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Setting the right discount rate for health technology assessment in the Slovak Republic

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Abbreviations and notation

List of abbreviations

AAZ	Agency for Quality and Accreditation in Health Care and Social Welfare
AIDS	Almost Ideal Demand System
AIFA	Agenzia italiana del farmaco (English: Italian Medicines Agency)
AIFP	Asociácia inovatívneho farmaceutického priemyslu (English: Association of the Innovative Pharmaceutical Industry)
AOTMiT	Agencja Oceny Technologii Medycznych I Taryfikacji (English: Agency for Health Technology Assessment and Tariff System)
ATMP	Advanced therapy medicinal product
CADTH	Canadian Agency for Drugs and Technologies in Health
CAR-T	Chimeric antigen receptor T-cell
CEA	Cost-effectiveness analysis
CET	Cost-effectiveness threshold
CUA	Cost-utility analysis
DHSC	Department of Health and Social Care
GDP	Gross domestic product
HAS	Haute Autorité de Santé (English: French National Authority for Health)
HIQA	Health Information and Quality Authority
HTA	Health technology assessment
HRQoL	Health-related quality of life
ICER	Incremental cost-effectiveness ratio
INFARMED	Autoridade Nacional do Medicamento e Produtos de Saude, I.P. (English: National Authority of Medicines and Health Products)
IQWiG	Institut für Qualität und Wirtschaftlichkeit im Gesundheitswesen (English: Institute for Quality and Efficiency in Health Care)
IRD	Inherited retinal disease
MIRI	Ministry of Investments, Regional Development and Informatization of the Slovak Republic
MoH	Ministry of Health of the Slovak Republic
MoF	Ministry of Finance of the Slovak Republic
NICE	National Institute for Health and Care Excellence
NMA	Norwegian Medicines Agency
NBS	Národná banka Slovenska (English: National Bank of Slovakia)
OECD	Organisation for Economic Co-operation and Development
PBAC	Pharmaceutical Benefits Advisory Committee
PHARMAC	Pharmaceutical Management Agency
PTM	Personal taxation model
QALY	Quality-adjusted life year
SDR	Social discount rate
SR	Slovak Republic
SRRI	Social rate of return on investment
SRTP	Social rate of time preference
UK	United Kingdom
XLRP	X-linked retinitis pigmentosa
ZIN	Zorginstituut Nederland (English: National Health Care Institute)

List of notations

r	Social discount rate
r_c	Social rate of time preference for consumption
r_h	Social rate of time preference for health
r_s	Interest rate facing the higher authority which funds healthcare
v	Expected growth rate of the consumption value of health
g_k	Growth rate of the cost-effectiveness threshold
L	Rate of catastrophic risk
δ	Rate of pure time preference
μ	Elasticity of marginal utility of consumption
g	Growth rate of real per capita consumption
ρ	Utility discount rate
$t_{average}$	Average rate of income tax
$t_{marginal}$	Marginal rate of income tax

Executive Summary

Decision makers should consider the value of a new health intervention and especially its costs and health-related effects when deciding whether to make it available to patients. Health interventions such as new medicines produce costs and health-related effects not only in the year they are introduced but in all future years until they are discontinued. Assessing the total value of the intervention therefore requires health technology assessment (HTA) bodies to aggregate costs and effects over time. People generally care less about future outcomes, even when it comes to health-related effects such as improvements in health-related quality of life (HRQoL), so in health economic evaluations, present outcomes are valued more than future outcomes.

The extent to which present outcomes are valued more than future outcomes is represented by the discount rate. This is the rate at which the value of a given cost or health-related benefit e.g., €100 in healthcare costs, is assumed to fall over time. The higher the discount rate, the lower the present value of a given cost or effects and ultimately the less weight they have in the economic evaluation.

The discount rate currently required for costs and effects in official pharmacoeconomic analysis in the Slovak Republic is 5% per year. This is one of the highest discount rates in the world and higher than the rates used in the Czech Republic, Hungary, and the United Kingdom (UK). Moreover, an official calculation used to validate the 5% rate is based on what is now old data and the appropriateness of the data used to estimate one of the key determinants of the discount rate is questionable. These two factors justify new evidence on the appropriate discount rate for health economic evaluation in the Slovak Republic.

In the report we present updated estimates of the social discount rate for the Slovak Republic, with the social discount rate being a common basis for setting a discount rate for the economic evaluation of healthcare programs. Our base case estimates come from estimating the social rate of time preference (SRTP) for consumption using the Ramsey Rule. This is a common and straightforward way of estimating an appropriate social discount rate and makes use of country-specific macroeconomic and demographic data.

Key messages

3.3% per year is a suitable reference-case discount rate for use in the evaluation of public investments: Our estimates suggest that a reference case discount rate of 3.3% per year is more appropriate for economic evaluation of health interventions than the 5% rate currently required by the Ministry of Health of the Slovak Republic for pharmacoeconomic analysis.

We take a common and straightforward approach to estimating the discount rate, the same approach which has been used by the Slovak government: We equate the social discount rate with the SRTP for consumption using the Ramsey Rule, similarly to the Ministry of Informatization, Regional Development and Informatization (MIRI, 2017). This method makes use of country-specific macroeconomic and demographic data.

Consumption growth is a key determinant of the discount rate: The difference between our best estimate and MIRI (2017) is explained by different values for the growth parameter of the Ramsey Rule. We use average growth in real *consumption per capita* (1.75% for 2010-2019) which is much more commonly used in the peer-reviewed literature and economic evaluation guidelines than average growth in *aggregate* real *GDP* (3.3% for 2010-2020) which is used in MIRI (2017).

The COVID-19 pandemic means that data must be carefully selected for estimation of the discount rate: There is uncertainty around our estimates, partly due to impacts of the COVID-19 pandemic, but we have taken appropriate action to address this and estimate a discount rate that applies over the long-term. In particular, we use recent macroeconomic data and consider growth forecasts, given that past data may be misleading for ex-transition economies such as the Slovak Republic (Florio and Sirtori, 2013).

We have taken a conservative approach to estimating an appropriate discount rate for pharmacoeconomic analysis in the Slovak Republic: Specifically, we have ignored two factors which could justify using different discount rates for costs and effects (differential discounting): 1) Growth in the consumption value of health and 2) Growth in the opportunity cost of new health investment[1]. These are rarely considered by HTA agencies, partly due to the difficulty in estimating them empirically. We focus on estimating the SRTP for consumption, the key component of the appropriate discount rate under a welfarist or extra-welfarist perspective.

Recommendations

We also provide a set of recommendations for consideration by the Ministries of Health and Finance, MIRI, and the Statistical Office of the Slovak Republic, which would improve discounting practice in pharmacoeconomic analysis:

> **Recommendation 1:** Lower the reference discount rate for future incremental costs and effects in reference case pharmacoeconomic analysis from 5% to 3.3% per year.
>
> **Recommendation 2:** Explore whether differential discounting is appropriate for either the reference case or sensitivity analysis. This requires evidence on growth in the opportunity cost of new health investment and the consumption value of health over time.
>
> **Recommendation 3:** Update the range for the discount rate for sensitivity analysis in line with the reference case rate. Although the importance of sensitivity analyses for final recommendation and reimbursement decisions can be questioned, rates for sensitivity analyses should be appropriate given the reference case rate. If the reference case rate is lowered, there may be a case for lowering the range required for sensitivity analysis.
>
> **Recommendation 4:** Explore whether it is appropriate to apply a lower discount rate to long-term costs and effects. This would mean replacing the current constant discount rate with a declining discount rate schedule e.g. 3.3% for costs and effects occurring in the first 30 years after introduction and a lower rate for costs and effects occurring after that.
>
> **Recommendation 5:** Ensure the discount rate and discounting method in the healthcare sector is consistent with other public sectors such as education, transport, and the environment.
>
> **Recommendation 6:** More transparency is needed on the choice of discount rate and discounting method for use in pharmacoeconomic analysis. More specifically, the Statistical Office of the Slovak Republic and the Ministries of Health, Finance and Investments, Regional Development and Informatization should collaborate to develop databases and rigorous and consistent estimates of the key parameters of the Ramsey equation for estimating the social rate of time preference.
>
> **Recommendation 7:** Continue to update the discount rate every four to five years in line with updates to HTA methods guides in other countries.

[1] *With a binding healthcare budget, investment in a new drug will displace healthcare elsewhere in the healthcare system. The opportunity cost of investing in the new drug is therefore the cost effectiveness of the healthcare that is foregone. As highlighted by Attema, Brouwer and Claxton (2018) this is often called the threshold but it should be distinguished from decision rules used by HTA agencies to determine cost-effectiveness as these are often not based on opportunity cost.*

1 Introduction

Background

Policymakers have finite budgets, and these budgets have many alternative uses. In the case of healthcare, policymakers must make choices between different health interventions and decide which ones to reimburse and make available to patients. In many countries, these decisions are made, in theory, to maximise health and health-related benefits (effects henceforth) and are based on health technology assessment (HTA). A key component of HTA in many countries is economic evaluation, i.e., quantitative assessment of an intervention's costs and effects.

One type of economic evaluation commonly used for HTA is cost-effectiveness analysis (CEA). This involves the comparison of two or more health interventions in terms of their costs and effects. In practice, CEA is implemented by calculating incremental cost-effectiveness ratios (ICERs). ICERs combine differences in costs and effects between the two or more interventions under study.

Consider a new drug that provides more health than the one currently used for the indication but is more expensive. The ICER tells you how much you must pay on average for each unit of additional health that the new drug delivers. If the ICER is below the cost-effectiveness threshold (CET) (Box 1), then the new drug is deemed cost-effective and is likely to be reimbursed at that price and made available to patients. For example, if the drug delivers five additional quality-adjusted life years (QALYs) per patient over their lifetime (and we only focus on health gains measured in QALYs) but is €100,000 more costly, then the ICER is €20,000 per QALY. It is likely that this intervention would be deemed cost-effective for use in the NHS in England given that the CET is €23,199 (£20,000).

Decision makers must choose a time horizon for costs and effects as these often extend into the future. While there is consensus that future costs and effects should be considered in economic evaluations of drugs, there is less agreement on how they should be valued compared to costs and effects materialising today. For example: how much should €100 in costs realised next year be valued, compared to €100 in costs realised this year? Also, how does 1 QALY gained this year compare to 1 QALY gained in ten years' time? In economic evaluations, these choices are reflected in the choice of discount rate(s).

A discount rate specifies how much a given amount of costs or effects realised at each point in time (typically each year) in the future should be weighed when compared to the same amount of costs or effects realised today[2]. Figure 1 illustrates the impact of different constant discount rates on the present value of €100 over 30 years.

[2] There is an important difference between inter and intra-generational discounting. Intergenerational discounting involves comparing effects on individuals who will be aged A years at both dates under study. Intragenerational discounting involves comparing effects on individuals who will be aged A in year T and A+1 in year T+1. We largely ignore intragenerational effects in this report. Further details can be found in Gravelle and Smith (2001).

Box 1: Cost-effectiveness thresholds

WHAT ARE THEY?

In economic evaluations of new drugs, analysts compare one or more ICERs associated with a new drug with a relevant CET to determine whether the technology represents good value money and should be reimbursed. If the ICER (expressed in € per QALY gained) is below the relevant CET, then the new health technology is generally deemed cost-effective. The discount rate and discounting method affects the ICER and therefore judgements about cost-effectiveness.

HOW ARE THEY ESTIMATED?

There are two main ways of estimating evidence-based cost-effectiveness thresholds for use in economic evaluations of health technologies. The first is called the demand-side approach and involves estimating how much society values a QALY. This is usually done through willingness-to-pay (WTP) experiments.

The alternative is the supply-side approach which involves estimating the opportunity cost of implementing cost-increasing technologies with a fixed budget. However, explicit cost-effectiveness thresholds (CETs) are not actually commonly used in decision-making and in the rare cases where they have this has been without reference to evidence (Sampson et al., 2022).

EXAMPLES

The National Institute for Health and Care Excellence (NICE) employs a CET range of £20,000-30,000 (€23,283-€34,940) per QALY gained for standard technologies (NICE, 2022). NICE may recommend standard technologies with ICERs above £30,000 (and up to £50,000) if the absolute or proportional QALY shortfall associated with the disease is sufficiently large. For highly specialised technologies (HST) NICE employs a CET of £100,000 (€116,467) per QALY gained.

In the Slovak Republic, the Ministry of Health uses several CETs equal to different multiples of GDP per capita. Which CET is used depends on the size of the incremental QALYs. The tables below give the CETs effective from September 2022 (Ministry of Health, 2022).

Standard technologies

Incremental QALYs	CET
0-0.33	2 x GDP per capita
≥0.33	3 x GDP per capita

Orphan medicines and advanced therapy medicinal products (ATMPs)

Incremental QALYs	CET
0-0.33	3 x GDP per capita
≥0.33 up to 0.5	5 x GDP per capita
≥0.5	10 x GDP per capita

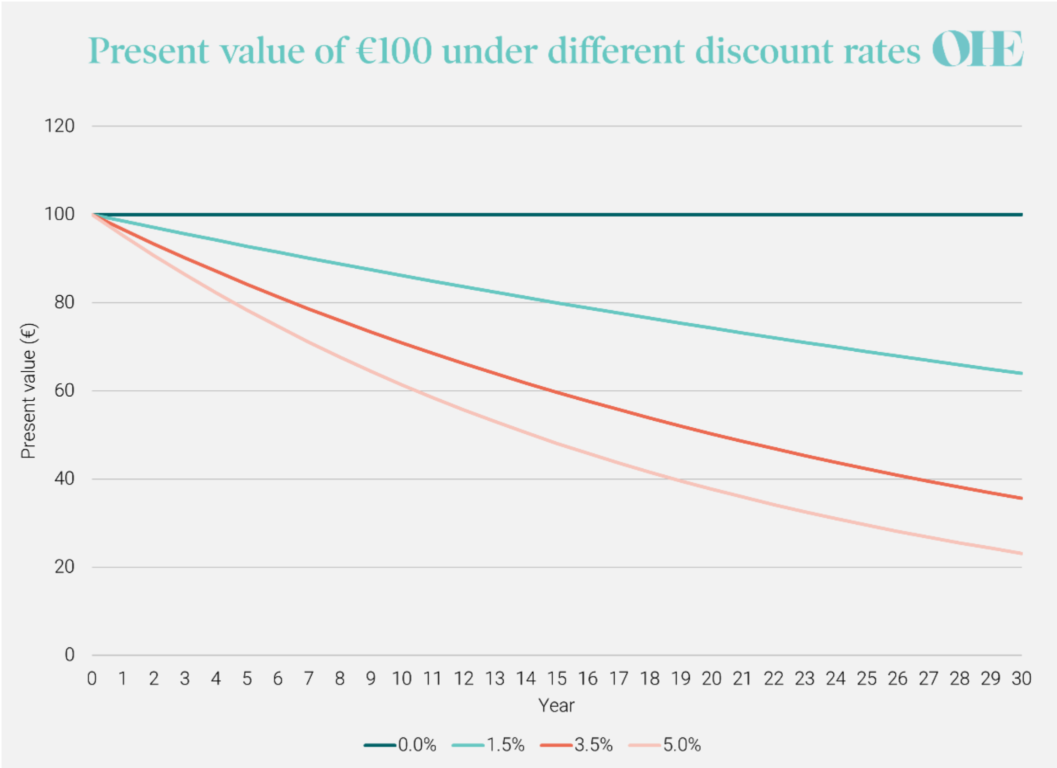

FIGURE 1: IMPACT OF DIFFERENT DISCOUNT RATES ON PRESENT VALUE OF €100

A discount rate of 5% per year implies that €100 of costs next year are worth approximately €95 in present value. If this discount rate is also applied to health, then 1 QALY gained next year is equivalent to approximately 0.95 QALYs gained this year. The higher the discount rate, the less future costs and effects are valued compared to present costs and effects.

Although it may seem like a technical detail, discount rates can have large effects on apparent cost-effectiveness and therefore influence the outcomes of HTA. For example, €10,000 of costs in 30 years' time would be worth about €2,300 or €6,400 in present value depending on whether a 5% or 1.5% discount rate is used. Huygens et al. (2021) find that moving from a discount rate of 4% for costs and 1.5% for effects to 4% for both costs and effects increases the ICER for a gene therapy for inherited retinal disease by 81%. Consequently, many countries are giving more attention to discounting practice in HTA based on the adverse effects that inappropriate discounting methods and discount rate levels can have on patient access to new medicines.

Almost all countries discount both future costs and health effects at the same constant positive rate. These rates have historically fallen in the range of 1.5%-5% (Attema, Brouwer and Claxton, 2018; Williams et al., 2023) and have generally come down over time (Khorasani et al., 2022). For countries showing a downward trend the main reason can be attributed to sustainability and economic development. Other reasons for the downward trend are changes in the methods for the estimation of the discount rate (Khorasani et al., 2022). Most countries use the same rate for costs and effects, but the Netherlands, Poland, Belgium, and Russia are all notable exceptions who use a lower rate for effects than costs in the reference case.

There has been significant debate about whether discount rates used in economic evaluations of healthcare programs and interventions, and particularly the rates applied to health, are too high (Attema, Brouwer and Claxton, 2018; Claxton et al., 2011; Paulden, O'Mahony and McCabe, 2017; Devlin and Scuffham, 2020). For example, the 5% discount rate used in Australia, the same rate currently used in the Slovak Republic, has been criticised for undervaluing the long-term benefits of preventive interventions such as gene therapies (Devlin and Scuffham, 2020). Similar arguments may therefore be levelled against the choice of discount rate in the Slovak Republic. Other Central European countries such as the Czech Republic, Hungary & Poland all use lower discount rates, at least for effects (3%, 3.7% & 3.5% respectively).

It is important that such debates about revisions to discount rate levels and methods is informed by high-quality and up-to-date evidence. This report addresses this need for the Slovak Republic by providing a new estimate of an appropriate discount rate for use in economic evaluations. We also contribute to the debate by providing a review of current discounting practice and key research areas.

Aim and objectives

The overarching aim of this report is to inform dialogue between key stakeholders in the Slovak Republic regarding potential revisions to discounting practice in economic evaluation.

More specifically, the objectives of this report are to:

1. Provide an independent view of what discount rate should be recommended for the Slovak Republic.
2. Explore the dimensions that are relevant to setting the discount rate.
3. Identify the discount rate, underpinned by the strongest rationale across the different approaches.
4. Develop a clear narrative for why we think that the identified discount rate is appropriate.

2 Understanding the rationale for reviewing the discount rate

2.1 Why are future costs and effects discounted in economic evaluations?

There are at least three separate reasons for valuing future costs and effects less and therefore discounting these relative to present costs and effects in economic evaluations. The first is that people are generally impatient and therefore prefer to enjoy benefits now rather than later. This is reflected in what economists called pure time preference. A distinct but related consideration is that there is generally always some risk of some catastrophe happening e.g., death or a natural disaster which would prevent you from enjoying a future benefit, suggesting that you would prefer to receive this benefit now rather than later. This is termed catastrophic risk. These two factors, pure time preference and catastrophic risk, are the two key components of the utility discount rate (Freeman, Groom and Spackman, 2020).

A separate rationale for discounting is that people's incomes tend to go up over time due to economic growth, and as they get richer and consume more, they will naturally value small amounts of additional consumption less and less. This feature is called diminishing marginal utility of consumption. This implies that additional consumption in the future (when people are richer and consuming more) will be valued less than the same amount of additional consumption today. This is called the wealth effect. The size of this wealth effect depends on the rate at which people grow richer over time (measured by the growth rate of real per capita consumption) and how much the average person's satisfaction from an additional amount of consumption (buying an additional car for example) declines as they accumulate more of them. This is called the elasticity of marginal utility of consumption.

A separate but nevertheless important rationale for discounting is that money and other resources have opportunity costs. For example, you could spend €100 on a new watch today or you could save it. If the interest rate on your savings account is 2% per year, then you will have €102 next year. Therefore, ignoring inflation and the two considerations discussed above, the present value of €102 next year is €100 this year, suggesting that future monetary flows should be discounted, i.e., valued less than the same monetary flows received today.

2.2 How should the discount rate be estimated?

One important approach is to set the discount equal to an estimate of the social rate of time preference (SRTP) for consumption. The SRTP for consumption is the rate at which society is willing to postpone consumption now to consume later. An alternative approach is to set the discount rate equal to an estimate of the social rate of return on private investments (SRRI), or, equivalently, the marginal social opportunity cost (MSOC) (Florio and Sirtori, 2013). This can be proxied by a measure of the real cost of borrowing facing the higher authority which is responsible for healthcare in the country (Paulden et al., 2016; Paulden and Claxton, 2012).

The choice of approach depends largely on key features of the decision context including the objective of the higher authority funding the health system (Paulden et al., 2016). If the decisionmaker takes a welfarist or extra-welfarist perspective meaning that it aims to maximise the present consumption value of population health, then the key component to estimating an appropriate discount rate is the SRTP for consumption. If the decisionmaker takes a social decision-making perspective meaning it aims to maximise the present value of population health, then they key component in estimating an appropriate discount rate for incremental costs is the real cost of borrowing facing the higher authority which funds healthcare (Paulden and Claxton, 2012). Here we discuss each of these two approaches in turn.

Social rate of time preference (SRTP) for consumption

The SRTP for consumption reflects the impatience of individuals or households regarding consumption, i.e., the strength of the preference for consumption now rather than later. The most common way of estimating the SRTP for consumption is using the Ramsey Rule (Box 2) which combines the utility discount rate and the wealth effect, both of which are described in section 2.1. To do this, you need estimates of the individual parameters of the Ramsey Rule: pure time preference (δ), catastrophic risk (L), the elasticity of the marginal utility of consumption (μ) and the growth rate of real per capita consumption (g). You can then substitute these into the equation.

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Box 2: Ramsey Rule

The Ramsey Rule (Ramsey, 1928) is an equation which is often used to calculate a country-specific social discount rate for use in the economic evaluation of public investment, including new health investment (Attema et al., 2018).

RAMSEY RULE

r	=	δ	+	L	+	μ	x	g
Discount rate	=	Pure time preference	+	Catastrophic risk	+	Elasticity of marginal utility of consumption	x	Expected growth rate of future real per capita consumption
Discount rate	=	Utility discount rate (**ρ**)			+	Wealth effect (**μg**)		

UTILITY DISCOUNT RATE: PURE TIME PREFERENCE

The rate of pure time preference may be defined as the rate at which future utility (satisfaction) declines in value 'simply because it is in the future'. People generally prefer to receive benefits now rather than later and put off costs to the future, even after ignoring the risk of catastrophe and economic growth decreasing the value of small increases in consumption (Kelleher, 2017).

UTILITY DISCOUNT RATE: CATASTROPHIC RISK

Catastrophic risk refers to the risk of natural disaster, or some other catastrophe happening which would result in society not being able to enjoy future benefits. As a result, future benefits are innately uncertain and therefore less value should be placed on future costs and effects.

WEALTH EFFECT: ELASTICITY OF MARGINAL UTILITY OF CONSUMPTION

The elasticity of marginal utility of consumption is the percentage change in your marginal utility of consumption (how much you value a small increase in consumption) associated with a 1% increase in consumption. Your marginal utility of consumption tends to decrease as you become richer and consume more. For example, you are likely to value a car much higher if you are currently do not have a car than if you already have ten cars. Therefore, the elasticity of marginal utility will be negative. In practice the absolute value of the elasticity is used in the calculation of the Ramsey rule.

The higher the elasticity (in absolute terms), the less you value each additional increase in consumption (each additional car) and therefore the less you care about increases in consumption in the future (when you will be richer) compared to today (when you are less rich).

WEALTH EFFECT: EXPECTED FUTURE GROWTH RATE OF REAL PER CAPITA CONSUMPTION

The wealth effect is also determined by the rate at which consumption is expected to grow over time. When calculating the discount rate according to this approach, the growth rate should relate to consumption adjusted for inflation and population growth i.e. it should relate to real consumption per capita. Most studies and guidelines recommend using data on consumption (Drupp et al. 2018; Florio and Sirtori, 2013; European Commission, 2015) but the growth rate of real GDP per capita may be used as a proxy if good consumption data is missing given that the two tend to be strongly positively correlated.

Moore and Vining (2018) summarise the relative merits of the STRP approach compared to the SRRI or MSOC approach. One of the main benefits of the SRTP approach is that it is a more accurate measure of how society values present vs future health and health-related effects compared to market interest rates which are subject to distortions from taxes and imperfect competition in markets. Also, the SRTP approach is more appropriate for valuing health either at its consumption value or system opportunity cost than the real cost of borrowing, which aligns mainly with time preferences for consumption. Finally, an important component of the SRTP for consumption is the wealth effect which incorporates consumption growth. The approach therefore reflects the country's specific level of economic development.

The main disadvantage of the SRTP approach is that a relatively large amount of data is required since all the individual terms of the Ramsey equation must be estimated separately, and the data may be unavailable or of poor quality. For example, Paulden et al. (2016) argue that the evidence on all parameters except the growth rate of per capita consumption is of poor quality, highly uncertain or absent for Canada. Another issue with this approach is that it requires the aggregation of the preferences of many individuals. Different populations of patients may have very different time preferences, purely because of differences in their disease conditions, and it is not obvious how these should be aggregated.

Social rate of return of private investment (SRRI)

The SRRI or MSOC approach is closely linked to the opportunity cost argument for discounting. Public investment, including investment in a new drug in a publicly funded health system, has an opportunity cost because it crowds out use of those resources by the private sector. The opportunity cost of this public investment can be approximated by the risk-free rate of return on private investment. Paulden et al. (2016) and Paulden and Claxton (2012) argue that this rate of return can be proxied by the real rate of interest on government bonds.

An important benefit of the SRRI approach is simplicity. It requires you to estimate just one variable, and the market data required to estimate it is likely to be more reliable and readily available than survey evidence needed to quantify the rate of pure time preference in the SRTP approach for example. A second advantage is that it is a measure which is often used for other public investments, and consistency in methods for economic evaluation across public sectors may be important. Thirdly, like the SRTP for consumption approach, it is country specific.

The main argument against the SRRI approach is that it does not necessarily reflect the intertemporal preferences for health of patients, taxpayers, and society in general. It is a measure of the opportunity cost of financial resources (proxied by the real before-tax rate of return on corporate or government bonds) and therefore it is not obvious that it should be applied to intertemporal valuations of health. Market interest rates are subject to distortions and macroeconomic circumstances that change over time. For example, government bond yields can be highly sensitive to changes in monetary policy that have little to do with how a country's citizens value health now versus health in the future. Moreover Moore and Vining (2018) argue that private returns are not an appropriate measure of the opportunity cost of public projects, and therefore market-based interest rates are an inappropriate basis for a social discount rate.

Nevertheless, the real cost of borrowing facing the higher authority that funds the health system i.e., the government, can be used to inform the discount rate under a certain set of conditions (Paulden et al., 2016). Therefore, we develop evidence on both the SRTP for consumption and on real government borrowing costs, a proxy for the social rate of return on private investments.

2.3 Should incremental costs and health effects be discounted at the same rate?

2.3.1 Arguments for uniform discounting

Discounting costs and effects at the same rate is called uniform discounting. It is the most common form of discounting recommended by HTA agencies for reference case analysis (Attema, Brouwer and Claxton, 2018; Khorasani et al., 2022; Williams et al., 2023). There are two main arguments for uniform discounting: the consistency argument and the postponement paradox argument. Although the two arguments differ, they both conclude that differential discounting can lead to counterintuitive outcomes and therefore uniform discounting is to be preferred.

Consistency argument
The consistency argument originates in Weinstein and Stason (1977) and states that uniform discounting is the only way to guarantee that two health interventions that have the same-sized costs and health effects are always equally likely to be approved, regardless of what point in time they jointly occur.

To illustrate, consider the example presented in Table 1. There are two health programmes: A and B. Programme A results in costs of €30,000 this year and delivers 1 QALY this year. Since all costs and health effects are realised this year, no discounting is required, and the cost-effectiveness ratio is €30,000/QALY. Programme B results in costs of €30,000 in year 40 and delivers 1 QALY in year 40. The two programmes are therefore identical except for the timing of costs and health effects which occur simultaneously. For this reason, it is argued they should have equal priority in decision making.

For programme B, the cost-effectiveness ratio depends on the choice of equal or differential discounting since the costs and effects occur in the future. If the same discount rate is used for costs and effects then the cost-effectiveness ratio is €30,000 per QALY, regardless of the level chosen for the rate. On the other hand, the cost-effectiveness ratio is €13,745 per QALY if 3.5% is used for costs and 1.5% for QALYs. Therefore, programme B appears to be significantly more cost-effective even though the costs and effects are the same size as those in programme A and, as for programme A, both costs are realised in the same year.

TABLE 1: CONSISTENCY ARGUMENT FOR UNIFORM DISCOUNTING
Source: Brouwer et al. (2005)

Programme	Costs	Effects	Cost-effectiveness ratio (3.5% costs, 1.5% effects)	Cost-effectiveness ratio (3.5% costs and effects)
A	€30,000 this year	1 QALY this year	€30,000/QALY	€30,000/QALY
B	€30,000 in year 40	1 QALY in year 40	€13,745/QALY	€30,000/QALY

The main criticism of the consistency argument is that the reasoning is circular. The argument is based on the premise that the two programmes are equivalent. This, in turn, requires the consumption value of health – the trade-off between the reduction in utility from reducing consumption by €30,000 now to pay for the programme, and the utility gain from increasing health by one QALY today – must stay the same over time. However, for this to be true, the discount rate for costs and effects must be equal. Therefore, the optimality of uniform discount rates is assumed before proving that uniform discounting is optimal (Gravelle and Smith, 2001; van Hout, 1998).

Postponement paradox
The postponement paradox or the Keeler-Cretin paradox (Keeler and Cretin, 1983) is the second major argument for uniform discounting. It states that if a lower discount rate is used for effects than costs (differential discounting), postponing the programme indefinitely appears to be theoretically

optimal from a cost-effectiveness point of view. Table 2 shows that under differential discounting, delaying the programme by an additional year will always increase its apparent cost-effectiveness.

TABLE 2: POSTPONEMENT ARGUMENT FOR UNIFORM DISCOUNTING

Timing of programme	Cost-effectiveness ratio (3.5% for costs and effects)	Cost-effectiveness ratio (3.5% for costs and 1.5% for effects)
This year	£30,000/QALY	£30,000/QALY
Year 1	£30,000/QALY	£29,420/QALY
Year 2	£30,000/QALY	£28,852/QALY
Year 40	£30,000/QALY	£13,745/QALY

The main criticism of the postponement paradox is that it has limited practical implications. In the real world, no decisionmaker is ever going to indefinitely delay a programme purely because of the timing appears to be more cost-effective. The decision that policymakers have to make is whether to implement programme A instead of the current programme B, not whether to delay implementation of programme A until next year or wait several decades (van Hout, 1998). Although there have been examples of decisionmakers delaying reimbursement until the price of the health technology has come down to an acceptable level, in the above example the costs of the two programmes are the same and there is still an apparent incentive to delay implementation.

Moreover, this strategy is not optimal for a decisionmaker whose objective is to maximise the present value of population health, nor is it optimal for pharmaceutical companies, whose objective may realistically be to maximise the present value of profit or revenue. This is partly because there is a very real risk of a competitor launching a similar product in the interim. Lastly, the example above is limited in that they type of programme is highly unrealistic, with costs and effects realised within one year and the programme stopping the year after implementation. van Hout (1998) show that the postponement paradox breaks down if you assume, realistically, that once the health program is started, it is continued next year with new patients, and then indefinitely, assuming it remains cost-effective.

2.3.2 Arguments for differential discounting

Differential discounting refers to the practice of discounting effects at a different (typically lower) rate than costs[3]. Attema, Brouwer and Claxton (2018) summarise the four questions that must be answered in deciding whether differential discounting is appropriate, based largely on Claxton et al. (2011):

1. What is the objective of the higher authority i.e. the government?
2. Is the healthcare budget fixed or variable?
3. Is the consumption or monetary value of health changing over time?
4. Is the opportunity cost of healthcare spending changing over time?

Certain sets of conditions will justify differential discounting. Here we take the lead from Claxton et al., (2011) and focus on questions 3 and 4, highlighting the objective and budget conditions under which differential discounting will be appropriate in each of these cases.

Growth in the consumption value of health
If the higher authority funding healthcare i.e. the government is operating with a welfarist or extra-welfarist perspective and an unconstrained budget, where the objective is to maximise the present consumption value of population health, then differential discounting will be appropriate if and only if the consumption value of health is increasing over time (Claxton et al., 2011; Paulden et al., 2016). The basic reasoning for this is as follows. If the budget is unconstrained then there is no threshold. The decision rule would be to compare the ICER to the current period consumption value of health.

[3] Differential discounting could conceivably involve a higher discount rate being applied to health effects than costs, but to our knowledge this has never been seriously considered for health economic evaluations let alone implemented in practice.

The consistency argument for uniform discounting assumes that the consumption value of health i.e. the monetary value that society attaches to one QALY does not change over time. However, Gravelle and Smith (2001) argue that the consumption (or monetary) value of health is expected to grow over time based on theoretical behavioural and welfare models and conclude that this needs to be accounted for in CEA. In CEA, where health is measured in non-monetary terms such as QALYs, the growth in the monetary value of health can only be accounted for by discounting effects at a lower rate than costs i.e., differential discounting. This argument is echoed by Brouwer et al. (2005) who criticised NICE for abandoning differential discounting in the early 2000s. The suggestion that the increasing monetary value of health should be accounted for in CEA through a lower discount rate for health has, however, been contested by Claxton et al. (2006).

Growth in the cost-effectiveness threshold

Paulden et al. (2016) and Claxton et al. (2011) argue that differential discounting will be appropriate if the opportunity cost of new health investment, which should be embodied in the CET, changes over time. They again specify a set of circumstances under which a changing threshold justifies differential discounting. Regardless of whether the decisionmaker operates with a welfarist (or extra-welfarist) perspective, or a social decision-making perspective, differential discounting will be appropriate if it faces a constrained budget and the cost-effectiveness threshold changes over time. Their definition of the CET is the opportunity cost of new health investment, rather than the threshold used in a practice by an HTA agency. This may differ significantly from this opportunity cost.

Double discounting

A final separate argument is based on the observation that time preference may already be reflected in estimates of health effects, and therefore applying a positive discount rate to health effects results in double discounting and should therefore be avoided. Utility weights used in the calculation of QALYs are often based on time trade-off surveys or other surveys with a time component. Respondents are asked to trade-off certain durations in suboptimal health against smaller durations in perfect health. People have a time preference health when completing this type of survey. They do not value future years of life as much as additional years of life experienced now. Therefore, utilities are already discounted in a sense.

Questions about whether health can be traded over time

Health is unlike money in that it cannot obviously be traded over time i.e., you cannot invest part of your health now to gain extra health in the future like you can with money. This suggests that the opportunity cost argument for discounting does not apply to health. However, a counterargument is that improvements in health require money and healthcare resources. Since money and healthcare resources can be traded over time, health can too. Foregoing spending on health today and saving the money means that you will have more money to spend to gain more health in the future. The tradability of wealth and health suggests that health should indeed be discounted.

2.4 Should different health technologies be discounted at the same discount rate?

The costs and effects of different types of health technology vary in terms of their magnitude and timing. For these reasons it has been argued that interventions such as vaccination programs, regenerative medicines, and ATMPs should face different discounting policies.

Vaccines and ATMPs are similar in that they generally have high upfront costs and health effects accumulate over a long period of time. In other words, there are large delays between the time of immunisation/administration and the time that the full health benefits are realised. Therefore, increasing the discount rate slightly will increase the ICER by a relatively large amount, weakening the apparent cost-effectiveness of the interventions and ultimately making them less likely to be approved. This suggests that it may be appropriate to apply a different form of discounting.

In Table 3, we summarise four alternatives to time-constant uniform discounting which have been discussed extensively in the context of vaccines (Jit and Mibei, 2015). The authors conclude that there are sound reasons for departing from constant uniform discounting in the case of vaccines, and they make a strong case for differential discounting. Problems with traditional discounting methods have also been discussed extensively in the context of ATMPs (Ham et al., 2020; Jönsson et al., 2019; Drummond et al., 2019).

TABLE 3: ALTERNATIVES TO CONSTANT UNIFORM DISCOUNTING
Source: Jit and Mibei (2015)

Type of discounting	Description
Differential discounting	Discounting costs and effects at different rates e.g., 3.5% for health and 5% for costs.
Non-constant discounting	A lower discount rate is used for costs or effects that are not expected to occur for many years e.g., discounting costs and effects incurred in the first 30 years at 3.5% and those incurred after 30 years at 1.5%.
Two-stage discounting[4]	Health effects accumulated by an individual are discounted back to a common age using individual time preference, and then these are discounted back to a common time using the SRTP.
Delayed discounting	Discounting the health gains from an intervention to a different discount year from the time of intervention.

At least one country recommends different (uniform) discount rates for some types of intervention. The National Institute for Health and Care Excellence (NICE), the HTA body covering England and Wales, recommends departing from the standard uniform rate of 3.5% per year to a rate of 1.5% per year for technologies that meet all of the three following criteria (NICE, 2022):

1. The technology is for people who would otherwise die or have a very severely impaired life
2. It is likely to restore them to full or near-full health
3. The benefits are likely to be sustained over a very long period

2.5 What are the potential consequences of applying a discount rate that is 'too high' or 'too low'?

Discounting affects estimates of the present value of different health interventions which in turn inform resource allocation decisions made today within healthcare systems. It is therefore important that policymakers set appropriate rates given their objectives. Here we discuss the likely consequences of too low or too high a discount rate within a uniform discounting framework, for simplicity.

2.5.1 Consequences of too high a discount rate

An important consequence of too high a discount rate is that too much priority is likely to be given to technologies with more immediate benefits (for example acute pain relief / imminent death delayed) comparing to interventions with longer-term benefits, potentially at the expense of population health and broader welfare.

[4] *This relates to the distinction between inter- and intragenerational discounting explained in Gravelle and Smith (2001)*

For example, gene therapies typically have high upfront costs, but their benefits may not be realised for many years or decades. If you heavily discount benefits realised beyond the year of the intervention, then these potentially transformative therapies will be overly penalised from a societal perspective. A good example are gene therapies for X-linked retinitis pigmentosa (XLRP), a type of inherited retinal disease (IRD) that causes very gradual vision loss.

XLRP patients start experiencing night blindness in adolescence, but vision worsens gradually over many decades and most patients do not become legally blind until the age of 40 (Tsang and Sharma, 2018). Gene therapies currently in development are administered as costly one-off injections in adolescence with the full benefits not being realised until the fourth decade of life, when the patient would have become legally blind.

Too high a discount rate will put too much weight on the upfront costs and not enough on the potentially transformative long-term benefits they offer patients and wider society. Other interventions which are likely to be overly penalised under too high a discount include vaccines, cell therapies, interventions for orphan and rare diseases, and immunotherapies. This could result in too few of these types of interventions being made available to patients. Partly due to this argument, NICE uses a discount rate of 1.5% instead of 3.5% for certain technologies delivering very long-term benefits, and some future gene therapies may be eligible for this lower rate.

The adverse consequences of using too high a discount rate were also flagged by the UK Government's Appraisal Alignment Working Group (AAWG) and the Cost-Effectiveness Methodology for Immunisation Programmes and Procurement (CEMIPP) group (DHSC, 2018). The AAWG highlighted the need to lower the health discount rate from 3.5% to 1.5% for the economic evaluation of immunisation programmes since this rate would more accurately represent the programme's actual impact. However, the recommendation was rejected by the Department of Health and Social Care (DHSC) who, to the time of writing, have maintained a 3.5% rate for immunisation programmes in the UK (DHSC, 2019).

2.5.2 Consequences of too low a discount rate

An important consequence of too low a discount rate on the other hand is the converse of too high a discount rate. Too low a discount rate will lead to more priority being given to technologies with longer-term and potentially highly uncertain health benefits compared to interventions with more immediate benefits, potentially at the expense of social welfare. When the discount rate is very low, costs and effects that are not expected to be realised for many years or decades may have a relatively large impact on cost-effectiveness ratios, even if they are highly uncertain.

As discussed above, gene therapies are one example of a technology with highly uncertain but potentially large long-term benefits. Although they have the potential to deliver transformational health benefits or even cure patients, they are relatively new and there is a lack of evidence on their long-term clinical effects. If the discount rate is lower than that which society would prefer, then this type of technology could be prioritised over interventions which offer more immediate health benefits such as relief from acute pain or an intervention which delays an imminent death. Other examples of interventions which may be overly prioritised under too low a discount rate include immunisation programs and other types of advanced therapy medicinal products (ATMPs) such as chimeric antigen receptor T-cell (CAR-T) therapy.

While it is appropriate that technologies with long-term benefits are given some priority in decision making, health systems have finite budgets and, therefore, more investment in these types of technology is likely to mean less investment in others. Therefore, if the discount rate is set too low, population health and broader welfare could be suboptimal.

3 Estimating the discount rate for the Slovak Republic

3.1 Review of estimates available in the literature

In this section we review existing estimates of discount rates relevant for the economic evaluation of health interventions. We review estimates for the Slovak Republic and similar Central European economies such as the Czech Republic and Hungary. We also discuss estimates for countries where there is a relatively large amount of detail published on data and methods in order to illustrate approaches that *can* be taken.

3.1.1 Discount rates in national guidelines for health economic evaluation

Most countries recommend discounting costs and effects at the same rate (typically 1.5-5% per year) except for the Netherlands, Belgium, Poland, and Russia which use a form of differential discounting.

Table 4 displays the official discount rates stipulated for base case health economic evaluations in a subset of countries for which detail on rationale and methods is available.

TABLE 4: DISCOUNT RATES IN NATIONAL GUIDELINES FOR HEALTH ECONOMIC EVALUATIONS
Source: Adapted from Attema, Brouwer and Claxton (2018) and updated based on most recent

Country	Source	Discount rate costs	Discount rate effects
Australia	PBAC (2016)	5%	5%
Slovak Republic	Ministry of Health (2009)	5%	5%
Croatia	AAZ (2011)	5%	5%
Portugal	INFARMED (2019)	4%	4%
Ireland	HIQA (2020)	4%	4%
Norway	NMA (2018)	4%	4%
Hungary	Discount Rate Working Group (2010)	3.7%	3.7%
UK	NICE (2022)	3.5%	3.5%
New Zealand	PHARMAC (2015)	3.5%	3.5%
Czech Republic	State Institute for Drug Control (2022)	3%	3%
Germany	IQWiG (2022)	3%	3%
Italy	AIFA (2020)	3%	3%
Canada	CADTH (2018)	1.5%	1.5%
Poland	AOTMiT (2016)	5%	3.5%
Netherlands	ZIN (2016)	4%	1.5%
France	HAS (2020)	2.5% (<30 years) 1.5%-2.5% (>30 years)	2.5% (<30 years) 1.5%-2.5% (>30 years)

national HTA/economic evaluation guidelines

Uniform discounting
Differential discounting
Time-variant discounting

Despite the homogeneity in discounting method, with constant uniform discounting being so prevalent, there is significant international variation in the discount rates used in health economic evaluations and the rate used in the Slovak Republic is one the highest globally.

Discount rates used for health economic evaluations have generally fallen over time (Khorasani et al., 2022). This could be due to changes in rationale and methods behind the discount rate and in particular a move away from the comparability approach. The comparability approach is defined as an approach to setting the discount rate based on similarity with rates in economic evaluation studies, health economic evaluation/pharmacoeconomic/health technology assessment guidelines, or other relevant organizations. However, this downward trend could also be due to economic growth decelerating over time i.e., economic growth rates falling. According to the Ramsey Rule, reductions in growth rates of real per capita consumption should lead to a decreasing discount rate. Despite this, the Ministry of Health has required the same rate to be used in pharmacoeconomic analysis since 2009 (5% per year).

Many of the countries that the Slovak Republic is closest to geopolitically recommend lower discount rates that the Ministry of Health. The Czech Republic employs a discount rate of 3% per year for both costs and effects, Hungary recommends 3.7% for costs and effects based on the Ramsey Rule with domestic empirical data, and Poland recommends differential discounting with 3.5% for health effects and 5% for costs.

Most country-specific health economic guidelines do not give a rationale for the chosen discount rate (Figure 2). In those documents which do, the most common rationale is alignment with the discount rate used by the respective government finance department which in the case of the Slovak Republic would be the Ministry of Finance. After this, the most common rationale is ensuring comparability between studies and countries, followed by alignment with the rate of return on bonds, with this being the key variable in the SRRI approach. The UK, Hungary and New Zealand are explicit that their discount rates are based on the SRTP approach. The Netherlands, Canada, Germany and Portugal on the other hand base their discount rates on the SRRI and do not make explicit use of the Ramsey Rule (Attema, Brouwer and Claxton, 2018).

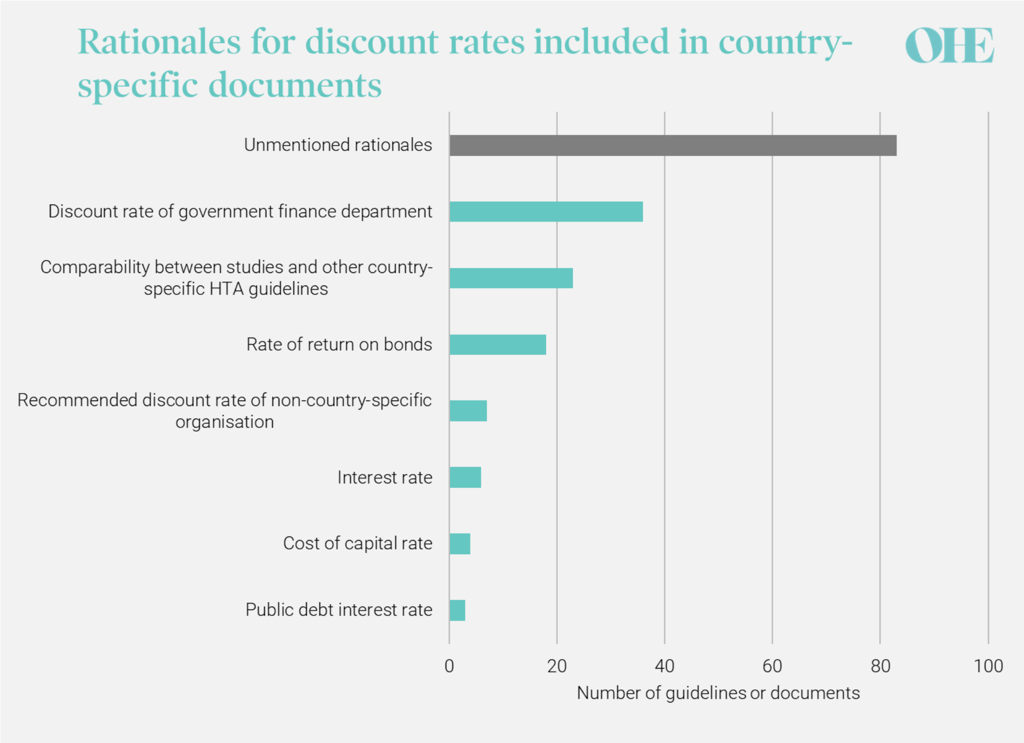
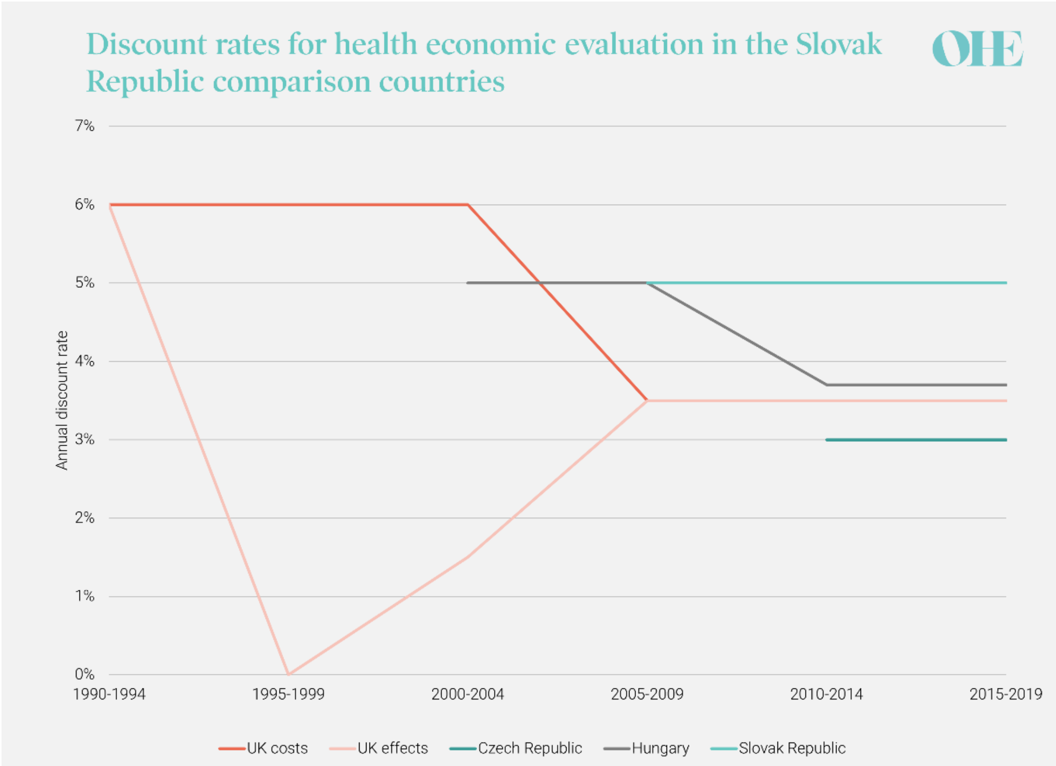


FIGURE 2: RATIONALES FOR DISCOUNT RATES INCLUDED IN COUNTRY-SPECIFIC GUIDELINES OR OTHER DOCUMENTS
Source: Khorasani et al. (2022)

3.1.2. Official discount rate in the Slovak Republic

Since June 2009 the Ministry of Health of the Slovak Republic has required costs and QALYs to be discounted at a rate of 5% per year. The Ministry of Health initially published this rate just as part of its guidelines for pharmacoeconomic analysis (Ministry of Health, 2009) but the rate was later written into a decree (Ministry of Health, 2011). Before this, a rate of 7% was required for pharmacoeconomic analysis. As Figure 3 shows, the discount rate in the Slovak Republic has remained high despite rates coming down in Hungary and the UK. The discount rate in the Slovak Republic is high compared to current rates used in two similar Central European countries: the Czech Republic and Hungary and is also high compared to the UK. The UK is the only country to have ever used differential discounting.



Notes: Costs and effects have been discounted equally (3.5% per year) in the UK since 2004

FIGURE 3: OFFICIAL DISCOUNT RATES IN THE SLOVAK REPUBLIC AND COMPARISON COUNTRIES
Source: Khorasani et al. (2022)

There is no explicit justification for the choice of discount required by the Ministry of Health. A report by the Ministry of Investments, Regional Development and Informatization of the Slovak Republic (MIRI) (2017) states that the 5% discount rate is based on European Commission (2015) guidelines and they also present a calculation of a 5.3% discount rate using the Ramsey Rule which supported future use of the 5% rate. A reminder of the Ramsey rule is given in Box 3 and a breakdown of the calculation in MIRI (2017) is presented in Table 5.

Box 3: Ramsey Rule revisited

r	=	δ	+	L	+	μ	x	g
Discount rate	=	Utility discount rate (**ρ**)			+	Wealth effect (**μg**)		

Note: see Box 2 for detail on the individual terms

TABLE 5: BREAKDOWN OF THE MIRI (2017) CALCULATION OF THE SOCIAL DISCOUNT RATE

Ramsey Rule component	Estimate	Detail	Source
Pure time preference (δ)	0%	N/A	N/A
Catastrophic risk (L)	0.992%	Crude death rate of the population in 2015: L = (deaths/population) x 100 =(53,826/5,421,432) x 100 = 0.992	Statistical Office of the Slovak Republic (2022)
Elasticity of marginal utility of consumption (μ)	1.304	Based on the progressivity of the income tax schedule. According to Florio and Sirtori (2013, pp.10–11) this approach is appropriate to use because it reflects society's redistributive preferences and the redistribution of public finances over time is equivalent to the redistribution between different income groups in the present: $\mu = \ln(1-t_{marginal})/\ln(1-t_{average})$ $=\ln(1-0.299)/\ln(1-0.238)$ $=1.304$ In 2016 the average rate of taxes and levies for a person earning an average monthly wage was 23.8% and the marginal rate of taxes and levies (the rate at which the next euro earned is taxed) was 29.9%.	OECD (2023)
Growth rate of real per capita consumption (g)	3.3%	Average annual growth in aggregate real GDP over the period 2010 – 2020 which at that time involved forecasts and was estimated to be 3.3%.	Ministry of Finance of the Slovak Republic (2023)

δ is set equal to zero in the calculation without clear justification. It was originally argued that using a positive pure time preference rate for the social discount rate is "ethically indefensible" (Ramsey, 1928). One argument for a zero rate of pure time preference (reflecting impatience regardless of catastrophic risk and economic growth) is that policymakers have the same responsibility to current and future generations, even those who have not been born yet. According to this argument, the utility discount rate will just be equal to the catastrophic risk rate, which in this case is equal to an estimate of the crude mortality rate. The next section discusses social discount rate estimates for the Slovak Republic, all of which also assume a zero pure time preference rate.

3.1.3 Other estimates of the social discount rate for the Slovak Republic

There are several other estimates of the SRTP for consumption for the Slovak Republic. These are presented in Table 6, which also includes the official 5% rate for ease of comparison.

TABLE 6: EXISTING ESTIMATES OF THE SOCIAL DISCOUNT RATE FOR THE SLOVAK REPUBLIC

r	=	δ	+	L	+	μ	x	g	Source
2.53%	=	0%	+	0.9902%	+	0.4830	x	3.1980%	Seçilmiş and Akbulut (2019) –elasticity based on Almost Ideal Demand System (AIDS)
5%	=	0%	+	0.992%	+	1.304	x	3.3%	MIRI (2017) –elasticity based on marginal and average tax rates
5.32%	=	0%	+	0.9902%	+	1.353	x	3.1980%	Seçilmiş and Akbulut (2019) – elasticity based on Personal Taxation Model (PTM)
6.6%	=	0%	+	1.1%	+	1.5	x	3.7%	Evans and Sezer (2005) – average values for elasticity
7%	=	0%	+	1.1%	+	1.6	x	3.7%	Evans and Sezer (2005) – elasticity evaluated at average production wage (APW) tax rates
Summary 2.53% - 7%				0.992-1.1%		0.4830-1.6		3.1980-3.7%	

The sensitivity of the discount rate to the method used to estimate the elasticity is demonstrated by the difference between the two estimates in Seçilmiş and Akbulut (2019). The 2.79% difference is due entirely to the difference between the two elasticity estimates: 0.4930 using the Almost Ideal Demand System and 1.353 using the Personal Tax Model.

In the PTM model (which we will refer to as the equal sacrifices income tax approach), the elasticity of marginal utility of consumption is interpreted as representing society's aversion to income inequality in the present day and is measured by the progressivity of personal income tax rates. For the prevailing progressivity of income tax rates to represent the government's aversion to income inequality two assumptions must hold:

1. **Equal absolute sacrifice of satisfaction:** income redistribution has an equal impact on rich and poor taxpayers in terms of their utility. In other words, every agent with positive post-tax income sacrifices the same amount of utility compared to her pre-tax income.
2. **Iso-elastic utility functions:** utility functions (relationship between consumption of some other economic variable, and utility) that have constant relative risk aversion.

Under these two assumptions, the elasticity can be estimated by examining the progressivity of the country's income tax schedule. In practice this means comparing the marginal tax rate with the average tax rate for the average individual or household in the population (Table 5). In the AIDS model on the other hand, the elasticity of marginal utility of consumption is calculated using the income elasticity, the compensated price elasticity, and the budget share for preference independent goods.

A smaller but not insignificant portion of the variation in discount rates can be explained by differences in values for the growth parameter. Evans and Sezer (2005) use the average annual rate over the period 1970-2001 whereas Seçilmiş and Akbulut (2019) use the average annual rate over the period 1996-2015. Both studies use average growth in real per capita consumption, contrasting with MIRI (2017) which makes use of average growth in real aggregate GDP without detailed justification.

3.1.4 Estimates of the social discount rate for other countries

Similar Central European countries

Social discount rates have been estimated for countries that similar to the Slovak Republic geopolitically and economically, notably other former transition economies. TABLE 7 presents estimates of the SRTP for consumption for five of these countries according to two different methods for estimating the elasticity of marginal utility of consumption: the PTM and AIDS. The AIDS methodology behind the elasticity clearly results in smaller estimates for the discount rate. There is also significant variation across countries within each methodology (range of 3.3-6.91% for the PTM and 1.94-3.5% for the AIDS).

The social discount rate for the Czech Republic has recently been estimated to fall within the range of 3-5% per year (Opatrny and Scasny, 2021) suggesting that a social discount rate of 5% per year may be too high for the Slovak Republic.

TABLE 7: SOCIAL DISCOUNT RATES FOR SIMILAR COUNTRIES TO THE SLOVAK REPUBLIC
Source: Seçilmiş and Akbulut (2019)

Country	Personal Taxation Model	Almost Ideal Demand System
Hungary	3.3%	2.11%
Poland	4.94%	2.75%
Czech Republic	3.75%	1.94%
Estonia	6.91%	3.42%
Latvia	6.67%	3.5%
Average	**5.11%**	**2.74%**

England and Wales

The discount rates recommended by His Majesty's (HM) Treasury in the UK and those stipulated by NICE warrant further discussion since there is a relatively large amount of information available on rationale and methods. NICE stipulates a reference-case discount rate of 3.5% per year for costs and health effects for most technologies (NICE, 2022). This is the same discount rate recommended by HM Treasury for *non-health outcomes* (HM Treasury, 2022). In turn, HM Treasury's choice of discount rate is based on the Ramsey Rule. A breakdown of the calculation is presented in Table 8.

Notably, HM Treasury recommends a discount rate of 1.5% for health outcomes such as life years and QALYs[5], which NICE has only adopted for certain technologies. HM Treasury also recommends a form of time-declining discounting in which a lower discount rate is applied to outcomes that are expected to occur more than 30 years into the future, which NICE does not adopt in its methods. Therefore, although NICE and HM Treasury both recommend a rate of 3.5%, there are several inconsistencies between their recommendations.

[5] *Note that the Department of Health and Social Care (DHSC) in the UK apply a discount rate of 1.5% to health effects in evaluations of health-related policies but NICE do not use this rate in economic evaluations of health technologies*.

TABLE 8: BREAKDOWN OF HM TREASURY'S 3.5% DISCOUNT RATE
Source: HM Treasury (2022)

Ramsey rule component	**Current value**	**Detail**
Pure time preference (δ)	0.5%	Freeman, Groom and Spackman (2020) survey the evidence and show that plausible values range from 0-1%.
Catastrophic risk (L)	1%	Includes different concepts of risk as a practical shortcut. It now includes a risk of some natural or man-made national catastrophe, essentially ending the current social structure, the risk that across almost all projects there will always be some underestimation of risks (for example few will have considered the risk of a Japanese tsunami leading to premature shut down of German nuclear power), and a small factor for the systematic risk associated with the covariance of social costs and benefits with national income.
Elasticity of marginal utility of consumption (μ)	1	The 2003 edition of the Green Book set a value of 1 (HM Treasury, 2003). The estimate used by the Department for Work and Pensions for distributional weighting is 1.3 based on Layard, Mayraz and Nickell (2008) who use a subjective wellbeing approach (Table 9), while Groom and Maddison (2019) use a number of techniques to estimate a pooled value of 1.5.
Expected future growth rate of real per capita consumption (g)	2%	The 2003 Green Book set g at 2% (HM Treasury, 2003). Freeman, Groom and Spackman (2020) reference 2.2% based on real annual per capita consumption growth for the UK for the period 1949-2016. Estimates based on ONS data from the recent past, for example 1996-2016 are lower at 1.7% per year.
Discount rate (r)	3.5%	

HM Treasury (2022) argues that the wealth effect component does not apply to health. This is because health and life effects are expressed using welfare or utility values such as QALYs rather than monetary values, and the value of additional health does not diminish as real incomes rise: a society is not expected to value health less as it becomes wealthier. The wealth effect is 2%, and therefore removing this from the discount rate calculation results in a discount rate of 1.5% for health.

Although NICE currently uses a reference-case discount rate of 3.5% for costs and health effects, it has accepted that it should lower its discount rate to 1.5% as soon as possible (NICE, 2021, p.3). The main issue that is delaying the lowering of the discount rate is that it overlaps with other issues across the NHS and wider public sector (Box 4) which require a change in the discount rate to be considered as part of a package of possible changes.

Removing the wealth effect entirely from MIRI's calculation of the discount rate by for the Slovak Republic lowers it from 5.3% to 0.99% (the discount rate becomes equal to the rate of time preference), which is a much more significant reduction compared to NICE. It is important to note that this argument only applies to the discount rate for future health effects – there is no case for removing the wealth effect for future costs. This is an important argument for discounting future health effects at a lower rate than costs.

Box 4: NICE's plans to lower the discount rate

NICE currently recommends a 3.5% discount rate for costs and effects but the national HTA agency accepts that this should be lowered as soon as possible to 1.5%:

> ***"We found evidence that we should change our discount rate to 1.5%, and this could make a particularly big difference to some treatments, like gene therapies. However, this overlaps with several other issues outside NICE and across the NHS. Having considered this further, we still think we should change the discount rate to 1.5% as soon as we can, but the other overlapping issues need to be addressed for this to happen. In the meantime, we will keep the current discount rate."***
> (NICE, 2021)

3.2 A discussion on the validity of existing estimates

Many decisionmakers rely on the Ramsey Rule to set their discount rates. Estimating the discount rate according to the Ramsey Rule requires estimates of pure time preference, catastrophic risk, elasticity of marginal utility of consumption, and the growth rate of real per capita consumption. Existing discount rate estimates can, in principle, be assessed (and criticised) on the basis of the data and methodology behind each component. Here we focus on growth in real consumption per capita and the elasticity of marginal utility of consumption since these are more contentious.

Growth rate of real consumption per capita (g)
In the Ramsey Rule, the relevant growth parameter to be estimated is *future* growth in real per capita consumption (Freeman, Groom and Spackman, 2020). Existing estimates of this parameter for the Slovak Republic, which are all above 3%, may be inappropriately high because they are based on historical data. Florio and Sirtori (2013) highlight that past data may be particularly misleading as an indicator of future growth for the former European transition economies since they have been affected by major structural shocks in their recent past which are unlikely to occur again. One solution is to restrict attention to more recent growth data. More recent growth may be more indicative of future growth, but it involves taking an over over a smaller number of years and therefore short-term business cycles will have a relatively large effect. An alternative solution is to use growth forecasts, but these are typically highly uncertain so neither approach is perfect.

Elasticity of marginal utility of consumption (μ)
There is uncertainty about the most appropriate method for estimating the elasticity of marginal utility of consumption. This is partly because the elasticity can be interpreted in numerous ways, leading to many different estimation methods and data sources. Table 9 provides detail on the most common methods for estimating the elasticity of marginal utility of consumption.

MIRI (2017) used the equal sacrifices income tax approach in its calculation. This approach is based on the assumption that the burden of income tax in terms of marginal utility is the same for all taxpayers. The approach gives a measure of inequality aversion which can be interpreted as the elasticity of marginal utility of intertemporal consumption.

Beyond criticism of the estimates of the individual components of the Ramsey equation, the calculation in MIRI (2017) is based on what is now old data as are the other estimates of the social discount rate for the country (see Table 6). Therefore, there is a clear argument for updating the official calculation.

TABLE 9: METHODS FOR ESTIMATING ELASTICITY OF MARGINAL UTILITY OF CONSUMPTION
Sources: Freeman, Groom and Spackman (2020); Groom and Maddison (2019)

Method	Detail
Equal sacrifice approach	This approach is based on the interpretation of μ as a reflection of inequality aversion at a given point in time. Inequality aversion is measured by the extent to which the income tax system is progressive, and this is analysed by comparing marginal and average tax rates.
Life-cycle behavioural models: The Euler-equation approach	This approach is based on the interpretation of μ as the inverse of the elasticity of intertemporal substitution. This elasticity is estimated through econometric estimation of the Ramsey equation where the elasticity is the coefficient on the growth rate (see Box 2).
Frisch additive-preferences approach	This approach relies on the presumed existence of additive preferences. Additivity implies that the marginal utility obtained from consuming infra-marginal units of the additively separable commodity, usually taken as good, is independent of the quantity consumed of any other commodity. Given additivity, all the information necessary for estimating μ can be obtained via the Frisch formula by analysing the demand for the additively separable commodity. The AIDS can be used to estimate the elasticity according to this approach.
Coefficient of relative risk aversion	The coefficient of relative risk aversion is a number that represents how much people dislike risk regarding consumption or wealth at a given point in time. The higher the coefficient of relative risk aversion, the more averse the individual is to risk. The coefficient of relative risk aversion can be estimated by analysing wealth and insurance data.
Stated preference and expert elicitation	Hypothetical elicitation among individual respondents, sometimes using incentivised experiments, or consultation of experts.
Subjective wellbeing	Surveys are used to elicit people's life satisfaction and income or consumption. If life satisfaction is taken to be synonymous with utility, then the relationship between consumption and utility can be estimated and this gives you an estimate of the elasticity of marginal utility of consumption.

3.2.1 What evidence is needed to estimate a more suitable discount rate for health technology evaluation?

The appropriate discount rate to estimate depends on several key features of the decision context such as the objective of the higher authority responsible for healthcare i.e. the government, and also whether the healthcare budget can be seen as fixed (Paulden et al., 2016). Table 10 presents the formulae for the theoretically appropriate discount rates to estimate in each case.

TABLE 10: APPROPRIATE DISCOUNT RATES FOR HEALTH AND COSTS UNDER DIFFERENT ASSUMPTIONS ABOUT THE DECISION CONTEXT

Source: Paulden et al. (2016)

Perspective on social choice	Objective	Discount rate for health (d_h)	Discount rate for costs (d_c)
Welfarist or extra-welfarist[6]	Maximise the present ***consumption value*** of population health	$d_h = r_c - v$	$d_c = r_c - v + g_k$
Social decision-making	Maximise the present ***value*** of population health	$d_h = r_h$ $= r_s - g_k$ See Paulden and Claxton (2012) for detail on the relationship between the SRTP for health and the interest rate facing the higher authority i.e. the government.	$d_c = r_h + g_k$ $= r_s$

d_h Discount rate for health
d_c Discount rate for costs
r_c SRTP for consumption
r_h SRTP for health
r_s Interest rate facing the higher authority
v Expected growth rate of the consumption value of health
g_k Growth rate of the opportunity cost of new health investment

Under a welfarist or extra-welfarist perspective, the three relevant variables are the SRTP for consumption, expected growth rate of the consumption value of health, and the growth rate of the opportunity cost of new health investment. Under a social decision-making perspective, the two relevant variables are the interest rate facing the higher authority responsible for healthcare, and the growth rate of the opportunity cost of new health investment.

In this report we focus on estimating r_c, the SRTP for consumption which is the key component of the discount rate under a welfarist or extra-welfarist perspective. It is also a common and straightforward way of setting a social discount rate. We also present evidence on r_h, the SRTP for health, which is the key component of the discount rate under a social decision-making perspective. We leave consideration of the growth rates of the opportunity cost of new health investment and the consumption value of health, which determine whether differential discounting is appropriate, to the discussion section.

Evidence needed to estimate the social rate of time preference (SRTP) for consumption

The SRTP for consumption can be estimated using the Ramsey Rule. This has four components: pure time preference, catastrophic risk, future growth of real consumption per capita, and the elasticity of marginal utility of consumption. We take the rate of pure time preference to be zero based on strong intergenerational welfare arguments against any other rate than 0% and in line with several similar studies (Ramsey, 1928; Pigou, 1932; Broome, 1992; Evans and Sezer, 2005).

[6] If the decisionmaker is budget constrained, then the appropriate discount rate for costs will be higher than the appropriate discount rate for health (differential discounting) if the cost-effectiveness threshold is expected to increase over time.

Social rate of catastrophic risk

Since the rate of pure time preference is assumed to be equal to zero, the utility discount rate will simply be equal to the catastrophic risk rate. In the past, catastrophic risk has often been proxied by individual mortality risk expressed as **the gross mortality rate** in the population. The gross mortality rate is equal to the number of deaths from any cause in the population, scaled to the size of that population, per unit of time.

Paulden et al. (2016) highlight that estimates of catastrophic risk based on individual mortality risk are likely to be overestimates compared to estimates of societal catastrophic risk. This is because for a society, the main source of catastrophic risk is large-scale disasters whereas for an individual, the most obvious source of catastrophic risk is death. Large-scale disasters are less common than individual deaths, and therefore individual catastrophic risk is likely to overstate catastrophic risk.

Expected growth rate of real per capita consumption

The growth rate of real per capita consumption, not income, should be used in the Ramsey Rule. While both are welfare-related variables and are often strongly correlated, we want to estimate the SRTP for consumption and doing this accurately requires use of consumption data, as long as the data is reliable and representative. We argue that the official data published by the Statistical Office of the Slovak Republic is reliable and representative, so we make use of this data in our analysis. However, we also analyse forecasted growth in GDP per capita to inform our likely range for this parameter.

Moreover, the period over which to average consumption growth should be carefully selected. For countries which have enjoyed high living standards for some time such as the UK and US, it is suitable to use data covering a large number of past years to smooth out business cycles. However, the Slovak Republic is an former European transition economy and therefore past growth is likely to be less indicative of future growth than for countries such as the UK and US (Florio and Sirtori, 2013). This supports restricting attention to more recent consumption data and analysing forecasts, as long as they are reliable. A final consideration is that the start of the COVID-19 pandemic was associated with a significant decline in consumption growth so the inclusion of data from 2020 onwards requires careful consideration.

Elasticity of marginal utility of consumption

As outlined in Table 9, there are many ways of estimating the elasticity of marginal utility of consumption. We make use of the *equal sacrifices income tax* approach in line with many other studies (Evans and Sezer, 2005; Florio and Sirtori, 2013; Freeman, Groom and Spackman, 2020; Groom and Maddison, 2019; Lopez, 2008). This is a validated and straightforward method which only requires data on average and marginal income tax rates, data which are publicly available for the Slovak Republic.

Evidence needed to estimate the interest rate facing the higher authority

As outlined by Paulden et al. (2016), the discount rate should align with the real interest rate faced by the higher authority that funds the health system if a social decision-making perspective is adopted. In the Slovak Republic, around 80% majority of healthcare spending is publicly funded, so the appropriate interest rates for analysis are the real costs of borrowing facing the country’s government. We therefore follow Paulden et al. (2016) and estimate real government bond yield curves for the Slovak Republic using data published by the National Bank of Slovakia (NBS).

3.3 An estimate of the discount rate for the Slovak Republic

3.3.1 Base case estimates: social rate of time preference for consumption

Our base case estimates come from estimating the SRTP for consumption. To estimate the SRTP for consumption, we treated each of the terms of the Ramsey equation as independent parameters (parameterisation) and estimated each of them separately using publicly available macroeconomic and demographic data for the Slovak Republic covering suitable time periods. The data was obtained from the Statistical Office DATAcube portal and the Ministry of Finance website. We also validated some of this data with data published by the OECD and World Bank.

Our best estimate for an appropriate social discount rate for the Slovak Republic is **3.3% per year**. This falls to 0.97% if the wealth effect is ignored. Table 11 provides detail on the methods and data used to estimate each of the parameters.

TABLE 11: BREAKDOWN OF THE BASE CASE DISCOUNT RATE ESTIMATE BASED ON THE RAMSEY EQUATION – SRTP APPROACH

Parameter	Value	Methodology	Justification	Data sources
Pure time preference	0.00%	N/A	A positive rate of pure time preference would imply that governments and health systems should give more priority to future generations even ignoring catastrophic risk and economic growth which lowers the utility of additional consumption in the future. Please see page 24 for further detail.	N/A
Catastrophic risk	0.97%	Gross mortality rate in the Slovak Republic in 2019 Gross mortality rate = (deaths/population) x 100	Data on the gross mortality rate is available for 2020 and 2021, but the COVID-19 pandemic has been associated with an increase in the rate which is unlikely to be sustained over the coming decades. We therefore chose to use the rate in 2019, a better reflection of what the rate would have been currently if the pandemic had not happened.	Statistical Office of the Slovak Republic (2023b)[7] The World Bank (2023)[8] also publishes data on the Slovak Republic gross mortality rate which we have used to validate a value of 0.97%
Elasticity of marginal utility of consumption	1.34	Average value of the Stern formula for the period 2010-2019 for a single individual earning average earnings and no children. The Stern formula is given by $\mu = \ln(1-t_{marginal})/\ln(1-t_{average})$	The equal sacrifices income tax approach has commonly been used to estimate the elasticity of marginal utility of consumption in order to estimate social discount rates. Groom and Maddison (2019) state that most previous studies have used data on single-individual households with no dependents.	OECD (2023)

[7] The population refers to the number of permanently resident population as of 30 June (1 July) of the reference year. This concept was used in the demographic statistics of the Slovak Republic until 2010 inclusive. Since 2011, the arithmetic mean of starting (1 January) and final (31 December) stocks of population has been calculated.
[8] The crude death rate data published by the World Bank is also based on mid-year population sizes

		where $t_{marginal}$ and $t_{average}$ are the marginal and average income tax rates for an average earner, and ln is the natural logarithm operator. For $t_{average}$ we used the average rate of income tax and employees' social security contributions. For $t_{marginal}$ we used the net personal marginal income tax rate.		
Growth rate of real per capita consumption	1.75%	Average annual growth rate of real final household consumption per capita over the period 2010-2019.	It has been argued that this component should be based on growth data spanning a long period of time to average out business cycle fluctuations. However, for a former European transition economy like the Slovak Republic, historic growth is likely to be less predictive of future growth compared to countries such as the UK and US. Therefore, we averaged over a relatively short span of time (2010-2019) but one which is in line with the calculation in MIRI (2017). We chose not to use forecasts for our main analysis because official per capita consumption forecasts are not available for the Slovak Republic. We do however make use of forecasts for GDP per capita to inform our choice of range for the growth parameter (please see pages 36-37). In many studies it is not made explicit whether household or total consumption is used. Total consumption includes consumption by government and non-profit institutions serving households	Historic aggregate consumption data: Statistical Office of the Slovak Republic (2023a) Population data for calculation of per capita consumption: Statistical Office of the Slovak Republic (2023b)

			(NPISH). We chose to use household consumption in line with Evans and Sezer (2005). The average annual rate of growth in total as opposed to household consumption per capita over this period is 1.69% so our base case estimate is not highly sensitive to the choice of measure.	

Table 12 presents a breakdown of the range and our best estimate, comparing it to the official estimate in MIRI (2017). The justification for the parameter values used in the best estimate is provided in Table 11. The justifications for the upper and lower bounds for each parameter is provided below.

TABLE 12: OHE RANGE AND BEST ESTIMATE COMPARED TO (MIRI, 2017)

	r	=	δ	+	L	+	μ	x	g
OHE range	**3.0% - 5.3%**	=	0.00% -	+	0.75% - 1.35%	+	1.28 - 1.44	x	1.72% - 2.77%
OHE best estimate	**3.3%**	=	0.00%	+	0.97%	+	1.34	x	1.75%
MIRI (2017)	**5.3%**	=	0.00%	+	0.99%	+	1.30	x	3.30%
Difference = MIRI – OHE best estimate	**-1.97%**	=	0.00%	+	-0.02%	+	0.04	x	-1.54%

Catastrophic risk (L)
For our best estimate, we use a value of 0.97% for the rate of catastrophic risk. In line with several other studies (Florio and Sirtori, 2013; Evans and Sezer, 2005; Seçilmiş and Akbulut, 2019) we base our estimate of catastrophic risk on the gross mortality rate. We use the mortality rate in 2019, the most recent data point before the COVID-19 pandemic which was associated with an increase in the reported mortality rate. Paulden et al. (2016) highlight that the risk of large-scale disasters, which is a better indicator of catastrophic risk for society as a whole, is typically smaller than individual mortality risk, and our estimates should be interpreted with this in mind.

We use a range 0.75% - 1.35% for catastrophic risk. 0.75% and 1.35% are the minimum and maximum annual gross mortality rates in the Slovak Republic over the period 1960-2021. These occurred in 1961 and 2021 respectively. Although the minimum comes from over 80 years ago, as mentioned above, the individual rate of catastrophic risk is likely to be higher than the social rate of catastrophic risk, and therefore 0.75% may not be significantly lower than the true social rate which is the appropriate rate to use in the calculation of a social discount rate. The maximum comes from the second year of the COVID-19 pandemic and therefore may be higher than in normal times. However, the death rate may be expected to rise in the coming decades due to an ageing population and lower birth rate so this maximum may be a better indicator of future mortality risk.

Elasticity of marginal utility of consumption (μ)
For our best estimate, we use a value of 1.34 for the elasticity of marginal utility of consumption. This makes use of the common equal sacrifices income tax approach using the Stern formula (Table 11). We use average and marginal income tax data averaged over the period 2010-2019. Although tax rates are less volatile than consumption growth for example, we chose to take an average over several years to smooth out any short-term economic and political effects on tax rates.

We use a range of 1.28 – 1.44 for the elasticity of marginal utility of consumption. 1.28 is the minimum value of the Stern formula for a single average earner without children over the period 2010-2019. This value occurred in the year 2019. 1.44 is the maximum value of the Stern formula for the same taxpayer over the same period. This value comes from the year 2010.

Expected growth rate of real consumption per capita (g)
For our best estimate, we use of value of 1.75% for the expected future growth rate of real consumption per capita. This is the average annual growth rate of real final household consumption per capita over the period 2010-2019. We ignore data points occurring after the start of the COVID-19 pandemic since this represents at most a medium-term shock in terms of its impact on consumption growth. Also, we use a relatively short period of data to increase comparability with MIRI (2017) and

in response to the argument that past growth is likely to be less indicative of future growth for former European transition economies (Florio and Sirtori, 2013). Further detail is provided in Table 11.

We use a relatively large range of 1.72% - 2.77% for expected growth in real consumption per capita. 1.72% is the forecasted average growth rate of real per capita household consumption over the period 2024-2025. This average is based on only two data points but may be indicative of expected future annual consumption growth than a long period of historic growth.

This lower bound is validated by longer-term forecasts for growth in real *GDP* (not consumption) per capita. Although GDP per capita and consumption per capita have different interpretations, they are typically highly positively correlated. Figure 4 shows a time series for the annual growth rate in real GDP per capita, combining 10-year moving averages of actual historic growth and forecasts from the OECD. The forecasted average annual growth rates of real GDP per capita over the periods 2023-2030 and 2023-2060 are 1.8% and 1.3% respectively based on data published by the OECD.

2.77% is the average annual growth rate in real household consumption per capita over the period 1996-2025, the largest range for which data on real per capita consumption is publicly available. We have used this as a realistic upper bound because it is based on a long period of data and therefore business cycles will have been smoothed out. However, as discussed above, the Slovak Republic is a former European transition economy and therefore growth rates further back in time are likely to be less indicative of future growth, hence why we do not use this as our best estimate.

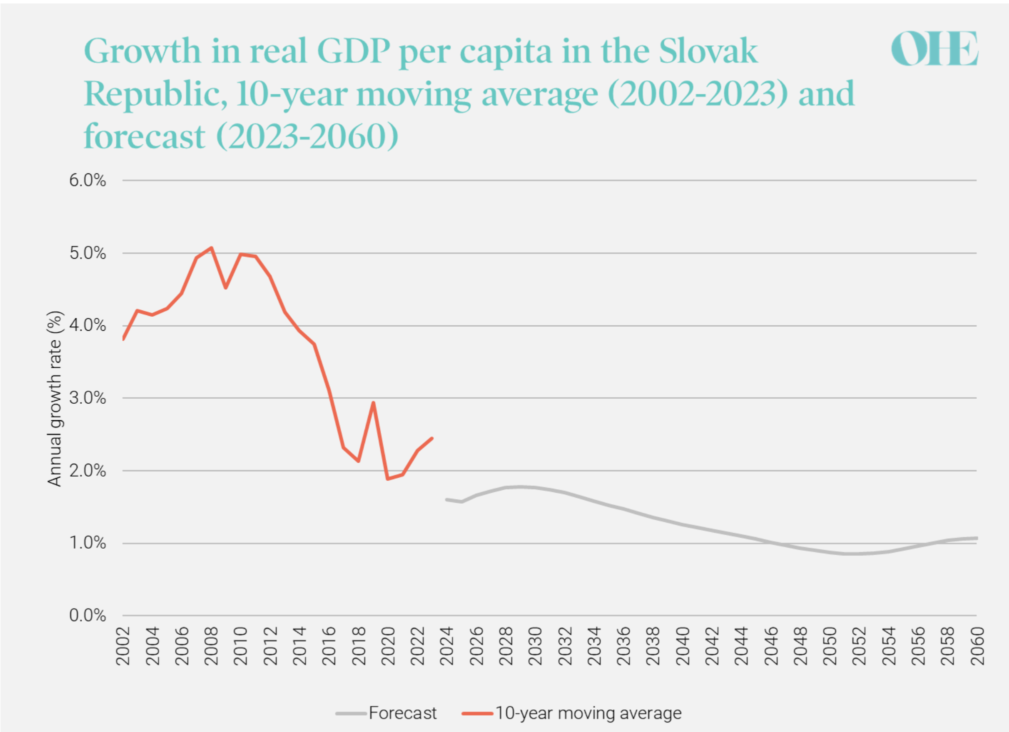


FIGURE 4: GROWTH IN REAL GDP PER CAPITA IN THE SLOVAK REPUBLIC
Source: OECD (2023)

Notes: 10-year moving averages are reported at the end of each 10-year period. For example, the data point for 2002 is the average annual growth rate over the period 1992-2002.

3.3.2 Real cost of borrowing for the Slovak government

As discussed in section 3.2.1, the discount rate for costs and effects should be aligned with the SRTP for health when taking a social decision-making perspective. Paulden and Claxton (2012) show that the SRTP for health is a function of the real cost of borrowing faced by the higher authority that funds the healthcare system. We follow Paulden et al. (2016) and analyse real government bond yield curves. It is important to note that various market-based interest rates have been used in practice to set discount rates for the evaluation of health interventions (Khorasani et al., 2022). These include market rates of return and interest rates or government bond yields.

Methodology
In order to explore this perspective, **we have estimated the real yield curve for the Slovak Republic** similarly to Paulden et al. (2016) - who conduct similar analysis for Canada. We use data on Slovak Republic government nominal bond yields published by the NBS. To convert the nominal spot yields into real spot yields we used the NBS inflation target of 2% as a proxy for long-term inflation expectations and subtracted this from the nominal spot yield for each maturity (ranging from one year to 15 years). Figure 4 shows our simple estimate of a real bond yield curve for the Slovak Republic based on this methodology.

Unlike the SRTP for consumption approach which gives one discount rate, we have one discount rate for each maturity. The real yield for a bond with a maturity of 10 years is approximately 1.5% so outcomes expected to occur in 10 years' time should in principle be discounted using this rate.

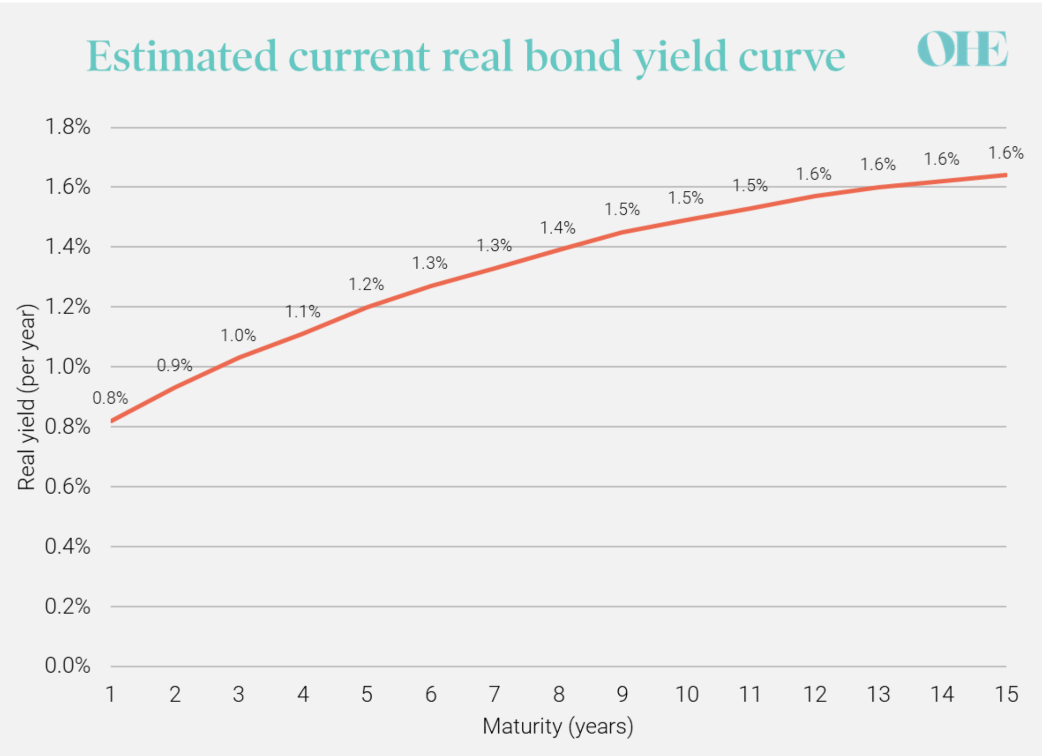


FIGURE 5: ESTIMATED REAL BOND YIELD CURVE FOR THE SLOVAK REPUBLIC
Sources: Nominal yields: Národná Banka Slovenska (2023a). Inflation target: Národná Banka Slovenska (2023b)

Notes: the yields shown in Figure 5 are zero-coupon yields estimated using the Nelson-Siegal-Svensson method. These nominal yields are adjusted for different coupons and other cash-flow conditions. As highlighted by the National Bank of Slovakia, estimated zero-coupon yield curves reflect interest rate expectations for the maturities covered (in this case 1-15 years).

Results
We estimate that the appropriate social discount rates to apply to flows occurring in the first 15 years after the specific public program under analysis are 0.8% - 1.6% depending on the year in the which they occur. A 0.8% rate should be applied to flows occurring in the year after the intervention increasing to 1.6% for flows occurring 15 years after the intervention. It has not been possible to estimate discount rates for flows occurring beyond 15 years into the future because of the lack of data for maturities longer than 15 years.

This analysis suggests that a time-variant discount rate is appropriate for health economic evaluations. Although some HTA agencies recommend a lower discount rate for long-term costs and effects (typically those expected to occur more than 30 years after the intervention), this is a much simpler version of time-variant discounting than what the yield curve suggests. Having a separate discount rate for costs and effects occurring in two- and three-years' time might not be practical.

It is important to note that these discount rates are significantly lower than the SRTP for consumption that we have estimated. This may be because bond yields are strongly correlated with interest rates and interest rates in Europe, as elsewhere, have been low (near-zero) for many years now. This highlights that one benefit of the SRTP approach is that it is less sensitive to monetary policy than the real cost of borrowing.

4 Discussion and Recommendations

4.1 Discussion

Our estimates suggest that a reference case discount rate of 3.3% per year is more appropriate for the evaluation of public programs in the Slovak Republic, including healthcare programs and reimbursement of new health technologies, than the 5% rate currently required by the Ministry of Health. Our range of 3.0% - 5.3% is relatively large and has a median of 4.1%, 0.9 percentage points lower than the current official rate and 1.2 percentage points lower than the value calculated in MIRI (2017). Our best estimate of 3.3% is 0.8 percentage points below the median, but we argue that it is based on the most appropriate data spanning the most appropriate time periods and therefore we consider it to be the most plausible estimate within the 3.0%-5.3% range.

The difference between our best estimate and MIRI (2017) is explained by the fact we use average growth in real *consumption per capita* (1.75% for 2010-2019) instead of average growth in real *aggregate GDP* (3.3% for 2010-2020). In the official calculation, the growth rate of real consumption per capita was proxied by the average annual growth rate of *aggregate* real GDP over the period 2010-2020. This was 3.3% at the time of calculation. However, it is more appropriate to use data on growth in real consumption per capita. There are two important reasons for this:

1. Firstly, aggregate GDP does not have as clear a welfare implication as GDP per capita. Two countries may have the same total GDP but if country A has double the population of country B, then average or per capita GDP (a common measure of living standards) is higher in country B. Therefore, dividing total GDP by population before calculating the growth rate removes the effect of population growth.

2. Secondly, consumption and GDP may grow at different rates, regardless of whether population growth has been accounted for. Based on the latest Slovak Republic macroeconomic forecast release, aggregate real household consumption increased by 1.8% over the period 2010-2019, significantly lower than the 3.3% rate used in the official calculation. If MIRI had used data on aggregate household consumption instead of aggregate GDP (but still not accounting for population growth), it likely would have ended up

with a significantly lower growth estimate but one which is ultimately more appropriate for estimating the SRTP for consumption.

We therefore chose to analyse growth in real consumption per capita instead in line with much of the literature (Paulden et al., 2016; Florio and Sirtori, 2013; Evans and Sezer, 2005; Freeman, Groom and Spackman, 2020; Moore, Boardman and Vining, 2013; Seçilmiş and Akbulut, 2019).

We have taken a conservative approach to estimating a uniform discount rate. Specifically, our estimates ignore growth in health opportunity costs and the consumption or monetary value of health which would provide theoretical justification for differential discounting i.e. a lower discount rate for health than costs.

- **A lower discount rate for health than costs may be appropriate if health opportunity costs grow over time.** Table 10 shows that different rates should be applied to costs and effects if the opportunity cost of new health investment is expected to change over time. More specifically, if the decisionmaker is facing a binding budget, the discount rate for health effects should be lower than for costs if health opportunity costs grow over time. Since new health investment will displace health elsewhere under a binding healthcare budget, the opportunity cost of new health investment is the marginal cost effectiveness of current health spending. Identifying whether the discount rate for health needs to be adjusted requires estimates of factors such as growth in the healthcare budget, the efficiency of marginal technologies, and the utilization of existing non-marginal health care services. As highlighted by Attema, Brouwer and Claxton (2018), estimates of these factors are lacking and estimating them is beyond the scope of the current work.

- **A lower discount rate for health than costs may be appropriate if the consumption value of health grows over time.** Table 10 also shows that under a budget-constrained welfarist or extra-welfarist perspective, the appropriate discount rate is partly determined by the growth rate of the consumption value of health i.e. society's willingness to pay for health. If this willingness to pay is expected to increase over time, then it will be appropriate to use a lower discount rate for health effects than costs. As with health opportunity costs, estimates of the growth in the consumption value of health are lacking and estimating them is beyond the scope of the current work.

There is uncertainty around our estimates for the SRTP for consumption, partly due to the economic and demographic impacts of the COVID-19 pandemic, but we have taken appropriate action to address this. There is uncertainty around the true values of each of the parameters of the Ramsey Rule. For example, expected future growth in real per capita consumption is inherently uncertain given that it relates to future consumption. Also, there has been both a significant economic decline and an increase in the gross mortality rate associated with the COVID-19 pandemic, affecting our estimates for the growth and catastrophic risk parameters. It is often preferable to use recent data but including data from the COVID years (2019-2022) may distort our estimates of consumption growth and catastrophic risk in 'normal times' which is what we want to estimate.

4.2 Recommendations for the Slovak government

1. **Lower the reference case discount rate from 5% to 3.3% per year:** Our estimates suggests that 3.3% per year would be a more appropriate discount rate. This is a large reduction but is based on the most appropriate macroeconomic and demographic data. The reduction would also bring the discount rate more in line with similar countries such as the Czech Republic (3%) and Hungary (3.7%), as well as the UK (3.5%), which is commonly used as an international benchmark.

2. **Explore whether differential discounting is appropriate for either the reference case or sensitivity analysis:** Whether differential discounting is appropriate depends on whether the opportunity of new health investment in terms of the cost-effectiveness of the healthcare displaced by the new investment is expected to grow over time.

3. **Update the discount rate range for sensitivity analysis in line with the new reference case rate(s):** For "indeterminate" parameters, the Ministry of Health currently requires that models should be analysed using the "most likely value" reduced by at least 30% and separate models using the most likely value increased by at least 30% (Ministry of Health, 2011). It is unclear whether the discount rate is deemed an "indeterminate" parameter, but the impact of different discount rates should be explored in sensitivity analysis, especially for technologies with long-term effects. Lowering the reference case discount rate from 5% to 3.3% will narrow the range based on the current methodology (from 3.5%-6.5% to 2.3%-4.3%) so whether this remains an appropriate range should be given separate consideration.

4. **Explore whether it is appropriate to apply a lower discount rate to long-term costs and effects**: There is strong empirical support for time-declining or hyperbolic discounting in which a lower discount rate is applied to costs and effects occurring beyond a certain number of years (Attema, 2012; Bleichrodt, Gao and Rohde, 2016). France and Denmark already recommend this form of discounting, with the first threshold being 30 years after introduction of the technology.

5. **Ensure the discount rate and discounting method is consistent with other public sectors:** One barrier to changes in the discount rate may be that it would reduce consistency with other public sectors such as education, transport, and the environment. The Ministry of Health should explore interactions between the discount rate in the health care system and discount rates in other public sectors. Differences in discount rates across public sector services should be justified.

6. **More transparency on choice of discount rate and discounting method, including making related data resources publicly available:** We recommend maintaining highly frequent updates of the data for these key parameters along with the development of a "smart" discount rate tool that updates itself with the latest official macroeconomic and demographic data for future updates of discount rate for the Slovak Republic. As discussed above, data on consumption growth and data required for the estimation of the elasticity of marginal utility of consumption are particularly important.

7. **Continue to update the discount rate every four to five years in line with updates to HTA methods in other countries.** The Slovak Republic will continue to change economically and demographically and this has implications for the social rate of time preference for consumption and other evidence relevant for the setting of discount rates. The best available data and methods should be used to calculate an appropriate rate.

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