

University of South Bohemia in Ceske Budejovice

Faculty of Economics

the Czech Republic

Investment Market Tool for Young People

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Approval Page

STATEMENT

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I hereby declare that the submitted master thesis is my own work and that I have used only the sources of information acknowledged and referenced in the list of used literature. For the thesis I have used information that cannot be published due to the existence of an agreement between the University of South Bohemia and CIRA Advisory s.r.o. and such information is available exclusively to the members of the committee for the defense of the thesis and to the reviewers.

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I would like to thank the University of South Bohemia for giving me the opportunity for studying and learning things that I never thought I would be interested in to learn and to have a deeper understanding of it.

I would like to thank both thesis professors, Dr. Marek Sulista and Dr. Daniel Kopta. Dr. Sulista has always helped me to clarify all the details in the thesis work, and Dr. Kopta has helped me a lot with the financial calculations for the tool. To both, my deepest gratitude for their help.

The possibility of accessing CSOB bond databases, as well as the NASDAQ databases is also duly acknowledged

I would like to thank my closest family for helping both emotionally and with the revision of the work, and by kindly supplying a nice environment to finish this thesis work.

Dedicated to:

Dedicated To: my parents, Carmen María and Agustín Miguel, my sister Irene María and Filos Alberto – our dog.

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1 Introduction

Since the beginning of the humanity, there has been always the necessity of owning a place for living and protecting human beings from nature and predators. It could have been a cave, in the Neandertal era, or a modest house for farming, up to a castle or a villa, to nowadays the well-known house or flat. The process of owning a place also changed over time. While initially it was based on occupation, it later developed in buying from earlier owner or governments and including the temporary right to use a place in exchange for currency, known as renting. Once the banking system grew and developed, one of the key businesses have been the loans to buy properties.

Nowadays, one of the most important banking operations are mortgage loans, understood as the loan given by a bank to a person to buy a place, and using such place as a security for the loan. It is now a frequent practice for young people once starting in the job market, to get a mortgage loan to buy a house or a flat. Such mortgages require meeting certain conditions on the applicant, one of the most important being the down payment, usually around 20% of the dwell's value, for which the person spends a few years saving money. Once mortgage is covered, the household usually becomes one of the most important assets of a natural person in middle class segment.

The household market in developed countries like the Czech Republic has been very stable over the years following the Velvet Revolution. (Global Property Guide, 2021) It was a standard practice for young people entering the employment market to save money for certain period and then got a mortgage to buy a property for living; very few people decided not to buy and live on renting for most or all their lives. However, a trend has been appearing in recent years suggesting that this proportion is being altered in favor or less buying and more renting (Global Property Guide, 2021; Bryx, 2021).

A probable cause for this change might be that salaries of ordinary people in general and young people are not keeping pace with the increase on housing price. Therefore, people have no option but to rent; some are even considering that investing the money for a house in a more aggressive investing market (stock market, hedge funds, even cryptocurrencies) could provide better long-term benefits.

It is the purpose of this project to present a tool that allows a young person to evaluate his or her options when presented the dilemma between renting and buying, considering aspects such as investment options, income, house cost, etc. This tool has been developed in Microsoft Excel® and it will make use of programming, finance and statistical tools learned during the career in a user-friendly tool. The main goal is to provide insights on the expected future value of different alternatives in an easy-to-handle tool, aimed for people with only basic knowledge of finance, so they have a guidance before choosing one alternative or another; it also allows them to study effects of different scenarios in market (selection of funds, revaluation factor, mortgage rate and term, etc). With this simplicity principle in mind, it is built on several assumptions:

- The expected future performance of bonds and stocks can be predicted based on previous performance. This implies a relatively stable behavior over time of such fund or stock. As with any forecasting tool, abrupt or sudden changes in market conditions render predictability almost useless.
- Emphasis is made on comparison of mortgages and investments, rather than on sophisticated forecasting tools, or complex mortgage models. This can be the subject of future improvements of the program, or in case it is to be used by financially proficient people.

1.1 Key Concepts

Although some of these concepts have almost universal understanding, they are explained below to have avoid misinterpretations and/or to provide details that can be useful in the rest of the work.

Mortgage is “an agreement that allows you to borrow money from a bank or similar organization, especially in order to buy a living place” (Oxford Dictionary, 2022)

Interest rate: “is the monetary charge for the privilege of borrowing money, typically expressed as an annual percentage rate. Interest is the amount of money a lender or financial institution receives for lending out money.” (Investopedia, 2022)

Types of mortgages: Mortgages can be classified in several ways, in this project the classification made by J. Kagan will be followed:

- a. **Fixed-Rate Mortgage:** “refers to a home loan that has a fixed interest rate for the entire term of the loan. This means that the mortgage carries a constant interest rate from beginning to end. Fixed-rate mortgages are popular products for consumers who want to know how much they’ll pay every month.” (Investopedia, 2021)
- b. **Adjustable-Rate Mortgage (ARM):** “is a type of mortgage in which the interest rate applied on the outstanding balance varies throughout the life of the loan. With an adjustable-rate mortgage, the initial interest rate is fixed for a period. After that, the interest rate resets periodically, at yearly or even monthly intervals. ARMs are also called variable-rate mortgages or floating mortgages. The interest rate for ARMs is reset based on a benchmark or index, plus an additional spread called an ARM margin.” (Investopedia, 2021)
- c. **Interest-Only Mortgage:** “is a type of mortgage in which the mortgagor (the borrower) must pay only the interest on the loan for a certain period. The principal is repaid either in a lump sum at a specified date, or in subsequent payments.” (Investopedia, 2022)
- d. **Reverse Mortgage:** “In a word, a homeowner who has considerable home equity can borrow against the value of their home and receive funds as a lump sum, fixed monthly payment, or line of credit. Unlike a forward mortgage—the type used to buy a home—a reverse mortgage doesn’t require the homeowner to make any loan payments. Instead, the entire loan balance becomes due and payable when the borrower dies, moves away permanently, or sells the home (Investopedia, 2022)
- e. **Maturity Date,** “is the date on which the life of a transaction or financial instrument ends, after which it must either be renewed, or it will cease to exist. The term is commonly used for deposits, foreign exchange spot trades, forward transactions, interest rate and commodity swaps, options, loans, and fixed income instruments such as bonds” (Investopedia, 2021). In this work, it will be used as the time in which the mortgage is to be fully repaid.

Rent: In mortgage and household market terms, rent the money paid by a person (tenant) to borrow a property to an external person (landlord), for the right to live in landlord’s property.

The landlord will require this money to be paid regularly (usually each month). Some landlords also ask their tenants to pay their services.

Safety Deposit (for a rent): “A security deposit is money that is given to a landlord, lender, or seller of a home or apartment as proof of intent to move-in and care for the domicile. Security deposits can be either be refundable or nonrefundable, depending on the terms of the transaction. A security deposit is intended as a measure of security for the recipient, and can also be used to pay for damages or lost property. Security deposits serve as an intangible measure of security, or as a means of tangible security in the event of damages or lost property.” (Investopedia, 2020). In The Czech Republic, it is customary to have one month rent as a safety deposit.

Agent Fee: “is the money paid an agent for carrying out responsibilities specific to the product or service (renting, buying or selling a property). It is usually a percentage of the property value or a number of rents (usually one). The fee is based on how much effort the agent puts into the sale and the cost of the product or service itself.” (Investopedia, 2021)

Rent Initial Payment: It’s a sum of money that a tenant would pay in advance to their landlord (or real estate company), in order to sign a contract, usually the first month or renting.

Investment: “An investment is an asset or item acquired with the goal of generating income or appreciation. Appreciation refers to an increase in the value of an asset over time. When an individual purchases a good as an investment, the intent is not to consume the good but rather to use it in the future to create wealth. An investment always concerns the outlay of some capital today—time, effort, money, or an asset—in hopes of a greater payoff in the future than what was originally put in.” (Investopedia, 2021)

Profitability: “Profitability is the ability of a business or investment to earn a profit. A profit is what is left of the revenue a business generates after it pays all expenses directly related to the generation of the revenue, such as producing a product, and other expenses related to the conduct of the business activities, including taxes. There are many different ways for you to analyze profitability” (Study.com, 2015)

Investment risk: “Risk is defined in financial terms as the chance that an outcome or investment's actual gains will differ from an expected outcome or return. Risk includes the

possibility of losing some or all of an original investment. [...]Risk is usually assessed by considering historical behaviors and outcomes. In finance, standard deviation is a common metric associated with risk.” (Investopedia, 2020)

Net Present Value (NPV): “is the difference between the present value of cash inflows and the present value of cash outflows over a period of time. NPV is used in capital budgeting and investment planning to analyze the profitability of a projected investment or project. NPV is the result of calculations used to find today’s value of a future stream of payments” (Investopedia, 2021)

Maturity: “Maturity is the date on which the life of a transaction or financial instrument ends, after which it must either be renewed or it will cease to exist. The term is commonly used for deposits, foreign exchange spot trades, forward transactions, interest rate and commodity swaps, options, loans, and fixed income instruments such as bonds.” (Investopedia, 2021)

Future Value (FV): “Future value (FV) is the value of a current asset at a future date based on an assumed rate of growth. The future value is important to investors and financial planners, as they use it to estimate how much an investment made today will be worth in the future. Knowing the future value enables investors to make sound investment decisions based on their anticipated needs. However, external economic factors, such as inflation, can adversely affect the future value of the asset by eroding its value” (Investopedia, 2021)

Creditworthiness: “Creditworthiness is how a lender determines that a borrower will default on his/her debt obligations, or how worthy the lender is to receive new credit. Creditworthiness is what creditors look at before they approve any new credit. Creditworthiness is determined by several factors including repayment history and credit score. Some lending institutions also consider available assets and the number of liabilities the borrower has when they determine the probability of default”. (Investopedia, 2021)

Investment type: For the purposes of this thesis, it will be used the risk definition given by the CSOB product score, which states: “Indicator of a comprehensive product risk based on group internal methodology taking into account, in particular, the following criteria: return

on investment amount, product credit quality, concentration risk, product price volatility, currency risk and product resale rate. The indicator may differ from SRRI” (CSOB, 2021)

Beta factor: “Beta is a measure of the volatility—or systematic risk—of a security or portfolio compared to the market as a whole.” (Investopedia, 2021)

Volatility:” Volatility is a statistical measure of the dispersion of returns for a given security or market index. In most cases, the higher the volatility, the riskier the security. Volatility is often measured as either the standard deviation or variance between returns from that same security or market index. In the securities markets, volatility is often associated with big swings in either direction. For example, when the stock market rises and falls more than certain admissible percent over a sustained period, it is called a "volatile" market.” (Investopedia, 2021)

Risk Free Ratio:” The risk-free rate of return is the theoretical rate of return of an investment with zero risk. The risk-free rate is the interest an investor would expect from a risk-free investment over a specified period. The so-called "real" risk-free rate can be calculated by subtracting the current inflation rate from the yield of the Treasury bond matching your investment duration.” (Investopedia, 2021)

Forecasting: “Forecasting is a technique that uses historical data as inputs to make informed estimates that are predictive in finding the direction of future trends. Businesses use forecasting to decide how to allocate their budgets or plan for expected expenses for an upcoming period. This is typically based on the projected demand for the goods and services offered.” (Investopedia, 2021)

The thesis is structured in the following manner:

- In the following chapter, it will be presented the literature that it was gathered on both the internet and some other books about this topic, mostly focusing on whether there is a justification for an expected increase in renting.
- The third chapter consist of how the tool was made and how it works, how the user interacts with the it and what are the results shown. It also includes some examples of use and analysis of key variables in the response.

- The fourth chapter consist of conclusion and recommendations gathered from the evaluation made by people who used the tool without previous knowledge of it.
- The fifth chapter are the references used on by the work, and the appendix includes the codes and explanation on the main function used for forecasting.

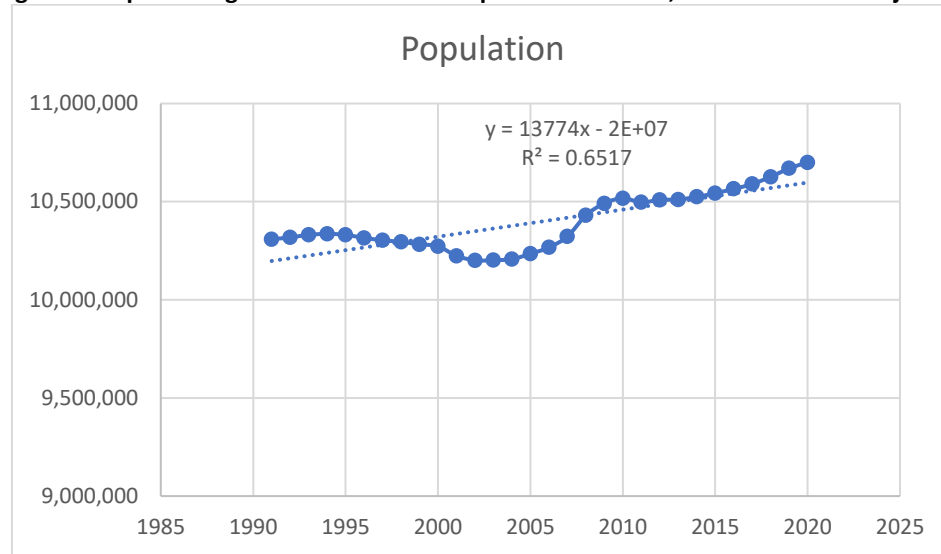
2 Literature Review

Since the beginning of the humanity, there has been always the necessity of owning a place for living and protecting human beings from nature and predators. It most likely started by looking for shelter in a cave in the prehistoric ages. Later, when small villages were formed for farming, it was a modest house, evolving to big buildings like a castle, or a villa, and to nowadays the commonly a house or a flat.

The process of owning a place also changed over time. While initially it was based on occupation of a place, it evolved at the end of the Middle Ages into great properties, where a wealthy property owner rented part of the lands owned to peasants, who have the obligation to cultivate the land in exchange for payment and the right to live in the premises. Ownership of land was mostly inherited, or the result of occupation of abandoned land (Encyclopedia Britannica, 2021). Later, the Industrial Revolution and the growth of the banking system created large cities with peasants moving to them to work in factories. The development of modern credits (lending money based on the positive expectation of a business) in the 17th century also boosted industry and business expansion, therefore creating the need for extensive labor, the move from rural areas to cities and, therefore, a big need for accommodation. Dwelling ownership and renting were the consequence of this growth (Harari Y., 2021). This has been the case till recent times.

To determine a country's housing needs, it is important first to figure out the population growth. According to the Czech Statistical Office (CZSO), population in the Czech Republic has experienced relatively slow growing since 1991, as shown in Figure 1.

Figure 1. Population growth in the Czech Republic since 1985, and linear trend adjusting



Source: Czech Statistical Office, 2020

In average, the Czech Republic has roughly 13.775 new inhabitants per year since 1991. This also means that since the population of the republic has been on a steady increase, more people has been on the lookout for new household.

Assuming a 4-member family average, it turns out that as a bare minimum, 3.375 new households should be built per year just to keep with vegetative growth of population (not counting dwelling replacement, conversion of buildings into commercial property, etc).

Based on CZSO data for 2020, more than 34.000 new houses were built in CZ. Table 1 shows the distribution of houses completed in 2020.

Table 1. Size and numbers of rooms of completed houses in the Czech Republic in 2020 per province

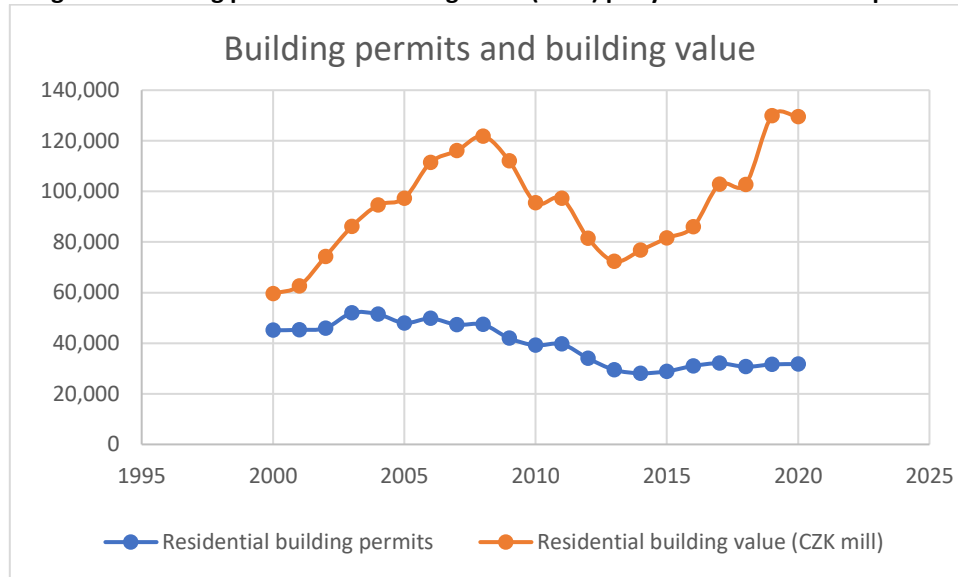
	Details of dwellings							Average floor area (m ²)	
	Total	Bed-sitters	Dwellings with kitchen and # of rooms					Living	Useful
			1	2	3	4	> 4		
Česká Republika	34.412	1.439	3.211	6.521	6.317	9.950	6.974	73,2	104,5
Hlavní město Praha	5.449	258	1.145	1.681	1.271	657	437	65,1	82,4
Středočeský kraj	6.836	234	283	890	1.018	2.340	2.071	80,3	111,4
Jihočeský kraj	1.667	51	62	288	289	554	423	86,0	116,5
Plzeňský kraj	2.506	111	194	533	494	716	458	68,1	98,5
Karlovarský kraj	549	14	66	58	81	198	132	78,3	113,0
Ústecký kraj	1.146	38	46	97	232	477	256	83,0	119,8
Liberecký kraj	788	21	43	106	138	256	224	84,3	119,6
Královéhradecký kraj	1.488	60	64	247	311	468	338	75,4	113,5
Pardubický kraj	1.568	59	73	226	296	573	341	76,7	113,3
Kraj Vysočina	1.556	52	84	277	273	473	397	73,7	114,8
Jihomoravský kraj	4.451	289	522	840	822	1.231	747	67,8	100,6
Olomoucký kraj	2.212	22	366	627	361	542	294	64,9	95,5
Zlínský kraj	1.478	53	87	277	274	467	320	75,8	118,0
Moravskoslezský kraj	2.718	177	176	374	457	998	536	70,5	107,0

Source: Czech Statistical Office, 2020

The average house size has 73 m² with a useful area of 105 m², so it is big enough to accommodate a typical 4-member family. Roughly two-thirds of new dwellings have 3 or more bedrooms. It also seems that the number of dwellings completed keeps a good pace with the population growth, at a ratio 2,5 times new dwellings per new inhabitant, per year. As expected, larger dwellings are in less populated areas.

Except for possibly punctual cases (big cities, near big industries), it seems that house offering is adequate. Figure 2 shows the evolution of the building permits and the overall building value, according to the CZSO.

Figure 2. Building permits and building value (total) per year in the Czech Republic.

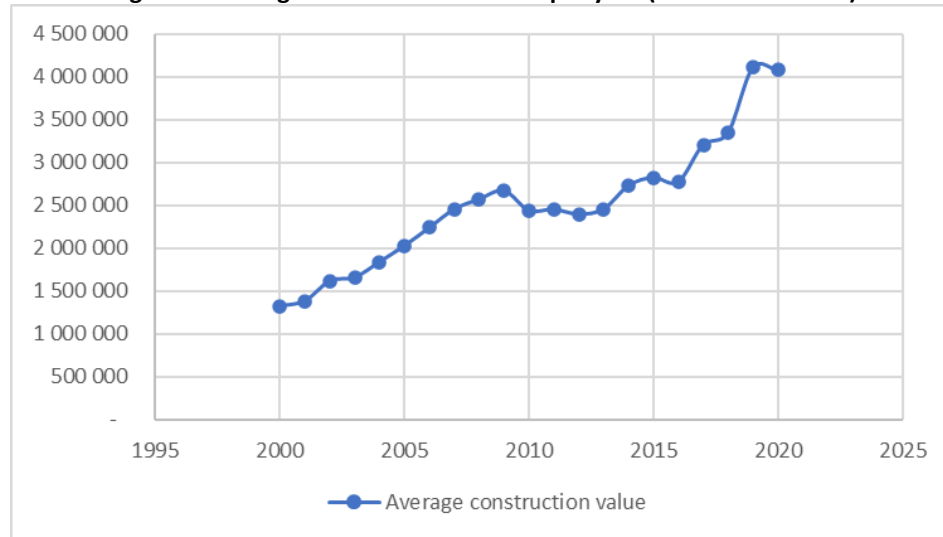


Source: Czech Statistical Office, 2020

The building permits for residential houses have stabilized around 30.000 per year in the last decade. In the first decade of XXI century, the average was at 45.000. Despite this, the building value saw three trends:

- sharp increase from 2000-2008, in what could be called a house bubble; the average price doubled from 1,3 million CZK to 2,7 million CZK – this figure is obtained dividing the building value by the building permits in Figure 2, and presented in Figure 3.
- a decline after the crisis of 2008 in both number and value from 2008-2014.
- and what can be called a second boom till today, where the prices grew with at least the same intensity as during the first period.

Figure 3. Average value of construction per year (own construction)

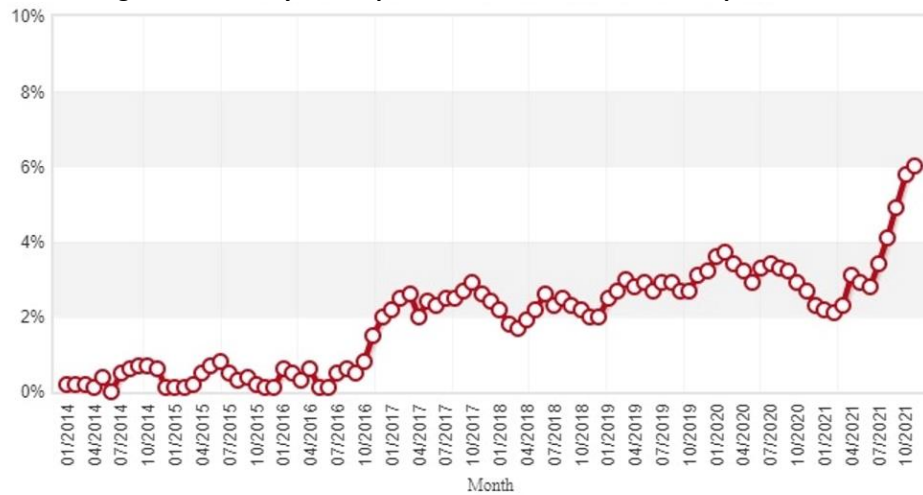


Source: Own construction

By dividing the residential building value by the number of residential building permits, an approximation to the average dwelling value can be obtained (Figure 3). It shows that, while during the 2008 crisis the price remained steady or even decreased slightly, after the 2008 financial crisis was over, a sudden increase of average household value is seen, the growth of which is higher than the inflation rate. Not even the Covid-19 pandemic seems to have significantly affected such prices – number of permits and average price remained almost equal in 2020 compared to 2019.

Apart from a possible speculative bubble, or very high demand for houses, several other factors can be used to explain this increase. One of them could be an inflationary period in the economy; however, Figure 4 shows this have not been the case in the period 2014-2020; it only burst for 2021 and 2022, where no data for new dwellings is yet available. Consumer price index have remained slow in the period.

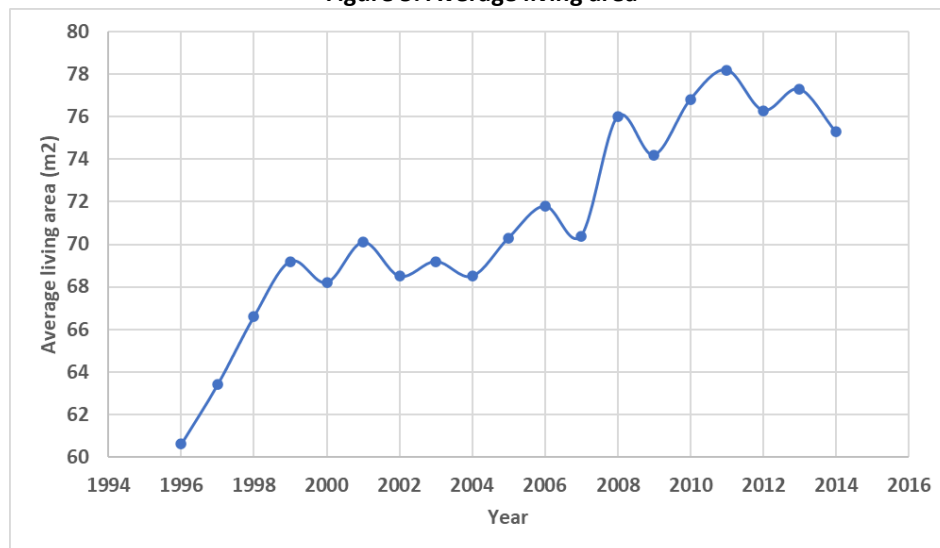
Figure 4. Monthly development of the annual consumer price index



Source: Czech Statistical Office, 2020

The other possible explanation could be an increase of the average size of the dwellings. Using data from the Ministry of Regional Development of the Czech Republic, available until 2014 and presented in Figure 5, the average living area per dwelling has reached a stable level around 76 m². More recent data from CZSO (Table 1) also confirms this finding.

Figure 5. Average living area



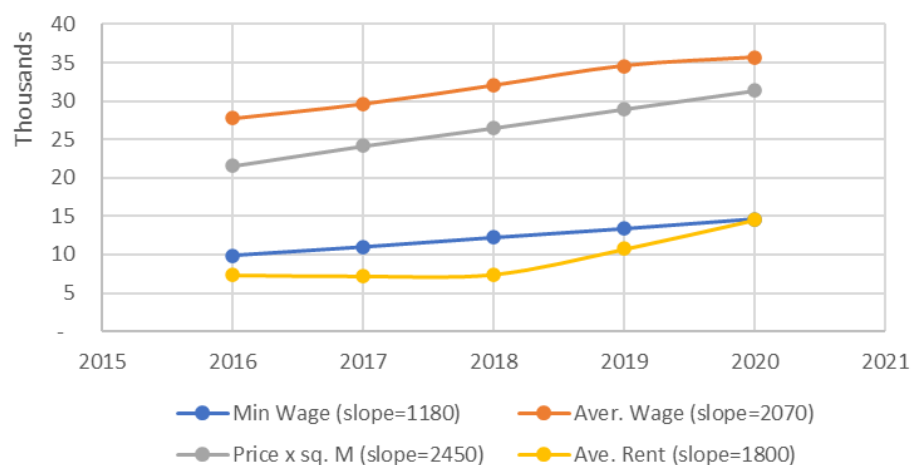
Source: Ministry of Regional Development, the Czech Republic, 2017

Another estimation can be made using the reference value for the square meter for flats from the CZSO Public database and combining it with the average construction value. Based on

this calculation, the average size of new dwelling has remained constant around 120-130 m² which correlates well with the average house size in Table 1. After discarding increase in construction cost and increase size of dwellings, the most logical explanation is an increased demand that drive the prices up.

It could be expected that the mortgages for households follow a similar trend. Using Czech National Bank (CNB) data, this does not seem the case. The loans for dwelling saw a sharp decrease around 2008 and then seems to be stable or with a slight increase in recent years. If the average house value increased, then it could be possible that people just do not have the resources for buying house or flats; or people do not want/afford to buy it and instead choose to rent, as going into a mortgage could increase the monthly expenditure for the household too much. It could also be argued that the resources for dwelling purchases came from non-local citizens, as foreigners are considering attractive to invest in the Czech Republic given its positive economic performance, safety, and relatively cheap house value compared with neighboring countries such as Austria and Germany. Another way to analyze the current purchasing power of dwellings is to compare the growth of salaries and remunerations vs the growth of renting and buying households. This is shown in Figure 6. In recent years, the growth in price of new housing seems to outpace the growth in increase of the two references for income – average salary and minimum wage as presented below.

Figure 6. Evolution of salary and purchase/rent indicators



Source: Own construction

Each plot is being accompanied with its slope, i.e., the yearly change. Since the 2016 the average wage in CZ grows faster than the minimum wage (2x approximately – 2.070

CZK/year vs 1.180 CZK/year, respectively). It is interesting to notice that the average rent prices are growing slightly less than the average wage (1.800 CZK/year vs 2.070 CZK/year, respectively), but it is not able to keep pace with the price of dwelling per square m (2.450 CZK/year). Therefore, it seems that renting is an alternative for people entering the job market when they are probably making less than the average salary, while the recent growth of average square meter for renting dwellings clearly outpaced average remuneration – this needs further studies as it could be sign of quality-of-life deterioration; however, this topic is beyond the scope of the present work.

There has been a similar study of the same problem in neighboring Poland (Bryx, M. 2021) After analyzing the changes of the dwelling prices and people remuneration, it is concluded that young people prefer owing a house rather than renting, in the expectation that they will save enough for buying a house later in their lifetime.

People perceive that owning a house should be their plan of the future, as they will give the security and stability that they desire and creates a good living condition for their future. But they also feel that having a mortgage that consumes a great deal of resources during a long time is a risky business that, in case of an unforeseen event, may lead to a complete loss of wealth.

The main drawbacks for the people to owning a house are:

- 1) insufficient funds to save for the down payment needed to buy a housing unit; or, at least, a long saving time for them (5 or more years)
- 2) lack of creditworthiness by own perception or by the bank's estimation. Or the financial institution concern about the sustainability of such creditworthiness. (Bryx, M 2021)

The person considering investing in a property is at one point faced with the question of whether they can afford the mortgage payments during the duration of the mortgage and at the same time saving money aside for emergencies and retirement. In the case of young people, it must be added the need to save for the down payment before even considering asking for a mortgage loan.

Based on the above, renting as a permanent choice may look a more economical alternative for many people (no need for down payment, probably lower monthly payments, no side costs of insurance, flat maintenance, etc), or, in the worst case, the only alternative at all. For a young person, with little or no financial ability, obtaining the proper answer to these questions can be difficult. Therefore, if some help can be provided in form of a comparison or scenario analysis, it could lead to better justified decision, without incurring in the extra expenses of paying costly financial analyst, or at least to minimize the expenses by asking for already filtered investment/buying scenarios.

3 Methodology

3.1 Scope

As the effort to sustain the needed investment for buying a house could be long and potentially depleting a person savings during an important fraction of his or her life, the alternative of investing resources while renting makes sense. Therefore, making such decision without data supporting it, might be difficult for a common person without financial education.

To this end, it is presented a simple tool that it can be used to help them evaluate the profits of investing in real estate versus going rental only plus long-term investment, and decide which one could be of better help for people who may lack enough economic knowledge to analyse these choices. Tool characteristics are: simple, user-friendly, and using software / resources available to most people.

It is the objective of this work is to offer a such simple tool, based on statistical housing data and investment calculation tools based mainly in future projection of known investment tools and stocks, using a common spreadsheet + programming software like Microsoft Excel® with VBA scripts (it can also be adapted if needed to Google Sheets, but this is beyond the scope of the present work) to provide a comparison tool between renting vs purchasing, with the possibility of scenario analysis.

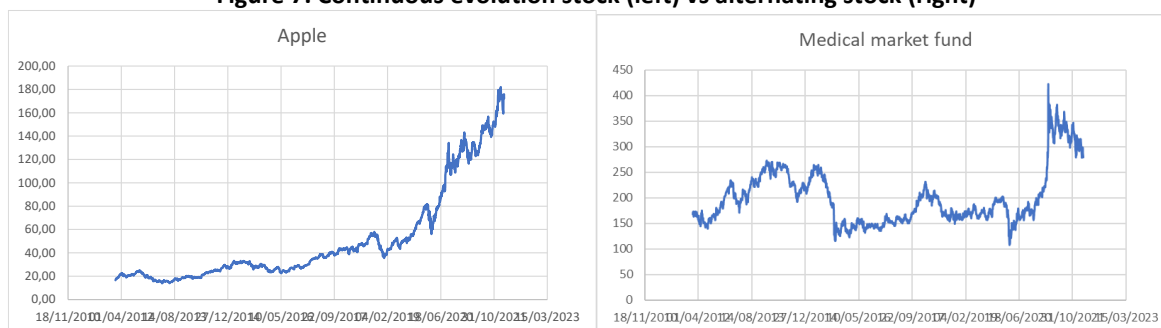
The tool does not pretend to be a precise financial predictor, nor to employ sophisticated predictive algorithms, but rather a prospective estimator of the effects of various investment decisions considered by the end user. For example, it can be used to decide the maximum

value of a house that is worth to be afforded with current assets, above which a better scenario is to invest. Or to play with the expected revaluation (or devaluation) of properties based on customer feeling of the current economic scenario.

This tool, like even the most professional software available, do not predict volatile economic environments, such as those generated by the outbreak of Covid, or the most recent Ukraine invasion war by the Russian army. Selected stocks and funds inside the tool were those with a stable and continuous evolution, suited for regression models.

As an example of the above, a preferred investment option selection for this tool is the Apple stock (it shows a growing continuous trend) rather than the medical market fund (it has a no clear trend) in Figure 7. Please note that Apple and the medical funds are used here as examples – any other fund or stock with continuous trend could be chosen.

Figure 7. Continuous evolution stock (left) vs alternating stock (right)



Source: Data taken from: Left (Nasdaq 2022); right (Nasdaq 2022)

Following a detailed explanation of the tool, several examples will be presented of use of such tool, and conclusions and recommendation for future work will be given.

3.2 Tool Development

3.2.1 Software Platform and User Interface

The tool was developed using Microsoft Excel[®]. The program consist of a single user tab with cells (marked in grey color for easy identification) where the user can input the data and later the program launches mathematical and financial calculations based on the input data. Informative answers are provided in orange cells, and the main results in green cells. Analysis and scenarios can be saved in pdf files for further analysis.

To perform the analysis and simplifying the appearance of the file, complex coding is made by use of Excel “macros” based on a programming language called Visual Basic Studio, or VBA for short, which is included in every license of Excel. VBA language dates back to 1993 based on Visual Basic, an interpretative language; is very simple to use and it has been on every major release of Excel since then; it combines the versatility of Excel and the easiness of Basic programming. VBA allows the user to execute a routine with a simple click of a button, easing the user to create multiple spreadsheets and calculus, in a hidden way, thus allowing complex calculations while keeping a very simple interface, which was one of the targets of the tool. Figure 8 shows the user interface (for easiness of reading, a space is used as a thousand separator in the tool). All the information is presented in one single sheet to facilitate analysis.

Figure 8. Main screen.

Scenario name		1 test	
INVESTMENTS			
<i>Portfolio</i>			
Monthly amount to invest	2	5 000	CZK
Extraordinary yearly investor	3	15 000	CZK
Yearly investment		75 000	CZK
Stocks proportion	4	75	%
Funds proportion	5	25	%
<i>List of stocks</i>			
Apple	4a	30	%
ActivisionBlizzard	4b	45	%
	4c		%
	4d		%
Taxes on stocks	4e	5	%
Commission on stocks	4f	0,5	%
<i>List of funds</i>			
KBC Bonds High Interest	5a	5	%
KBC Renta Dollarenta	5b	5	%
CSOB Bohatsvli	5c	15	%
	5d		%
Taxes on funds	5e	5	%
Commission on funds	5f	0,5	%
Confidence Interval (1-99%)	6	95	%
<i>Informative - volatility</i>			
Risk-free rate	7	1	%
Volatility		48,2	%
Beta index		5,02	
Sharma index		1 NR	
PERIOD FOR ANALYSIS			
Maturity Date 2a Years 3 Months 6			
(year counting starts on zero)			
Start calculation!			
RESULTS			
At the end of the maturity date, expect:			
<i>Investment Portfolio</i>			
Average Return	8a	283	232
Minimum Return	8b	103	782
Maximum Return	8c	360	866
<i>Mortgage Results</i>			
Selling the dwelling			
Expected value	9	126	852
<i>Keeping investment in Bank</i>			
Savings Account in Bank	10	256	112
(for reference)			
Save the scenario			
MORTGAGE			
<i>Mortgage information</i>			
Value of property	11	4 750 000	CZK
Mortgage interest rate	12	2,49%	
Payment term	13	20	years
Down payment percentage	14	10%	of property value
Down payment		475 000	CZK
Loan		4 275 000	CZK
Real agent commission	15	150 000	CZK, assuming house will be sold
<i>Yearly payments (owning home)</i>			
Home insurance	16	9 500	0,20% use 0,2% of property value
Personal insurance	17	23 750	0,50% use 0,5% of property value
Property tax	18	950	0,02% use 0,02% of property value
Maintenance	19	23 750	1% use 1% of property value
Revaluation factor	20	5%	increase value of property/year
Bank Savings interest rate	21	0,25%	Standard saving account
Rent (CZK/month)	22	15 000	for comparative purposes
<i>Only for your information</i>			
Mortgage monthly payment	23	22 633	
Monthly extra payments		4 829	
Planned monthly rent		15 000	
Available for investing		12 462	monthly, or
Available for investing		149 540	yearly

Source: Own construction

The tool is divided into three main parts. Two sections where data input exists are the investment part in left side of the screen, that consist of a selection of stocks and funds, and a second part, in the right side, for mortgage information (user inputs are shaded in gray). The selection of funds and stock has been limited in this development, but it can include as many funds/stocks as worksheets Excel may have (and this is limited by the computer

memory). The last part is the informative section (green and orange for results and additional information, respectively).

The gains (or losses) of the funds are projected using the Exponential Smoothing prediction (imbedded in Excel commands named Forecast.ETS and Forecast.ETS.ConfInt, for mean and standard deviation predictions, respectively). A short explanation of ETS function is given in Appendix. In Excel, this function needs the time and value array of the stock or portfolio funds, and the date for which the forecast needs to be made, which is given by the user.

Mortgage calculations are also Excel functions based on loan payment based on compound interest (also explained in Appendix). It is assumed that with every principal payment made, the user already owns this additional fraction of the dwelling, which can be also revaluating (or devaluating) with time. It is also assumed that dwelling-related payments are part of expenses (such as home and personal insurance, property tax and general maintenance costs), and therefore deducted from the net gains. Costs that are incurred both in renting and owning are excluded (heating, electricity, internet), since as for simplicity, it is assumed the same value for both scenarios (renting vs owning).

3.2.2 Data Input

Using red labels in Figure 8 as a guide for the different variables, the user inputs and receive the following information:

1. Name of the scenario: Name of the file under which the desired scenario is saved.
2. Monthly amount user is willing to invest in a portfolio of bonds and stocks; in 2a, Maturity Date is set, as the number of years and months for which mortgage and investment is calculated; after that period, house is sold, and investments are capitalized. As long-term extrapolation may give highly unrealistic results, a limit of 5 years forecasting is set.
3. Extraordinary (annual figure) amount to invest, in case this is possible.
4. Stock Proportion: the amount of money given to the stocks that the user will give to the portfolio, this proportion should not be greater than 100%, and the sum of the stock and fund's portfolio should not exceed 100%. Taxes and agent's commission are also included, and these are applied only in case of gains.

5. Funds Proportion: the amount of money given to the funds that the user will give to the portfolio. this proportion should not be greater than 100%, and the sum of the stock and fund's portfolio should not exceed 100%. Taxes and agent's commission are also included, and these are applied only in case of gains.
6. Confidence Interval: the confidence interval is the percentage of the normal curve that the user will choose for the calculation of the portfolio forecasting, the higher the percentage, the broader the probabilities. As default, 95% is used.
7. Informative values: Two indices (Beta and Sharpe) are included for calculating the volatility, risk and returns when compared to reference indices. In this case, the Nasdaq index is used as a reference. This is intended for the more experienced user, to help assess the portfolio performance, and it is calculated based on past portfolio performance.
8. The investment portfolio: the result of the forecasting is presented here.
9. Expected Value: The expected value of the property, calculated via the revaluation factor and the value of the property that correspond to the user after selling it (bank is returned the capital costs not paid yet). Bank rate is specified in field 21.
10. Saving Account of the Bank: As a reference, the value of the money saved for investment if it were placed on a standard saving bank account.
 - Fields 11-15 are data inputs for the mortgage calculations (value of property, down payment, mortgage interest rate, payment term, etc.)
 - Fields 16-19 are data inputs for the homeowner expenses expressed as percentage of home value and includes suggested values for it as these are not commonly used values.
20. Revaluation factor: This allows the user to include a value for the revaluation factor for the owned dwelling, calculated yearly. This is used for the scenario where the owner sells the house at the end of maturity term.
22. Rent: Used only for calculating next field – amount of money the user pays in rent.
23. Informative data: Shows the difference between paying rent and mortgage payment. This is to provide some backgroun on what could be the available money for investment.

3.3 Calculation Procedure.

Once user fills in the data, VBA macros developed in this project makes the comparative calculations for the scenarios of renting + investment and for paying a mortgage + selling house at end of investment term. This takes a couple of seconds in any standard laptop.

3.3.1 Portfolio Data

As first step, data from past performance of library of funds and stocks are gathered. To properly calculate volatility, all funds and stocks have values over the same period, covering the last 10 years, on a daily basis. When data is missing (due for example to a bank holiday) linear interpolation is used using the two closest data points. This needs to be done only when new portfolio options are added.

For routine calculations, once user click “Start calculation!” button, first results fields (8-10, in green) are cleared. Then, two routines are called – Invest and Mortgage.

3.3.2 “Invest” subroutine

A 3-d matrix named Portfolio is used to store the cash flow of each of the investment options selected - first dimension is for time, second dimension is for values for portfolio (max investment, min investment, average, year, and month, etc.), and third is for each investment option selected. Data for each investment options are stored in a 2-d matrix called Stocks (first dimension is the investment option, and second are the relevant values, like name, percentage of option in portfolio, and vector values for time and investment). Here, advantage of the “Variant” data type in VBA Excel is used, that allows to define different data types for each of the columns and rows of a multidimensional array. Each investment option has a separated Excel sheet with all the related information, including the average expected return, and the covariance vs the Nasdaq reference index (also included as an Excel sheet).

Once these are loaded, calculations for volatility and risk are done. Beta index, a measure of portfolio volatility compared to a market reference (in this case Nasdaq) is calculated as (Investopedia, 2022):

$$\beta = \sum_{i=1}^n w_i * \frac{Covar(i, Nasdaq)}{Var(Nasdaq)} \quad (1)$$

where n is the number of instruments in portfolio, and w is the weight of each instrument in portfolio. Volatility is calculated for the portfolio as: (Riskprep, 2021)

$$Vol = [W]^T[C][W] \quad (2)$$

where W is the vector of weights in portfolio, and C is the covariance matrix of each investment with the Nasdaq option. Another portfolio information provided is the Sharpe index, which is a measure of the investment return relative to the risk taken in the portfolio is calculated as: (Corporate Finance Institute, 2022)

$$S = \frac{(R_x - R_f)}{Vol} \quad (3)$$

where R_x is the expected return of investment and R_f is the risk-free rate or return.

These values are displayed in the informative section (Field 7), and then a loop is made per every month in the investment term to create a cash flow, using the Forecast.ETS forecasting tool available in Excel. This method, and its Excel implementation function have been used in several research areas, including stock predictions (Dritaski, M & Dritaski, C, 2021)

Three cash flow scenarios are created: one for the average and other two for the maximum and minimum return using the confidence interval defined and the Forecast.ETS.ConfInt function. Here is also calculated the bank saving account return by creating an additional cashflow only with the planned investment money (Fields 1 and 2) and using present and future value concepts (in Excel, using NPV and FV functions). As options are to be compared at the end of the investment term, the future value of the cashflow saved is needed, but Excel only calculates NPV of a cashflow vector, so first and NPV value is calculated for the cashflow and then, this NPV value is calculated as FV.

3.3.3 “Mortgage” Subroutine.

This subroutine is simpler than the previous one, as it makes use of the mortgage payment calculations to determine the cashflow of capital and interest payments. Three Excel functions are used: PMT, PPMT, and IPMT, which are, respectively, the total payment, capital fraction payment and interest fraction payment for the given period under analysis.

The total payment and the interest fraction, PMT and IPMT, are calculated as (Expert Exchange, 2002):

$$PMT = \frac{(P)(r)}{(1 - (1 + r)^{-n})} \quad (4)$$

$$IPMT = r \left[\frac{PMT[(1 + r)^{(i-1)} - 1]}{r} + P(1 + r)^{(i-1)} \right] \quad (5)$$

where P is the loan value, r the monthly interest rate, n is the number of payment periods, and i is the current payment period. It easily follows that $PPMT = PMT - IPMT$.

For this comparative analysis, it is assumed that the owner of the dwelling will be able to receive the following if the dwelling is sold:

- The capital cost payments made so far (new owner will cover for the remaining capital cost at moment of purchase).
- The down payment made (at future value, using savings account interest rate).
- The revaluation value of the dwelling (excluding down payment and capital costs).

3.3.4 Auxiliary Routines.

There is possibility to save the scenario in a pdf file (a screen copy of the scenario calculated), using the “Save Scenario”. This makes use of the print-to-file routines of Excel. In the previous routines there are checks for mistakes. Also, in selected field values, user can get a brief explanation by passing the mouse over it.

3.4 Explanation of the Tool – Graphical Example

The Novák family has a monthly joint net income of 85.000 CZK, and they are living on a rented apartment paying 18.000 CZK per month. They are considering investing into a same-size dwelling which cost approximately 5.000.000 CZK; they have saved around 20% of the property value, enough for a down payment; and they want to repay the mortgage in 30 years. The mortgage monthly payments, calculated with a 3,75% interest rate, are approximately 18.500 CZK. The tool shows that they should expect extra monthly payments due to insurance, maintenance and taxes of approximately 2.000 CZK, for a total of 22.500 CZK,

some 2.500 CZK above what they are paying now for rent; they are also considering they can save additionally 15.000 CZK per year and make monthly investment payments of 5.000 CZK. On the other hand, they are expecting an average 10% revaluation of the dwelling per year. The question is whether it is worth waiting some time (in this case 3,5 years) and invest the difference and the additional savings and then reconsider the home purchase – they believe interest rate may come down vs buying a dwelling now and selling later for a profit. A portfolio of stocks and funds are selected with a proportion of 65:35. The input data in the tool is shown in Figure 9.

Figure 9. Input data for Novák's case.

INVESTMENTS			
<i>Portfolio</i>			
Monthly amount to invest	2	5 500	CZK
Extraordinary yearly investment	3	15 000	CZK
Yearly investment		81 000	CZK
Stocks proportion	4	65	%
Funds proportion	5	35	%
List of stocks	Proportion		
Apple	4a	35	%
ActivisionBlizzard	4b	30	%
	4c		%
	4d		%
Taxes on stocks	4e	5	%
Commission on stocks	4f	0,5	%
List of funds			
KBC Bonds High Interest	5a	10	%
KBC Renta Dollarenta	5b	10	%
CSOB Bohatstvi	5c	15	%
	5d		%
Taxes on funds	5e	5	%
Commission on funds	5f	0,5	%
Confidence Interval (1-99%)	6	95	%
Informative - volatility	7		
Risk-free rate		1	%
Volatility		38,1	%
Beta index		3,32	
Sharpe index		1,28	

MORTGAGE			
<i>Mortgage information</i>			
Value of property	11	5 000 000	CZK
Mortgage interest rate	12	3,75%	
Payment term	13	30	years
Down payment percentage	14	20%	of property value
Down payment		1 000 000	CZK
Loan		4 000 000	CZK
Real agent commission	15	150 000	CZK, assuming house will be sold
Yearly payments (owning home)			
Home insurance	16	5 000	0,10% use 0,1% of property value
Personal insurance	17	5 000	0,10% use 0,1% of property value
Property tax	18	1 000	0,02% use 0,02% of property value
Maintenance	19	12 500	0,25% use 0,25% of property value
Revaluation factor	20	10%	increase value of property/year
Bank Savings interest rate	21	0,25%	Standard saving account
Rent (CZK/month)	22	18 000	for comparative purposes

Only for your information	
Mortgage monthly payment	18 525
Monthly extra payments	1 958
Planned monthly rent	18 000
Available for investing	2 483 monthly, or
Available for investing	yearly

Source: Own construction.

It is important to notice that the mortgage payments appear only after the calculation button is pressed. The results are shown in Figure 10, for the investment analysis and with the more specialized information about the investment volatility and risk. They show that investment is more volatile than the reference Nasdaq index, but the Sharpe index value shows that return is worth the risk.

Figure 10. Simulation results for the Novák's case.

RESULTS		
<i>At the end of the maturity date, expect:</i>		
<u>Investment Portfolio (including capital and profits)</u>		
Average Value 8a		301 783
Variability		
Minimum Value 8b		140 671
Maximum Value 8c		373 154
<u>Mortgage Results</u>		
Selling the dwelling		
Expected value 9 -		11 860
<u>Keeping investment in Bank</u>		
Savings Account in Bank 10		277 207
(for reference)		

Source: Own construction.

In this case, after 3,5 years, they would have gotten in average 300.000 CZK between capital invested and profits (field 8a). But it is also possible to lose some of the capital in the stock market (field 8b). If they have chosen to buy a dwelling and sell it, they will lose near 12.000 CZK after all the commission and taxes, mainly due to the high interest rate that makes capital recovery slow; also, revaluation factor seems not big enough. So, it seems that investing the money in the stock market could be an option to increase their patrimony.

3.5 Effect of Variables

Besides the obvious considerations, such as the more money invested, the more returns, there are some interesting behaviors found when playing with certain variables of the model, particularly with mortgage variables. They are highlighted in the following sections.

3.5.1 Revaluation Factor

This is possibly the factor that can change more dramatically the results. If a valuable dwelling can increase 15%, 20% or more the price per year, results can change from “better invest” to “better buy”. Referring to Figure 6, and getting the increase percentage of the price per sq.m. of dwellings in the Czech Republic, an approximate 13% per year increase can be estimated. Also, by using data from tradingeconomics.com site (Trading Economics, 2021), the house price index increases for years 2019 to 2021 were approximately 15% per year. Of

course, this is an average and variations are to be expected depending on region, type of dwelling, location, age, etc.

Table 2. Effect of Revaluation factor - Novak's case.

Reval. Factor	Portfolio return (ave)	Bank savings account	Dwelling sell price	Decision
0%	301.783	277.207	-458.622	Invest
5%	301.783	277.207	-235.241	Invest
10%	301.783	277.207	-11.860	Invest
15%	301.783	277.207	211.521	Invest
20%	301.783	277.207	434.902	Buy dwelling

Source: Own construction. All other values similar to example.

If the revaluation value keeps around 15% per year, the option of buying a dwelling and later selling it, looks better than investing (using the proposed portfolio). If not, investing may look a better decision. So, one of the key variables to consider when facing the renting versus buying decision, is the revaluation factor of the dwelling.

3.5.2 Mortgage Interest Rate and Term for Payment.

As model considers selling the dwelling after the term period, recovering the capital paid and the increased value of the house, a very high interest rate makes the capital payments lower and therefore the value recovered after selling lower. Same consideration is made for the term payment. The longer the term, the more interest paid, and less capital payment, particularly at the beginning of the re-payment.

Table 3 shows the results and the impact on decision.

Table 3. Effect of mortgage rate and term period - Novak's case.

Mortgage int. rate	Term period	Portfolio return (ave)	Bank savings account	Dwelling sell price	Decision
2,5%	20	301.783	277.207	414.380	Buy dwelling
2,5%	30	301.783	277.207	193.752	Invest
3,75%	20	301.783	277.207	209.408	Invest
3,75%	30	301.783	277.207	-11.860	Invest
5,0%	20	301.783	277.207	6.667	Invest
5,0%	30	301.783	277.207	-212.079	Invest

Source: Own construction. All other values similar to example.

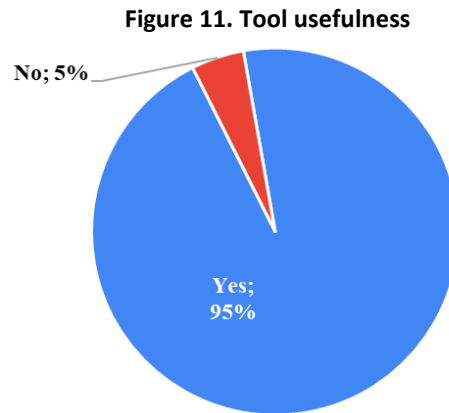
3.6 Survey of Tool

A survey of the tool was made available in Google Surveys (<https://surveys.google.com/>), and published in social sites, sent via email, or directly asked persons for considering renting/buying a dwelling to read a brief explanation, evaluate the tool and fill the survey. In total, there were 43 answers. The questions covered the following topics:

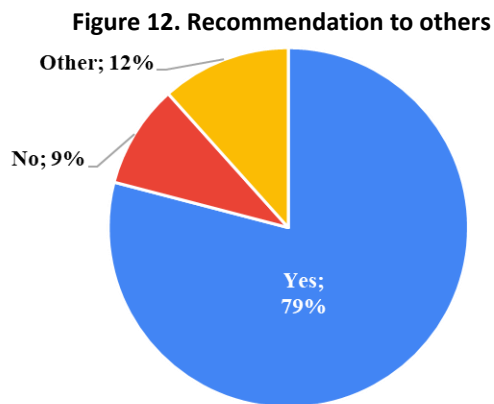
1. Tool usefulness – how easy it was for the person to use the tool.
2. Results usefulness – how useful are results provided by the tool.
3. Accuracy of results – how accurate the user believes the results are.
4. Report – How realistic the report is
5. Whether tool can be recommended to others
6. Likelihood of making an investment / getting a mortgage
7. Changes proposed to improve the tool.
8. Whether the doubts of user were clarified.
9. Current profession.

Questions 1 and 5 were yes/no questions. Question 5 allow for a “maybe” answer where user can comment on conditions for recommendations. Questions 2, 3, 4 and 6 are multiple choice, being 1 the lowest possible score and 5 the highest. The other questions are to be filled by the user. 25% of respondent were students, being this the majority of professions chosen.

The tool was considered useful by vast majority of respondents (95%, see Figure 11). The respondents that considered the tool not useful commented that they do not know much about the topic and that it is very technical.



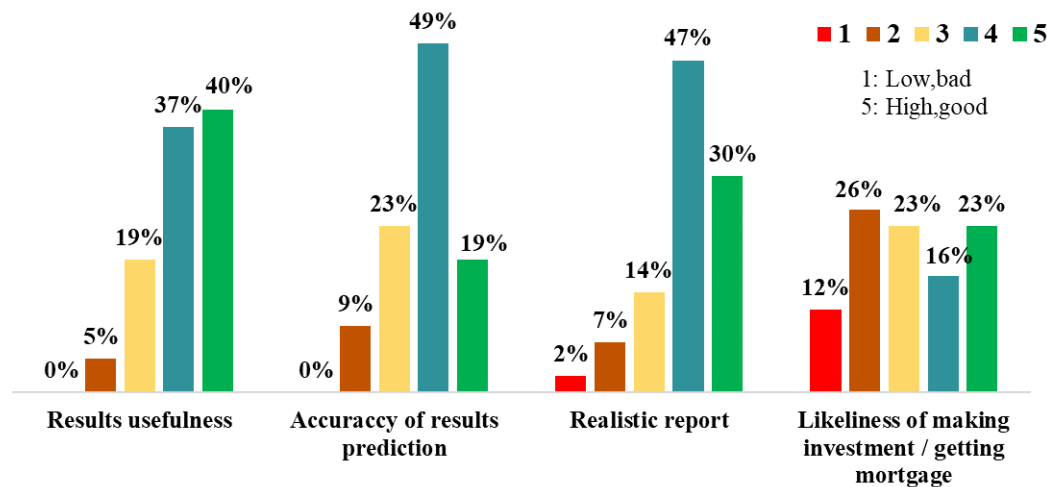
In a similar way, many surveyed people would recommend the tool to friends and relatives (Figure 12). As expected, those that found the tool not useful, also consider it not for recommendation. Other people asked for the need to export the data. Those who selected “maybe” commented that recommendation will be done only to people considering investment or mortgages, or that tool is very specific to this topic.



In Figure 13 it is presented a summary of tool evaluation. Evaluations of 4 and 5 are considered an approved qualification. 77% of people found the results useful; this is considered a good sign that the tool can provide relevant information to intended audience. 68% of respondents considered the results to be accurate; comparing it to usefulness answers, it is a lower number and more biased to lower evaluation (more “4s” than “5s”). Under the current volatile scenarios (post-Covid, Ukraine invasion, high inflation) it is still considered

positive. 77% considered the report realistic, in a proportion similar to the accuracy question. As expected, the respondents are not expecting to make investment or loan decisions soon – only 39% responded positively to this answer, 38% answered as “unlikely” or “very unlikely”.

Figure 13. Tool performance evaluation



In the open questions, the most relevant comments to the tool being able to answer to respondents' doubts, which can be pointed in the direction of improvement are:

- Need for more user-friendliness
- Use of other currencies
- Include more details (no specifics given)

Finally, to the question of what should be changed to improve this tool, the most relevant answers were:

- Improve the user interface (also commented as user-friendliness, interface, UI, or the “front-end” by some). This was, by far, the most common answer.
- Better explanation on how to use it (variable definition, data that can be used, procedure explanation, how to enter the data).
- In a couple of cases, color selection and buttons shape, and more options for stocks and mortgages.

4 Conclusions and Recommendations

4.1 Conclusions

To help answering the dilemma of many young professionals about investment decisions between money markets or dwellings, a simple-to-use tool was developed using common spreadsheets programs and their programming language to analyze the options between creating an investment portfolio or buying a property, during a small to medium term (maximum 5 years). The tools used are included in the spreadsheet program and have been also used in other areas for making forecasting.

The tool is based on forecasting scenarios that assume a relatively stable economic environment. As a key feature, design was made with simplicity in mind and intended for people with general knowledge about finances. Use of imbedded Excel forecasting tools helped to keep an easy-to-use interface for the user. Events like recent pandemic and war in nearby Ukraine makes predictions more difficult, but this limitation is present in even the most advanced predictive tools.

It was found that the interest rate, term payment and mainly dwelling revaluation are factors that can change decision from renting/investment to buying a dwelling. With the current lag between salary growth and dwelling costs growth, plus the increasing interest rate for mortgages, use of this tool can help supporting a mid-term decision on buying or not a dwelling, while at the same time providing investment scenarios that allows people to cope with increasing inflation rates. This was validated by a survey of potential users, who gave, in 70% or more of the cases, a positive evaluation of the various aspects of the tool. This survey also helped to obtain feedback on improvements for future work.

4.2 Recommendations

The feedback from people surveyed who use the tool provide a basis for making recommendations for tool improvement. In addition, during tool development, some potential improvements were realized; however, implementation of these was beyond the time frame and resources available assigned to this project, and are stated here for future studies on the subject:

- Closed Environment: it means that the tool works on the data that has been obtained up to a certain time. An interesting addition could be the automatic update of bonds and stock market data, using cloud services (within Microsoft environment: Azure, Power BI and others).
- Use down payments savings in investment environment: Currently, the program assumes that down payment is money saved in bank for the sole purpose of buying a house. A riskier person may want to evaluate the scenario of investing part or whole down payment (if already saved). This could be added as an extra input in the investment part – now has only monthly and yearly investments.
- UI (User Interface) is how the user interacts and sees upon opening the tool. In the survey for tool evaluation there were included some comments such as:
 - Adding more information about the variables and user inputs.
 - Offer the opportunity to select the mortgage structure before going into the calculation section (user can currently run scenarios based only on mortgage variables)
 - Improvement of aesthetics – this can be done using VBA UserForms to make the data input in a more friendly fashion
 - Develop the tool for other spreadsheets programs (like Google sheets)
- Include options for more stocks and funds, beyond the four each currently selected, which was done for demonstrative purposes.
- Currency: the tool was developed initially for the Czech housing/investment market, and therefore, the default currency is the Czech koruna, but may include the most used currencies, which can be made in future versions of the program.
- Help section and tool explanations: also based on respondent suggestions, it would be a good addition an extensive help section, with detailed explanation on how to use the tool.

5 Summary

This thesis presents an investment decision tool, allowing to select the best strategy for maximizing their resources, when young people in the Czech Republic are faced with the dilemma of buying a house or living via rent and making an investment with a possible extra money they have. Nowadays, the housing market might be too expensive for the common people. Based on national average dwelling prices and average income, saving for the down payment might take several years. Also, the mortgage monthly payments can take a sizable part of a person income.

The tool is written in Microsoft Excel[®] using VBA programming language to predict investments portfolios return and compare it to a hypothetical mortgage. Several scenarios can be saved for further analysis and the tool has the possibility to include further investment options and prediction techniques. Several examples are given to show the utility as well as a survey of potential users that have evaluated this tool.

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7 Appendix

7.1 Exponential Smoothing & Forecasting

When forecasting time series data, the aim is to estimate how a sequence of observations will continue, in this case, how a stock or an investment fund. The general form of the prediction is³⁰:

$$x_{t+1} = f(x_t, x_{t-1}, x_{t-2}, x_{t-3}, \dots) \quad (6)$$

In this case, it is assumed that the future behavior can be solely described by the past behavior. This is not usually true, but it could be a good assumption if enough data is available. For example, predicting yearly wheat production in a given area can be estimated from earlier productions, but it also be a function of rain fallen in the year under study. But if enough data is available, effects of rainy and dry years will be also included.

Most methods are based on a series of observations at equally spaced time intervals (days, months, years). In this work, data is collected daily. For weekends and holidays, a linear interpolation between the two adjacent data is used.

The simplest method is called the moving average, in which the next time in series is predicted as the simple average of a certain set of immediately previous data (5, 7, 11, for example). Thus:

$$x_{t+1} = \frac{\sum_{i=t-k}^n x}{k} \quad (7)$$

A method to improve the prediction is to add weights to the previous data. One can weight more the most recent data and less the older ones.

$$x_{t+1} = \frac{\sum_{i=t-k}^t c_i x}{k}; \quad (8)$$
$$\sum_{i=1}^k c_i = 1$$

Exponential smoothing is a special type of function to smooth time series by a special weighting function, with the weights decaying exponentially as the observations get older. The simplest method for exponential smoothing is the single exponential smoothing (SES). The forecasted values are predicted as:

$$x_{t+1} = \alpha x_t + \alpha(1 - \alpha)x_{t-1} + \alpha(1 - \alpha)^2 x_{t-2} + \dots, \quad 0 \leq \alpha \leq 1 \quad (9)$$

How the weights change is controlled by the parameter α . As the weights decrease exponentially as the observations is older, the name is then appropriately given as “exponential smoothing”. The above equation can be decomposed into a “forecast equation” and a “smoothing equation”:

$$\begin{aligned} x_{t+1} &= l_t \\ l_t &= \alpha x_t + (1 - \alpha)l_{t-1} \end{aligned} \quad (10)$$

When a trend is found in the data, the simple exponential smoothing can be extended to include it. The above equation becomes:

$$\begin{aligned} x_{t+h} &= l_t + hb_t \\ l_t &= \alpha x_t + (1 - \alpha)(l_{t-1} + b_{t-1}) \\ b_t &= \beta(l_t - l_{t-1}) + (1 - \beta)b_{t-1} \end{aligned} \quad (11)$$

Where l denotes estimate for the level of series data, b denotes an estimate of the slope, and β is the smoothing parameter for the trend, h is the number of steps ahead to be predicted. The proper choice of the smoothing parameters and the initial values for l and b can be done with the known data – the procedure of doing so is well beyond the scope of the present work. Methods like this are known as double exponential smoothing.

Finally, when seasonality is involved, a third smoothing equation can be included to capture the seasonal part, usually named s . The new smoothing parameter is γ , and the value m denote

the number of “seasons” in the period, usually considered a year. With $m=4$, data is quarterly seasoned, $m=12$ is monthly. As there are three components of the forecast equation, this method is known as the “exponential triple smoothing” or ETS. There are many variations of this method, and Excel implemented the additive version of it, which can be expressed as:

$$\begin{aligned}
 x_{t+h} &= l_t + hb_t + s_{t+h-m(k+1)} \\
 k &= \text{int}\left(\frac{h-1}{m}\right) \\
 l_t &= \alpha(x_t - s_{t-m}) + (1 - \alpha)(l_{t-1} + b_{t-1}) \\
 b_t &= \beta(l_t - l_{t-1}) + (1 - \beta)b_{t-1} \\
 s_t &= \gamma(x_t - l_{t-1} - b_{t-1}) + (1 - \gamma)s_{t-m}
 \end{aligned} \tag{12}$$

The Holt-Winters’ method is used quite often for predicting future values of time series values, including stocks and investment tools. In Excel, optimization of the smoothing parameters α , β , and γ is done internally in the program by minimizing the prediction error with the available data using the “Solver” tool.

In addition to Excel, the R statistical package includes a subroutine for public use. Sharaff and Choudhary³², included Holt-Winters’ among several comparative tools for stock market predictions, including neural networks; according to authors, “it has outperformed many other models in the domain in prediction”, although the authors find neural network models performing better in terms of error. Sen and Datta³³ used Holt-Winters method to study the auto sector in India in the individual components of forecast, trend, and seasonality. Dritsaki and Dritsaki³⁴ used Holt-Winters to predict GDP growth in five Balkan states, in a mode like the one used in this work. Mgale et al.³⁵ used it to forecast rice price in Tanzania; Makatjane and Moroke³⁶ also used this method to predict short-term car sales in South Africa. Finally, Manoj and Dholakia³⁷ used Excel version of Holt-Winters to predict temperature variations in India.

7.2 Forecast.ETS Method in Excel

This latter method has been implemented as a “black box” in Excel through the function FORECAST.ETS (*x, R1, R2, seasonality, missing, aggregation*):

- *x* is the time value in the future to be forecasted.
- *R1* is a vector that contains the observed data values (also called historical values) and *R2* is a vector that contains the time values
- *seasonality* takes the value 1 for no seasonality, 4 for quarterly, 12 for monthly, etc. The value 0 means that Excel will choose the value for itself.
- *missing* takes the value 0 or 1, where 0 means that any missing data values in the time sequence are replaced by the value 0, where 1 (default) means that any missing data values are determined using linear interpolation – this is not the case in the present work
- *aggregation* is used when range *R2* contains elements with the same value, and to determine how they will be treated – this is not the case in the present work.

In Excel’s help or in specialized webpages, there is no information available on how parameters or calculation is made for this function (see, for example, <https://www.real-statistics.com/time-series-analysis/basic-time-series-forecasting/excel-2016-forecasting-functions/>).

7.3 Survey Data

The tool was sent or shown with the following introductory note:

“This tool allows people to predict, or give an estimate, of scenarios for investment or mortgages for people to help deciding between one or another (or both if there is enough money). Although intended for young people, it can work for anyone. The idea is to help decide between investing none/little and buying a house or living by rent (cheaper) and invest some more. What is more reasonable? – this is the target. Please play with tool for a while and then fill in the below survey.

How to use it?

1. Make sure Macros are enabled in Excel (you should see a yellow label in the top part in Excel). It will not run without macros enabled
2. Fill only the gray areas. Orange cells are informative, results are in green area. Yellow is for future development, does not work.

3. Left side (investment) allows you to create an investment portfolio with stocks and funds. Make sure that the ratio between stocks and funds is kept (if you choose 70% of stocks, the sum of stocks in list of stocks should add to 70%, and so on. You can place any amount you consider there, even zero. As a reference, taxes are 10% and commissions are around 1%. In confidence interval, common number is 95%, others are 99% or 90%. The higher the confidence interval, the higher the spread between max and min on the return in green area.
4. Right side (mortgage) is the common info for a mortgage + house/flat maintenance – fill in as you consider. The real estate agent commission is usually between 100 k – 300 k CZK. It is important to place a re-evaluation factor, which is how much the property will gain value every year. If you choose a 1,000,000 CZK property and 10% revaluation factor, it means that after 1st year you will be able to sell the house for 1,100,000 CZK and so on. Please also include the estimated bank savings account (standard savings), and the rent you are willing to pay
5. The third step is to set the period for analysis in years & months. Please note that year count start in zero (like a newborn baby). Based on the quality of prediction tool developed, please do not exceed 5 years, and please do not choose less than 1 year.
6. Once completed, green zone will be updated. The best option is the one with the highest value (sell the house, expected value, portfolio, average return, and savings in bank. Repeat the steps as many times as you want.
7. Please fill survey. Although it will name your email there, it will be only to avoid duplicate answers, as required; I promise your data will not be shared at all. All data will be erased fully by the end of summer, once thesis is approved (hopefully!). Please be honest and give a fair impression.”

Responses were compiled by Google Sheets software in .csv format (except for the email data due to privacy reasons). This was then processed in Excel.