Konference doktorandů
na Vysoké škole finanční a správní 2023

Doctoral Students Conference
at the University of Finance and Administration 2023

Prezentace výsledků společenskovědního výzkumu s ekonomickými a finančními efekty (10. ročník)

Presentation of the results of social science research with economic and financial effects (10th annual conference)

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Doctoral Students Conference at the University of Finance and Administration 2023

Presentation of the results of social science research with economic and financial effects (10th annual conference)
University of Finance and Administration, November 15, 2023

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Z konference bude vydán recenzovaný sborník příspěvků s ISBN v tištěné i on-line podobě.
Konference je podpořena z prostředků účelové podpory na specifický vysokoškolský výzkum poskytnutých VŠFS na rok 2023.

10th annual Doctoral Students Conference at the University of Finance and Administration

Presentation of the results of social science research with economic and financial effects

November 15, 2023

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MORE CONTRIBUTIONS

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A peer-reviewed collection of contributions with ISBN (printed and online form) will be published from the conference. The conference is supported by using objective oriented support for specific university research.

Ondřej Roubal
Úvodní slovo

V letech 2021 a 2022 se pozornost světové společnosti soustředila na dvě hlavní události. První událostí byla koronavirová krize, druhou pak válka na Ukrajině. V roce 2023 světem otřásá válečný konflikt mezi Izraelem a hnutím Hamás. Teorie černých labutí libanonského autora Nassima Taleba se v posledních letech reálně zhmotnila do podoby nečekaných a výjimečně destruktivních sil v podobě jak těch přírodních, tak i lidských. Svět podle generálního tajemníka OSN Guterrese přestává fungovat a státy nejsou připravené řešit problémy *„Náš svět je v nebezpečí, je ochromený. Pracujme společně jako světová koalice, jako sjednocené národy"* (New York, všeobecná rozprava 77. zasedání Valného shromáždění OSN září 2022).

Věk nerovnováhy je saturován nejistotou. Jen těžko dokážeme předpovídat a předvídat s pomocí vědeckých modelů, ekonomických prognóz nebo sociálně politických trendů spolehlivé scénáře budoucího vývoje. Černé labutě jsou v nedohlednu, nemáme pod kontrolou směry jejich pohybu, detekování jejich trajektorií zůstává stále mimo naše možnosti. Objevují se náhle a působí v globalizovaném a intenzivně propojeném světě drtivou silou. Svět už není obytným domem vzájemně oddělených bytů, stal se jedním větším, společně sdíleným obývacím pokojem. Vidíme problémy a nemáme řešení. Jen v západní Evropě v relativně krátkém čase koncentrují demografické, sociální, environmentální, ekologické, politické a ekonomické problémy, doprovázené otázkami energetické bezpečnosti, rostoucí inflací a krizí životních nákladů.

Prof. Miroslav Bárta v knize Sedm zákonů – Jak se civilizace rodí, rostou a upadají, inspiruje k zamyšlení o stavu a vývoji naší civilizace, která jako každá jiná historicky existující civilizace má svá omezení v čase a prostoru. Podle šestého Herakleitova zákona vývoje civilizací (Bárta, 2020, s. 91–115) je kolaps každé civilizace pevně usazen již v samotném počátku každého společenského systému. Přesně ty faktory, které stály u zrodu vzestupu komplexity systémů, stávají se později příčinnou krizí, zdrojem eroze, degradace a silou vedoucí k jejich úpadku. Například přístup k informacím a hodnota informací byla na počátku revoluce vědeckého poznání a nadějí dosahování autentické pravdy. Dnes jsou všudypřítomné informace nezodpovědně ztotožňovány se znalostmi, beznadějně zneužívány ve prospěch politické moci a ekonomického profitu. Informace se stávají promiskuitní entitou, úmožňující demokratizaci expertního vědění a to v podobách často velmi extravagantních a kuriózních. Informace tak často neslouží k dobývání hradeb poznání a dosahování pravdy, stávají

se pouťovou atrakcí, horskou dráhou, které mají pobavit a vyděsit současně. Dochází k poklesu role odborníků a krizi poznání, v níž pravda působí jako ušmudlaná popelka, vedle pestrobarevných informací přesycených emocionalitou vzrušujících, šokujících a provokujících motivů. Informací máme více, ale světu méně rozumíme. A co je největším nebezpečím? Terorismus, radikalizovaná náboženská hnutí, dezinformační války, expanzivní tendence světových mocností, klimatická změna,…? Nikoli. Největším nepřítelem jsme jen my sami.

Nezapomeňme, že budoucnost máme stále ve svých rukách. Jsme první civilizací, disponující ohromným znalostním kapitálem, technologiemi, komunikačními možnostmi a dostatkem energie, tvořící robustní a velmi komplexní fundament společenské rezistence. Doufejme, že rok 2024 přinese více klidu a pocitu bezpečí.

V době přípravy 10. ročníku Konference doktorandů patřil k nejvýznamnějším událostem válečný konflikt v Pásmu Gazy. Média v listopadových dnech zaměřují pozornost i k dalším událostem. Rok 2023 se ukazuje jako nejteplejší v celé historii měření. Evropa dále kupuje ruský LNG, dovoz do Číny nečekaně vzrostl, v Austrálii dochází k výpadku telekomunikačních služeb, v Ohiu se prosadil přístup k potratům. Cena ropy Brent je pod 80 USD a Polsko pozastavilo snižování úroků. Zemřel bývalý český ministr zahraniční Karel Schwarzenberg. Maďarsko dál blokuje pomoc Ukrajině, řecká opoziční strana Syriza se rozpadla. Na Islandu hrozí erupce sopky a Emirates objednaly 95 boeingů. Král Karel III. slaví 75. narozeniny. Stávka strojvedoucích v Německu, inflace v USA zpomalila na 3,5 %, ekonomika EU ve třetím čtvrtletí opět stagnuje a Čína je ve schodku zahraničních investic. V Turecku je základní úrok 40 % a v Peru za 4 roky zmizelo 175 ledovců.

Stejně jako byly na události bohaté listopadové dny letošního roku, podobně pestré je i tematické zaměření odborných příspěvků našeho konferenčního sborníku. Ten je i letos tematicky profilován do oblasti společenských věd, s důrazem na ekonomické a finanční souvislosti výzkumné orientace. Vystoupení doktorandů probíhala ve dvou sekcích. První sekce byla určena pro vystupující v českém jazyce, zde jsme přivítali doktorandky a doktorandy z VŠFS a VŠE. Druhá sekce pro prezentující v anglickém jazyce, probíhala on-line formou a většinové zastoupení zde měli kromě vystupujících z Polska (Wroclaw University of Economics and Business), Slovenska (Ekonomická univerzita v Bratislavě) a Karlovy Univerzity, zahraniční doktorandi z Německa.

Sborník z 10. ročníku Konference doktorandů zahrnuje celkem 14 odborných příspěvků, které prošly anonymním recenzním řízením. Tematicky se zaměřují z větší části na oblasti finančního a bankovního sektoru, měnovou politiku, controlling, management finančních rizik, v neposlední řadě inflaci.

Rád bych na tomto místě poděkoval nejen autorům za jejich příspěvky, ale i recenzentům za důkladné posouzení odborné kvality textů. Poděkování patří rovněž moderátorům jednotlivých vědeckých sekcí, prorektorovi pro strategii a mezinárodní vztahy VŠFS doc. RNDr. Petrovi Budinskému, CSc., děkanovi FES VŠFS doc. JUDr. Ing. Otakarovi Schlossbergerovi, Ph.D. vedoucí Katedry financí Ing. Evě Kostikov, Ph.D. a odborné asistence Ing. Andree Tomáškové, Ph.D. Za pečlivou organizátorskou a redakční práci děkuji kolegyni Markétě Holendové z Odboru výzkumu a vývoje VŠFS a za technickou podporu Petrovi Svobodovi.

Přehled všech dosavadních konferencí, včetně elektronické verze tohoto sborníku příspěvků, naleznou naši čtenáři na internetových stránkách https://www.vsfs.cz/konferencedoktorandu/.

doc. Mgr. Ondřej Roubal, Ph.D.

prorektor pro výzkum a vývoj VŠFS,

odborný garant konference

Ondřej Roubal

Introduction

In 2021 and 2022 the attention of global society was focused on two major events. The first event was the COVID-19 crisis and the second was the war in Ukraine. In 2023, the world will be rocked by the military conflict between Israel and Hamas. The black swan theory of Lebanese author Nassim Taleb has taken shape in recent years in the form of unexpected and exceptionally destructive forces, both natural and human. The world, according to UN Secretary-General Guterres, is ceasing to function and nations are ill-prepared to solve their problems: *"Our world is in peril — and paralyzed. Let us work as one, as a coalition of the world, as united nations"* (New York, General Debate of the 77th Session of the UN General Assembly September 2022).

The Age of Imbalance is saturated with uncertainty. It is only with difficulty that we can forecast and foresee reliable scenarios of future developments using scientific models, economic forecasts, or socio-political trends. Black swans are in sight; we have no control over the direction of their movement and determining their trajectories remains beyond our capabilities. They appear suddenly and act on our globalized and intensively interconnected world with overwhelming brute force. The world is no longer a house with separate living spaces, but one large, shared living room. We see problems and have no solutions. In Western Europe alone, demographic, social, environmental, ecological, political, and economic problems have been concentrated into a relatively short time period, accompanied by issues arising from energy security, rising inflation, and a cost-of-living crisis.

In his book *Sedm zákonů – Jak se civilizace rodí, rostou a upadají*, Prof. Miroslav Bárta inspires us to reflect on the current state and future development of our civilization, which like any other civilization existing in history has its limitations in time and space. According to Heraclitus's sixth law of the development of civilizations (Barta, 2020, pp. 91–115), the collapse of every civilization is deeply rooted in the very beginning of every social system. The very factors that stood behind the genesis of the increased complexity of systems will later become a causal crisis, a source of erosion and degradation, a force leading to their decline. For example, access to and value of information characterized the beginning of a revolution in scientific knowledge and the hope of achieving authentic truth. Today ubiquitous information is irresponsibly equated with knowledge hopelessly exploited for political power and economic gain. Information is becoming a promiscuous entity that allows for the democratization

of expert knowledge in ways that are often highly extravagant and curious. As such, information often serves not to overcome the walls of knowledge and arrive at the truth; it instead has become a carnival attraction, a roller coaster designed to entertain and frighten at the same time. There has been a decline in the role of experts and a crisis of knowledge in which the truth seems like a grimy Cinderella next to colorful information saturated with the emotionality of exciting, shocking, and provocative themes. We have more information but understand the world less. And what is the greatest danger? Terrorism, radicalized religious movements, disinformation wars, the expansionist tendencies of world powers, climate change? No. Our greatest enemy is ourselves.

Let us not forget that we still hold the future in our hands. We are the first civilization to possess vast knowledge capital, technologies, communication capabilities, and abundant energy, all of which make for a robust and very comprehensive foundation for social resilience. Let us hope that 2024 will bring more peace and a sense of security.

One of the most significant events during the preparations for the 10th Doctoral Student Conference was the military conflict in the Gaza Strip. In November, the media has turned its attention to other events as well. The year 2023 is proving to be the warmest in the history of measurement. Europe continues to buy Russian LNG, China's imports are unexpectedly rising, Australia is experiencing a telecommunications outage, and the question of access to abortion has taken hold in Ohio. The price of Brent crude is below USD 80 and Poland has suspended interest rate cuts. Former Czech Foreign Minister Karel Schwarzenberg has died. Hungary continues to block aid to Ukraine; the Greek opposition party Syriza has fallen apart. A volcano is threatening to erupt in Iceland and Emirates has placed an order for 95 Boeing jets. King Charles III is celebrating his 75th birthday. There's a train driver strike in Germany, inflation in the US has slowed to 3.5%, the EU economy is stagnating again in the third quarter, and China is running a deficit in foreign investment. The main interest rate in Turkey is 40% and 175 glaciers have disappeared in Peru over the past 4 years.

Just as the days of November have been eventful this year, the thematic focus of the papers in our conference proceedings is similarly varied. This year, the thematic focus is again on the social sciences, with an emphasis on the economic and financial implications of research orientations. Papers by doctoral students were presented in two sections. The first section was intended for presenters in the Czech language; here we welcomed doctoral students from the University of Finance and Administration and Prague University of Economics and Business.

The second section was for English language presenters and was held online, where the majority of the presenters hailed not only from Poland (Wroclaw University of Economics and Business), Slovakia (University of Economics in Bratislava) and Charles University, but also included international doctoral students from Germany.

The Proceedings of the 10th Doctoral Students Conference feature a total of 14 papers, all of which have undergone an anonymous peer review process. The topics of the papers focus for the most part on the areas of the financial and banking sector, monetary policy, controlling, financial risk management, and last but not least, inflation.

Here I would like to thank not only the authors for their papers, but also the reviewers for their thorough assessment of the scholarly quality of the work. My thanks also to the moderators of the individual technical sessions, to the Vice-Rector for Strategy and International Affairs of the University of Finance and Administration, Assoc. Prof. RNDr. Petr Budinský, C.Sc., the Dean of the Faculty of Economic Studies of the University of Finance and Administration, Assoc. Prof. Ing. Otakar Schlossberger, J.D., Ph.D., the Head of the Department of Finance, Ing. Eva Kostikov, Ph.D., and the Assistant Professor Ing. Andrea Tomášková, Ph.D. I would like to thank my colleague Marketa Holendová from the Research and Development Department of the University of Finance and Administration for her careful organizational and editorial work and Petr Svoboda for his technical support.

Our readers can find a summary of all the conferences to date, including the electronic version of this publication with the papers, online at https://www.vsfs.cz/konferencedoktorandu/.

<div style="text-align: right">

Assoc. Prof. Mgr. Ondřej Roubal, Ph.D.

Vice-rector for Research and Development

at the University of Finance and Administration,

the conference's expert guarantor

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Felix Florian Balz
How did the interest rate risk influence
the German real estate economy?

Felix Florian Balz

How did the interest rate risk influence the German real estate economy?

Abstract

The German residential real estate market has thrived in recent decades, driven by low-interest rates, demand and supply factors. However, concerns arise about the impact of changing interest rates. This paper explores the nature of interest rate risk and its effects on the German real estate market. Interest rate risk, affecting instruments and portfolios, extends to residential real estate. Interest rate changes can affect mortgage costs, influencing demand and prices. It can alter investors' decisions and project development. While the effects of interest rate risk can lead to market changes, they are not expected to cause a collapse. The market's stability is not immune to interest rate risk, as research suggests an 11% overvaluation. Understanding the interplay between interest rate risk and the German real estate market is vital for risk management. Demographic trends, regional differences, and the market's ability to manage interest rate risk are key factors in its future. In conclusion, this paper underscores the intricate relationship between interest rate risk and the German residential real estate market, emphasising the need for ongoing research to gauge the market's vulnerability to changing interest rates and demographic shifts. Such analyses will provide a more comprehensive understanding of how interest rate risk influences real estate pricing and market dynamics.

Key words

JEL Classification

DOI

Introduction

The aim of this contribution is to work out to what extent interest rate risk affects the German residential real estate market. Real estate is difficult to compare with normal goods because of its location-specific nature, which makes the valuation and development of real estate prices more complex (Bull, 2020). Phases of a real estate boom are always accompanied by attractive financing conditions and interest rates (Gischer & Weiß, 2007). Conversely, existing real estate booms are slowed or ended by a deterioration in interest rate conditions. A good example of this is the United Kingdom at the end of the 1990s and the beginning of the 2000s. One experienced a long real estate boom that was eventually slowed down by interest rate hikes and warnings from international economic organisations (Gischer & Weiß, 2007). A change in interest rates was thus partly responsible for the end of the real estate boom in the UK – at that time. The so-called interest rate risk thus made its appearance here and lived up to its name.

If one looks at the development of the German real estate market over the past two decades, massive price increases that persisted over a very long period quickly become apparent (Budde & Micheli, 2013). This was favoured, among other things, by the historically long-lasting low-interest phase. The question that many experts have been asking for some years now is how prices in Germany will develop further once the low-interest phase ends and a change in interest rates occurs. What will happen to the German real estate market if the interest rate risk, which is essential for banks and other financial institutions (Alessandri & Drehmann, 2010), becomes reality?

This paper examines the impact of interest rate risk on the German real estate market. The aim is to understand the impact of interest rate changes on financial instruments, financial institutions and households. The development of the real estate market in Germany since 2000 is analysed and its stability compared to other countries is examined. In addition, the specific impact of interest rate risk on real estate prices, demand and investment behaviour is highlighted. The paper identifies potential risks and opportunities for various actors and examines the macroeconomic implications. Overall, it aims to provide a comprehensive understanding of the relationship between interest rate changes and the German real estate market.

This study has shed detailed light on the interactions between the German real estate market and interest rate risk. As a result of this analysis, several crucial findings were obtained. First, the historical stability of the German real estate market was confirmed compared with other countries. Despite isolated speculative price developments, especially in metropolitan areas,

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the market remained comparatively resilient to macroeconomic shocks and turbulence. Second, interest rate risk has been identified as a key factor influencing the real estate market. A change in interest rates can have a significant impact on the financing costs of real estate purchases. An increase in interest rates can lead to higher monthly payments and thus reduced demand for real estate, while lower interest rates can boost demand. Third, banks and financial institutions, because of their large portfolios of fixed-income securities, have been found to be particularly vulnerable to interest rate risk. A change in interest rates can significantly affect their financial condition and net margins. Fourth, it has been shown that interest rate risk not only affects demand and prices in the real estate market, but also has an impact on investment decisions by market participants. When interest rates rise, investors tend to withdraw their capital from the real estate market and redirect it to higher-yielding investments. Finally, it was pointed out that there are regional differences in the development of the German real estate market. While urban centers with positive employment prospects saw price increases, shrinking regions saw lower demand. Interest rate risk could exacerbate these regional differences. In summary, interest rate risk plays a significant role in the German real estate market and affects various market players. The findings provide valuable insights into the complexity of this relationship and serve as a basis for further research and the development of risk management strategies.

In this academic paper, we will first take a closer look at the nature of interest rate risk and its implications. In addition, the relevant aspects of the German real estate market development from the past two decades will be listed. The focus is exclusively on the development of residential real estate prices. Following the explanation of the two topics, the acute interest rate risk for the German real estate market will be evaluated on the basis of various literary works and historical crises. The literature currently focuses primarily on interest rate risk with respect to banks (Alessandri & Drehmann, 2010; Entrop et al., 2008) or small business (Vickery, 2008). In this context, the state of knowledge on a link between interest rate risk and the real estate market is less developed. The summary and conclusion of this paper also discusses in more detail what further research on this topic might look like and what developments can be expected as a result of the interest rate change that took place in 2022.

1 The interest rate risk

Interest rate risk refers to the risk that interest rates in the market may change, thereby adversely affecting the performance of financial instruments, such as bonds or loans, with respect to portfolio risk (Piepelow, 1991). It usually arises due to the fact that the value of bonds and other fixed income instruments is inversely correlated with interest rates. When interest rates

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rise, this leads to a loss in value of existing bonds with lower interest coupons compared to current market rates (Piepelow, 1991). Various definitions in the literature differ widely on this topic. For example, these definitions can be divided into stock-oriented definitions (statistical approaches) and fixed-interest risk-oriented approaches (Piepelow, 1991). Other authors rather speak of a value approach or a cash flow approach (English, 2002). In this paper, we rather work with a fixed interest rate risk oriented approach.

However, interest rate risk does not only affect bonds, but can also have an impact on other financial products, such as loans, mortgages and derivative instruments. Institutions such as banks and insurance companies are particularly vulnerable to interest rate risk, as they often hold large portfolios of fixed-income securities. Looking more closely at the bank, a bank's interest rate risk reflects the extent to which its financial condition is affected by changes in market interest rates (English, 2002). Banks with riskier loans and higher interest rate risk tend to set lending and deposit rates to achieve higher net interest margins. In this context, commercial banks' net interest margins are affected by both default risk and interest rate risk premia (Angbazo, 1997).

However, interest rate risk is not identical for every bank, in every country. Various studies have already shown that there are differences in the level of interest rate risk across countries (Madura & Zarruk, 1995). This fact suggests that capturing differences in interest rate risk is important in setting risk-based capital requirements for international banks (Madura & Zarruk, 1995). Moreover, this also underscores the point that both domestic and international interest rates must be considered when assessing the risk profiles of banks from different countries (Madura & Zarruk, 1995). It should be added at this point that there are differences in interest rate risk across banks of different sizes and banking groups (Entrop et al., 2008).

However, interest rate risk is not only important for banks and other financial institutions. For example, households are also strongly affected by interest rate risk (Van Hemert, 2010). A study by Van Hemert analyzed the way households manage interest rate risk using a life-cycle asset allocation model that takes into account mortgage and bond portfolio choices. The research showed that the majority of investors prefer adjustable-rate mortgages because they can save the bond risk premium associated with fixed-rate mortgage payments (Van Hemert, 2010).

Over the past decades, banks and regulators have already spent a great deal of time and effort developing systems to monitor and manage interest rate risk (English, 2002). If appropriate measures are not taken for interest rate risk, the consequences can be significant. Examples include the secondary banking crisis in the United Kingdom in the 1970s and

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the sharp decline in net interest margin at U.S. savings banks in the early 1980s, when interest rates rose to historic highs (English, 2002).

In general, banks earn returns for their shareholders by accepting and managing risk, including the risk of loan defaults or changes in interest rates that can narrow the interest rate spread between assets and liabilities (Wright & Houpt, 1996). Historically, loan defaults have caused the largest losses for commercial banks, while interest rate spreads have remained relatively stable even during periods of high interest rate volatility (Wright & Houpt, 1996). In contrast, a 2018 study showed that bank stock prices decline following an unanticipated increase in interest rates or steepening of the yield curve (English et al., 2018). This subsequently leads to problems for banks and their shareholders.

2 The German real estate market

This chapter takes a look at the development of the German real estate market since 2000. The focus is exclusively on the German residential real estate market. When real estate prices change, especially when they rise, this has a major impact on the different strata of the population and their purchasing power (Bull, 2020). This is because (residential) real estate markets have a major impact on the economy, price levels and financial market stability. They affect aggregate demand and also influence the credit decisions of private households (Gischer & Weiß, 2007). Real estate prices are influenced by demand-side and supply-side factors. Demand-side factors include, for example, demographic trends, household structures, economic conditions and preferences (Westermeier & Grabka, 2017). Supply-side factors, on the other hand, include, for example, construction activity, availability of building land, prices in surrounding regions, infrastructure development and housing equality (Westermeier & Grabka, 2017).

Various studies assume a declining population in many regions of Germany (Westermeier & Grabka, 2017; Bräuninger & Otto, 2006; Zabel, 2022). As a consequence, this would also affect the real estate market, as a lower number of buyers would also lead to a lower amount of demand. This would force real estate prices to fall. In shrinking regions in particular, the problem exists anyway that existing residential properties cannot be marketed sufficiently due to a lack of demand (Zabel, 2002). Accordingly, it becomes necessary to develop options for action in order to be able to guarantee the long-term marketability of the corresponding residential properties in shrinking regions.

In general, however, real estate prices in Germany have first risen massively in recent years. This also applies to residential real estate. Reasons for this are, for example, the robust

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economic development, the low interest rate level (until 2022), protection against inflation (even low inflation can no longer be detected in Germany in 2023) and immigration (Budde & Micheli, 2013). Even during the 2008 financial crisis, the German real estate market shone with stability, although transaction volumes were very volatile from 2005 onwards (Just & Maennig, 2017). Due to this stability, risk-averse national and international investors started to invest in almost all German real estate classes (Just & Maennig, 2017).

Back to real estate price increases. Urban centers with good employment prospects are particularly affected by price increases, which have a positive impact on disposable incomes and purchasing power (Budde & Micheli, 2013): Speculative real estate price developments entail considerable risks in this context and have been a recurring topic in Germany in past debates (Kholodilin et al., 2014). Concerns about speculative exaggerations are mostly based on experiences in other countries such as the United States or Spain (Kholodilin et al., 2014).

Until around 2010, the German regional housing market is said to have experienced price developments in line with economic developments. In the following six years, however, price developments were increasingly driven by supply shortages and rising demand, especially in large cities (Dahl & Goralczyk, 2017). Asylum seekers, of which around 890,000 arrived in Germany in 2015, leading to a population growth of around 1.00%, also increased demand for affordable housing in the short to medium term (Dahl & Goralczyk, 2017).

In Berlin, for example, the development of rent prices for apartments in recent years led to a rent cap, which, however, was already declared unconstitutional by the Federal Constitutional Court on April 15, 2021, as the competence to legislate in rent price law lies with the federal government and not with the city or state of Berlin (Arlia et al., 2022). Accordingly, the rent cap lasted only one year (introduced on February 23, 2020)(Arlia et al., 2022). However, this experiment illustrates that real estate prices in Germany have developed so strongly in recent years that such measures have been demanded by parts of the population. Such real estate price development was favored by a historically long-lasting low interest rate environment. However, the low interest rate environment disappeared into thin air last year and there is no sign of it in 2023 either. Currently, interest rates for real estate financing in Germany are around 3.42% with a fixed borrowing rate of 10 years (Dr. Klein Privatkunden AG, 2023). At the same time last year, for example, interest rates were "only" around 2.52% with a fixed borrowing rate of 10 years (Dr. Klein Privatkunden AG, 2023). So the question at this point is, what risks do changes in interest rates pose for the German residential real estate market?

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3 How did the interest rate risk influence the real estate economy in Germany?

The particular stability of the German housing market compared with other countries is repeatedly highlighted in the literature by various authors (Voigtländer, 2013). In the 2000s, there were cycles of excessive boom and bust in the housing market. However, not all countries experienced high volatility in house prices. Germany was characterized by stable prices throughout this period, which did not react to macroeconomic shocks (Voigtländer, 2013). This stability is often justified by real estate financing and the existence of a sophisticated rental market. While in other countries monetary policy stimulus is effectively passed on to the real economy through the housing market, the German emphasis on prudent lending insulates the housing market from distortions in financial markets (Voigtländer, 2013). This finding by Voigtländer indicates at first glance that a change in interest rates should not pose a serious risk to the German residential real estate market, as real estate financing policies already deal with this issue cautiously.

From 2014 to 2019, real estate prices in Germany rose significantly faster than consumer prices, with the exception of a single quarter. As a result, concerns have arisen about excessive overheating of the real estate market (Hertrich, 2019). An empirical application during this data period subsequently outlined that the German real estate market is overvalued by about 11%. The main factors that have driven this imbalance have been identified as interest rate risk and a relatively advanced stage of the real estate cycle, while a solid debt servicing capacity has mitigated these imbalances since late 2009 (Hertrich, 2019). Taking a closer look at these facts, it becomes clear that despite the "stabile lending" of the German banking sector, interest rate risk (among other factors) has led to an 11% overvaluation as of 2019. Accordingly, prudent handling of the interest rate issue is not sufficient to cushion serious consequences of the interest rate risk.

Real estate derivatives represent a special case in this regard. Although real estate markets account for a large share of developed countries' total assets, real estate derivatives markets often lag behind in terms of trading volume and liquidity (Fabozzi et al., 2009). The 2000s also saw increasing activity in the development of derivative instruments that can be used by asset managers to manage real estate risk (Fabozzi et al., 2009). Some experts speak of a fundamental stability that cannot be shaken by a change in interest rates (Voigtländer, 2013), and others have spoken of regionally overheated prices for many years (Hertrich, 2019). The question now is specifically what influences interest rate risk can have on the German residential real estate

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market exactly and who these effects will hit particularly hard. Interest rate risk in general can have a significant impact on affected market participants (Sweeney & Warga, 1986). A change in interest rates directly affects the cost of mortgage loans. When interest rates rise, monthly payments on existing and new loans become more expensive as a result. This may discourage potential buyers from purchasing real estate because financing costs increase. It can also lead to a decline in demand for real estate, which in turn affects the real estate market.

In addition, interest rate risk can also have a direct impact on real estate prices (Chaney & Hoesli, 2010). If interest rates rise, many potential buyers may be discouraged from purchasing real estate because monthly payments would be higher. This could also lead to a decrease in demand for real estate, which in turn could lead to a decrease in real estate prices. On the other hand, falling interest rates may increase demand for real estate and lead to rising prices. Thus, interest rate risk can also have positive effects in the real estate context if interest rates change in the "right" direction. For example, if we look at the real estate boom in the early 2000s and previous years, it was accompanied by strong credit growth among households (Gischer & Weiß, 2007). Accordingly, when interest rates are good, this often leads to a real estate boom. Conversely, however, it also leads to stronger household debt.

In this context, it makes sense to look at the development of real estate prices in Germany after the global economic crisis of 2008. A continuous price increase can be clearly seen here. The more interest rates have fallen in the same period, the more real estate prices have risen. The following chart also illustrates this observation:

Figure No. 1: Development of the real estate index since 2008 according to bulwiengesa
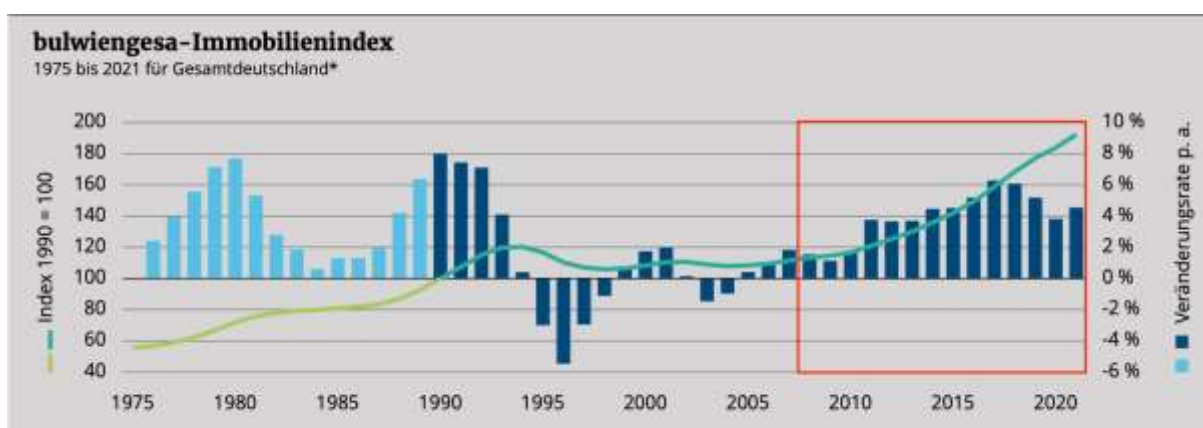
Source: bulwiengesa AG (2022).
Translation: bulwiengesa-Immobilienindex = bulwiengesa real estate index; 1975 bis 2021 für Gesamtdeutschland = 1975 to 2021 for All of Germany; Veränderungsrate p.a. = Rate of change p.a.

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bulwiengesa is an independent market research company that has been analyzing the German real estate market for over 45 years and compiles an annual price index. Year after year, it has identified price increases and also regular record values. In order to determine specifically how strongly interest rate changes will affect property prices in Germany, the rate of price increases between 2022 and 2023 can be calculated. The following equation can be used to determine the rate of price increases.

(1)   P = (VPI2 / VPI1 - 1) * 100

Data from immowelt.de was used to determine the price increase rate. Immowelt is the second largest German online platform for real estate listings for rent and purchase. It is important to note that the data used are the asking prices for residential properties for sale. While positive price increase rates were recorded every year in previous years, the rate of change from 2022 to 2023 is negative again for the first time. After analysing all 401 districts in Germany, the following average can be determined for the 16 German federal states:

Table No. 1: Price rate change of the 16 German federal states

Federal state	Rate of price change (2022 → 2023)
Baden-Wuerttemberg	-5,66%
Bavaria	-5,10%
Berlin	-2,04%
Brandenburg	-5,02%
Bremen	-8,46%
Hamburg	-8,59%
Hesse	-4,70%
Lower Saxony	-5,88%
Mecklenburg-Western Pomerania	-1,49%
North Rhine-Westphalia	-4,57%
Rhineland-Palatinate	-1,85%
Saarland	3,80%
Saxony	-1,68%
Saxony-Anhalt	1,08%
Schleswig-Holstein	-9,10%
Thuringia	3,45%

Source: Author's calculation based on data from immowelt.de (2023)

As can be seen from the table, the massive rise in interest rates has had an initial dampening effect on real estate prices and in this sense illustrates the relevance of interest rate risk for the German real estate market. It should be emphasised that the change in interest rates has led to a fall in prices in 13 of the 16 German federal states. Only in Saarland, Saxony-Anhalt and Thuringia did prices continue to rise. Nevertheless, the price increases here are also significantly lower than in previous years. At this point, it is questionable whether this negative

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trend will continue if interest rates remain constant and whether a correction in market prices can be assumed.

Moreover, interest rate risk can and should also influence investors' investment decisions (Chaney & Hoesli, 2010). When interest rates rise, investors may tend to withdraw their money from the real estate market and divert it to other types of investments in higher yields. This could be particularly significant for institutional investors in real estate, such as insurance companies and pension funds (Chaney & Hoesli, 2010). As a result, this could lead to a reduction in the volume of investment in the real estate market. However, the impact of interest rate risk is not only relevant for existing properties, but also for those that are still being developed. Interest rate risk can also have an impact on project development (Reed, 2021). If interest rates rise, financing costs for project developers may increase, which could affect the profitability of real estate projects. This could lead to a reduction in the number of new construction projects, limiting the supply of real estate. Given the existing construction backlog of almost 850,000 apartments (Federal Institute for Research on Building, Urban Affairs and Spatial Development (original name: "Bundesinstitut für Bau-, Stadt- und Raumforschung"), 2022), such an impact of the interest rate risk would be fatal.

It therefore remains to be noted that interest rate risk can have various effects on the residential real estate market and its participants. In general, however, it should also be noted that the effects cannot cause a market collapse. Rather, they are consequences that can lead to an increase or decrease in demand, supply and prices. Accordingly, there may be greater changes in market events. However, one should not expect a collapse as a result. At this point, the German real estate market has already proven its stability in various crises. In general, however, an accurate measurement of interest rate risk is of great importance for appropriate risk management (Sweeney & Warga, 1986). For example, one can measure interest rate risk with duration analysis. This measure is also recommended to banks in part as part of their risk management to reliably measure and manage their interest rate risk and maximize their long-term profits (Sweeney & Warga, 1986).

But the real estate market, and in particular its housing prices, can also have a major impact on monetary policy decision making and implications for economic activity and price developments the other way around. In the 2000s, for example, the sharp rise in house prices in the United States was the starting point of the debate on real estate markets and their influence on interest rate decisions (Gischer & Weiß, 2007). The bursting of the price bubble in the U.S. housing market at that time led to global financial market turmoil and subsequently to the global economic crisis. Thus, the macroeconomic relevance of real estate markets became clear

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(Gischer & Weiß, 2007). It is therefore questionable whether real estate prices have a stronger influence on a change in interest rates than the other way around.

Conclusion and Outlook

Now that the nature of interest rate risk, the development of the German residential real estate market and the interplay between these two aspects have been discussed in detail, this summary is intended to highlight the key points once again and provide an assessment of how the German real estate market could develop in the coming years.

Interest rate risk can have a significant impact in various areas. It plays a major role for banks (Alessandri & Drehmann, 2010), small businesses (Vickery, 2008) and also for the real estate market and its market participants (Sweeney & Warga, 1986). In the introduction to the topic, it was already pointed out that real estate is difficult to compare with other goods due to its location-specific nature and that the valuation and development of real estate prices is therefore complex (Bull, 2020). Real estate booms are often accompanied by attractive financing terms and interest rates, and changes in interest rates can influence the real estate boom in the process (Gischer & Weiß, 2007). The end of the real estate boom in the United Kingdom also coincided with a deterioration in interest rate conditions.

Interest rate risk refers to a possible change in interest rates on the market and the associated - possible - negative performance of financial instruments, which can affect portfolio risk (Piepelow, 1991). In this context, interest rate risk affects not only bonds but also other financial products such as loans and mortgages. Banks and other financial institutions are particularly vulnerable to interest rate risk (English, 2002), but households are also affected by interest rate risk (Van Hemert, 2010). In recent years and decades, banks and regulators have already spent considerable time and effort developing systems to monitor and manage interest rate risk (English, 2002).

Boosted by the prolonged period of low interest rates, the German real estate market and its prices for residential property have risen sharply over the past two decades (Budde & Micheli, 2013). Especially in metropolitan areas with good employment prospects, real estate price increases are clearly noticeable (Budde & Micheli, 2013). Based on such observations, various experts repeatedly point to the speculative exaggerations that have been observed in other countries in the recent past (Kholodilin et al., 2014).

The objectives of this study as formulated in the introduction were carefully examined in the course of the work. The main objective was to understand and quantify the impact of interest rate risk on the German real estate market. This research has shown that interest rate

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risk does indeed have a significant impact on the real estate market in Germany, both on prices and on demand. It has been confirmed that changes in interest rates have a significant impact on the financing costs of real estate purchases and the investment decisions of market participants. In this sense, it was concluded that the first objective of this study was successfully achieved. Another objective was to analyse the stability of the German real estate market in comparison with other countries. The results have shown that the German real estate market has indeed been historically more stable than many other markets. Despite speculative price developments and regional differences, it has been able to withstand macroeconomic shocks and turbulence. This confirms that the stability of the market is a remarkable feature.

Finally, the objective was to identify potential risks and opportunities for different players in the real estate market and to analyse the macroeconomic impact of interest rate changes. The research findings suggest that banks, financial institutions, households, and investors are all affected by interest rate risk to varying degrees. This allows risk management strategies to be developed and the impact of interest rate changes to be better understood. In summary, this study has successfully achieved the objectives set out in the introduction. It has provided valuable insights into the relationship between interest rate changes and the German real estate market and offers a basis for further research in this area. Moreover, it has underscored the urgency of effective risk management for market participants and the importance of maintaining the stability of the real estate market in Germany.

The question now, however, is where these observations might lead in the future. Based on the information presented, there is an end to the low interest phase. The German real estate market has benefited from the historically low interest phase over the past decades. An end to this phase and a change in interest rates could have an impact on real estate prices. If interest rates rise, this could lead to an increase in financing costs and affect demand for real estate. The vulnerability of banks and other financial institutions could also cause problems. As mentioned previously, banks and other financial institutions are particularly vulnerable to interest rate risk. A change in interest rates can affect their financial condition and net interest margins. Accordingly, an increase in interest rates could lead to problems for banks and their shareholders.

In addition, regional differences must not be ignored when considering possible future problems. The German real estate market has developed very differently from region to region. While there have been strong price increases in conurbations with good employment prospects, there are already problems marketing residential properties in shrinking regions. A change in interest rates could reinforce these regional differences. Speculative price developments and

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possible exaggerations have already been a regular topic of various debates and publications in recent years. Concerns about such exaggerations are mostly based on experiences in other countries. A change in interest rates could have an impact on speculative real estate markets.

Finally, demographic developments should also be taken into account when analyzing this topic. This is because demographic trends in Germany, particularly in shrinking regions, have an impact on the real estate market. A smaller population can lead to lower demand and a possible drop in prices. It is important to note, however, that the existing literature only sparsely examines the relationship between interest rate risk and real estate. A comprehensive outlook on this issue requires a careful analysis of current market trends, economic indicators, and policy decisions that go beyond the previous literature and this paper. Once an appropriate analysis is available, a more qualified statement can be made about how much interest rate risk actually affects real estate pricing.

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v České republice

Abstrakt

Nemovitostní trh ovlivňuje celá řada faktorů, a to jak těch, které můžeme předpovědět (např. hospodářský vývoj země, populační vývoj, úrokové sazby z vkladů, zásahy a regulace ČNB apod.), tak i těch, jejichž předpověď je složitější (např. tlak médií, zahraniční vývoj, očekávání a nálada trhu apod.). Tento příspěvek je zaměřen na vyhodnocení vlivu inflace a úrokové sazby na nemovitostní trh v České republice. Cílem příspěvku je na základě provedených analýz vyhodnotit, zda a jaký má inflace a úroková míra vliv na nemovitostní trh v České republice. Pro analýzu dat byla v příspěvku využita dvoustupňová metoda nejmenších čtverců a statistické hodnocení prostřednictvím autoregresního integrovaného klouzavého průměru. Výsledky ukazují, že při kladné změně cenové hladiny v minulém roce o 1 procentní bod vzroste cena nemovitostí o 0,11 %. Dále z výzkumu vyplývá, že při 1% změně 2 T Repo sazby, vzroste cena nemovitostí o 0.14 %.

Úvod

Situace na realitním trhu je ovlivňovaná mnoha ekonomickými, politickými, sociálními, demografickými, kulturními a dalšími faktory. Nemovitostní trh spadá do ekonomického odvětví stavebnictví (dává práci stavebním firmám, výrobcům stavebních materiálů, dopravcům apod.), obchodu (realitním makléřům, administrativním pracovníkům, bankám apod.). Nemovitosti lze považovat za poměrně specifický druh zboží s existencí vlastního trhu,

který je citlivý na celkové tržní prostředí, jeho cyklický vývoj (růst, krize) a na mimoekonomické aspekty, jako je politické a právní prostředí (Ort, 2019). Na základě provedených empirických analýz je doložitelné, že makroekonomické ukazatele mají značný vliv na tvorbu cen nemovitostí.

Realitní trh v bývalých socialistických zemích má řadu společných rysů. Jedná se například o privatizace, masivní regulace, málo rozvinutý finanční trh, restituce majetku apod. Tyto jevy zapříčinily nerovnováhu na trhu s nemovitostmi a časté dynamické změny. Výše zmíněné změny byly také v posledních letech umocněny pandemií Covid-19, válkou na Ukrajině a energetickou krizí (Hromada, et al., 2022).

Vývoj nemovitostního trhu je nepochybně provázaný s vývojem celé ekonomiky (Kauškale & Geipele, 2014). Odborníci tvrdí, že nemovitostní trh a ceny nemovitostí jsou úzce spojeny s hospodářskými cykly. Makroekonomické změny mohou významně určovat velikost a směr pohybu cen nemovitostí v zemi a mají důležité politické implikace (Duan, et al., 2018). Dle Ciarloneho (2015) může mít neočekávaný kolaps realitního trhu negativní dopad na makroekonomické faktory a finanční stabilitu státu. Dle Hromada, et al. (2023) lze pozorovat vyšší rigiditu cen směrem dolů v luxusním segmentu trhu nemovitostí a také u regionů s vysokými cenami nemovitostí (např. Praha, Středočeský kraj apod.). Cílem příspěvku je na základě provedených analýz vyhodnotit, zda a jaký má inflace a úroková míra vliv na nemovitostní trh v České republice. Budou zodpovězeny tyto výzkumné otázky:

VO1: Ovlivňuje vývoj inflace trh nemovitostí v ČR?

VO2: Ovlivňuje výše úrokové sazby nemovitostní trh v ČR?

Statistickými metodami budou testovány tyto hypotézy:

H1: Zvýšení inflace o 1 procentní bod zvýší cenu nemovitostí v ČR o 0,027 % (při stanovení výše byl využit výzkum Gholipouret, et al., 2014).

H2: Zvýšení úrokové sazby o 1 % sníží cenu nemovitostí v ČR o 0,036 % (při stanovení výše byl využit výzkum Zhao, et al., 2022).

Příspěvek bude uspořádán následovně. V *části teoretická východiska* budou uvedeny pohledy světových autorů a metodou rešerše textů budou představena teoretická východiska k dané problematice. V části *data a metody* budou popsána data a metody, které byly využity k analýze dat. V části *výsledky* budou představeny výsledky výzkumu. *Závěr* shrne získané poznatky.

1 Teoretická východiska

V posledních desetiletích vzrostl význam ceny nemovitostí pro několik subjektů na trhu nemovitostí. Těmi jsou např. investoři, developeři, prodávající, regulační orgány, vlády apod. Finanční cykly jsou v zemích s vysokou mírou vlastnictví nemovitostí větší a delší a trh s nemovitostmi je hlavním zdrojem rizika při mezinárodních strukturálních bankovních krizích (Runstler, 2016). Vzhledem k tomu, že prodejní ceny bytů v uplynulých letech vzrostly tak, že jsou v současné době pro velkou část obyvatelstva nedostupné, developeři, investoři i místní úřady se budou snažit najít jiné cesty, jak řešit bytovou krizi. Pozornost se proto přesouvá například na projekty určené pro nájemní bydlení (Stanko, 2023).

1.1 Vliv inflace na nemovitostní trh pohledem světových autorů

Většina autorů se shoduje na tom, že veličinou, která má významný vliv na cenu nemovitostí, je inflace (Latif, et al., 2020, Bahmani-Oskooee & Wu, 2018, Morley, 2015). Jedním z poznatků je, že po obdobích, kdy inflace rostla a klesala, dochází k vzestupu cen bydlení (Andrewse, 2010). Nielsen & Sorensen (1994) uvádí, že růst inflace vede k růstu cen nemovitostí. Gholipouret, et al. (2014) zkoumali soubor zemí OECD od roku 1995 až do roku 2008 a dospěli k závěru, že zvýšení inflace o 1 %, zvýší cenu nemovitostí o 0,027 %. Oproti tomu existují studie Tsatsaronis & Zhu (2004) a Berlemann & Freese (2013), které uvádí, že při vyšší inflaci se růst cen nemovitostí zpomaluje. Jak uvádí Hong & Lee (2013), když je inflace vysoká, reálné i nominální úrokové sazby budou vysoké, budoucí peněžní toky budou silně diskontované a ceny nemovitostí budou nižší. Ceny nemovitostí vykazují především silnou sestupnou cenovou přilnavost, protože v období recese nikdo neprodává svou nemovitost pod určitou cenu. Proto mají ceny nemovitostí v období inflace tendenci spíše klesat (Adams & Füss, 2010).

1.2 Vliv úrokové sazby na nemovitostní trh pohledem světových autorů

Vliv úrokové sazby na cenu nemovitostí byl již v minulosti několikrát prokázán. Vonlanthen (2023) v letech 2005 až 2018 zkoumal souvislost mezi úrokovými sazbami a cenami nemovitostí ve Švýcarsku. Při posuzování mediánových cen zkoumal šest skupin nemovitostí a to: nájemní byty, byty obývané vlastníky, rodinné domy, kancelářské prostory, průmyslové nemovitosti a prodejní plochy. Výsledky ukazují, že pokles variabilních úrokových sazeb hypoték o 1 p.b. zvyšuje mediánové ceny domů o 1,5 % a ceny vlastnických bytů o 2,3 %. V podobném časovém horizontu snížení fixních úrokových sazeb hypoték o 1 p.b. zvýší mediánové ceny domů o 1,0 % a mediánové ceny bytů obývaných vlastníky o 1,8 %. Výsledky studií Adelino, et al. (2012) a Justiniano, et al. (2018) naznačují, že pokud klesá úroková sazba,

tak cena nemovitostí roste. Dalším zjištěním autorů Sutton, et al. (2017) je, že reálné ceny domů ve Spojených státech v období 1970 až 2015 se po třech letech zvýšily přibližně o 8 % v reakci na 1% pokles nominální krátkodobé úrokové sazby. Recese na trhu s bydlením je velmi pravděpodobná, pokud bude růst úrokových sazeb pokračovat (Lee & Park, 2022). Oproti tomu Fortura & Kushner (1986) provedli analýzu s využitím dat z 30 měst v Kanadě, vytvořili model měření a zjistili, že úrokové sazby pozitivně ovlivňují ceny bydlení. Song, et al. (2014) zjišťují, že reálné úrokové sazby významně a pozitivně souvisejí s reálnými cenami bydlení.

Ambivalentní postoje k vlivu inflace a úrokové sazby na nemovitostní trh dle světových autorů je uveden v Tabulce č. 1.

Tabulka č. 1: Ambivalentní postoje autorů zkoumajících vliv makroekonomických veličin na nemovitostní trh

Makroekonomický ukazatel	Pozitivní vztah	Negativní vztah
Inflace	Goetzmann & Valaitis, (2006), Naji Meidani, et al., (2011), Gou, et al., (2015), Kuang & Liu (2015), Umar et al. (2019).	Bjørnland & Jacobsen, (2010), Arestis & González, (2014).
Úroková míra	Fortura & Kushner (1986), Kenny (1999), Shi, et al. (2014), Song, et al. (2014), Bollard & Smith (2006).	Kau & Keenan (1980), Harris (1989), Reichert (1989), Adelino, et al. (2012), Berlemann & Freese (2013), Sutton, et al. (2017), Justiniano, et al., (2018), Cevik & Naik (2022), Vonlanthen (2023).

Zdroj: Vlastní zpracování

Důležité je také zmínit vztah mezi inflací a úrokovou mírou. Teoretické kořeny vztahu mezi úrokovou mírou a inflací sahají až k Fisherovi (1930) Fisherova hypotéza předpokládá, že nominální úrokové sazby a očekávaná míra inflace mají pozitivní vztah, stejně jako kauzalitu od míry inflace k úrokovým sazbám. Ayub et al. (2014) v návaznosti na Fisherovu hypotézu předpokládají, že mezi inflací a úrokovou mírou existuje pozitivní vztah v každé ekonomice na světě. Výsledky studie Khumalo et al., (2017) ukázaly, taktéž že mezi úrokovými sazbami a inflací existuje pozitivní vztah.

Centrální banky reagují na výši inflace především prostřednictvím změny úrokových sazeb. Česká národní banka zvedá základní úrokovou sazbu a tím se snaží bojovat proti inflaci. Nastavuje svoji měnovou politiku zejména prostřednictvím tří úrokových sazeb. Klíčovou je

tzv. limitní úroková sazba pro dvoutýdenní repo operace, ve zkratce označovaná jako 2T repo sazba. Úrokový kanál pak působí přímo na chování firem i domácností. V případě růstu úrokových sazeb centrální banky a následně tržních sazeb na mezibankovním trhu dojde postupně i k růstu klientských úrokových sazeb pro vklady a úvěry. Domácnosti při vyšších sazbách více spoří a méně si půjčují, a tedy méně nakupují. Je pro ně totiž relativně výhodnější svou spotřebu částečně odložit do budoucna. Poptávka po zboží a službách tak klesá, což se promítá do zpomalení inflace. Firmy zároveň čelí vyšším úrokovým nákladům svého financování a omezují tak výdaje na investice. Pokles spotřebitelské poptávky domácností a investičních výdajů firem pak vede k poklesu výroby v ekonomice jako celku. Dochází ke zpomalení ekonomického růstu, zpomalení růstu mezd a v konečném důsledku k poklesu inflace. Úrokový kanál je zesilován kanálem úvěrovým. Při zvýšení úrokových sazeb dochází k nárůstu výše splátek úvěrů a roste riziko nesplácení úvěrů. Banky tedy zpřísňují hodnocení rizikovosti svých klientů a zvyšují svoji rizikovou přirážku, čímž snižují dostupnost nově poskytovaných úvěrů. Výsledkem je další snížení spotřeby, investic, výroby, růstu mezd a následně inflace. Tyto kroky ovlivňují i cenu nemovitostí a realitní trh (Česká národní banka, 2023). Pro stabilní trh s hypotečními úvěry je důležité stabilní makroekonomické prostředí s nízkou inflací (Warnoc & Warnoc, 2008, Boamah, 2009, Krkoskova & Szkorupova, 2021).

2 Data a metody

Pro účely tohoto příspěvku byla zvolena následující data. Cena nemovitostí byla vysvětlena pomocí průměrného indexu nabídkových cen bytů, kde 2010 = 100 (Český statistický úřad, 2023). Úroková sazba byla vysvětlena 2T Repo v % sazbou ČNB (Česká národní banka, 2023). Jako ukazatel cenové hladiny byl zvolen deflátor v %, kde stejné období přechozího roku = 100 (Český statistický úřad, 2023). Pozorování probíhalo od čtvrtého kvartálu 2013 do třetího kvartálu 2023. Pro účely příspěvku bylo také stanoveno časové zpoždění 4 kvartály, jelikož nástroje monetární politiky se propisují do reálné ekonomiky se zpožděním 4 až 6 kvartálů (Slaný, 2003).

Metodologie je založena na modelech dvoustupňové metody nejmenších čtverců. Dvoustupňová metoda nejmenších čtverců je nejrozšířenější užívaná metoda poskytující (přinejmenším) konzistentní odhady strukturních parametrů regresních rovnic v interdependentních ekonometrických modelech (autoři metody: Theil, 1953, Bassman, 1957). Autoregresní integrovaný klouzavý průměr (ARIMA), je třída modelů časových řad, sloužících

k pochopení vlastností časových řad a k předpovědi jejich chování do budoucnosti. Rovnice modelu - byla použita viz Cipra (2014).

Dále byl využit Rozšířený Dickey-Fullerův test pro deflátor, cenu nemovitostí a 2T Repo sazbu, který zkoumá přítomnost jednotkového kořene. Rovnice modelu - byla použita viz Cipra (2014). Data byla zpracována v programu Gretl a výstupy byly převedeny do grafické či tabulkové podoby.

3 Výsledky

Je důležité zmínit, že Evropa od roku 2020 čelí několika po sobě jdoucím krizím. Nejdříve v roce 2020 pandemie Covid-19, která mimo jiné vedla k narušení globálních dodavatelských řetězců, dále geopolitické konflikty (rusko-ukrajinský konflikt, izraelsko-palestinský konflikt), energetická krize, celosvětová inflace atd. Všechny tyto události měly nepochybně vliv na světovou, ale i českou ekonomiku, na významné makroekonomické ukazatele – viz Tabulka č. 2.

Tabulka č. 2: Vývoj základních makroekonomických ukazatelů v ČR 2016–2022

UKAZATEL	2016	2017	2018	2019	2020	2021	2022
Meziroční růst/pokles HDP (%, stálé ceny 2015)	2,5	5,2	3,2	3,0	-5,5	3,6	2,4
Průměrná roční míra inflace (%)	0,7	2,5	2,1	2,8	3,2	3,8	15,1
Meziroční růst/pokles reálné mzdy (%)	3,7	4,2	5,9	5,0	1,4	1,9	-8,5
Obecná míra nezaměstnanosti (%)	4,0	2,9	2,2	2,0	2,6	2,8	2,2
Průměrný kurz koruny vůči euru	27,03	26,33	25,64	25,67	26,44	25,65	24,57
Saldo běžného účtu platební bilance k HDP (%)	1,8	1,5	0,4	0,3	2,0	-2,8	-6,1
Saldo hospodaření sektoru vládních institucí k HDP (%)	0,7	1,5	0,9	0,3	-5,8	-5,1	-3,2

Zdroj: Vlastní zpracování dle https://www.czso.cz/csu/czso/hmu_cr

Vývoj veličin zkoumaných ve vztahu k nemovitostnímu trhu je uveden na Obrázku č. 1. Lze jej komentovat následujícím způsobem: Ceny nemovitostí vykazovaly trend růstu od roku 2014 až do prvního kvartálu roku 2023. Deflátor vykazuje kolísavou tendenci. Od roku 2022 došlo k nárůstu cenového indexu. Úrokové sazby byly na nízkých hodnotách až do roku 2022. Česká národní banka v důsledku vysoké inflace zvedla 2T Repo sazbu v průměru na hodnotu 5,6 %.

Nulová hypotéza o přítomnosti jednotkového kořene byla zamítnuta, jelikož P hodnota > 0,05. Časové řady jsou tedy nestacionární, a proto byla data logaritmizována.

Obrázek č. 1: Vývoj makroekonomických ukazatelů
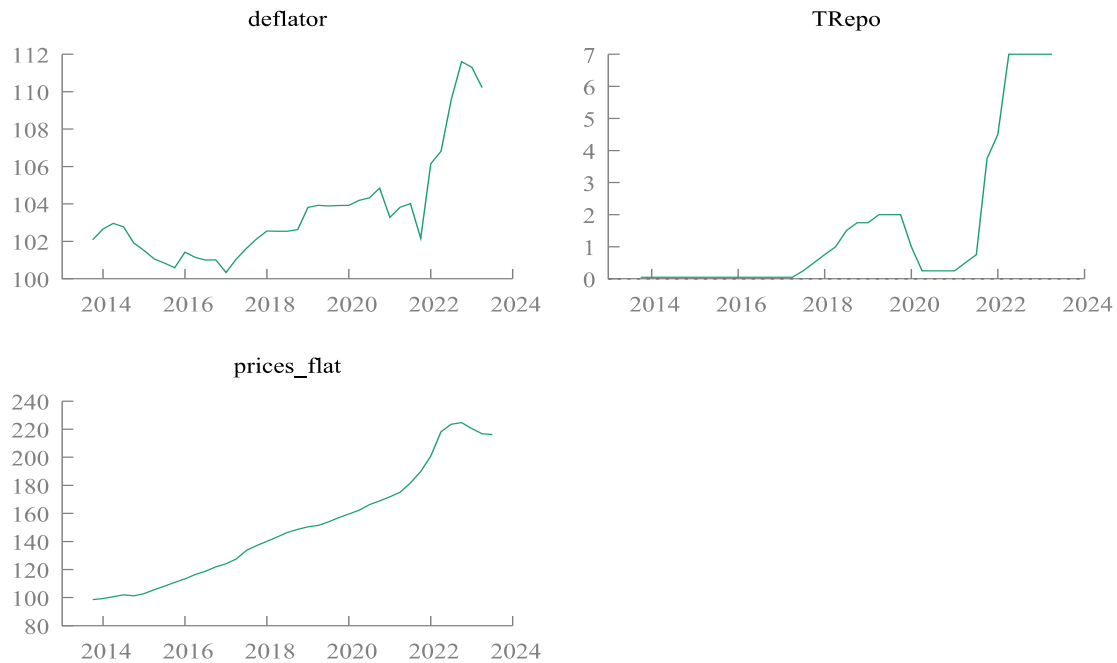
Zdroj: Vlastní zpracování dle ČNB 2023, ČSÚ 2023.

Dále byl proveden test korelační matice, výsledky jsou znázorněny na obrázku níže.

Obrázek č. 2: Korelační matice
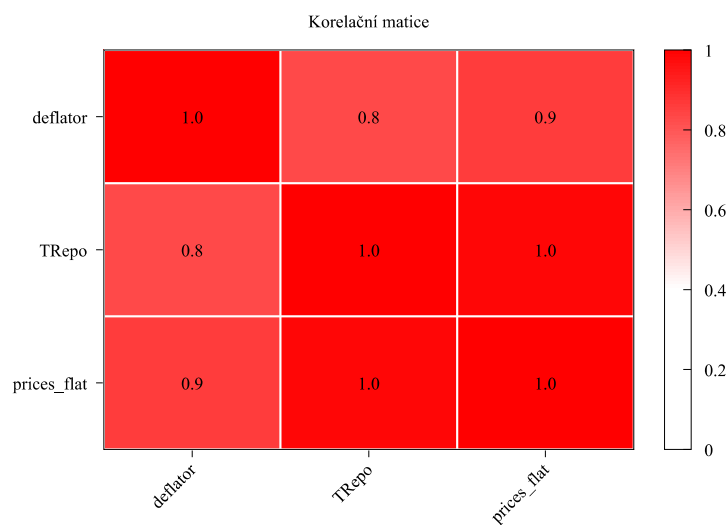
Zdroj: Vlastní zpracování

Korelační matice indikuje velmi silnou míru korelace a to od 0.8 do 1.0.

Dále byl sestaven TSLS model, který zkoumá vztah mezi cenou nemovitostí a deflátorem.

Model č. 1: TSLS model ve vztahu k deflátoru

Model 25: TSLS, za použití pozorování 2013:4-2023:3 (T = 40)

Závisle proměnná: l_prices_flat
Instrumentováno: deflator_4
Instrumentální proměnné: const TRepo_4
HAC standardní chyby, šířka okénka 2, Bartlettovo jádro

	Koeficient	Směr. chyba	t-podíl	p-hodnota	
const	−6.39795	3.08259	−2.076	0.0448	**
deflator_4	0.110731	0.0299834	3.693	0.0007	***

Sm. Chyba regrese	0.19136	Durbin-Watsonova statistika	0.362941
Koeficient determinace	0.493498	Adjustovaný koeficient determinace	0.480169
Hannan-Quinnovo kritérium	249.4457		

Zdroj: Vlastní zpracování. Koeficienty jsou statisticky významné. P-hodnota <0,05

Model potvrzuje pozitivní závislost mezi inflací a cenou nemovitostí. Pokud se deflátor zvýší o 1 procentní bod, vzroste cena nemovitostí se zpožděním o 4 kvartály o 0,11 %.

Dále byl sestaven TSLS model, který zkoumá vztah mezi Cenou nemovitostí a 2 T Repo sazbou.

Model č. 2: TSLS model k 2 T Repo sazbě

Model 30: TSLS, za použití pozorování 2013:4-2023:3 (T = 40)

Závisle proměnná: l_prices_flat
Instrumentováno: l_TRepo_4
Instrumentální proměnné: const deflator_4
HAC standardní chyby, šířka okénka 2, Bartlettovo jádro

	Koeficient	Směr. chyba	t-podíl	p-hodnota	
const	5.17300	0.0546786	94.61	<0.0001	***
l_TRepo_4	0.140358	0.0218963	6.410	<0.0001	***

Sm. Chyba regrese	0.158807	Durbin-Watsonova statistika	0.649738
Koeficient determinace	0.658719	Adjustovaný koeficient determinace	0.649738
Hannan-Quinnovo kritérium	230.1069		

Zdroj: Vlastní zpracování. Koeficienty jsou statistky významné. P hodnota <0,05.

Oskar Crnadak, Hana Lipovská
Vliv inflace a úrokové sazby na nemovitostní trh
v České republice

Model potvrzuje pozitivní zavilost mezi úrokovou sazbou a cenou nemovitostí. Pokud se 2T Repo sazba zvýší o 1 %, vzroste cena nemovitostí se zpožděním o 4 kvartály o 0,14 %.

Na základě provedeného výzkumu je možno konstatovat, že existuje pozitivní vztah mezi cenovým indexem a cenou bytových jednotek. Potvrzen byl také pozitivní vztah mezi úrokovou sazbou a cenou bytových jednotek.

Dále byl odhadnut model ARIMA, pro který bylo zvoleno 3Q/2020 až 2Q/2023. Sledované období bylo provázeno několika krizemi, docházelo k ekonomické recesi – probíhala například pandemie Covid-19, Rusko-Ukrajinský konflikt, energetická krize atd.

Model č. 3: ARIMA model

Model: ARMAX, za použití pozorování 2020:3-2023:2 (T = 12)

Estimated using AS 197 (přesné ML)
Závisle proměnná: l_prices_flat
Směrodatné chyby založené na Hessiánu

	koeficient	směr. chyba	z	p-hodnota	
const	5.25362	0.00187310	2805	0.0000	***
phi_1	0.179293	0.327253	0.5479	0.5838	
theta_1	−0.999999	0.218451	−4.578	4.70e-06	***
l_TRepo_1	0.0790085	0.00211085	37.43	1.29e-306	***
TRepo_4	−0.00250600	0.00129365	−1.937	0.0527	*

Koeficient determinace 0.981290	Hannan-Quinnovo kritétium −52.34878
Adjustovaný koeficient determinace 0.974273	

Zdroj: Vlastní zpracování

ARMA model (1,1) byl využit pro nastavení a vyhodnocení ex-post prognózy na posledním známém období 3Q/2023. Na základě dosažených výsledku bylo zjištěno, že chyba v logaritmickém vyjádření činila rozdíl -0,016. Po zpětné transformaci do indexu cen nemovitostí (2010=100), byl tento rozdíl -3,48 procentních bodů. Odchylka předpovědi od skutečnosti je 1,61 %.

Na výzkumné otázky lze odpovědět následujícím způsobem:

VO₁: Ovlivňuje vývoj inflace trh nemovitostí v ČR? Ano, inflace pozitivně ovlivňuje cenu nemovitostí v ČR.

VO₂: Ovlivňuje výše úrokové sazby nemovitostní trh v ČR? Ano, úroková sazba pozitivně ovlivňuje cenu nemovitostí v ČR.

Statistickými metodami byly testovány tyto hypotézy:

H₁: Zvýšení inflace o 1 procentní bod zvýší cenu nemovitostí v ČR o 0,027 %. (při stanovení výše byl využit výzkum Gholipouret, et al., 2014). K hypotéze se nelze přiklonit, protože pokud se cenová hladina v minulém roce zvýšila o 1 procentní bod, vzrostla cena nemovitostí o 0,11 %.

H₂: Zvýšení úrokové sazby o 1 % sníží cenu nemovitostí v ČR o 0,036 %. (při stanovení výše byl využit výzkum Zhao, et al., 2022 s). K hypotéze se nelze přiklonit, protože pokud se úroková sazba zvýšila o 1 %, tak cena nemovitostí vzrostla o 0,14 %.

Závěr

Příspěvek se zabýval vyhodnocením vlivu úrokové sazby a inflace neboli zvýšení cenové hladiny na cenu nemovitostí. V části teoretická východiska byla pozornost věnována pohledům světových autorů na danou problematiku a byly představeny názory jednotlivých autorů, které jsou shrnuty v Tabulce č. 1.

Cílem příspěvku bylo na základě provedených analýz vyhodnotit, zda a jaký má inflace a úroková míra vliv na nemovitostní trh v České republice. Cíl příspěvku je možno považovat za naplněný, jelikož se na základě provedeného výzkumu za použití dvoustupňové metody nejmenších čtverců podařilo prokázat pozitivní vztah mezi úrokovou mírou a cenou nemovitostí. Pozitivní vztah byl také potvrzen mezi růstem cenové hladiny a cenou nemovitostí. Při zvýšení cenové hladiny o 1 procentní bod, vzroste cena nemovitostí o 0,11 % a při 1% kladné změně 2T Repo sazby, vzroste cena nemovitostí o 0,14 %.

Na rozdíl od výše uvedených výsledků, aktuálně jsou všechny fundamenty, které mají vliv na realitní trh, negativní. Není tedy možné se domnívat, že ceny nemovitostí v blízké budoucnosti porostou. Trend poklesu se změní až s příchodem nižších úrokových sazeb na úrovni 3–4 % p.a. a to lze s ohledem na negativní vývoj inflace očekávat nejdříve v roce 2024. Do té doby je pravděpodobné, že budou ceny klesat. Bude následovat stabilizace a až se trend otočí, začnou opět ceny stoupat a to tempem +5 % za rok. Z toho je zřejmé, že na úroveň cen nemovitostí z vrcholu roku 2022 se trh dostane nejdříve za 5–6 let po změně trendu na trend růstu. To by se mohlo stát někdy v roce 2029–2030. Záležet bude samozřejmě také na lokalitě – lze očekávat, že ve větších městech bude propad cen menší, ale v menších městech a obcích nebo odlehlejších regionech ceny klesnou výrazněji. Vliv na cenu bude mít také kvalita a stáří nemovitosti (Šimon, 2023). Momentálně – dle Obrázku č. 1 – je trend cen nemovitostí v ČR sestupný. Bude proto zajímavé sledovat, analyzovat a vyhodnocovat faktory, které ovlivní jeho budoucí vývoj.

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Controlling jako významný faktor ovlivňující odolnost MSP

Abstrakt

Příspěvek je zaměřen na analýzu MSP a manažerských funkcí. Cílem tohoto příspěvku je na základě provedených analýz identifikovat klíčové funkce v managementu MSP, vyhodnotit roli controllingu jako významného nástroje ovlivňujícího odolnost MSP. Pro analýzu dat byla v příspěvku využita metoda korelační analýzy a metody deskriptivních statistik. Výsledky práce ukazují, že controlling nelze jednoznačně považovat za významný faktor ovlivňující odolnost MSP. Z výzkumu dále vyplývá, že nejvýznamnější manažerskou funkcí je schopnost delegování a nejméně významnou je controlling samotný.

Úvod

Malé a střední podniky (MSP) tvoří dle zprávy o vývoji podnikatelského prostředí v České republice za rok 2019 vydané Ministerstvem průmyslu a obchodu 99,8 % podílu všech aktivních podnikatelských subjektů. K 31. prosinci 2021 bylo evidováno celkem 2 976 264 ekonomických subjektů. Z toho bylo aktivních 1 590 149 a neaktivních 1 386 115. Nejvíce aktivních ekonomických subjektů tvořily fyzické osoby 1 120 597, následují obchodní společnosti 393 371, zemědělští podnikatelé 36 867, akciové společnosti 21 731, družstva 9 666 a státní podniky 68 (Ministerstvo průmyslu a obchodu, 2021). Evropský parlament výše uvedené potvrzuje i na celoevropské úrovni a uvádí, že více než 99 % podniků spadá do velikosti MSP a mikro podniků (Evropský parlament, 2022).

Podle Litvaj, et al. (2023) jsou MSP hlavním zdrojem podnikatelských dovedností, inovací a zaměstnanosti, ovšem často se potýkají s nedokonalostmi trhu. Začínající MSP mají často potíže se získáváním kapitálu. Jejich omezené zdroje mohou v konečném důsledku omezit přístup k novým technologiím a inovacím na celospolečenské úrovni. I z těchto důvodů je podpora schopností managementu MSP jednou z priorit Evropské komise pro hospodářský růst, tvorbu pracovních míst a hospodářsky-sociální soudržnost (European Commission, 2023). Litvaj, et al. (2023) v rámci MSP dále udávají funkce, které mají celospolečenský přesah. Těmi jsou funkce sociální, strukturální, dodavatelské, zaměstnavatelské a funkce zastánců společenské odpovědnosti. Tyto funkce zároveň potvrzuje MPO (2021) či European Commision (2023) a dodávají, že i z těchto důvodů je třeba MSP podporovat.

Na základě těchto údajů lze bezpochyby potvrdit, že MSP jsou nesmírně důležitým prvkem celé evropské ekonomiky a jejich dlouhodobá odolnost, stabilita a růst bude mít kladný dopad na celou společnost. Kromě makroekonomického hlediska mají MSP silný kulturní a sociální význam na regionální úrovni (Ministerstvo průmyslu a obchodu, 2021; Sabanidze, 2021). MSP jsou zároveň velice citlivé na ekonomické šoky. Hoke, et al. (2022) zjišťují, že zásadním faktorem pro zvládnutí krizí pramenících z ekonomických šoků je jejich včasná identifikace a následné řízení. Autoři dále zjišťují, že 63 % malých podniků a 59 % středních podniků identifikuje vnější faktory jako svoji největší hrozbu, ale jsou si vědomi i skutečnosti, že klíčovým prvkem odolnosti je koherentní povaha strategického myšlení a interních rozhodovacích schopností managementu. Lze vyvodit závěr, že pro udržení kladného ekonomického růstu, prosperity a rozvoje na celostátní i regionální úrovni, je třeba nalézt vhodné způsoby a cesty, jak MSP stimulovat, rozvíjet a zvyšovat jejich odolnost. Ministerstvo průmyslu a obchodu (MPO, 2021) řeší podporu MSP v rámci Strategie podpory malých a středních podniků v České republice pro období 2021–2027, kde jako klíčové oblasti podpory a rozvoje MSP identifikuje: podnikatelské prostředí, přístup k financím, přístup na trhy, pracovní síla, dovednosti a vzdělávání, výzkum, vývoj a inovace, digitalizace, nízkouhlíková ekonomika a účinné nakládání se zdroji.

Jedním z nástrojů, jak stimulovat konkurenceschopnost, odolnost a dlouhodobou stabilitu MSP může být podle Písař & Kupec, (2019) zapojení metod strategického a operativního controllingu. Controllingové mechanismy, v dnešní době ve spolupráci s relativně snadno dostupnými daty, mohou poskytnout MSP nástroj, jak předvídat externí šoky, ale zároveň také nástroj, díky kterému mohou na dané šoky vhodně reagovat.

Cílem tohoto příspěvku je na základě provedených analýz identifikovat klíčové funkce v managementu MSP, vyhodnotit roli controllingu jako významného nástroje ovlivňujícího odolnost MSP. V rámci tohoto příspěvku zodpovíme na výzkumnou otázku, jestli je controlling pro MSP klíčovou funkcí, která ovlivňuje odolnost MSP vůči šokům externího prostředí. Stanovujeme hypotézu, že pro 60 % a více sledovaných firemních charakteristik, bude controlling vyhodnocen jako nejvýznamnější parametr.

1 Přehled literatury

Ačkoliv v rámci České republiky a Evropské unie MSP tvoří více jak 99 % všech podniků, je důležité si blíže přiblížit podíl MSP v rámci zaměstnanosti či v rámci generování přidané hodnoty. Podle informací a dat plynoucích z Eurostat (2022) zjišťujeme, že ačkoliv v roce 2019 drtivou většinu (98,9 %) všech podniků v rámci EU tvořily mikro, nebo malé podniky, jejich ekonomická váha byla podstatně nižší. Mikro a malé podniky zaměstnávaly na úrovní EU 48,4 % pracovní síly a v rámci přidané hodnoty se podílely pouze 35,3 %. Následující tabulka znázorňuje podíly nefinančních MSP na vybraných makroekonomických složkách na úrovni EU (Eurostat, 2022).

Tabulka č. 1: Podíly nefinančních MSP na vybraných makroekonomických složkách na úrovni EU

	Mikro a malé podniky (0-49 zaměstnanců)	Střední podniky (50-249 zaměstnanců)	Velké podniky (250 a více zaměstnanců)
Podíl na všech podnicích	98,8 %	0,9 %	0,2 %
Podíl na zaměstnanosti	48,4 %	16,0 %	35,6 %
Podíl na přidané hodnotě	35,3 %	17,1 %	47,6 %

Zdroj: Eurostat, 2022

Obecné charakteristiky MSP lze definovat podle studie Audretsch, et al. (1998) tak, že MSP mají větší potenciál flexibility, blízkosti k zákazníkovi a výhodu se rychle adaptovat a inovovat. MSP obvykle vyhledávají trhy, kde mohou své výhody uplatnit a nemusí tak čelit přímé konkurenci. Jako nevýhody MSP autoři uvádí především horší využití úspor z rozsahu, nedostatek znalostí, omezený počet kvalitních zaměstnanců, absenci dlouhodobého strategického plánování. Podle Edwards, et al. (2001) mají MSP rysy, které jim oproti velkým

podnikům dávají konkurenční výhodu, a to především v oblasti rychlé reakce a adaptace na změny, časové a místní flexibility, zarputilosti a odhodlání, motivace, vytrvalosti, optimismu apod. MSP upřednostňují efektivnější osobní komunikaci a jsou schopny v krátkém čase řešit problémy. Rothwell (1992) říká, že MSP mají problémy v oblasti nedostatku finančních prostředků, díky kterým nemohou podporovat R&D, či lépe rozkládat riziko v rámci širšího produktového portfolia. Pokud tyto uvedené postoje starší literatury v rámci definice a charakteristiky MSP porovnáme se současnou literaturou, jako je například (MPO, 2021; Sabanidze, 2021; Hoke, et al., 2022; Litvaj et al., 2023; Písař & Kupec, 2019; Písař & Bílková, 2019, Petrů & Lipovská, 2022) dojdeme k závěrům, že i přes rozdíl v čase těchto publikací se výše definované charakteristiky MSP od současných definic a postojů nijak zásadně neliší.

MSP dnes působí ve složitém a dynamickém tržním prostředí. Nevyhnutelně čelí mnoha vlivům, které působí na jejich výkon (Williams et al., 2017). Široká škála nepříznivých faktorů – od přírodních událostí (např. zemětřesení, požáry, tsunami, povodně, extrémní klimatické vlivy, výskyt viru Coovid-19 apod.) až po události způsobené člověkem (např. regulační změny, terorismus, občanské války, ekonomické krize, inflace, energetické krize, převratné inovace, zvyšování nákladů, přerušení logistických řetězců, nedostatek kvalifikovaných lidských zdrojů na trhu práce apod.) s různou intenzitou ohrožují chod a udržitelnou kontinuitu účastníků trhu.

Existující teorie o odolnosti organizace se kromě makroekonomických vlivů soustředí na vnitřní zdroje a schopnosti organizace udržet svůj výkon tváří v tvář nepřízni osudu (Kahn et al., 2018). Odolnost souvisí s tím, jak se jednotlivci, organizace, komunita vyrovnává s poruchami, překvapeními, změnami a krizemi (Mitchell, Haris, 2012). Odolnost znamená efektivní reakci na nepříznivé situace (události) a to nejen po události, ale také před ní, v jejím průběhu a po jejím doznění (Duchek, 2020). Odolnost souvisí s inherentními a adaptivními kvalitami a schopnostmi, které umožňují adaptační schopnost organizace během turbulentních období (Burnard & Bhamra, 2011). Obchodní odolnost popisuje schopnost organizace reagovat a rychle se přizpůsobit narušení nebo významným, neplánovaným změnám, které by mohly ohrozit její provoz, lidi, majetek, značku nebo pověst. Obchodní odolnost je schopnost organizace absorbovat stres, obnovit kritické funkce a prosperovat za změněných podmínek prostřednictvím uplatnění manažerských funkcí a controllingu.

Cílem budování odolnosti je zajistit kontinuitu podnikání, tedy schopnosti organizace dodávat produkty a služby v přijatelných časových rámcích s předem definovanou kapacitou během přerušení. Plán kontinuity podnikání je zdokumentovaná informace, která vede organizaci k reakci na narušení. Řízení kontinuity podnikání (*Business Continuity Management*

– BCM) poskytuje rámec pro budování odolnosti a pro rychlou a efektivní reakci v případě narušení činnosti podniku. Jejím nezbytným nástrojem je controlling.

1.1 Význam controllingu pro budování odolnosti MSP

Controlling můžeme identifikovat jako mechanismus kontinuálního řízení a vyhodnocování podnikových strategických plánů a jejich rizik (Havlíček, 2011). Eschenbach & Siller (2012) controlling definují jako systém dohledu nad podnikovými plány a strategiemi. Písař & Kupec (2019) u controllingu uvádějí, že jeho hlavním smyslem je orientace na budoucí vývoj, který povede k získání konkurenční výhody. Dále uvádí, že na controllingové procesy lze nahlížet jak ze strategického, tak operativního pohledu, kdy v rámci strategického pohledu je smyslem dlouhodobý dohled nad naplňováním strategických cílů podniku.

Úroveň controllingových procesů lze měřit pomocí modelu CMMI, který je možné využívat v rámci řízení strategických inovací (Wen-Lung, 2021; Písař & Kupec, 2019). Kromě strategického controllingu, lze uvažovat také nad controllingem operativním, který je dle Bedenik (2015) využíván nejčastěji v rámci řízení naplňování krátkodobých, úsekových cílů s přímým dopadem na finanční ukazatele. Podle Pfeifer (2021) lze data získávaná prostřednictvím metod operativního controllingu dále využít v rámci Průmyslu 4.0 pro implementaci řídicích systémů v rámci tzv. chytrých továren. Podle Rúben & Ferreira (2019) je v rámci implementace nových inovací důležité nepřetržitě řídit celý proces zavádění inovací, a to ideálně díky kontinuální analýze a vyhodnocování dat.

Na problematiku významu controllingu také upozorňuje MPO, které vybrané controllingové nástroje využívá například v rámci sestavování finanční analýzy podnikové sféry, nebo prostřednictvím controllingu vyhodnocuje naplňování cílů strategických dokumentů, jako je například Strategie podpory MSP v České republice pro roky 2021–2027.

Autoři Pavlák & Písař (2020) se zaměřují na zjištění stavu vlivu controllingu na stabilitu a konkurenceschopnost MSP. Dochází k zjištěním, že existuje vazba mezi systémem řízení, technologickou úrovní a controllingem. Controlling dle této studie staví mezi rozhodující nástroje systému řízení MSP, který zvýší úroveň MSP v oblasti inovací a tržní výkonnosti. Autoři zároveň tvrdí, že controlling ve spojení s moderními technologiemi je efektivní a snadno použitelný nástroj řízení pro každou firmu, a to zejména pro malé a střední podniky.

Podle Písař & Bílková (2019) je využití controllingu efektivním přístupem pro uplatnění a vyhodnocení účinnosti a výkonnosti manažerských funkcí (organizování, plánování, komunikace, rozhodování, delegování, vedení, hodnocení a poskytování zpětné vazby apod.). Autoři na základě statistické analýzy plynoucí ze statistického vzorku n=341 potvrdili existenci

vtahu mezi controllingem, zralostí procesů, inovačními aktivitami a technologickou úrovní podniku. Kromě potvrzení výše uvedených vztahů autoři zjistili, že úroveň controllingového řízení podniku a jeho inovační aktivity jsou důležitým faktorem pro jeho finanční zdraví a konkurenceschopnost. Na základě výše uvedeného můžeme dojít k závěru, že metody strategického a operativního controllingu mohou hrát důležitou úlohu v rámci budování odolnosti MSP.

2 Data a metodologie

Data, použitá v této práci, vycházejí z výzkumu týkajícího se uplatnění manažerských funkcí v praxi MSP. Data byla pro výzkum získána na základě kvalitativního šetření, které prováděly speciálně proškolené pomocné vědecké síly. Kvalitativní šetření probíhalo v období 1Q–2Q 2023 a šetření se zúčastnilo 127 respondentů (n=127). Respondenti byli vybráni náhodným výběrem z interní databáze VŠFS, a.s. obsahující k datu zahájení výzkumu 2 300 podnikatelských subjektů. Výzkum probíhal buď prostřednictvím osobní návštěvy PVS v sídle firmy nebo metodou telefonického dotazování (CATI). Vybrané parametry oblasti zkoumání kvalitativního šetření, které jsou dále použity v rámci naplnění cílů této práce, shrnuje následující tabulka (Tabulka č. 2).

Tabulka č. 2: Vybrané sledované parametry kvalitativního šetření

Parametr	Specifikace parametru
ORG	Tento parametr má za úkol postihnout organizační strukturu podniku, tedy jeho schopnost být řízen a kontrolován
CON	Rozhodnutí o nejvhodnějším postavení controllingu v podniku spočívá v rukou managementu. Ten je při řešení této otázky ovlivněn vlastním vnímáním controllingu a na jeho základě může být controlling umístěn jako útvar štábní nebo liniový.
PLA	Nejlépe řízené společnosti využívají plánování pro strategické řízení. Prostřednictvím struktury plánování a řízení aplikují strategii v praxi, mají zavedeno programové řízení a ukazatele pro analýzu výsledků a také jasně a konzistentně komunikují strategii externě i interně, a to na všech úrovních organizační struktury.
HR	Nejlépe řízené společnosti rozvíjejí vztahy se zaměstnanci i prostřednictvím efektivních procesů řízení výkonnosti a komplexního systému odměňování. Patřičnou pozornost věnují také investicím do podpory talentů, plánování nástupnictví a do rozvoje budoucího managementu
DEL	Delegování je takový postup manažera (majitele firmy), kterým přiděluje svým zaměstnancům úkoly a potřebné pravomoci a odpovědnosti k jejich plnění

Zdroj: zpracováno autorem

Kvalitativní šetření bylo sestaveno ve formě uzavřených dotazů ohodnocených na základě Likertovy škály v rozmezí 1–5, kdy 1 značí nejhorší stav a 5 nejlepší stav. Po dokončení šetření došlo k agregaci odpovědí a následné sestavení korelační analýzy pro vybrané charakteristiky firmy, které jsou popsány v následující tabulce (Tabulka č. 3).

Tabulka č. 3: Charakteristiky firmy využité v rámci korelační analýzy

Charakteristika	Možné hodnoty charakteristiky
PRAVNI_FORMA	- Neznámá - Fyzická osoba podnikající podle živnostenského zákona - Společnost s ručením omezeným - Akciová společnost - Obecně prospěšná společnost - Příspěvková organizace - Odštěpný závod zahraniční právnické osoby - Spolek - Obec nebo městská část hlavního města Prahy - Evropská společnost
ZALOZENO	- Před rokem 1989 - 1989–1999 - 2000–2010 - 2011–2020 - 2021 a mladší
ZAMESTANCI	- 0 - 1–20 - 21–50 - 51–100 - 101–300 - 301–500 - 501 a více
TYP_FIRMY	- Rodinná - Nerodinná
NACE	- 0;1;2;3;4;5;6;7;8;9;10;11;12;13

Zdroj: zpracováno autorem

Korelační analýza hledá vztahy mezi parametry uvedenými v Tabulce č. 2 a č. 3. V rámci každého řádku tabulky dojde k označením nejvyšší hodnoty/hodnot symbolem „+" a nejmenší hodnoty/hodnot symbolem „-". Tyto dílčí výsledky nejvýznamnějších a nejméně významných parametrů poslouží jako základ pro rozhodnutí o vyhodnocení hypotézy práce. Abychom zohlednili váhu jednotlivých počtů odpovědí v rámci sledovaných hodnot charakteristik, výslednou hodnotu vynásobíme počtem pozorování.

3 Výsledky práce

V této části práce dojde k realizaci korelační analýzy pro vybrané parametry a charakteristiky. Tyto výsledky, orientované podle jednotlivých charakteristik firmy, budou popsány v následujících tabulkách (Tabulka č. 4–13).

Tabulka č. 4: Závislost sledovaných parametrů na právní formě

charakteristika = PRAVNI_FORMA						
Právní forma	**Počet**	**ORG**	**CON**	**PLA**	**HR**	**DEL**
Neznámá	12	2,55	-2,50	2,75	2,58	+3,50
Fyzická osoba podnikající podle živnostenského zákona	7	3,71	-2,43	+4,00	+4,00	3,86
Společnost s ručením omezeným	84	3,68	-2,57	3,41	3,37	+3,94
Akciová společnost	16	+3,63	2,56	3,31	-2,44	3,50
Obecně prospěšná společnost	1	2,00	1,00	5,00	4,00	2,00
Příspěvková organizace	2	+4,00	-1,00	3,00	2,00	2,00
Odštěpný závod zahraniční právnické osoby	1	+4,00	-3,00	+4,00	+4,00	+4,00
Spolek	1	+5,00	-4,00	+5,00	+5,00	-4,00
Obec nebo městská část hlavního města Prahy	1	3,00	+5,00	4,00	-2,00	+5,00
Evropská společnost	2	4,50	3,00	4,50	-2,50	+5,00

Zdroj: zpracováno autorem

Tabulka č. 5: Nejvýznamnější a nejméně významný parametr na právní formě

Nejvýznamnější (+)	**Nejméně významný (-)**
DEL (váha = 100)	CON (váha = 107)

Zdroj: zpracováno autorem

Tabulka č. 6: Závislost sledovaných parametrů na roku založení firmy

charakteristika = ZALOZENO						
Rok založení	**Počet**	**ORG**	**CON**	**PLA**	**HR**	**DEL**
Před rokem 1989	3	3,00	-2,33	+3,67	-2,33	+3,67
1989-1999	41	3,92	-2,90	3,77	3,41	+4,10
2000-2010	35	3,06	-2,09	2,88	2,79	+3,29
2011-2020	41	3,80	-2,71	3,51	3,37	+4,00
2021 a mladší	7	3,29	-2,43	3,43	3,29	+4,00

Zdroj: Zpracování vlastní na základě dat a hodnocení výzkumu Ing. Vladimírem Nulíčkem, CSc.

Tabulka č. 7: Nejvýznamnější a nejméně významný parametr na roku založení firmy

Nejvýznamnější (+)	**Nejméně významný (-)**
DEL (váha = 127)	CON (váha = 127)

Zdroj: zpracováno autorem

Tabulka č. 8: Závislost sledovaných parametrů na počtu zaměstnanců

charakteristika = ZAMESTANCI						
Počet zaměstnanců	**Počet**	**ORG**	**CON**	**PLA**	**HR**	**DEL**
0	6	-2,17	2,67	3,17	+3,50	3,17
1-20	56	3,67	-2,38	3,38	3,42	+3,91
21-50	17	4,12	-3,35	+4,18	-3,35	3,88
51-100	17	3,24	-2,41	2,88	2,88	+3,88
101-300	10	+3,89	-2,56	+3,89	2,67	3,78
301-500	5	2,80	-2,00	2,80	2,80	+3,00
501 a více	16	3,71	-2,73	3,33	2,87	+4,00

Zdroj: zpracováno autorem

Tabulka č. 9: Nejvýznamnější a nejméně významný parametr na počtu zaměstnanců

Nejvýznamnější (+)	**Nejméně významný (-)**
DEL (váha = 94)	CON (váha = 121)

Zdroj: zpracováno autorem

Tabulka č. 10: Závislost sledovaných parametrů na typu firmy

charakteristika = TYP_FIRMY						
Typ firmy	**Počet**	**ORG**	**CON**	**PLA**	**HR**	**DEL**
Rodinná	45	-2,53	3,37	3,05	3,58	+3,96
Nerodinná	82	-2,59	3,44	3,27	+3,96	3,83

Zdroj: zpracováno autorem

Tabulka č. 11: Nejvýznamnější a nejméně významný parametr na typu firmy

Nejvýznamnější (+)	**Nejméně významný (-)**
HR (váha = 82)	ORG (váha = 127)

Zdroj: zpracováno autorem

Tabulka č. 12: Závislost sledovaných parametrů na NACE

charakteristika = NACE						
NACE	**Počet**	**ORG**	**CON**	**PLA**	**HR**	**DEL**
0	14	2,85	-2,71	3,00	2,79	+3,64
1	2	3,67	3,33	3,33	4,00	-3,00
2	9	3,56	3,44	3,44	-3,33	+4,22
3	8	+4,25	-2,38	3,63	3,25	+4,25
4	2	2,50	-1,00	2,50	3,00	+3,50
5	6	3,60	-2,80	3,60	3,00	+4,60
6	33	3,70	-2,45	3,45	3,15	+3,76
7	11	4,09	-3,09	+4,36	3,18	4,00
8	4	+4,25	3,25	3,75	-2,50	3,00
9	7	3,71	-2,71	3,29	3,14	+4,00
10	8	3,38	-1,88	2,63	3,38	+3,63
11	5	3,40	-2,80	3,40	3,40	+4,40
12	10	3,56	-1,89	3,11	3,44	+3,78
13	3	2,67	-2,00	+3,33	3,00	2,67

Zdroj: zpracováno autorem

Tabulkač. 13: Nejvýznamnější a nejméně významný parametr na NACE

Nejvýznamnější (+)	Nejméně významný (-)
DEL (váha = 102)	CON (váha = 107)

Zdroj: zpracováno autorem

Následující tabulka (Tabulka č. 14) představuje shrnující pohled na nejvýznamnější a nejméně významné parametry provedeného kvalitativního šetření v závislosti na jednotlivé sledované firemní charakteristiky.

Tabulka č. 14: Shrnující vyhodnocení nejvýznamnějších a nejméně významných parametrů

Charakteristika	Nejvýznamnější (+)	Nejméně významný (-)
PRAVNI_FORMA	DEL	CON
ZALOZENO	DEL	CON
ZAMESTANCI	DEL	CON
TYP_FIRMY	HR	ORG
NACE	DEL	CON

Zdroj: zpracováno autorem

Výsledky provedených analýz jasně ukazují, že v případě nejvýznamnějšího parametru se ve 4 z 5 případů umístil parametr DEL, který reprezentuje manažerskou funkci delegování.

Nejméně významný parametr se taktéž ve 4 z 5 případů umístil parametr CON, který reprezentuje manažerskou funkci controlling.

Odpověď na stanovenou výzkumnou otázku, tedy otázku, *jestli je controlling pro MSP klíčovou funkcí, která ovlivňuje odolnost MSP vůči šokům externího prostředí*, můžeme na základě výsledků práce formulovat tak, že controlling jednoznačně nelze považovat za klíčovou manažerskou funkci, která by podpořila odolnost MSP v rámci jejich reakcí na šoky externího prostředí. Ačkoliv na základě výsledků předešlých výzkumů (Písař & Kupec, 2019; Pavlák & Písař 2020; Písař & Bílková 2019) existuje pozitivní vztah mezi controllingem a podporou konkurenceschopnosti a stability MSP, tak na základě tohoto výzkumu MSP funkce controllingu reálně ve své praxi nevyužívají.

Definovaná hypotéza, *že pro 60 % a více sledovaných firemních charakteristik, bude controlling vyhodnocen jako nejvýznamnější parametr*, nebyla podpořena. Výsledky práce ukazují, že funkce controllingu nebyla pro žádnou ze sledovaných charakteristik vyhodnocena jako nejvíce významná, ba naopak, funkce controllingu byla v 80 % případů označena jako nejméně významnou manažerskou funkcí.

Závěr

Tato práce se zabývala problematikou MSP a analýzou manažerských funkcí, které MSP využívají. Práce se specializovala na problematiku manažerské funkce controllingu a jeho úlohou v rámci posílení stability MSP. Na základě výsledků práce zjišťujeme, že controlling je MSP považován za málo důležitý faktor a problematiku controllingu v rámci manažerských funkcí uplatňují minimálně. Ačkoliv jsou výsledky práce pro významnost controllingu nepříznivé, existují další studie, které důležitost controllingu pro posílení stability a udržení konkurenceschopnosti MSP potvrzují. V případě, kdy budeme zkoumat problematiku stability a odolnosti MSP, zjistíme, že MSP jako své největší hrozby identifikují makroekonomické a systémové šoky, na které nedokáže efektivně reagovat. Ačkoliv controlling bezpochyby poskytuje nástroje, díky kterým je možné predikovat a řídit vybrané oblasti podnikání, ne vždy se náklady spojené s řízením vzniklých rizik MSP vyplatí. V případě, že se podíváme na podíly MSP na vybraných makroekonomických složkách v rámci EU (Tabulku č. 1), vidíme, že ačkoliv je drtivá většina podniků definována jako MSP, jejich přínos v oblasti zaměstnanosti a generování přidané hodnoty již není takový jako u podniků velkých.

V případě, zániku jednoho MSP, budou existovat s největší pravděpodobností v jeho teritoriu další MSP, které díky obvyklému prostředí, kde nabídka převyšuje poptávku,

bezpochyby dokáží pokrýt poptávku zákazníků a zároveň také absorbovat jeho zaměstnance. V případě, kdy by ovšem došlo k zániku jednoho velkého podniku, jakým může být na českém trhu například Škoda Auto a.s., jednalo by se o systémový problém, který by mohl negativně ovlivnit tisíce domácností, ale také další velké množství MSP, které jsou s tímto podnikem úzce svázány.

Z informací plynoucí z literární rešerše a z výsledků práce můžeme dále přistoupit k úvaze, že role controllingu a jeho význam při sestavování predikčních modelů a kontinuálního vyhodnocování plnění operativních i strategických plánů podniku bude významnější pro velké podniky, stabilita a prosperita má pozitivní dopad na stovky až tisíce domácností a další MSP, které jsou na existenci velkých podniků závislé.

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Analýza vztahu koeficientu ekonomické náročnosti a mezd zaměstnanců fakult veřejných vysokých škol

Abstrakt

Na podzim 2023 se poměrně hojně diskutuje rozdílná úroveň průměrné mzdy mezi akademickými pracovníky jednotlivých typů fakult veřejných vysokých škol. V příspěvku hledáme příčiny této rozdílnosti a analyzujeme vztah mezd a historického koeficientu ekonomické náročnosti (KEN). Cílem příspěvku je prozkoumat mzdy ve vysokém školství s detailnějším pohledem na filozofické fakulty. Příspěvek reaguje na aktuální téma a poukazuje nejen na nerovnost ve finančním ohodnocení pracovníků, ale i na problematiku metodiky zdrojových dat. Fakulty s velmi nízkými a vysokými koeficienty vyplácejí výrazně nižší průměrné mzdy ve srovnání s fakultami s průměrnými koeficienty.

Klíčová slova

Vysoké školství, financování veřejných vysokých škol, koeficient ekonomické náročnosti, MŠMT, mzdy akademických a vědeckých pracovníků

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Úvod

17. října 2023 se konala celostátní výstražná hodinová stávka, jíž se účastnili akademici z různých fakult veřejných vysokých škol. Cílem stávky bylo upozornit na nízké výdělky akademiků a celkové podfinancování vysokého školství v České republice[1]. Protesty a s nimi spojené nízké mzdy se týkají zejména filozofických fakult, které tvrdí, že jedním z důvodů

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nedostatečného financování konkrétního typu fakult je koeficient ekonomické náročnosti (KEN)[2]. Téma je velmi aktuální a zároveň podpořené zájmem médií i širší veřejnosti.

Analýza vztahu koeficientů ekonomické náročnosti a mezd akademických a vědeckých pracovníků veřejných vysokých škol (VVŠ) v České republice je součástí mé disertační práce, která zkoumá financování vysokého školství v ČR. Disertační práce navazuje na bakalářskou a diplomovou práci. V bakalářské práci jsem zjišťovala efektivitu a porovnávala veřejné vysoké školy pomocí analýzy obalu dat (DEA) a shlukové analýzy. V diplomové práci jsem se zaměřila na porovnání českého a slovenského systému financování vysokého školství, přesněji na první rozpočtový okruh financování rozpočtu vysokého školství Ministerstva školství, mládeže a tělovýchovy (MŠMT) v ČR a jeho analogii na Slovensku; konkrétně jsem se věnovala českému koeficientu ekonomické náročnosti a jeho slovenské analogii (koeficient oboru). Součástí práce byl experiment výpočtu KEN pomocí slovenské metodiky výpočtu koeficientu oboru jako možné alternativy k současnému systému KEN v ČR.

Cílem příspěvku je analyzovat souvislost mezi výší odměňování akademických a vědeckých pracovníků fakult veřejných vysokých škol a koeficienty ekonomické náročnosti.

1 Současný stav poznání

1.1 Literatura o financování vysokého školství ve světě

Každá země má systém financování vysokého školství nastavený jiným způsobem, proto se při hledání podkladů pro svou práci zaměřuji spíše na publikace zabývající se mapováním systémů financování vysokého školství ve světě a jejich srovnáním, případně publikacemi, které se přímo zabývají financováním vysokého školství v ČR.

Dosud nejrozsáhlejší literaturou pojednávající o systémech financování vysokého školství ve světě je (Teixeira & Shin, 2020). Tato publikace mapuje vysokoškolské instituce po celém světě, zkoumá současné výzvy, které se objevily ve vysokoškolských systémech a institucích v 21. století, a sleduje vývoj vysokoškolského vzdělávání v průběhu let. Publikace zahrnuje téměř 150 zemí světa a odráží rostoucí propojenost a složitost oboru, což je také patrné na počtu editorů a přispěvatelů zapojených z různých regionů i akademických úrovní.

Na Slovensku se tématem zabývali například (Hužvár & Rigová, 2010), jejichž publikaci jsem použila jako teoretický základ pro svůj výzkum v diplomové práci.

1.2 Literatura o financování vysokého školství v ČR

V tuzemsku se analýze financování vysokého školství a mezinárodnímu srovnání věnovali autoři M. Kuncová a P. Mulač ve své publikaci z roku 2015 Financování profesně orientovaných vysokých škol v evropském kontextu. Publikace podrobně popisuje systém financování vysokého školství v ČR včetně historického vývoje. Pro porovnání autoři uvedli i zahraniční přístupy k financování vysokých škol několika evropských zemí.

Bohužel českých odborníků, kteří by se detailně zabývali systémem financování vysokého školství, je poměrně málo, což se projevuje jak v nízkém počtu českých vědeckých publikací, tak v obtížnosti vést na toto téma seriózní debatu přesahující tezi „KENy je zapotřebí řešit".

1.3 Historie koeficientů ekonomické náročnosti používaných v ČR[3]

Systém koeficientů ekonomické náročnosti (KEN) zavedený MŠMT na počátku 90. let 20. století do jisté míry navazoval na způsob financování vysokých škol z konce let osmdesátých, přičemž základy lze najít již v letech padesátých. Cílem nových pravidel rozdělování prostředků na neinvestiční výdaje vysokým školám bylo „*odstranit neprůhledné, nespravedlivé a nepředvídatelné přidělování těchto prostředků" (MŠMT, 1992).* KENy, jimiž se následně násobil započitatelný počet vysokoškolských studentů, byly odvozeny od neinvestičních výdajů vysokých škol na jednoho započítaného studenta. Vypočtená hodnota tehdejšího normativu (KENu) vycházela z finanční náročnosti oborů na jednotlivých fakultách. Podrobnější podklady k tehdejším výpočtům se bohužel přes veškerou snahu nepodařilo získat ani s pomocí zaměstnanců MŠMT a pamětníků tehdejších diskusí.

Tehdejší KENy přitom odrážely historickou nákladovou strukturu jednotlivých oborů. Na počátku 90. let přitom byla ve srovnání s počátkem 20. let 21. století relativně levnější lidská práce, naopak byly relativně dražší nejrůznější technologie včetně technologií informačních a komunikačních. I s ohledem na tyto změny v relativních cenách se čas od času scházeli zástupci vysokých škol a nastavení KENů diskutovali. Poslední vážnější diskuse opřená o hlubší analýzy proběhla v letech 2002 a 2003 v projektu *Rozvoj veřejných vysokých škol – finanční podmínky a předpoklady*, jehož součástí byl podprojekt *Změna normativu a koeficientů finanční náročnosti studijních programů.* Členy jednotlivých pracovních podskupin byli akademičtí a vědečtí pracovníci, zastupující zájmy příslušných oblastí vzdělávání na veřejných vysokých školách (VVŠ) v ČR, a zástupci MŠMT, kteří se danou problematikou zabývají. Z aktuálních 26 českých VVŠ do dotazníkového šetření nezasáhli pouze zástupci VVŠ, které vznikly až po roce 2002 (Vysoká škola polytechnická Jihlava a Vysoká škola technická

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[3] Obsah této podkapitoly vychází primárně ze zdroje (Flusková, 2022).

a ekonomická v Českých Budějovicích). Hlavní tehdejším závěrem řešeného podprojektu nicméně bylo poukázání nikoli na špatné nastavení KEN, ale na problematiku nastavení normativu a obecně nedostatek finančních prostředků v rozpočtu MŠMT, který se mezi VVŠ rozděluje. (Durčáková, 2003)

V roce 2015 stát zafixoval poměr mezi VVŠ, kterým se odstranil vliv konkrétního počtu studií studentů. Vysokoškolský trh se z pohledu počtu proplácených studií studentů ze zdrojů MŠMT pomyslně poměrově rozdělil a současně byl také téměř úplně odstraněn vliv koeficientu ekonomické náročnosti. KEN je zachován pouze u jednoho z parametrů v jedné z částí rozpočtového okruhu, kterým MŠMT zaručuje, že VVŠ nebudou preferovat určité skupiny studentů za základě studijních programů s nižším KEN. Tuto skutečnost lze chápat tak, že se MŠMT snaží zabránit situaci, kdy by VVŠ mohly přijímat tzv. levnější studenty.

„V současné době z důvodu zafixování hodnot, orientaci na historické hodnoty a odklonu od tzv. soutěžního principu, rozdělení finančních prostředků mezi jednotlivé VVŠ nemusí odpovídat skutečnými finančním prostředkům, na které by na základě počtů studentů VVŠ a dalších ukazatelů měnících se v čase měly nárok. Pro některé VVŠ by byl výhodnější, pro některé VVŠ méně." (Flusková, 2022)

Lze říci, že koeficient můžeme považovat za historický. Po zafixování poměrů se jeho vliv na celkovou částku získávanou z ukazatele A postupně snižuje, není ale rozhodně zanedbatelný.

2 Data

V analýze vztahů KEN a mezd akademických a vědeckých pracovníků používáme dva datové soubory získané z MŠMT:

- přepočtené počty studií studentů[4] po fakultách a studijních programech (SP) včetně koeficientu ekonomické náročnosti (KEN) k 31. 10. 2021,
- údaje o mzdových prostředcích ze Statistické ročenky školství – Zaměstnanci a mzdové prostředky, konkrétně z části Kapitola B1 – oddíl B1.6 Vysoké školství – vysoké školy.

Data jsou shromažďována MŠMT na základě Zákona č. 111/1998 Sb., o vysokých školách a o změně a doplnění dalších zákonů (zákon o vysokých školách)[5]. Tento zákon mimo jiné říká, že *„vysoké školy jsou povinny předávat ministerstvu tyto údaje v termínech, struktuře a formě*

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[4] V ČR se nepracuje s fyzickými počty studentů na SP (dříve studijní obory), ale s počtem studií, na které jsou studenti přihlášeni, proto přepočtené počty studií studentů.

[5] Zákony pro lidi. (2021). *111/1998 Sb. Zákon o vysokých školách.* Získáno 20. říjen 2023, z https://www.zakonyprolidi.cz/cs/1998-111

stanovené prováděcím právním předpisem". Pracujeme tedy s hodnotami za všechny veřejné vysoké školy (VVŠ), resp. jejich fakulty, v České republice.

2.1 Přepočtené počty studií studentů

První uvedený datový soubor pro rok 2021 obsahuje údaje o 162 fakultách a celoškolských pracovištích státních a veřejných vysokých škol v České republice. V práci pracujeme pouze se 158 fakultami a celoškolskými pracovišti, protože státní vysoké školy mají jiná pravidla, způsob a zdroje financování a některé údaje nejsou veřejně dostupné. Soubor obsahuje celoškolská pracoviště, která uskutečňují studijní programy; buď se jedná o studijní programy, které nejsou uskutečňované fakultou, nebo se jedná o neuniverzitní vysoké školy, které se na fakulty nečlení.

Průměrný fakultní KEN je vypočítán jako podíl normativního počtu studentů (normativ) k přepočtenému počtu studií studentů pro jednotlivé fakulty. Normativní počet studií studentů je vypočítán jako vážený průměr přepočtených počtů studií studentů na jednotlivých studijních programech fakulty, kde vahami jsou koeficienty ekonomické náročnosti přidělené jednotlivým studijním programům.

2.2 Údaje o mzdových prostředcích

Druhý datový soubor pro rok 2021 je členěn do několika částí. Pro náš výzkum je relevantní část s názvem Vysoké školy včetně kolejí, menz, VŠZS a VŠLS – zaměstnanci podle profesního zařazení, mzdy celkem a průměrná měsíční mzda (bez OON[6]) – podle vysokých škol, jednotlivých fakult a pracovišť. Soubor obsahuje všechny fakulty VVŠ a hodnoty za soukromé vysoké školy v ČR. Státní vysoké školy se v souboru nenacházejí. Hodnoty za soukromé vysoké školy nevyužijeme, protože nejsou předmětem našeho výzkumu.

Oproti prvnímu datovému souboru tento soubor obsahuje údaje za podstatně více součástí VVŠ, např. ústavy, další celoškolská pracoviště, centra, nakladatelství, protože všechny tyto součásti veřejných vysokých škol mají zaměstnance, ale ne všechny mají studenty zapsané ve studijních programech uskutečňovaných mimo fakulty.

Zaměstnanci podle profesního zařazení jsou členěni do následujících kategorií: zaměstnanci celkem, akademičtí pracovníci celkem (v tom: pedagogičtí pracovníci výzkumu, vývoje a inovací (V, V a I), profesoři, docenti, odborní asistenti, asistenti, lektoři), vědečtí pracovníci, ostatní zaměstnanci. Ostatní zaměstnanci byli z šetření vyřazeni z důvodu rozdílnosti zařazení na jednotlivé fakulty nebo na celoškolská pracoviště v rámci struktury

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[6] Ostatní osobní náklady.

jednotlivých veřejných vysokých škol. Tento problém je blíže specifikován v diplomové práci Flusková (2022).

Zdroje financování jsou různé: prostředky státního rozpočtu na vzdělávací činnost, doplňková činnost, institucionální a účelové prostředky na VaVaI[7], evropské zdroje financování (prostředky z operačních programů, evropské výzkumné projekty) a další. V účetnictví jsou zdroje financování rozděleny, ale v tomto datovém souboru jsou údaje nerozlišeny s následujícím komentářem: *„Bez ohledu na zdroj financování, tj. kap. 333 - MŠMT vč. doplňkové činnosti, prostředků strukturálních fondů EU a ostatních zdrojů"*. V praxi to znamená, že financování úvazku zaměstnance může být složeno z různých zdrojů, např. 1 celý úvazek zaměstnance může být sestaven z 0,1 úvazku na katedře, 0,4 úvazku na projektu národního programu obnovy (NPO), 0,5 úvazku na grantu Grantové agentury ČR (GAČR). Podrobnější členění včetně rozlišení zdrojů financování zaměstnanců se nachází ve výkazu o zaměstnancích a mzdových prostředcích za vysoké školy (P1b-04[8]) za 1.-4. čtvrtletí daného roku. S tímto výkazem ovšem ani MŠMT přímo nepracuje při zveřejňování tiskových zpráv a opírá se o výše zmíněný zjednodušený datový soubor Údaje o mzdových prostředcích, který zdroje financování nerozlišuje[9]. Na problematiku nerozlišeného financování a následnou interpretaci hodnot upozorňuje článek z Novinky.cz z 23. 10. 2023[10].

3 Výsledky

Na základě podkladů z MŠMT byla pomocí vážených průměrů sestavena tabulka porovnávající průměrné mzdy a fakultní KENy. Fakulty VVŠ jsme rozdělili na základě průměrných fakultních KEN do kategorií, které odpovídají KEN pro jednotlivé SP na základě metodiky MŠMT (1,00; 1,20; 1,65; 2,25; 2,80; 3,50; 5,90).

Z Tabulka č. 1 plyne, že vztah průměrné mzdy a KEN není monotónní – fakulty VVŠ, které mají nižší nebo naopak vyšší průměrný fakultní KEN, mají významně nižší průměrné mzdy oproti celkovému průměru (červené hodnoty se nacházejí pod průměrem, zelené nad průměrem). Nejhůře si vedou fakulty VVŠ, které mají průměrný fakultní KEN roven

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[7] Výzkum, vývoj a inovace

[8] MŠMT ČR. (2023). *Čtvrtletní výkaz o zaměstnancích a mzdových prostředcích za vysoké školy (výkaz P 1b-04) pro rok 2023*. Získáno 11. říjen 2023, z https://www.msmt.cz/vzdelavani/skolstvi-v-cr/statistika-skolstvi/sber-dat-vykazu-skol-msmt-p1b-04-o-zamestnancich-a-mzdovych

[9] MŠMT ČR. (2023, 16. říjen). *Přehled průměrných mezd akademických pracovníků na veřejných vysokých školách*. Získáno 20. říjen 2023, z https://www.msmt.cz/ministerstvo/novinar/prehled-prumernych-mezd-akademickych-pracovniku-na-verejnych

[10] Novinky.cz. (2023, 23. říjen). *MŠMT: Ve výdělcích akademiků na různých VŠ jsou rozdíly v desítkách tisíc korun*. Získáno 24. říjen 2023, z https://www.novinky.cz/clanek/veda-skoly-msmt-ve-vydelcich-akademiku-na-ruznych-vs-jsou-rozdily-v-desitkach-tisic-korun-40447999

hodnotě 5,9. Tyto fakulty pocházejí ze tří VVŠ (Akademie múzických umění v Praze, Akademie výtvarných umění v Praze, Janáčkova akademie múzických umění). Ani poměrně vysoký KEN (například ve srovnání s koeficientem oboru pro umělecké obory na Slovensku) tedy vysoké průměrné mzdy zaměstnancům uměleckých vysokých škol nezaručí. Příčinami tohoto jevu se budeme podrobněji zabývat v dalším výzkumu.

Tabulka č. 1: Porovnání rozdílů průměrných mezd akademických a vědeckých pracovníků fakult VVŠ podle KEN kategorií oproti celkovému průměru, celkový vážený průměr mezd (Kč) a počet fakult VVŠ v jednotlivých kategoriích

kateg. prům. fak. KEN	akademičtí pracovníci						věd. prac. celk.	počet fakult VVŠ
	ped. prac. V, V a I	*prof.*	*docenti*	*odborní asist.*	*asist.*	*lektoři*		
1 až 1,2	**-6 659**	**-14 770**	**-6 449**	**-3 556**	**-3 773**	**-6 991**	**-1 201**	41
1,2 až 1,65	**56**	**-7 473**	**-5 293**	**-889**	**-850**	**-5 956**	**-2 878**	22
1,65 až 2,25	**2 101**	**9 614**	**6 570**	**3 219**	**1 005**	**5 974**	**5 601**	44
2,25 až 2,8	**-1 778**	**6 357**	**3 652**	**3 100**	**3 384**	**3 812**	**-3 507**	31
2,8 až 3,5	**-9 362**	**9 993**	**5 962**	**1 106**	**-374**	**789**	**-4 217**	6
3,5 až 5,9	**–**	**-34 239**	**-19 545**	**-10 629**	**-3 241**	**-12 073**	**-11 133**	8
5,9	**3 994**	**-42 429**	**-26 716**	**-13 693**	**-9 746**	**-4 663**	**-335**	6
vážený průměr	58 919	95 827	73 586	51 648	40 096	42 521	46 473	

Zdroj: Vlastní zpracování, MŠMT 2021

V přílohové části se nacházejí grafy (Graf č. 1, Graf č. 2, Graf č. 3), které vizuálně znázorňují výsledky porovnání průměrných mezd fakult VVŠ ve vztahu ke KEN. Přílohy

Graf č. 1 doplňuje Tabulka č. 1 a ještě více poukazuje na nižší průměrné mzdy fakult s průměrným KEN v kategoriích od 1 do 1,65 a od 3,5 do 5,9, zejména u profesorů.

Graf č. 2 poukazuje na výrazně vyšší průměrné mzdy profesorů a připojují se k nim v tomto pohledu také docenti. Vzhledem k nerozlišení zdrojů financování ve zdrojovém souboru lze předpokládat a navázat na předchozí tvrzení, že úvazek profesora nebo docenta je složen z mnoha částí včetně případných funkcí ve vedení fakulty, případně i VVŠ (např. děkan,

proděkan) a vědeckých činností financovaných z grantů. Naopak na fakultách s KEN 5,9 mají pedagogičtí pracovníci V, V a I vyšší průměrné mzdy oproti ostatním kategoriím akademických a vědeckých pracovníků. V celkovém srovnání se v této kategorii jedná pouze o 6 fakult z celkových 158 zkoumaných a jedná se zřejmě o specifikum uměleckých VVŠ. Na fakultách s průměrným KEN mezi 3,5 až 5,9, kam rovněž patří fakulty s uměleckými SP a dále např. fakulty s veterinárními SP, kategorie pedagogických pracovníků V, V a I úplně chybí.

Poslední Graf č. 3 blíže popisuje situaci filozofických fakult VVŠ v ČR. Jednotlivé fakulty jsme vybrali na základě seznamu členů Asociace děkanů filozofických fakult ČR[11], který obsahuje 11 fakult filozofického a humanitního zaměření. Ne všechny filozofické fakulty z tohoto seznamu jsou také součástí iniciativy Hodina pravdy[12], která organizovala březnový protest a říjnovou stávku. Z 11 vybraných fakult pouze 1 fakulta spadá do KEN kategorie 1,65 až 2,25, a to Filozoficko-přírodovědecká fakulta Slezské univerzity v Opavě. Zdůvodnění je prosté, fakulta kombinuje filozofické SP s nízkou hodnotou KEN za SP s přírodovědeckými SP, které mají přidělenou vyšší hodnotu KEN na SP. Ostatních 10 filozofických fakult náleží do kategorie fakultních KEN od 1 do 1,2. Při porovnání s celkovými průměry mezd za všechny VVŠ je vidět značný rozdíl a mzdy pracovníků filozofických fakult se vždy nacházejí pod celkovým průměrem. Největší rozdíly v průměrném mzdovém ohodnocení se nacházejí ve srovnání s kategorií fakultních KEN 1,65 až 2,25, kde průměrná mzda profesora filozofické fakulty je o 38 479 Kč nižší oproti celkovému průměru na všech VVŠ.

V přílohové části se dále nachází Tabulka č. 2, která obsahuje fakulty VVŠ[13] s minimálními průměrnými mzdami akademických a vědeckých pracovníků v jednotlivých kategoriích KEN. Červeně označená pole v tabulce poukazují na fakulty, případně celoškolská pracoviště, které mají průměrnou měsíční mzdu pod 25 000 Kč. Žlutě označená pole v tabulce symbolizují fakulty a pracoviště s minimální měsíční mzdou pod 30 000 Kč. Při porovnání výstupu z Graf č. 3 s médii hojně diskutovanými filozofickými fakultami a Tabulka č. 2, kategorii fakult s KEN mezi 1 a 1,2 dominují s nejnižšími mzdami teologické fakulty, nikoli filozofické. Naopak v kategorii fakult s KEN mezi 1,65 a 2,25 se Filozoficko-přírodovědecká fakulta Slezské univerzity v Opavě objevuje opakovaně.

[11] dekaniff. (2019). *O asociaci*. Získáno 20. říjen 2023, z https://dekaniff.cz/o-asociaci/
[12] Hodina pravdy. (2023). *Kontakt*. Získáno 20. říjen 2023, z https://hodinapravdy.cz/kontakt/
[13] VVŠ s pouze jednou fakultou mají uvedeny pouze název školy.

Závěr

Cílem příspěvku bylo analyzovat mzdy akademických a vědeckých pracovníků fakult veřejných vysokých škol v České republice v souvislosti s koeficienty ekonomické náročnosti. Výsledky analýzy ukazují, že fakulty s velmi nízkými a velmi vysokými koeficienty dosahují výrazně nižších průměrných mezd. Naproti tomu fakulty s průměrnými fakultními koeficienty mají v průměru vyšší mzdy.

Tabulka č. 2 poukázala na problémy se mzdami nejen filozofických fakult VVŠ, ale také teologických, uměleckých a některých technických fakult, které se pohybují pod průměrnou mzdou 30 000 Kč u pedagogických pracovníků V, V a I, asistentů, lektorů a vědeckých pracovníků napříč jednotlivými kategoriemi fakultních KENů.

Analýza bude pokračovat rozšířením na časovou řadu, kde bude možné zaznamenat případné legislativní změny, změny v metodice sběru dat, demografické vlivy (např. vlivy silných a slabší ročníků při nástupu na veřejné vysoké školy) i další možné vlivy. Dále plánujeme vypočítat, jaký vliv by mohly koeficienty ekonomické náročnosti mít, pokud by v roce 2015 nedošlo k jejich zafixování, a jak se vyvíjí podíl financí z MŠMT na vysokoškolské vzdělávání k HDP.

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[5] FLUSKOVÁ, H. (2022) Financování vysokého školství v ČR a na Slovensku: koeficienty ekonomické náročnosti. Praha. Diplomová práce. Vysoká škola ekonomická v Praze. Vedoucí práce prof. Ing. Jakub Fischer, Ph.D.

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Přílohy

Graf č. 1: Průměrná mzda akademických a vědeckých pracovníků fakult VVŠ podle KEN intervalů, pohled přes KEN
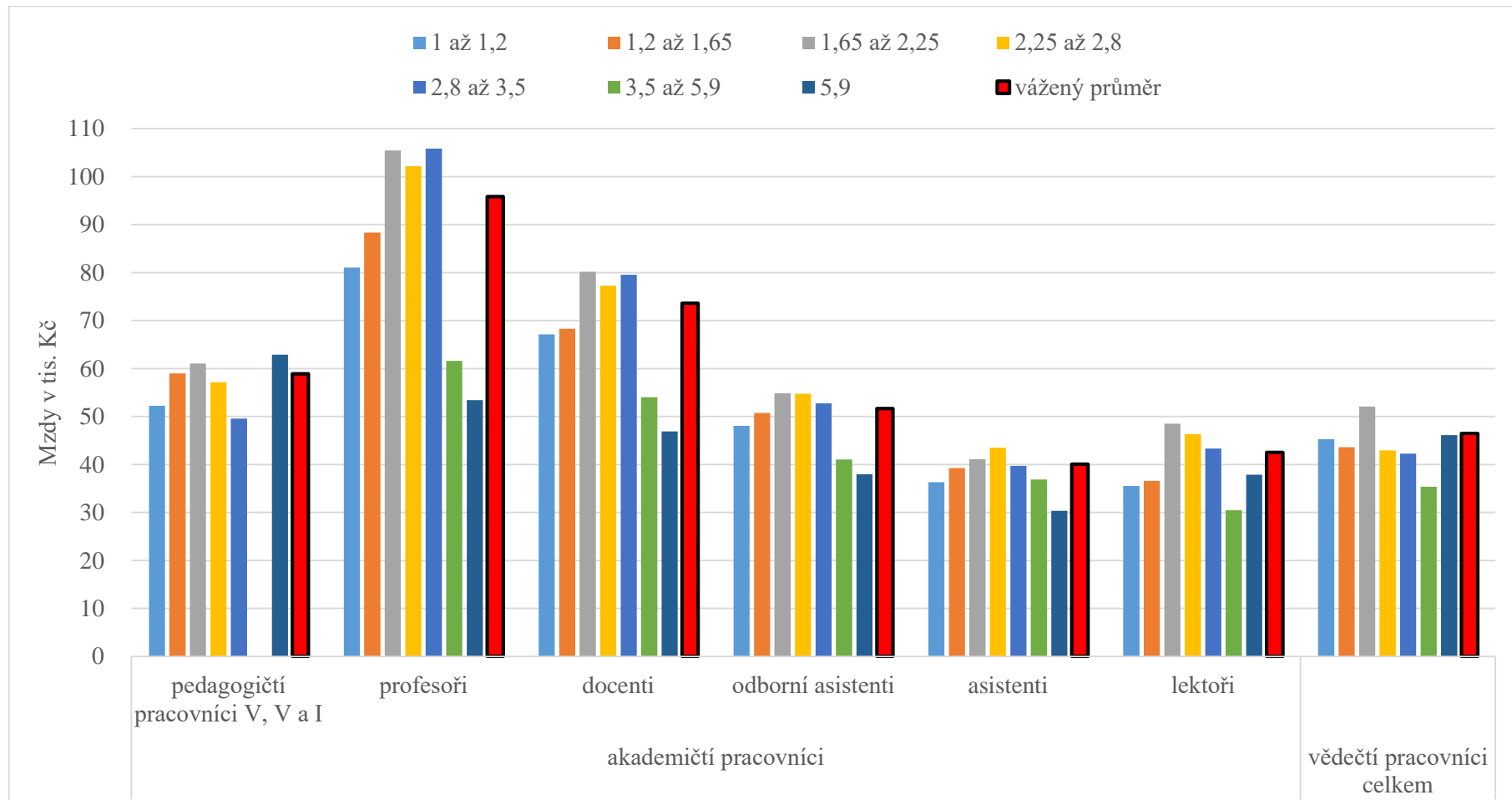
Zdroj: Vlastní zpracování, MŠMT 2021

Graf č. 2: Průměrná mzda akademických a vědeckých pracovníků fakult VVŠ podle KEN intervalů, pohled přes zaměstnance[14]
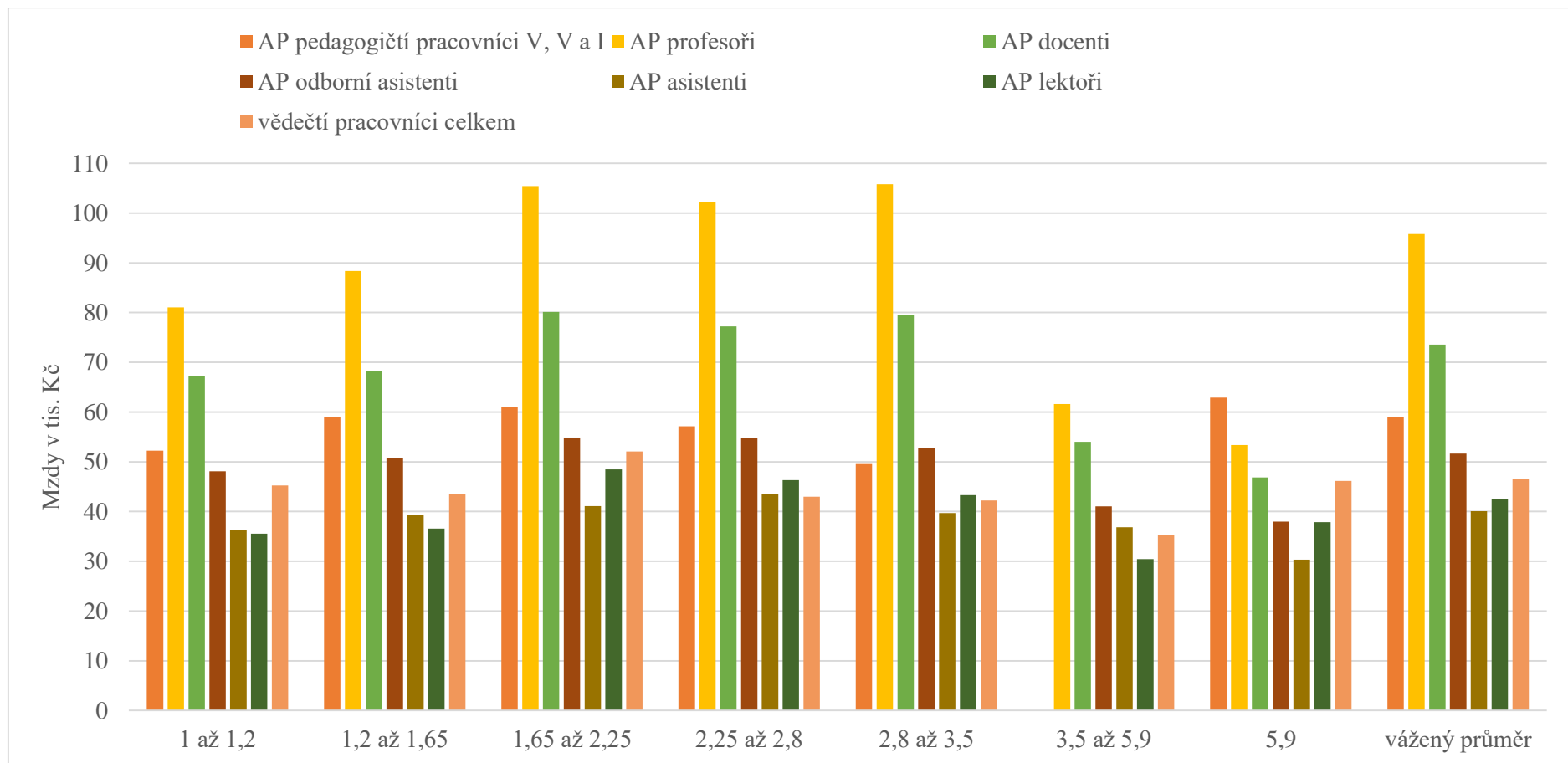
Zdroj: Vlastní zpracování, MŠMT 2021

_____

[14] VVŠ s pouze jednou fakultou mají uvedeny pouze název školy.

Graf č. 3: Průměrných mezd akademických a vědeckých pracovníků filozofických fakult podle příslušných KEN kategorií a celkově vs. příslušné hodnoty průměrných mezd za všechny fakulty VVŠ
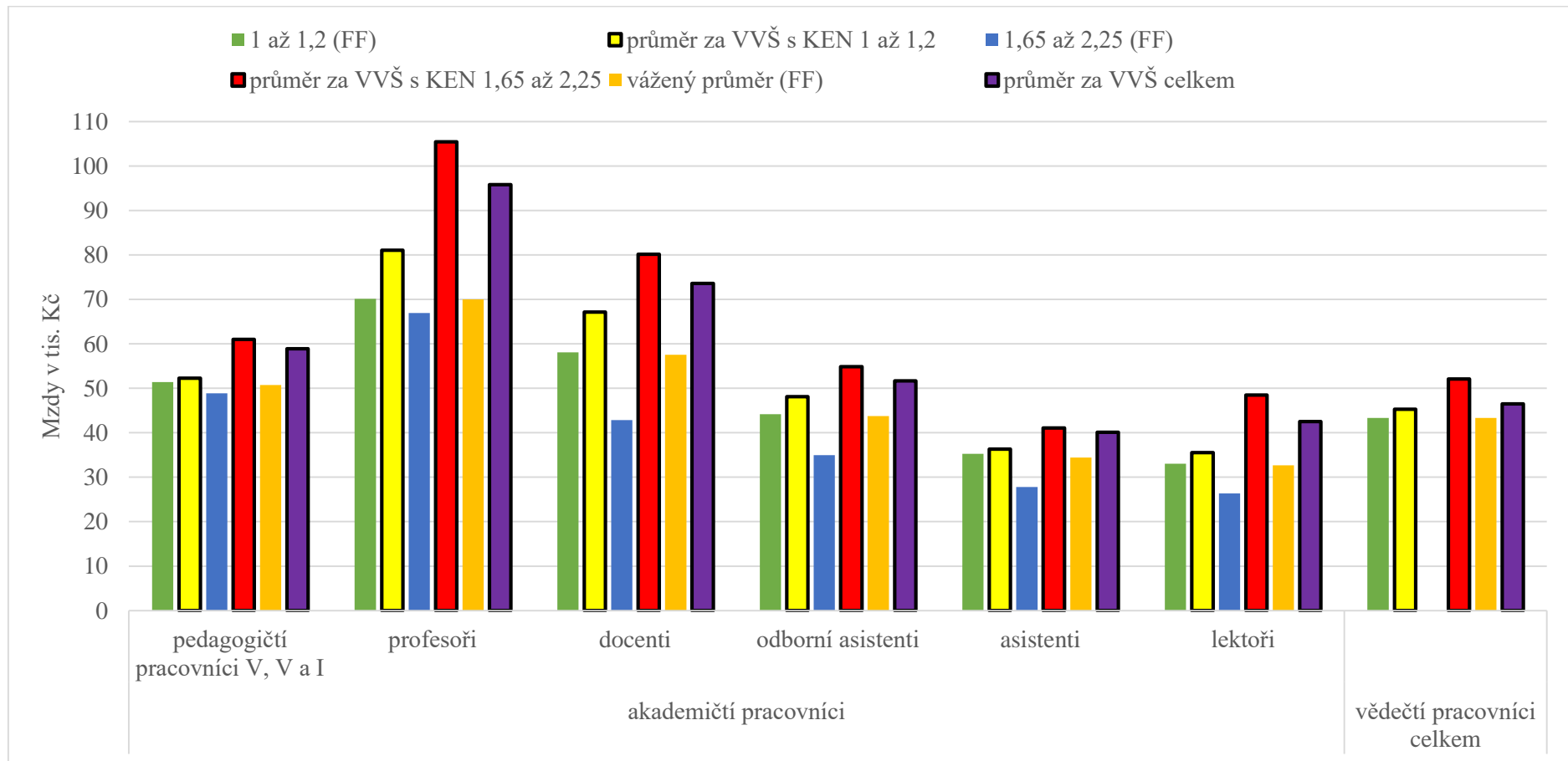
Zdroj: Vlastní zpracování, MŠMT 2021

Tabulka č. 2: Fakulty VVŠ s min. průměrnými mzdami akademických a vědeckých pracovníků v jednotlivých kategoriích KEN

kateg. prům. fak. KEN	akademičtí pracovníci						vědečtí pracovníci celkem
	ped. prac. V, V a I	*prof.*	*docenti*	*odborní asist.*	*asist.*	*lektoři*	
1 až 1,2	UK Evangelická teolog. fakulta	ZČU Fakulta filozofická	UK Katolická teolog. fakulta	UK Husitská teolog. fakulta	**OSU Fakulta soc. studií**	**UPOL Cyrilometoděj. teolog. fakulta**	**UK Katolická teolog. fakulta**
1,2 až 1,65	**JČU Pedagogická fakulta**	ZČU Fakulta pedagogická	ZČU Fakulta pedagogická	SLU Fakulta veřejných politik	**VŠCHT Celoškolská pracoviště**	VŠTE	UJEP Pedagogická fakulta
1,65 až 2,25	VUT Fakulta elektrotech. a komunik. techn.	UJEP Fakulta zdravot. studií	SLU Filozoficko-přírodověd. fakulta	SLU Filozoficko-přírodověd. fakulta	**ČVUT Fakulta elektrotechnická**	**SLU Filozoficko-přírodověd. fakulta**	UJEP Fakulta zdravot. studií
2,25 až 2,8	ČVUT Fakulta jader. a fyzikálně inženýrská	ZČU Fakulta zdravot. studií	ZČU Fakulta zdravot. studií	TUL Fakulta zdravot. studií	**UTB Fakulta technologická**	**TUL Fakulta umění a architektury**	**MU Farmaceutická fakulta**
2,8 až 3,5	UK Lékařská fakulta v Plzni	VŠCHT Fakulta technolog. ochrany prostř.	UK Lékařská fakulta v Plzni	UK Lékařská fakulta v Plzni	UPOL Lékařská fakulta	UK Lékařská fakulta v Plzni	VŠCHT Fakulta technolog. ochrany prostř.
3,5 až 5,9	–	OSU Fakulta umění	OSU Fakulta umění	UJEP Fakulta umění a designu	**UMPRUM**	UJEP Fakulta umění a designu	**UJEP Fakulta umění a designu**
5,9	AVU	AMU Hudební a taneční fakulta	AMU Hudební a taneční fakulta	AMU Hudební a taneční fakulta	**AVU**	AMU Divadelní fakulta	JAMU Divadelní fakulta

Zdroj: Vlastní zpracování, MŠMT 2021

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The collapse of Silicon Valley Bank –
The importance of proactive risk management in order
to prevent financial contagion

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The collapse of Silicon Valley Bank – The importance of proactive risk management in order to prevent financial contagion

Abstract

In the underlying paper, the collapse of Silicon Valley Bank (SVB) serves as a case study to explore the causes and the crash´s aftermath. The main question is, if the crash and its spill over effects could have been prevented. The study highlights the importance of effective risk management practices, diversification, and capital management for mitigating systemic risk in order to prevent financial contagion. The findings underscore the necessity of a robust regulatory framework, like the Dodd-Frank Act and Basel III, but also emphasize the importance of proactive risk management within banks to prevent future failures. The collapse of SVB reveals that despite regulatory measures, gaps in risk management practices can still lead to catastrophic consequences, emphasizing the need for continuous improvement in risk management strategies within the banking sector. The underlying research hypothesis is that the crash of SVB and its aftermath could have been prevented by adequate and prospective risk management.

Key words

Bank collapse, Silicon Valley Bank, risk management, banking risks, financial contagion, systemic risk, mitigation strategies, regulatory framework

JEL Classification

G01, G21, G24, G28, G33, G38

DOI

http://dx.doi.org/10.37355/KD-2023-05

Introduction

Like any other business, banks are exposed to various risks that can cause them to collapse. Credit risk is the risk that a borrower will fail to meet its obligations to repay its debt, resulting

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in a loss for the lender (Leo et al., 2019). Liquidity risk is the risk that a bank will be unable to meet its financial obligations due to an inability to convert assets into cash (Leo et al. 2019; Nikolaou, 2009). Market risk is the risk that the value of a bank's assets will decline due to changes in market conditions (Leo et al., 2019). Operational risk is the risk of loss resulting from inadequate or failed internal processes, people, and systems (Leo et al., 2019; Basel Committee on Banking Supervision, 2011). Reputational risk is the risk of damage to a bank's reputation, which can lead to a loss of customers and revenues (Adeabah et al., 2022; Cummins et al., 2006).

The collapse of Lehman Brothers is a perfect example of how the failure of one bank can have significant ripple effects throughout the global financial system, highlighting the importance of effective risk management strategies and the need for a robust regulatory framework to ensure the stability of the banking sector (Feldkircher et al., 2014). In light of the devastating effects of the Lehman Brothers crash, the collapse of SVB also elicited strong concerns about systemic impacts among various stakeholders.

This paper is structured as follows. First, systemic risk and the phenomenon of financial contagion will be explained. Building on this background information, the focus of this paper will then be devoted to an analysis of the causes of SVBs' crash and its aftermath addressing the following core question:

What factors led to the crash of the Silicon Valley Bank, what implications did the collapse have in terms of financial contagion and could the underlying risks have been mitigated?

Following Bales and Burghof (2023), which summarize that the default of SVB was the result of an asset-liability mismatch caused by inappropriate risk management, the underlying research hypothesis of this paper is:

The collapse of Silicon Valley Bank and its aftermath could have been prevented by adequate and prospective risk management.

1 Systemic Risk & Financial Contagion: The Domino Effect in Banking

Systemic risk, often examined within the broader spectrum of financial contagion, is the potential for a specific disturbance or failure within an institution or market segment to incite substantial instability or collapse in the larger financial system or the entire economy (Acharya et al., 2016). A significant factor contributing to systemic risk is the interconnectedness of institutions and markets; the dense web of financial systems means that the downfall of one entity can catalyze a domino effect, causing a ripple of failures across

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interconnected institutions (Gai et al., 2011). Alle & Gale (2000) explain that financial contagion is a phenomenon closely tied to systemic risk and refers to situations where panic or failures in one financial institution or market extend to other institutions or markets, even without direct financial ties. Such contagion can be accelerated by vulnerabilities in financial infrastructure, including payment systems or clearing houses, as these can channel disruptions across the financial landscape (Bernanke, 2010). Brunnermeier et. al (2009) explain that furthermore, macroeconomic shocks, which are large, unforeseen economic events, can intensify these disruptions, leading to a more widespread financial system instability.

1.1 Financial Contagion: Term and Causes

Rose and Spiegel (2010) argue that there is disagreement in academic discourse about whether economies can "contagion" from crises originating elsewhere, or whether international or even global crises are not rather common shocks affecting different economies to different degrees. Moser (2003) points out that even though financial crises may occur at the same time in different countries, it can be coincidence rather than cause-and-effect. This means that concluding contagion would be a misperception. Moser also states that a causal connection is required for contagion. Financial contagion is the case when the cause for the shock is common. On the other hand, he argues that it is debatable whether a transmission of country-specific shocks should be considered contagion since interdependence between countries results in particular from the interconnectedness of the economic indicators of their payment balances, thus a financial crisis in one country can affect the economy of another (e.g. trade shocks). It can be concluded that one must distinguish between contagion and interdependence between countries.

Rose and Spiegel (2010) who investigated the cross country causes of the financial crisis in 2008 state that there is a contagious response when it comes to real and financial crises. According to Bayona and Peia (2022) contagion can take place between countries, markets and asset classes both in situations in which fundamentals are related, through trade or linkages in the financial sector, and unrelated, trough the actions of investors. Regarding the situations in which fundamentals are related, Rose and Spiegel (2010) state that there are three main distribution channels through which crises can spread: international trade relations, foreign asset exposure, and sudden stops in international credit.

Nowadays, it is widely recognized that financial linkages across countries were critical to the rapid transmission of the crisis across national borders, which led to a reevaluation of the effects of international market integration – previously assumed to diversify risk but

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today also considered to amplify the international spread of crises (Devevereux & Yu 2020). This is in line with the results of the literature review of Tafakori et al. (2022) which showed that interdependencies between financial institutions and financial markets are considered as a main cause for contagion.

As Bayona and Peia (2022) state contagion can also occur by certain investor behavior. They argue that financial crises are often a self-fulfilling prophecy since investors who are convinced that a crisis will arise, will retract their investments because they expect that other investors will do the same. This argument is inspired by the "animal spirits" theory. De Grauwe (2008) describes the concept of "animal spirits" introduced by Keynes as a form of self-fulfilling prophecy expected by investors and consumers. The underlying concept is that consumers and investors adjust their investment behavior depending on their expectations of the future, which then actually affects the market. Since the crash of the SVB lead to panic on the markets, a similar behavior could be observed.

2 Silicon Valley Bank Collapse: Case Study

2.1 Causes of Silicon Valley Bank's collapse

The default of Silicon Valley Bank was a significant event in the banking industry, and it was the result of several factors. This section focusses on an analysis of the bank's financial performance from 2019 to 2022 conducted by the authors Vo and Le (2023), while deriving the key reasons behind SVBs' failure. It also examines the bank's performance ratios during the same period to provide insights into its business model and practices.

One of the main reasons of the bank's downfall was its substantial investment in debt securities during a period of low-interest rates. SVB heavily allocated its investments to securities, particularly debt securities, which are highly sensitive to interest rate fluctuations (Vo & Le, 2023). The downfall of SVB can be traced back to its substantial investment portfolio, valued at USD 120 billion (bn), which primarily consisted of long-dated mortgage-backed securities (MBS) issued by US government agencies (Hauf & Posth, 2023). By acquiring a substantial MBS portfolio at a historically low yield-to-maturity of around 1.64% in 2020 and opting not to sufficiently hedge it, the bank's management not only exposed itself to significant interest rate risk but also recorded a return on capital that is significantly below present-day levels (ibid.). As interest rates increased, the value of these securities declined, resulting in substantial unrealized losses. The bank's low reliance on equity capital also exacerbated this situation, as it did not have sufficient capital to absorb these losses (Vo

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& Le, 2023). Barr (2023) states that although the immediate reason for SVB's collapse was a liquidity run, the fundamental problem stemmed from doubts regarding its financial viability.

The bank's lack of depositor diversification was another crucial factor that led to its collapse. The bank's deposit base was heavily concentrated among a small group of depositors from venture capital and tech industry, amplifying the risk of a bank run (Barr, 2023; Politi & Fedor, 2023). This concentration of deposits also limited the bank's ability to attract new customers, reducing its ability to diversify its funding sources and increase its resilience to shocks (Vo & Le, 2023). It can be concluded that SVB's significant investment in debt securities and its concentrated deposit base, along with a lack of depositor diversification, played pivotal roles in the bank's downfall, highlighting the critical importance of risk management and financial stability in the banking sector.

Furthermore, the bank's business model heavily emphasized securities, leading to a decline in its loan portfolio. The proportion of net loans and leases to total assets significantly decreased from 46.96% to 35.22% during the analyzed period, substantially deviating from the industry average. Consequently, the bank's loss provision for loans and leases, as well as net charge-offs for loans and leases, were significantly lower than industry benchmarks (Vo & Le, 2023). This lack of focus on loans and leases, which are typically considered lower risk than securities, also contributed to the bank's vulnerability to interest rate fluctuations.

The bank's low proportion of loans and leases also impacted its net interest margin, which decreased from 3.53% to 2.23% during the period (Vo & Le, 2023). This figure fell below the industry average, attributable to the bank's heavy investments in securities and limited proportion of loans and leases (ibid.). Additionally, the yield on earning assets declined from 3.83% to 2.77% (ibid.). Concurrently, the cost of funding earning assets escalated from 0.30% to 0.53%.

The bank's return on assets and return on equity also declined during the period. Return on assets shrunk from 1.65% to 0.96%, while return on equity decreased from 21.47% to 13.43%. In 2022, SVB's return on assets significantly lagged behind the industry average, while its return on equity outperformed it. This suggests that the bank used less equity capital than the industry average (Vo & Le, 2023).

Despite SVB's relatively low equity capital ratio, its total risk-based capital exceeded the industry average significantly. This can be attributed to the bank's lower credit risk stemming from a higher proportion of U.S. government securities and a lower proportion of loans and leases. Furthermore, the bank maintained assets with low credit risks, resulting

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in its classification as "well capitalized" by U.S. banking regulators for several years (Vo & Le, 2023).

Additionaly, the authors Bales and Burghof (2023) postulate, that the collapse of SVB was boosted by public attention. The authors analyze the relationship between public attention and trading activity of Silicon Valley Bank (SVB) stock during its default in March 2023. By analyzing tweets and Google searches, the researchers demonstrate that public attention significantly influenced the crash dynamics and contributed to reduced market excess returns for SVB. Their research highlights the significance of social media in maintaining financial stability and provides empirical evidence supporting the occurrence of bank runs driven by media attention (Bales & Burghof, 2023). This is also confirmed by Barr (2023), who emphasized the possibility of depositors to instantly spread their concerns about a bank run and herby accelerate the possibility of its occurrence.

In conclusion, a combination of factors, including SVB's significant investments in debt securities, concentrated deposit base, reduced focus on loans, and amplified media attention, played crucial roles in the bank's collapse. While the bank was classified as "well capitalized" by U.S. banking regulators, it ultimately failed due to its vulnerability to market fluctuations. As a result of these factors, investor confidence eroded, resulting in underperforming share prices and the bank's failure.

2.2 The Aftermath of the Collapse

Following the collapse, the academic and financial spheres witnessed a surge in research endeavors focused on understanding the aftermath and the intricate mechanisms of financial contagion that ensued. In this section, we will delve into a comprehensive literature review, drawing from a diverse array of studies.

Akhtaruzzaman and colleagues (2023) conducted a study to determine whether the SVB collapse triggered financial contagion. Their research shows that the SVB crash caused a significant increase in dynamic conditional correlations (DCCs) between the returns of banks in the US, France, Germany, Italy, and the UK which shows that the financial problems spread beyond just the US market and affected these European countries as well. DCCs between US and Brazilian bank returns also increased during the crisis, but surprisingly there was no significant increase in DCCs between the US and banks in China, India, or South Africa during the SVB crisis. They conclude that the European banking industry was greatly affected by SVB's failure, as seen in the takeover of Credit Suisse and First Republic Bank.

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The researchers point out that contagion was significant within the banking industry but that it luckily only had minimal impact on other market sectors.

When it comes to the impact on markets, Yousaf et al (2023) state that the SVB collapse had a significant negative impact on some markets like U.S. stocks, global banks, Bitcoin, and equities in the Gulf Cooperation Council (GCC) region. However, it didn't have much impact on most traditional currencies, metals, and energy markets which suggests that the SVB event had a major effect but was limited to a small number of markets and didn't affect many others.

Aharon et al. (2023) confirm the findings of Yousaf et. al since they state that markets reacted negatively to the SVB collapse. They point out that specifically on capital markets in Europe, Latin America, and the Middle East and Africa a significant negative response was detected. The researchers emphasize based on their findings that companies and investors should pay close attention to systemic risk since financial markets are highly interconnected.

Chobi et al. (2023) observed the contagion effects of the Silicon Valley bank run and investigated factors contributing to declines in banks' stock returns after the Silicon Valley Bank (SVB) failure. Their findings show that mid-sized banks faced more stress, but that negative effects spread to most banks, except for the largest ones. The researchers point out that holding liquid assets like cash and high-quality securities or relying more on deposits than wholesale funding doesn't always prevent bank runs like the SVB failure showed. The panic started when depositors got worried about unrealized losses in SVB's high-quality securities, even though they were of good quality. As described earlier, therefore, the banks had to sell these securities, which led to actual losses and made the situation worse. The researchers also found out that banks whose stocks did poorly after SVB's failure had already underperformed in the previous year. This suggests that investors anticipated the problems linked to relying on uninsured deposits during interest rate hikes but didn't foresee the issues with unrealized securities losses until the SVB crisis, even though the data was available which shows the challenges in creating comprehensive and robust stress scenarios.

Martins (2023) examined the effects of the collapse of the SVB and the credit Suisse on the stock market. He states that stocks of banks tend to go down when two banks fail. This can be explained by the fact that other banks get worried, people panic, and there's a lack of clear information. Martins explains that whether the stock price drops a lot or a little depends on factors like how easily the bank can access cash, how much they make from interest, how much risk they're willing to take, how well they operate, and who owns their stock.

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In the conducted study, Martins investigated how the stock market responded when two banks, SVB and CS, failed among the top 100 European banks. He explains that recent studies also examined the impact of SVB's failure on global stock markets and that the result was, that the SVB's collapse had a significant negative effect on various market indices worldwide. It was also found that social media and herd behavior intensified the SVB crisis, since many tweets and Google searches contributed to the bank's problems.

3 Discussion

Bales and Burghof (2023) summarize that the default of SVB was primarily the result of an asset-liability mismatch which was caused by inappropriate risk management and the special characteristics of its depositors.

Following the statement of Bales and Burghof (2023), one could argue that the collapse of Silicon Valley Bank could have been prevented if the bank had implemented more effective risk management practices. Indeed, the bank's heavy investment in debt securities during a period of low interest rates was a significant risk factor that could have been managed through diversification and more conservative investment strategies. Additionally, the bank's lack of depositor diversification left it vulnerable to a bank run, and its low proportion of loans and leases made it more susceptible to interest rate fluctuations.

One of the main issues with SVB's risk management was its overreliance on securities, which caused a decline in its loan portfolio. This lack of focus on loans and leases, which are typically lower risk than securities, ultimately contributed to the bank's vulnerability to interest rate fluctuations. This could have been mitigated through a more balanced investment portfolio that included a greater proportion of loans and leases.

SVB's low reliance on equity capital also exacerbated its risk exposure. The bank did not have sufficient capital to absorb losses when its debt securities declined in value, which ultimately led to its collapse. This situation could have been improved if the bank had maintained a higher level of equity capital, allowing it to weather market fluctuations and economic shocks.

The bank's lack of depositor diversification was another significant risk factor that could have been managed through better risk management practices. If the bank had diversified its deposit base, it could have reduced the risk of a bank run and improved its ability to attract new customers. This would have increased its resilience to market shocks and reduced the impact of potential loss events.

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The collapse of Silicon Valley Bank raises questions about the effectiveness of Basel III and other banking regulations (Hauf & Posth, 2023). Despite these regulations, the collapse of SVB suggests that there are still gaps in the risk management practices of banks. The heavy investment in debt securities during a period of low-interest rates and the lack of depositor diversification were significant risk factors that could have been mitigated with stronger risk management practices. These practices could have included more diversified investments, better capital management, and more stringent risk controls.

Despite that, regulations such as Basel III are not designed to eliminate all risks in the banking sector. They are intended to reduce the probability and impact of a crisis. In the case of SVB, it is possible that the bank's management did not adequately implement or adhere to the regulations, leading to its collapse. This means that regulations such as Basel III aim to improve the resilience and risk management practices of banks, but do not guarantee that financial institutions will not fail. It is essential for banks to have robust risk management practices in place to identify and mitigate potential risks, even in the presence of regulations. Furthermore, effective implementation and adherence to regulations are critical to their success in reducing systemic risks in the banking sector.

For preventing financial contagion, exogenous international cooperation is named as a key factor in avoiding financial contagion by Sáez & Shi (2004). In their findings, the researchers determined that indirect interconnections between banks, with liquidity loan decisions dependent on the presence of a liquidity pool, can lead to effective risk sharing and prevention of financial contagion. The liquidity pool acts as a mediator, ensuring consistent liquidity demand and shielding affected regions from others. Although the liquidity pool can be centralized in a designated money center, as referred to here, this arrangement may be constrained by the nature of deposits. One of the crucial components of a banking safety net, as per their statement, is likely the proficient and prompt regulation of bank insolvencies. However, they point out that banks can become exposed to the risk of bank runs through this mechanism of risk sharing, which can escalate into bank panics as financial contagion spreads, creating a domino effect (Sáez & Shi 2004).

Castiglionessi (2007) states that central banks achieve optimal allocation and prevent contagion by imposing reserve requirements on the amount of deposits obtained from commercial banks.

Gavin and Hausmann (1999) state that banks in economy who face a higher volatility should require higher capital ratios. They also found out that the geographical diversity of internationally active banks makes them more resilient to macroeconomic and financial

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shocks specific to individual countries, thereby enhancing their overall robustness. In order to promote confidence, they recommend elevating bank disclosure standards and collaborating with the private sector to enhance accounting norms in order to facilitate transparency. Besides that the state that, establishing sufficient safety nets can alleviate concerns among small depositors regarding the security of their deposits and reduce the likelihood of them fleeing due to unfounded fears or baseless rumors.

It can be said that preventing financial contagion is a complex and that the contagion can only be prevented by prevention at international, micro and macro level.

Conclusion

In conclusion, the collapse of Silicon Valley Bank can be attributed to a combination of factors, including its heavy investment in debt securities, low reliance on equity capital, lack of depositor diversification, and low proportion of loans and leases. These weaknesses in risk management practices left the bank vulnerable to market fluctuations and loss events.

Regarding its aftermath the examined studies collectively highlight that the SVB's collapse had significant but relatively narrow impacts on financial markets. Stock markets, in general, reacted negatively to the event, with U.S. equities, global banks, Bitcoin, and equities in regions like Europe, Latin America, and the Middle East and Africa experiencing substantial negative responses. However, this negative effect did not extend to most traditional currencies, metals, and energy markets, indicating that the SVB's impact was largely confined to a specific set of markets.

Factors contributing to stock declines after the SVB failure included concerns about unrealized losses in high-quality securities, as well as bank-specific vulnerabilities related to access to cash, interest income, risk tolerance, operational efficiency, and ownership structure. It was also observed that investors anticipated some risks, such as those associated with uninsured deposits during interest rate hikes, but failed to foresee the implications of unrealized securities losses.

The analysis highlights the need for stronger risk management practices in the banking industry, despite the implementation of regulations such as Basel III. While regulations aim to improve the resilience of banks, they do not guarantee immunity from failure. The case of SVB emphasizes the importance of monitoring systemic risk, as financial markets are highly interconnected. The interconnectedness of markets suggests that even though investors typically diversify their portfolios, the effectiveness of risk reduction may be limited in the face of a significant event like the SVB collapse.

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The collapse of SVB serves as a lesson for other banks to strengthen their risk management practices. It underscores the importance of comprehensive risk assessment, prudent investment strategies, and adequate capitalization. Banks should continuously monitor and evaluate their risk exposure, adapt to changing market conditions, and prioritize a customer-centric approach to foster long-term stability and sustainability.

While regulations such as Basel III play a crucial role in promoting stability in the banking sector, it is imperative for banks to go beyond regulatory compliance and proactively identify and address potential risks. By doing so, banks can enhance their resilience and mitigate the likelihood and impact of financial crises.

To sum it all up, the main result regarding the underlying research hypothesis is, that the crash of Silicon Valley Bank could indeed have been prevented by adequate and prospective risk management. Nevertheless, given the fact that SVB collapsed financial contagion cannot be avoided on an institutional level alone but on an international and mainly regulatory level.

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Exploring the Inflation-GDP Growth Relationship
in Germany: A Mild Positive Linear Association

Abstract

This study investigates the relationship between inflation and gross domestic product (GDP) growth in Germany over the period 2012-2022. The objective of this study was to investigate the relationship between inflation and its potential influence on GDP growth. The conducted research reveals a weak positive linear relationship (correlation coefficient of 0.18) between inflation and GDP growth, suggesting that increased inflation corresponds to a moderate increase in GDP growth. This study underscores the importance of ongoing monitoring of inflation and its influencing factors, as it contributes to a more comprehensive understanding of these economic dynamics.

Key words

JEL Classification

DOI

Introduction

This study examines the interrelationship between inflation and GDP growth, focusing on Germany over the decade from 2012 to 2022. The study sought to explore the interplay between inflation and its effects on GDP development, with a focus on determining both the existence and magnitude of this relationship. The paper gives an overview of existing research on the relationship between GDP growth and inflation, as well as the definition and measurement of inflation. The aim of the research is, to find out if there is a relationship between GDP and inflation by conducting a literature review and a short analysis based on the GDP and inflation rate in Germany.

The correlation between these two variables is explored, shedding light on the nature of their connection. While historical research provides insights into the varying degrees of impact, recent findings emphasize the significance of maintaining a moderate inflation rate for fostering economic growth, particularly in the context of the Eurozone. To gain a comprehensive understanding of the subject, we delve into Germany's yearly inflation rates along with the average inflation in the Eurozone, considering the fluctuations and variations observed.

1 Definition and measurement of inflaton

Inflation means that the consumer's purchasing power goes down, which means that he has to pay a higher amount for the same goods and services over time - thus, the general price level within the economy rises (Smilalek 2022).

To measure inflation within the euro area, the "Harmonised Index of Consumer Prices" (HICP) is used. By measuring the price of 295 goods and services that a typically used by consumers within the euro area (according to the European statistical office) it is possible to measure the price development of goods that are commonly purchased in the Euro Zone over time (Federal Reserve Bank of San Francisco 2002). Since the products purchased within the Euro Zone differ from country to country, the differences in consumption patterns are reflected by weighting products differently depending on the concerned country. (European Central Bank n.d.). Examples for the considered goods are the prices for food, clothing, petrol, household items such as washing machines and insurance prices etc. (European Central Bank n.d.)

In summary it can be said that inflation, as reflected in the rising general price level within the economy, erodes the purchasing power of consumers, and this phenomenon is meticulously assessed using the HICP.

2 Causes of inflation and influencing factors on inflation

It is distinguished between two causes of inflation: Demand-Pull Inflation and Cost-Push Inflation. Demand-pull inflation occurs when the economy's productive capacity is lower than the aggregate demand for goods and services. This means that the consumer demand is higher than the supply (e.g., oil or gold). In comparison to that, cost-push inflation arises when the production process inputs increase (e.g., increasing prices for raw material) (Juselius et al. 2016).

When it comes to the influencing factors on inflation, increased money supply, rising wages, devaluation of a country's currency and certain fiscal policies can be named as the main factors. In the following, the effect of the named causes will be explained. Increased money supply is the case when the production rate is lower than the money supply. If this is the case, demand-pull inflation takes place because the amount of money exceeds the amount of available goods (K. Matthews 2021). Devaluation means, that the country's exchange rate goes down, which results in lower priced exports and thus increased prices of foreign products which results in less purchasing power for the domestic population. An example for this is China, since the Yuan was strategically devaluated for a long time to increase exports (K. Matthews 2021).

Rising wages go hand in hand with increased production costs, unless rising wages go along with higher productivity. If wages are rising faster than the prices of goods and services, purchasing power increases. However, the price level will be adjusted to the in long-run which probably results in inflation at latest then (K. Matthews 2021). With regard to the effect of policies and regulations on the part of the government or the central bank, the effect depends on the type of measure. Tax subsidies e.g. for electric cars may result in a higher demand, which in turn results in an increased price for the subsidized product (K. Matthews 2021). Another example would be tax cuts by the government or increased money supply by the central bank to boost consumption on the consumer side.

It can be concluded tax subsidies, rising wages, increased money supply and tax cuts influence the purchasing power in the short run, but the price level adjusts in the long term.

Banerjee et al. (2005) observed the key indicators for Euro-area Inflation and GDP Growth and group the best indicators for predicting inflation into four main categories:

- Labor market factors, including unemployment rates, employment shares, and wage and labor productivity growth.
- Specific prices, like commodity price growth and the private consumption deflator.
- Fiscal factors, mainly expenditure and receipts as a percentage of GDP.
- Real economic factors, such as GDP growth, total factor productivity growth, investment growth, and private consumption growth.

They conclude that continuous updating of leading indicators is crucial for accurate one-year forecasts within the near real-time framework.

In conclusion, understanding the distinct causes of inflation, such as demand-pull and cost-push inflation, along with their influencing factors like increased money supply, rising wages, and government policies, is essential for comprehending the dynamics of price levels in the short run and the adjustments that occur in the long term. Moreover, ongoing assessment and updating of key indicators, as identified by Banerjee et al., play a vital role in making accurate one-year inflation forecasts in a timely manner.

When it comes to the influence of inflation on GDP, scientists expect a negative correlation. Fisher showed in 1993 that there is a negative relationship between inflation and GDP growth. In 1995 and 1996 this was confirmed by Barro (1995) and by Bruno and Easterly (1996). While Barro claimed that there is a slightly negative relation, Bruno and Easterly stated that there is only a relationship in case of high inflation rates. In 1998 Ghosh and Philipps found out that there are non-linearities in the inflation-growth relationship since it appeared to be negative in case of low inflation rates around 2% but also that a growth decline was related to high inflation rates of 10% or higher which resulted in even higher inflation (Smith 2019).

Kryeziu and Durguti (2019) who analyzed the impact of inflation on economic growth state that suggest that there is a favorable relationship between the inflation rate and economic growth in the Euro area which means that inflation has a statistically significant positive impact on economic growth in the Eurozone which is in line with the findings of their literature review. According to their findings, a 1 percent increase in the Inflation Rate corresponds to a 22.4 percent increase in the Growth Rate when all other variables remain constant. The researchers point out that these findings highlight the importance of maintaining a moderate inflation rate in Eurozone countries, in line with the Convergence Requirements to promote consumption and economic growth.

In summary, the relationship between inflation and GDP growth is a complex one, with historical research showing varying degrees of impact. However, recent findings by Kryeziu and Durguti emphasize the significance of maintaining a moderate inflation rate in Eurozone countries, as it has a statistically significant positive influence on economic growth, underlining the importance of striking the right balance for promoting consumption and sustained economic expansion.

3 Description of the development of inflation in Germany

Figure No. 1: Inflation rate in Germany in percent
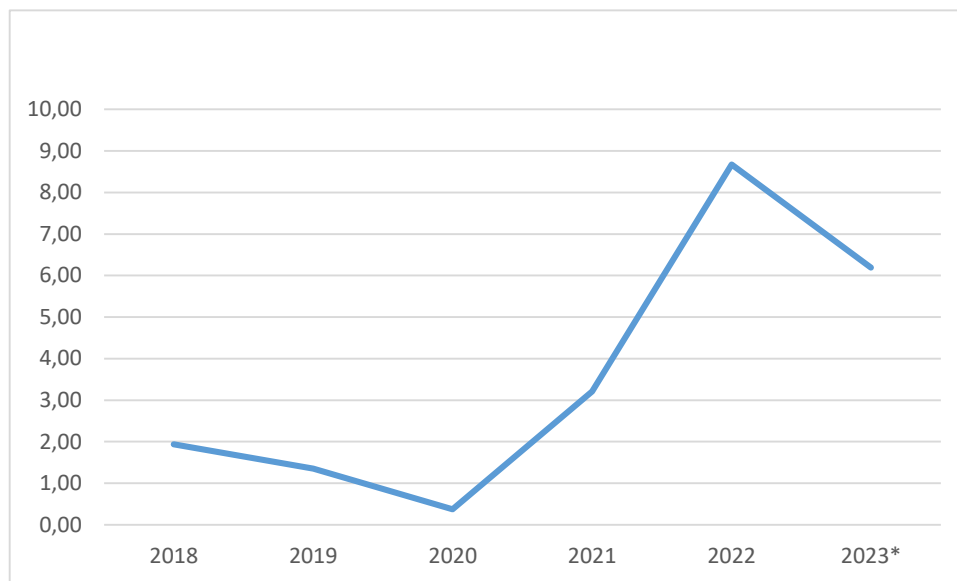
Source: Statista / IMF 2023
Own representation

Looking at the yearly inflation rate in Germany from 2012 to 2021, it can be observed that it fluctuates between 0.37% in 2016 and a maximum value of 8.67% in 2022. Within the observed period, the average inflation was 2,07% which shows that the ECB target was reached approximately. If we exclude the peak value of 2022, the average inflation is only 1.41% which is under the targeted value. It should be mentioned that the inflation was not stable but fluctuating (Statista,2022).

When it comes to the inflation, expected future inflation within the next five years, it can be observed that it is also within the targeted 2% range. The average inflation is 1,65% - the highest expected value is 2,03% in 2026 and the lowest is 1,35% in 2023 (Statista 2023). It is important to mention that the inflation rate 2022 clearly exceeds the desired inflation rate (Statista 2023).

4 Inflation rate in the Euro Area

The average inflation in the Eurozone was 2,76% between 2018 and 2022 - if we exclude the inflation peak of 2022 it is 1.4% on average. The low point was in 2020 with an inflation rate of 0.25%. It can be observed that the inflation rate in Germany is slighltly higher than the european average, but that it is similar to it. It can be said that the fluctuation in the Eurozone is reflected in the German inflation as well.

Figure No. 2: Inflation in the Euro Area
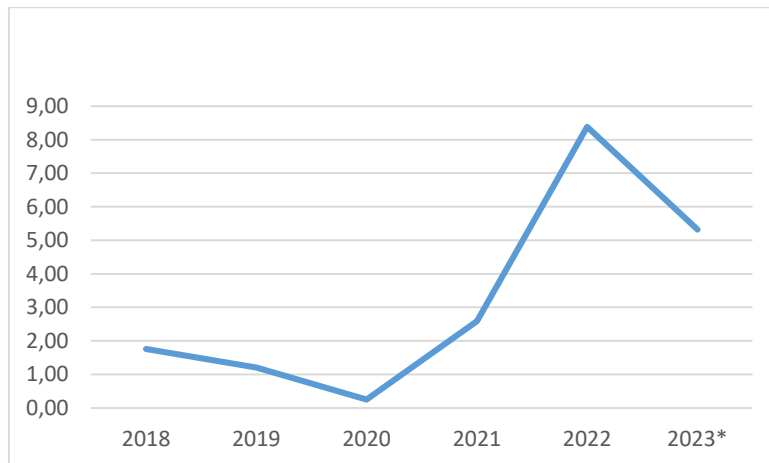
Source: IMF / Statista 2023
Own representation

5 Influence of inflation and Gross Domestic Product (GDP)

To find out if inflation influences the GDP, the German GDP and the German inflation rate within between 2012 and 2022 will be compared. It can be observed the highest growth rate in GDP within the observed period was recorded in 2012 and 2013 with 4,0% – the inflation rate was at 2.1% (2012) and 1.6%. It should be mentioned that during the financial crisis in 2009 the GDP growth was negative with 5,7%. So it can be assumed that the economy recovered in the following years which was reflected in a peak in growth.

In the following two years (2014 and 2015) the inflation continued to decline to 0.76% in 2014 and 0.67% in 2015 while the GDP growth rate increased to 1.5% in 2014 and 2.2% in 2015. During the period 2016–2019 the inflation rate fluctuated between 0.37% in 2016 and 1.94% in 2019. The growth rate was 2,2% in 2016 and 1,1% in the following two years.

Within the recent years 2020 and 2021 the inflation rate increased from 0,37% in 2020 to 1,51% in 2021 while after a pandemic-related decline in GDP growth with -4,9% in 2020 an increase of 2,9% in 2021 happened.

The correlation coefficient between inflation and GDP growth is 0,18 - this suggests a relatively weak positive linear relationship between the two variables under investigation. This means that there is some tendency for an increase in one variable to be associated with an increase in the other variable, but the relationship is not very strong. It's important to note that a correlation coefficient alone does not indicate whether the relationship between the variables is causal or if other factors may influence the relationship and it has to be considered that the impact of inflation on GDP might be time-delayed and not directly noticable.

Figure No. 3: Inflation and GDP Growth in Germany
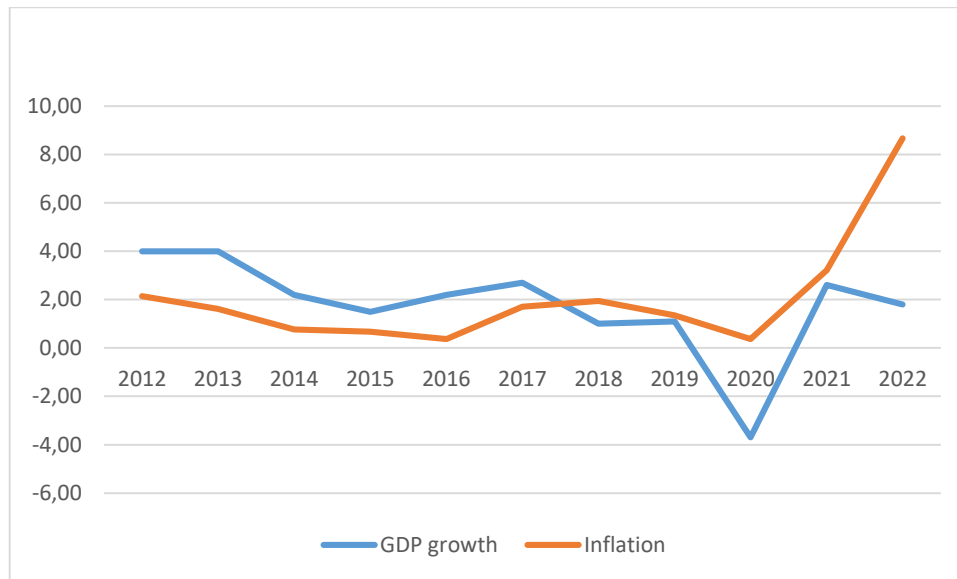
Source: Statista / IMF 2023
Own representation

6 Recommendations for further research

It is strongly advised for future research to evaluate the repercussions of the recent interest rate increase initiated by the European Central Bank. This analysis should encompass both short-term and long-term effects, providing a comprehensive assessment of its impact.

Exploring additional dimensions, such as the influence of inflation expectations and global economic variables, including international trade dynamics and global financial crises, on the interplay between inflation and GDP growth within individual countries, would add depth and relevance to the research.

Furthermore, a thorough and extensive time-series analysis is recommended to meticulously trace the historical trends in both inflation and GDP growth. This approach will enable the identification of potential patterns and shifts over time.

Additionally, it would be prudent to investigate the disparities between short-term inflation fluctuations and long-term structural inflation in terms of their differential effects on GDP growth. Such an examination can contribute to a more nuanced understanding of the multifaceted relationship between inflation and economic growth.

Conclusion

In conclusion, from the conducted litarature review it can be said that inflation has a positive impact on the development of the GDP, if it is moderate inflation. When it comes to the conducted correlation analysis, it indicates a weak positive linear relationship (correlation

coefficient of 0.18) between inflation and GDP growth, suggesting that an increase in one variable may be associated with a moderate increase in the other.

The data analysis over the past decade reveals notable fluctuations in both inflation and GDP growth rates in Germany. While inflation rates have exhibited variability, with occasional peaks surpassing the desired targets, the average has remained relatively close to the European Central Bank's objective.

However, it's crucial to acknowledge that correlation alone does not establish causation, and the impact of inflation on GDP growth may not be immediately evident, possibly involving time-delayed effects and the influence of other factors. Further research and a more in-depth analysis are warranted to better understand the complex dynamics between inflation and economic growth.

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Improving Compliance and Sales Cooperation in Banks: a Preliminary Study

Abstract

The aim of the paper is to characterize interdepartmental Compliance – Sales relationships while servicing external customers and explore a potential for improving it in financial institutions in literature and practice of Czech Republic. The paper utilizes mainly exploratory qualitative research. Methods are literature review and qualitative context analysis for semi-structured interviews with 7 employees of 7 banks in Czech Republic. The results indicates that sales department is in the position of internal customer within a cooperation with compliance department. This cooperation might be improved by six sigma (and related) project as a current cooperation does not take in consideration sales requirements for this cooperation with compliance department in sufficient manner. Literature review indicated the research opportunity consisting of not sufficient coverage of financial services by DFSS methodology. Research opportunity is apparent.

Key words

JEL Classification

DOI

Introduction

The customer is central to any company's activity. Voice of Customer (hereinafter referred to as "VoC") is the customer's voice, expectations, preferences, comments, of a product or service in discussion. It is the statement made by the customer on a particular product or service (Linde & Philippov, 2021).

Customers are different: new and constant, random and loyal, potential and adherents. All customers contribute differently to the total revenue, but they are all equally important. Existing literature distinguish, among other decompositions, between internal and external customers. Internal customers are individuals or areas of the company that receives the intermediate product or service or as a finished product. While the voice of customers, employees, and other stakeholders have been identified as key components of corporate and marketing communication, comparatively little attention has been paid to how organizations listen to, make sense of, and use information provided. Similarly lower attention had a group of internal customers (Macnamara, 2020). Park & Tran (2020) showed that internal marketing is significantly associated with salesperson's customer-oriented selling behavior and relational selling behavior which are relevant to customer relationship quality. Regarding serving internal customers, Martin et al. (2022) stated that employee proficiency and proactivity were the main predictors of delivering reliable services. Employee proficiency was the main predictor for creating a sense of assurance. Employee adaptivity was the main predictor of being viewed as responsive. Employee proactivity was the main predictor for establishing a sense of empathy. In addition, Lee & Lee (2022) examined the effects of quality management activities and sociotechnical systems on internal customer (employee) experience and organizational performance in healthcare organizations and indicated that indicated that quality management activities have positive effects on sociotechnical systems components, which in turn help improve internal customer experience and organizational performance. Chen et al. (2021) asserted that to attain customer satisfaction, service firms invest significant resources to implement customer relationship management (CRM) systems to support internal customer service employees who provide service to external customers in both face-to-face and virtual channels. Financial sector is highly regulated therefore in many cases of customer service there is an involvement of legal, compliance or risk-related department.

The Design For Six Sigma (hereinafter referred to as "DFSS") methodology and other "six sigma" methodologies (e.g. Lean Six Sigma) is one of the most important to achieving excellence in an organization's product development process (Francisco et al., 2022).

Ensuring competitiveness, especially in financial services facing the disruption and increased regulatory pressure, is not possible without proper intradepartmental relations resulting to proper servicing of external customers.

Clearly, this study has following aim: The aim of the paper is to characterize interdepartmental Compliance – Sales relationships while servicing external customers and explore a potential for improving it in financial institutions in literature and practice

of Czech Republic. Derived goal is to capture VoC of Front Office employees regarding their needs of cooperation with compliance department to ensure provision of best possible service to final (potential) external customer.

Figure No. 1: Conceptualisation of Front Office in the role of Internal Client of Compliance Departments
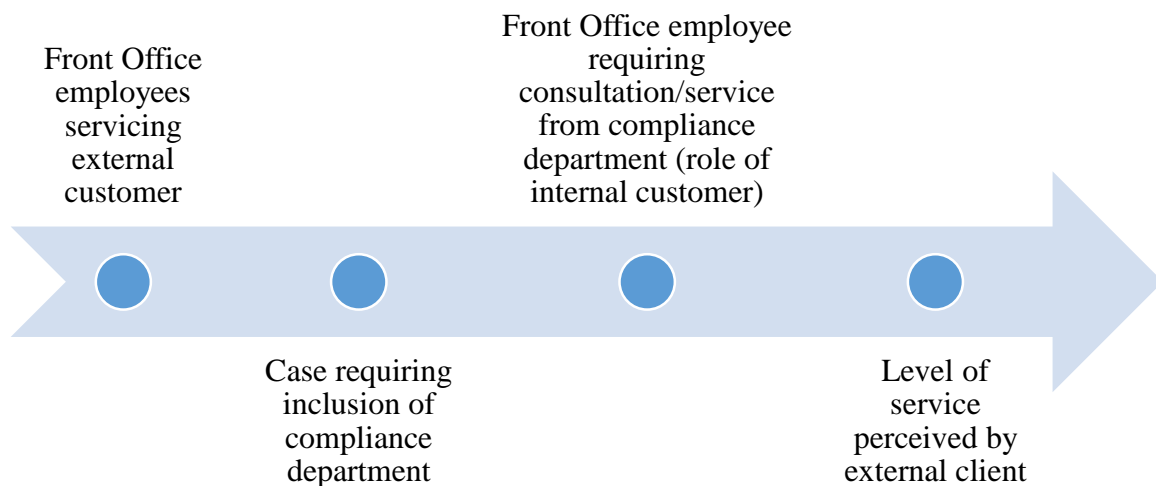
Source: Author's own

The reminder of this paper is organized as follow. First, Introduction section provides a review of relevant knowledge and conceptualization of a problem investigated. This is followed by providing methodological framework for the paper. Empirical application of data collection techniques and described methods is presented next, in the Results section of the paper. Based on of the exploratory analysis, the analysis of role of Front Office as the internal customer of compliance department followed by captured VoC of Front Office is the core of the paper and it includes also managerial implications. The paper concludes with general conclusion and opportunities for future extension of this research.

1 Material and Methods

The paper utilizes mainly exploratory research and methods of qualitative research.

To fulfil the goal of the paper, it must explore and map attitudes, opinions and experience of banks' front office employees regarding cooperation of front office (sales) and compliance department.

Research question is: What are the interdepartmental Compliance – Sales points of cooperation? Clearly, this research does not cover the intention of the paper hence

it is decomposed to following research sub-questions that translated to open questions for the interviews (questions author asked interviewees – front office employees as explained later):

- How often do Front Office employees cooperate with compliance department?
- In what occasions Front Office employees cooperate with compliance department?
- Do Front Office employees recognize a need for improvement of sales department in position of internal customer with compliance department in financial institution?
- What Front Office employees expect from the cooperation with compliance department in financial institution?
- What Front Office employees perceive as barriers, defects or deviations from quality in the cooperation with compliance department in financial institution?
- What aspects of cooperation between Front Office employees and compliance department result to dissatisfy of external customer based on the experience of Front Office employees?

VoC methodology pack is focused mainly on surveys, interviews and focus groups, but also experiments. As this paper has a character of a preliminary study, interviews are the chosen technique for primary data collection to answer research questions. Interviews allows lower sample than surveys and allow potentially capturing knowledge in detail, but for the price of lower robustness of the research.

Reproducibility of research, connected to interviews as data collection tool, is the limitation of this paper. Considering having a character of exploratory research, it is acceptable for clearing out the limits of future research that will utilize more robust and valid data collection techniques and methods. More of the potentially influential limits of research are following:

Table No. 1: Potential Biases of the Paper

Risk	Remedy/Commentary
Small sample (non-response bias)	The sample can be expanded geographically (e.g. we might include also subjects from Slovak republic) or expand to new industry. Every participant will be offered an individual report of the findings of our study.
Potential misunderstanding	Despite the fact that author studied required literature to conduct the research, there is still a possibility of lack of training and knowledge to provide deep results as in case of scientific teams. First we will test research tools on smaller sample to identify misunderstandings.
Lack of confidence	We will propose signing the Non-disclosure agreement to subjects in the sample; all data will be used anonymously and in aggregate form.
Social desirability	We will warn subjects in the sample regarding these issues and demotivate them from such answers.

Source: Author's own based on the evaluation of proposed research

Research sample included 7 Front Office employees from 7 banks serving mass retail or mass affluent retail for both natural persons or small and medium enterprises (no private banking services); professionals with at least 5 years of experience within current or similar Front Office in Czech Republic. Available sampling was applied, respondents were contacted by LinkedIn or by e-mail. Interviews were conducted individually, within the period of October 2023, in person.

Regarding methods of processing gained primary data, results were Qualitative content analysis (hereinafter referred to as "QCA") of the data is used to identify the key concepts and opinions. Denzin & Lincoln (2018, p. 122) stated that QCA "*is not intended to celebrate the empirical detail*" but rather to identify new and emerging issues for future, in line with paper's intention of conducting exploratory research. This approach was proposed in similar conditions of investigating internal audit by Knott (2022) who stated that for future research, the constructed theories can be explored by conducting interviews with experts in single organizations. Moreover, Burdon & Sorour (2020, p. 54) added that "*QCA is also widely used in mainstream management journals*". Schreier (2012, p. 7) specifies that the coding scheme would be valid "*to the extent that your categories adequately represent the concepts in your research question*"; in case of this paper, the main themes are clearly stated above in title, main and partial goals and research questions.

Naturally, some of the respondents could provide similar or even the same answers, considering the expectation that strongly regulated financial sector requires some processes to be similar between subjects. For this purpose the affinity diagram method was applied (also known as affinity chart, affinity mapping, K-J Method, thematic analysis) to cluster same or similar answers between respondents (American Society for Quality, 2023). Based on this the results are drawn and summarized in following chapter.

Considering the Six Sigma process and acceptable range and character or this paper, it does not provide full VoC method application as it is limited to following steps:

- Identify the Verbatim (Direct Quotes): Collect direct quotes, feedback, and comments from customers. These are typically verbatim statements that reflect what customers have said about their experiences, preferences, and expectations. This is the raw, unfiltered voice of the customer.

- Analyze and Transform into Needs: Analyse the verbatim statements to identify recurring themes, patterns, and underlying needs. Convert the direct quotes into actionable needs that can guide process improvement efforts. This step involves categorizing and prioritizing the VOC data.

Prioritization and translation of needs to metrics are not conducted in the paper.

VoC in this paper consists of three interconnected themes: verbatim, need, and requirement:

- Verbatim: Verbatim represents the direct, unfiltered feedback and comments provided by customers. These are the exact words and statements that customers use to express their opinions, preferences, and experiences with a product or service.

- Need: Needs, within the context of VOC, are the underlying and often unspoken customer requirements or desires that are revealed through the verbatim feedback. Needs reflect what customers truly want and value from a product or service.

- Requirement: Requirements are the specific, actionable, and measurable criteria derived from customer needs. These are the detailed specifications or expectations that must be met to deliver a product or service that aligns with customer desires and ensures satisfaction.

2 Results

There are various situations when Front Office employees are in the role of internal customer of compliance department:

Front Office as Internal Indirect Customer of compliance department:

In this context, the Front Office serves as an internal indirect customer of the compliance department. The Front Office comprises roles such as sales, client services, and relationship management within a financial institution. These teams are not the direct recipients of compliance services but are indirectly affected by compliance activities.

The compliance department plays a vital role in establishing and enforcing regulatory and internal policies, ensuring that the organization operates within the bounds of the law. Compliance teams define the rules and guidelines that the Front Office must adhere to when conducting business with external customers. They monitor and assess the Front Office's activities to verify their compliance with these rules, identify potential risks, and ensure that the institution's reputation and legal standing are upheld.

While the Front Office does not directly receive compliance services, they rely on the compliance department to provide clear and up-to-date guidelines, training, and oversight. Any misalignment or misunderstanding between the Front Office and compliance can result in compliance breaches, legal issues, and damage to the institution's reputation. Therefore, the Front Office indirectly depends on the compliance department to operate effectively within the boundaries of the regulatory landscape.

Front Office as Internal Direct Customer of compliance department:

In this scenario, the Front Office acts as an internal direct customer of the compliance department within a financial institution. The Front Office includes teams responsible for revenue generation, client interactions, and sales. These teams are directly engaged with external customers and are reliant on the compliance department to ensure their activities adhere to regulatory and internal policies.

The compliance department provides essential services to the Front Office, including regulatory guidance, risk assessment, approval processes, and ongoing monitoring of activities. Compliance staff work closely with the Front Office to interpret and apply compliance requirements, assess the suitability of marketing materials, approve new product offerings, and provide real-time guidance on customer interactions to maintain legal and ethical standards.

The Front Office's dependence on the compliance department is significant, as they must navigate a complex regulatory landscape while meeting customer needs and sales objectives. Failure to obtain timely and accurate compliance support can lead to delays, legal issues, and customer dissatisfaction. Therefore, the Front Office relies on the compliance department as its direct provider of regulatory guidance and oversight to ensure that their day-to-day activities remain compliant and align with the institution's values and legal obligations.

Figure No. 2: Decomposition of Intradepartmental Cooperation while Servicing External Customers
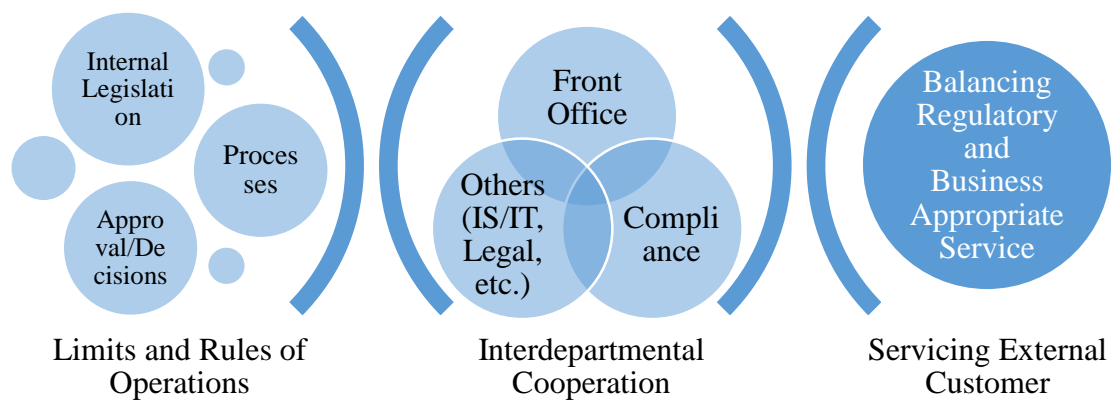
Source: Author's own

Effective cooperation between the sales and compliance departments is essential for delivering a seamless and compliant customer experience in the financial industry. This collaboration helps to prevent compliance issues, enhances customer trust, and supports overall business success.

The following Table No. 2 provides aggregated (clustered) VoC as the crucial concept for this paper that should allow financial institutions to meet Front Office expectations from compliance cooperation effectively.

Table No. 2: Voice of the Customer – Front Office Employees

Verbatim (clustered)	Need	Requirement
I do not know who to contact and I have customer at the counter. There is no clear point of contact. We do not have dedicated compliance liaison for quick issue resolution.	I need clear roles and contact information for compliance department colleagues.	Availability
I cannot tell client when I will get to him (compliance request will be solved). We do not have dedicated compliance liaison for quick issue resolution. (again) I do not know when they will get back to me.	Give an estimation of a time to solve compliance request.	Timeliness
I just receive an e-mail in "legal language" which I do not understand. I am not sure how to use information provided for future. I am not sure how I can use trainings they deliver to us. Compliance does not provide user-friendly tools to check regulatory compliance in real-time. Our sales team struggles with interpreting complex compliance jargon; simplification is needed.	I need to understand message regarding law and regulation.	Clarity/Usefulness
I just receive an e-mail in law language which I do not understand. (again) I have to refuse a customer and his request and explain complicated regulation reasoning.	I need compliance department to back me during meetings with clients.	Accompaniment
I feel sometimes like stupid when they talk to me. They are superior. I am afraid of them. We are on the opposite side of business. Sales and compliance do not have any shared platform. Compliance often seems like a roadblock; we need a smoother collaboration process.	I need to feel that we are working towards common goal.	Common Cause/Team Work feeling

Source: Author's own based on the conducted interviews

In (Lean) Six Sigma, organizations collect verbatim feedback from customers to uncover their needs. Needs, in turn, are transformed into specific requirements that guide process improvements, product development, and service enhancements. By connecting these themes, organizations can effectively translate customer feedback into actionable steps for delivering higher-quality products or services that align with customer expectations. This customer-centric approach is a fundamental principle of Lean Six Sigma, ensuring that the end result reflects what the customer truly values. From provided results it is clear that Front Office values within cooperation with compliance department following requirements: Availability, Timeliness, Clarity/Usefulness, Accompaniment and Common Cause/Team Work feeling.

At the end, these points critical to quality of cooperation translates via channel of indirect and direct customers to servicing also external customers.

Discussion, Conclusion and Research Opportunity

The main goal of the paper was to characterize interdepartmental Compliance – Sales relationships while servicing external customers and explore a potential for improving it in financial institutions in literature and practice of Czech Republic. Derived goal was to capture VoC of Front Office employees regarding their needs of cooperation with compliance department to ensure provision of best possible service to final (potential) external customer.

Paper provided initial proof that Front Office is in a role of internal customer of compliance and other risk-oriented departments (e.g. risk management department) while servicing external customers of financial institutions. There are several attributes of intradepartmental compliance – sales departments' cooperation that might improve: Availability, Timeliness, Clarity, Accompaniment and Common Cause/Team Work feeling.

In case of special business cases but also in case of regular providing of financial services, Front Office employees directly receive, depend on, and are directly impacted by the output of compliance (and also risk management) department.

Research opportunity is apparent. Respondents, interviewed Front Office employees, very often perceive the compliance and other risk-related departments as internal enemies. This has to change and create in a financial institution climate that promotes the fact that all departments work towards the common goal and both business and risk are important to ensure growing, but healthy, portfolio of deals. Sales and compliance need in most cases a shared platform for tracking client interactions and their regulatory implications. Compliance often works in isolation; we need more cross-departmental meetings. As one of the respondents stated: "*We*

need clearer communication with compliance on the regulatory changes affecting our sales processes."

Figure No. 3: Research Opportunity

Source: Author's own

Internal customers are sometimes underestimated, as those within the organization might not be perceived as revenue generators. However, this perception is inaccurate. Any disruptions in delivering products or services from compliance department to Front Office department, which relies on quality and consistency, can significantly impact the overall production, timing, and quality of the final service provided to external customers.

It's important to bear in mind that the primary objective of Lean methodology is to eliminate waste from processes. Any breakdowns in the delivery of products or services, regardless of the level, are considered wasteful and should be addressed.

As the focus of Lean Six Sigma is on improving the quality, efficiency, and effectiveness of processes within an organization and combines two powerful methodologies, Lean and Six Sigma, to achieve these objectives, we propose future examination of issues in this paper by this approach. To ensure proper utilization of these approaches, we recommend to follow *Ten commandments for successful implementation of Design for Six Sigma* by Gijo et al. (2021): "*alignment of DFSS with organisational strategy; top management support and involvement; listening to the voice of the customers (VOC); effective training programme for right project teams; project selection and prioritisation; linking DFSS with ISO international standards; linking DFSS with organisational learning and innovation; linking DFSS with the 4th Industrial Revolution; effective use of DFSS methodology and the integrated*

tools within the methodology and reward and recognition schemes". In addition, 18 critical
failure factors of DFSS projects are provided by Bhat et al. (2022).

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The Evolution of CBDC in G20 Economies

Design, Progress and Strategy

Abstract

This paper aims to provide a comprehensive examination of the rapidly evolving landscape of Central Bank Digital Currencies (CBDCs) within G20 economies. It seeks to differentiate the primary use cases of retail, wholesale, and cross-country CBDCs across the four development stages: research-, development-, pilot- and live-stage. The research reveals that, except for Argentina, all G20 economies are in advanced research or proof-of-concept stages, each with unique motivations and design considerations. Also, eastern nations, notably China, India, and Russia are progressing toward the imminent launch of retail CBDCs. In contrast, predominant western economies like the USA, UK and Eurozone remain in exploratory phases, preparing for a potential future launch should CBDC integration become necessary. Also, it can be concluded that CBDC is seen as an addition to cash and not as a replacement in all portrayed economies. Furthermore, most countries are undecided regarding the underlying technology, but are certain to distribute CBDCs via intermediaries and not directly via the Central Bank to avoid disintermediation. Noticeably, most G20 economies are involved in one of twelve international projects for cross-country CBDCs which are currently underway.

Key words

Introduction

Central banks (CB) around the world are examining the potential issuance of Central Bank Digital Currency (CBDC) as either an addition or as a replacement of physical cash (Auer et al., 2020). CBDC is a concept for a CB digital means of payment. It is a risk-free liability of the CB (Panetta, 2021) and, besides overnight deposits and bank notes, a CBDC can be seen as the third form of base money (Bindseil, 2020). CBDC is only a recent concept but there are global efforts being undertaken by central banks to investigate it´s potential implementation (Auer et al., 2020; Bordo & Levin, 2017). In most cases, CBDC is contemplated as an addition to cash and not considered a replacement (Beniak, 2019). Despite this, some researchers examined the possibility of a full replacement of cash, leaving CBDC the only remaining currency in place (Bordo & Levin, 2017).

As of August 2023, no major advanced economy has fully implemented a general purpose CBDC. Still, several countries have initiated pilot programs and are actively researching CBDC design options. In contrast, several smaller countries in the Caribbeans have already launched general purpose CBDCs to the public. The Bahamas was the first country to launch a live CBDC in October 2020 with the "Sand Dollar" (Boar & Wehrli, 2021a). Issued by the Central Bank of the Bahamas and built on a private permissioned blockchain, the Sand Dollar allows users to make payments and transfers via a dedicated wallet app. Its objectives include expanding financial inclusion, streamlining service delivery costs, and enhancing payment efficiencies (Central Bank of the Bahamas, 2021). Other nations within the Eastern Caribbean Currency Union (ECCU) jointly launched the retail CBDC "DCash," a digital version of the EC Dollar (https://www.atlanticcouncil.org/cbdctracker/). This cross-border project aims to facilitate both retail and peer-to-peer financial transactions (https://www.eccb-centralbank.org/d-cash). As the first African country to fully roll out a digital currency, Nigeria launched the eNaira in October 2021 (Nwanisobi, 2021). Developed by the Central Bank of Nigeria (CBN) to operate alongside the existing naira currency, the eNaira seeks to enhance cross-border trade, foster financial inclusion, optimize payment methods, and generate insights for policymakers (CBN, 2023).

CBDCs are mainly being discussed in context to three use cases. As a retail CBDC to be used as means of payment for the public, as a wholesale CBDC to be used by a restricted user group, or as a multi-CBDC (or cross-country-CBDC) to be used for transactions between countries. Various options are being contemplated for the design of CBDCs. Whether CBDC shall be remunerated or non-remunerated, account-based or token-based and whether it should

be unrestrictedly available are discussed controversially. Furthermore, whether a CBDC should be distributed by a CB directly or via intermediaries such as local banks are not yet universally agreed.

By August 2023, 130 countries which represent more than 95% of the world's GDP, are at various development stages (Fabrichnaya, 2023). With such dynamic and versatile landscape, the aim of this contribution is to provide an overview of the current CBDC developments in G20 countries, which collectively represent roughly 80% of global GDP. Given that all G20 countries are actively researching CBDCs, they offer an appropriate group for researching CBDC-related activities.

This paper is structured as follows: The first chapter details the status of CBDC implementation across all G20 countries and distinguishes them in four development phases. The paper ends with a conclusion of the research findings.

1 CBDC implementation in G20 countries

Every G20 country is actively researching, developing, or piloting CBDCs. The G20 members can be distinguished by their most advanced development phase. Inspired by Auer & Böhme, we categorize CBDC development into four key phases: research, development, pilot testing, and live implementation (Auer & Böhme, 2020). The research phase involves initial exploration of the potential benefits, risks, and design choices involved with issuing a CBDC. Central banks in this phase are focused on building knowledge and assessing whether a CBDC could help meet public policy objectives (Bindseil, 2020). No firm decisions have been made at this stage about issuing a CBDC. Once a CB decides to further pursue CBDC, it enters the development phase. This involves more detailed design choices on technology, distribution models, policy features, and governance (Auer & Böhme, 2021). Central banks may develop basic prototypes to test functionality at this stage, but no interactions with external users take place. The pilot testing phase marks the first controlled interactions with users and a CBDC. Central banks create experimental environments or sandboxes to trial the CBDC with a limited set of users and use cases. Pilots allow central banks to test performance, refine design parameters, and gauge user reactions before full launch (Auer et al., 2020). Finally, the live implementation phase means the official issuance and circulation of the CBDC. In most cases not all CBDC design features have been agreed upon until the live phase. The CBDC is now broadly available to intended end users within the jurisdiction. Ongoing monitoring and adjustments may still occur post-launch (Davoodalhosseini, 2022).

2 CBDC in research phase

The only G20 country still in research phase is Argentina. In 2022, the Banco Centrale de la Republica **Argentina** (BCRA) published their position, that issuing a CBDC is not an immediate priority. Still, the BCRA stated that they will continue to research issuing a digital peso as the country´s CBDC (Marcelino et al., 2023, Mikhalev et al., 2021). This is in alignment with the bank's strategy to rely on their recent innovation, Transferencias 3.0, a new digital eco system in which users can make easy and fast digital payments with QR-codes (https://www.bcra.gob.ar/Noticias/Transferencias-3-0-puesta-en-marcha.asp).

3 CBDC in development phase

The Bank of **Canada** (BoC) is exploring both, a wholesale mCBDC with a project called "Jasper" and a retail CBDC with the project named "CADcoin". The BoC has partnered with Payments Canada, R3, and other central banks on Jasper to build and test a DLT platform for interbank payments (Auer & Böhme, 2020). CADcoin aims to study the viability of a retail CBDC and is assessing implications for monetary policy and financial stability (Bech & Garratt, 2017). The BoC does not see any urgency in issuing a digital Canadian dollar, but they entered a contingency planning mode in order to being ready to launch the CBDC in case the use of banknotes further declines to a point where Canadians don´t have the options anymore to use cash in day-to-day transactions, or in a case where an alternative digital currency were to become a wide spread means for day-to-day payments (https://www.bankofcanada.ca, accessed 08/24/2023, (Kumar et al., 2023)).

Opposed to the BoC, the Reserve Bank of **India** (RBI) has started preliminary studies on a digital rupee with the goal for issuance in the near future. The RBI is examining the scope of an Indian CBDC, its implementation and impact on monetary policy (Peterson, 2022). The introduction of the Digital Rupee is anticipated to have multiple advantages, including a diminished reliance on physical cash, less currency administration expenses, and a decrease in settlement-associated risks. The RBI anticipates that the digital rupee could offer a secure and highly liquid electronic payment option for both consumers and enterprises. Also, it could serve as a foundation upon which Indian innovators can develop new products and services. Moreover, the new legal tender, could also facilitate easier and cheaper cross-border transactions. No decision on design features or technology have been made so far (Garg & Kumar, 2023).

Indonesia is actively working on both, wholesale and retail CBDC, commonly referred to as the digital rupiah. Bank Indonesia (BI), the country's central bank, aims to design

the digital rupiah with cross-border interoperability features (BIS, 2022b). The central bank has also released a white paper about the so called "Project Garuda" that outlines the importance of ensuring that the CBDC does not harm central bank policy mandates in monetary and macroprudential domains. It is planned that the CBDC is to be distributed by wholesalers in addition to commercial banks (Bank Indonesia, 2022).

End of December 2021, **Mexico**'s Central Bank (Banxico) originally announced that Mexico will issue the digital peso by 2024 (reuters.com, Dec 30th, 2021). It is researching implications of retail CBDC as part of its fintech strategy and exploring design options of the future CBDC (BIS, 2022b). The date for the launch of the retail CBDC is now moved to 2025 (Banxico, 2022).

The Kingdom of **Saudi Arabia** has been actively researching the potential of a Central Bank Digital Currency (CBDC) as part of its broader financial innovation strategy. This initiative aligns with Saudi Arabia's Vision 2030 and aims to explore the benefits and challenges associated with the issuance of a CBDC (Chen et al., 2022). The Saudi Central Bank (SAMA) has also collaborated on cross-border CBDC projects on a project called "Aber" with the Central Bank of the United Arab Emirates with the goal to explore the feasibility of issuing a wholesale CBDC for cross-border payments. While no pilot has been announced yet, Saudi Arabia continues with its research and development phase (SAMA, 2023).

The **South African** Reserve Bank (SARB) started "Project Khokha" in 2018 to build a proof of concept for a wholesale CBDC using distributed ledger technology. Key objectives were to test viability, improve interbank efficiency, and study regulatory implications. One primary objective of South Africa's CBDC initiative is financial inclusion, aiming to bring financial services to individuals previously without bank accounts (Chen et al., 2022).

The Bank of **England** (BoE) has been actively researching the potential of the Digital Pound, though it has not yet committed to issuing the CBDC for the public. In 2020, the BoE created a taskforce to lead exploration of design, implementation, and implications of the CBDC (HM Treasury, 2021). Regarding a wholesale CBDC, the Bank is assessing the ability of DLT to improve efficiency and reduce settlement risk in interbank payments. It has partnered with the Bank of Canada and others on Project Jasper – which has started in 2017 already (Kiff et al., 2020) - to experiment with an integrated wholesale CBDC platform to facilitate cross-border interbank settlements (Bank of Canada et al., 2018). Surveys indicate a reasonable public demand for a digital pound as a retail CBDC, but adoption will depend on ease of use and the potential benefits over cash and cards (BoE, 2022). Next steps will likely

involve small-scale pilots to test functionality and performance of a potential digital currency (BoE & HM Treasury, 2023).

The **United States of America** are in the early stages of researching both wholesale and retail CBDC. The Federal Reserve (FED) has been actively analysing design options and implications through partnerships with MIT, Federal Reserve Banks, and other domestic central banks (Boar & Wehrli, 2021b; FED Boston, 2022). Regarding a wholesale CBDC, the Federal Reserve Bank of Boston is working with MIT on Project Hamilton to build and test a hypothetical digital currency for interbank settlements (FED Boston, 2022). The aim is to improve efficiency in wholesale payments and understand impacts on monetary policy implementation (Bowman, 2022). For a general purpose or retail CBDC, the Federal Reserve Board is partnering with scholars, foreign central banks, and international organizations to assess implications for payments, financial stability, privacy, and innovation (Bowman, 2022; FED Boston, 2022). Research priorities include exploring CBDC use cases and technology platforms while weighing risks of disintermediation (Davoodalhosseini, 2022). The FED has not decided yet, whether to issue a digital USD but it continues its development in order to be ready should the implementation become appropriate (FED, 2023).

In the **Eurozone**[1], the European Central Bank (ECB), together with most national central banks of the EU (including separate G20 member states France, Italy, and Germany) has been exploring the possibility of a Digital Euro (DE) since 2020 (ECB, 2020). It launched the investigation phase in 2021 to focus on key design choices and understand user needs. Areas of analysis include impacts on payments, monetary policy, financial stability, and the banking sector (ECB, 2023; Panetta, 2021). The DE aims to complement current bank notes and coins, not replace them (ABI, 2023). Technical experiments have also begun, including simulated transactions. The ECB has not decided whether to proceed with a digital euro but aims to be prepared should the decision be made. The investigation period is expected to be finished in 2023 and the ECB will determine on the next steps after completion of this phase (ECB, 2023).

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1 For our contemplation the development of the Digital Euro (DE) is relevant. The European Union and EU countries Germany, Italy, and France, though they are separate G20 members, are not separately examined because they are part of the Eurozone. Thus, countries which are not EU members (and therefore not G20) like Andorra, San Marino and Vatican City but have formal agreements with the EU to use the Euro, are included in this summary. Also, non-Euro members which are part of the EU like Bulgaria, Czech Republic, Croatia, Denmark, Hungary, Poland, Romania and Sweden, though they are part of the G20 countries via the EU membership are excluded from separate research, though they might research on their own CBDC program with their local currency.

4 CBDC in pilot phase

The Reserve Bank of **Australia** (RBA) is considering issuing an Australian CBDC, usually referred to as the "eAUD", as a complement to existing forms of money, both physical and digital. The RBA is exploring various use cases, benefits, opportunities, and challenges associated with CBDCs. It is also examining how a CBDC could be designed and developed, with DLT being one of the technology platforms under consideration (RBA, 2022). After actively investigating the potential of an Australian CBDC for the past few years, the RBA announced in August of 2023 that the pilot phase was successfully conducted and that the RBA will continue exploring use cases (RBA, 2023). Like most countries, Australia has not yet decided, whether to actually issue a CBDC, but the RBA aims to be ready just in case the decision will be made in the future.

 Brazil´s CB, the Banco Central do Brazil (BCB) is researching and developing the digital Brazilian real (DREX) as the foundation of a smart payment platform. As such, the DREX could complement other building blocks of the existing electronic payment such as e-money (currently available via PSPs since 2013) or PIX, electronic instant payment service, which is available since 2020 (BIS, 2022b). The primary objective behind DREX as a retail CBDC is to increase financial services offered to everyday Brazilians. It is planned that the digital real will enable easier loans, more accessible investment options, and simpler insurance plans. The Central Bank is also testing the digital real for use cases like paying government benefits; thus, with issuing the Brazilian CBDC, the BCB is aiming to advance financial digitalization and social inclusion. As of July 2023, the DREX-platform has entered the pilot-phase with the goal to be concluded by the end of 2024 (BCB, 2023).

 China, among the initial economies to delve into CBDC, started its research in 2014. This stemmed from the People's Bank of China´s (PBOC) concerns about Alipay, Tenpay, and WeChat Pay's dominance in the payment market, with Alipay and Tenpay controlling 93% of the mobile-payments (Bilotta & Botti, 2021; Chorzempa, 2021). In response, the DCEP (or e-yuan) was launched in April 2020 in Shenzhen, Suzhou, Xiong'an, and Chengdu (Gengxuan et al., 2021; Wang, 2022). By early 2022, it was already adopted by over 260 million people with transactions exceeding $14 billion (Kumar, 2022). Designed as a two-tier system, the PBOC issues e-yuan tokens to banks and payment firms, who then manage the public's e-wallets, thus using an intermediate system for the CBDC distribution. This hybrid CBDC system merges token and account-based elements (Aysan & Farrukh, 2022). Utilizing "permissioned" Distributed Ledger Technology, it ensures user identity verification

and payment management. Notably, it offers "controllable anonymity" for micropayments, balancing user privacy and regulatory needs (Allen et al., 2013; Bilotta & Botti, 2021; Gengxuan et al., 2021). The DCEP also enables offline transactions, promoting financial inclusion especially in regions without internet connectivity (Gengxuan et al., 2021). As of June 2023, while still in its pilot phase, the DCEP serves as a legal tender used by 20% of China's population, with growing adoption (Elston, 2023a).

The Bank of **Japan** began the first "proof of concept" phase (PoC) of its CBDC research in 2021, looking at conceptual models and impacts on monetary policy and payment systems. In March 2023 the PoC has concluded a development phase in which technical feasibility and specific use cases for CBDCs were explored. Also, interoperability with other digital currencies were explored (BOJ, 2023b). In July 2023, the BoJ announced that Japan will enter the pilot phase for issuance of the digital yen (BOJ, 2023a).

Unlike most other countries, the **South Korean** Bank of Korea (BOK) and the Korean government are not concerned that private stablecoins might compete with the government financial system. An Open Banking System (OBS) was established in 2019, so that private initiatives could act freely and build their own ecosystem (Chen et al., 2022). Though the BOK does not see an urgent need to implement a retail or a wholesale CBDC, it launched a first pilot testing phase for a wholesale CBDC based on a DLT-platform between August and December 2021. As of the end of phase 2, which was ended in June 2022, the BOK concluded, that all regular P2P payments, including off-line-payments (currently under development in cooperation with SAMSUNG), transaction of digital assets, as well as cross-border-payments, met the expectations. The current solution is based on DLT but no further decisions on CBDC design options have been made (BOK, 2022).

Also, **Russia** has been actively working on its own digital currency, known as the digital ruble, with plans to test it in real-world scenarios. In July 2023, the digital ruble law was signed to provide the legal basis for issuing the Russian CBDC (Fabrichnaya, 2023). The Bank of Russia confirmed that a launch of Russia´s retail CBDC is planned for 2025 (Handagama, 2023).

The Central Bank of the Republic of **Turkey** initiated the "Digital Turkish Lira Collaboration Platform" project in 2020 to analyse CBDC models and assess technical design options (Chen et al., 2022). The CBRT is studying efficiency, policy effectiveness, and implementation issues. The CBDC will be blockchain-based and will be integrated with digital identity and FAST, a payment system operated by the Turkish central bank. This

integration aims to streamline payments and make financial transactions more efficient. Turkey is continuing the extended pilot phase of the digital Turkish Lira in 2023 (Lyons, 2022).

5 CBDC in live phase

As of August of 2023, no G20 country had entered a live phase with a broad access of the public or commercial sector to a retail or wholesale CBDC.

Conclusion and outlook

This paper sought to analyze the current status of CBDC activities in G20 economies to get a better understanding of their different strategical and technological approaches, as well as their timing regarding a potential implementation of retail, wholesale, and cross-country CBDCs. Initial efforts have focused on CBDCs to enhance the efficiency of P2P, interbank, or cross-country payments and securities settlement. Although many G20 economies are conducting extensive research at various stages, many have not yet committed to implementing a CBDC in the future and also remain non-committal about potential design features or the underlying technology they might use. In contrast to cryptocurrencies, which utilize blockchain technology, known CBDC concepts include this technology only in a minority of G20 jurisdictions, whereas DLT is a component of most proposed solutions. Also, decisions on whether a CBDC should be token-based or account-based, and whether it should be remunerated or non-remunerated, remain pending in most cases.

Understanding the impacts on monetary policy is also a key focus for CBDC research. For retail CBDCs, common motivations include financial inclusion, the availability of central bank money, and the resilience of payment systems. One consistent aspect among all researched economies is the plan to introduce CBDCs as an addition to, rather than a replacement for, physical cash. Notably, with twelve international projects involving cross-country CBDCs currently underway, many G20 countries are exploring CBDCs for international transactions.

With the exception of Argentina, all G20 countries are at advanced research or proof-of-concept stages related to CBDC development. Besides China, which has already initiated an extended pilot for its retail CBDC, other major eastern economies such as India and Russia have committed to launching CBDCs in the near future. However, other major western economies, including the USA, the UK, and the countries in the Eurozone, have yet to finalize plans for issuing a retail CBDC. Their exploration of CBDCs rather stems from a desire to be prepared should the need arise to issue CBDCs in the future.

The aim of this paper was to give an overview of the overall CBDC strategy and the current status of implementation, and this could be archived. Still, there are two main limitations to the research results. First, the G20 members, among others, consist of the EU countries. Due to the scope of this paper, the author opted to limit the research to Eurozone members instead of the EU members, thus EU members (Denmark, Sweden, Poland, Czech Republic, Croatia, Bulgaria and Hungary) which have their own CBDC activities are missing. Second, the implementation of CBDC is discussed controversially across the board and the landscape for CBDCs is rapidly evolving. Hence, this paper can only give a snapshot of the current situation and needs to be frequently updated.

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Appendices:

Appendix A: List of Acronyms

BCB	Banco Central do Brazil
BI	Bank Indonesia
BIS	Bank for International Settlement
BoC	Bank of Canada
BOJ	Bank of Japan
BOK	Bank of Korea
CB	Central Bank
CBDC	Central Bank Digital Currency
CBN	Central Bank of Nigeria
DCEP	Digital Currency / Electronic Payment
DE	Digital Euro
DREX	Digital Real Electronic Transaction
ECCU	Eastern Caribbean Currency Union
EU	European Union
FED	Federal Reserve Bank
FX	Foreign Exchange
GFC	Global Financial Crisis
NIRP	Negative Interest Rate Policies
OBS	Open Banking System
PoC	Proof of concept
PSP	Payment Service Provider
RBI	The Reserve Bank of India
SARB	South African Reserve Bank
SNB	Swiss National Bank
US, USA	United States of America

Appendix B: Summary of CBDC implementations in G20 countries

The following table shows a summary of the statuses from all G20 countries or regions respectively. It shows the status of the phase of the development or implementation of retail CBDC (R), wholesale CBDC (W) or cross country multi-CBDC (C). Also, available information whether the distribution is planned via intermediates or directly from the CB and the accessible information about the underlying technology was implemented.

Table No. 1: Status or CBDC implementation of G20 economies

Country / Region	Status		International Cross Border Projects / Distribution / Technological Basis	References
Argentina	R	-	Undecided delivery	Marcelino et al., (2023), https://www.bcra.gob.ar
	W	-		
	C	-		
Australia	R	Pilot	Joined Project Dunbar (mCBDC) Undecided delivery, Ethereum, DLT	RBA (2022), RBA, (2023), Kumar et al. (2023)
	W	Pilot		
	C	Pilot		
Brazil	R	Pilot	Intermediate delivery, DLT	BIS (2022), BCB (2023), Kumar et al. (2023), Mikhalev et al. (2023)
	W	Pilot		
	C	Pilot		
Canada,	R	Pilot	Joined Project Jasper for mCBDC Intermediate delivery, DLT	Auer and Böhme (2020), Bech and Garratt (2017), https://www.bankofcanada.ca, accessed 08/24/2023
	W	Pilot		
	C	Pilot		
China	R	Pilot	Joined mCBDC Project mBridge (together with Hong-Kong, Thailand and UAE), Intermediate delivery	Bilotta and Botti (2021), Chorzempa (2021), Gengxuan et al. (2021), Wang (2022), Kumar (2022), Aysan and Farrukh (2022), Allen et al. (2013), Elston (2023)
	W	Pilot		
	C	Pilot		
India	R	Pilot	Announced cooperation with UAE on mCBDC, Undecided delivery	Peterson (2022), Garg and Kumar (2023), Mikhalev et al. (2023)
	W	Pilot		
	C	Dev.		
Indonesia	R	Dev.	Intermediate delivery	BIS (2022a), Kumar et al. (2023), Bank Indonesia (2022)
	W	Dev.		
	C	Res.		
Japan	R	Pilot	Joined Project Stella (together with the ECB) for mCBDC, Intermediate delivery, DLT	BOJ (2023a), Mikhalev et al. (2023), BOJ (2023b)
	W	Pilot		
	C	Pilot		
Mexico	R	Dev.	Undecided delivery	Reuters.com (2021), BIS (2022a), Mikhalev et al. (2021), Banxico (2022)
	W	-		
	C	-		
Russia	R	Pilot	Intermediate delivery	Fabrichnaya (2023), Handagama (2023), Kumar et al. (2023)
	W	Pilot		
	C	Pilot		
Saudi Arabia	R	Dev.	Project Aber, together with UAE. Based on SAR and AED (Pegged to USD) for mCBDC, Undecided delivery, DLT	Chen et al. (2022), Kumar et al. (2023), SAMA (2023)
	W	Dev.		
	C	Dev.		
South Korea	R	Pilot	Intermediate delivery, DLT, Ethereum	Chen et al. (2022), Kumar et al. (2023), BOK (2022)
	W	Pilot		
	C	Pilot		
South Africa	R	Dev.	Joined Project Dunbar in 09/2021 for mCBDC, Undecided delivery	Chen et al. (2022), Kumar et al. (2023), Mikhalev et al. (2023)
	W	Dev.		
	C	Dev.		
Turkey	R	Pilot	Retail CBDC in extended pilot phase, Undecided delivery, DLT, Blockchain	Chen et al. (2022), Mikhalev et al. (2023), Lyons (2022)
	W	-		
	C	-		
United Kingdom	R	Dev.	Project Jasper for mCBDC, Intermediate delivery, DLT	HM Treasury (2021), Kiff et al. (2020), Bank of Canada et al. (2018), BoE (2022)
	W	Dev.		
	C	Dev.		
United States of America	R	Dev.	Entered Project Cedar for mCBDC, project Hamilton for wholesale CBDC, Intermediate delivery	Boar and Wehrli (2021), FED Boston (2022), Bowman (2022), Davoodalhosseini (2022), FED (2023)
	W	Dev.		
	C	Dev.		
Eurozone (incl. D, I, F)	R	Dev.	Joined Project Stella (together with the BoJ) for mCBDC, Intermediate delivery, DLT	ECB (2020), Kumar et al. (2023), ECB (2023), Mikhalev et al. (2023), Panetta (2021), ABI (2021)
	W	Dev.		
	C	Dev.		

Source: own research

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Abstract

The movement towards a low-carbon economy is driven by processes like decarbonization, digitalization, ESG transition, and Industry 4.0. ESG investing has evolved into sustainable finance, aligning corporate governance with long-term ESG principles (Friede et al., 2015). The recent Russian-Ukrainian war has accelerated the shift to a low-carbon economy due to rising energy costs. Companies with high energy consumption have seen their stock prices decline, while ESG-driven companies show lower sensitivity to macroeconomic factors like energy prices. This paper aims to explore how macroeconomic factors affect the stock performance of ESG-driven companies compared to traditional ones in the Eurozone, which represents developed economies and dominates the sustainable finance landscape. ESG-driven companies are expected to be more resilient in some aspects.

Key words

JEL Classification

DOI

Introduction

Climate change, caused by natural and human factors, significantly affects socioeconomic systems, economic growth, and global value chains. It represents a shift towards a new economic model known as the "new normal" or "new reality" by El-Erian & PIMCO in 2010 (Candelon et al., 2016). To limit global warming attributed to human activities, studies suggest that greenhouse gas emissions must be reduced by 43% by the end of this decade. This requires

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immediate action and aligns with the goals of the Paris Agreement on Climate Change and the UN 2030 Agenda for Sustainable Development.

Efforts to combat climate change and protect biodiversity require greener and more sustainable financial flows. This involves incorporating Environmental (E) goals into the ESG transition alongside social (S) and government (G) criteria. Originally, ESG referred to a niche investment strategy (ESG investing) favored by asset and capital managers. However, the need to align corporate governance with investors' demands for long-term ESG-aligned investments led to the emergence of sustainable finance. This phenomenon was catalyzed by the United Nations Environment Programme Finance Initiative (UNEP FI, 1992), which aimed to mobilize private financial resources for the Sustainable Development Goals (SDGs) through a partnership with the global financial sector (Friede et al., 2015).

In 2006, the PRI of Responsible Investments (PRI) introduced the concept of Environmental, Social, and Governance (ESG) factors to mitigate long-term investment risks. The PRI is a voluntary commitment by institutional investors and asset managers to incorporate ESG factors into their investment strategies. The Action Plan on Financing Sustainable Growth, published in March 2018, aims to redirect capital flows towards sustainable investments, manage financial risks associated with climate change and other challenges, and promote transparency and long-term financial performance.

In recent years, various guidelines and frameworks have emerged to facilitate the integration of non-financial information into financial and investment decisions. These include the Global Reporting Initiative (GRI) sustainable development standards, the Integrated Reporting (IR) conceptual framework, and the Sustainability Accounting Standards Board (SASB) standards. The SASB standards are particularly relevant for companies listed on the US stock market, as they govern disclosure requirements. The International Sustainability Standards Board of the IFRS Foundation encourages companies to adopt SASB standards (PRI, 2021; SASB, 2022).

At the EU level, efforts are being made to regulate and promote socially responsible economic activity while preventing "greenwashing" and protecting investors. Greenwashing refers to presenting products or organizations as environmentally friendly when they are not. Regulations such as Regulation (EU) 2019/2088 on sustainability-related disclosures and Regulation (EU) 2020/852 on the Taxonomy of environmentally sustainable economic activities aim to address this issue and promote transparency.

The European Commission is prioritizing the integration of climate and environmental factors into the risk management systems of banks and insurance companies. Climate policy

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is a key component of the EU Green Deal strategy and an instrument of competition. The EU has set ambitious goals to reduce greenhouse gas emissions, aiming for at least a 55% reduction by 2030 compared to 1990. The EU is also working towards phasing out fossil fuels and transitioning to "decarbonized" gases like hydrogen. Capital flows are being redirected towards climate projects, leading to increased public investment in green initiatives and reduced subsidies for environmentally harmful industries. Research by Scatigna et al. (2021) supports the role of the financial market in achieving climate goals. It highlights the impact of funding costs and the existence of a carbon premium for companies with a higher carbon footprint.

The involvement of financial markets is crucial for the transition to a sustainable economy. Financial markets provide a platform for companies to raise capital for ESG-related projects and initiatives, and investors can allocate funds towards companies with strong ESG performance, incentivizing sustainable practices. Financial markets also enable the trading of ESG-related instruments, allowing investors to invest in companies aligned with their ESG preferences. They also play a role in ESG disclosure and reporting, providing a platform for companies to disclose information and for investors to access and analyze it.

However, challenges such as the need for standardized ESG metrics and inconsistent reporting practices hinder the effectiveness of financial markets in driving the ESG transition. Efforts are being made to address these challenges and improve transparency and reliability. Despite these challenges, financial markets play a vital role in the ESG transition by providing capital, facilitating trading, and enabling disclosure. Besides the case of "green transition" the financial market is becoming increasingly important as a mediator of most processes and structural shifts in national and global economies in general. Changes occurring within the financial market have a noticeable impact on the real economy, public finances, and other spheres.

The global financial market has undergone revolutionary changes in the past 30 years and has had a notable impact on the creation and exchange of goods and services in the real economy. Economic imperialism, as introduced by Nobel Prize winner Becker (1976), has guided this transformation. Historical research by Bagehot (1873), Schumpeter (1911), and Robinson (1952) also highlights the critical role of the financial sector in economic development and industrialization. Research by Gurley and Shaw (1955), Hicks (1969), and Goldsmith (1969) found that there is a positive relationship between financial development and economic growth rates. Financial development stimulates economic growth by expanding the financial system's structure. Goldsmith found that financial system development

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and investment efficiency are linked, and that financial development accelerates economic growth by facilitating the migration of funds to the most efficient economic system.

Several researchers have explored the connection between financial development and demographic characteristics, such as fertility rate. Hotz et al. (1997), Becker & Barro (1988), Willis (1973), and Filoso & Papagni (2015) have all studied this relationship. Additionally, other researchers have examined how improvements in the functioning of financial markets can impact a country's success in adopting modern technologies and overcoming the "digital divide". Hartmann et al. (2007), Papaioannou (2007, 2009), and Kuang et al. (2023) have contributed to this line of research.

Financial development can have both positive and negative effects on economic activities. Recent research by economists Beck (2012, 2013), Allen (2014), and Čihák (2014) has shown that financial development can have a negative impact on economic growth, as seen during the financial crisis of 200–2009. The direction of causality is essential for countries to determine their development strategy. If supply-leading, policies should focus on financial liberalization, but if demand-following, other growth-enhancing policies should be prioritized (Calderon & Liu, 2003, p. 331).

Previous research suggests a strong interdependency between the growth of financial markets and the real economy. Market indexes are often used as proxies for financial market growth, but a more comprehensive analysis using financial depth indicators is needed. For example, studies have shown that oil and gas prices can significantly impact stock market returns, particularly in the Canadian oil and gas sector (Sadorsky, 2001). Moreover, an increase in oil prices has a more significant effect on stock market returns than a decrease in oil prices. Park & Ratti (2008) also showed that oil price shocks significantly impact stock returns in the same month or over one month. However, the impact of oil price shocks on stock returns varies across different markets, with some Chinese stock market indices being unaffected (Cong et al., 2008).

The recent Russian-Ukrainian war led to a decrease in oil and gas supply and an increase in energy prices, resulting in a decline in the stock prices of companies with high energy consumption. Companies in low-carbon sectors focusing on ESG factors have shown lower sensitivity to these shocks (Deng et al., 2022). Basdekis et al. (2022) attempt to use daily data to research whether there are any relationships between petroleum prices, exchange rates, and stock exchange indexes from January 2021 to July 2022. Recent research also suggests a relationship between the integration of ESG factors in companies and the performance of their

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stock prices, as well as the resilience of ESG indices against external shocks. These relationships will be further analyzed in subsequent chapters (Basdekis et al., 2022).

Regarding the relationship between ESG and macroeconomic performance, a well-known Oxford University study by Zhou et al. (2020) found a positive relationship between adopting ESG practices and economic growth. However, the influence of ESG factors on GDP per capita is complex and influenced by numerous factors. The study's panel data only covers a limited period, and recent events like COVID-19 and geopolitical conflicts must be considered. Therefore, further research is needed to explore the relationship between ESG, market indices, and macroeconomic drivers considering recent events. Hence, this paper aims to improve understanding and evaluation of the sensitivity of the relevant ESG index to macroeconomic factors.

The rest of this paper is structured as follows: The chapter "Methodology and data" provides the reader with the detailed description of model, used variables (reasoning behind used proxies) and methods used for every step of analysis. The chapter "Results and discussion" provides a brief overview of results within every step of analysis. The last chapter "Conclusion" provides a detailed summary of achieved results and their interpretation in economic context.

1 Methodology and data

1.1 Model specification & Data

The author analyzes the relationship between macroeconomic variables in the Euro Area and their influence on ESG indices and European market indices. The Euro Area was chosen due to its strong and developed economies, representing a sizable portion of global economic activity. The European region dominates the sustainable finance landscape, with a share above 80% of the global market. The European Fund and Asset Management Association sums up that in Q1 2021, the net assets of funds promoting ESG in Europe were around $3.7 trillion.

The **goal of this study** is to gain insights into the impact of ESG factors on financial markets and regulatory frameworks in this economically significant region. This paper's main hypothesis can be formulated as follows: The macroeconomic factors have a similar impact on an ESG-Related Market Index as on a general Market Index within the same region. Additionally, the author interprets the relationship between macroeconomic variables and ESG-Related Market Index. Therefore, models considered within this survey looks as follows:

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$$MSCI\_ESG\_EUR_t = f(GDPgrRate_t, CPI_t, UNEMPLR_t, ECBr_t, EURIBOR3M_t, EURtoUSD_t)$$

$$(1)$$

$$MSCI\_EUR_t = f(GDPgrRate_t, CPI_t, UNEMPLR_t, ECBr_t, EURIBOR3M_t, EURtoUSD_t)$$

$$(2)$$

The subsequent independent variables were used as proxies for macroeconomic indicators or Euro Area and financial markets development supported the factors used from ESG within the Dynamic Stochastic General Equilibrium Model, proposed by the Society of Actuaries (2020):

1) GDP per capita (Variable: GDPgrRate) is a widely accepted indicator of an economy's dimensions and growth rate. It closely correlates with living standards over time (Roubini, 2022). Data Source: Federal Reserve Economic Data.

2) The Index of Consumer Prices (CPI) measures changes in the average price index of goods and services consumed by households. It is used to track inflation, make informed policy decisions, and analyze consumer spending patterns. Data Source: Eurostat.

3) The Unemployment Rate (Variable UNEMPLR) is used to measure the health of an economy and job opportunities available. It provides insights into economic activity, consumer spending, and overall demand. Data Source: Eurostat.

4) The Key ECB Rate (Variable ECBr), the main refinancing rate, is a policy tool used by the European Central Bank (ECB) to influence credit availability and costs within the Eurozone. It indirectly impacts economic indicators such as borrowing costs and consumer spending. Data Source: ECB, Statistical Data Warehouse.

5) EURIBOR 3 Months Rate (Variable: EEURIBOR3M) is a benchmark interest rate reflecting interbank lending conditions in euros. It is used as a reference rate for various financial products and provides insights into borrowing costs and liquidity conditions. Data Source: ECB, Statistical Data Warehouse.

6) The Exchange Rate between the Euro and the US Dollar (Variable: EURtoUSD) reflects the value and demand for each currency. Changes in the exchange rate can impact trade, investment, inflation, and market competitiveness. Data Source: ECB, Statistical Data Warehouse.

7) The MSCI Europe ESG Index (Variable: MSCI_ESG_EUR) was chosen as a proxy for ESG in the model. This sustainability-focused index measures the performance

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of European companies based on environmental, social, and governance (ESG) criteria. It serves as a benchmark for sustainable investing and evaluating the ESG performance of European companies. Investors and asset managers can use it to assess the sustainability and ESG performance of their investment portfolios. Data Source: MSCI.

8) The MSCI Europe Index (Variable: MSCI_EUR), was chosen as benchmark, representing the entire market, was also selected for comparison with the results of the model performance with ESG. Data Source: MSCI.

Collected monthly data covers the period between September 2007 and December 2022. The primary criterion for selecting time series for econometric analysis was their availability and the presence of sufficient observations to make it possible to use the proposed analysis methodology (e.g., availability of ESG-linked market index). Additionally, the dataset should capture a constant number of Euro-zone members over a more extended period without new "members".

1.2 Methodology

Step 1: Overall, preliminary data analysis and graphical exploration provide a foundation for regression analysis. They ensure data quality, guide variable selection (correlation analysis), assess assumptions (e.g., normality of distribution), assist in model specification, and detect outliers (descriptive statistics, mean vs median; skewness; kurtosis).

Step 2: Additionally, the classic form of regression (OLS) may help at first step to understand the relationship between a dependent variable and independent variables and to make predictions based on this relationship (methods to interpret results: Adjusted R^2, Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC)). However, it has limitations in capturing complex non-linear relationships or handling non-stationary time series, hence the VECM will be used for this model.

Step 3: Residual diagnostics are an essential part of model analysis and validation and help to assess the adequacy of the model fit and identify any potential issues or violations of model assumptions. Specific attention was paid to homogeneity of variance of the error terms (tests Breusch–Pagan Test, Cook–Weisberg test) and their distribution (Hamilton & Lawrence Test or Shapiro-Wilk W Test). Due to the nature of used data additional attention was paid to the serial independence/ Autocorrelation (Breusch–Godfrey LM Test as extended version of the Durbin-Watson Test, and Durbin Watson D Test). However, it is important to note that the Breusch-Godfrey LM test assumes that the residuals are normally distributed and that the relationship between the residuals and the lagged residuals is linear.

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Step 4: Based on the achieved results the author had to use the robust methods of estimation: Analyzed Studentized residuals and leverage points; DF-Betha / DF-Fits methods; Quantile regressions; M-Estimates by Hubert, including method with "bi-weight" kernel. These methods provide reliable parameter estimates and inference in the presence of violations of assumptions, such as non-normality, heteroscedasticity, and outliers.

Step 5: After all preliminary tests, helping with the model specification, the dynamic part was added. As a first step, the unit tests were performed to determine whether a time series variable is stationary or exhibits a unit root, which implies that the time series has a stochastic trend and is not stationary (Augmented Dickey-Fuller (ADF) Test). The same procedure was performed for both models to specify how many lags to include based on Hannan–Quinn information criterion (HQIC), Akaike's information criterion (AIC), Final Prediction Error (FPE).

Step 6: The next step was to perform a Multivariate Cointegration Test, which is used to determine whether a set of variables in a multivariate time series are cointegrated – e.g., implication of a long-term relationship between the variables, even though they may exhibit short-term fluctuations (Johansen Test). The estimated cointegration vectors can then be used to interpret the economic meaning of the relationships and to construct long-term equilibrium models.

Step 7: As the last step author used Vector Error Correction Model (VECM) to analyze the long-term equilibrium relationships among multiple variables and the short-term dynamics that govern their adjustments towards this equilibrium. The error correction model is based on the following equation: $\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_j \Delta y_{t-i} + D_t + \epsilon_t$

$$(3)[1]$$

Based on the parameter estimation results, the VECM estimation is obtained, i.e.

$$\Delta Y_t = \Pi Y_{t-1} + \Gamma_1 \Delta Y_{t-1} + \Gamma_2 \Delta Y_{t-2} + \Gamma_1 \Delta Y_{t-3} + \cdots + \epsilon_t$$

$$(4)$$

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[1] Where: Δ - operator differencing, where $⟦\Delta y⟧\_t = ⟦y\_t- y⟧\_{(t-i)}$; $y\_{(t-i)}$ - vector variable endogenous with lag 1, ϵ_t - kx1 vector residuals; D_t - kx1 vector constant, Π - matrix coefficient of cointegration ($\Pi = \alpha\beta t$; α - vector adjustment, kxr matrix and β - matrix cointegration); Γ_i - kxk matrix coefficient the ith - variable endogenous.

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2 Results and discussion

Step 1: Initial data are characterized by a high dispersion. The high kurtosis value of a variable GDPgrRate lets us assume a leptokurtic distribution and implies that the data have heavy tails and may contain more frequent extreme values. Attention should also be paid to CPI, ECBr and EUROBOR3m. Based on the results discussed, we can conclude that the distribution is not normal. In general, most of the explanatory variables have a low correlation with each other (except medium levels for EURIBOR and FX rate), which reduces concerns on multicolinearity within a model. The Bonferroni adjustment was also applied to ensure that the overall probability of incorrectly rejecting the null hypothesis (finding a significant relationship by chance) is controlled at the desired level.

Step 2: The regression analysis shows that information criteria AIC and BIC are higher for the model with the market index. Hence, presumably, the goodness of fit of selected regressors is better for the model with ESG. All regressors in the model are significant at a 1% level except CPI for MSCI_EUR model. The proxy for inflation still tends to be significant at the 10% level. The model with ESG has only three variables significant at the 1% level (Unemployment rate, ECB rate and EURIBOR3m) and two variables at the 5% level (GDP Growth rate and FX rate). The direction of coefficient signs is similar for both models and reflects the expectations formulated within the hypothesis.

Step 3: The results of Breusch–Pagan / Cook–Weisberg tests indicate non-constant variance ($p > 0.05$), so we cannot reject the H0. However, the Shapiro-Wilk W Test shows that the data does not follow a normal distribution, which can lead to biased estimates. In the next step, the author will use robust methods of estimation. The Breusch–Godfrey LM Test confirms the presence of serial autocorrelation, and the Durbin Watson D-statistic is not used due to endogeneity. The next step will address the serial autocorrelation.

Step 4: Indeed, the weight-function allowed to account for outliers, making GDP Growth Rate, Unemployment Rate and ECB Rate and EURIBOR 3m significant at 1% - level for both models. The inflation index is still insignificant for both models. The last of three non-linear methods (two-step procedure: M-estimates for the coefficients with Hubert Kernel and then "bi-weight" Kernel) produces highest pseudo R2.

Step 5: The previously performed tests let us assume a presence of dependency between some explanatory variables and market indices. As preliminary data analysis has shown before, the data has some dynamic (test for serial autocorrelation). The presence of unit roots was confirmed for all variables, and the problem was addressed with the help of first or second

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differences to achieve stationarity. The lag selection procedure has also confirmed the optimal usage of two lags for both models.

Step 6: The test of both models shows a cointegration rank of 4: e.g., meaning that there can be up to 4 cointegrating vectors. The existence of multiple cointegrating vectors implies that even though individual variables may have random fluctuations in the short run, they eventually move together in the long run due to some underlying economic relationship. Hence, there are multiple possible long-term relationships among the variables being analyzed, and both current models require adjustment of specification due to the presence of a long-term cointegration relationship.

Step 7: As the last step the VECM fitted with four cointegrating equations and two lags on all six series was used. By analyzing the results, we will assess the parameters in the cointegrating equations, so we can specify the notable option to suppress the estimation table for the adjustment and short-run parameters. Before proceeding with the interpretation, the goodness of the model fit will be tested. The Jarque–Bera results do not reject the null of normality. The Skewness tests confirm that the results in all equations jointly have zero Skewness. However, in singular equations, we can observe it for the Unemployment rate and EURtoUSD. Based on the results of the Kurtosis Test, we cannot reject the null hypothesis on disturbance terms that have kurtosis consistent with normality. Hence, the observed VECM disturbances are at an acceptable level. The stability check does not indicate that our models are mis specified.

The long-term cointegration can be observed between the following equations: a) CPI, GDPgr.Rate, UNEMPLR and EURtoUSD; b) GDPgrRate and UNEMPLR; c) Unemployment rate, EURIBOR3m and CPI; d) EURtoUSD and EURIBOR3m. The analysis of short-term cointegration shows that, for example, the first lag of MSCI ESG Index has a short-term causality with the GDP growth rate and FX rate. Additionally, the first lag of EURIBOR3m shows a short-term causality with EURtoUSD; and the first lag of the Unemployment rate has a short-term causality with CPI.

Conclusion

In this paper, the influence of macroeconomic factors on traditional market indices and ESG-driven market indices was further explored. The regression analysis (including robust methods of estimation) indicated a high statistical significance of various macroeconomic factors such as GDP, Unemployment rate, ECB rate, and EURIBOR 3M while having a high explanatory power with an R^2 of approximately 80% for the MSCI EUR and the MSCI ESG Index. Hence,

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a significant part of the variance of the indices can be explained by the chosen independent variables. Even though there is a light correlation (c. 30-40%) between the independent variables, the VIF statistics are still between 1 and 2, indicating that there should be no serious bias present in the model. The analysis confirms the main hypothesis that the independent variables can similarly explain the variance of both indices.

The signs of the regression coefficients are similar for both models. However, the regression coefficients for the MSCI EUR model are 2-3 times higher than the MSCI ESG model. This confirms a stronger resilience of companies with a stronger focus on ESG factors. The results may be slightly biased by lower trading volumes for the MSCI ESG index. A negative correlation is observed between the unemployment rate and EURIBOR with the index, meaning the lower the unemployment and borrowing cost, the higher the index growth. The positive correlation between GDP and the indices indicates that higher economic output leads to growth in the indices. No negative correlation with inflation could be observed.

Hence, within the previous step we have analyzed the relationship between the dependent variable (MSCI EUR / MSCI ESG) and our independent variables. We can confirm a strong relationship between the market indices and GDP growth rate, Unemployment rate, ECB Rate and EURIBOR3M- rate. The regression analysis assumes that that all variables are stationary, and do not incorporate non-stationary characteristics like cointegration to understand the non-linear relationship between variables. Within the next step, we address the time series dynamics in the model: The VECM was applied to analyze the long-term correlation between the non-stationary times series in the model with a focus on causality, meaning that one variable directly influences or causes changes in another variable. It is important to notice that within this method all variables are treated as dependent and independent simultaneously, as it models the equilibrium relationship among the time series variables. The model determines both the short-term dynamics and the long-term equilibrium relationship.

It is important to notice that the model specification (also used for the regression analysis before) should be adjusted because the Johansen test identified four cointegration vectors, which can lead to ambiguity in interpreting the results. This means that the model might be miss specified. Nonetheless, the model indicates long-term causalities for traditional macroeconomic variables such as GDP, unemployment rate, and CPI. This implies that changes in one of these variables have a lasting effect on another variable, even after accounting for short-term fluctuations.

However, there is only short-term causality between the MSCI ESG and GDP meaning that the MSCI ESG is influenced by GDP development in the short-term. This relationship seems

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intuitive as economic development as resembled by GDP drives the stock prices of companies within the index. Additionally, there is a short-term causality between MSCI ESG and the EUR/USD exchange rate. This could also be expected as fluctuations in the exchange rate generate short-term arbitrage opportunities and drive the stock prices in the index until they are fully priced. Both relationships are significant in the long-term as the development of MSCI ESG may deviate for these two variables.

The lack of further causality could be explained by a structural problem as the MSCI EUR and ESG comprises stocks of companies in the 15 leading European economies while the Euro Area comprises 19 countries and macroeconomic data from the Euro Area was used. Hence, for further analysis panel data will be used to reflect the structure of the index composition in the macroeconomic data. The research performed gave a good indication of the significance and causality between time series processes. Further research is required regarding improving model specification and data availability for other geographic regions.

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Why House Prices Increased in the COVID-19 Recession: Evidence from Germany

Abstract

After the outbreak of the COVID-19 pandemic, real estate prices in Germany have risen significantly. This happened unexpectedly because several macroeconomic determinants pointed to a fall in property prices during this period. This provides an extraordinary opportunity to empirically investigate the particular connection between interest rates and real estate prices. The aim of the contribution is to verify the real interest rate hypothesis. This study performs a time series regression analysis to test the hypothesis. The time series ranges from 2017Q1 to 2021Q1. The results confirm that the long-term real interest rate might have a negative and significant impact on the growth rate of property prices after the factors of economic growth and unemployment have been controlled. The endogeneity is largely eliminated through an experimental design. The results have far-reaching practical implications for housing policy and for ways to solve the problem of housing affordability.

Key words

JEL Classification

DOI

Introduction

Since the global financial crisis, the affordability of housing has begun to be investigated (Wetzstein 2017, Haffner und Hulse 2021). Previous pre-crisis macroeconomic models have not taken into account satisfactory links between the real economy, credit markets, and asset prices (Duca et al. 2021). The IMF found that house prices are synchronized across countries, and they claimed that this is caused by global interest rate shocks (Hirata et al. 2013, Katagiri 2018). The COVID-19 pandemic offers a quasi-experiment to test their hypothesis.

Since the beginning of 2020, a contagious disease of a new coronavirus called COVID-19 by the WHO has been spreading around the world. It has led to many deaths and a global recession. Many companies also have significant difficulties in maintaining proper business operations due to supply chain problems. As a result, economic growth has fallen significantly behind the good results of recent years. The unemployment rates of many developed economies have risen noticeably for the first time in years because of the pandemic. The unemployment rate in Germany rose to 6,3% in 2020, as reported by the Federal Statistical Office. Contrary to general expectations, however, real estate prices in many countries, including Germany, have skyrocketed rather than fallen in this catastrophic event.

Opposite to the traditional theoretical prediction of a negative impact of a pandemic on the housing market (Francke und Korevaar 2021) house prices rose significantly in many countries after the outbreak of COVID, including Germany. The development was also observed when business operations were disrupted, GDP growth rates were negative and unemployment rates were unprecedentedly high (Wang 2021).

The hypothesis is plausible that the counterintuitive increases in house prices worldwide after the outbreak of COVID might be the result of a synchronized countercyclical interest rate cut by central banks. Most of these took place in the first quarter of 2020 when central banks tried to prop up the economy by lowering interest rates; some even fell to historic lows. Yiu (2021) found empirical evidence in 2021 through his examination of the monetary policy hypothesis in the pandemic era. This hypothesis was tested by a cross-border panel regression analysis, as the synchronization of central bank interest rate cuts worldwide after the outbreak of COVID is practically an experiment to test the monetary policy hypothesis. This study looked at five countries where property prices have risen sharply since the outbreak of COVID. These are Australia, Canada, New Zealand, the United Kingdom, and the USA.

In this study, the residential property market in Germany is examined based on Yiu's research design. It is examined whether there is also a causality between interest and real estate prices. Unlike the countries studied by Yiu, Germany has historically had a culture of long-term secured interest rates. Thus, not only the short-term interest rate but also the long-term interest rate level of the central banks is considered.

Hypothesis:

H0: There exists no good relationship between the HPI and the explanatory variables.

H1: There exists a good relationship between the HPI and one or more of the explanatory variables.

The paper is structured as follows. Section 2 is a literature review of studies on the monetary policy hypothesis. Section 3 outlines the research materials and methods used. Section 4 reports on the results of the empirical tests. Section 5 discusses the results and implications. Section 6 concludes with a conclusion.

1 Methods

1.1 Data

In this study, data from the Federal Statistical Office are used to collect quarterly data on house prices in Germany. Germany is a developed OECD country with a market-oriented capitalist system. This makes the German real estate market efficient and transparent. The collected house prices are aggregated as a house price index (HPI).

Quarterly GDP growth rates, unemployment rates, nominal short-term and long-term interest rates as well as the inflation rate were taken from the Central Bank, Deutsche Bundesbank. Real interest rates were calculated by subtracting the inflation rate from the nominal interest rate. They show that real interest rates and GDP change were stationary in levels, while house prices and unemployment rates were stationary in the first differences.

1.2 Research Design

In this study, a quasi-experiment was carried out for the German real estate market. This research examined the effects of certain determinants on property prices. The aim was to determine which determinants are strongly correlated with real estate prices. Due to the environment of the quasi-experiment, it was possible to investigate not only correlations but possibly also causalities.

Based on this analysis, multiple linear regression was performed by using the real estate price index as a response variable and the variables short- and long-term real interest rates, GDP growth, and unemployment rate as explanatory variables.

Conducting linear regression starts by importing the dataset and conducting a Principal Component Analysis so that the variables to be included in the regression model can be obtained by looking at the factors in the Prin matrix. Moreover, to conduct the linear regression in E views 12 student lite, the data importation procedure plays a crucial role and after the importation, the selection of response and explanatory variables was done as in the regression analysis. The design enabled to get the coefficients which include

the R squared values as well as the p-value to determine which variables were significant
and would be included in the regression equation to predict HPI.

1.3 Controls by Quasi-Experiment

The pandemic situation creates the environment of a quasi-experiment. The recession phase
(continuous negative GDP growth rates) controls the positive effect of economic growth
and the negative effect of unemployment on real estate prices. Historically, for example, there
have been periods of real estate price growth that coincided with economic growth and negative
real interest rates. Since the explanatory variables are not independent but linked to each other,
their individual effects on real estate prices cannot be easily distinguished.

In this study, the period of global recession after the outbreak of COVID was used
as a quasi-experiment to investigate the monetary policy hypothesis in Germany. The pandemic
has caused a global recession. It is a unique situation in which the GDP growth rates of many
countries, including Germany, have been negative, unemployment rates have increased,
and central banks have significantly lowered interest rates in a concerted action to save
economies. In other words, after the outbreak of COVID, two of the three main factors
(recession and unemployment) drove property prices down, and only one factor (the real interest
rate) caused property prices to rise.

Figure No. 1: Real Short- and Long-Term Interest Rates, 2017Q1–2021Q1
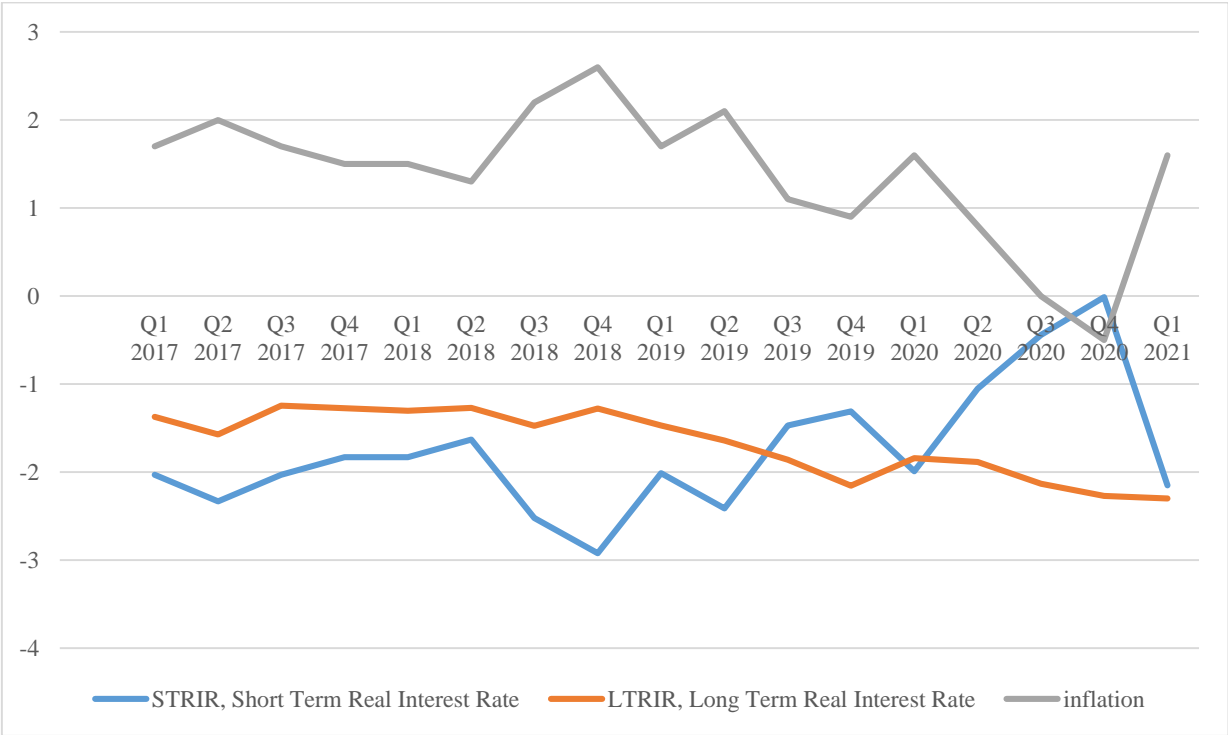
Sources: Federal Statistical Office (Statistisches Bundesamt (Destatis)), Deutsche Bundesbank

Real short-term interest rates are determined by using nominal short-term interest rates less inflation. With the outbreak of COVID-19, there was initially a decline in inflation. This result in a rather atypical development compared to the development of other countries, which was also observed by Yiu. Real short-term interest rates rise initially. The long-term interest rates, on the other hand, which are regularly decisive for the financing of real estate in Germany, are determined by the Bundesbank based on expectations. This gives a picture that corresponds to Yiu's study. This situation most likely led to a more negative long-term real interest rate regime, as shown in Figure No. 1. House prices then rose again almost simultaneously with strong momentum. This works as an intervention experiment: If economic growth and the effects of unemployment are controlled to negatively affect house prices, only real interest rates are lowered to test the reactions of house prices worldwide.

2 Results

Based on the regression model, House Price Index was the response variable and when it was regressed against the explanatory variables (STRIR, Short Term Real Interest Rate, LTRIR, Long Term Real Interest Rate, Gross Domestic Product, Unemployment Rate), the results showed that efficient to explain the variations of up to 81.25% according to the R- squared coefficient. Since the Prob of F statistics was 0.000255 when the model was created at alpha=0.05, the null hypothesis was rejected and it was to conclude that there exists a good relationship between the HPI and the explanatory variables, as shown in Table No. 1.

Table No. 1: Regression model, 2017Q1–2021Q1

Dependent Variable: House Price Index
Method: Least Squares
Included observations: 17 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LTRIR, Long Term Real Interest Rate	-29.57710	5.406081	-5.471079	0.0001
STRIR, Short Term Real Interest Rate	1.191473	2.909154	0.409560	0.6893
Unemployment Rate	-2.125819	3.420788	-0.621441	0.5459
Gross Domestic Product	-0.268276	0.470700	-0.569950	0.5792
R-squared	0.812522	Mean dependent var		151.3882
Adjusted R-squared	0.750029	S.D. dependent var		12.75891
S.E. of regression	6.379090	Akaike info criterion		6.783856
Sum squared resid	488.3134	Schwarz criterion		7.028919
Log likelihood	-52.66278	Hannan-Quinn criter.		6.808216
F-statistic	13.00184	Durbin-Watson stat		0.990505
Prob(F-statistic)	0.000255			

Sources: own work

The result of the correlation confirms most likely the fact that long-term real interest rates are negatively correlated with house prices. Contrary to Yiu's examination, however, only long-term real interest rates in Germany are strongly negatively correlated. Short-term interest rates are even positively correlated. On the one hand, the result supports the observation that the relevant interest rates for real estate financing in Germany are the long-term real interest rates due to the preference for interest rate security. On the other hand, this shows the rather unusual situation in international comparison that after the outbreak of the COVID-19 pandemic, inflation is initially healthy before an increase occurs. As a result, short-term real interest rates initially rose before falling.

The significance of the results of long-term real interest rates provides to a great extent evidence for the monetary policy hypothesis in the form of a quasi-experiment. The model found most probably a negative correlation between long-term real interest rates and house price changes.

Therefore, since interest rates were lowered during this particular period and the economic growth effect and the unemployment effect were controlled to have a negative impact on house

price changes, the relationship between long-term real interest rates and house price changes implies presumably a causal relationship between real interest rates and house price changes.

3 Discussion

This study is the first attempt to apply a quasi-experiment to investigate the monetary policy hypothesis in Germany. It differs from previous studies, which rely on econometric methods to avoid confusion and distorting effects. Analogous to Yiu's study, the special time after the outbreak of the COVID-19 pandemic, when the global economy was negatively affected, is used instead. Central banks in most countries took concerted action to cut interest rates synchronously, among other easing measures, to support the economy. In Germany, on the other hand, central bank-controlled interest rates have remained constant, while long-term interest rates have risen. As a result, real estate prices rose most presumably with strong momentum, also in Germany. These phenomena offered a unique opportunity to empirically test the monetary policy hypothesis, i.e., that an expansionary monetary policy, such as a negative real interest rate, ceteris paribus causes probably an increase in real estate prices. On the other hand, the application of a quasi-experimental approach during this period can rule out the reason for economic growth, as the global economy has been hit hard by the pandemic and most developed countries experienced an economic recession with high unemployment rates in 2020. Furthermore, the unemployment rate has risen slightly, so an exclusion could also be made here.

The use of a time lag would be useful to expand the analysis. After all, it is not unrealistic to assume that the change in interest rates will only have an impact on the real estate market. The real estate market is not as transparent as, for example, the stock market. There are also certain legal deadlines that must be considered when purchasing real estate in Germany. In this way, greater significance could be achieved.

Furthermore, a shadow rate could also be used as the real interest rate. The shadow rate is an interest rate in some financial models. It is used to measure the economy when nominal interest rates come close to the zero lower bound. The shadow rate derives from Fischer Black's insight that currency is an option and offers advantages in a phase of severely negative real interest rates.

The empirical results seem to confirm the monetary policy hypothesis, more precisely the real interest rate hypothesis in Germany, through the quasi-experiment in the COVID period. The real drop in interest rates during the COVID-19 period, as reported by Kingsly

and Henri (2020), acts arguably as an intervention approach to test the causality relationship in addition to the correlation association.

Intuitively, it is widely believed that cheap credit and relaxed lending regulations should boost the economy during the pandemic. It is also believed that this has attracted investors back to the market. In theory, Ryan-Collins (2019) argued that when unlimited credit and money flow into a naturally finite supply of real estate, it causes rising house prices. Empirically, there is some evidence that unusually low real interest rates may be associated with high real estate prices (Yiu 2009), but causality has not been proven until this study.

Conclusions

With the help of a time series regression model, this work aims to test the hypothesis of the effect of the real interest rate on the change in house prices on the data shortly before and after the COVID-19 pandemic. The pandemic was used as a quasi-experiment to test the hypothesis, as it was able to rule out two key factors associated with an increase in house prices, firstly, positive economic growth and, secondly, a low unemployment rate. The rise in property prices in Germany following the outbreak of the COVID-19 pandemic suggests that it was likely caused by a shock rather than an insufficient supply of real estate and building plots or other individual factors such as tax policies or stimulus measures.

In Contrast to many other OECD countries, interest rate risk in Germany is in general hedged over the long term. Consequently, it can be assumed that the long-term real interest rate level in particular influences real estate prices more than the short-term interest rate. After the outbreak of COVID, long-term interest rates fell to unprecedented low levels. The pandemic situation led to negative real interest rates in Germany and almost all developed economies. This provided a unique opportunity to test the real interest rate hypothesis using a time series regression model as an intervention approach in a quasi-experiment.

The results of the regression model show a negative influence of the real interest rate on property price developments. This fulfills the aim of the investigation, the confirmation of the real interest rate hypothesis. The results of this study can be of great political and practical importance. However, it is difficult to take all local aspects into account in a single-country analysis.

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The General Semimartingale Model with Dividends

Abstract

This paper delves into the evolution and intricacies of financial mathematics, tracing its roots from Bachelier's groundbreaking work in 1900 to the comprehensive financial market models of the 1990s. While the general market model postulated by Delbaen in 1998 serves as an inclusive framework, certain gaps and limitations persist, particularly concerning non-discounted setups, potentially negative price processes, and dividend considerations. The aim of the contribution is to bridge these gaps by presenting a general market model that encompasses dividend payments in real-world contexts, transitioning subsequently to a discounted setup. We define such a market and find the necessary technical requirements.

Key words

JEL Classification

DOI

Introduction

The theory of modern financial mathematics in its present form has its origin in the dissertation "Théorie de la Spéculation" by L.F. Bachelier from 1900 (Bachelier, 1900). In this publication, one finds the first mathematical description of Brownian motion as a stochastic process (although not under that name). Bachelier's goal was to derive theoretical values for various types of options on certain goods by modelling prices of goods using a Brownian motion and comparing these prices with actual market prices. He proposed as option prices the expected value of the payment arising from the option. The crucial shortcoming in Bachelier's modelling was that the prices of goods could become negative.

Bachelier's work was forgotten for a long time. It was only after the development of the stochastic integral and the introduction of geometric Brownian motion as a pricing model

in the 1960s that financial mathematics revived (Itô, 1944; Itô, 1946; Itô, 1950; Itô, 1951a; Itô, 1951b; Itô, 1951c).

In 1973, Fischer Black and Myron Scholes made the decisive breakthrough (Scholes et al., 1973) by developing the famous Black-Scholes equation and formula.

Since then, financial mathematics has become a huge field of research, and numerous models have been proposed and analysed. The progress and advancement of stochastic analysis and stochastic integral, mainly by Doob (1953), Meyer (1962), Meyer (1963), Kunita et al. (1967), Meyer (1967a), Meyer (1967b), Meyer (1967c), Meyer (1967d), Doléans-Dade et al. (1970), Meyer (2002), Jacod (1979), Chou et al. (1980), and Jacod (1980) also opened up numerous new possibilities for financial mathematics. In particular, the modern approach of option pricing according to the duplication principle has established itself as a standard. This approach is a natural application of the martingale theory and representation theorem. Here Harrison et al. (1981) can be considered as a cornerstone.

However, at that time, while many different models had been examined and studied, there was no overarching theory that combined all these models to lay the groundwork for modelling financial markets. A significant breakthrough in the general theory of financial mathematics was achieved in the 1990s by Delbaen et al. (1994) and Delbaen et al. (1998) by presenting a very general financial market model that included almost all of the known models and proving the connection between arbitrage and mathematical conditions on the existence of specific probability measures. Since then, most publications have referred to this model. The financial market, as discussed in Delbaen et al. (1998), can be seen as the general market, which comprises almost all models of frictionless markets that are used in practice. Therefore, the results are universal, and the general set-up of the market is, without a doubt, the most important market model in Mathematical Finance. However, there are some gaps and shortcomings in the literature.

- The model in Delbaen et al. (1998) assumes a discounted set up (sometimes also referred as normalized set up). However, most models used in practice are described in non-discounted terms in order to be able to verify its assumption with real-world observations. The question how and under which assumptions non-discounted set ups can be transformed to discounted set-ups has not been described in general terms, but only for specific models.

- The price processes in Delbaen et al. (1998) are potentially negative. The price processes of any most results of the general theory, such as the Second Fundamental

Theorem of Asset Prices, the Third Fundamental Theorem of Asset Prices, or the theory of bubbles are assumed to be bounded from below. A generalisation to the original set-up has not taken place yet.

- The model as it is presented in Delbaen et al. (1998) does not consider dividends or additional cash-flows, and therefore excludes some essential models, such as models for pricing and setting of futures. In many cases, it is possible to transform dividend-paying models to non-dividend models (see for example Jarrow, 2021, Section 2.3). Therefore, an extension of the initial model to include dividends is desirable.

- Some basic properties of market models are often assumed to be true without validating them for this very general model. This applies to the notion of admissible strategies, discounted processes, numéraires and so on. In particular, since the general market model allows for negative prices some of the available properties get more complicated or even completely devalidated.

The aim of this contribution is to close the gaps mentioned above and to define a general market model that considers dividend payments in a real-world set-up. Then introduce the notion of a numéraire and transform the model to a discounted set-up. The special conditions and technical requirements are investigated and motivated. Furthermore, the literature on these topics and some examples are reviewed.

1 The General Semimartingale Model with Dividends

In this section, we are going to define a very general market model with dividends.

Our discussion primarily centers on time-continuous models. Although discrete models can be viewed as a subset of time-continuous models, they are typically easier to navigate mathematically. Nevertheless, time-continuous models are arguably more popular in financial mathematics, especially within portfolio theory. A key rationale for not exclusively relying on discrete models is that optimization problems in such a domain ideally have unique solutions. However, this uniqueness is often absent in discrete-time strategies, leading practitioners to settle for an approximate series of trading strategies.

For a given $\mathbb{R}^d$-valued semimartingale S, the space $L(S)$ is defined as the set of possible integrands for S for the general vector-valued stochastic integrals for a semimartingale integrator. Furthermore for a semimartingale $S, \varphi \in L(S)$ and $t \in \mathbb{R}_+$

$$\varphi_0^\top S_0 + \int_{(0,t]} \varphi \mathrm{d}S_u$$

denotes the stochastic integral at time t.

Consider a financial market that comprises $d+1$ tradable securities. The price processes of these securities are depicted by the $d+1$-dimensional process $S_t = \left(S_t^0, S_t^1, \dots, S_t^d\right)_{t \in \mathbb{R}_+}$. These processes also have associated cumulative dividend processes, termed $D = \left(D_t^0, D_t^1, \dots, D_t^d\right)_{t \in \mathbb{R}_+}$, which are adapted to the filtration $\mathbb{F} = (\mathcal{F}_t)_{t \in \mathbb{R}_+}$

It is assumed that the market is both frictionless and competitive. A market that is referred to as "frictionless" is characterized by the absence of transaction costs, differential taxes, and trading constraints, including short sale restrictions, borrowing limits, and margin requirements. Furthermore, within this particular market, it is worth noting that shares possess the characteristic of being infinitely divisible. The term "competitive" in reference to the market denotes a situation where traders function as price takers. In this context, individuals have the ability to engage in trading activities involving any desired quantity of shares without exerting any influence on the market price. This ensures that there is no presence of liquidity risk.

Furthermore, the following mathematical assumptions are being made:

- $(\Omega, \mathcal{F}, \mathbb{F}, \mathbf{P})$ is a filtered probability space with probability measure $\mathbf{P}$.
- The processes S_t^i and D_t^i are semimartingales for all $i = 0, \dots, d$. [1]
- The filtration $\mathbb{F}$ satisfies the usual conditions and the σ-algebra $\mathcal{F}_0$ is trivial, that is, $A \in \mathcal{F}_0$ implies $\mathbf{P}(A) = 0$ or $\mathbf{P}(A) = 1$. [2]

Remark 1.1. Markets with dividends can often be transformed into dividend-free ones. However, these transformations usually need additional assumptions to hold that are not universally applicable. For instance, Jarrow, 2021 presumes all cash flows to be positive and that the numéraire follows a deterministic continuous FV process.

The process D_t^i denotes the cumulative dividend payments of the i-th share up until the time t. We don't mandate monotonicity; hence, distributions might even be negative (additional distribution). Dividend processes that potentially have negative increments are crucial

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[1] There are several definitions for semimartingales in the literature, see for example Cohen et al. (2015) vs. Protter (2010). However, they are equivalent, as it is shown in Section 3.9 in Protter (2010).

[2] The usual conditions are, for example, defined in Cohen et al. (2015) p. 139 or Protter (2010) p. 3 as usual hypotheses.

for the study of certain products such as futures. Such dividend payments can be viewed as cash flows, making the limitation to solely positive cash flows appear overly stringent.

Generally, dividend processes are categorized into two types:

The first type posits continuous paths for the dividend processes, which, while mathematically convenient, isn't particularly realistic. The second assumes discrete dividend payments, with the dividend process D being a pure jump process[3] ($D = \sum \Delta D$). This is more aligned with reality, though not straightforward mathematically.

Mathematically speaking, it's prudent to presume price processes as semimartingales because the most widely accepted definition of the general stochastic integral only incorporates semimartingales as integrators. This assumption also finds economic justification; for instance, if the price process is locally bounded, adapted, and the market adheres to the 'No Free Lunch With Vanishing Risk' principle (a variant of 'No Arbitrage'), then the price process is a semimartingale, as demonstrated in Theorem 8 of Ansel et al. (1992) and on pages 504-507 of Delbaen et al. (1994). Another economic rationale is provided in Kardaras et al. (2011), where Constantinos Kardaras and Eckhard Platen show that in markets where only simple predictable trading strategies are permitted, where short-selling is disallowed and no-arbitrage principles hold, price processes are always semimartingales[4].

Requiring all price processes to be semimartingales excludes fractional Brownian motions with a Hurst parameter $H \neq \frac{1}{2}$. As of now, a consistent no-arbitrage theory for these processes in a frictionless, continuously trading market is non-existent. Yet, in markets with transaction costs, such arbitrage possibilities typically vanish. In these settings fractional Brownian motions are considered realistic and reasonable, for example, in Guasoni (2006).

1.1 Self-financing Trading Strategies

Definition 1.2. (a) *A $d + 1$-dimensional process $\varphi = (\varphi^0, \dots, \varphi^{d+1}) \in L(S)$ is called a trading strategy.*

(b) The wealth process of the investor is defined as

$$V_t := \sum_{i=0}^{d} \varphi_t^i \left(S_t^i + \Delta D_t^i \right), \ t \in \mathbb{R}_+$$

where φ_t^i represents the number of the i-th security that an investor holds in his portfolio at t.

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[3] For the pure jump process definition, refer to Klebaner (2005, Chapter 9).
[4] However, the No Arbitrage definition in this paper deviates from NFLVR.

Definition 1.3. *A trading strategy* $\varphi = (\varphi^0, \varphi^1, \ldots, \varphi^d)$ *is called self-financing if the wealth process* $V_t(\varphi)$ *satisfies*

$$V_t = \int_0^t \varphi_s \, d(S_s + D_s), \ \text{for all } t \in \mathbb{R}_+$$

Note the equation deals with higher dimensional processes and hence multi-dimensional integration.

Remark 1.5. The variable φ_t^i represents the quantity of securities i held by the agent within the portfolio, specifically within the time frame of t - to t (referred to as the investment in ΔS_t^i). The jumps referred to as ΔS_t^i and ΔD_t^i should be considered as synchronous. The term S^i can be conceptualised as the ex-dividend price, which refers to the price of a security after the dividend payment has been made.

The dividend payout for the agent at time t is $\sum_{i=0}^d \varphi_t^i \Delta D_t^i$. This is now invested in the $d + 1$ securities immediately after t. So, as before, there is no permanent cash holding. Therefore, only ΔD and not D appears in 1.

1.2 Numéraire

In practice, comparing two assets at different times based on their nominal size is unusual and makes no sense. Therefore, a benchmark should be introduced that enables us to produce comparative values. A numéraire represents this benchmark.

Definition 1.6. *A predictable semimartingale* $(N_t)_{t \in \mathbb{R}_+}$ *which satisfies* $\inf\limits_{t \in [0,T]} N_t > 0$, *for all* $T \in \mathbb{R}_+$ $\boldsymbol{P} -$ *a.s. is called a numéraire.*

Remark 1.7. The predictability is necessary to ensure that $\frac{1}{N}$ can be used as integrand. This is important to define the discounted dividend process and to map the self-financing condition of price processes to the self-financing condition of their discounted counterparts.

If one writes asset values as multiples of the numéraire, they can also be compared independently of the time. The discounted processes are denoted by $\hat{S}^i$ or $\hat{V}$, which means:

$$\hat{S}^i := \frac{S^i}{N} \ \text{ and } \ \hat{V} := \frac{V}{N}$$

For further analysis, one needs the following result.

Lemma 1.8. *Let* N *be a numéraire, then* $\frac{1}{N}$ *is bounded on each compact interval and in particular locally bounded.*

Proof. Given the definition of a numéraire, for every $T \in \mathbb{R}_+$, with probability 1, the infimum of N_t over the interval $[0, T]$ is strictly positive. This implies that for any compact interval $[a, b] \subset \mathbb{R}_+$, there exists a $\delta > 0$ such that $N_t > \delta$ for all $t \in [a, b]$ almost surely.

Considering the reciprocal function $\frac{1}{N_t}$, since $N_t > \delta$ for all $t \in [a, b]$ almost surely, we deduce $\frac{1}{N_t} < \frac{1}{\delta}$ for all $t \in [a, b]$ almost surely. Thus, the function $\frac{1}{N_t}$ is bounded by $\frac{1}{\delta}$ on the compact interval $[a, b]$ almost surely. Since this argument holds for any compact interval $[a, b] \subset \mathbb{R}_+$, we conclude that $\frac{1}{N}$ is locally bounded. $\qquad\square$

The literature does not present a unique definition for the numéraire. For instance, in works like Bingham et al. (2013), Elliott et al. (2005), or Pascucci (2011), it is only required that N should be a positive semimartingale. This notion also extends to Geman et al. (1995), regarded as the standard reference for a numéraire in an abstract context. However, to ensure that discounted price processes remain semimartingales, the numéraire's left limit must also be greater than 0. Even stricter conditions are demanded in specific settings such as Ebenfeld (2007). Additionally, distinctions between strong and weak numéraire concepts are discussed in (Klein et al., 2016). Our interpretation aligns with the one presented in Qin et al. (2017). Recent publications have started to describe financial market models without invoking the concept of a numéraire. Nevertheless, more intricate market assumptions, as described in (Herdegen et al., 2016), are necessary to maintain the feasibility of discounting price processes.

It is essential to introduce both a discounted dividend process, $\hat{D}^i$, and a discounted wealth process, $\hat{V}$. The process $\hat{D}_t$ denotes cumulative dividends up to a given time. However, each dividend gets discounted by the numéraire value, N, at its payment time - not by its value at t. This approach ensures that any change in the discounted dividend process, $\hat{D}^i$, occurs only when the dividend process, D^i, changes. In scenarios like $\frac{D^i}{N}$, these properties would not hold since a mere change in the numéraire N could lead to a change in $\frac{D^i}{N}$. Therefore, the following definition naturally arises.

Definition 1.9. *By* $\hat{D}_t^i := \int_0^t \frac{1}{N} \, dD_u^i, i = 0, \dots, d$ *the discounted dividend processes is denoted. Furthermore*

$$\hat{V}(\varphi) := \frac{V}{N}(\varphi) = \sum_{i=0}^{d} \varphi^i \left(\hat{S}^i + \Delta \hat{D}^i \right)$$

denotes the discounted wealth process.

Remark 1.10. By Protter (2010) Theorem IV.18, one has $\Delta \hat{D}^i = \frac{\Delta D^i}{N}$.

While it is commonly assumed that D is a pure jump process, we want to avoid making this assumption here and rather stay as general as possible.

However, if we operate under the assumption that the dividend process is a pure jump process (meaning $D = \sum \Delta D$ is valid), then, by Theorem IV.17 and Theorem IV.18 from Protter (2010), we arrive at

$$\hat{D} = \int_0^t \frac{1}{N_s}\, dD_s^i = \int_0^t \frac{1}{N_s}\, d\left(\sum_{0 \leq u \leq s} \Delta D_u^i \right) = \sum_{0 \leq s \leq t} \Delta \left(\int_0^s \frac{1}{N_u}\, dD_u^i \right) = \sum_{0 \leq s \leq t} \Delta \hat{D}_s^i.$$

In this scenario, $\hat{D}$ also becomes a pure jump process, only changing when D does.

The following theorem is immensely beneficial, offering the foundational technical knowledge to explore properties in discounted settings using the conventional tools of stochastic analysis.

Theorem 1.11. *The processes $N, S^0, \dots, S^d, D^0, \dots, D^d$ are semimartingales and N is a numéraire if and only if the processes $\frac{1}{N}, \hat{S}^0, \dots \hat{S}^d, \hat{D}^0, \dots, \hat{D}^d$ are semimartingales and $\frac{1}{N}$ is a numéraire. If, furthermore, φ is self-financing, then the discounted wealth process $\hat{V}(\varphi)$ is a semimartingale.*

Proof. $\Rightarrow$ Let N be a numéraire and $S^0, \dots, S^d$ semimartingales. We define

$$T^n := \inf\left\{ t \geq 0; N_t \leq \frac{1}{n} \right\}$$

Now (T^n) is a localizing sequence and we examine the processes

$$N_t^n := (N^n)_t^{T^n-} := \begin{cases} N_t & \text{for } t < T^n \\ N_{T_n-} & \text{for } t \geq T^n \end{cases}$$

Let f_n be a convex function, which satisfies $f_n(x) = \frac{1}{x}$ for $x \geq \frac{1}{n}$. By Remark 3.2, we obtain that $f_n(N^n)$ is a semimartingale and since $N^n \geq \frac{1}{n}$ holds, $\frac{1}{N^n}$ is also a semimartingale. Thus $\frac{1}{N^n}$ is prelocally a semimartingale and hence, by Theorem 3.3, a semimartingale. Since N is a semimartingale and therefore in particular càdlàg, we also have

$$\mathbf{P}\left(\sup_{t \in [0,T]} N_t < \infty \right) = 1 \ \text{ for all } T \in \mathbb{R}_+$$

and hence

$$\inf_{t\in[0,T]} \frac{1}{N_t} > 0 \text{ for all } T \in \mathbb{R}_+ \text{ } \mathbf{P} - \text{ almost surely.}$$

Thus $\frac{1}{N}$ is a numéraire and $\hat{S}^i = \frac{S^i}{N}$ is by Theorem 3.1 also a semimartingale.

$\Leftarrow$ Let $\frac{1}{N}, \hat{S}^0, \dots, S^d$ be semimartingales and $\frac{1}{N}$ a numéraire. If we proceed as above, we

obtain that $N = \frac{1}{\frac{1}{N}}$ is a semimartingale and by arguing as above, it follows that N is càdlàg.

Hence N is a numéraire. Since

$$\hat{\hat{S}}^i = \frac{\hat{S}^i}{\frac{1}{N}} = S^i \; i = 0, \dots d$$

holds, we obtain that S^i are also semimartingales.

Now we assume φ to be self-financing. Then we have $\hat{V}_t = \frac{\int_0^t \varphi \mathrm{d}S_u}{N_t}$, which

is a semimartingale by Theorem 3.1.

The subsequent theorem asserts that the self-financing property stays valid regardless of whether the associated wealth process is viewed in nominal or discounted terms.

Theorem 1.12. *Let $\varphi = (\varphi^0, \varphi^1, \dots, \varphi^d)$ be a trading strategy, V be the associated wealth process and N a numéraire with $\left[N, D^i\right]^c = 0$ for all $i \in \{0, \dots, d\}$. Then φ is self-financing if and only if*

$$\hat{V}_t(\varphi) = \sum_{i=0}^d \int_0^t \varphi_u^i \, d(\hat{S}_u^i + \hat{D}_u^i), \; t \in [0, T]$$

where $\hat{v}_0 := \frac{v_0}{N_0}$

Proof. We show the one-dimensional case. The multi-dimensional case follows from the linearity of the integral and the fact that any strategy can be approximated by component-wise integrable strategy.

By the definition of V and $\hat{V}$, it is easy to see that $V_- = \varphi S_-$ and $\hat{V}_- = \varphi \hat{S}_-$.

We first assume

$$\hat{V}_t(\varphi) = \int_0^t \varphi_u \, \mathrm{d}(\hat{S}_u + \hat{D}_u).$$

By Theorem 1.11, $\hat{V} = \hat{V}(\varphi)$ is a semimartingale and with Theorem 3.4, we obtain with a slight abuse of notation

$$
\begin{aligned}
V_t = \hat{V}_t N_t &= \int_0^t N_{s-}\mathrm{d}\hat{V}_s + \int_0^t \hat{V}_{s-}\mathrm{d}N_s + [N, \hat{V}]_t \\
&= \int_0^t N_{s-}\mathrm{d}\left(\int_0^s \varphi_u \, \mathrm{d}(\hat{S} + \hat{D})_u\right) + \int_0^t (\varphi\hat{S}_{u-})\mathrm{d}N_u + \left[N_t, \int_0^t \varphi\mathrm{d}(\hat{S}_u + \hat{D}_u)\right] \\
&= \int_0^t \varphi\mathrm{d}\left(\int_0^s N_{u-}\mathrm{d}\hat{S}_u + \int_0^s (N_u - \Delta N_u)\mathrm{d}\hat{D}_u + \int_0^s \hat{S}_{u-}\mathrm{d}N_u + [N_s, \hat{S}_s] + [N_s, \hat{D}_s]\right) \\
&= \int_0^t \varphi\mathrm{d}\left(N_s\hat{S}_s + \int_0^s N_u \, \mathrm{d}\hat{D}_u - \sum_{0 \le u \le s} \Delta N_u \Delta \hat{D}_u + [N, \hat{D}]_s^c + \sum_{0 \le u \le s} \Delta N_u \Delta \hat{D}_u\right) \\
&= \int_0^t \varphi_s \, \mathrm{d}\left(N_s\hat{S}_s + \int_0^s N_u \, \mathrm{d}\left(\int_0^u \frac{1}{N_r} \, \mathrm{d}D_r\right)\right) \\
&= \int_0^t \varphi_s \, \mathrm{d}(S_s + D_s)
\end{aligned}
$$

Hence φ is self-financing. The converse follows analogously with $N' = \frac{1}{N}$ and $\hat{V} = VN'$.

Since each trading strategy can be approximated with component-wise integrable trading strategy, the general result follows by taking limits. □

2 Conclusion

This paper explores the evolution of financial mathematics, starting with Bachelier's early work in 1900 and ending with the comprehensive market models of the 1990s. Despite its breadth, Delbaen's 1998 model had limitations, such as not accounting for non-discounted settings, the possibility of negative price paths, and importantly, dividends.

To address these issues, we developed a general model including dividends. We carefully defined each component. When we moved from a standard to a discounted model, we made sure to close literature gaps and found that traditional features often changed or became irrelevant, particularly in dividend models. However, we pinpointed necessary technical requirements to keep these features consistent. Key among these are the predictability and lower bound limits of the numeraire, as well as the uncorrelatedness of the continuous part of dividends and numeraire. By combining a thorough review of relevant literature with our innovative insights, this paper manages to fill existing gaps and strengthen the foundations of financial mathematics.

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Appendix:

Some referenced results

A proof for the following result can be found in Protter, 2010, Corollary 2 of Theorem 2.22.

Theorem 3.1 (Partial integration). Let X, Y be two semimartingales. Then XY is a semimartingale and

$$X_t Y_t = \int_0^t X_{s-} \, dY_s + \int_0^t Y_{s-} \, dX_s + [X, Y]_t$$

Remark 3.2. The space of semimartingales posseses some remarkable stability properties. For example, for a convex function $f : \mathbb{R} \to \mathbb{R}$ and a semiartingale $X, f(X)$ is also semimartingale. This is a consequence of the Tanaka-Meyer-Itô Rule (see, for example, Cohen et al. (2015) Theorem 14.3.11 or Protter (2010) Theorem IV.70). Theorem IV.66 from Protter (2010) also provides a simplified proof of the abovementioned fact.

The next result is taken from Protter, 2010, Chapter II Section 2

Theorem 3.3. (a) Local semimartingales and processes that are prelocally semimartingales are semimartingales.

(b) An $\mathbb{R}^d$-valued stochastic process X is a d-dimensional semimartingale if and only if all components are one-dimensional semimartingales.

(c) The set of all semimartingales form a vector space.

(d) Let **Q** be a probability measure that is absolutely continuous with respect to **P**. Then every **P**-semimartingale is also a **Q**-semimartingale.

The following result can be found in Protter, 2010, Chapter II Section 6

Theorem 3.4. Let $X, Y \in \mathcal{S}^1$. The process $[X, Y]$ is an FV process, a semimartingale and has the following properties.

(a) $[X, Y]_0 = X_0 Y_0$ and $\Delta[X, Y] = \Delta X \Delta Y$.

(b) Let T be a stopping time. Then we have

$$[X^T, Y] = [X, Y^T] = [X^T, Y^T] = [X, Y]^T$$

(c) The quadratic variation $[X, X]$ is a positive, increasing process.

(d) If X is an FV process, we have

$$[X, Y]_t = X_0 Y_0 + \sum_{0 < s \leq t} \Delta X_s \Delta Y_s$$

(e) For $X, Y \in \mathcal{S}^1, H \in L(X)$ and $K \in L(Y)$, we have

$$[H \cdot X, K \cdot Y]_t = \int_0^t H_s K_s \, \mathrm{d}[X, Y]_s \ (t \geq 0)$$

Zdeněk Truhlář

Impact of inflation targeting on a selected indicator of the real economy

Abstract

In fulfilling its monetary policy role, i.e., ensuring price stability, the central bank chooses one of several monetary policy regimes. Important features of inflation targeting are a publicly announced inflation target, the use of macroeconomic forecasting and open communication between the central bank and the public. The aim of the paper is to present, if exists, the impact of inflation targeting on the gross wage indicator in the Czech Republic. Real economy means the economy of the Czech Republic. Among other things, the thesis will discuss some of the principles and purposes of Inflation targeting as a central bank monetary policy tool in the context of the evolution of the inflation indicator and the identification of the main factors affecting it and the role of the average gross wage indicator. Inflation, as one of the most important economic indicators that affects the behavior and decision-making of economic agents, it is desirable to monitor, understand the regularities of its development and to some extent predict it.

Key words

JEL Classification

DOI

Introduction

The sources of the data presented in this paper are the Czech Statistical Office (CSO) and the Czech National Bank (CNB). The data used will cover the period from 2011 to 2021. The average gross wage indicator is chosen as the real economy indicator for the purposes of this paper. Real economy means the economy of the Czech Republic. The aim of the paper is to present, if exists, the impact of inflation targeting on the gross wage indicator. Inflation

can be defined as a rise in the price level that results in a reduction in purchasing power, in practice it is the depreciation of a currency against goods and services. The expression of inflation for statistical purposes is based on the measurement of net price changes using consumer price indices. That is, indices measuring the price level of a selected basket of representative products and services over two periods of comparison. The share of a given type of consumption in total household consumption represents the weight or importance of the representative items in the consumption basket. For completeness, the consumption basket includes food, non-food goods and services.

1 The inflation targeting and the average gross wages

1.1 The inflation targeting

The inflation target is usually set higher than zero inflation, or no country targets zero inflation. Because inflation measurements tend to be biased upwards, it is desirable to build in a buffer against hitting the zero bound on interest rates and the risk of deflation. Thus, empirically, a target of 2% has proven to be appropriate globally. With flexible inflation targeting, rates are set so that the forecast returns to the target given the costs to the economy, or especially when supply shocks are negative.

If demand falls, the central bank cuts nominal (and thus real) interest rates. This dampens anti-inflationary pressures and returns the economy to a state where it can use its full productive capacity. However, the situation is more complex in the case of cost shocks, where the central bank must strike a balance between stabilizing inflation and the real economy.

Figure No. 1: The role of monetary policy
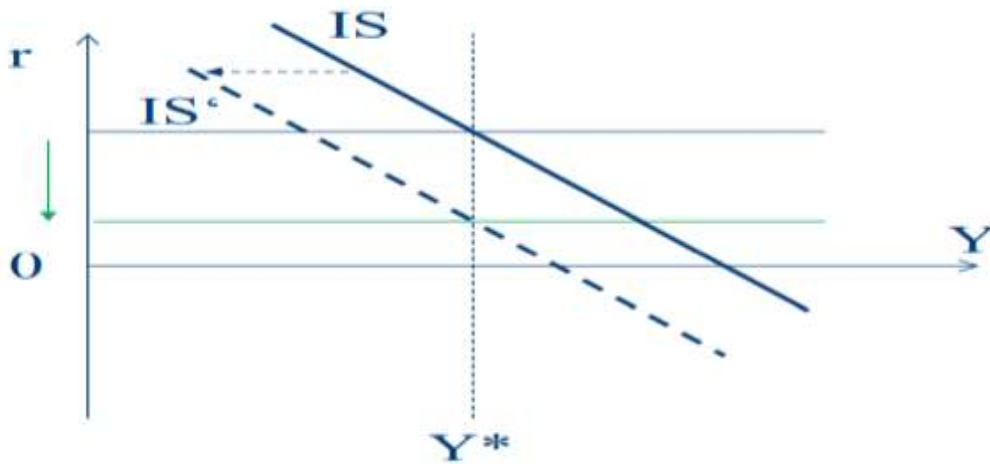
Source: author's own

The current price increases can be classified as a widespread and intense phenomenon. In the second half of last year, price increases across consumer basket categories cannot be overlooked. By the end of 2022, most items have shifted to higher price growth year-on-year. The question is why prices are rising so fast. Low unemployment, rising incomes, strong demand...Typical of the Czech Republic, house prices are rising fast and core inflation is high. Interesting is that in a period of low inflation, firms' and households' expectations do not correlate with central bank announcements (Coibon et al., 2020).

High growth in regulated prices goes hand in hand with a significant/steep rise in energy prices (22% VAT on electricity and gas renewed from January 2022). Rising food and Agri commodity prices due to world events are felt by every consumer. The rise in world oil prices is the primary driver of fuel price increases.

Table No. 1: Price stability over a longer period

	Average (%)
Inflation targeting (1998)	2,8
Headline inflation targeting	2,3
2% inflation targeting	2,2
3 years	4,3
5 years	3,5
10 years	2,3

Source: CNB Inflace - Česká národní banka (cnb.cz)

In the case of the economies for which imports of this commodity from Russia are crucial, the effect is stagflation or slumpflation.

"Across the spectrum of commodities imported into the EU, particularly in countries with a higher share of industry in GDP, the real economy would be particularly affected by a sudden stop in the supply of natural gas. To a lesser extent, economic activity would be negatively affected by a halt in the supply of oil, coal and possibly other commodities." (Benecka et al.) The increase in costs due to the reduction in the supply of mainly energy and food commodities was strongly anti-inflationary. A halt in the supply of gas and oil would result in a sharp rise in the prices of these commodities, but also in a simultaneous depreciation of the exchange rates of the countries concerned. High import prices would be reflected in domestic inflation and would be much more pronounced in the case of dollar commodity prices.

The inflation rate for 2011 was 1.9%. The growth of the Czech economy had gradually slowed during the year as a result of unfavorable external developments, the associated heightened uncertainty and the ongoing domestic consolidation of public budgets. However, domestic inflationary pressures remained subdued, and inflation was slightly below the 2% target. The slightly appreciating exchange rate of the koruna also contributed to low inflation, partly dampening the price effects of high global commodity and food prices.

For 2012, the inflation rate was 3.3%. The headline inflation rate, or its increase compared to the previous year, was affected by the reduction in the VAT rate. This measure, together with the rise in world commodity prices and import prices, was the cause of the increase

in the inflation rate compared to the previous year. On the other hand, developments in the domestic economy counteracted the price increases and the so-called core inflation was negative (continuing the trend of the previous period).

In 2013, the inflation rate reached 1.4%. The deepening economic recession was reflected not only in the level of headline inflation but also in core inflation. The unfavorable development of the domestic economy, accompanied by the regulator's announcement that it was ready to intervene in the area of foreign exchange reserves, ultimately weakened the koruna.

For 2014, the inflation rate was 0.4%. The main reason for the sharp reduction in the headline inflation rate can be the decline in administered prices and the market's adjustment to the change in VAT bands. Interestingly, the shift of the core inflation indicator into positive territory is largely due to the unwinding of the anti-inflationary effects of the domestic economy, but also to rising wages and import prices.

The lowest average inflation rate was 0.3% in 2015 (the lowest since 2003). A more detailed look at the inflation rate over this period shows a significant and deepening year-on-year decline in prices, mainly of fuels, due to the fall in global oil prices, as well as falling administered prices and stagnating food prices in the second half of the year. However, looking at the inflation rate adjusted for fuel prices, there was a slight increase to 1.5% at the end of the year (the highest level in seven years). Interesting in this context is the statement by the CNB Board, which said that it would not react to a positive supply shock and was prepared to tolerate an inflation rate of around zero.

The value of the indicator for 2016 was 0.7%. This year was marked by a slowdown in economic growth (more pronounced towards the end of the year) due to subdued export growth. Low prices of energy raw materials and food were the main reason. The ongoing decline in fuel prices also subsided towards the end of the year. It can also be noted that the price effects of the electronic sales register in the catering and accommodation sector were already apparent towards the end of the year.

Record low unemployment and the highest ever number of job vacancies translated into a further acceleration in wage growth in 2017. High wage growth, together with continued growth in the real economy, resulted in strong domestic inflationary pressures. At the same time, the inflationary effect of import prices resumed, which, in addition to the rise in foreign prices, was also reflected in the exchange rate of the koruna, which mostly depreciated during the year. Domestic inflation was within the tolerance band of the CNB's 2% target during the year and the average inflation rate was 2.5% over the period. In 2018, the average inflation

rate was 2.1%. Historically one of the lowest unemployment rates and the highest number of job vacancies translated into a further cceleration in wage growth. High wage growth, together with continued growth in the real economy, resulted in strong domestic inflationary pressures.

Growth in the global economy slowed in 2019, which, together with uncertainty about future developments, was reflected in a slowdown in economic growth, not excluding the German economy, to which a substantial part of domestic exports is linked. Although the Czech economy also slowed, it maintained a solid growth rate and continued to generate clear domestic inflationary pressures. The persistently tight labor market led to rapid wage growth and contributed to upward pressures on consumer prices.

Global economic developments in 2020 were significantly affected by the coronavirus pandemic. The anti-epidemic measures taken impacted world trade and negatively affected economic development in virtually all countries. The result was a deep downturn in the global economy.

Rational inflation expectations influence economic behavior. Businesses can make investment decisions and consumers can choose to spend and save based on their expectations of future inflation. If these expectations align with the central bank's goals, this can contribute to stable economic conditions.

On the other hand, if there is a persistent mismatch between actual inflation and set targets, this can lead to suboptimal economic outcomes, including volatility in financial markets and uncertainty in the real economy.

1.2 The average gross wages

The interplay and certain interconnectedness of macroeconomic indicators is also generally valid in the Czech Republic. To be more informative and to understand all the connections, it would probably be beneficial to monitor inflation in relation to the development of, for example, average gross wages, or to find seasonal trends.

The average gross monthly wage represents a certain proportion of wages, excluding other personal costs, per employee per month. Wages consist of base pay, fringe benefits, payroll compensation, on-call pay, and other components that are added to an employee's paycheck for a given period. However, it does not include wage or salary compensation for periods of temporary incapacity for work or quarantine paid by the employer. The average gross monthly salary is defined by the following relationship: $\sum$ gross monthly wage the number of employees on the register, where gross monthly wage covers basic wage, allowances and supplements to wages, wage compensation (but does not include compensation for temporary

incapacity for work paid by the employer). The number of employees on the register represents the persons employed.

There are therefore 22 different average gross salaries. The median or value in the middle of the ordered set is equal to 24 160. The standard deviation, which tells us how much the cases in the set of values examined typically differ from each other, is 6 763.58. Using the average function, we then find that the average wage between 2000 and 2021 is 24 096 CZK. Looking at the data, we immediately see that wages do not fluctuate, but rise steadily, and in neither case has there been a decrease.

2 Research objective, methodology and data

This part of the paper states its aim, detailed methodology and data used.

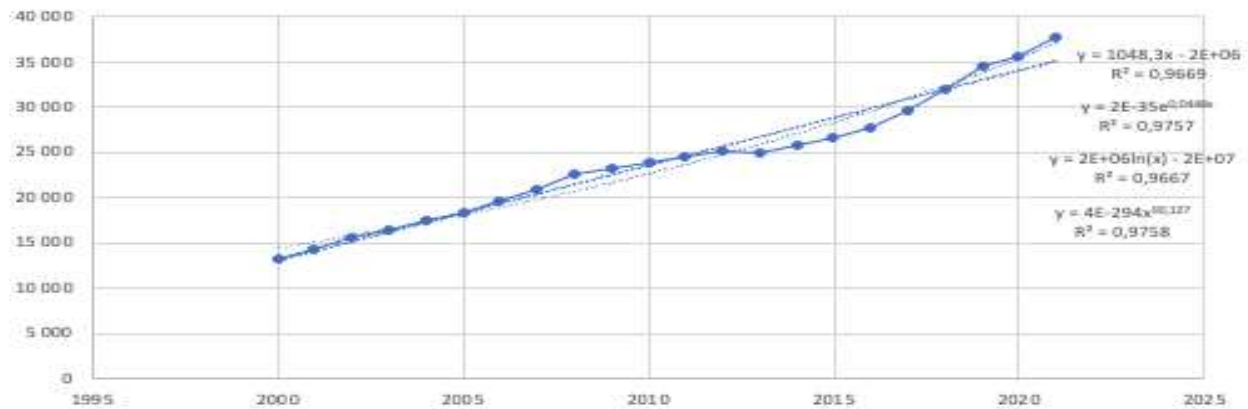**Table No. 2: Development of the gross wage indicator**

Year	Average Gross Wage	Differentiation	Growth Rate	Change (%)
2000	13 219			
2001	14 378	1 159	1,087676829	8,76768288
2002	15 524	1 146	1,079705105	7,9705105
2003	16 430	906	1,058361247	5,83612471
2004	17 466	1 036	1,063055386	6,30553865
2005	18 344	878	1,050269094	5,02690942
2006	19 546	1 202	1,065525512	6,55255124
2007	20 957	1 411	1,072188683	7,21886831
2008	22 592	1 635	1,078016892	7,80168917
2009	23 344	752	1,033286119	3,3286119
2010	23 864	520	1,022275531	2,22755312
2011	24 455	591	1,024765337	2,47653369
2012	25 067	612	1,025025557	2,50255571
2013	25 035	-32	0,998723421	-0,1276579
2014	25 768	733	1,029279009	2,92790094
2015	26 591	823	1,031938839	3,19388389
2016	27 764	1 173	1,04411267	4,41126697
2017	29 638	1 874	1,067497479	6,74974787
2018	32 051	2 413	1,08141575	8,14157501
2019	34 578	2 527	1,078843094	7,88430938
2020	35 662	1 084	1,031349413	3,13494129
2021	37 839	2 177	1,06104537	6,10453704

Source: Author's own processing. CSU data

Average growth rate …………………………………1,05135546.

Increase from the initial value to the final value…………186%. According to the auxiliary linear model, the parameters for further calculations were calculated in the form of a table. The linear regression was also plotted using a graph, where it can be noticed that the power function has the highest degree of determination, and this is exactly the value we found for the auxiliary calculations.

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Table No. 3: Point chart average gross wage

Author's own processing. CSU data

Since the difference between the variances of the test sets is statistically insignificant ($p > 0.05$), there is no significant difference in wage variability between 2000–2010 and 2011–2021.The value came out greater than alpha=0.05 hence seasonality is not evident in the time series.

Table No. 4 a) b): F-Test

Year	Average gross wage
2000	13 219
2001	14 378
2002	15 524
2003	16 430
2004	17 466
2005	18 344
2006	19 546
2007	20 957
2008	22 592
2009	23 344
2010	23 864
2011	24 455
2012	25 067
2013	25 035
2014	25 768
2015	26 591
2016	27 764
2017	29 638
2018	32 051
2019	34 578
2020	35 662
2021	37 839

2000-2010	2011-2021
13 219	24 455
14 378	25 067
15 524	25 035
16 430	25 768
17 466	26 591
18 344	27 764
19 546	29 638
20 957	32 051
22 592	34 578
23 344	35 662
23 864	37 839

Source: Author's own processing. CSU data

HO: DX=DY. H1: DX is not as DY. F- Test 0,411650368. F > alfa (0,05).

3 Results and discussion

There is a relationship between inflation targeting and gross wage developments. Inflation targeting is a monetary policy framework in which a central bank sets a target for the inflation rate and adjusts its policy instruments, such as interest rates, to achieve that target. When inflation targeting is implemented, it can affect gross wage developments in several ways. Firstly, if inflation is high, the central bank may increase interest rates and second what could happen is that this would lead to a decrease in demand for goods and services, which could lead to a decrease in economic activity and ultimately result in lower wages.

On the other hand, if inflation is low, the central bank may reduce interest rates, which could stimulate economic activity and lead to higher wages. Additionally, if inflation is expected to be low and stable in the future, this could increase confidence among businesses and workers, which could lead to higher wage growth. Overall, the relationship between inflation targeting and average gross wage developments is complex and multifaceted.

One way in which inflation targeting can affect average gross wage developments is through its impact on the labor market. When inflation is high, the central bank may increase interest rates, which can reduce the demand for labor as firms may cut back on their hiring or lay off workers. This can put downward pressure on wages, as workers may be willing to accept lower wages to remain employed. Conversely, if inflation is low, the central bank may reduce interest rates, which can stimulate hiring and lead to higher wages as firms compete for workers.

Another way in which inflation targeting can affect average gross wage developments is through its impact on the exchange rate. When central bank increase interest rates, this can make its currency more attractive to foreign investors, which can lead to an appreciation of the currency. This can make exports more expensive and reduce demand for goods and services, which can put downward pressure on wages.

Conversely, if the central bank reduces rates, this can make its currency less attractive to foreign investors, which can lead to a depreciation of the currency. This can make exports more competitive and increase demand for goods and services, which can lead to higher wages.

Inflation expectations play a crucial role in the effectiveness of inflation targeting. Clear communication of the central bank's inflation targets helps shape expectations among business, consumers and financial markets. The goal of inflation targeting is to anchor inflation expectations, especially in the long term. Well-grounded expectations help reduce inflation volatility, making it easier for businesses and households to plan for the future.

The relationship between inflation targeting and average gross wage developments is complex and multifaceted. While inflation targeting can affect average gross wage developments through its impact on interest rates, the labour market, the exchange rate, and expectations about future inflation and wage growth, the direction and magnitude of these effects can vary depending on a range of factors, including the state of the economy, the level of inflation, and the actions of other economic factors such as governments and companies.

Conclusions

We see inflation targeting as a monetary policy framework in which the central bank sets an explicit target for the rate of inflation and uses various monetary policy instruments to achieve and maintain it. Inflation is usually considered as a negative side of the economy. On the other hand, however, one cannot fail to mention the possible positive effect on the economy in the form of mild inflation.

However, the strengthening of the domestic currency against the euro will probably have an anti-inflationary effect. The average inflation rate in 2021 was 3.8%. From a macroeconomic point of view, the impact of the coronavirus pandemic on the development of the variable is also interesting. The initial phase of the pandemic actually reduced aggregate supply and demand, but the consequences for the development of inflation cannot yet be clearly indicated. The global economy recovered relatively quickly from the slump in the first half of 2020 thanks to massive monetary or monetary policy stimulus. The situation regarding developments in the transport sector and drops in supply in manufacturing companies as a result of pandemic developments (shortage of chips, etc.) are known, which ultimately resulted in supply frictions and production shutdowns.

A specific aspect that influenced the evolution of the variable over the period under review was the changes in indirect tax rates in a situation of persistent strong inflationary pressures in the domestic economy. If, on this basis, we were to identify strong inflationary factors, we should mention supply-side frictions, the significant rise in the price of oil and other commodities and, to a lesser extent, the rise in unit labor costs. Persistent supply-side frictions are likely to be a strong inflationary factor this year as well. In addition, the rise in administered prices, especially for electricity and natural gas, will have a stronger impact on the average inflation rate.

The approach to assessing the impact of wage developments on inflation is based on a twofold possible effect of wages on inflation. Wages can be both a potential cost and demand inflation factor. The distinction between wage-cost and wage-demand inflation

is not straightforward. Its difficulty is evident in estimating the contribution of demand and cost inflation to headline inflation.

The impact of inflation targeting on the average gross wage indicator is indirect and depends on a variety of factors. In general, inflation targeting aims to keep inflation low and stable, which can have both positive and negative effects on wages.

On the positive side, low and stable inflation can help to create a more stable economic environment, which can lead to more investment, job creation, and higher wages. When inflation is high and volatile, it can create uncertainty for businesses and individuals, which can make it difficult to plan and lead to lower investment and wages.

On the negative side, some argue that inflation targeting can lead to a focus on controlling inflation at the expense of other economic goals, such as employment and economic growth. This could potentially lead to slower wage growth if the central bank prioritizes inflation over job creation.

Although, inflation targeting can be a powerful tool for shaping rational inflation expectations, the effectiveness of this approach depends on the credibility, transparency of the central bank and its ability to consistently adhere to announced inflation targets. A dynamic process requires constant communication, adaptability and a proven commitment to maintaining price stability.

It can be stated that inflation expectations are an integral part of both the success of inflation targeting as a monetary policy framework and the development of the gross wage indicator. They shape economic behavior, influence wage negotiations, and play a key role in maintaining overall economic stability. Alignment of inflation expectations with monetary policy objectives contributes to more predictable and sustainable economic results.

The impact of inflation targeting on the average gross wage indicator is complex and depends on a variety of factors, including the specific economic conditions in the country, the effectiveness of the central bank's policies, and the priorities of policymakers.

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An Approach to Explain Bank Runs with Game Theory

Abstract

This paper presents an approach to understand the bank runs with game theory. In the model, each player decides if they withdraw their deposit from the bank and loose accumulated interest or leave the deposit in the bank risking losing the deposit partially or completely. The model considers interest rates, transaction fees, and deposit insurance. The aim of the contribution is to analyse the root cause of bank runs and investigate the impact of deposit insurance on the depositors' withdrawal strategies. Within a dynamic game with incomplete information, a playoff matrix for players is build and the results are analyzed. The results show that there two Bayesian Nash equilibrium and two strategies that can be considered as optimal in the game without deposit insurance which leads to a bank run. On the other hand, with deposit insurance introduced in the game, the optimal strategy is to keep the deposits in the bank which minimizes probability of bank runs.

Key words

JEL Classification

DOI

Introduction

Bank runs are a phenomenon that can have devastating consequences for the economy. They occur when a large number of depositors withdraw their money from a bank over a short period of time, fearing that the bank is about to fail. This is a self-fulfilling prophecy, since no bank is able to pay off all its obligations immediately (Arifovic et al., 2013).

Bank runs are not new and can be caused by a variety of factors. They have occurred throughout history, and they have been especially common during periods of financial crisis. For example, the Great Depression of the 1930s was preceded by a wave of bank runs.

Similarly, the 2008 financial crisis was accompanied by a number of bank runs, including the failure of Lehman Brothers and the near-collapse of AIG. In recent years, there have been a number of high-profile bank runs in the Czech Republic and the United States. In 2022, a bank run on Sberbank in the Czech Republic was triggered by the Russian invasion of Ukraine. In 2023, two bank runs on Silicon Valley Bank and Signature Bank in the Unites States leaded to their failure.

Bank runs can have a significant impact on the economy. When depositors withdraw their money from banks, banks have less money to lend to businesses and consumers. This can lead to a decline in investment and economic growth. Bank runs can also damage confidence in the banking system, which can make it more difficult for banks to borrow money and make loans.

This article explores the phenomenon of bank runs in more detail. It discusses the causes of bank runs with the help of game theory, providing explanations on the depositors' behaviour. The aim of the contribution is to analyse the root cause of bank runs and investigate the impact of deposit insurance on the depositors' withdrawal strategies.

1 Bank Runs

Bank runs occur when a large number of depositors withdraw their money from a bank over a short period of time even if all depositors are rational and fully informed about the bank's financial condition. This was first shown by Douglas Diamond and Philip Dybvig (Diamond a Dybvig, 1983), who presented bank runs as a coordination problem among depositors: each depositor has an incentive to withdraw their money early, before other depositors do, in order to avoid losing their money if the bank fails. This is a self-fulfilling prophecy, even if the bank is solvent. In recent years, more sophisticated theories of bank runs were developed that showed that bank runs can be more likely to occur when depositors have heterogeneous information about the bank's solvency (Allen a Gale, 1998).

The fundamental view of bank runs, on the other hand, sees them as a result of depositors' rational assessment of the bank's solvency. In other words, bank runs occur because depositors believe that the bank is actually insolvent and that they are likely to lose their money if they do not withdraw it immediately. The fundamental view is most famously associated with the work of Xavier Freixas, who argued that bank runs were more likely to occur in countries with weak banking systems and poor regulatory oversight (Xavier Freixas et al., 2000). In recent years, bank runs were caused by both coordination problems and concerns about the bank's solvency.

There are a number of policies that can be used to prevent bank runs. Deposit insurance guarantees depositors up to a certain amount of their money in the event of a bank failure. This can help to reduce depositors' incentives to withdraw their money in the event of a bank run. Another approach to prevent bank runs is capital requirements to hold a certain amount of capital in reserve (Shakina 2019). This helps to protect banks from insolvency and makes them less vulnerable to bank runs. In this article, the major focus is on deposit insurance as a policy to minimize probability of bank runs.

2 Game Theory Model

A basic game model for bank runs was introduced by Diamond and Dybvig in 1992, in which two investors had deposited the amount of D each to a bank. The bank has reinvested the amount of 2D to a long-term project with expected pay-out of 2R to investors in the end of the project, where R > D. In case any of investors withdraw their deposits before the project ends, the bank is required to sell its investments for 2r, where D > r > D/2, due to a penalty. In the model, there are two periods of time when the depositors can withdraw from the bank: period 1 is considered as withdrawal before the project ends, and period 2 is after the project is complete (Lu, 2023).

During period 1, each depositor decides if they want to keep investing or get their amount back. Thus, if one investor makes a withdrawal decision, then:

1. bank sells its investment for 2r;
2. this investor receives amount of D;
3. another investor gets amount of 2r – D;
4. the game ends.

If both investors decide to withdraw, each investor gets amount of r and the game ends. And finally, if both investors keep their deposits in bank, then the project ends, and investors make their decisions at the period 2. Here, if one investor withdraws their deposit, they get amount of 2R – D, and the other one gets only D back. If both investors make the same decision either to get their investment back, or keep in the back, both of them get amount of R (Sun 2023). Since the model doesn't assume any of discounting, the payment matrix can be presented as in the table 1, where R > D > r > 2r – D.

Table No. 1: Payment matrix for standard game

		Investor 2	
		Withdraw deposit	Keep invested
Investor 1	Withdraw deposit	(r,r)	(D, 2r – D)
	Keep invested	(2r – D,D)	(R,R)

Source: Gibbons, 1992, p. 75

The game has two Nash equilibria when both depositors either withdraw or keep deposits invested. The first equilibria, when the depositors withdraw their investments, is considered as a bank run. Due to the game is considered a dynamic game of imperfect information, both investors don't obtain the information regarding the strategy of other players. Thus, if at least one investor believes that the second one is going to withdraw before at period 1, the best response is to play the strategy "withdraw".

This model doesn't consider discounting and deposit protection implemented in the majority of developed countries. Also, this model of a bank run leaves big space for expert assessment of the values of r and R. To cover this gap a new model is presented in the next chapter.

2.1 Game with deposit rates and fall in the stock index

In this game, there are also two of investors: investor 1 and investor 2, which deposited the amount of D each to a bank. The expected payoff for the investors is $D(1 + i) – w$ at the end of their deposits, where i = deposit rate - inflation rate ($i \geq 0$) and w is a bank's withdrawal fee ($w \geq 0$). Taking into account statistics of occurrence of bank runs, we can assume that bank run is most likely to happen during financial crises, when the majority of stock indexes are rapidly going down. Thus, if the bank run occurs, the bank is forced to sell its assets at a reduced price with a large discount. If the initial investments are in total 2D, then the discounted price at the period 1 is going to be $2D(1 – f)$, where f is the magnitude of the fall in the stock index ($f > 0$). Another parameter for the game is DI, the amount covered by deposit insurance.

In this game, there are also two iterations when the depositors can withdraw from the bank: iterations 1 is considered as withdrawal before the deposit expiration time, and iterations 2 is after. During iterations 1, each depositor decides if they want to keep deposited or get their amount back. Thus, if one investor makes a withdrawal decision, then:

1. bank sells its investment for $2D(1 – f)$;
2. this investor receives amount of $D – w$;

3. another investor gets amount of $\min\{DI, 2D(1 - f) - (D - w) - w\} = \min\{DI, D(2 - 2f)$ $- D + w - w\} = \min\{DI, D(2 - 2f - 1)\} = \min\{DI, D(1 - 2f)\}$;

4. the game ends.

Here, $D > D - w > D(1 - f) > D(1 - 2f)$. If both depositors decide to withdraw their deposits, they will get $\min\{DI, D(1 - f) - w\}$ each and the game ends. Otherwise, if both investors decide to keep depositing, the game continues at the stage 2. The payment matrix for the iteration 1 is presented in the table 2.

Table No. 2: Payment matrix at the iteration 1

		Investor 2	
		Withdraw deposit	Keep invested
Investor 1	Withdraw deposit	$(\min\{DI, D(1 - f) - w\},$ $\min\{DI, D(1 - f) - w\})$	$(D - w,$ $\min\{DI, D(1 - 2f)\})$
	Keep invested	$(\min\{DI, D(1 - 2f)\},$ $D - w)$	The second iteration

Source: Author's own

At the iteration 2, if both investors decide to keep their deposit, they both will get $D(1 + i) - w$. If both investors decide to withdraw their deposit, they both will get $D(1 - f)$ each. If only one investor makes a withdrawal decision, they will get $D(1 + i) - w$, while the other gets $\min\{DI, D(1 - f)\}$. These options are illustrated as payment matrix in the table 3.

Table No. 3: Payment matrix at the iteration 2

		Investor 2	
		Withdraw deposit	Keep invested
Investor 1	Withdraw deposit	$(D(1 - f), D(1 - f))$	$(D(1 + i) - w,$ $\min\{DI, D(1 - f)\})$
	Keep invested	$(\min\{DI, D(1 - f)\},$ $D(1 + i) - w)$	$(D(1 + i) - w,$ $D(1 + i) - w)$

Source: Author's own

Since $\min\{DI, D(1 - f)\} \leq D(1 - f)$ and $D(1 - f)) \leq D(1 + i) - w$ the strategy "Withdraw" strongly dominates the "Keep invested" strategy. We can simplify the payment matrixes with 2 iterations into normal game with only 1 iteration, as it is presented in the table 4.

Table No. 4: Summarized payment matrix for the game

		Investor 2	
		Withdraw deposit	Keep invested
Investor 1	Withdraw deposit	$(\min\{DI, D(1-f)-w\},$ $\min\{DI, D(1-f)-w\})$	$(D-w,$ $\min\{DI, D(1-2f)\})$
	Keep invested	$(\min\{DI, D(1-2f)\},$ $D-w)$	$(D(1+i)-w,$ $D(1+i)-w)$

Source: Author's own

2.2 Impact of the deposit insurance on the preferred strategy

To analyze this game, let us consider 2 cases: when the deposited amount D equals or less than deposit insurance ($D \leq DI$), and the opposite case $D > DI$.

In the first case, $D(1-2f) < D(1-f) - w < D \leq DI$, the min functions will have the following solutions:

- $\min\{DI, D(1-f)-w\} = D(1-f)-w$
- $\min\{DI, D(1-2f)\} = D(1-2f)$

The payment matrix is presented in table 5 for the case 1.

Table No. 5: Summarized payment matrix with deposited amount less than insurance

		Investor 2	
		Withdraw deposit	Keep invested
Investor 1	Withdraw deposit	$(D(1-f)-w, D(1-f)-w)$	$(D-w, D(1-2f))$
	Keep invested	$(D(1-2f), D-w)$	$(D(1+i)-w,$ $D(1+i)-w)$

Source: Author's own

Since $D(1-2f) < D(1-f) - w$ and $D - w < D(1+i) - w$, we have 2 Nash equilibria: $(D(1-f)-w, D(1-f)-w)$ and $(D(1+i)-w, D(1+i)-w)$. The first equilibrium is bank run and this strategy is the most likely to choose for any of investors if they believe that other investor is going to withdraw their deposit. But in the second case, when $D > DI$, the payment matrix has values as it is presented in the table 6. Here, the strategy "Keep invested" strongly dominated "withdrawal" strategy. This result shows that if a policy of deposit insurance is implemented, depositors are less likely to participate in withdrawals causing bank runs.

The second conclusion that can be done from the model, that the bigger insurance deposit, the less likely depositors will take out their funds.

Table No. 6: Summarized payment matrix with deposited amount more than insurance

		Investor 2	
		Withdraw deposit	Keep invested
Investor 1	Withdraw deposit	(DI, DI)	(D – w, DI)
	Keep invested	(DI, D – w)	(D(1 + i) – w, D(1 + i) – w)

Source: Author's own

Conclusion

The aim of the contribution is to analyse the root cause of bank runs and investigate the impact of deposit insurance on the depositors' withdrawal strategies. The article investigates the reasons why depositors choose the "withdrawal deposits" strategy over "keep deposited" with the game theory model. It was shown, that the game with two investors has 2 Nash equilibria, one of which is to withdraw funds from the bank. If any of investors believe that the other investor will withdraw their funds from the bank, the best strategy for that investor is to withdraw the funds either. This satiation is considered as ban run. On the other hand, implementing policy of deposit insurance decreases probability for bank that their depositors will withdraw their funds. The bigger insured amount, the less motivation to make a withdrawal decision.

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Factors affecting Academic Performance in Econometrics: interests, abilities and attitudes

Abstract

The presented study was conducted with the objective of identifying the factors that influence the outcomes of grades in the Introduction to Econometrics, particularly using the Gretl program. A total of 163 students enrolled in the undergraduate program participated in the study, during which data was gathered via two questionnaires, resulting in the collection of over 50 variables. This article aims to provide a follow-up of the previous research conducted by Vojtasová and Solej (2023) and evaluate the impact of broader variables on academic performance. The article's primary objective was to evaluate the degree to which individual factors contribute to the academic performance of students in the field of econometrics. The results of the research confirmed statistical significance of previously used variables such as tutorial attendance and row, time preparation. Moreover, it reaffirms the importance of regular engagement with course materials and active participation in tutorial sessions. Results highlight the importance of previous knowledge of statistics and attitudes towards learning econometrics.

Key words

Econometrics, GRETL, study results, quantitative methods

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DOI

Introduction

Econometrics requires a unique set of skills and perspectives from students. Many elements impact student's academic performance as they work through the complex concepts of econometric analysis. This includes student's personal interests, innate skills, and attitudes

toward the topic. The presented study aimed to find the factors influencing students' marks in the Introduction to Econometrics course. The primary motivation for our research originates from finding a way to improve teaching, understanding how to motivate students to obtain better results, and finding out what to focus on when it comes to preparation for teaching. Moreover, the following study, together with primary anonymized data, can be used as a case study in the future for participants of econometric courses within the University of Economics.

In the earlier research conducted by Vojtasová and Solej (2023), the primary objective was to investigate the fundamental factors that influence the study outcomes pertaining to the course titled "Introduction to quantitative methods". In the winter semester of 2022/2023, 163 students specializing in Finance, Banking, and Insurance were at the University of Economics in Bratislava. Approximately 50 variables were collected, which had been subjected to partial evaluation in the initial study. The variables mostly related to the quantitative measurement of activity in seminars that were mandatory for students and participation on lectures that were voluntary. In addition, the models also incorporated characteristics such as the proximity to the blackboard. This variable was quantified as the count of rows starting from the teacher's desk. Our primary focus was on the ongoing preparation of students for seminars and their preparation prior to the midterm test. The model also incorporated the variable gender. A comprehensive examination of the gender differences was addressed in a different article.

Given the previous article's emphasis on the significance of econometrics (Vojtasová, Solej, 2023; Conaway et al., 2018; Mahjabeen, Mahmud, 2016), we now aim to integrate and assess the outcomes of extended variables within the models. Students undertook two midterm examinations to evaluate their comprehension of econometrics and proficiency in the statistical program GRETL (Gnu Regression, Econometrics, and Time-series Library). The program was selected based on its ease of instructing the introductory econometrics course (Mixon, Smith, 2006).

1 Literature review

Many academics and studies have examined the elements that affect academic achievement in universities and other educational settings. Tintner (1954) conducted an initial investigation on the teaching of econometrics, primarily emphasizing the examination of teaching methods across various countries worldwide. According to him, econometrics is the field that utilizes mathematical economic theory and quantitative statistical methods to solve various economic issues.

The primary objective of the original studies was to examine the correlation between academic achievement in the fields of economic theory, mathematics, and statistics. Cohn (1972) designed a questionnaire to evaluate the possibility of reorganizing the "Introduction to Quantitative Methods" course. The findings confirmed a possible link between skills in mathematics and performance in quantitative methods. In contrast, the study revealed no substantial correlation between academic performance in economics and proficiency in econometrics. Anderson et al. (1994) provided more evidence that a solid foundation in mathematics is a powerful indicator of success in this subject.

MacDowell et al. (1977), conducted a study to investigate the differences in learning economics among men and women. The collected data revealed that academic performance in the field of economics failed to have a substantial influence. Following that, Dancer (2003) extended the research of gender disparities in the identical field. The study encompassed a group of 696 students from the University of Sydney, with a fairly balanced distribution between males and females. It was assumed that female students would surpass male students in academic performance. This hypothesis was validated when reviewing the data in econometrics, since it became evident that women attained better results. Nevertheless, within the field of economics, women had poorer results in comparison to their male counterparts.

Incorporating a variable related to part-time employment, Paul (1982) and Greenberger and Steinberg (1986) observed a statistically significant association. These findings indicate the existence of possible prejudice, as students who held part-time jobs had restricted preparation time because they come from financially less secure families. Romer (1993) identified class attendance as a significant determinant. The research was conducted at the University of California and involved a total of 195 students. The study's main aim was to assess the impact of absences and verify the feasibility of implementing mandatory lectures.

Cladera (2021) conducted a study that intended to assess the methodology of econometrics among undergraduate students in Spain. The author claims that there has been an increasing importance and need for econometric knowledge and skills in the labor market. Nevertheless, students frequently dislike and have unfavorable attitudes towards this subject (Cladera, 2021, p. 8). The study used a sample of 87 students registered in the econometrics course throughout 2018. Cladera (2021, p. 4) employed 36 factors in the study to evaluate several aspects, such as Affect, Self-confidence, Value, Difficulty, Interest, and Effort. The results indicated a direct relationship between students' self-perception of their talents in econometrics and their passion for the subject, consequently leading to improved academic achievement. The observed pattern

of findings is consistent with prior studies that explored analogous associations in different disciplines, such as Statistics (Mills, 2004; Emmioğlu, Capa-Aydin, 2012).

Vojtasová and Solej (2023) conducted a recent study that specifically examined a group of students from Slovakia. The research findings have shown that incorporating econometrics and quantitative methods can improve the quality of research. As a result, modern institutions deliberately provide their students with the necessary information and abilities right from the beginning of their academic journey. The main aim of this study was to investigate the factors that impact students' grades, general academic achievement, and comprehension of the subject matter at universities. One hundred sixty-three students participated in the study as part of the research sample. A questionnaire was given to the students at the end of two mid-term assessments. A designed econometric model indicated that active participation in seminars and involvement in tutorials had a statistically significant effect. Furthermore, in the initial examination, students' distance to the teacher's desk was identified as a noteworthy variable; the greater the distance between the student and the teacher's location, the more unfavorable their outcomes were likely to be. Moreover, attending lectures was essential in deciding one's score on the initial mid-term test. Comprehensive preparation before the test was also recognized as a significant predictor of academic success.

2 Data and methodology

The chapter explores the related data collection processes and describes our selected sample. The primary objective of this paper, building upon the prior research conducted by Vojtasová and Solej (2023), is to investigate additional explanatory factors that affect the outcomes of the econometrics course. Data was collected between November 2022 and January 2023, involving 163 second-year bachelor's students at the University of Economics in Bratislava. As part of their final evaluation in the course "Introduction to Quantitative Methods," students were required to complete two mid-term assessments.

Data obtained through methods other than questionnaires relate to diverse factors, including the distribution of students by gender, their involvement in study groups, scores attained in the first and second midterms, participation in seminars, and the accumulation of activity points during these seminar sessions. The original questionnaire conducted after the first midterm included fundamental questions on the classification based on study groups. This survey also included factors related to the accessibility of computer equipment. Significantly, the classroom design consisted of four rows containing four computers. As a result, some students had to either work on their own laptops or work with their

classmates. To address this circumstance, the variable "school computer" was created. There was a simultaneous interest in determining whether the distance from the blackboard impacted students' academic performance.

The primary focus of the initial questionnaire centered predominantly on students' preparedness for seminars and their engagement in pre-seminar lectures, typically held two days before the actual seminars, and served to provide students with a theoretical foundation pertinent to the topics of the seminar. This questionnaire gathered information about the specific actions performed by students before seminars and evaluated the average time spent preparing, excluding lecture and seminar hours. Furthermore, it explored the importance of the preparation that takes place before the midterm examination, measured in minutes. In addition, the questionnaire investigated the amount of time students spent preparing before submitting their credit reports. It is crucial to emphasize that this variable measured only days prior to the midterm exam.

In contrast, the following questionnaire addressed to the second midterm test and included a wider range of questions and factors aligned with the existing scientific literature. Significantly, it replicated the factors associated with seminar preparation and lecture attendance from the first questionnaire. After open discussion with students, additional questions were incorporated to evaluate the effectiveness of collaborative and individual exam preparation approaches. The survey also included questions regarding students' utilization of office hours. In addition, a personality type variable was included, allowing students to select whether they identify as introverted or extroverted. Most full-time students also participated in internships or other paid activities while studying to support themselves financially. Considering this, the survey incorporated inquiries about the students' employment status and the number of hours they dedicate to their jobs on weekly basis. Furthermore, it aimed to assess students' length of sleep before midterm test and whether they participated in physical activities such as sports during their free time.

Since the econometrics lesson utilized the Gretl program, we investigated whether there were any connections between technical proficiency demonstrated by proficiency in Microsoft Office applications like Word and Excel. In addition, our analysis included characteristics related to students' academic achievement, specifically focusing on their grades in statistics and their overall cumulative academic averages in all disciplines. In addition, during the data collection phase, we prioritized the variables specified in the study conducted by Kara et al. (2009), where the authors analyzed the factors that influence student performance in introductory courses on microeconomics and macroeconomics. The study's findings indicate

that various factors significantly impacted students' final grades. These factors included demographic variables such as gender and variables like work hours, SAT scores, class absences, and the number of economics courses taken. Moreover, factors such as students' inherent motivation, grade point average, age, living in university housing, enrollment in mathematics courses, and the instructor teaching the course were recognized as significant factors influencing student achievement.

In her study, Cladera (2021) assessed the attitudes of undergraduate Economics students towards econometrics by conducting a questionnaire after they finished the introductory Econometrics course. This investigation emphasized the significance of evaluating students' viewpoints after completing the course. Examining students' self-perceptions of their achievements is crucial for identifying methods to increase motivation and, consequently, improve their academic performance.

2.1 Empirical model

We constructed an Ordinary Least Squares (OLS) model to analyse empirical data, integrating particular data obtained from questionnaire responses. The model includes statistically significant variables from the previous paper of Vojtasová, Solej (2023). These variables are points for the activity where a positive relationship has been demonstrated. Likewise, the number of seminars that the student participated in was significant. Attendance at lectures (Romer, 1994), the ROW variable with the expected final effect, and preparation before the credit report were also significant in Test I. Our research involved the construction of two initial empirical models using the following equation:

$$POINTS\text{-}total = a0 + a1.TUTORIAL\text{-}activity + a2.TUTORIAL\text{-}attendance + a3.ROW + a4.LECTURES\text{-}attendance + a5.PREP\text{-}beforetest + a6.CONSULTATION + a7.EXTROVERT + a8.SLEEP + a9.JOB + a10.WORK\_HOURS + a11.EXERCISE\_HOURS + a12.EXERCISE + a13.GRADE\_AVERAGE + a14.DORMITORY + a15.SELFEVALUATION + a16.INTEREST + a17.TECHNICAL\_SKILLS + a18.STATISTICS + \varepsilon \quad (1)$$

$$POINTS\text{-}total = a0 + a1.COGNITIVE\_COMPETENCE + a2.INTEREST + a3.AFFECT + a4.EFFORT + a5.DIFFICULTY + a6.VALUE + \varepsilon \quad (2)$$

, where

a0	Initial value (constant)
POINTS-total	Total number of points from Test I. / Test II.
TUTORIAL-activity	number of points for the activity (max. 6 points)
TUTORIAL-attendance	the number of seminars attended by a student
ROW	row from the blackboard in which the student sat during the seminars
LECTURES-attendance	the number of the lectures attended
PREP-beforetest	the number of minutes the student spent preparing before for the test. (during the week before the test held)
CONSULTATION	dummy variable (1 = if student attended consultation, 0 = if not)
EXTROVERT	dummy variable (1 = if student considers himself to be an extrovert, 0 = if not)
SLEEP	the number of hours of sleep before test
JOB	dummy variable (1 = if student had part-time job, 0 = if not)
WORK_HOURS	number of work hours as part-timer per week
EXERCISE_HOURS	number of hours exercised per week
EXERCISE	dummy variable (1 = if student exercised regularly, 0 = if not)
GRADE_AVERAGE	average of student's grade from the academic system (AIS2)
DORMITORY	dummy variable (1 = if student lived in dormitory, 0 = if not)
SELFEVALUATION	student's self-evaluation of his work during seminar on a following scale: (1 = not enough, 2 = enough, 3 = good, 4 = very good, 5 = excellent)
INTERESTING	dummy variable (1 = if student the class interesting, 0 = if not)
TECHNICAL_SKILLS	dummy variable (1 = if student considers himself/herself to be a technical type, 0 = if not)
STATISTICS	students grade of obtained from Statistics
COGNITIVE_COMPETENCE	average of student's self-evaluation of cognitive competencies connected with econometrics on a scale 1-5, where five is the highest
INTEREST	average of student's self-evaluation of interest towards econometrics on a scale of 1-5, where five is the highest
AFFECT	average of student's perception of the class on the scale of 1-5, where five is the highest
EFFORT	average of student's self-evaluated performance during the semester on a scale of 1-5, where 5 is the highest
DIFFICULTY	average of student's self-evaluated difficulty of the class on a scale of 1-5, where five is the highest
VALUE	average of student's self-perceived value of econometrics on a scale of 1-5, where five is the highest
εi	error term

This research searches through new variables, notably focusing on designated consultation sessions that students had access to before their exercises. We anticipate a positive influence

stemming from this factor. Furthermore, we have included the personality trait variable "Extrovert" in our analysis, although we do not anticipate statistically significant differences in outcomes between extroverted and introverted students, drawing from the findings of Paul (1982). Moreover, we have incorporated the variable "job" (part-time employment) into our model, with the expectation that students juggling additional employment commitments may allocate less time to their studies, potentially resulting in lower academic performance. To quantify this difference, we introduce the variable "Work hours." Similarly, we consider the presence of adequate physical activity, with the expectation that it will positively impact academic performance.

Furthermore, the overall study results (grades) hold considerable significance in our analysis. In this context, we anticipate a robust and favorable impact. The same principle applies to the conversion of the statistics grade, a methodology previously employed by Cohn (1972). In addition, we have introduced variables such as "dormitory" or "self-evaluation" into our model. Moreover, we consider the assessment of students' interest in the subject matter and whether the students perceive themselves as technically skilled.

2.2 Summary statistics

Table 1 shows the most important descriptive statistics for all used variables as part of analysis. Its aim is to better comprehend the data. Total number of observations was 163 students, who filled the first questionnaire. The second questionnaire was not filled by 4 of them.

The maximum attainable score for both tests was 17 points. Upon comparing summary statistics, Test 2 yielded slightly superior results for parameters such as mean, median, 5th percentile, and 95th percentile.

Additional variables considered included activity, attendance at tutorials and lectures. These variables were further stratified based on the semester stage. Tutorials, obligatory with a 25% permissible absence rate, naturally exhibited higher participation. In contrast, lectures, which were non-mandatory, witnessed increased attendance in the initial segment. Data related to preparation were denoted in minutes, with noticeably shorter preparation times for the second mid-term test due to prior student experience. The Row variable lacked substantial significance in terms of summary statistics, as students were freely distributed across four rows.

Consultations, a binary variable, indicated that only 20% availed themselves of consultation hours. Extrovert was another binary variable. Sleep hours ranged from 1.5 to 10, while the Job variable, also binary, reflected whether students were employed. Work Hours, closely correlated, represented the hours worked by full-time employees. Similarly, Exercise

and exercise hours exhibited a comparable correlation. Grade average variables captured the study's average results, determined by the weighted study average in the AIS academic system (A – 1.0, B – 1.5, C – 2.0, D – 2.5, E – 3.0, Fx – 4.0). Dormitory, another binary variable, pertained to accommodation. Self-evaluation gauged students' self-assessment, with higher values indicating a more favorable evaluation of their class performance. The Interest variable, a dummy variable, reflected students' interest or lack thereof in the subject. This statistic denoted the average grade from the subject of the same name completed by the student in the preceding semester before the course. Other variables were derived from a study by Cladera (2021), and a questionnaire completed separately by students, with individual variable values averaged.

Table No. 1: Descriptive statistics of selected variables

Variable	Mean	St. Dev.	Median	Min	Max	5-perc	95-perc	IQ range	Observations
Mid-term Test_1 points	10,9	4,7	12,0	0,0	17,0	2,1	16,5	7,3	163
Mid-term Test_2 points	11,9	3,9	12,5	0,0	17,0	2,7	17,0	4,8	163
T1_TUTORIAL-activity	2,4	2,4	2,0	0,0	6,0	0,0	6,0	4,0	163
T1_TUTORIAL-attendance	5,6	0,8	6,0	2,0	6,0	4,0	6,0	1,0	163
T1_LECTURES-attendance	2,8	2,0	3,0	0,0	6,0	0,0	6,0	3,0	162
T1_PREP-beforetest	277,0	214,0	240,0	0,0	1700,0	30,0	600,0	240,0	162
Total_TUTORIAL-activity	5,8	2,4	6,0	0,0	12,0	1,0	9,8	2,0	163
Total_TUTORIAL-attendance	10,2	1,1	10,0	4,0	11,0	8,0	11,0	1,0	163
Total_LECTURES-attendance	4,2	3,4	3,0	0,0	11,0	0,0	11,0	5,0	159
T2_PREP-beforetest	185,9	132,0	150,0	0,0	600,0	30,0	480,0	150,0	159
ROW	2,5	1,1	3,0	1,0	4,0	1,0	4,0	1,0	162
CONSULTATION	0,2	0,4	0,0	0,0	1,0	0,0	1,0	0,0	159
EXTROVERT	0,5	0,5	1,0	0,0	1,0	0,0	1,0	1,0	159
SLEEP	6,9	1,5	7,0	1,5	10,0	4,0	9,0	2,0	159
JOB	0,7	0,5	1,0	0,0	1,0	0,0	1,0	1,0	159
WORK_HOURS	13,6	12,7	15,0	0,0	52,0	0,0	35,0	20,0	159
EXERCISE_HOURS	153,0	204,0	70,0	0,0	1200,0	0,0	540,0	240,0	159
EXERCISE	0,7	0,4	1,0	0,0	1,0	0,0	1,0	1,0	159
GRADE_AVERAGE	2,2	0,6	2,1	1,0	4,0	1,5	3,5	0,6	159
DORMITORY	0,6	0,5	1,0	0,0	1,0	0,0	1,0	1,0	159
SELFEVALUATION	3,5	0,9	3,0	1,0	5,0	2,0	5,0	1,0	159
INTERESTING	0,7	0,5	1,0	0,0	1,0	0,0	1,0	1,0	159
TECHNICAL	0,6	0,5	1,0	0,0	1,0	0,0	1,0	1,0	159
STATISTICS	2,0	0,6	2,0	1,0	4,0	1,0	3,0	1,0	159
COGNITIVE_COMPETENCE	2,8	0,7	2,8	1,0	4,3	1,5	4,0	1,0	159
INTEREST	3,0	0,8	3,0	1,0	5,0	1,5	4,5	1,3	159
AFFECT	2,8	0,6	2,8	1,2	3,8	1,7	3,8	1,0	159
EFFORT	3,6	0,8	3,5	1,3	5,0	2,0	4,8	1,0	159
DIFFICULTY	2,0	0,6	2,0	0,5	3,5	0,8	3,0	0,8	159
VALUE	2,6	0,9	2,5	0,5	4,5	1,3	4,3	1,3	159

Source: own calculation

3 Results

The purpose of this chapter is to show the key findings of our research. Building upon prior investigations, our emphasis is on the expansion of data that was not incorporated in previous studies. Our primary focus is on understanding the influence of interests, capabilities, and attitudes on academic performance in the field of econometrics.

3.1 Empirical model

The results of the empirical model can be seen in Table 2, which includes the unrestricted and restricted models. An unrestricted model shows us that the model is statistically significant as whole. The value of the F-statistic is relatively high (12,42) and is in the area of rejecting the null hypothesis ($p<0.05$). Among the previously considered variables, several emerged as statistically significant, notably tutorial attendance, class rank, and preparation efforts. Conversely, activity levels during seminars and participation in lectures did not exhibit statistical significance in this context.

Focusing on the recently added factors, the variable consultation, which had a negative coefficient, was determined to be statistically insignificant. Moreover, there was no statistically significant differentiation observed between introverted students and those who were extroverted. The impact of sleep before mid-term test remains unsubstantiated despite a positive coefficient. Similarly, there was no proven effect on the students' job status or the amount of time they dedicated to work in relation to their academic achievements during the semester.

Remarkably, a statistically significant relationship was found with the variable "hours of exercise," despite the fact that the binary variable "exercise" itself did not reach statistical significance. Furthermore, additional factors such as students' use of school-provided accommodation, their level of interest in the subject, and their self-perceived technical proficiency were not identified as statistically significant factors influencing the outcomes.

In line with existing literature, our analysis confirmed the significance of certain variables correlating with the number of points obtained. These factors include self-evaluation, grade average, and the grade received in statistics. Worth noting is that these grades exhibited negative coefficients, with the best grade 'A' assigned a value of 1 and the poorest grade 'Fx' (fail) assigned a value of 4, as per the grading scale.

Table No. 2: Dependence of the result from mid-term test 1 on the explanatory variables

Dependent variable: Mid-term Test_1 points	Unrestricted Model Coefficient (p-value)			Restricted model Coefficient (p-value)		
const	7,07131	**	(0,0243)	8,23257	***	(0,0035)
T1TUTORIALactivity	0,07596		(0,5102)			
T1TUTORIALattendance	1,07595	***	(0,005)	1,18381	***	(0,0009)
ROW	−0,441990	*	(0,0688)	−0,465888	**	(0,0382)
T1LECTURESattendance	0,021		(0,8857)			
T1PREPbefore	0,00380	***	(0,0012)	0,00363	***	(0,0012)
CONSULTATION	−0,220314		(0,7056)			
EXTROVERT	0,00488		(0,9923)			
SLEEP	0,16472		(0,344)			
JOB	0,52987		(0,5047)			
WORK_HOURS	−0,0256915		(0,4156)			
EXERCISE_HOURS	−0,00284651	**	(0,0387)	−0,00265724	**	(0,0249)
EXERCISE	−0,379851		(0,5561)			
GRADE_AVERAGE	−1,80656	***	(0,0005)	−2,11705	***	(<0,0001)
DORMITORY	−0,235485		(0,6452)			
SELFEVALUATION	1,30284	***	(0,0002)	1,45560	***	(<0,0001)
INTERESTING	0,26142		(0,6533)			
TECHNICAL	0,77393		(0,1597)			
STATISTICS	−1,74763	***	(0,0001)	−1,74273	***	(<0,0001)
Observations	159			162		
Adjusted R square	0,5653			0,5771		
F-Statistic	12,4155			31,7954		
P-value (F)	5,09 e^{-21}			8,80 e^{-27}		

Note: Statistical significance is indicated by (*), (**) and (***) at the 10%, 5% and 1% significance level, respectively. **Source:** own calculation

Statistical tests showed that the specification of the unrestricted model is inadequate. The Ramsay reset test came out with a p-value is less than 0.05 (p = 0.00669984). Based on White's test for heteroskedasticity, heteroskedasticity also seems to be a problem (p = 0.013454), but the Breusch-Pagan test came out the opposite way (p = 0.0602513). The random errors in this model are randomly distributed (p = 0.615343).

In the case of the restricted model, a problem with heteroskedasticity is obvious. White's test and Breusch pagan's test are gaining value in the area of rejecting the null hypothesis (p-value<0.05). Test for normality of residual indicates that errors are normally distributed. The Ramsay reset test acquired a higher value than the previous one, but it is still in the area of rejecting the null hypothesis (p = 0.043). Possible multicollinearity problems were not detected based on the analysis. Variance Inflation Factors was very close to the number 1 and condition index based on Belsley-Kuh-Welsch collinearity diagnostics does not indicate problems with collinearity for restricted and unrestricted model.

Table No. 3: Dependence of the result from mid-term test 2 on the explanatory variables

Dependent variable: Mid-term Test_2 points	Unrestricted Model Coefficient (p-value)			Restricted model Coefficient (p-value)		
const	1,70073		(0,6194)	1,93602		(0,5212)
TotalTUTORIALactivity	0,14584		(0,2134)			
TotalTUTORIALattendance	1,18272	***	(<0,0001)	1,35253	***	(<0,0001)
ROW	0,02648		(0,9048)			
TotalLECTURESattendance	−0,0447044		(0,5654)			
T2PREPbefore	−0,000171685		(0,9219)			
CONSULTATION	0,55572		(0,3051)			
EXTROVERT	0,06897		(0,8778)			
SLEEP	0,27318	*	(0,0855)	0,30859	**	(0,0365)
JOB	0,52352		(0,4669)			
WORK_HOURS	−0,0149360		(0,6019)			
EXERCISE_HOURS	−0,000382052		(0,757)			
EXERCISE	−1,66332	***	(0,005)	−1,49203	***	(0,0025)
GRADE_AVERAGE	−1,09857	**	(0,0159)	−1,14336	***	(0,0067)
DORMITORY	−0,0237635		(0,9588)			
SELFEVALUATION	0,30436		(0,3285)			
INTERESTING	0,03708		(0,9439)			
TECHNICAL	0,98031	*	(0,0522)	1,00241	**	(0,0238)
STATISTICS	−1,18755	***	(0,0038)	−1,29210	***	(0,0007)
Observations	159			159		
Adjusted R square	0,4215			0,4397		
F-Statistic	7,3947			21,6619		
P-value (F)	$4,10\ e^{-13}$			$2,65\ e^{-18}$		

Note: Statistical significance is indicated by (*), (**) and (***) at the 10%, 5% and 1% significance level, respectively. **Source:** own calculation

Table 3 provides an overview of the outcomes from the Mid-term Test II. Considering the R-squared value, it is apparent that the initial model accounts for approximately 42% of the overall variance in the dependent variable, signifying a relatively robust explanatory capability. Both the restricted and unrestricted models exhibit statistical significance as complete entities.

Regarding the original variables, a notable and statistically significant influence is observed in the context of overall seminar participation throughout the entire semester. However, among the newly introduced variables, consultation, extroversion, part-time employment, dormitory residency, self-evaluation, and interest did not demonstrate statistical significance.

Conversely, a noteworthy finding emerged, highlighting the positive impact of the number of hours of sleep prior to the credit report submission. Each additional hour of sleep is associated with an increase of 0.31 test points. Contrarily, engagement in regular physical exercise displayed a negative effect, revealing that students who maintained consistent physical

activity scored, on average, 1.49 points lower compared to those who did not engage in such activities.

Comparatively, similar to the preceding results, the technical skills of students were deemed statistically significant. More proficient students exhibited an average score that was 1 point higher. Moreover, the cumulative academic performance across all subjects and the grade in statistics once again demonstrated significance, indicating that a stronger academic performance in these domains corresponded to better results in the introductory econometrics course. Statistical tests for the unrestricted model showed that heteroskedasticity is not present in the model. White's test has a p-value of 0.4628. A test of normality of the residuals indicates that the errors are not normally distributed. The specification of the model based on the Ramsay reset test is adequate. With the restricted model, there is a strong indication of a problem with heteroskedasticity. White's test and Breusch-Pagan test yielded p-value<0.05. Also, errors are not normally distributed. Moreover, the specification of the model is adequate based on the Ramsay reset test. Model indicates no problem with multicollinearity.

Table No. 4: Dependence of the result from mid-term test 1 on the explanatory variables

Dependent variable:	*Unrestricted Model*			*Restricted model*		
Mid-term Test_1 points	Coefficient (p-value)			Coefficient (p-value)		
const	−1,87659	**	(0,3478)	−1,02118		(0,5959)
COGNITIVE_COMPETENCE	0,53363		(0,3811)			
INTEREST	0,99021	***	(0,0879)	1,17694	***	(0,0074)
AFFECT	0,75283	*	(0,2786)	1,54352	***	(0,0007)
EFFORT	1,398		(0,0026)			
DIFFICULTY	1,26484	***	(0,04)	1,59471	***	(0,0067)
VALUE	−0,384624		(0,4147)			
Observations	159			159		
Adjusted R square	0,2404			0,2200		
F-Statistic	8,0166			14,5756		
P-value (F)	1,59 e^{-07}			2,07 e^{-08}		

Note: Statistical significance is indicated by (*), (**) and (***) at the 10%, 5% and 1% significance level, respectively. **Source:** own calculation

Table 4 and Table 5 show the variables we included based on Cladera's (2021) study. These are proxy variables that subjectively measure the influence of cognitive competence, interest, affect, effort, difficulty, value. In both cases, interest and also difficulty proved to be a key variables. In the first mid-term test, the variable affect was also significant, and in the second, effort during tutorials. The analysis did not identify potential multicollinearity issues. The Variance Inflation Factors were closely approximating 1, and the condition index, as per

Belsley-Kuh-Welsch collinearity diagnostics, did not signal any collinearity problems for both the restricted and unrestricted models.

Table No. 5: Dependence of the result from mid-term test 1 on the explanatory variables

Dependent variable: Mid-term Test_2 points	Unrestricted Model Coefficient (p-value)			Restricted model Coefficient (p-value)		
const	3,62530	**	(0,0255)	3,56932	**	(0,0222)
COGNITIVE_COMPETENCE	0,54056		(0,2718)			
INTEREST	0,95902	**	(0,0409)	0,713469	**	(0,0427)
AFFECT	−0,251815		(0,6528)			
EFFORT	1,290	***	(0,0006)	1,2948	***	(0,0004)
DIFFICULTY	0,85473	*	(0,0848)	0,968774	**	(0,0395)
VALUE	−0,508043		(0,1825)			
Observations	159			159		
Adjusted R square	0,2404			0,1763		
F-Statistic	6,0620			11,0580		
P-value (F)	0,00001			1,28 e^{-06}		

Note: Statistical significance is indicated by (*), (**) and (***) at the 10%, 5% and 1% significance level, respectively. **Source:** own calculation

Conclusion

The presented paper provides valuable insights into the determinants of academic performance in the context of econometrics. Our research aimed to integrate and assess the outcomes of expanded variables to identify the fundamental factors that influence the study outcomes. Through a comprehensive analysis of various variables, we have identified factors that significantly influence students' outcomes in this discipline.

Among the variables we considered, tutorial attendance, row, and preparation time emerged as statistically significant contributors to academic success. These findings reaffirm the importance of regular engagement with course materials and active participation in tutorial sessions. Furthermore, when examining the average grade, we have also found previous knowledge of statistics and performance in econometrics are strongly corelated.

Conversely, several other variables, such as consultation, extroversion, and certain demographic factors, job, or hours worked did not exhibit statistically significant associations with academic performance. While these factors may still play roles in students' overall experiences, their direct impact on econometrics performance appears to be limited.

Notably, our study unveiled some unexpected insights. The positive effect of sleep duration on academic performance suggests the importance of rest and alert students. On the other hand, the negative impact of regular exercise on performance highlights the potential challenges faced by students who engage in intensive physical activities alongside their studies.

In conclusion, this research enriches our understanding of the multifaceted nature of academic success in econometrics, shedding light on the complex interplay of various factors that influence students' outcomes. These findings can inform educators and institutions in devising strategies to support students in their pursuit of excellence in this field.

For future research, exploring the relationships among additional potential indicators that impact teaching would be suitable. Specifically, investigating the influence of specific study materials and determining whether early semester absences have a significant effect would be valuable avenues of inquiry. Additionally, examining the correlation between the academic outcomes of students and those of their classmates who sat next to them in class could provide further insights into the dynamics of the learning environment.

Acknowledgements

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