CHARLES UNIVERSITY

FACULTY OF SOCIAL SCIENCES

Institute of Economic Studies

Commercial Real Estate Analysis for the CEECs during Unstable Times

Master's Thesis

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Year of the defence: 2024

Declaration

1. I hereby declare that I have compiled this thesis using the listed literature and resources only.
2. I hereby declare that my thesis has not been used to gain any other academic title.
3. I fully agree to my work being used for study and scientific purposes.

In Prague on 28.07.2024 Dávid Řeřicha

References

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Abstract

This thesis investigates the dynamics of commercial real estate markets in Central and Eastern European Countries (CEECs), with a particular focus on the period surrounding the COVID-19 pandemic. By employing a semi-structural model comprising equations for net take-up, rent, capital value, and credit supply, the study examines the overvaluation and undervaluation trends in office and industrial properties. The analysis is conducted using both cross-country and cross-property panel data, providing a comprehensive overview of market behaviors across different countries and property types. The findings reveal significant shifts in investment preferences and market valuations, particularly highlighting the consistent overvaluation of industrial properties and the undervaluation of office properties post-pandemic. These results underscore the lasting impact of the COVID-19 pandemic on the commercial real estate landscape in the CEECs, offering valuable insights for investors, policymakers, and stakeholders.

Keywords

Commercial real estate, CEECs, office properties, industrial properties, COVID-19, market valuation, panel data analysis, property price misalignment, semi-structural model, investment trends

Title

Commercial Real Estate Analysis for the CEECs during Unstable Times

Abstrakt

Táto diplomová práca skúma dynamiku trhu s komerčnými nehnuteľnosťami v krajinách strednej a východnej Európy (CEECs), so zvláštnym zameraním na obdobie okolo pandémie COVID-19. Použitím semi-štrukturálneho modelu pozostávajúceho z rovníc pre čistý odber, nájomné, kapitálovú hodnotu a ponuku úverov, práca analyzuje trendy nadhodnotenia a podhodnotenia kancelárskych a priemyselných nehnuteľností. Analýza je realizovaná s použitím panelových dát na úrovni krajín aj typov nehnuteľností, poskytujúc komplexný prehľad o správaní trhu naprieč rôznymi krajinami a typmi nehnuteľností. Výsledky odhaľujú významné zmeny v investičných preferenciách a trhových oceneniach, pričom najmä po pandémii zdôrazňujú konzistentné nadhodnotenie priemyselných nehnuteľností a podhodnotenie kancelárskych nehnuteľností. Tieto výsledky podčiarkujú trvalý vplyv pandémie COVID-19 na trh s komerčnými nehnuteľnosťami v CEECs, ponúkajúc cenné poznatky pre investorov, politikov a zainteresované strany.

Klíčová slova

Komerčné nehnuteľnosti, CEECs, kancelárske nehnuteľnosti, priemyselné nehnuteľnosti, COVID-19, trhové ocenenie, panelová analýza dát, nesúlad cien nehnuteľností, semi-štrukturálny model, investičné trendy

Název práce

Analýza komerčních nemovitostí v zemích střední a východní Evropy v nestabilních časech

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Master's Thesis Proposal

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Proposed Topic:

Commercial Real Estate Analysis for the CEECs during Unstable Times

Motivation:

Commercial real estate markets in Central Eastern European Countries (CEECs) have undergone significant transformations in recent years, influenced by various factors such as economic growth, geopolitical events, and financial stability risks. As these markets play a crucial role in driving economic development, it becomes imperative to comprehensively analyze and understand their dynamics to inform effective policy-making and investment decisions. By focusing on Commercial Real Estate Analysis for the CEECs, this research aims to bridge the existing knowledge gap and contribute to the literature on this subject. Previous studies have primarily emphasized the analysis of residential real estate markets, leaving a significant research void in understanding the complexities of the commercial sector. The existing evidence by Fessenden and Muething (2017) demonstrates greater volatility of commercial property prices compared to housing prices in advanced countries. Given the rising importance of commercial properties, such as office and logistics real estate, it is essential to delve deeper into their performance, resilience, and susceptibility to various market shocks.

Moreover, the availability of data during extraordinary events like the COVID-19 crisis and the war in Ukraine provides a unique opportunity to examine the impacts of these disruptions on commercial real estate markets. Hoesli and Malle (2022) highlights that COVID-19 has had a varying impact on different real estate sectors, emphasizing the increasing importance of asset type and location in their valuation, which adds a crucial dimension to our understanding of commercial real estate markets during such extraordinary events. According to a study by Gupta, Mittal, and Van Nieuwerburgh (2022), the Covid-19 pandemic and the shift to remote work have led to significant and lasting impacts on the commercial office sector in the United States, resulting in substantial declines in office values, particularly affecting lower quality office buildings, with far-reaching consequences for local public finances and financial sector stability. Given the substantial impact of remote work on the commercial office sector in the US, research aims to investigate whether a similar trend is observable in the commercial real estate markets of CEECs and assess its implications.

Which brings us to another unexplored field in academic literature, specifically the relationship between real estate prices and home office regulations, largely emerging as consequences following the COVID-19 crisis in CEECs. At the onset of the pandemic, Poland responded proactively by enacting a temporary 'covid law,' empowering employers to mandate remote work wherever feasible, which now evolved into a comprehensive regulation of remote work, in effect since April 7, 2023. On the other hand, Romania, prior to the pandemic and also during the crisis, recorded one of the lowest percentages of employed persons working from home in the European Union. As we delve into the study of regulatory dynamics and their connections with real estate markets, investigating these relationships holds the potential to reveal complex patterns that may influence the commercial real estate market in CEECs.

The outcomes of this research will not only enhance our understanding of the CEECs commercial property landscape but also provide valuable insights into the potential risks, misalignments, and policy measures necessary to ensure stability and sustainable growth. By presenting a thorough analysis supported by

empirical evidence and employment of a semi-structural model inspired by the work of Hlavacek et al. (2020), this research aims to provide a comprehensive framework for evaluating and managing commercial real estate risks in the CEECs.

Hypotheses:

1. Hypothesis #1: The COVID-19 crisis resulted in a decline in office commercial real estate prices due to the widespread adoption of home offices in CEECs.

2. Hypothesis #2: The rising interest rates in the past year have had a significant impact on the commercial real estate market in CEECs in both office and logistic commercial real estate sectors.

3. Hypothesis #3: Industrial properties demonstrated greater stability and resilience compared to office properties during the COVID-19 pandemic in CEECs.

Methodology:

The data for the analysis of the physical commercial property markets will be provided by JLL. In terms of coverage, the dataset will specifically focus on modern stock, encompassing offices and industrial properties. This will ensure that the analysis captures the trends and dynamics within the high-quality segments of the market. Regarding geography, the dataset will encompass the CEE capital cities, including Prague, Warsaw, Bratislava, Budapest, and Bucharest.

In the empirical part of my thesis, I will build upon the semi-structural model developed by Hlavacek et al. (2020) to analyze the commercial property market. This model accurately replicates the operations and interactions of different market segments, enabling separate examinations of office and industrial properties.

To estimate the empirical model and assess the hypotheses, advanced econometric methods and panel data techniques will be employed. These approaches take into account the specific characteristics of the data and build upon insights from existing literature. For instance, in addressing potential simultaneity issues highlighted by Freeman (1999), appropriate techniques will be employed to mitigate this concern. Additionally, considering the recommendation by Chintrakarn and Herzer (2012), panel cointegration analysis will be conducted to further enhance the validity of the findings.

Furthermore, to ensure the robustness of the results, additional appropriate robustness checks will be performed. These checks will involve testing the sensitivity of the estimated model to various specifications, alternative control variables, and potential data limitations.

Expected Contribution:

To contribute to the existing literature I will follow up on CNB working paper by Hlavacek et al. (2020) and I will enhance their analysis by incorporating the most relevant and recent data. This updated analysis will shed light on the effects of the COVID-19 crisis and the ongoing War in Ukraine on the commercial real estate market in CEE countries. By considering these significant events, we can assess the potential impacts on commercial real estate market prices missalingments.

Another substantial contribution emerges from evaluating the influence of regulatory changes in home office policies on the dynamic landscape of commercial real estate. The analysis of how these regulatory changes impact real estate prices offers a compelling path for academic investigation, providing valuable perspectives on the adjustments real estate markets undergo in response to these regulatory changes.

Furthermore, I propose to extend their semi-structural model by introducing an additional equation. This new part of the model will aim to investigate the relationship between commercial real estate loans, interest rates, and the influence of macroprudential policy tools on commercial real estate market. This innovative component of the model will provide valuable insights into the financial underpinnings of the commercial real estate sector in CEE countries. By including these variables, I intend to uncover how lending conditions

and regulatory measures shape investment decisions, asset prices, and market stability, thereby contributing to a more comprehensive understanding of the market's dynamics. By including these variables, we can gain insights into the role of lending conditions and regulatory measures in shaping the commercial real estate sector in CEE countries.

Outline:

1) Introduction: I will introduce the topic of the thesis and its contribution.
2) Literature Review: I will summarize the existing literature.
3) Data: I will describe how I will collect the key variables.
4) Methodology: I will explain the panel data techniques I will use to estimate the model and test the hypotheses. I will also comment on how I will check the robustness of the results.
5) Empirical Results: I will discuss the results of the estimation and evaluate the hypotheses.
6) Conclusion: I will provide concluding remarks along with potential areas for future research.

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1 Introduction

The commercial real estate market in Central and Eastern European Countries (CEECs) has experienced profound transformation over the past few decades. This sector, represented by office and industrial properties in our study, serves as a crucial indicator of economic health and stability in these markets. The importance of understanding the commercial real estate market in the CEECs cannot be overstated, as it not only reflects the economic conditions of the region but also influences global investment flows and financial stability.

Historically, the CEECs have been characterized by a rapidly evolving economic landscape, marked by transitions from centrally planned to market economies, integration into the European Union, and subsequent economic reforms (Roland, 2000). These changes have significantly impacted the commercial real estate market, influencing everything from property values and investment patterns to regulatory frameworks and market behavior. However, despite its importance, the academic literature on this sector remains relatively sparse compared to other regions, particularly in the context of the unique socio-economic and political conditions prevalent in the CEECs.

This thesis aims to fill this gap by providing a comprehensive analysis of commercial property price misalignments in the CEECs. The study employs a semi-structural model that closely mirrors the structure of the commercial real estate market, incorporating a range of variables such as credit supply, macroeconomic indicators, and investor sentiment. This approach not only builds on the foundational work of (Hlaváček, et al., 2020) but also introduces new dimensions to the analysis, particularly in understanding the role of credit availability in shaping property prices. The inclusion of credit supply as a variable is particularly relevant in the current economic climate, where the availability of financing has become a critical factor influencing real estate investment decisions.

The research methodology involves both cross-country and cross-property panel

analyses. The cross-country panel analysis examines the under- or overvaluation of commercial properties across multiple countries, offering insights into broader regional trends and the impact of macroeconomic factors. In contrast, the cross-property panel analysis focuses on individual countries, comparing the valuation dynamics of office and industrial properties. This dual approach allows for a more nuanced understanding of the market, highlighting how local and regional factors interplay in shaping property values.

A significant aspect of this study is its examination of the period marked by the COVID-19 pandemic. The pandemic has had an unprecedented impact on the global economy, with profound implications for the commercial real estate market. The thesis explores how the pandemic has influenced property values and investor behavior, providing a timely analysis of these effects. This thesis aims to contribute to the existing body of knowledge by offering a detailed and context-specific analysis of the commercial real estate market in the CEECs. By addressing the complexities of the CEECs market, the study seeks to provide a clearer understanding of the factors driving property price misalignments and the implications for future market developments.

In summary, this thesis not only enhances the understanding of the commercial real estate market in the CEECs but also offers a framework for analyzing similar markets in other regions. The comprehensive approach, incorporating both cross-country and cross-property analyses, ensures that the findings are robust and nuanced, providing a valuable resource for future research and discussions. The inclusion of recent data, particularly in the context of the COVID-19 pandemic, adds an important dimension to the study, highlighting the dynamic and evolving nature of the commercial real estate market.

This thesis is organized as follows: Chapter 2 reviews the relevant literature that forms the foundation of this research. Chapter 3 outlines the methodology, empirical framework, and dataset utilized. Chapter 4 presents, interprets, and thoroughly discusses the results of the analyses. Finally, the thesis concludes with a summary of the findings and their implications.

2 Literature review

The commercial real estate sector is crucial for the financial stability of many European Economic Area countries. Its significance stems from its considerable size and its intricate connections with both the financial system and the broader economy (European Systemic Risk Board, 2023). Despite its significant impact, the academic exploration of this sector remains relatively underdeveloped compared to residential real estate. Comprehensive studies and sophisticated theoretical models have long elucidated the dynamics between pricing and procyclical lending in residential markets. However, similar rigorous analyses are notably sparse for commercial real estate. This sector's critical role in financial stability underscores a glaring gap in our understanding. The limited research available fails to fully explain the complex interplay between commercial real estate and financial stability, highlighting an urgent need for more focused academic inquiry to bridge this knowledge gap. This chapter aims to review the existing literature, shedding light on what is known and identifying areas where further research is desperately needed.

Understanding the interconnections between residential and commercial real estate can provide deeper insights into the shared and distinct factors influencing both markets. Gyourko (2009) investigates the interconnectedness of residential and commercial property prices, proposing that both sectors are influenced by common demand determinants. Data represented by 32 US districts were utilized. The study reveals that market cycles in both sectors share common elements. Urban economics suggests that similar factors impact both real estate markets, leading to comparable performance patterns. Nevertheless, the unique aspects of the housing market can result in more volatile price fluctuations. The analysis indicates a significant correlation, nearly 40%, in appreciation rates between owner-occupied housing and commercial real estate. Both sectors exhibit similar trends in price appreciation over time, characterized by short-term persistence and long-term mean reversion.

Lieser and Groh (2011) analyze the factors influencing investment activity in the

commercial real estate sector across a diverse panel of 47 countries from 2000 to 2009, including Central Europe region. They identify 66 different variables impacting investment, encompassing economic and demographic indicators, property market development metrics, capital market depth, legal system quality, investor protection mechanisms, administrative and regulatory constraints, as well as sociocultural and political conditions. Through panel regression analysis, the study concludes that GDP growth, high urbanization levels, and population growth positively affect commercial real estate investment. Conversely, investment is hindered by legal system transparency issues, administrative hurdles, sociocultural challenges, and political instability.

Plazzi, Torous and Valkanov (2010) explored the variability in expected returns and rent growth rates in the commercial real estate market using data from various U.S. metropolitan areas. Their research revealed that a significant part of the fluctuations in actual returns and rent growth could be linked to differences in their anticipated values. The cap rate, which is the ratio of rent to price in commercial real estate, effectively captures expected return variations for certain property types, such as apartments, retail, and industrial properties, but is less effective for office properties. Factors like population density and land-use regulations influence rent growth predictability, with more consistent predictability seen in densely populated areas with strict land-use policies.

In the paper by Hlaváček, et al. (2020), which serves as the main inspiration for this thesis, the authors developed a semi-structural model to estimate the misalignment of commercial property prices, specifically focusing on office and industrial properties. This model is applied to a unique dataset provided by JLL, covering five CEE countries and Germany. Key findings include a notable tendency among investors to orient towards specific property types rather than specific countries, suggesting potential market segmentation. The study reveals significant misalignments in commercial property prices, varying between the office and industrial sectors but sharing a correlated trend. By avoiding the end-point bias common in traditional filtering methods like the HP filter, the analysis provides a more accurate picture of price misalignment.

Numerous studies have aimed to estimate the price misalignment for specific property types or the overall commercial real estate market. Hlaváček, Novotný and Rusnák (2016), for example, modeled equilibrium prices for office properties in six Central and Eastern European (CEE) countries, considering macroeconomic factors, demographic determinants,

and structural components. Using an error-correction model across capital cities, their results highlighted the significant roles of both demand represented by GDP and consumer prices and supply factors mostly in available office space in shaping property price dynamics.

To facilitate a comparative analysis between the commercial real estate market and the residential real estate market, we refer to the research conducted by Cuestas, Kukk and Levenko (2022), which explores house price misalignments and their repercussions on the real economy. Using data spanning from 2005 to 2018 and employing dynamic OLS for a panel of European countries, the research explores the long-term connection between house prices and their foundational determinants. Income stands out as the main influence on house prices in all examined countries, while the availability of housing serves as a moderating factor in some areas. The study calculates house price misalignments, representing deviations from fundamental values, and integrates them into a growth model. The growth regression results indicate that short-term imbalances in house prices amplify business cycles, while long-term overvaluations impede economic growth. The study underscores the significance of implementing measures to stabilize housing cycles.

For full understanding of the dynamics of real estate market movements, it is essential to also include the residential real estate sector. Huynh-Olesen, et al. (2013) explore the notable fluctuations in residential property prices in emerging markets, with a particular emphasis on Central, Eastern, and Southeastern European (CESEE) countries from 1999 to 2011. Utilizing a cointegration framework within an unbalanced panel, they analyze the relationship between residential property price movements, economic fundamentals, and transition-specific factors. The study reveals that demand-side fundamentals, such as disposable income, interest rates and population along with transition-related factors like remittances and credit growth, significantly influence housing demand. Additionally, supply-side elements such as construction costs are crucial in shaping residential property prices. Despite this, these factors do not entirely account for the price movements observed, indicating that house prices often exceeded the levels suggested by these determinants in the years leading up to the 2008 financial crisis. The subsequent sharp correction during the crisis period rectified these overextensions, bringing house prices back to, and occasionally below, the levels indicated by the explanatory variables. This suggests that as economic conditions improve, residential property prices are likely to rebound.

To identify potential misalignments in commercial property markets, the ECB (2011)

proposes a unique methodology that involves comparing commercial property values with macroeconomic variables and aggregate data. This approach uses two comprehensive sets of indicators computed for euro area countries. The first set examines commercial property values in relation to macroeconomic conditions, using variables such as GDP, consumption, and employment. These variables serve as proxies describing economic conditions that significantly influence the demand for commercial properties, especially in the retail and office sectors. The second set of indicators includes rents and initial yields describing the future income streams. This framework broadly aligns with a standard dividend-discount asset-pricing model, providing insights into the income-generating potential of commercial properties. By leveraging macroeconomic benchmarks and property-specific data, this method offers a multifaceted analysis that considers both demand-driven factors and income-related indicators to detect potential misalignments in commercial property values. The measures of misalignment indicate that the decline in commercial property values across most euro area countries since 2007 has significantly reduced the average overvaluation in these markets.

To comprehensively understand the commercial real estate, it becomes crucial to identify the primary factors serving as key determinants influencing commercial real estate (CRE) prices. Hagen and Hansen (2018) studied the factors influencing the dynamics of CRE prices, particularly the drivers leading to upward trends followed by sharp declines. Focusing on the prime office segment across 58 European cities, the study identifies turning points in CRE and dissects the components of CRE prices into rents and yields. The findings of authors reveal a distinct pattern in the drivers of CRE prices during different periods. Between 1980 and 2003, the surge in rents emerged as the primary force propelling the ascent of CRE prices. Conversely, from 2004 to 2016, the primary influence shifted to the reduction in CRE yields. This notable decrease was partly due to a broader downward trend in European CRE yields that began before the global financial crisis.

Study by Davis and Zhu (2011) explored the determination of prices of commercial properties and their intricate relationship with bank lending. The model proposed by the authors emphasizes the close association between lending activities and prices, suggesting the potential cycles development in property markets under plausible assumptions. This theoretical framework aligns with the empirical analysis, which, when applied cross-country, validates the model's predictions. Notably, the study reveals robust connections

between property prices and credit, particularly in nations that underwent banking crises associated with property losses during the period of 1985–1995.

2.1 Unstable times

Roulac (1996) underscores the critical importance of discerning market cycles, transformation forces, and structural changes. Effective management of real estate portfolio hinges on strategies that distinguish cyclic phenomena from transformative societal forces and profound structural shifts. Author's insights form a foundational framework for comprehending the challenges and opportunities inherent in the dynamic landscape of real estate during unpredictable and unstable times.

Extensive studies have investigated the interplay between stock and bond market returns and macroeconomic phenomena, such as interest rate changes, inflation, and industrial output, particularly during times of economic instability. Ling and Naranjo (1997) explore how these macroeconomic elements impact real estate returns. Their research highlights that factors like the growth rate of real per capita consumption, the real T-bill rate, the term structure of interest rates, and unexpected inflation play crucial roles in determining real estate returns. Notably, they discover a significant and consistent risk premium associated with consumption, which challenges earlier studies that did not consider consumption when analyzing the risk-adjusted performance of real estate.

Levitin and Wachter (2013) shed light on a critical yet overlooked aspect of the pre-2008 financial landscape—the origin of the real estate bubbles in the United States. While substantial attention has been directed towards the residential real estate bubble, the authors contend that the commercial real estate bubble has been disproportionately neglected. Their analysis identifies a unique characteristic of the commercial real estate bubble, which is a notable change in the way financing is structured within the market.

In the period around the global financial crisis of 2008, the volatility of equity real estate investment trusts (REITs) share prices was greater than that of the underlying commercial real estate prices. A study by Sun, Titman, and Twite (2015)investigates the variation in REIT returns during this time, focusing on how their capital structures influenced these returns. Authors used the debt ratio and the maturity structure of the debt as a key variable. The study separates the effects of pure leverage from those of financial distress. The results

indicate that REITs with higher debt-to-asset ratios and shorter debt maturities underwent more severe share price declines during the crisis period from 2007 to early 2009. This suggests that leverage and the costs associated with financial distress played a significant role in amplifying the price declines.

Deghi, Mok and Tsuruga (2021) highlighted the profound impact of the COVID-19 on the commercial real estate (CRE) sector has raised significant concerns regarding its potential repercussions for macro-financial stability. Addressing these concerns, the authors employ a novel methodology to quantify vulnerabilities within the CRE sector, revealing an overvaluation of CRE prices in several major advanced economies during the first quarter of 2020. This overvaluation not only signals the potential for future corrections in CRE prices but also amplifies downside risks to future GDP growth.

In their compelling study, Rosentahl, Strange, and Urrego (2022) explore how firms assess the value of city center access and examine the impact of COVID-19. Pre-COVID-19 rent prices exhibited a 2.3% decline per mile from the city center and an 8.4% increase with doubled employment density across 89 U.S. districts. Post-COVID, the rent gradient in transit cities decreased by approximately 15%, along with a diminished premium for proximity to transit stops. Contrarily, car-oriented cities did not show a corresponding decline. The extra rent charged in areas with high employment density significantly dropped after the COVID-19 pandemic, indicating important changes in preferences for commercial real estate.

Similarly, Allan, Liusman, Lu, and Tsang (2021) investigate the recent effects of the COVID-19 pandemic on commercial property rent trends in the Asia–Pacific region. Using up-to-date proprietary data, their study reveals significant rent reductions of about 15% in the first half of 2020 across the Asia–Pacific commercial real estate market. The steepest declines were seen in areas hardest hit by the pandemic, especially in the retail property sector, where rents dropped by over 30% with minimal recovery by the second quarter of 2020.

Hoesli and Malle (2022) highlights that COVID-19 had a diverse effect on various real estate sectors, emphasizing the increasing importance of asset type and location in their valuation, which adds a crucial dimension to our understanding of commercial real estate markets during such extraordinary events. According to the authors, the COVID-19 pandemic significantly affected retail and hospitality properties, with office buildings also

impacted but to a lesser extent. In contrast, the residential and industrial sectors faced relatively minor disruptions compared to the other sectors. The authors contend that the future price trends will exhibit divergence across sectors, emphasizing that the valuation of assets will increasingly hinge on their type and location.

The study by Wang and Zhou (2023) constructs three novel measures of FTF interactions: tenant remote working capability, internal communication (teamwork), and external communication (customer contact). The COVID-19 pandemic served as an exogenous shock to these interactions, providing a unique opportunity to assess their impact on CRE performance. The study finds that properties with tenants more resilient to social distancing, typically those with better remote working capabilities, performed better during the pandemic. Conversely, properties dependent on customer contact suffered more significant disruptions. The research highlights the nuanced effects of FTF interactions on CRE markets, emphasizing the importance of considering both internal and external communication dimensions in assessing tenant resilience and property performance.

According to a study by Gupta, Mittal, and Van Nieuwerburgh (2022), the Covid-19 pandemic and the shift to remote work have led to significant and lasting impacts on the commercial office sector in the United States, resulting in substantial declines in office values, particularly affecting lower quality office buildings.

2.2 Monetary policy and macroprudential regulation

In the real estate market, the movement of interest rates and monetary policy influence property values, investment patterns, and overall market stability. The meta-analysis by Ehrenbergerová and Bajzík (2020) is focused on phases characterized by reduced interest rates and excessively heated housing markets. Authors conduct a comprehensive review of the empirical literature on this subject. Their analysis encompasses 1,447 estimates derived from 31 studies, employing vector autoregression models. The findings indicate that, on average, a one-percentage-point increase in interest rates leads to a median decrease in house prices of 0.7 percent for the one-year horizon and 0.9 percent for the two-year horizon. Additionally, the study reveals that, even at the medium-term horizon related to monetary policy and considering the possibility that the results reported in the literature may be

influenced by publication bias, the impact still proves to be substantial.

Within the framework of macroprudential regulation, Bassett and Marsh (2016) offer an insightful analysis of the effects of federal guidance introduced in the United States in January 2006. This directive mandated that banks with substantial levels of commercial real estate (CRE) loans implement enhanced managerial controls. The study's findings indicate that banks exceeding the specified CRE thresholds exhibited significantly slower growth in their CRE portfolios, beyond what could be explained by bank-specific factors or overall economic conditions. Additionally, these banks showed reduced growth in commercial and industrial loans, but experienced accelerated growth in household loans following the regulatory guidance.

On the other hand, the study by Davis and Zhu (2009), which examines the interplay between commercial property price movements and individual bank behavior across industrialized economies, it is evident that the dynamics of commercial real estate (CRE) extend their influence to the banking sector. The study reveals positive links between commercial property prices and both profitability and bank lending, while highlighting negative correlations with net interest margins and bad loan ratios. These findings underscore the complex interrelationships between the real estate and financial sectors.

Whitley and Windram (2003) propose a quantitative framework for analyzing the UK commercial property sector's implications for financial stability and the broader corporate sector. The authors construct a model combining econometric analysis of rental values and bank lending with a calibrated financial accounts model for real estate companies. Empirical results reveal the significance of borrowing costs in the bank lending equation post-1999, shedding light on the systematic underestimation of lending growth without their inclusion. While the rental equation remains stable, the model's historical tracking performance is attributed to shifts in discount rates during the early 1990s. The paper emphasizes the property sector's connection to the broader corporate sector through collateral, offering insights into the sensitivity of real estate companies to macroeconomic shocks and their potential impact on the financial health of the overall corporate sector.

2.3 Regulatory challenges

Examining the transformative impact of home office on the commercial real estate

market, Bergeaud, Eyméoud, Garcia, and Henricot (2023) shed light on how market participants adapt to this paradigm shift. Through the development of a comprehensive index gauging teleworking exposure in French counties, considering both capacity and deployment frictions, the study unveils that in areas more exposed to telecommuting, the valuation of offices experienced a decline—a phenomenon not replicated in the retail asset domain. Furthermore, the research establishes that telecommuting correlates with increased vacancy rates, reduced construction activity, while transaction volumes remain unaffected. This suggests a shift in demand for space as the primary driver behind the observed price drop. Notably, the findings imply a sustained impact of teleworking on the demand for office space, underscoring market participants' anticipation of a lasting transformation in workspace dynamics.

In recent years, the evolving landscape of commercial real estate in Central and Eastern European Countries (CEECs) has been shaped by a confluence of regulatory challenges, particularly in response to unprecedented events such as the COVID-19 crisis. This period has witnessed a paradigm shift in the dynamics of home office regulations, with countries like Poland and Romania exemplifying distinctive approaches.

Poland, for instance, responded assertively with a temporary 'covid law,' empowering employers to mandate remote work during the pandemic, which has now evolved into a comprehensive regulation of remote work. In a pre-pandemic landscape, Radziukiewicz (2021) provides insights into the remote work landscape in Poland. In 2018, the share of employees with remote work options was below the EU average at approximately 4.6%. However, by 2020, a notable shift occurred, doubling the percentage to 8.9% in Poland. Examining the 1st quarter of 2021, sectors such as IT (66.8%), education (45.9%), financial and insurance services (36.1%) emerged as leaders in remote work adoption. Notably, these sectors had already positioned themselves as frontrunners in digitalization and automation before the COVID-19 crisis.

In contrast, Romania, which has historically had one of the lowest percentages of employees working from home within the European Union, encountered distinct challenges during the crisis. Prior to the pandemic, Romania reported nearly the lowest rate of employees regularly working from home in the European Union, with only Bulgaria having a lower percentage and almost the highest percentage of employees who had never worked from home, reaching 98.6% Despite beginning from a low baseline, the prevalence of

telework has doubled since the onset of the COVID-19 (Gavril, et al., 2022)

3 Methodology

Empirical part of this paper will build upon the semi-structural model developed by Hlavacek et al. (2020) to analyze the commercial property market. This model accurately replicates the operations and interactions of different market segments, enabling separate examinations of office and industrial properties.

The objective of this study is to assess commercial property price misalignment by employing a model that mirrors the structure of the commercial real estate market. In pursuit of this goal, we use a four-equation model which describes the four key segments of the commercial real estate market—rental, investment, construction and newly added financing sector —and delineates their interconnections.

Furthermore, we propose to extend the semi-structural model developed by Hlaváček et al. (2020) by incorporating additional variables to enhance the analysis of the commercial real estate market. This extension includes the introduction of a credit supply equation, which accounts for the availability of loans to non-financial enterprises as a critical variable. This equation integrates variables such as the growth rate of long-term loans, interest rates, and financial supply and demand factors, providing a comprehensive view of how credit conditions influence property capital values. By including these new elements, our model offers a deeper understanding of the interplay between commercial real estate loans, interest rates, and market dynamics

3.1 Structural Equation Modelling (SEM)

Structural Equation Modelling (SEM) is a sophisticated statistical technique that enables researchers to analyze complex relationships among observed and latent variables. According to Bollen (1989) It merges multiple regression analysis with factor analysis,

allowing for the examination of both direct and indirect effects within a network of variables. SEM is particularly advantageous in fields where relationships between variables are intricate and multi-dimensional, such as economics.

3.1.1 Introduction to SEM

SEM provides a robust framework for testing hypotheses about the relationships among variables, accounting for measurement errors and latent constructs. It consists of two main components: the measurement model and the structural model. The measurement model defines the relationships between latent variables (unobserved constructs) and their indicators (observed variables). The structural model specifies the causal relationships among the latent variables (Kline, 2016)

3.1.2 Application of SEM in Real Estate Analysis

In the real estate sector, SEM is particularly valuable for analyzing how various economic, financial, and market-specific factors influence property prices and market dynamics. This approach allows for a nuanced understanding of the interplay between these factors, which is essential for both policymakers and investors.

For example, Liow (2004) utilized SEM to analyze the dynamic relationships between economic indicators, market fundamentals, and real estate returns in Singapore. The study demonstrated how SEM could disentangle the direct and indirect effects of macroeconomic variables on real estate prices. Similarly, Edelstein et al. (2011) applied SEM to examine the interaction between market fundamentals and return performance in Asian real estate markets. In a comprehensive study, Gyourko and Keim (1992) investigated the relationship between real estate and stock market returns using SEM, revealing significant insights into how macroeconomic factors and market conditions interact to influence property prices.

3.2 Structure of the market

The structure of the commercial real estate market can be divided into three interconnected segments: rental, investment, and construction. Understanding these segments is crucial for analyzing the dynamics and potential misalignments in commercial property prices. The following subchapters provide detailed overview of mentioned

segments. (Baum, 2015)

3.2.1 Rental Segment

The rental segment of the commercial real estate market involves the interaction between the supply of rental space and the demand for such space from end-users. The supply is relatively inelastic in the short term due to the time required for constructing new properties. Key outcomes of this interaction include the net take-up, which is the total volume of newly rented spaces, the price of rent, and the vacancy rate.

Several factors drive the demand for rental space, including macroeconomic indicators like GDP growth and employment rates. For instance, GDP growth often leads to increased business activities, which subsequently boosts the demand for office and industrial spaces. Employment rates directly impact the need for office spaces, as more jobs typically require more office space. Additionally, sector-specific factors such as manufacturing output for logistics properties and household consumption for retail properties also play significant roles.

3.2.2 Investment Segment

The investment segment focuses on transactions involving new and existing commercial spaces. A crucial variable in this segment is the prime yield, which represents the return investors expect from their investments in commercial properties. The prime yield is influenced by factors such as risk-free interest rates, alternative asset yields, and overall economic outlook. (Ling & Archer, 2018)

The prime yield, combined with expected rent and vacancy rates, determines the capital value of a property, which is the price an investor is willing to pay. This can be expressed mathematically as:

$$CapitalValue = \frac{Rent \times (1 - VacancyRate)}{Yield}$$

This formula shows that higher rents and lower vacancy rates increase the capital value

of a property, making it more attractive to investors. (Hlaváček, et al., 2016)

3.2.3 Construction Segment

The construction segment deals with the supply side, where new spaces are built and added to the market. This segment is influenced by factors such as labor and material costs, land prices, profit margins in the construction industry, and policies adopted by various urbanities. These policies can be controlled by national or local authorities and can significantly affect the pace and volume of new construction.

The interaction between supply and demand in the construction segment can be observed through the vacancy rate. When new spaces are constructed and added to the market, it increases the total supply. The vacancy rate changes depending on the balance between new supply (completions) and net take-up, which is the volume of new rentals. This relationship can be captured by the equation:

$$\Delta Vacancy = \frac{Completions - NetTakeUp}{TotalSupply}$$

This equation highlights the dynamic nature of the market, where changes in supply and demand continuously affect vacancy rates and, consequently, rental prices. (Coffinet & Kintzler, 2019)

3.3 Semi – structural model

To estimate commercial property price misalignment, a semi-structural model reflecting the market structure is employed. This model is based on the study by Hlaváček et al. (2020) and consists of four interlinked equations representing different segments of the market. The equations and explanatory variables remain consistent with the original framework, focusing on the rental, investment, and construction segments. However, a completely new addition to this model is our credit supply equation, which aims to capture the influence of credit availability on commercial real estate prices.

The first equation describes the net take-up of rental space, capturing the demand side

influenced by macroeconomic indicators:

$$\begin{aligned} NetTakeUp_{it} &= c + a_1 Unemployment_{it} + a_2 \Delta \log(Consumption_{it}) \\ &\quad + a_3 \Delta \log(Investment_{it}) + a_4 \Delta \log(ExportsGoods_{it}) \\ &\quad + a_5 \Delta \log(ExportsServices_{it}) + \varepsilon_{it} \end{aligned}$$

The net take-up equation models the demand for commercial property space, accounting for various economic factors that influence this demand. The dependent variable, net take-up, refers to the net change in occupied commercial property space within a given period, a critical indicator of market activity and demand dynamics in the commercial real estate sector. Unemployment is a crucial determinant of net take-up as it directly reflects the economic health of a region. Higher unemployment typically signals weaker economic conditions, leading to reduced business expansion and consequently, lower demand for commercial property space. Prior studies (see for example Wheaton and Torto (1994)) have shown a negative correlation between unemployment rates and commercial real estate demand.

The logarithmic change in consumption serves as a proxy for consumer demand and economic activity. Higher consumption indicates increased economic activity, which can drive business growth and the need for additional commercial space. Hendershott et al., (2003) showed the positive relationship between consumption growth and commercial property demand.

Investment in capital goods is a direct indicator of business expansion and economic growth. Increased investment generally leads to higher demand for commercial real estate as businesses require more space for operations. This relationship is well-documented in the literature, with investment being a strong predictor of commercial real estate demand (Ling & Naranjo, 1997).

Finally, many CEE countries have a significant focus on exports. Commercial properties, specifically industrial properties, play a crucial role in the production and distribution of export goods. The logarithmic change in exports of goods reflects the economic output and global trade activity of a region. Higher exports can lead to increased production activities, necessitating additional industrial and commercial space. Studies have shown that regions with higher export activities tend to have stronger demand for

commercial properties. (D´Arcy & Keogh, 1999)

Similar to goods, the change in exports of services indicates economic health and international trade dynamics. A robust service export sector can drive demand for office and commercial spaces required by businesses engaged in global trade.

The second equation explains the price of rent, determined by the net take-up and the vacancy rate:

$$\log(Rent_{it}) = c + \beta_1 NetTakeUp_{it} + \beta_2 Vacancy_{it} + \varepsilon_{it}$$

Rent equation describes the dynamics of rental prices by incorporating net take-up and vacancy rates as key variables. Net take-up reflects the demand for rental space, while vacancy rates indicate the availability of such space. When net take-up is high, it signals strong demand for rental properties. Conversely, low vacancy rates suggest a shortage of available space. The combination of these factors puts upward pressure on rental prices, as landlords can leverage the high demand and limited supply to negotiate higher rents.

The capital value equation evaluates the investment segment by explaining the capital value of property, which substitutes for direct price information in our study:

$$\begin{aligned} \log(CapitalValue_{it}) \quad = \quad & c + \gamma_1 \log(Rent_{it}) + \gamma_2 BondYields_{EUR,it} \\ & + \gamma_3 VIX_{it} + \gamma_4 \Delta(GDP_{it}) \\ & + \gamma_5 \Delta(Loans_{it}) + \varepsilon_{it} \end{aligned}$$

The third equation models the capital value of property, influenced by rent, bond yields, and market stress indicators. As described by Bassett and Marsh (2016), the crucial variables to include are investor sentiment, aggregate demand indicators, and financial conditions. To capture investor sentiment, the VIX indicator is utilized. The VIX index captures periods of market stress, typically associated with uncertainty and higher risk aversion, which may dampen commercial property transactions. The utilization of the VIX index aligns with approaches used in prior research (See for example Banque de France (2017)).

For global economic activity, we include GDP growth and Eurozone 10-year

government yields. We posit that global economic growth incentivizes investors to pay higher prices for properties. This relationship underscores the positive impact of economic expansion on property values, as higher GDP growth typically leads to increased business activity and demand for commercial space.

In addition we incorporate the fitted values of loans to non-financial enterprises from the credit supply model, which is described in the following subchapter. This addition accounts for the availability of credit, reflecting how financial conditions influence property capital values. The inclusion of this variable acknowledges the critical role of credit availability in supporting property market activities, as suggested by multiple studies on credit supply and financial conditions (See for example Bernanke and Blinder, (1988) or Kashyap and Stein, (2000)).

Furthermore, by including the credit supply variable, we address the issues highlighted by Hlaváček et al. (2020). In their research, authors noted that their model was constrained by several omitted variables due to a lack of data. Among others, these variables included the variation in the supply of credit over time. By incorporating the fitted values of loans to non-financial enterprises, we enhance our model by capturing the dynamics of credit supply, thereby providing a more comprehensive understanding of the factors influencing capital values in the commercial property market.

The fourth equation pertains to the construction segment, describing the completion of new spaces based on yield and vacancy rates:

$$Completions_{it} = c + \delta_1 Yield_{it} + \delta_2 Vacancy_{it} + \varepsilon_{it}$$

Although including the construction equation could provide a more comprehensive view of the market's long-term dynamics, we chose not to present its estimation results in this study. This decision was primarily due to the complexity involved in accurately modeling the lagged effects between completions and the influencing variables, such as rents and vacancy rates. Properly capturing these dynamics requires detailed, high-frequency data on construction activities and market conditions, which may not have been fully available or consistent across all the studied countries. Additionally, the inclusion of this equation would have necessitated a separate, in-depth analysis to adequately address the specific factors affecting the construction segment, such as regulatory changes, construction costs, and

developer expectations. Thus, for the sake of brevity and focus, we have omitted the detailed estimation of the construction equation from this paper.

These equations collectively capture the dynamics within the rental, investment, and construction segments of the commercial real estate market (Hlaváček et al (2020)).

3.4 Credit supply

The inclusion of the credit supply equation in our structural model introduces a significant enhancement compared to structural model used in paper from Hlaváček et al. (2020). This addition allows us to account for the critical role of credit availability in shaping commercial property prices. To model the credit supply equation, we will use several key variables. Given the inherent difficulties in precisely modeling credit supply in any economy (see Bernanke and Blinder, (1988); Kiyotaki and Moore, (1997); Kashyap and Stein, (2000)), we will follow the estimation approach outlined by the ECB in their working paper series (ECB Working Paper No. 2202 (2018)), where the authors modeled credit supply and demand during unconventional times:

$$\Delta(Loans_{it}) = c + \alpha_1 Supply_{it} + \alpha_2 Demand_{it} + \alpha_3 IR_{it} + \alpha_4 \Delta(GDP_{it}) + \varepsilon_{it}$$

As a proxy for credit supply, we will use the quarter-on-quarter growth rate of long-term loans provided to non-financial corporations (NFCs) by banks in the respective countries. We recognize that using loan growth to NFC as a proxy for credit supply may introduce potential endogeneity issues, particularly within the context of the commercial real estate market. This complexity arises due to the bidirectional relationship between credit availability and property prices, where not only does the supply of credit influence real estate investments, but fluctuations in property values can also impact the lending behavior of financial institutions (Kashyap and Stein, (2000)). Recognizing these potential challenges, our model incorporates qualitative data from the Bank Lending Survey (BLS) to provide a more exogenous measure of credit conditions, thereby enhancing the robustness and reliability of credit supply equation.

To model the explanatory variables, we will utilize the Bank Lending Survey (BLS),

which provides qualitative data on changes in credit supply and demand conditions as perceived by banks (European Central Bank, 2021). On the supply side, we will use the following survey question: “Over the past three months, how have your bank’s credit standards as applied to the approval of loans or credit lines to enterprises changed?” The resulting variable is the total net percentage change of the bank’s behavior derived from the banks' responses.

For the demand side, we will employ the survey question: “Over the past three months, how has the demand for loans or credit lines to enterprises changed at your bank, apart from normal seasonal fluctuations?” Similar to the supply side, this variable is the total net percentage change of the bank’s behavior based on the banks' responses.

In addition to the model developed by the ECB, we will include the interest rate and the change in total GDP. To address stationarity issues with the real interest rate, we can treat the interest rate as stationary at first differences, even though this assumption might not be entirely accurate. Alternatively, we can use the nominal interest rate, which is the chosen approach for this study.

3.5 Estimation approach

The empirical analysis was conducted using a panel regression with fixed effects to estimate the equations related to the commercial property market in Central and Eastern European countries (CEEC). This approach was chosen to accurately capture the dynamics of property prices and to account for potential heterogeneity across the countries in the sample, which includes Czechia, Slovakia, Hungary, Romania, and Poland.

Equations were estimated using a two-stage approach. Initially, the explanatory variables were estimated, and the fitted values from these estimations were then used in subsequent equations. Specifically, the fitted values from the credit supply equation were incorporated into the capital value equation to assess their impact on property prices. The primary focus was on deriving the residuals from the capital value equation, which provide insights into the under- or overvaluation of commercial real estate.

Given the structure of the dataset, which comprises multiple cross-sectional identifiers (countries) over a relatively long-time span, a panel regression with fixed effects was deemed appropriate. This method controls for unobserved heterogeneity across countries

and captures the specific characteristics influencing commercial property prices in each country. While pooled OLS with fixed effects might have been considered, the presence of unit roots in some variables violated OLS assumptions. Additionally, first differencing the unit root variables would result in losing valuable information about the levels of these variables, which is crucial for assessing property price misalignment.

Robust standard errors were used in the estimation process to mitigate the generated regressors problem, ensuring more reliable coefficient estimates. The analysis focused on two types of commercial properties: office and industrial. The inclusion of these property types allows for a comprehensive assessment of the commercial real estate market in the region, capturing the distinct dynamics of both sectors.

The panel regression with fixed effects also controls for panel-specific constants, accounting for differences in the levels of macroeconomic and real estate indicators among the countries. This approach is supported by previous research, such as Davis and Zhu (2011), which emphasizes the importance of controlling for such heterogeneity in panel models with fixed effects.

The final results, derived from the residuals of the capital value equation, offer an estimation of property price misalignments. These residuals indicate the extent of under- or overvaluation of commercial properties, providing valuable insights for investors and policymakers. By addressing the issues highlighted in the research by Hlaváček et al. (2020), our model incorporates additional variables to account for variations in credit supply, thus enhancing the robustness and relevance of our findings.

3.6 Data

This section provides an overview of the data sources, a detailed summary of the key variables used in the analysis: Rent, Yield, Vacant, and Take Up can be found in the Appendix. The data encompasses five Central and Eastern European countries: Czech Republic, Slovak Republic, Hungary, Romania, and Poland. The dataset integrates both macroeconomic indicators and real estate-specific variables, offering a comprehensive view of the commercial real estate market in these countries.

The analysis utilizes a balanced panel dataset covering the period from the first quarter of 2008 (Q1 2008) to the first quarter of 2024 (Q1 2024). The early stages of the commercial

real estate market in CEECs, starting from the year 2000, were characterized by a relatively underdeveloped market where high demand and limited supply meant that almost any property could be sold. However, our dataset begins in 2008, which corresponds to a period when the market had already experienced significant development and stabilization.

Using data from 2008 onwards allows us to focus on a more mature phase of the market, providing a clearer understanding of the factors influencing commercial property prices in a more stabilized economic environment. This approach also aligns with the full availability of more comprehensive and reliable data for this period. Earlier data, such as from 2002, while valuable, is less representative of the current market dynamics and conditions. Additionally, focusing on the post-2008 period enables us to capture the effects of the global financial crisis and subsequent recovery, which are critical to understanding the contemporary commercial real estate market trends in the current times. The data are quarterly, providing a high-frequency overview of the commercial real estate market dynamics. The balanced nature of the dataset ensures that each country has a complete set of observations across the specified time span, which is crucial for robust panel data analysis.

The data for Rent, Yield, Vacant, and Take Up were provided by iO Partners, formerly known as JLL, a firm specializing in real estate market analysis, specifically in CEE region. These variables capture the dynamics of the commercial property market, with Rent representing the income generated from leasing commercial spaces, denoted as the maximum open-market rent that could be anticipated for a theoretical office or industrial unit of superior quality and specification, situated in the most desirable location within a market. The prime yield represents iOPartner's market view, derived from a combination of market evidence, where available, and a survey of expert opinions, encompassing the initial net income at the date of purchase of the property as a percentage of the total purchase price, including acquisition costs and transfer taxes. TakeUp measuring the volume of newly rented spaces, where a unit is considered taken-up once a legally binding agreement to acquire the unit has been finalized. Vacant variable denoting the office or industrial floorspace that is currently unoccupied and available for immediate use in all completed buildings within a given market and expressed as a percentage of the total available stock. Comprehensive data characteristics and summary statistics are provided in the appendix.

Macroeconomic data, including GDP and its components, as well as unemployment rates, were sourced from Eurostat. These variables are essential for understanding the

broader economic context in which the commercial real estate market operates. The export components were also retrieved from Eurostat, providing insight into the economic activities and international trade performance of the respective countries.

Interest rate data were obtained from the European Central Bank (ECB), reflecting the monetary policy environment. Long-term loans to non-financial corporations, used as a proxy for money supply, were sourced from Eurostat and represent the availability of credit to non-financial corporations, which is crucial for financing commercial real estate investments. Additionally, data on demand and supply conditions were derived from the Bank Lending Survey conducted by the national central banks of the respective countries. This survey captures the lending behavior of banks and the credit conditions faced by borrowers in the commercial real estate market.

The Volatility Index (VIX) and 10-Year Bond Yields, which were included to account for financial market conditions and investor sentiment, were obtained from the Datastream and ECB.

4 Empirical part

This section introduces the motivation behind the empirical analysis, outlining how it builds upon and contributes to existing research in the field of commercial real estate markets in Central and Eastern European countries (CEEC). The initial focus is on the structural model approach, providing a comprehensive framework to understand the dynamics of commercial property prices in the region.

The first part of the empirical analysis involves an examination of the credit supply equation. By incorporating this equation, we aim to address gaps in the literature regarding the impact of credit availability on commercial real estate markets. Specifically, we integrate the quarter-on-quarter growth rate of long-term loans to non-financial corporations (NFCs) as a proxy for credit supply, enhancing the understanding of how financial conditions influence property values. This approach follows the methodologies outlined by the European Central Bank (ECB) and expands upon the limited empirical evidence available in this area.

Subsequently, we conduct a comprehensive panel data analysis to identify the determinants of commercial property prices across Czechia, Slovakia, Hungary, Romania, and Poland. Recognizing that panel regression has been extensively used in prior studies on CEE countries, we employ two types of panel analyses: cross-country and cross-property panels. The cross-country panel analysis investigates industrial and office properties separately across the five countries, focusing on broad regional trends and macroeconomic influences. In contrast, the cross-property panel integrates data for both property types within individual countries, offering insights into how these markets interact under the same national conditions. In addition, we derive property price misalignments by examining the residuals from the capital value equation, providing insights into under- or overvaluation of commercial properties. By analyzing these residuals, we can better understand market dynamics and identify periods of significant deviation from fundamental values, thereby

offering a more comprehensive analysis of property price behavior.

Additionally, our research covers the period of the COVID-19 pandemic, a time of significant economic disruption. By including data from this period, we aim to provide insights into how the pandemic influenced commercial real estate markets, addressing the rapid changes in economic fundamentals and property demand dynamics. This aspect of our study is particularly relevant given the shifting trends and structural changes in the market observed during and after the pandemic, as highlighted by recent studies (see Deghi, Mok, & Tsuruga (2021)or Similarly, Allan, Liusman, Lu, and Tsang (2021)).

4.1 Structural model equations result of cross-country panel

In the following subchapters, we will discuss the findings of each structural equation in detail. This includes the results of the credit supply equation, net take-up equation, rent equation, and capital value equation, derived from a cross-country panel dataset, separately for office and industrial real estate.

4.1.1 Credit supply equation results

The results of the credit supply equation, where the dependent variable is change in loans to non-financial enterprises, provide crucial insights into the factors influencing credit supply in the context of commercial real estate markets in Central and Eastern European countries.

Table 1: Results for Credit Supply Equation

	Dependent variable:
	Loans
Supply	0.007**
	(0.004)
Demand	0.005*
	(0.003)
IR	−0.010**
	(0.005)
dlog_GDP	0.858***
	(0.014)
Fixed Effect CZ	0.042***
	(0.019)
Fixed Effect SK	0.017***
	(0.018)
Fixed Effect HU	0.063***
	(0.020)
Fixed Effect RO	0.054***
	(0.052)
Fixed Effect PL	0.019***
	(0.030)
Note:	*p<0.1; **p<0.05; ***p<0.01

The coefficient for supply is positive and statistically significant, indicating that an increase in supply positively influences the amount of loans extended to non-financial enterprises. This suggests that as the supply of credit increases, more loans are available to businesses, aligning with the intuitive understanding that greater credit supply facilitates more borrowing.

Similarly, the demand coefficient is positive and significant, implying that higher demand for credit leads to an increase in the amount of loans extended. This relationship is expected as higher demand reflects businesses' needs for financing, which banks meet by extending more loans.

The interest rate coefficient is negative and statistically significant, indicating that higher interest rates reduce the amount of loans extended. This finding is consistent with economic theory, where higher borrowing costs interest rates defer businesses from taking out loans, thereby reducing the overall credit supply.

The coefficient for the logarithmic change in GDP is positive and highly significant. This suggests that economic growth enhances credit supply. As the economy grows, businesses are more likely to invest and expand, leading to increased borrowing and higher

credit supply.

Country-specific fixed effects (CZ, SK, HU, RO, PL) indicate unique factors influencing credit supply in each country. These fixed effects capture the distinct economic, regulatory, and financial conditions that affect the availability and extension of loans. The positive and significant coefficients for these fixed effects could suggest that these countries, on average, have factors that contribute positively to the credit supply. Country-specific fixed effects further illustrate the heterogeneous nature of credit markets across different countries, reflecting varying regulatory environments, economic conditions, and financial market structures.

Overall, the credit supply equation underscores the importance of both supply and demand factors in determining the availability of credit to non-financial enterprises. The significant negative impact of interest rates highlights the sensitivity of credit supply to borrowing costs, while the positive influence of economic growth emphasizes the role of broader economic conditions in facilitating credit extension.

4.1.2 Net TakeUp equation results

The results for the net take-up equation in the office property market highlight several significant variables. Our results align completely with the findings of Hlaváček et al. (2020) for both the office and industrial markets.

Table 2: Office Property: Results for TakeUp Equation

	Dependent variable:
	TakeUp
Unemployment	−4.124***
	(0.513)
dlog (Consumption)	37.449
	(52.799)
dlog (Investment)	33.104*
	(15.050)
dlog (ExportGoods)	−66.274**
	(66.638)
dlog (ExportServices)	39.956
	(57.120)
Fixed Effect CZ	74.703***
	(12.207)
Fixed Effect SK	76.134***
	(18.896)
Fixed Effect HU	46.658***
	(14.559)
Fixed Effect RO	81.991***
	(15.292)
Fixed Effect PL	12.993***
	(14.460)
Note:	*p<0.1; **p<0.05; ***p<0.01

The coefficient for unemployment for office market is negative and statistically significant, indicating that higher unemployment rates lead to reduced net take-up of office space. This is consistent with economic theory, as higher unemployment typically reflects weaker economic conditions, reducing business expansion and the demand for additional office space.

The coefficient for investment is positive and significant, suggesting that increases in investment stimulate the demand for office properties. This makes sense economically, as higher investment often leads to business growth and the need for more office space to support operations.

Interestingly, the coefficient for export of goods is negative and significant. This finding indicates that higher exports of goods are associated with a reduction in net take-up of office space. This is hardly to explain but could be due to firms optimizing their existing space or

improving efficiencies, thus reducing the need for new office space.

Table 3: Industrial Property: Results for TakeUp Equation

	Dependent variable:
	TakeUp
Unemployment	−3.124***
	(0.478)
dlog (Consumption)	−1.495
	(15.259)
dlog (Investment)	1.222*
	(4.350)
dlog (ExportGoods)	−11.398***
	(19.258)
dlog (ExportServices)	20.587
	(16.507)
Fixed Effect CZ	74.524***
	(3.528)
Fixed Effect SK	−58.037***
	(5.461)
Fixed Effect HU	75.774***
	(4.207)
Fixed Effect RO	66.905***
	(4.419)
Fixed Effect PL	−135.773**
	(4.179)
Note:	*p<0.1; **p<0.05; ***p<0.01

In the industrial property market, the results are consistent, the net take-up equation shows that unemployment again has a negative and significant impact, reinforcing the idea that higher unemployment reduces demand for industrial space.

Investment remains positively significant, suggesting that investment growth drives demand for industrial properties. This is aligned with the notion that increased investment leads to business expansion, necessitating more industrial space.

The coefficient for export of goods is also negative and significant in this market, indicating that increased exports reduce the net take-up of industrial properties. This could be attributed to better utilization of existing space or enhanced logistical efficiencies that reduce the need for new industrial space.

4.1.3 Rent equation results

The rent equation for office properties identifies several significant determinants of rental

prices, which align with the findings of Hlaváček et al. (2020). The only exception is the TakeUp variable in the industrial market, which may be attributed to the increasing importance and investor confidence in this sector of commercial real estate, as discussed in the subchapter on property price misalignments.

Table 4: Office Property: Results for Rent Equation

	Dependent variable:
	log_Rent
fitted_TakeUp	−0.005***
	(0.0005)
Vacant	−0.005***
	(0.001)
Fixed Effect CZ	2.854***
	(0.035)
Fixed Effect SK	2.679***
	(0.022)
Fixed Effect HU	2.919***
	(0.036)
Fixed Effect RO	2.800***
	(0.031)
Fixed Effect PL	2.708***
	(0.059)
Note:	*p<0.1; **p<0.05; ***p<0.01

In the office market the TakeUp has a negative and significant coefficient, indicating that higher net take-up is associated with lower rents. This counterintuitive result may suggest that high take-up rates reflect oversupply in the market, putting downward pressure on rents.

The vacancy rate is also negatively significant, suggesting that higher vacancy rates lead to lower rents. This relationship is expected as higher vacancies typically indicate an

oversupply of office space, which reduces rental prices.

Table 5: Industrial Property: Results for Rent Equation

	Dependent variable:
	log_Rent
fitted_TakeUp	0.002***
	(0.0002)
Vacant	−0.002
	(0.002)
Fixed Effect CZ	1.152***
	(0.059)
Fixed Effect SK	1.530***
	(0.024)
Fixed Effect HU	1.347***
	(0.032)
Fixed Effect RO	1.260***
	(0.035)
Fixed Effect PL	1.116***
	(0.043)
Note:	*p<0.1; **p<0.05; ***p<0.01

Our findings for the TakeUp variable in the industrial market reveal a positive and significant relationship, indicating that higher net take-up leads to higher rents. This contrasts with the findings of Hlaváček et al. (2020), where the TakeUp variable was also significant but negatively related to rents. The positive coefficient in our analysis makes more intuitive sense, reflecting the increasing importance and investor confidence in the industrial sector of commercial real estate, which drives up rental prices as demand for industrial space increases.

Interestingly, the vacancy rate is not significant in this model, similar results as in Hlaváček et al. (2020) suggesting that vacancy rates may not have a strong impact on industrial rents, or other factors might be more influential in determining rents in this market. The observed trends can be attributed to the fact that new industrial properties are often constructed according to the specific requirements of the end-users.

4.1.4 Capital value equation results

The results obtained from the capital value equations for both office and industrial properties exhibit the most significant differences across the property types among all the structural equations.

Table 6: Office Property: Results for Capital Value Equation

	Dependent variable:
	CapitalValue
fitted_log_Rent	0.964*
	(1.509)
dlog_GDP	2.567
	(1.425)
X10BondYield	1.247**
	(0.493)
VIX	0.011**
	(0.065)
fitted_Loans	1.884**
	(1.918)
Fixed Effect CZ	0.705***
	(0.569)
Fixed Effect SK	−0.872***
	(0.622)
Fixed Effect HU	0.872***
	(0.967)
Fixed Effect RO	−0.903***
	(0.980)
Fixed Effect PL	−0.859***
	(0.765)
Note:	*p<0.1; **p<0.05; ***p<0.01

In the office property market, the coefficient for the rent variable is positive and significant, indicating that higher rental income increases the capital value of office properties. This finding aligns with economic intuition, as higher rents typically enhance property valuations. The coefficient for GDP is positive, though not statistically significant.

The coefficient for government bond yield is positive and significant, indicating that higher long-term bond yields are associated with higher capital values. This relationship may reflect the attractiveness of real estate as an investment alternative during periods of rising interest rates. Additionally, the VIX coefficient is positive and significant, suggesting that higher market volatility increases office property values, possibly due to real estate being perceived as a safer investment during times of market stress. Lastly, the loans which serves as a proxy for credit supply is positive and significant, highlighting the critical role of credit availability in supporting office property values. Easier access to financing likely boosts the

prices of office type of commercial real estate.

Table 7: Industrial Property: Results for Capital Value Equation

	Dependent variable:
	CapitalValue
fitted_log_Rent	−0.147
	(0.393)
dlog_GDP	0.759*
	(0.890)
X10BondYield	−0.476**
	(0.194)
VIX	−0.058***
	(0.013)
fitted_Loans	0.858**
	(0.474)
Fixed Effect CZ	−0.364***
	(0.417)
Fixed Effect SK	−0.537***
	(0.624)
Fixed Effect HU	−0.159***
	(0.455)
Fixed Effect RO	−0.531***
	(0.075)
Fixed Effect PL	−0.819***
	(0.646)
Note:	*p<0.1; **p<0.05; ***p<0.01

In the industrial property market, the capital value equation shows different dynamics. The coefficient for rent is negative but not statistically significant, suggesting that rental income might not be a primary driver of industrial property values in this context. However, the coefficient for GDP is positive and significant, indicating that economic growth positively impacts industrial property values, similar to the office market.

The coefficient for government bond yield is negative and significant, suggesting that higher long-term interest rates reduce industrial property values, possibly reflecting the increased cost of financing during such periods. Similarly, the VIX coefficient is negative and significant, indicating that higher market volatility reduces industrial property values. Lastly, the loans variable is positive and significant, underscoring the role of credit availability in supporting industrial property values.

Comparing these findings with those of Hlaváček et al. (2020) reveals both

consistencies and deviations. Hlaváček et al. (2020) found a positive relationship between capital prices and GDP growth in the Eurozone, which is consistent with the positive coefficients for GDP in the industrial property markets in our study. They also identified a negative relationship between capital value and Eurozone government bond yields, which aligns with our findings for the industrial property market but contrasts with the positive relationship observed in the office property market.

Moreover, Hlaváček et al. (2020) reported a positive effect of VIX on CEE property prices, indicating that investors require higher yields from investments during times of stress. Our findings partially corroborate this, with a positive and significant VIX coefficient for office properties, though the industrial property market shows a negative relationship. This discrepancy might suggest differing investor perceptions of risk between office and industrial properties during volatile periods.

4.2 Commercial property price misalignments

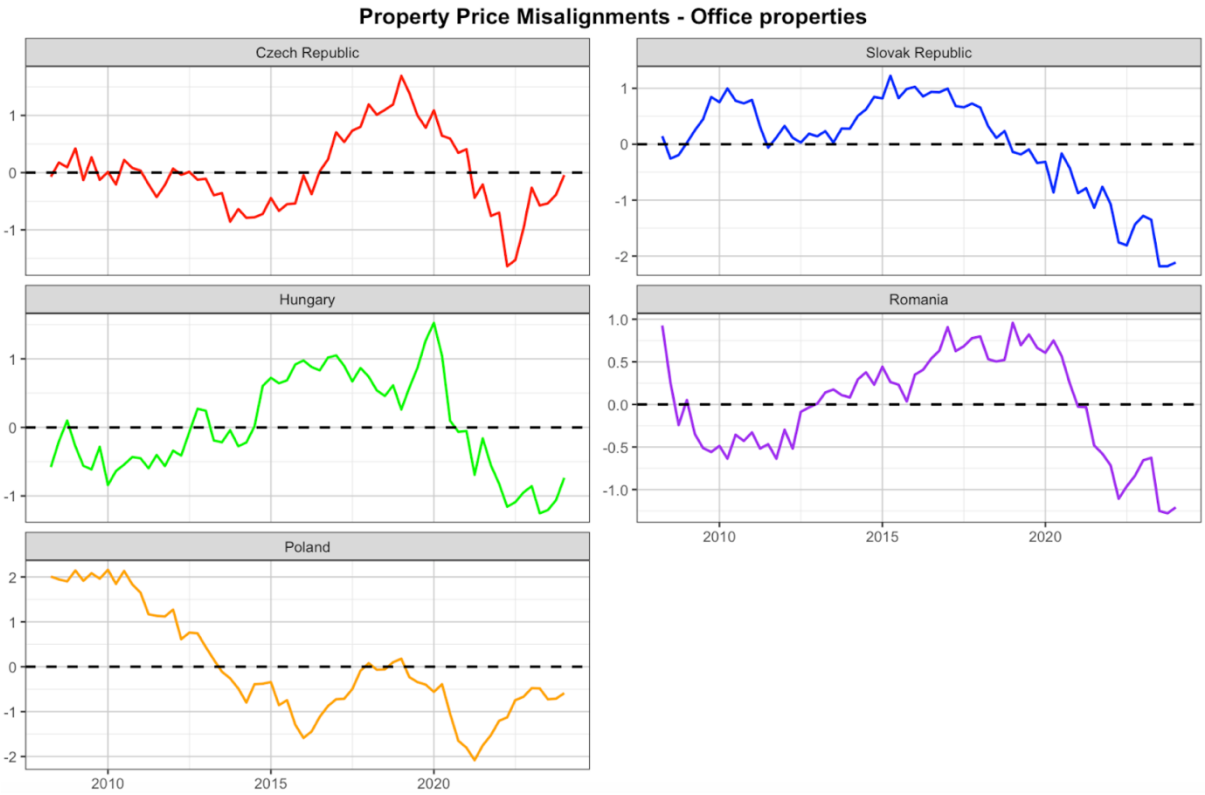
The following subchapters will provide an in-depth analysis of the overvaluation and undervaluation trends observed in the office and industrial real estate markets, with particular attention to the disruptions primarily caused by the COVID-19 pandemic.

It is essential to exercise caution when interpreting the residuals derived from the capital value equation in this study. While these residuals provide insights into potential overvaluation or undervaluation trends within the commercial real estate market, they should not be directly considered as definitive indicators of a market bubble. Several unobserved fundamental variables, such as investor sentiment, regulatory changes, property-specific characteristics, specific risk premiums, which are not included in the model, may influence the residuals from the capital value equation. These unobserved factors could distort the interpretation, leading to misleading conclusions about market conditions. Therefore, the residuals should be interpreted with careful consideration of these limitations, acknowledging that they reflect only the observed variables' effects and not the entirety of the market dynamics.

4.2.1 Office properties

The first set of figures illustrates the property price misalignments for office properties across five Central and Eastern European countries: Czech Republic, Slovak Republic, Hungary, Romania, and Poland. These graphs plot the residuals from the capital value equations, providing information about the under- or overvaluation of office property prices.

Figure 1: Office Property: Price Misalignments



In the Czech Republic, the graph reveals periods of both overvaluation and undervaluation. Notably, from around 2016 to 2019, there was significant overvaluation of office properties, followed by a sharp correction around the onset of the COVID-19 pandemic. This trend suggests that the market initially experienced a boom period, likely due to strong economic growth, relatively cheap borrowing costs, and low interest rates that made financing more accessible. However, the economic uncertainty brought by the pandemic led to a rapid decline in property values, indicating a shift towards undervaluation.

The Slovak Republic shows a clear pattern of overvaluation from 2013 to 2018, with a steady decline leading to undervaluation by 2020. This trend mirrors the broader economic conditions, where an initial phase of economic expansion, driven by favorable borrowing

conditions and low interest rates, gave way to the pandemic-induced economic slowdown. The prolonged period of overvaluation followed by a sharp decline suggests a market correction in response to changing economic fundamentals, with Slovakia continuing in undervaluation territory.

Hungary's office property market exhibits notable volatility. The graph indicates several peaks and troughs, with significant overvaluation observed around 2019-2020. The sharp decline in 2020 aligns with the onset of the COVID-19 pandemic, which disrupted economic activities and reduced demand for office space. The volatility in the graph may reflect Hungary's economic cycles and fluctuating investor sentiment in the office property market. Similar to Romania, Hungary experienced undervaluation after the financial crisis leading to overvaluation before the pandemic.

Romania's graph shows a pronounced overvaluation trend leading up to the pandemic, with peaks around 2018. The decline during the pandemic period indicates a shift towards undervaluation. This pattern suggests that Romania's office property market was also buoyed by economic growth, investor confidence, and low interest rates before the pandemic, which were subsequently undermined by the economic uncertainties and disruptions caused by COVID-19. Romania continues in undervaluation territory post-pandemic, similar to Slovakia.

Poland's office property market shows a more gradual trend compared to other countries. The graph indicates overvaluation leading up to 2013, followed by a prolonged period of undervaluation. This trend may suggest structural issues within Poland's office property market, such as oversupply or slower economic growth compared to its peers. Unlike the other countries, Poland's market currently appears to be stabilizing towards equilibrium prices rather than continuing into undervaluation or overvaluation extremes.

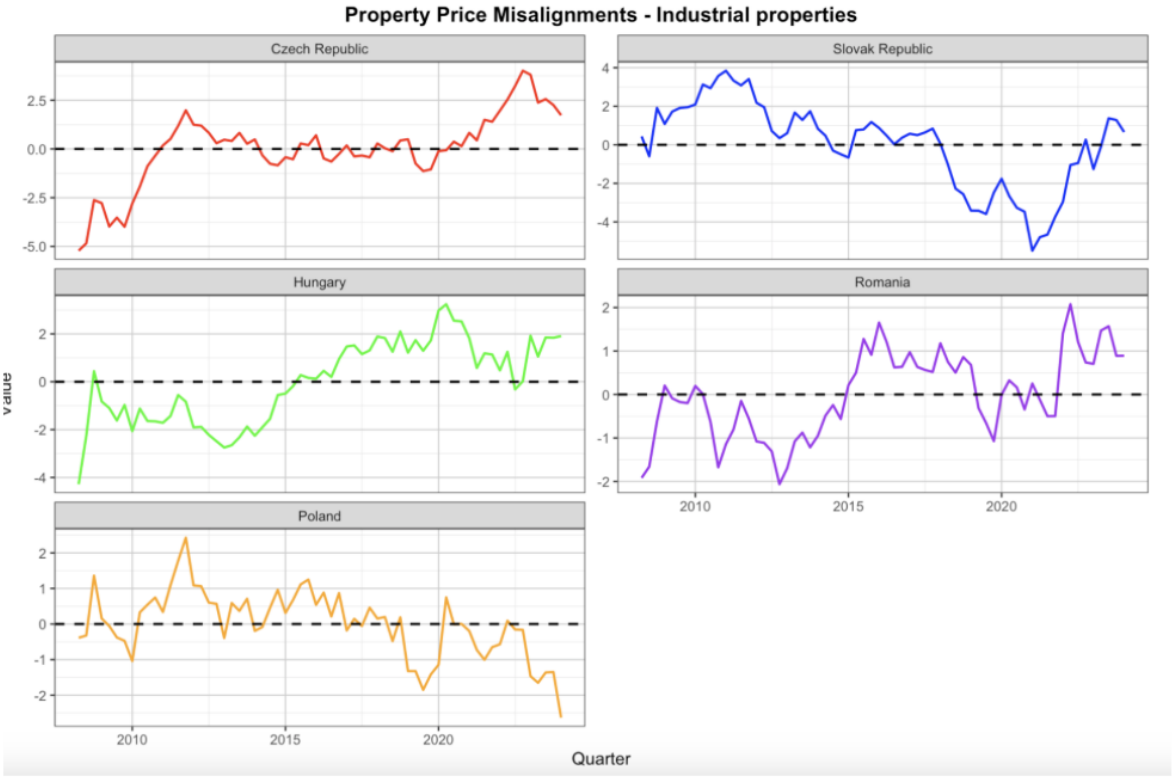
Overall, the trends across these countries exhibit similarities, with most markets experiencing undervaluation after the financial crisis, followed by overvaluation leading up to the COVID-19 pandemic. Hungary and Romania show almost identical trends, with undervaluation post-crisis and overvaluation before the pandemic. Both the Czech Republic and Poland currently display trends moving back towards equilibrium prices, while Slovakia

and Romania continue in undervaluation territory.

4.2.2 Industrial Properties

The second set of figures presents the property price misalignments for industrial properties in the same countries.

Figure 2: Industrial Property: Price Misalignments



In the Czech Republic, the graph demonstrates a rise from undervaluation in 2008, followed by a period of very stable equilibrium prices. Surprisingly, right after the COVID-19 crisis, the prices moved towards overvaluation. Interestingly, during these past market disruptions, the prices never fell into undervaluation, indicating robust demand and resilience in the industrial property market.

Slovak Republic exhibits a different pattern. After a relatively stable period until 2018, the prices fell into the undervaluation territory. There was an immediate attempt to recover, but the prices fell again before rising back to equilibrium in recent times. This volatility suggests that the Slovak industrial property market is more sensitive to economic

fluctuations and external shocks.

Hungary shows a relatively similar trend to the Czech Republic. After an initial period of undervaluation around 2008, the market quickly stabilized and has remained relatively stable with trends towards equilibrium. This stability and subsequent movement towards equilibrium reflect strong demand and positive economic conditions, similar to the trends observed in the Czech Republic.

Romania's graph indicates a more volatile pattern. The market experienced significant undervaluation during the 2008-2010 financial crisis, followed by a recovery. However, the market remained volatile with frequent shifts between overvaluation and undervaluation. After the pandemic, the market tended towards overvaluation, suggesting strong demand despite the economic disruptions.

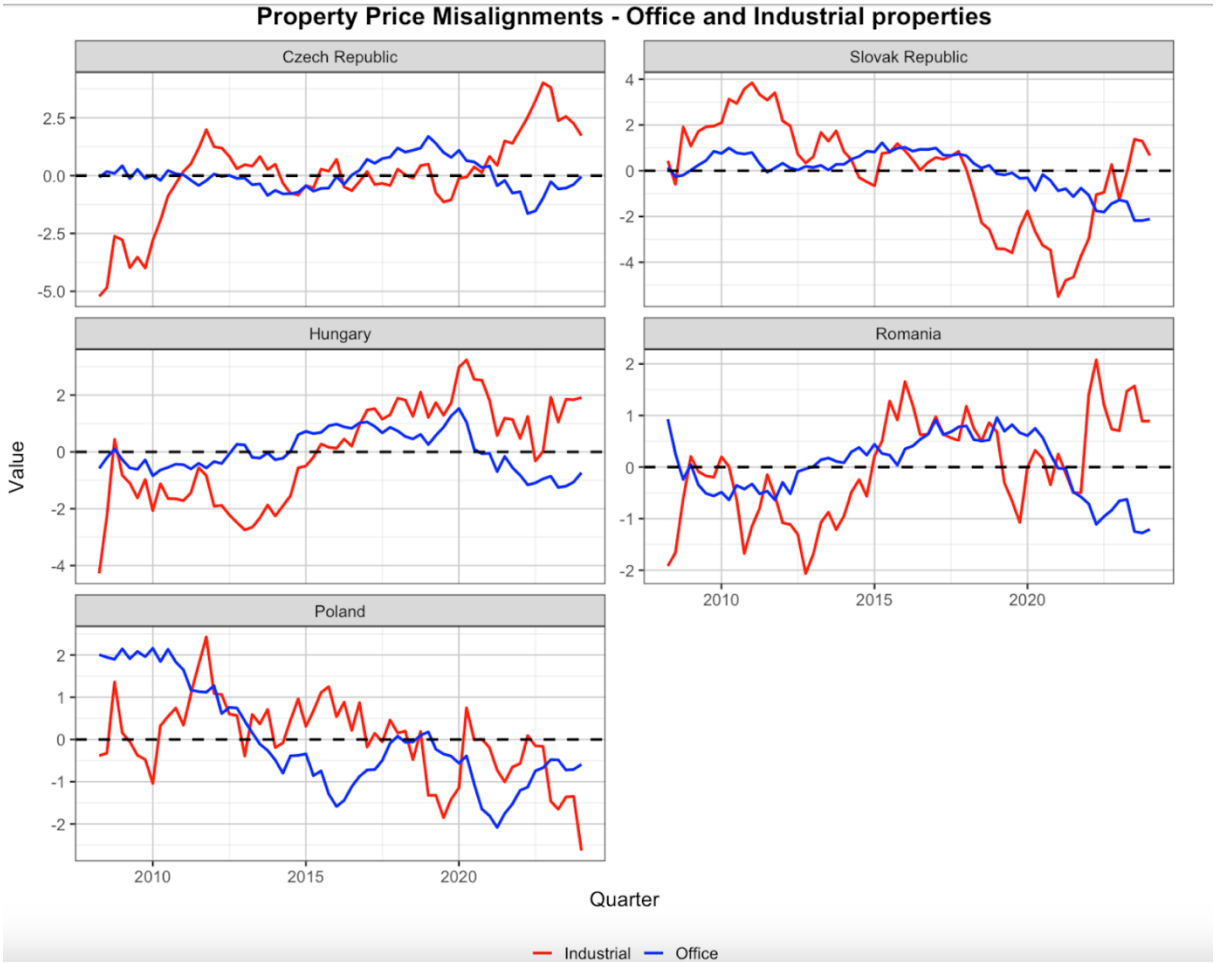
Poland's industrial property market is the most volatile among the countries analyzed. The market experienced significant fluctuations, with periods of overvaluation followed by undervaluation. Currently, Poland's industrial property prices are undervalued, contrasting with the trends in other countries. This persistent undervaluation may indicate challenges such as changes in global trade dynamics and supply chain disruptions affecting investor confidence.

Overall, the trends across these countries exhibit both similarities and differences. The Czech Republic and Hungary show stable equilibrium prices with movements towards overvaluation post-pandemic, indicating strong demand and resilience. Slovakia and Romania display more volatility, with attempts to recover from undervaluation and recent trends towards equilibrium or overvaluation. Poland, however, stands out with significant volatility and current undervaluation, suggesting unique challenges in its industrial property market.

4.2.3 Combined Analysis of Office and Industrial Properties

The third set of figures combines the misalignments of office and industrial properties, allowing for a comparative analysis.

Figure 3: Office and Industrial Property: Price Misalignments



In the Czech Republic, the industrial property market exhibits volatility with a relatively stable equilibrium prices leading to a substantial overvaluation post 2020. Notably, the industrial sector never dips into undervaluation after the 2020. In contrast, the office property market demonstrates a more stable trend, fluctuating around the equilibrium line for much of the period. However, it enters a phase of undervaluation post-2020, diverging significantly from the industrial market trend.

A similar trend is observed in Slovakia. Following the economic recovery period post-crisis, there is a sharp overvaluation in the industrial sector, which then gradually declines, returning closer to equilibrium. Interestingly, shortly before the onset of the COVID-19 pandemic and during its early stages, the industrial sector in Slovakia dipped significantly below equilibrium prices, while the office sector displayed a relatively stable decline. This discrepancy might be due to the still less developed industrial market in Slovakia compared to other CEE countries before the pandemic. The current trend towards overvaluation in the

industrial sector also confirms a stronger investor preference for industrial properties over office spaces. Office properties experienced a relatively more stable trend, with a brief overvaluation following the 2008 crisis, consistent with the findings of Hlaváček et al. (2020).

In Hungary, the data reveal that industrial properties are more volatile than office properties, yet they share a relatively similar trend. Both sectors exhibited overvaluation prior to the pandemic, followed by subsequent corrections. However, the industrial sector remains in an overvaluation phase, while office properties are still perceived by investors as undervalued. This sustained overvaluation in the industrial sector underscores the heightened demand and perceived stability of industrial investments post-pandemic.

Romania mirrors the trends observed in other CEE countries, particularly the Czech Republic, with similar patterns in the post-COVID-19 pandemic period. Notably, Romania displays two significant peaks in the overvaluation of the industrial sector in the post-COVID period, followed by price corrections. This pattern may reflect the impact of increased industrial activity and the subsequent adjustments as market expectations recalibrate.

In Poland, both sectors exhibit significant fluctuations with periods of overvaluation and undervaluation. The office sector appears to have a more prolonged period of undervaluation, while the industrial sector shows greater volatility with sharp peaks and troughs, and it remains undervalued, making Poland the only country with this trend compared to the other countries.

In the latest period following the COVID-19 pandemic, a clear trend emerges across all analyzed countries, except for Poland, where industrial properties are consistently overvalued, and office properties are undervalued. This consistent trend across various markets indicates underlying factors that extend beyond national boundaries, reflecting broader economic shifts and structural changes in the real estate sector. The explanations for this trend can be numerous and are discussed in detail below.

The COVID-19 pandemic accelerated the growth of e-commerce, leading to a surge in demand for logistics and warehousing space. This shift significantly boosted the value of industrial properties as businesses sought to enhance their supply chain capabilities. As a result, industrial properties have seen sustained overvaluation due to heightened demand and limited supply. Conversely, the widespread adoption of remote work reduced the demand for traditional office spaces. Companies have been downsizing their office footprints or

rethinking their need for physical office space altogether, leading to an undervaluation in the office property market. This shift reflects a structural change in how businesses operate, with many embracing hybrid or fully remote work models.

In the wake of economic uncertainty, investors may perceive industrial properties as safer investments compared to office spaces. Industrial properties, particularly those tied to essential services like logistics and warehousing, are seen as more resilient to economic disruptions. This perception has driven investment towards the industrial sector, which can contribute to its overvaluation. The office market, on the other hand, faces greater uncertainty regarding future demand. Questions about the long-term viability of remote work and hybrid models, coupled with potential changes in office space utilization, have led investors to be more cautious. This caution is reflected in the undervaluation of office properties, as investors weigh the risks associated with potential vacancies and changing tenant requirements.

The disruptions to global supply chains during the pandemic have prompted businesses to reconsider their supply chain strategies. Many are adopting reshoring or nearshoring to bring production closer to home, increasing the demand for local industrial spaces. This strategic shift has bolstered the value of industrial properties as companies seek to mitigate future supply chain risks. Additionally, governments and private entities have increased investments in infrastructure to support the growing e-commerce and logistics sectors. These investments have further driven up the value of industrial properties, as enhanced infrastructure improves the attractiveness and functionality of these spaces.

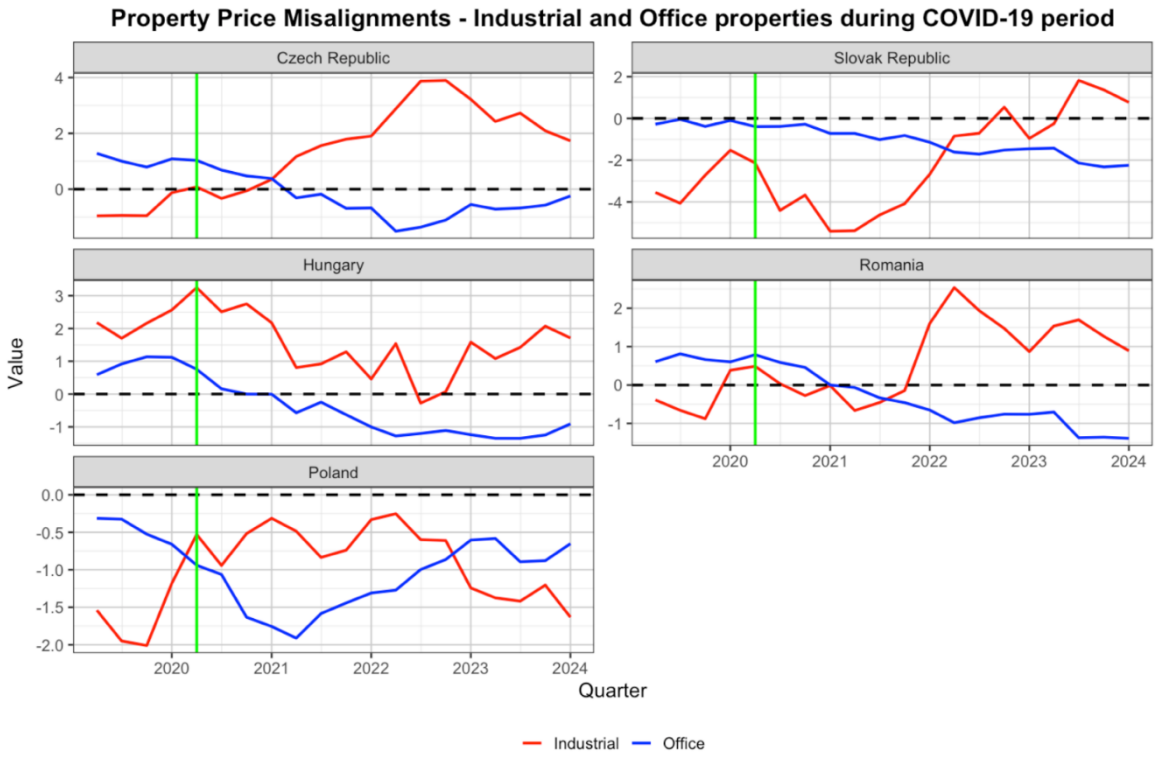
The industrial sector has generally experienced a quicker recovery compared to the office sector, as depicted in the figures and also supported by the findings of Hlaváček et al. (2020), from the years that are not covered in our study. The essential nature of logistics, warehousing, and manufacturing activities has ensured steady demand even during economic downturns. This resilience has resulted in overvaluation as the market quickly rebounded and even expanded. In contrast, the office sector's recovery has been slower and more uncertain. Companies are still evaluating their long-term space needs, leading to delayed leasing decisions and higher vacancy rates. This ongoing uncertainty has kept office

property values depressed, contributing to the observed undervaluation.

4.2.4 COVID-19 and post COVID-19 period

Our results reveal an interesting pattern regarding the correlation of commercial property price misalignments. While in the paper by Hlaváček et al. (2020), a consistent correlation between the misalignments of office and industrial properties was observed throughout the entire study period, our findings indicate that this correlation has diminished in recent years. Notably, similar patterns of under- or overvaluation between these property types were apparent only until the COVID-19 pandemic significantly impacted the economy, after which the correlation is no longer observed. The impact of the COVID-19 period is examined in detail in the following subchapter.

Figure 4: Office and Industrial Property: Price Misalignments during COVID-19 pandemic



The graph provides a comprehensive analysis of the period immediately preceding the onset of the COVID-19 pandemic and extending to the present day. This detailed

examination of each quarter aims to evaluate the reaction of different property types to the immediate impact of the pandemic. The green vertical line in the graph denotes the first quarter of 2020, including February 2020 marking the beginning of the pandemic.

The data reveal an intriguing aspect in the immediate aftermath of the pandemic, particularly in the second quarter of 2020. In all countries except the Czech Republic, and to some extent Romania, there is a pronounced decline in the industrial sector, while office properties continued a slight downward trend from prior periods. This pronounced reaction in the industrial market is particularly noteworthy, demonstrating a sharper response compared to the office sector.

Furthermore, the recovery patterns during the subsequent years of the pandemic are of interest. In the Czech Republic, there was a continued mild decline in the undervaluation of office properties, while industrial properties experienced a significant increase between 2022 and 2023. This suggests that the industrial market was more sought after and preferred by investors over office spaces. A similar trend is observed in Slovakia, where the values of industrial properties, previously perceived as significantly undervalued, began to recover. The office sector in Slovakia showed greater stability, but the trend in industrial properties supports the notion that industrial real estate was seen as a safer and more attractive investment during times of uncertainty and economic crisis.

Hungary and Romania also display stable declines in the office sector, with slightly more volatile trends in the industrial market. The notable sharp drop in industrial property values from the Q2 of 2022, also observed in the Czech Republic around a quarter later, may suggest that investors were beginning to reconsider office spaces as the pandemic's pressure eased. This is indicated by a slight increase in office property values towards equilibrium in both countries during that period.

Poland remains somewhat ambiguous, as it is the only CEEC country showing undervaluation in both property types, with a continued declining trend in industrial properties, unlike in other countries. One possible explanation could be a specification error in the panel or the presence of omitted variables that are not accounted for in this analysis. Poland is known for having a significant presence of foreign investors with capital originating from abroad, while domestic Polish investors constitute only a small portion of the real estate market. Therefore, it might be beneficial to examine each country separately

to determine if the findings are consistent with results across all CEEC countries combined.

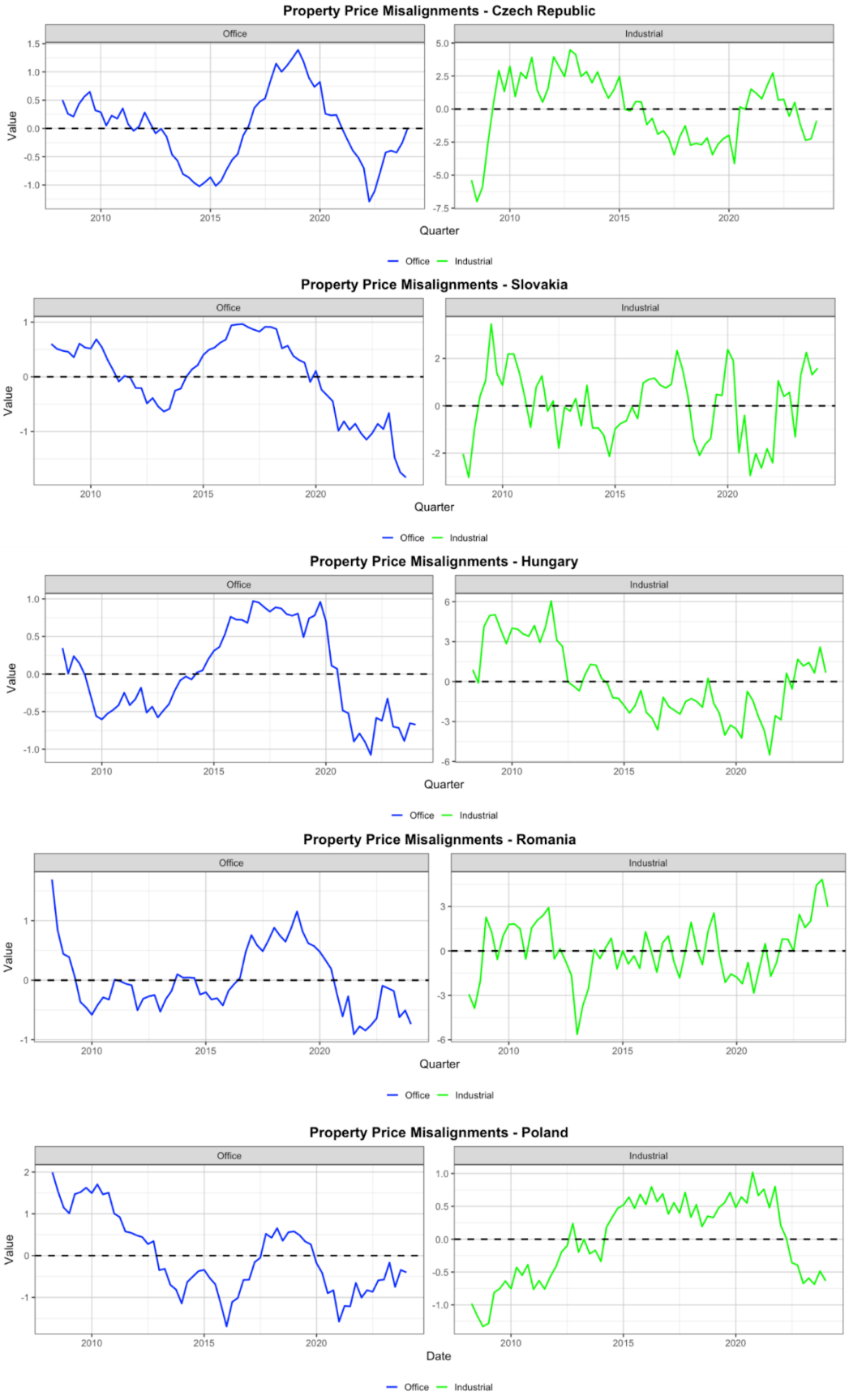
4.3 Structural model equations result of cross-property panel

In this subchapter, we explore the results from the cross-property panel analysis, contrasting them with those from the cross-country panel approach. The cross-country panel analysis examined industrial and office properties separately across multiple countries, focusing on broad trends and macroeconomic influences. In contrast, the cross-property panel integrates data for both property types within individual countries, offering insights into how these markets interact under the same national conditions.

This approach reveals within-country dynamics. It suggests that market segmentation is more pronounced by property type than by country, indicating that investors may prioritize the type of property over the location when making investment decisions. This pattern underscores the international nature of the commercial real estate market, where investors often select a specific property type first and then choose a country for their investment. The cross-property panel analysis provides a nuanced view of these intra-country market behaviors, complementing the broader international comparisons made in the cross-country panel analysis.

We enhance the study by Hlaváček et al. (2020), who conducted a cross-property panel analysis only for the Czech Republic due to the availability of a balanced dataset for this country. Taking advantage of our balanced dataset, we extend this analysis to include all countries in our study, providing a more comprehensive view across different national contexts. This extension also contributes to the existing literature by offering a broader understanding of how commercial real estate markets operate not only across but also within countries.

Figure 5: Cross-property panel – Office and Industrial Property: Price Misalignments



The office property sector exhibits a distinct and consistent trend across all CEEC countries, aligning well with our initial expectations, particularly regarding the market's response to the COVID-19 pandemic. This observed pattern is consistent with the conclusions drawn from the cross-country panel data analysis. Across all CEEC nations, office properties experienced a notable decline in perceived value at the onset of the pandemic. By 2021, values in these markets began to recover, trending towards equilibrium, with the exception of Slovakia, where the undervaluation has continued to persist over the past two years. This anomaly in Slovakia could be attributed to its unique position as the only CEEC country within the Eurozone, where banking financing and economic policies are significantly influenced by the European Central Bank's decisions. This linkage may have led to more conservative lending practices and investment behavior in the office property market.

In contrast, the industrial property sector shows a markedly different pattern. Only Romania and to some extent Slovakia exhibit trends similar to those identified in the cross-country panel analysis. However, it is consistently observed that during the COVID-19 pandemic, the industrial sector was perceived by investors as more stable. This is evidenced by the overvaluation of industrial properties in all countries except Poland. This stability could be fundamentally linked to the essential nature of industrial properties in supporting logistics and supply chain operations, which became particularly crucial during the pandemic. The increased demand for e-commerce and the need for robust supply chain infrastructure likely bolstered investor confidence in industrial properties, thereby sustaining their values during periods of economic uncertainty.

The observed similarities in property price misalignments for office properties across both the cross-property and cross-country panel analyses can be attributed to the more standardized and homogeneous nature of the office market perceived by the investors. Office properties tend to have more uniform characteristics and are often influenced by similar macroeconomic factors, such as general economic growth, employment rates, and corporate investment trends. This homogeneity can lead to consistent valuation patterns across different countries, reflecting a global investor sentiment and similar market dynamics.

In contrast, the industrial property market is inherently more diverse and sensitive to local factors, which can explain the discrepancies observed in the property price misalignments between the cross-property and cross-country panels. Industrial properties

are often influenced by region-specific factors such as local economic conditions, industrial policies, infrastructure developments, and supply chain logistics. These local factors can lead to significant variations in the valuation and performance of industrial properties, even within the same country. Additionally, industrial properties can range widely in type and use, from warehouses to manufacturing facilities, each with its own set of market drivers and investor considerations. This diversity results in more variable market responses, which can sometimes manifest as divergent or even opposite trends in property price misalignments across different analysis frameworks.

Table 8: Cross-property panel: Results for Credit Supply Equation

	Dependent variable:				
	Loans (CZ)	Loans (SK)	Loans (HU)	Loans (RO)	Loans (PL)
Supply	0.010**	−0.015	0.012	0.025***	−0.008
	(0.006)	(0.007)	(0.008)	(0.009)	(0.010)
Demand	0.009*	0.005	−0.014	0.018**	0.007
	(0.002)	(0.003)	(0.004)	(0.005)	(0.006)
IR	−0.021*	0.031	−0.018	0.022	−0.028**
	(0.011)	(0.012)	(0.010)	(0.013)	(0.014)
dlog_GDP	0.548***	−0.423***	0.365	−0.501	0.287*
	(0.013)	(0.014)	(0.015)	(0.016)	(0.017)
Fixed Effect Office	0.083***	−0.067***	0.102**	0.095	−0.054**
	(0.021)	(0.023)	(0.025)	(0.027)	(0.029)
Fixed Effect Industrial	0.097***	0.045	−0.089*	0.067*	−0.071***
	(0.036)	(0.037)	(0.038)	(0.039)	(0.040)
Note:					*p<0.1; **p<0.05; ***p<0.01

The results for the credit supply equation across the five countries show diverse influences of the explanatory variables on loan provision. The Supply variable positively influences loan supply in the Czech Republic, Hungary, and Romania, indicating that an increase in available credit supply leads to a higher volume of loans in these markets. In contrast, the effect is negative in Slovakia and Poland, but not significant, suggesting possible tightening in credit conditions or misspecification of the model equation.

The demand variable, which captures the demand for loans, shows a significant positive effect in the Czech Republic and Romania. This relationship is not statistically significant in other countries. The Interest Rate variable is negative and significant in the Czech Republic and Poland, indicating that higher interest rates discourage loan provision in these countries. This is consistent with economic theory, where higher borrowing costs reduce the demand

for loans.

The GDP variable shows mixed results: it is positive and significant in the Czech Republic and Poland, suggesting that economic growth boosts loan provision. However, it is negative in Slovakia and Romania, which may reflect different economic conditions, or the impact of other factors not captured in the model.

Table 9: Cross-property panel: Results for TakeUp Equation

	Dependent variable:				
	TakeUp (CZ)	TakeUp (SK)	TakeUp (HU)	TakeUp (RO)	TakeUp (PL)
Unemployment	−4.124**	−2.235*	−1.987	−3.421***	−0.678
	(0.513)	(1.123)	(0.834)	(0.942)	(1.456)
dlog (Consumption)	37.449	−12.345	28.754	−5.123	15.789
	(52.799)	(25.678)	(14.345)	(19.876)	(20.564)
dlog (Investment)	33.104*	45.321**	22.765**	10.876	34.210*
	(15.050)	(13.987)	(9.432)	(11.321)	(16.543)
dlog (ExportGoods)	−66.274**	33.876**	−29.654	27.432**	−10.987
	(66.638)	(16.543)	(14.987)	(12.432)	(18.123)
dlog (ExportServices)	39.956	−19.876	21.098	−15.432	25.678
	(57.120)	(13.765)	(19.876)	(17.321)	(12.987)
Fixed Effect Office	74.703***	−54.321***	43.987**	−62.123**	29.876**
	(12.207)	(10.876)	(11.543)	(12.321)	(10.654)
Fixed Effect Industrial	76.134***	63.432***	−71.321**	55.432*	−48.123***
	(18.896)	(14.765)	(13.432)	(11.987)	(15.876)
Note:					*p<0.1; **p<0.05; ***p<0.01

The results for the Net Take-Up equation from cross property panel across the five countries show notable variation in the impact of the explanatory variables. Unemployment generally exhibits a negative effect, significant in most countries, indicating that higher unemployment reduces the net take-up of office space. Investment, however, shows a significant positive effect in countries like Slovakia and Hungary, suggesting that increased investment stimulates demand for office properties. The ExportGoods variable reveals in mixed results; it is significantly negative in the Czech Republic, while significantly positive

in Slovakia and Romania, indicating differing economic structures and reliance on exports.

Table 10: Cross-property panel: Results for Rent Equation

	Dependent variable:				
	log_Rent (CZ)	log_Rent (SK)	log_Rent (HU)	log_Rent (RO)	log_Rent (PL)
fitted_TakeUp	-0.008^{***}	0.007^{**}	-0.003	0.006^{*}	-0.004
	(0.0005)	(0.001)	(0.0007)	(0.0008)	(0.0012)
Vacant	-0.006^{***}	0.004	0.002^{**}	-0.003^{*}	0.005^{***}
	(0.001)	(0.0009)	(0.0006)	(0.0011)	(0.0007)
Fixed Effect Office	2.923^{***}	-1.234^{**}	1.412^{***}	1.789^{*}	-2.543^{***}
	(0.035)	(0.045)	(0.032)	(0.046)	(0.038)
Fixed Effect Industrial	1.694^{***}	1.876^{**}	-2.123^{***}	2.654^{***}	-1.987^{**}
	(0.035)	(0.040)	(0.034)	(0.037)	(0.039)
Note:					*p<0.1; **p<0.05; ***p<0.01

The results for the Rent Equation in the Office Property sector indicate that the fitted Take-Up variable exhibits mixed effects across the five countries, being significantly positive in Slovakia and Romania, and significantly negative in the Czech Republic. This suggests that higher take-up can lead to higher rents in some countries, while it reduces rents in others, potentially due to different supply-demand dynamics. The vacancy rate generally has a negative impact on rents, significantly so in most countries, indicating that higher vacancies typically reduce rental prices.

Table 11: Cross-property panel: Results for Capital Value Equation

	Dependent variable:				
	CapitalValue (CZ)	CapitalValue (SK)	CapitalValue (HU)	CapitalValue (RO)	CapitalValue (PL)
fitted_log_Rent	0.724^{*}	-0.521	1.245^{**}	0.789	1.032^{**}
	(1.311)	(0.654)	(0.789)	(0.456)	(0.541)
dlog_GDP	1.063	3.123^{***}	-1.235	4.567^{**}	2.345
	(0.918)	(0.987)	(1.231)	(1.678)	(1.456)
X10BondYield	2.112	-0.987	2.134^{**}	-1.456	1.654^{***}
	(0.125)	(0.234)	(0.567)	(0.789)	(0.876)
VIX	0.021^{*}	-0.009^{*}	0.014^{***}	0.002	-0.005
	(0.049)	(0.005)	(0.004)	(0.006)	(0.003)
fitted_Loans	1.335^{*}	0.876	2.567^{***}	3.123^{**}	-1.234
	(1.227)	(0.876)	(1.432)	(1.567)	(1.234)
Fixed Effect Office	0.338^{***}	0.144^{**}	1.567^{**}	-0.987^{**}	0.876^{**}
	(0.569)	(0.123)	(0.345)	(0.456)	(0.321)
Fixed Effect Industrial	-0.968^{***}	1.543^{**}	-1.876^{*}	0.678^{**}	-2.345^{***}
	(0.439)	(0.432)	(0.543)	(0.321)	(0.567)
Note:					*p<0.1; **p<0.05; ***p<0.01

The results for the Capital Value Equation in the Office Property sector reveal varying

impacts of key variables across the countries analyzed. The fitted log Rent variable shows a positive and significant effect on capital values in the Czech Republic, Hungary, and Poland, suggesting that higher rents are associated with increased property values in these markets.

The GDP growth variable significantly increases capital values in Slovakia and Romania, highlighting the positive relationship between economic growth and property investment in these countries. The Eurozone bond yield presents mixed results; it is positively significant in Hungary and Poland, indicating that these markets might be seen as alternative investments to bonds, while being non-significant or negative elsewhere.

The VIX index, reflecting market volatility, generally has a less consistent impact across countries. It is positively significant in the Czech Republic and Hungary, suggesting that investors may demand higher yields during periods of market stress in these countries.

The fitted Loans variable, representing credit availability, significantly increases capital values in Hungary and Romania, underscoring the importance of financing conditions in these markets.

The findings from the cross-country panel were generally more consistent with market expectations, offering more intuitive results regarding the significance and direction of the estimated coefficients. This consistency aligns with the broader market perception that investors are often more focused on specific property types rather than particular countries. The cross-property panel analysis, while providing valuable insights into intra-country market dynamics, sometimes produced results that were less intuitive, reflecting the complexity and variability inherent in property type-specific investment behaviors within the same national context.

5 Conclusion

In conclusion, this thesis has provided a comprehensive analysis of the commercial real estate market within the Central and Eastern European Countries (CEECs), focusing on the distinct behaviors observed in the office and industrial property sectors. The core of the analysis was built upon a semi-structural model, which effectively captured the dynamics of three key segments of the commercial real estate market: rental, investment, and construction. This model comprised four primary equations that delineated the factors influencing each segment, offering a detailed view of how macroeconomic indicators and sector-specific variables drive market behavior.

A significant contribution of this thesis was the introduction of an additional equation focused on credit supply, which enhances the existing framework established by Hlaváček et al. (2020). This newly integrated credit supply equation provided critical insights into the role of financial conditions in shaping property market outcomes, an aspect that has often been underexplored in previous studies. This addition not only fills a notable gap in the literature but also provides a more robust model for analyzing the complex interplay between credit availability and commercial real estate markets. The value added by this research is further exemplified by its ability to capture the effects of the COVID-19 pandemic, providing a contemporary perspective on how such unprecedented global events can reshape market dynamics.

The empirical findings have revealed notable trends in the commercial real estate market post-COVID-19, particularly highlighting the consistent overvaluation in the industrial property sector and undervaluation in the office property sector across the CEECs. This divergence can be largely attributed to shifts in economic activity, evolving investment preferences, and changing supply chain strategies, compounded by varied recovery rates across different property types.

The industrial property sector's overvaluation reflects several critical factors, including

the rapid growth of e-commerce, which has significantly increased demand for logistics and warehousing spaces. These properties have been perceived as safer investments during times of economic uncertainty, bolstered by strategic reshoring activities and supportive economic policies. This perception of safety and growth potential has attracted substantial investor interest, driving significant price appreciation in the industrial sector.

Conversely, the office property sector has faced challenges, particularly with the widespread adoption of remote work and flexible working arrangements, which have led to ongoing uncertainties in office space demand. The slower recovery in this sector reflects broader structural changes in business operations, with many companies reassessing their real estate needs in light of new work patterns. This cautious outlook on office space investment has contributed to the sector's undervaluation.

The results from the cross-country panel analysis were more aligned with market expectations, providing intuitive insights into the significance and direction of the estimated coefficients. This consistency underscores the broader market perception that investors are more focused on specific property types rather than particular countries. The cross-property panel analysis, while offering valuable intra-country insights, sometimes produced less intuitive results, possibly due to model misspecifications or unique market characteristics.

These findings not only build upon existing literature, which indicates a correlation between office and industrial property misalignments but also significantly expand our understanding of the post-pandemic commercial real estate landscape in the CEECs. Notably, the pre-pandemic trend of correlated property price misalignments between office and industrial sectors was disrupted during the COVID-19 pandemic. Our analysis revealed that while there was a consistent pattern of correlation in the misalignments of office and industrial properties before the pandemic, this correlation dissipated during the post-COVID period. This shift highlights how the pandemic uniquely affected these sectors, with industrial properties experiencing consistent overvaluation and office properties showing sustained undervaluation. Overall, this thesis contributes to the existing body of knowledge by providing a detailed analysis of the CEECs' commercial real estate market. The research underscores the need for a nuanced understanding of market dynamics, particularly in the wake of the COVID-19 pandemic and offers valuable insights into the factors driving

valuation changes in the office and industrial property sector.

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Appendix

Figure 6A: Prime Rent

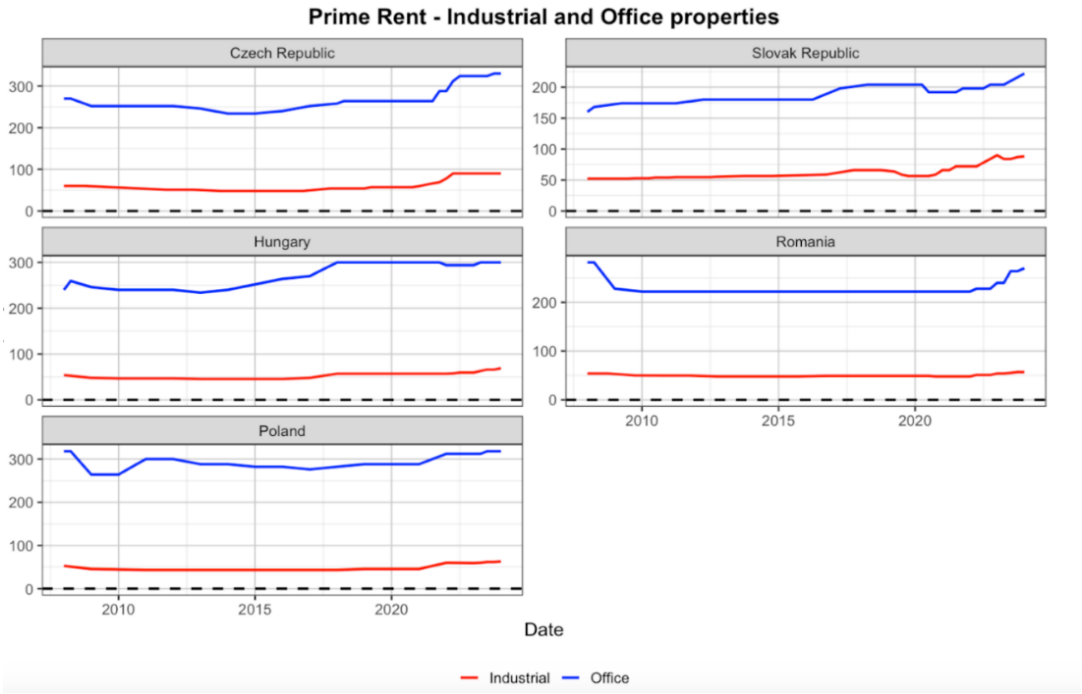

Figure 7A: Prime Yield

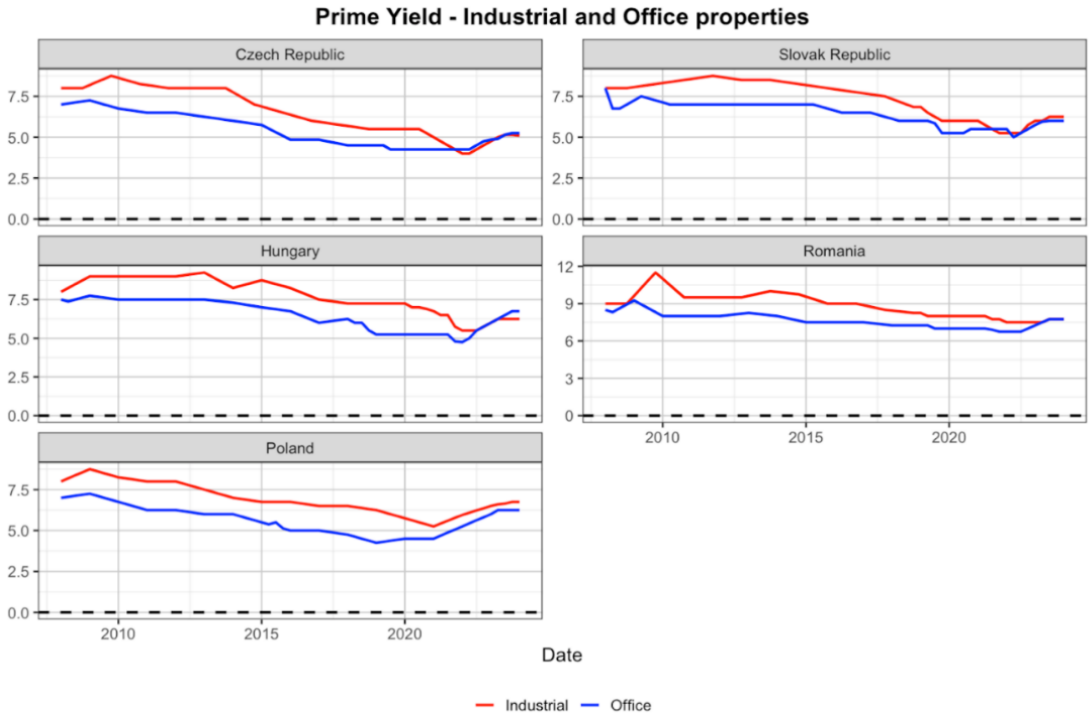

Figure 8A: TakeUp

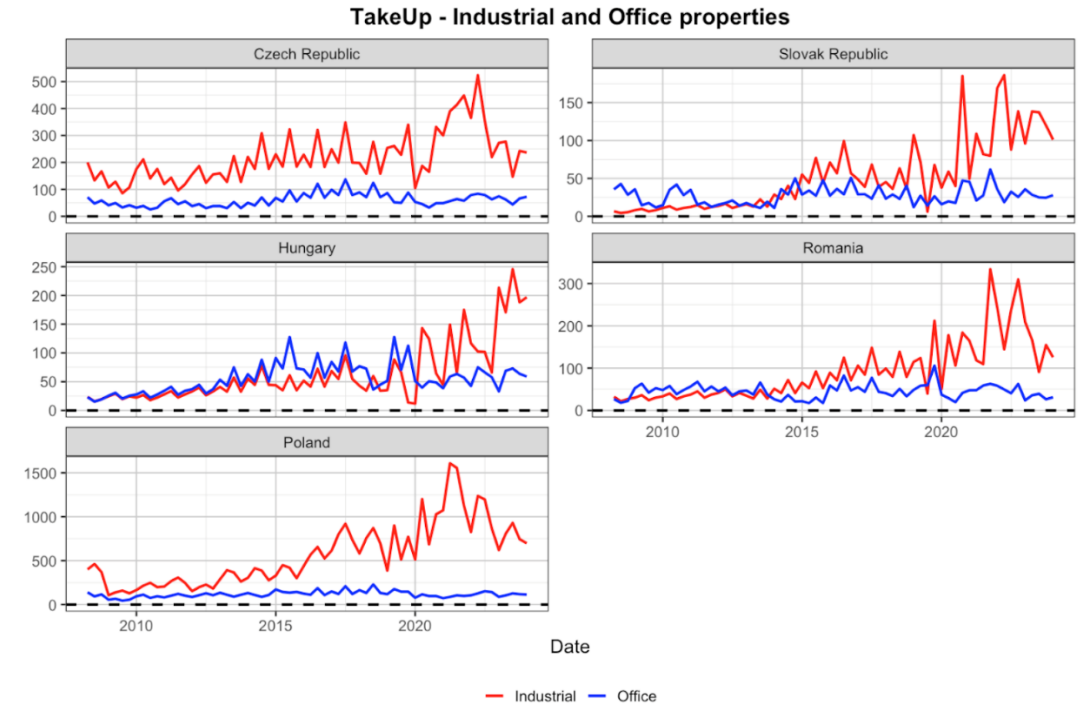

Figure 9A: Vacancy

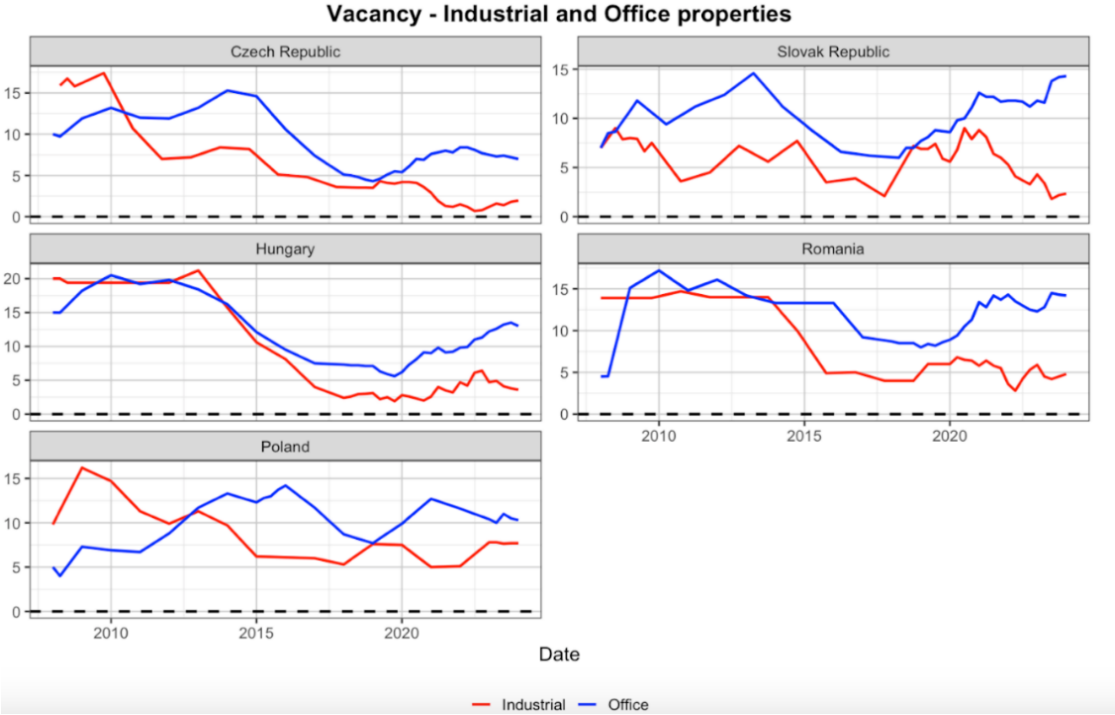

Table 12A: Summary Statistics of the data

	Office					Industrial			
	Rent					**Rent**			
Country	**Mean**	**Std. Dev.**	**Min**	**Max**		**Mean**	**Std. Dev.**	**Min**	**Max**
Czech Republi	262.3	26.04	234	330		58.61	13.07	48	90
Slovakia	187.92	13.63	160.2	222		61.29	9.97	52.2	90
Hungar	268.63	26.61	234	300		51.77	6.24	45.6	69
Romania	227.96	14.73	222	282		49.89	2.28	48	57
Poland	290.41	14.35	264	318		47.03	6.07	43.2	63
	Yield					**Yield**			
Country	**Mean**	**Std. Dev.**	**Min**	**Max**		**Mean**	**Std. Dev.**	**Min**	**Max**
Czech Republi	5.47	1.02	4.25	7.25		6.57	1.44	4	8.75
Slovakia	6.44	0.7	5	8		7.41	1.13	5.25	8.75
Hungar	6.56	0.94	4.75	7.75		7.81	1.13	5.5	9.25
Romania	7.66	0.58	6.75	9.25		8.91	0.97	7.5	11.5
Poland	5.64	0.88	4.25	7.25		6.95	0.94	5.25	8.75
	TakeUp (in ths)					**TakeUp (in ths)**			
Country	**Mean**	**Std. Dev.**	**Min**	**Max**		**Mean**	**Std. Dev.**	**Min**	**Max**
Czech Republi	60.5	23.38	25.52	137.02		217.05	91.81	85.718	524.132
Slovakia	27.18	11.34	11.01	61.8		51.25	46.87	4.4	186.29
Hungar	54.85	26.2	15.31	127.48		63.1	53.41	11.843	245.626
Romania	44.25	16.93	17.3	105.66		90.42	70.73	21.53	333.979
Poland	115.41	34.08	43.54	229.28		558.44	355.42	105.529	1609.404
	Vacant					**Vacant**			
Country	**Mean**	**Std. Dev.**	**Min**	**Max**		**Mean**	**Std. Dev.**	**Min**	**Max**
Czech Republi	9.79	3.29	4.3	15.3		6.76	4.85	0.7	17.4
Slovakia	10.13	2.46	6	14.6		5.53	1.88	1.8	9
Hungar	12.93	4.91	5.6	20.5		10.59	7.47	1.9	21.2
Romania	12.43	2.99	4.5	17.2		8.87	4.39	2.8	14.7
Poland	10.01	2.5	4	14.2		8.65	3.13	5	16.2