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DESIGNING A NEW DERIVATION OF THE SUBJECTIVE DISCOUNT RATE AND ITS APPLICATION IN THE CZECH REPUBLIC

Abstract:

The paper deals with the derivation of the subjective discount rate and for this purpose; it introduces a new subjective discount index: Current Discount Index (CDI). The author assumes a very close relationship with the commonly known subjective discount rate (ρ). CDI is derived indirectly from the ratio of loans to deposits of households. New index is considered the aggregate variable of the subjective discount rate (ρ), of the elasticity of intertemporal substitution (1/θ) and also other unspecified psychological factors (ξ). The values of CDI in the Czech Republic suggest reasons why there was a long-term decline in household consumption during the years 2012 and 2013.

Keywords:

Subjective discount rate, subjective discount factor, consumption of households, intertemporal choice, current discount index

JEL Classification: E21, D91

1 Introduction

*"*Intertemporal choice became firmly established as a distinct topic in 1834 with John Rae's publication of *The Sociological Theory of Capital"*(Frederic, Loewenstein, O'Donoghue, 2002). Rae (1834) considered the missing element in intertemporal decision making as "psychological motives", respectively soft factors which are commonly known as *subjective discount rate (ρ)* or *elasticity of intertemporal substitution (1/θ).*

The *subjective discount rate (ρ)*, or the *rate of time preference (τ = 1+ρ)* and the consequently derived the *subjective discount factor (β)*[1] is one of the topics that are often the subject of empirical analyses or theoretical models[2]. Currently in Europe, there is a certain phenomenon that reflects the economic and political events of the last decade. Explaining the consumer behaviour and subsequently setting the monetary policy on its grounds is not an easy task.

Across Europe, consumers have behaved more responsibly after the economic crisis of 2008-2009. For example ING Bank's market research shows that the expenditures of consumers have changed their structure (they spend less money on leisure and vacation) after the economic recession.

The ING study suggests that consumer behaviour has changed significantly, but nevertheless the central bank, in an attempt to revive the GDP growth and household consumption, performs a standard action of the monetary policy (reducing interest rates, interventions using foreign exchange reserves, etc.). We tend, however, to believe that the economic environment has changed due to the recent financial and economic recession so greatly that the current macroeconomic paradigms inadequately describe and reflect the current political and socio-economic structure. This reduces the efficiency of the conventional tools of monetary policy in relation to the behaviour of households.

Household debt grew faster than household deposits in the Czech Republic before the recession, but after the recession, the situation has changed dramatically. This turnover may be attributed to the increase of mistrust and uncertainty of future, threats of further economic recession and other changes in the political environment. All these factors serve as a response to strong and negative experiences from the last economic recession.

Economic theory uses the intertemporal *subjective discount factor (β)*, or the *subjective discount rate (ρ)* to reflect the agent's patience in relation to current and future utility. The *subjective discount factor (β)* can be used within many economic and social cases. For example, we could mention the environmental issues and the relationship of the current population to future population in terms of natural

[1] $\beta = 1/\tau = 1/(1+\rho)$

[2] We can find many papers or articles about subjective discounting – for example in the Google: more over 200 000 links to this topic and from that more over 45 000 link to research papers.

resources. Stern (2006), Cline (2008), Shah (2008), Heal (2008) use the discount factor in relation to climate change. We can also mention some inter-temporal models of consumption: “Overlapping generation model”, “Koopmans-Cass-Ramsey model” etc.

In the framework of intertemporal analysis there must also be psychological factors that characterise each consumer in relation not only to his impatience in consumption, but also its relationship to the future (fear of the future or vice versa belief in a better future).

I believe that contemporary society lives in a much higher uncertainty after the experience of the economic recession than before 2008. Agents usually have average risk aversion. Hence increase threats in the economic and social environment must necessarily produce a response in the form of increased concerns for the future.

The aim of this paper is not; however, to prove the existence of relationships between environment uncertainty and fear of the future. I only intuitively assume that this is so. My goal is to focus on finding indirect derivation of the general subject discount variable that could be used by policy-makers to select the adequate instruments of monetary or fiscal policy.

Many papers deal with the psychology experiences for derivation of the *subjective discount rate (ρ)* or the *subjective discount factor (β)*. All studies are hypothetical. My aim is indirect derivation of the subjective variable from the aggregate macroeconomic data.

2 Current discount index (CDI)

The reason why I started to deal with the issue of the *subjective discount factor (β)* is the fact that Czech households’ consumption decreased on average of -1.8% per quarter in the years 2012 - 2013, although their deposits in banks grew and although the central bank at the same time eased monetary policy by reducing the interest rates to the historically low level (Discount rate[3] = Lombard rate = 0.05%)

This situation can be explained by changing perception of the future (overly pessimistic perception). Some households have started to realize instability of the environment based on the experience of the economic and financial recession in 2008-2009 and they began to behave more cautiously due to the natural characteristics of man: risk aversion, especially in relation to their debt, which confirms the ING Bank’s study (2014) over Europe, not only in the Czech Republic.

The expected benefit of the *Current Discount Index (CDI)* lies mainly in the fact that, values of CDI could be used for forecasting household consumption several months ahead of the first estimates of consumption by any statistical office.

[3] There is different between *discount rate (i_d)* and *subjective discount rate (ρ)*. *Subjective discount rate (ρ)* is used for intertemporal discounting of utility function of households and *discount rate (i_d)* is used by Central bank as interest rate of deposits of commercial banks.

The statistical data on household consumption are available only quarterly and delayed by almost three months. CDI has the advantage of its continuous monthly monitoring. Therefore, we can indirectly estimate in advance the consumption of households before we have the first direct estimates of that.

CDI represents function of set of indexes:

- ρ_t = subjective discount rate,
- $1/\theta_t$ = elasticity of intertemporal substitution,
- ξ_t = further psychological nonspecific factors,
- $l_t = h_t$ = rate of change population, resp. households.

Hence we can write the *Current Discount index (CDI)* as fiction of the indexes:

$$CDI = F(\rho, \theta, h, \xi)$$

The subject of this paper is not to fully clarify the mutual functional relationship of these indexes. I only assume that these variables affect the final consumption of households.

The first component of the CDI is the *subjective discount rate (ρ)*, which is related to the evaluation of opportunity, or abstinence, whose advocate was N.W. Senior (1836). For example, if we are thirsty: "How much are we willing to pay for it, that we can drink now? What amount of compensation we will ask for your patience in the consumption of drinks when we are thirsty or not?"

The second important element of CDI is the *Elasticity of Intertemporal Substitution (1/θ)* which represents the sensitivity of lognormal of total consumption with respect to the lognormal of the intertemporal changes in expected interest rates (in the literature, it is often abbreviated as EIS): $EIS = -\frac{\partial \log c_t}{\partial r_t}$ (T. F. Crossley, H. W. Low, 2010). The "θ" expresses the *Coefficient of relative risk aversion* ($\theta = -\frac{C_t.u''(C_t)}{u'(C_t)}$*).*

In addition to the purely economic aspects, we can also talk about non-economic influences on consumer behaviour. They can easily be identified and thus quantified. Everyone will probably agree that individual's decisions are influenced by media, uncertainties and associated risks (e.g. increasing the climate threat, the risk of loss of employment, etc.).

Relevant examples include soft factors, i.e. *psychological factors*, which comprise such practices as the level of selfishness, perception of the length of life, suggestibility of fashion fads, risk aversion, suggestibility of opinion based on media, etc. (see I. Fisher, 1907, 1930).

We can also talk about the *sociological factors* related to the possible influence of an individual in relation to group behaviour, such as mass hypnosis, level of socialization, etc.

The legal environment, the social conditions, the functioning labour market, the bureaucracy, the political environment and the perception of corruption, etc. are among the institutional factors (Rae 1834).

A value of *Current discount index (CDI)* represents the final combined effect of these mentioned components that represent shocks on the domestic demand side. In summary, these are exogenous variables depending upon these various factors:

- Economic factors;
- Psychological factors;
- Sociological factors;
- Institutional factors.

I suppose the perception of current and future consumption and its changes is a matter of minutes, hours or days, depending on how quickly and often the above mentioned factors change (e.g. winning the lottery, breaking a leg, loss of job, wage increases, etc.). Therefore, this variable was named the *Current discount index (CDI)*. Also, we cannot assume that the values of CDI are constant over time, or that they have a hyperbolic, exponential or linear form. The value of CDI is changing unpredictably over time on the basis of the above psychological, sociological, economic and institutional shocks and we can only observe the current value of CDI.

2.1 Assumption of derivation of CDI

The underlying idea is that if households prefer current consumption versus future, then the increase of the current consumption will be co-financed by the increase of net disposable income, new loans or reducing savings. The fundamental and important assumption consists in the relationship of consumption of households and their outstanding amount of loans and deposit, which I consider, for the purposes of this paper, to be identical with the savings of households.

The assumption is as follows:

If the amount of loans increases faster than the deposits, the value of subjective discount rate (ρ) is higher than the interest rate (CDI is higher than zero). If the rate of growth of loans and deposits are identical, then the subjective discount rate (ρ) is equal to the interest rate (CDI is equal to zero). The last option is if the outstanding amount of loans is growing slower than the growth rate of deposits, then the subjective discount rate (ρ) is lower than the interest rate (CDI is less than zero).

Similarly, declines may occur - if loans decrease more slowly than deposits, the value of subjective discount rate (ρ) is higher than the interest rate (CDI is higher than zero); if the rate of decline in loans is equal to the rate of decline in deposits, the subjective discount rate (ρ) is equal to the interest rate (CDI is equal to zero), and if the rate of decline in loans is higher than the rate of decline in deposits, the value of subjective discount rate (ρ) is lower than the interest rate (CDI is less than zero).

With these assumptions, we can focus on the credit-deposit differential (i.e. the difference between the amount of loans and deposits of households). The absolute

value of the differential is not insufficiently significant; therefore we observe its dynamics in time, i.e. the first derivative of the ratio of loans to deposits of households.

The *Current Discount Index (CDI)* is derived from the rate of growth of loans and deposits of household. We cannot say that CDI expresses the same value of the *Subjective Discount Rate (ρ)*.

The derivation of the *Current Discount Index (CDI)* is based on the ratio of the absolute value of loans and deposits, expressed in current prices:

$$\alpha_t = \frac{L_t}{D_t} \tag{17}$$

The first derivation of a function $\boldsymbol{\alpha_t = F(L_t, D_t) \equiv \frac{L_t}{D_t}}$ indicates the rate of changes, the differential between the value of loans and deposits of households with respect to the time. The function of the *Current Discount Index (CDI)* in the time series ***CDI = F(α)*** is expressed as the first derivative of the function: $\boldsymbol{\alpha_t = F(L_t, D_t)}$, it can be written as follows:

$$\mathrm{CDI_t} = \frac{\mathrm{d\alpha_t}}{\mathrm{dt}} = \frac{\mathrm{dF(L_t, D_t)}}{\mathrm{dt}} \tag{18}$$

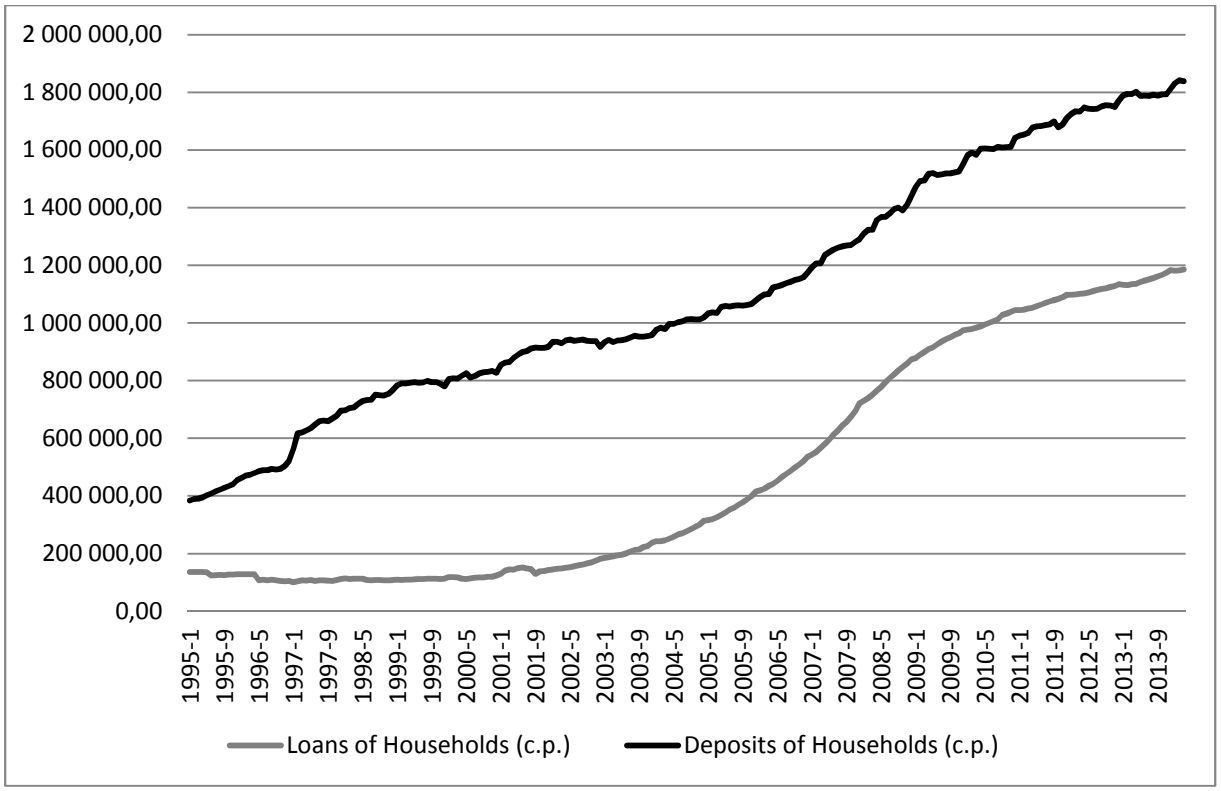
3 Empirical Analysis of Data

3.1 Data for analysis in the Czech Republic

Data that was used to analyse and derive the CDI index was obtained from the Czech National Bank (CNB). Deposits of households are based on CNB statistics: “Households (residents) - Client deposits by time (CZK+FC)”. These are thus demand and term deposits accounts that are held with the commercial banks (demand, short-term, medium-term and long-term deposits).

The Czech National Bank has been monitoring these values since 1993. For the purposes of analysis were used data from 1995 to 2014/I. Czech households save money into mutual funds significantly less in comparison with German or Austrian households. This is proven by the statistics of international comparison studies such as BVI (German Investment Funds Association), which states that the volume of assets of Czech households in mutual funds was only 428 EUR / person at the end of 2012. For comparison: in Germany 8930 EUR/person, Austria: 9474 EUR/person (source: www.bvi.de, [quoted: 2014-16-05]).

Figure 1: Course of loans and deposits of households (1995 – 2014/I)



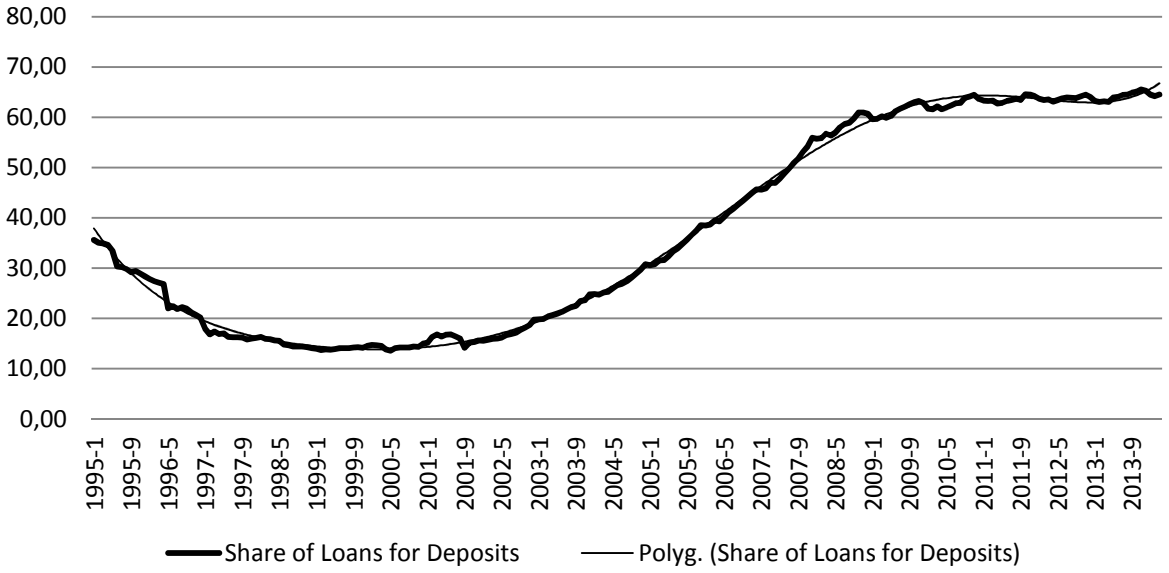
Source: Own adjustment based on CNB data

Loans that were used for the empirical analysis come from the CNB statistics: "Residents - loans to households (incl. NPISHs) - CZK+FC". The data also include the loans of non-profit organisations whose proportion in the total level of loans amount to merely 0.15% to 3.5%, thus having only a negligible effect onto the resulting course of household loans (see Figure 1).

When comparing deposits and loans, we can draw conclusions that over the last almost 20 years, households have behaved differently in various time periods. The key values can be found during the years 2009 - 2014, which clearly show that household deposits were increasing, and loans showed a significantly decreasing rate of growth.

The following **Figure 2** expresses the share of loans to deposits of households and clearly shows that in the years 2001 – 2008, households increased their share of loans to deposits several times. After the economic recession in 2009, the share of loans to deposits levelled off and even showed a slight decline. The bottom of the share was situated in April 2013 (63.0%). It increased to 63.9% in May 2013 and 64.1% in June. This trend was maintained until the end of 2013; the share was 65.3% in December and dropped slightly in January and February 2014 (64.2%, February 2014).

Figure 2: Share of loans to deposits of households (1995 – 2014/I)

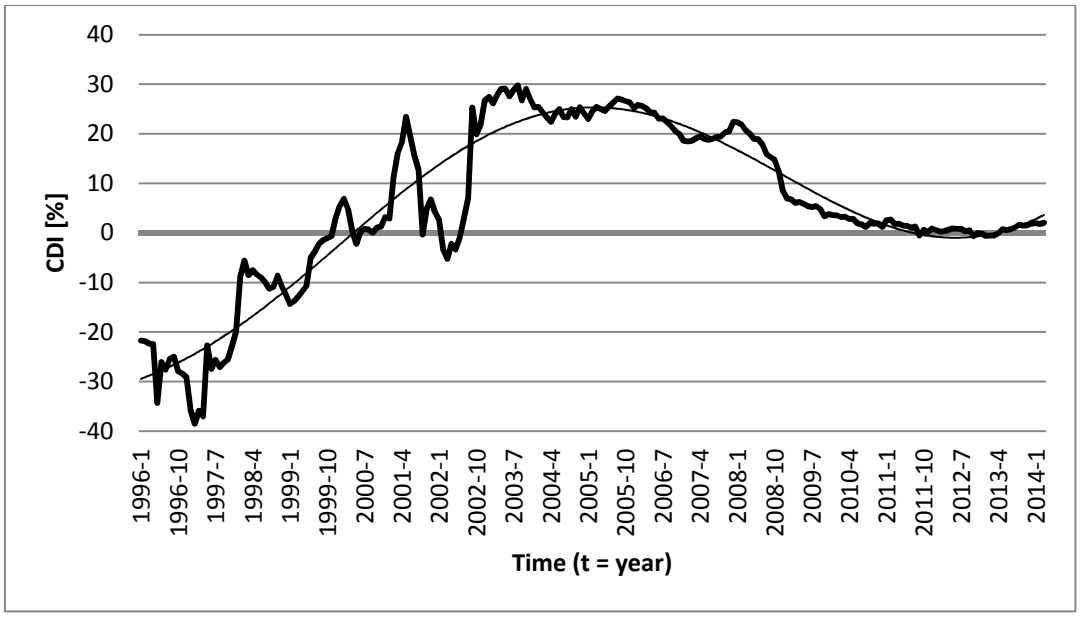


Source: Own adjustment based on CNB data

3.2 CDI in the Czech Republic

Figure 3 shows the course of the current discount indicator for the Czech Republic in the years 1996 - 2013. The course indicates several periods that characterize the general situation in the Czech economy for the last nearly 20 years.

Figure 3: Current Discount index CDI in the Czech Republic (1996 – 2014/03)



Source: Own adjustment based on CNB data

The first substantial period 1996 - 1998 is marked by the transformation process, the economic crisis of 1997 (the value of CDI 04/1997: -37% corresponds to matters in late 1996 and the first half of 1997, when the government pushed through the austerity measures), the value of Current Discount Index (CDI) is further expressed

floods in July 1997 (June-August 1997: -26%). The actual growth in household consumption was only 0.14%.

The situation improved starting from 1998, when the government of Prime Minister Klaus was replaced by the caretaker government of Tosovsky. This second period 1998 – 2002 represents the restructuring period of banks and industry. It brought real consumption growth of 2.41%, which also corresponds to the increasing value of the Current Discount Index CDI.

After these two highly volatile periods came a long stable period 2003 - 2007, in which the willingness of households to debt increased, while also maintaining a high level of consumption. The average annual real growth of household consumption reached 3.96%, driven not only by increasing income but also by an increasing willingness to run into debt.

The fourth period 2008 - 2011 is marked by the economic recession of 2009, which affected consumer behaviour (reduced willingness to run into debt). The average real household consumption growth in this period was only 1.15%.

Although there was a slight economic recovery in 2011, from 2012 to mid-2013 the economy returned again to the recession. This period (from 2012 to 06/2013) was characterised by the growth in savings at the expense of consumption. Consumers increased the deposits in bank accounts, even though interest rates achieved historically lowest levels. The average real decline in household consumption was -1.70%.

The second half of 2013 saw the recovery of the Current Discount Index, which is confirmed by the CSO preliminary statistical data of household consumption. The values of the Current Discount Index serve as a proof of a very cautious growth in the willingness to run into debt in favour of the current consumption. I can say that households remain cautious due to unfavourable information from the labour market.

4 Conclusion

The regression and correlation analysis of the ratio of loans/deposits to the absolute value of household consumption in current prices shows the relation of nearly 93% in the observed period (1998-2013). The analysis confirms the hypothesis that the amount of the loans-deposits differential is related to the level of household consumption, and hence we can use the Current Discount Index (CDI) in intertemporal decision making.

The CDI curve shows the relation of households to the present and the future, after projection of psychological, economic, sociological and institutional factors in their decision making. A simple regression and correlation analysis showed that CDI has no statistically significant relationship with any interest rates (nominal or real).

Therefore, on the basis of CDI design, we may conclude that the final decisions of households are not affected by the current level of the interest rates. Loans and

savings of households are mainly a reflection of their actual needs, psychological factors and uncertainties of perception of the environment.

For these reasons, I believe that there was a decline in the consumption of Czech households in the years 2012-2013 in the context of increasing uncertainties and pressures of governments to save money. It is also due to the earlier threats of financial problems of Greece, Spain and Italy. These circumstances led to excessively pessimistic perception of future by households, showing a decline in their consumption.

5 Resources

CLINE, William R. (2008). Comments on the Stern Review. *Peterson Institute for International Economics* [online].[cit. 2014-01-01]. Dostupné z: http://www.iie.com/publications/papers/paper.cfm?ResearchID=874

CROSSLEY, T. F. and H. W. LOW. (2011). Is the Elasticity of intertemporal substitution constant?. *Journal of the European Economic Association*. 9.1: 87 – 105.

FISHER, Irving. (1907). *The Rate of Interest: Its Nature, Determination and Relation to Economic Phenomena*. 1. vyd. New York: The Macmillan and Company.

FISHER, Irving. (1930). *The Theory of interest*. New York: The Macmillan Company.

FREDERICK, Shane, George LOEWENSTEIN a Ted O'DONOGHUE. (2002). Time Discounting and Time Preference: A Critical Review. *Journal of Economic Literature.* Vol. 40, No. 2, s. 351-401.

HEAL, Geoffrey. (2008). Climate Economics: A Meta-Review and Some Suggestions. *NBER Working Paper*. No. 13927. Dostupné z: http://www2.gsb.columbia.edu/faculty/gheal/EnvironmentalEconomicsPapers/NBER%20Climate%20paper%2090198-w13927.pdf.

MANKIW, N. Gregory, Julio J. ROTEMBERG and Lawrence H. SUMMERS. Intertemporal Substitution in Macroeconomics. *Quarterly Journal of Economics*. 1985, Vol. 100, No. 1, s. 225-251.

RAE, John. (1834). *The Sociological Theory of Capital*. 1. vyd. London: Macmillan and Co., 1905. Reprint originálu 1834.

SENIOR, Nassau W. (1836). *An Outline of the Science of Political Economy*. 1. vyd. New York: Augustus M. Kelley, 1965. Reprint originálu 1836.

SHAH, Nihar Kaushik. (2008). *Climate change and discounting*. Ann Arbor, Dostupné z: http://gradworks.umi.com/33/53/3353210.html. Disertační práce. UNIVERSITY OF CALIFORNIA, BERKELEY. Vedoucí práce Arun Majumdar.

STERN, Nicholas. (2006). The Economics of Climate Change: Executive Summary. *Journal of Corporate Citizenship*. s. 17-18.

Websites, studies and databses:

Study of ING Bank 2014, http://www.ingbank.cz/files/svet-sporeni/ing-bank-svet-sporeni_16_01_2013.pdf [quoted: 2014-16-01].

Czech Statistical Office: www.czso.cz

Czech National Bank: http://www.cnb.cz/docs/ARADY/HTML/index.htm

German Investment Funds Association www.bvi.de [quoted: 2014-16-05]