore, the study by Amonhaemanon et al. (2013) in Thailand also indicates that real estate may not be a reliable hedge against unexpected inflation, depending heavily on economic conditions.

Do periods of high inflation have a significant impact on residential property yields?

The results show that, for the period 1992-2010, periods of high inflation have no significant impact on residential property returns in Belgium. None of the property categories studied showed a significant response to periods of high inflation. For the period 2011-2023, the results indicate that periods of high inflation have a small positive impact on the returns on houses with 2 or 3 facades in Wallonia. This means that these houses benefit from an increase in yields during periods of high inflation. Although our method differs, some studies have analysed the performance of real estate during periods of high inflation. For example, Le Moigne and Viveiros (2008) found that real estate provided an effective hedge against inflation during periods of high inflation in Canada (1973-1984). Our results differ in that we find no significant protection during these periods in Belgium. However, our results are more aligned with those of Wu and Pandey (2012), who found that residential real estate in the US offered limited protection against inflation, including during periods of high inflation.

Do periods of recession have a significant impact on residential property yields?

According to our results, for the period 1992 to 2010, almost all the coefficients are negative, but only that for villas in Brussels is significant, with a value of -0.0830. This indicates a decline in the returns on villas in Brussels during periods of recession. For the period 2010-2023, the results show that the prices of houses with 2 or 3 facades in Wallonia and Flanders suffer a negative impact during periods of recession. Furthermore, for houses with 4 or more facades in Flanders, recession periods also have a negative impact, with a significant coefficient of -0.1260, indicating a sharp fall in property prices during these periods. These observations are in line with the findings of Wu and Pandey (2012), who found that recession periods had a significantly negative impact on house prices in the United States.

7.2 Robustness tests

By analyzing the various robustness tests and comparing the results with our two basic models, represented by equations 1 and 6, we note several important points for the period from 2011 to 2023.

Houses with 2 or 3 facades in Brussels provide a hedge against actual inflation in the basic model, as well as when using the health index and the addition of lagged variables, which reinforces our confidence in these results. However, this robustness is not perfect, as this result is not confirmed when the HICP is used. In addition, the first three robustness tests and the basic model consistently show that houses with 2 or 3 facades in Flanders provide partial hedge against expected inflation. This repetition of similar results across several tests and the basic model increases the reliability of this conclusion.

Other similar significant results are also observed, but they are all negative, suggesting that there is no effectiveness against different types of inflation for certain types of property such as houses with 2 or 3 facades in Wallonia against expected inflation. In particular, periods of recession have a negative impact on the prices of houses with 2 or 3 facades in Wallonia and Flanders, as well as on houses with 4 or more facades in Flanders.

Finally, the results of the test with the HPI confirm the general trend, namely that residential property in Belgium offers no hedge against the various types of inflation. The HPI-based cointegration test also revealed that there is no long-term relationship between real estate and inflation. This conclusion is also shared by Zhou and Clements (2010) and Tang et al. (2019). Beyond the similarities, new conclusions have also emerged from the various robustness tests, showing that modifying the basic model can produce different results.

7.3 Limitations

This study has some notable limitations. One of the main limitations is the quality of the data on property yields. The data used comes from two different methodologies, an old one covering the period from 1992 to 2010, and a new one covering the period from 2011 to 2023. These two methodologies present fundamental differences in the collection and classification of the data, which could introduce biases. In the old methodology, the distinction between different types of property is based on a subjective assessment, which is not always updated in the event of a change of use. In addition, this methodology includes the sale of new properties, unlike the new methodology. These differences may bias our results. Although we tried to verify the consistency between the two methodologies over the overlap period from 2010 to 2017, significant differences were observed. These differences make it impractical to merge the series and could affect the comparability of results between the two periods. In addition, the impossibility of merging the two-time series forces us to work with shorter series, which reduces the number of observations available and may therefore reduce the reliability of our conclusions.

Secondly, due to data availability, we have had to use inflation data on a quarterly basis. Property data is available on a quarterly basis, whereas inflation data is available on a monthly basis. The choice was therefore made to use inflation data on a quarterly basis, which reduces the number of observations and may not capture all market dynamics. However, this choice was made to avoid the overly complex methods that would have been required to transform the property data. We preferred to use a controlled method rather than risk errors with a more complex model.

Lastly, an important limitation is the failure to take account of the differences in tax regimes between the various regions of Belgium. These differences can facilitate access to housing and thus increase demand and property prices. Variations in regional tax policies, such as registration fees, property tax and tax incentives for property investment, can have a significant impact on the property market. Failure to take these factors into account may limit the accuracy of our conclusions.

7.4 Suggestions

To deepen our understanding of the dynamics of the Belgian property market and reinforce the conclusions of this study, a number of suggestions can be made. These suggestions focus on the influence of economic and regulatory policies, as well as a more detailed territorial analysis of the different regions of Belgium.

Firstly, the influence of economic and regulatory policies on property markets is crucial and deserves particular attention. Although some economic variables have been included in our study, other factors, such as changes in tax legislation and housing subsidy policies, have not been explicitly modelled. It would be relevant to include these specific variables in future research.

Secondly, our study then analysed Belgium as a whole, focusing on the regions. However, to obtain a more complete and detailed picture, it would be interesting to study the dynamics at the level of the provinces and municipalities. A more granular analysis would make it possible to identify local trends and finer regional disparities. Comparing the results between provinces and municipalities would help to identify common patterns or significant differences, enabling more targeted recommendations to be formulated.

Finally, an important point to consider is that the analysis period based on the new methodology (2011-2023) remains relatively short. Although this study has produced some interesting results, it would be appropriate to repeat it in a few years, when more data will be available. A longer observation period could provide a more complete picture and enable us to determine whether the current conclusions are maintained or evolve over time. This would help to strengthen the robustness of the results and refine our understanding of the effectiveness of Belgian residential property as a hedge against inflation.

8 Conclusion

The main objective of this research was to assess whether Belgian residential property could be used as a hedge against different forms of inflation, including actual, expected and unexpected inflation. It also aimed to study the impact of particular economic conditions, such as periods of high inflation and recession. This study takes place in a context where research on this specific subject in the Belgian market is scarce, providing crucial insights for investors, owners and policy makers.

In this study, two time series were used, the first covering the period from 1992 to 2010, and the second from 2011 to 2023. It is important to note that the method of calculating house prices for the first period is subject to bias, particularly due to a subjective classification of property types and the inclusion of new build sales, which could distort the results. Therefore, although the results for the period 1992-2010 are presented, it is crucial to interpret them with caution. The most reliable results come from the 2011-2023 period, for which more robust and accurate calculation methods have been employed.

For the period 2011-2023, the results indicate that residential property in Belgium offers partial protection against certain forms of inflation, although this depends very much on the type of property and the region. Only houses with 2 or 3 facades in Flanders showed partial hedge against expected inflation, a conclusion corroborated by the various robustness tests. Furthermore, only houses with 2 or 3 facades in Brussels showed more than proportional protection against actual inflation, a result also confirmed by the robustness tests. On the other hand, the other types of property in the various regions did not show any significant coverage. These results suggest that residential property in Belgium offers little hedging against inflation. As regards periods of high inflation, there is insufficient evidence to draw any conclusions. On the other hand, there is evidence that periods of recession have a negative impact on residential property.

However, the results for the period 1992-2010, although biased, also showed cases where property was able to act as an effective hedge against expected inflation and, in some cases, against actual inflation. These results, while interesting, should be interpreted with caution due to the methodological limitations of this period. However, the general conclusion remains similar to that for the 2011-2023 period, namely that, overall, the Belgian housing market offers little protection against the various forms of inflation.

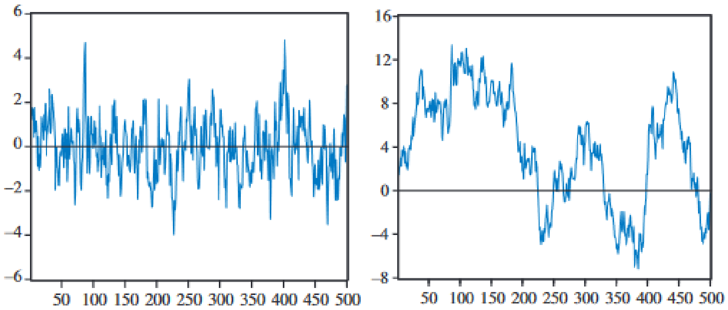
Adding lagged variables to the analysis revealed important temporal dynamics in the relationship between inflation and house prices. The results showed that, in some cases, the effect of inflation on property returns does not manifest itself immediately, but with a time lag. For example, some properties showed a hedge against actual inflation only when a lagged effect was taken into account, suggesting that investors and policy makers need to be aware of these lags in their inflation management strategies. This finding highlights the importance of considering not only actual inflation, but also historical dynamics when assessing the potential of real estate as a hedge against inflation. These findings add to our understanding of how inflationary shocks affect the property market.

Our study makes a significant contribution to the existing literature by filling an important gap concerning the Belgian property market. While much research has examined the relationship between inflation and real estate internationally, few studies have explored these dynamics in the specific context of Belgium. By taking an in-depth look at how residential real estate in Belgium reacts to inflation, this research provides valuable insights that enrich our understanding of the role of real estate as a hedge against inflation. In addition, the incorporation of regional variations and the analysis of lagged effects through lagged variables add a further dimension to the literature, underlining the complexity and importance of a nuanced approach to the evaluation of property markets.

In conclusion, this study shows that residential property in Belgium can offer some protection against inflation, particularly against expected and actual inflation in certain regions and for certain types of property. However, this ability is neither uniform nor guaranteed. The results highlight the importance of taking into account regional specificities and property characteristics when valuing property as an inflation hedge. This general conclusion confirms the findings of Stevenson (2000), Wu and Twidell (2015) and Zouari and Nasreddine (2023). Despite its limitations, this research makes a significant contribution to our understanding of the Belgian property market and provides valuable guidance for future research.

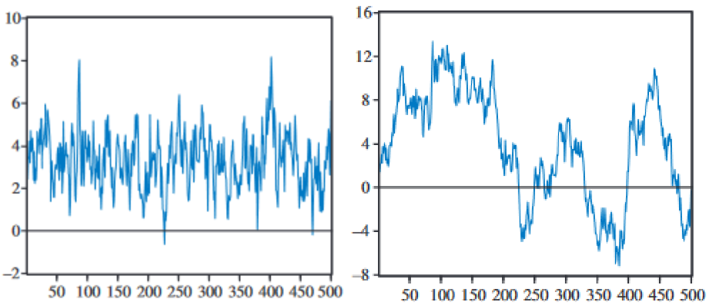
9 Appendices

Appendix 1: Example for ADF test with no constant and no trend



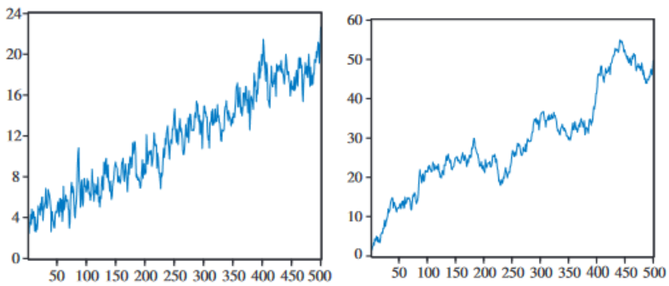
Source: Hill et al (2011)

Appendix 2: Example for ADF test with constant but no trend



Source: Hill et al (2011)

Appendix 3: Example for ADF test with constant and trend



Source: Hill et al (2011)

Appendix 4: Correlation matrix

	R (2 or 3)	R (4 or more)	R(flats)
Belgium			
R (ordinary)	0.9010***		
R (villas)		0.7823***	
R (Flats)			0.4240**
Wallonia			
R (ordinary)	0.5095***		
R (villas)		0.5332***	
R (flats)			0.3011
Brussels			
R (ordinary)	0.3996**		
R (villas)		0.7498***	
R (flats)			0.6586***
Flanders			
R (ordinary)	0.8847***		
R (villas)		0.5732***	
R (flats)			0.3771**

Notes:
** Significant at 5% level
*** Significant at 1% level

Source: our own calculations with Gretl

Appendix 5: ADF test for all types of inflation

	At level	1st difference
2011-2017		
AI	0.9503	0.0002***
EI	0.9263	0.0000***
UI	0.0076	0.0000***

Notes:
*** Significant at 1% level

Source: our own calculations with Gretl

Appendix 6: ADF test for returns based on old methodology from 2011 to 2017

	At level	1st difference
Belgium		
R (ordinary)	0.0000***	
R (villas)	0.0105**	
R (flats)	0.0037***	
Wallonia		
R (ordinary)	0.0058***	
R (villas)	0.0091***	
R (Flats)	0.0208**	
Brussels		
R (ordinary)	0.4322	0.0000***
R (villas)	0.0000***	
R (flats)	0.0128**	
Flanders		
R (ordinary)	0.0000***	
R (villas)	0.0001***	
R (flats)	0.0170**	

Notes:
** Significant at 5% level
*** Significant at 1% level

Source: our own calculations with Gretl

Appendix 7: ADF test for returns based on new methodology from 2011 to 2017

	At level	1st difference
Belgium		
R (2 or 3)	0.0000***	
R (4 or more)	0.0001***	
R (flats)	0.5315	0.0000***
Wallonia		
R (2 or 3)	0.2071	0.0000***
R (4 or more)	0.0003***	
R (flats)	0.0051***	
Brussels		
R (2 or 3)	0.0000***	
R (4 or more)	0.0254**	
R (flats)	0.0865	0.0000***
Flanders		
R (2 or 3)	0.0000***	
R (4 or more)	0.0061***	
R (flats)	0.0016***	

Notes:
R (2 or 3) = returns of houses with 2 or 3 facades
R (4 or more) = returns of houses with 4 or more facades
** Significant at 5% level
*** Significant at 1% level

Source: our own calculations with Gretl

Appendix 8: Regression results for actual inflation from 2011 to 2017 based on old methodology

Dependant variable	Constant	Actual inflation	Adjusted R^2	DW Statistics
Belgium				
R (ordinary)	0.0243***	1.3665	0.1053	1.9527
R (villas)	0.0187***	0.5765	0.1906	1.9485
R (flats)	0.0196***	0.1434	0.0390	2.0253
Wallonia				
R (ordinary)	0.0200***	2.7503***	0.3199	1.9532
R (villas)	0.0165**	0.2744	0.0764	1.8294
R (flats)	0.0233*	2.2923	0.1017	2.0543
Brussels				
R (ordinary)	−0.0014	−0.4414	0.0293	2.0349
R (villas)	0.0018	−3.5249	0.0329	1.9071
R (flats)	0.0310***	1.0526	0.1319	2.0378
Flanders				
R (ordinary)	0.0281***	1.4859	0.0537	2.0233
R (villas)	0.0165***	0.98642	0.1588	1.9278
R (flats)	0.0172*	0.4403	0.1109	1.9264

Notes:
* Significant at 10% level
** Significant at 5% level
*** Significant at 1% level
DW denotes Durbin-Watson statistics

Source: our own calculations with Gretl

Appendix 9: Regression results for actual inflation from 2011 to 2017 based on new methodology

Dependant variable	Constant	Actual inflation	Adjusted R^2	DW Statistics
Belgium				
R (2 or 3)	0.0241***	0.1693	-0.0277	1.9503
R (4 or more)	0.0191***	0.8257	0.0133	2.0119
R (Flats)	0.0004	0.6199	0.0478	2.0786
Wallonia				
R (2 or 3)	0.0002	0.7502	0.2647	2.2989
R (4 or more)	0.0185***	1.9754**	0.2347	2.0285
R (Flats)	0.0230***	−0.5335	0.0865	2.0854
Brussels				
R (2 or 3)	0.0332***	2.6484*	0.2418	2.0213
R (4 or more)	−0.0157	0.6783	0.1534	1.5810
R (Flats)	0.0010	0.7059	-0.0156	1.9784
Flanders				
R (2 or 3)	0.0273***	1.0861	0.0111	2.0418
R (4 or more)	0.0167***	1.4719**	0.2567	2.0381
R (Flats)	0.0255***	1.3277*	0.1015	2.2047

Notes
R (2 or 3) = returns of houses with 2 or 3 facades
R (4 or more) = returns of houses with 4 or more facades
* Significant at 10% level
** Significant at 5% level
*** Significant at 1% level
DW denotes Durbin-Watson statistics

Source: our own calculations with Gretl

Appendix 10: Regression results for expected and unexpected inflation from 2011 to 2017 based on old methodology

Dependant variable	Constant	Expected inflation	Unexpected inflation	Adjusted R^2	DW Statistics
Belgium					
R (ordinary)	0.0002	1.4272	1.1097	0.4506	2.9361
R (villas)	−0.0004	0.5659	1.2830	0.0934	1.94812
R (flats)	−0.0006	0.1925	0.1319	0.1205	2.1957
Wallonia					
R (ordinary)	0.0199***	3.4145***	−0.8417	0.3969	1.9979
R (villas)	0.0166**	0.2587	−0.3948	0.0384	1.8402
R (flats)	0.0232*	2.6871	−0.1608	0.0837	2.0298
Brussels					
R (ordinary)	−0.0014	−0.3710	−0.8601	-0.0122	2.0331
R (villas)	0.0019	−2.3845	−10.5836	0.0066	1.8982
R (flats)	0.0308	1.3250	−1.1311	0.1206	2.0385
Flanders					
R (ordinary)	0.0278***	1.5691	1.0876	0.0106	1.9666
R (villas)	0.0165***	0.9318	1.3478	0.1249	1.9092
R (flats)	0.0171*	0.5027	−0.0705	0.0740	1.9192

Notes:
*Significant at 10% level
** Significant at 5% level
*** Significant at 1% level
DW denotes Durbin-Watson statistics

Source: our own calculations with Gretl

Appendix 11: Regression results for expected and unexpected inflation from 2011 to 2017 based on new methodology

Dependant variable	Constant	Expected inflation	Unexpected inflation	Adjusted R^2	DW Statistics
Belgium					
R (2 or 3)	0.0241***	0.1129	0.5263	-0.0719	1.9487
R (4 or more)	0.0192***	0.4348	3.5407	0.0472	2.0317
R (flats)	0.0007	0.7302	0.3890	0.0217	1.8433
Wallonia					
R (2 or 3)	0.0003	1.3155*	−2.3359	0.3565	2.3448
R (4 or more)	0.0185***	1.8659**	2.7935	0.2103	2.0240
R (flats)	0.0229***	−0.3557	−2.0260	0.0667	2.0839
Brussels					
R (2 or 3)	0.0175*	0.8049	−0.5255	0.1023	1.9541
R (4 or more)	−0.0159	−0.1692	7.4888	0.1244	1.5895
R (flats)	0.0010	0.8566	−0.2527	-0.0518	1.9699
Flanders					
R (2 or 3)	0.0273	1.2625	−0.0398	-0.0229	2.0445
R (4 or more)	0.0167***	1.5277**	1.0727	0.2257	2.0208
R (flats)	0.0255***	1.2616	1.9992	0.0685	2.1974

Notes
R (2 or 3) = returns of houses with 2 or 3 facades
R (4 or more) = returns of houses with 4 or more facades
* Significant at 10% level
** Significant at 5% level
*** Significant at 1% level
DW denotes Durbin-Watson statistics

Source: our own calculations with Gretl

Appendix 12: Quarterly inflation rate based on HICP

	Mean	Median	Min	Max	Std. Dev
2011-2023					
AI	0.0247	0.0193	-0.0066	0.1126	0.0265
EI	0.0247	0.0191	-0.0066	0.1123	0.0265
UI	8.3462e-006	9.1500e-005	-0.0014	0.0009	0.0005

Source: our own calculations with Gretl

Appendix 13: ADF test for quarterly inflation rate based HICP

	At level	1st difference
2011-2023		
AI	0.0001***	
EI	0.0002***	
UI	0.0001***	
Notes *** Significant at 1% level		

Source: our own calculations with Gretl

Appendix 14: Results for actual inflation from 2011 to 2023 based on HICP

Dependant variable	Constant	Actual Inflation	Adjusted R^2	DW Statistics
Belgium				
R (2 or 3)	0.0247***	0.5697**	0.0882	2.2046
R (4 or more)	0.0026	−0.1168	0.3107	2.2487
R (Flats)	0.0013	−0.0551	0.1225	2.1061
Wallonia				
R (2 or 3)	0.0024	−0.1127*	0.2018	2.3481
R (4 or more)	0.0195***	0.4684**	0.2246	2.2274
R (Flats)	0.0013	−0.0676	0.2456	2.3220
Brussels				
R (2 or 3)	0.0260**	0.3932	0.1075	2.0455
R (4 or more)	0.0457	−0.7750	0.1341	2.0119
R (Flats)	0.0334***	0.0696	0.4066	2.2464
Flanders				
R (2 or 3)	0.0283***	0.4723***	0.0302	1.9874
R (4 or more)	0.0026	−0.1079	0.2418	2.2963
R (Flats)	−0.0001	−0.0033	0.4369	2.9848

Notes
R (2 or 3) = returns of houses with 2 or 3 facades
R (4 or more) = returns of houses with 4 or more facades
** Significant at 5% level
*** Significant at 1% level
DW denotes Durbin-Watson statistics

Source: our own calculations with Gretl

Appendix 15: Results for expected vs. unexpected inflation and economic cycles from 2011 to 2023 based on HICP

Dependant variable	Constant	Expected inflation	Unexpected inflation	High inflation	Recession	Adjusted R^2	DW Statistics
Belgium							
R (2 or 3)	0.0305***	0.5604*	1.3824	−0.0021	−0.0218	0.0717	2.1734
R (4 or more)	0.0035	0.0328	0.7221	−0.0124	0.0044	0.2978	2.2731
R (Flats)	0.0017	−0.0041	−1.4936	−0.0043	0.0014	0.0885	2.0853
Wallonia							
R (2 or 3)	0.0038	−0.1824**	4.4883	0.0049	−0.0088*	0.2252	2.3508
R (4 or more)	0.0182**	0.4399*	2.6150	0.0029	0.0036	0.1818	2.2522
R (Flats)	2.70e-05	−0.0930	0.4565	0.0027	0.0033	0.2028	2.3253
Brussels							
R (2 or 3)	0.0336***	0.3321	2.9106	0.0019	−0.0326*	0.1203	2.0407
R (4 or more)	0.0745	−0.9120	−24.7997	0.0015	−0.1202	0.1345	2.0009
R (Flats)	0.0320***	0.0863	3.9574	−0.0034	0.0115	0.3970	2.3362
Flanders							
R (2 or 3)	0.0316***	0.5117**	1.2694	−0.0047	−0.0097	0.0996	1.9622
R (4 or more)	0.0024	−0.1456	3.4888	0.0031	−0.0016	0.2023	2.3080
R (Flats)	−0.0002	−0.0076	−5.5722	0.0003	0.0006	0.4038	2.9958

Notes:
R (2 or 3) = returns of houses with 2 or 3 facades
R (4 or more) = returns of houses with 4 or more facades
*Significant at 10% level
** Significant at 5% level
*** Significant at 1% level
DW denotes Durbin-Watson statistics

Source: our own calculations with Gretl

Appendix 16: Quarterly inflation rate based on Health index

	Mean	Median	Min	Max	Std. Dev
2011-2023					
AI	0.02477	0.0183	0.0002	0.1117	0.0241
EI	0.0247	0.0191	-0.0066	0.1123	0.0265
UI	-6.7138e-006	0.0001	-0.0183	0.0301	0.0087

Source: our own calculations with Gretl

Appendix 17: ADF test for quarterly inflation rate based on Health Index

	At level	1st difference
2011-2023		
AI	0.7382	0.0000***
EI	0.0002***	
UI	0.0895*	

Notes
*Significant at 10% level
*** Significant at 1% level

Source: our own calculations with Gretl

Appendix 18: Results for actual inflation based on Health Index

Dependant variable	Constant	Actual Inflation	Adjusted R^2	DW Statistics
Belgium				
R (2 or 3)	0.0387***	0.7016	0.0054	2.0304
R (4 or more)	−0.0001	0.0413	0.2932	2.1916
R (Flats)	5.93681e-05	0.0699	0.1062	2.0808
Wallonia				
R (2 or 3)	−0.0003	0.1070	0.1589	2.2657
R (4 or more)	0.0318***	1.5092***	0.3494	2.1246
R (Flats)	−0.0002	−0.0233	0.2390	2.3095
Brussels				
R (2 or 3)	0.0350***	1.4355**	0.1643	2.0782
R (4 or more)	0.0183	3.2081	0.1246	1.8449
R (Flats)	0.0364***	0.4255	0.4249	2.2301
Flanders				
R (2 or 3)	0.0395***	0.2664	0.0119	2.0479
R (4 or more)	−1.78864e-05	0.0359	0.2089	2.2387
R (Flats)	−0.0002	0.0774	0.4378	2.9766

Notes
R (2 or 3) = returns of houses with 2 or 3 facades
R (4 or more) = returns of houses with 4 or more facades
** Significant at 5% level
*** Significant at 1% level
DW denotes Durbin-Watson statistics

Source: our own calculations with Gretl

Appendix 19: Results for expected vs. unexpected inflation and economic cycles from 2011 to 2023 based on Health Index

Dependant variable	Constant	Expected inflation	Unexpected inflation	High inflation	Recession	Adjusted R^2	DW Statistics
Belgium							
R (2 or 3)	0.0327***	0.3955	−0.8891	0.0013	−0.0205	0.0953	2.2654
R (4 or more)	0.0032	0.0548	0.1187	−0.0130	0.0043	0.2992	2.2737
R (Flats)	0.0021	−0.0303	−0.1430	−0.0036	0.0013	0.0978	2.0970
Wallonia							
R (2 or 3)	0.0047*	−0.2551***	−0.4002*	0.0066	−0.0079*	0.2668	2.4269
R (4 or more)	0.02188***	0.2618	−0.9930*	0.0047	0.0035	0.2192	2.1990
R (Flats)	0.0006	−0.1438	−0.2756	0.0040	0.0037	0.2125	2.3410
Brussels							
R (2 or 3)	0.0372***	0.1028	−1.2896	0.0057	−0.0298*	0.1539	1.9931
R (4 or more)	0.0994*	−2.0875	−6.2569	0.0165	−0.1239*	0.1676	1.9715
R (Flats)	0.0273**	0.2384	0.7602	−0.0036	0.0130	0.4031	2.2997
Flanders							
R (2 or 3)	0.0327***	0.4270*	−0.4526	−0.0029	−0.0090	0.1118	1.9946
R (4 or more)	0.0025	−0.1555	−0.0504	0.0033	−0.0012	0.1971	2.3019
R (Flats)	−0.0001	−0.0201	−0.0818	0.0006	0.0003	0.3992	2.9835

Notes:
R (2 or 3) = returns of houses with 2 or 3 facades
R (4 or more) = returns of houses with 4 or more facades
*Significant at 10% level
** Significant at 5% level
*** Significant at 1% level
DW denotes Durbin-Watson statistics

Source: our own calculations with Gretl

Appendix 20: Quarterly Inflation rate with lagged variables

	Mean	Median	Min	Max	Std. Dev
2011-2023					
AI	0.0256	0.0190	-0.0048	0.1108	0.0249
EI	0.0255	0.0192	-0.0036	0.1123	0.0262
UI	0.0001	-0.0001	-0.0116	0.0237	0.0061

Source: our own calculations with Gretl

Appendix 21: ADF test for quarterly inflation rate with one lagged variable

	At level	1^{st} difference
2011-2023		
AI	0.309	0.0001***
EI	0.0000***	
UI	0.0000***	

Notes
*** Significant at 1% level

Source: our own calculations with Gretl

Appendix 22: Results for actual inflation from 2011 to 2023 with lagged variables

Dependant variable	Constant	Actual Inflation	Adjusted R^2	DW Statistics
Belgium				
R (2 or 3)	0.0383***	1.2206*	0.0500	2.1048
R (4 or more)	−0.0002	0.0593	0.2935	2.1922
R (Flats)	3.46823e-05	0.0388	0.1030	2.0752
Wallonia				
R (2 or 3)	−0.0004	0.1860	0.1688	2.2201
R (4 or more)	0.0309***	1.1545***	0.2148	2.1321
R (Flats)	−0.0003	0.1864	0.2447	2.2949
Brussels				
R (2 or 3)	0.0341***	2.0036***	0.2559	2.1180
R (4 or more)	0.0160	1.0094	0.1004	1.8845
R (Flats)	0.0360***	0.3155	0.4175	2.2779
Flanders				
R (2 or 3)	0.0396***	0.9390**	0.0650	1.8133
R (4 or more)	−3.89510e-05	0.0891	0.2110	2.2227
R (Flats)	−0.00025	−0.0846	0.4378	2.9773

Notes
R (2 or 3) = returns of houses with 2 or 3 facades
R (4 or more) = returns of houses with 4 or more facades
** Significant at 5% level
*** Significant at 1% level
DW denotes Durbin-Watson statistics

Source: our own calculations with Gretl

Appendix 23: Results for expected vs. unexpected inflation and economic cycles from 2011 to 2023 with lagged variables

Dependant variable	Constant	Expected inflation	Unexpected inflation	High inflation	Recession	Adjusted R^2	DW Statistics
Belgium							
R (2 or 3)	0.0312***	0.4540	−0.7673	−0.0070	−0.0022	0.0001	2.0883
R (4 or more)	0.0314***	0.2247	−0.7249	−0.0093	0.0027	0.1100	2.2174
R (Flats)	0.0032	−0.1065	−0.1628	0.0014	−0.0053	0.1292	2.1581
Wallonia							
R (2 or 3)	0.0044*	−0.2657***	−0.4851	0.0071	−0.0059	0.2474	2.5428
R (4 or more)	0.0339***	0.2263	−1.8167**	−0.0164	−0.0007	0.2684	2.2127
R (Flats)	0.0014	−0.0038	−0.0671	−0.0055	0.0039	0.2073	2.2967
Brussels							
R (2 or 3)	0.0368***	−0.3193	−2.9375**	0.0220	−0.0121	0.1247	2.0008
R (4 or more)	0.1055*	−2.8197	−3.1809	0.0238	−0.0774	0.1420	1.9745
R (Flats)	0.0400***	0.1753	−0.3766	−0.0197**	0.0011	0.4482	2.2254
Flanders							
R (2 or 3)	0.0334***	0.4418*	−0.5195	−0.0068	−0.0057	0.0682	1.8566
R (4 or more)	0.0032	−0.0685	−0.0318	−0.0038	0.0009	0.2020	2.3112
R (Flats)	0.0005	0.0287	0.0298	−0.0036	0.0005	0.4012	2.9648

Notes
R (2 or 3) = returns of houses with 2 or 3 facades
R (4 or more) = returns of houses with 4 or more facades
* Significant at 10% level
** Significant at 5% level
*** Significant at 1% level
DW denotes Durbin-Watson statistics

Source: our own calculations with Gretl

Appendix 24: Quarterly property returns based on House Price index (HPI)

	Mean	Median	Max	Min	Std. Dev	Correlation with AI
2011-2023						
Belgium	0.0305	0.0319	0.0736	-0.0058	0.0191	0.4400***
Wallonia	0.0254	0.0246	0.0698	-0.0234	0.0698	0.4491***
Brussels	0.0362	0.0373	0.0974	-0.0134	0.0282	0.1418
Flanders	0.0306	0.0276	0.0780	-0.0025	0.0196	0.4733***

Note:
***Significant at 1% level

Source: our own calculations with Gretl

Appendix 25: ADF test for quarterly property returns based on House Price Index (HPI)

	At level (with constant)	1st difference
2011-2023		
Belgium	0.4570	0.0000***
Wallonia	0.2223	0.0000***
Brussels	0.5351	0.0015***
Flanders	0.3309	0.0000***

Notes
*** Significant at 1% level

Source: our own calculations with Gretl

Appendix 26: Results for actual inflation based on House Price Index (HPI)

Dependant variable	Constant	Actual inflation	Adjusted R^2	DW Statistics
2011-2023				
Belgium	−0.0002	0.0072	-0.0203	2.1121
Wallonia	−0.0002	0.1298	0.2280	2.1452
Brussels	−0.0005	−0.0279	0.0485	2.0227
Flanders	−0.0002	−0.0096	-0.0203	2.1036

Notes
DW denotes Durbin-Watson statistics

Source: our own calculations with Gretl

Appendix 27: Results for expected vs. unexpected inflation and economic cycles from 2011 to 2023 based on Housing Price Index (HPI)

Dependant variable	Constant	Expected inflation	Unexpected inflation	High inflation	Recession	Adjusted R^2	DW Statistics
2011-2023							
Belgium	0.0038**	−0.0703	−0.2109	−0.0038	−0.00215	0.1024	2.3651
Wallonia	0.0032**	−0.1490**	−0.4901**	0.0022	−0.0030	0.3356	2.4853
Brussels	0.0019	−0.0495	−0.1007	−0.0041	0.0027	0.0450	2.0387
Flanders	0.0043**	−0.0770	−0.2351	−0.0038	−0.0036	0.0869	2.2901

Notes
** Significant at 5% level
DW denotes Durbin-Watson statistics

Source: our own calculations with Gretl

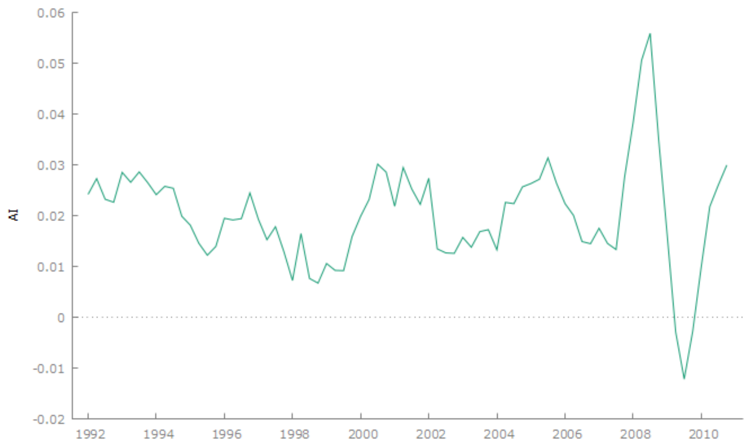
Appendix 28: ADF test for residuals based on House Price index returns

	P-value of the residuals
2011 – 2023	
Belgium	0.5252
Wallonia	0.3363
Brussels	0.7421
Flanders	0.3543

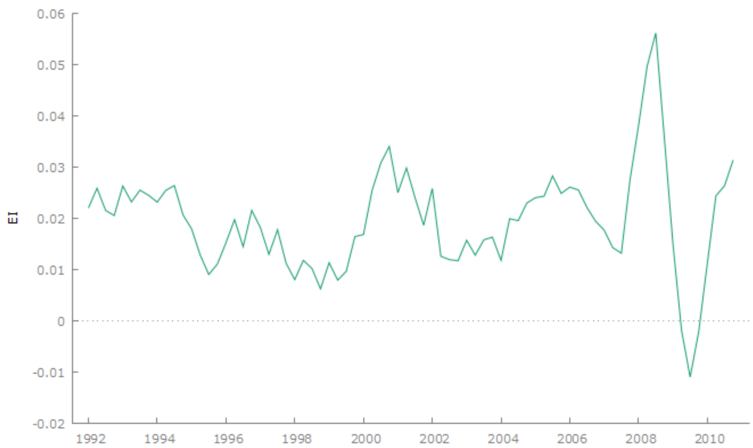
Source: our own calculations with Gretl

Appendix 29: Choice of the method for the ADF test for AI, EI, UI from 1992 to 2010

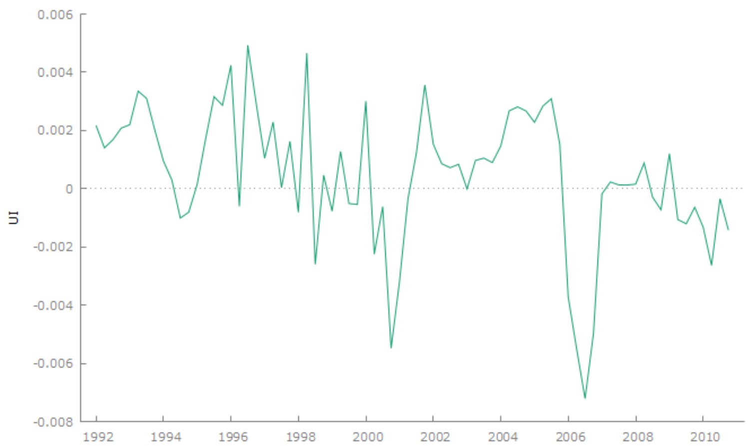
AI → with constant



EI → with constant

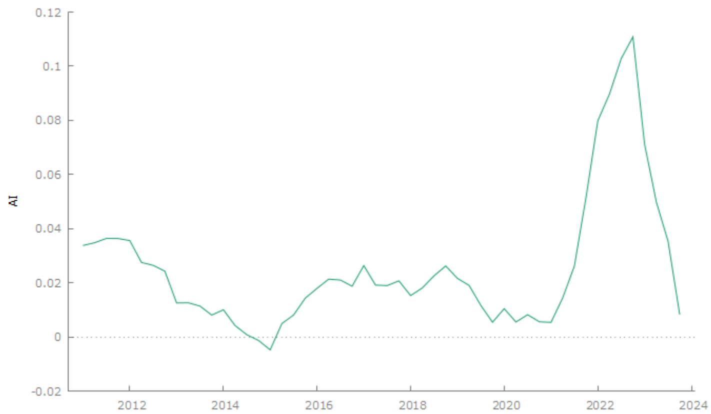


UI → without constant



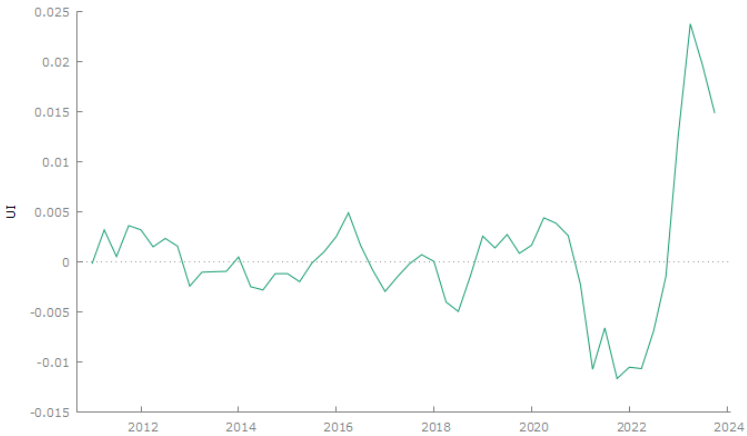
Appendix 30: Choice of the method for the ADF test for AI, EI, UI from 2011 to 2023

AI → with constant



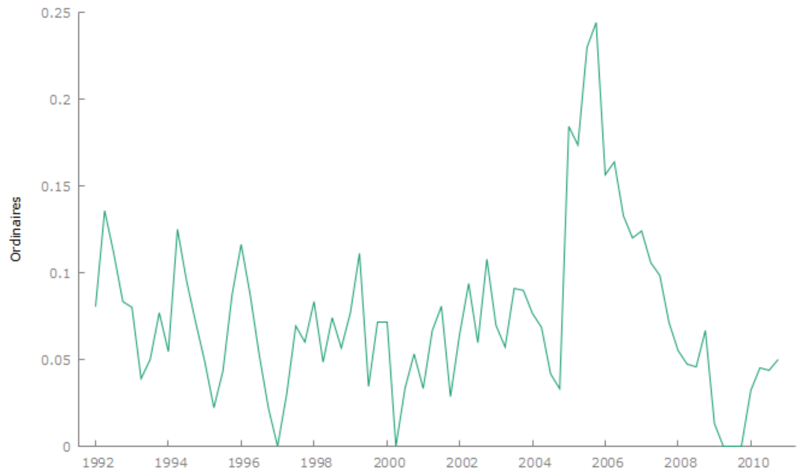
EI → with constant

UI → without a constant

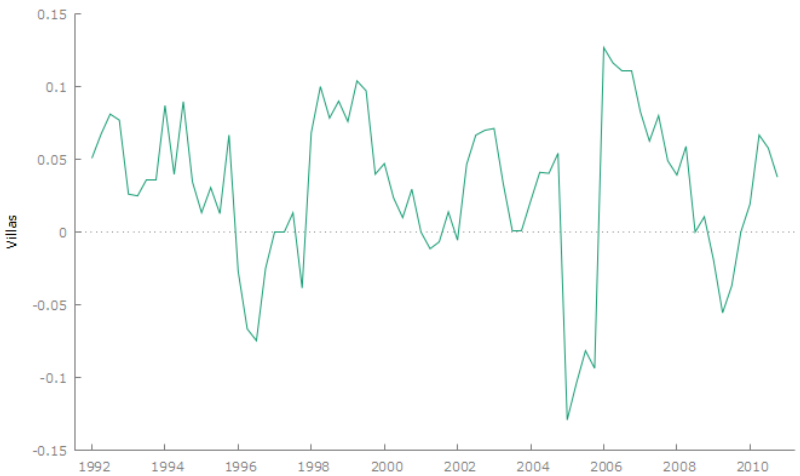


Appendix 31: Choice of the method for the ADF test for property returns from 1992 to 2010

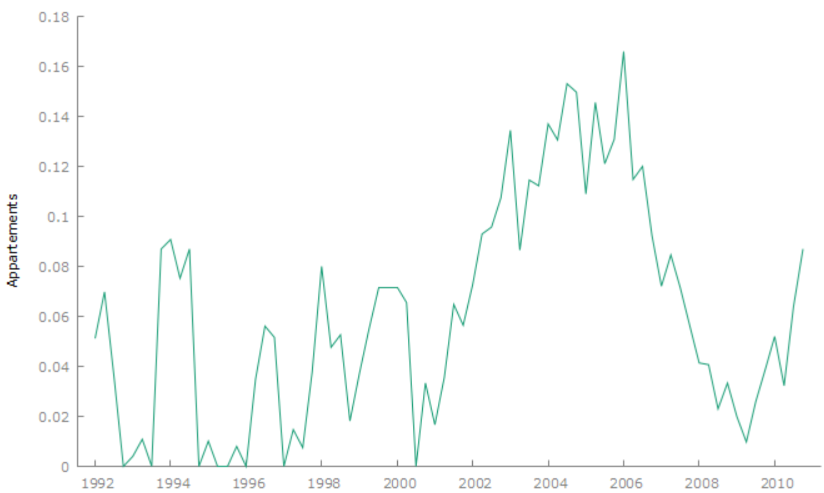
Ordinary (Belgium) → with a constant



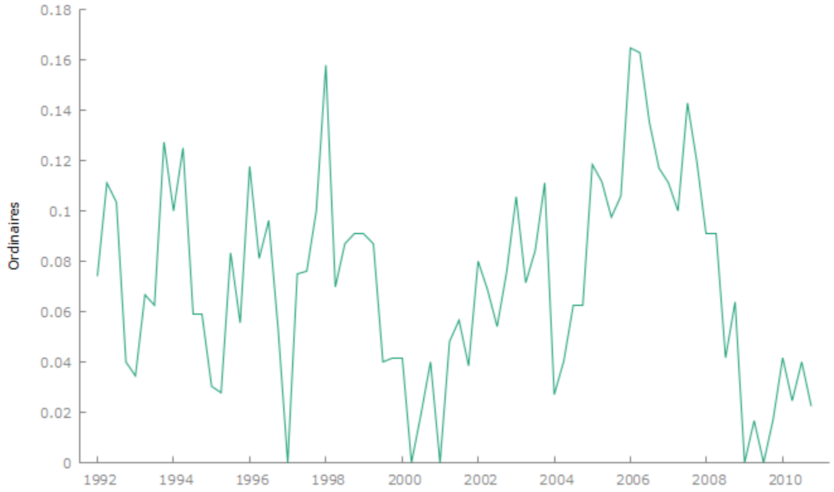
Villas (Belgium) → without a constant



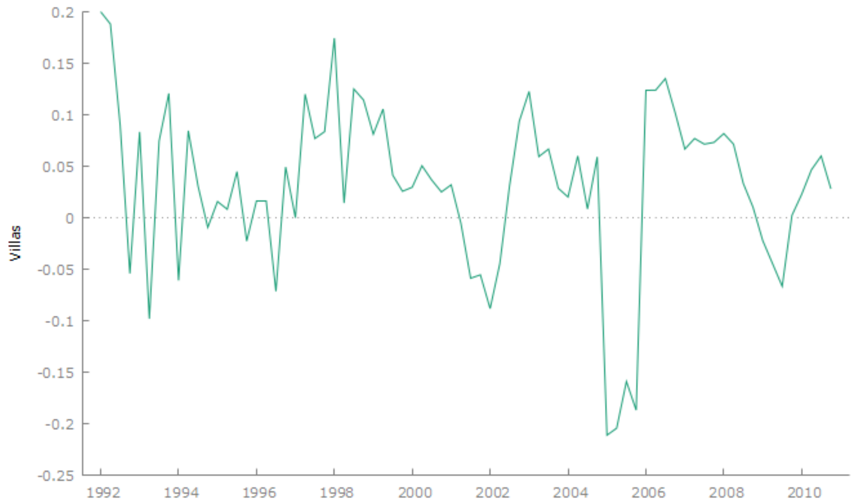
Flats (Belgium) → with a constant



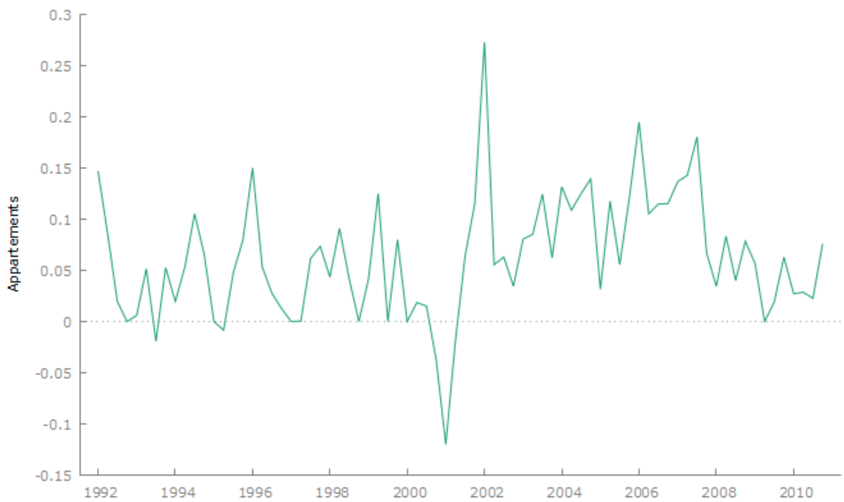
Ordinary (Wallonia) → with a constant



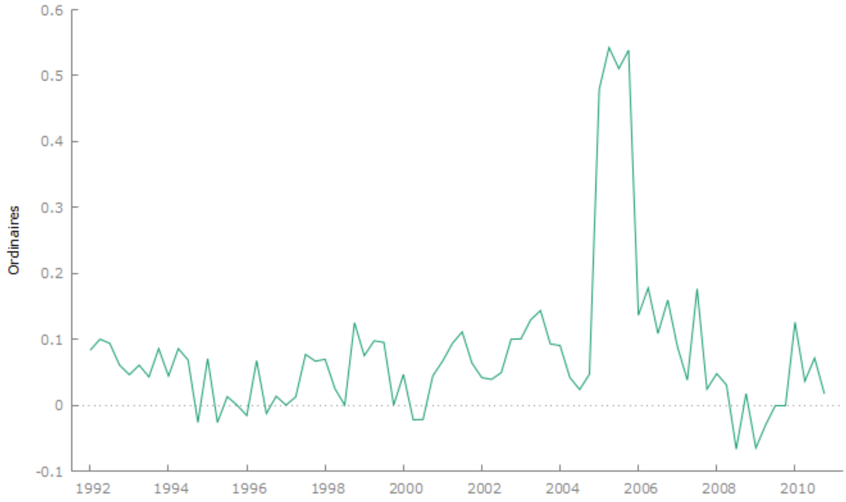
Villas (Wallonia) → without a constant



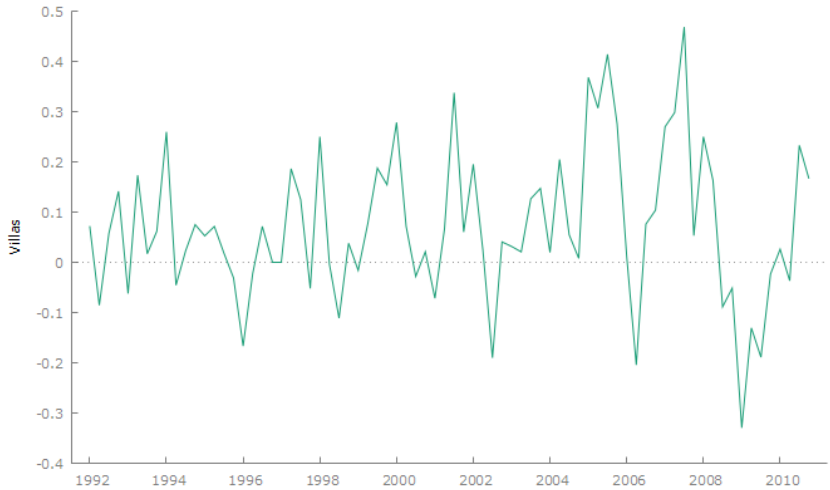
Flats (Wallonia) → with a constant



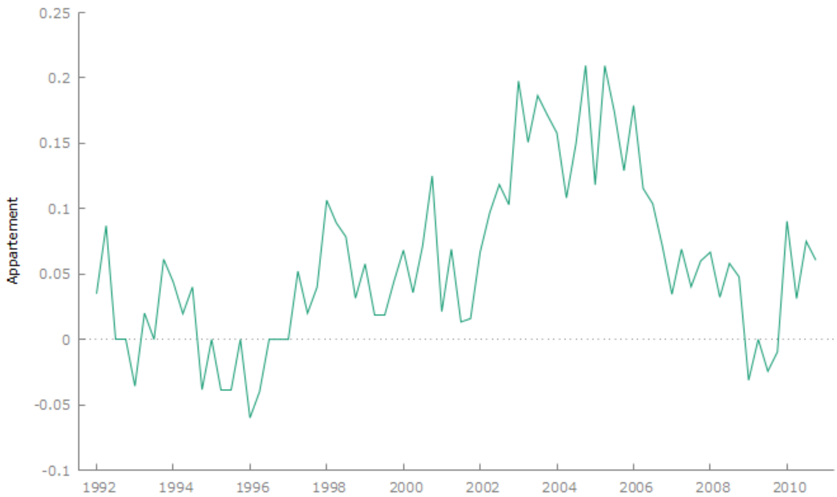
Ordinary (Brussels) → with a constant



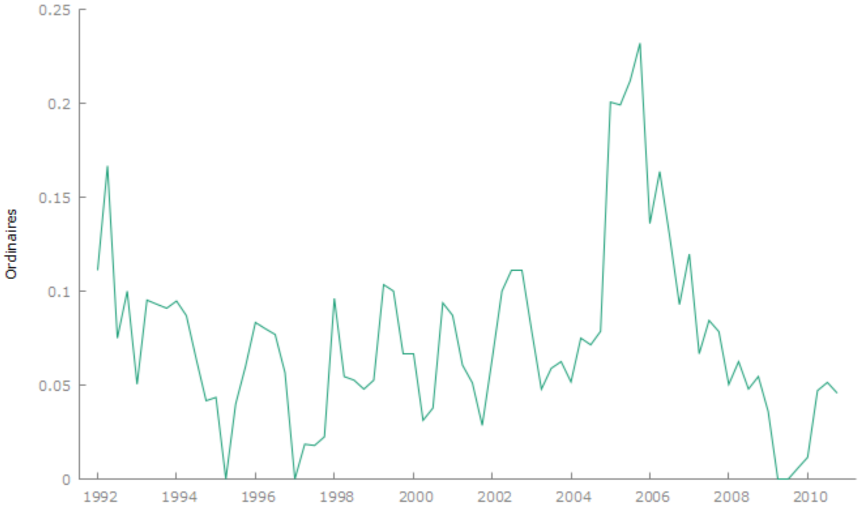
Villas (Brussels) → without a constant



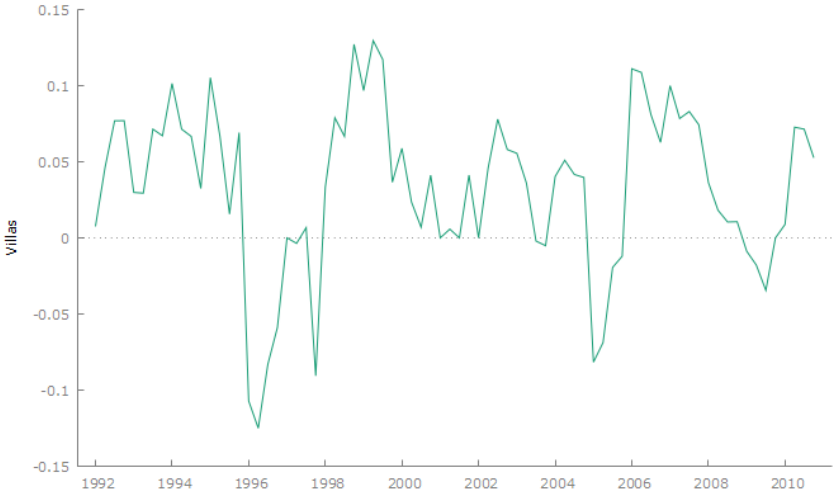
Flats (Brussels) → with a constant



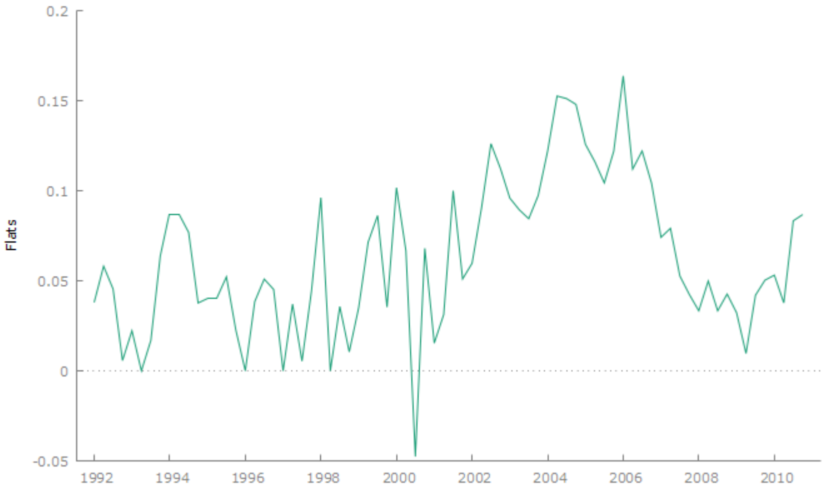
Ordinary (Flanders) → with a constant



Villas (Flanders) → without a constant

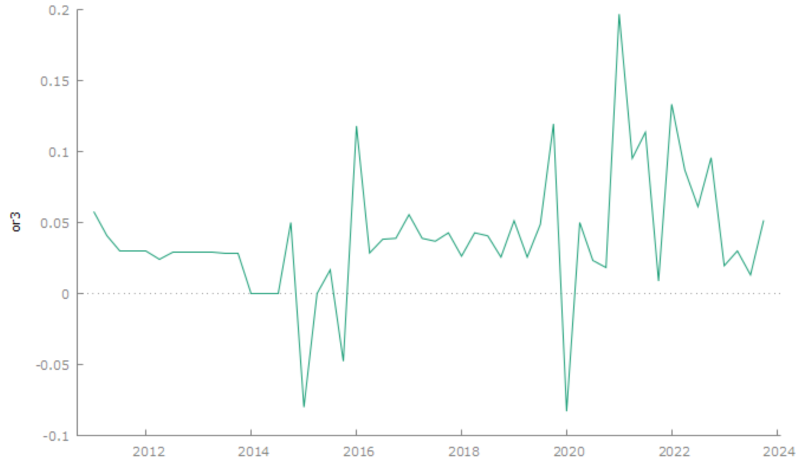


Flats (Flanders) → with a constant

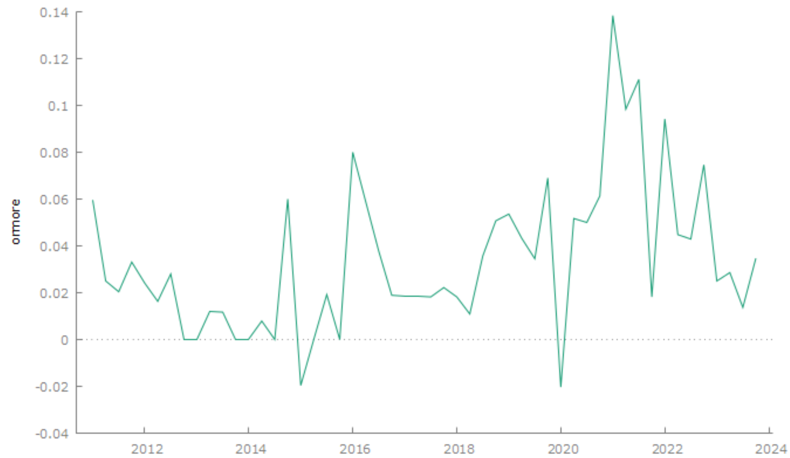


Appendix 32: Choice of the method for the ADF test for property returns from 2011 to 2023

2 or 3 facades (Belgium) → without a constant

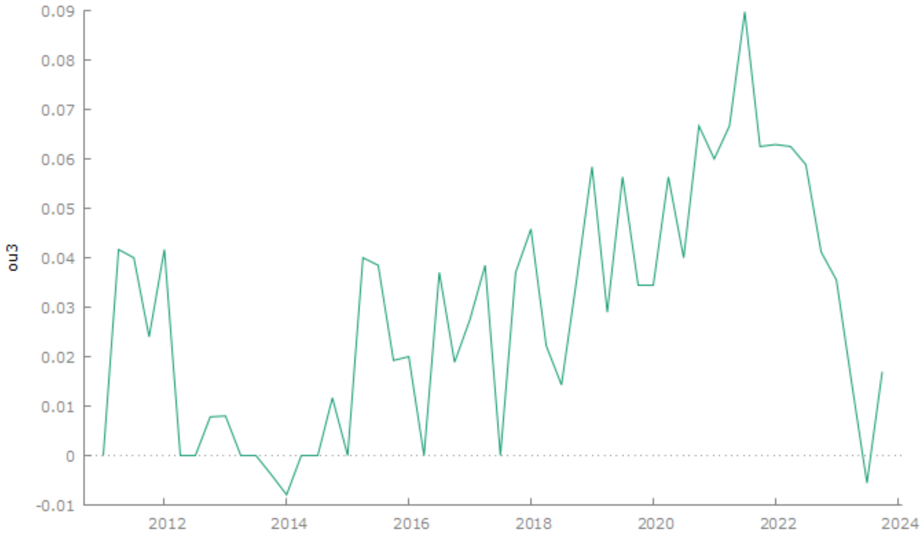


4 or more facades (Belgium) → with a constant

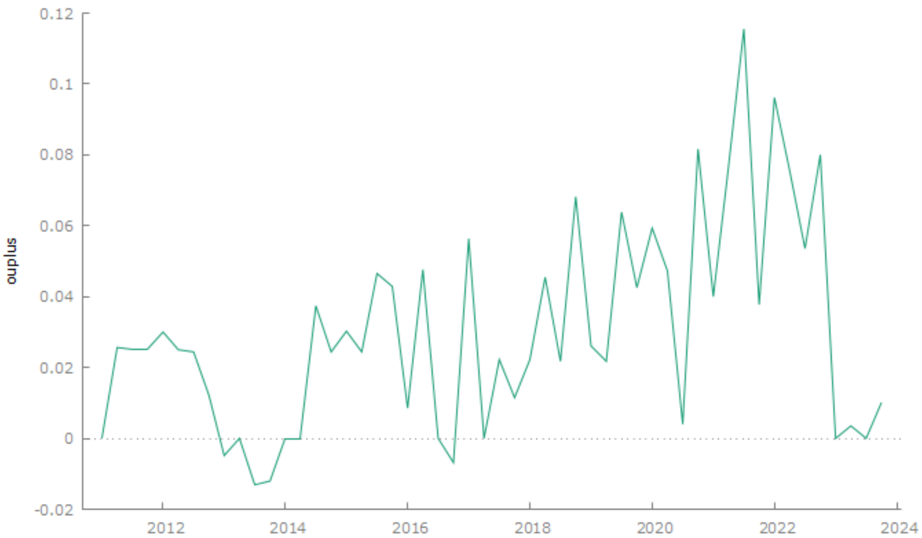


Flats (Belgium) → with a constant

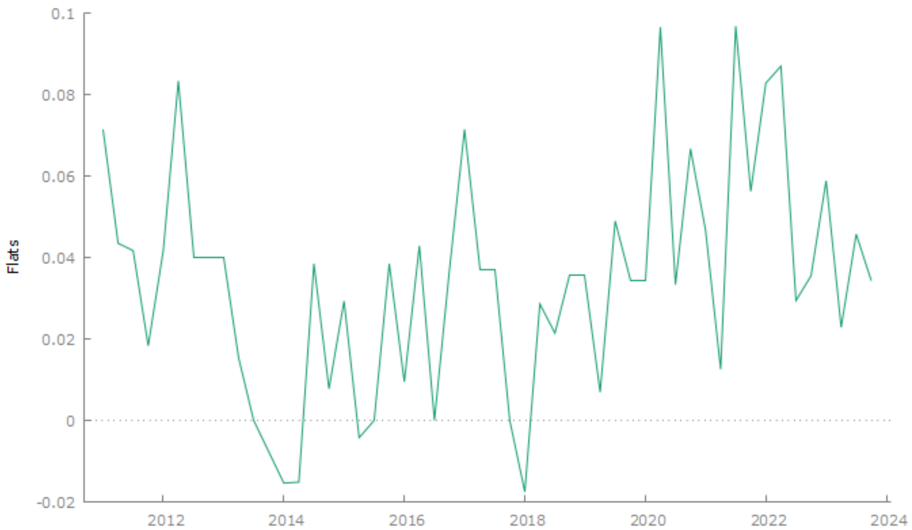
2 or 3 facades (Wallonia) → with a constant



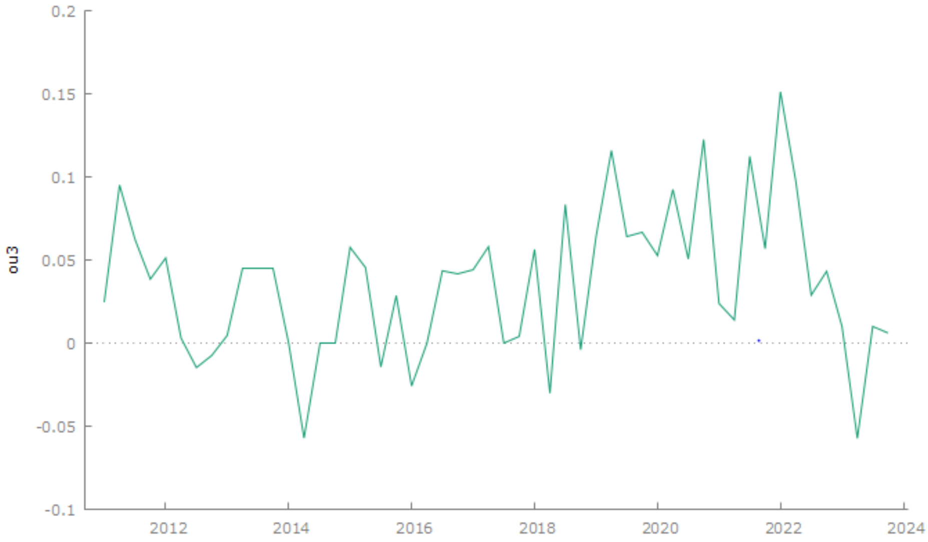
4 or more facades (Wallonia) → with a constant



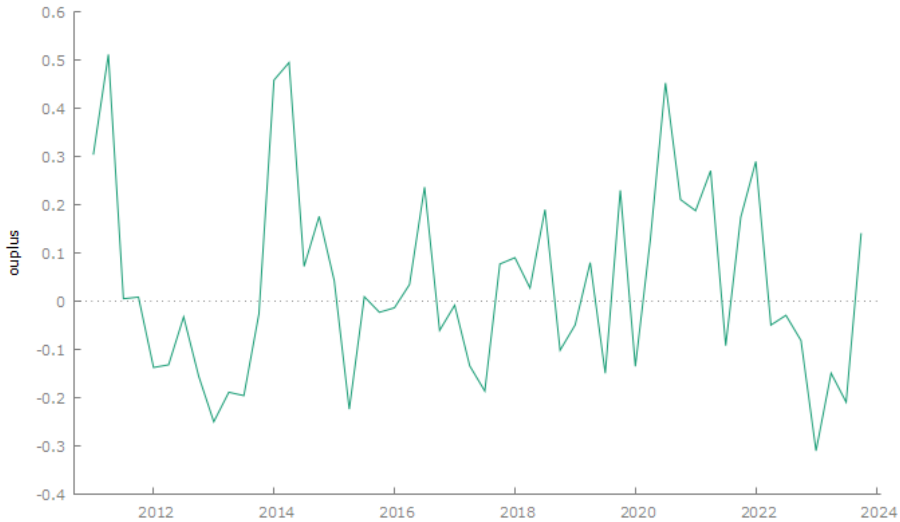
Flats (Wallonia) → with a constant



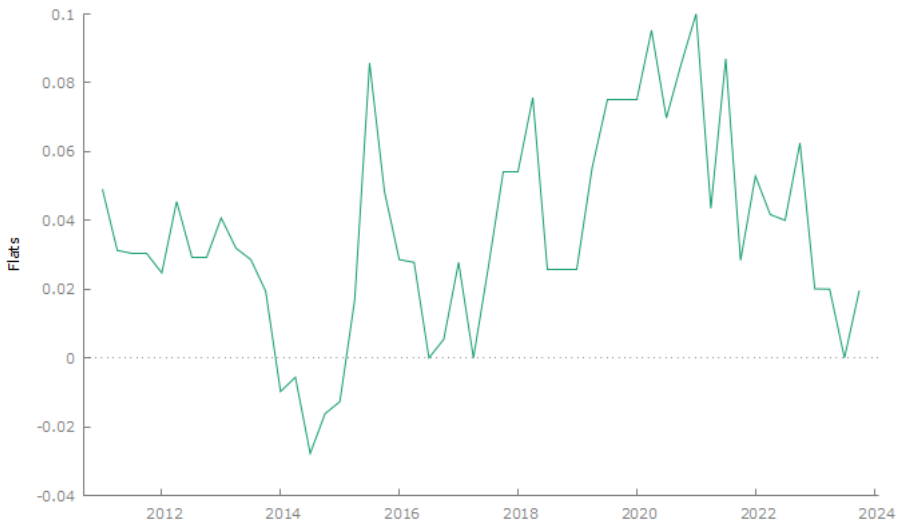
2 or 3 facades (Brussels) → with constant



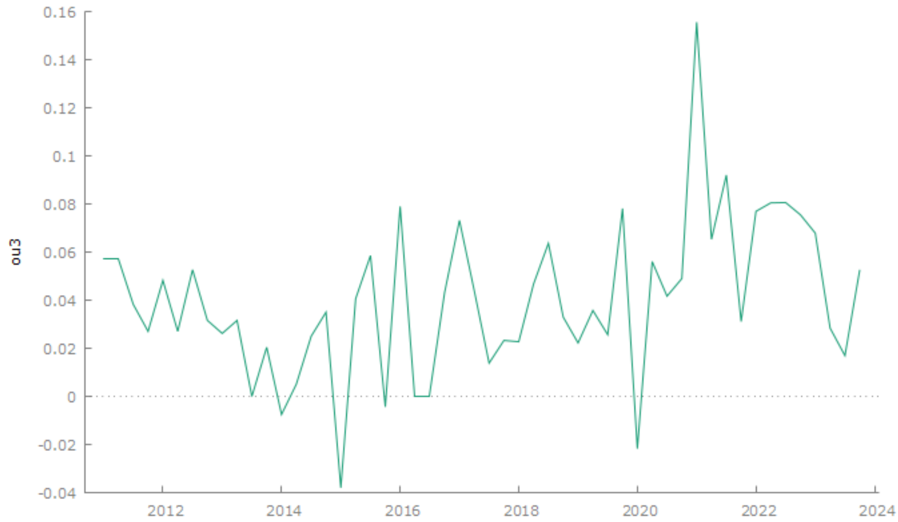
4 or more facades (Brussels) → without a constant



Flats (Brussels) → with a constant

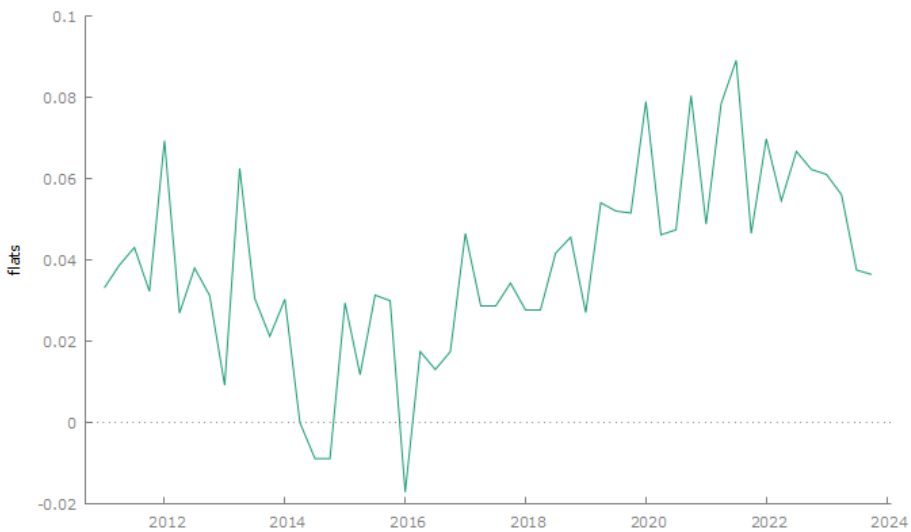


2 or 3 facades (Flanders) → with a constant



4 or more facades (Flanders) → with a constant

Flats (Flanders) → with a constant



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11 Executive summary

This study examines the potential of Belgian residential property to act as an effective hedge against inflation. Although property is often perceived as a safe investment capable of preserving the value of wealth in the face of economic fluctuations, this research fills an important gap in the literature by focusing specifically on the Belgian market, a subject that has been little explored until now.

The analysis covers data from 1992 to 2023, divided into two distinct periods: 1992-2010 and 2011-2023. Different econometric models have been used to assess the relationship between property yields and different types of inflation, actual, expected and unexpected. In addition, dummy variables were included to analyse the impact of periods of high inflation and recession. Robustness tests, including the Harmonised Index of Consumer Prices (HICP), the Health Index, the inclusion of lagged variables, as well as a cointegration test to analyse long-term relationships, were carried out to check the reliability of the results.

The results show that Belgian residential property is not always an effective hedge against inflation. This effectiveness varies according to the period, the region and the type of property studied. For the period 1992-2010, only flats in Brussels provide protection against actual inflation. And only villas in Wallonia offer protection against expected inflation. In contrast, for the period 2010-2023, houses with 2 or 3 facades in Brussels offer protection against actual inflation, while similar houses in Flanders offer protection against expected inflation. These observations suggest that the effectiveness of real estate as a hedge against inflation in Belgium is highly dependent on the temporal and regional context.

The robustness tests confirm several conclusions of the basic model, particularly with regard to the protection offered by houses in Flanders against expected inflation over the period 2011-2023. However, the inclusion of lagged variables in the analysis has revealed new dynamics, suggesting that the Belgian housing market may react with some delay to inflationary pressures.

This study makes a significant contribution to the existing literature by filling an important gap on the link between inflation and residential property in Belgium. It highlights the importance of taking into account regional differences and the potential impact of economic cycles on property yields. The results provide valuable insights for policymakers, investors and players in the Belgian property market, shedding light on the role of property as a hedge against inflation.

In conclusion, although residential property in Belgium does not offer universal protection against inflation, certain segments and regions show varying levels of protection. These results highlight the complexity of the property market and the need for further research to explore the nuanced relationships between inflation, economic cycles and property returns.

Word count = 18,956