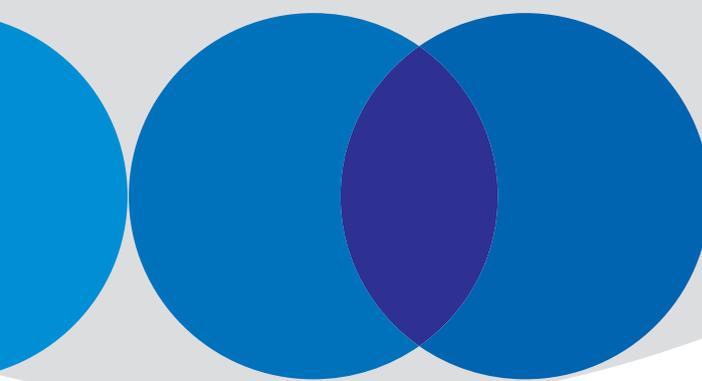


The discount rate in the evaluation of public investment project

29 March, 2017



The discount rate in the evaluation of public investment projects

Proceedings of the conference

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**Commissariat général à l'investissement
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France Stratégie**

chaired by:

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Présentation

Problématique

Dans un calcul socioéconomique, l'actualisation consiste à ramener à une date unique des grandeurs monétaires ou monétarisées qui s'échelonnent dans le temps. C'est un élément déterminant du calcul socioéconomique des projets d'investissements publics qui ont des impacts très éloignés dans le temps.

En pratique, la prise en compte du taux d'actualisation dans le calcul socioéconomique des projets présente de fortes différences suivant les pays. C'est notamment le cas entre les États-Unis, le Royaume-Uni et la France.

Aux États-Unis, les taux d'actualisation de référence sont multiples. Depuis 2003, l'Office of management and budget (OMB) recommande d'appliquer deux taux d'actualisation de 3 % et de 7 % constants dans le temps. Le premier correspond au rendement moyen des obligations d'État à dix ans, considéré comme une estimation du taux social de préférence au temps. Le second est le rendement moyen avant impôt du capital privé, considéré comme une estimation du coût d'opportunité du capital.

Au Royaume-Uni, le taux d'actualisation en vigueur est fondé sur la règle de Ramsey et décroît dans le temps. La formule est : $\alpha = \delta + \gamma\mu$. Le premier terme ($\delta = 1,5\%$) est interprété comme une combinaison de la préférence pure pour le présent et de la prise en compte du risque catastrophe. Le paramètre « élasticité de l'utilité marginale de la consommation (γ) » est égal à 1 et le taux de croissance de la consommation par habitant μ estimée à 2,0 %, qui est décroissant dans le temps. On obtient ainsi un taux d'actualisation de 3,5 % ($\alpha = 1,5\% + 1*2\%$). Par ailleurs le Trésor britannique considère qu'un taux d'actualisation important pose problème pour les évaluations socio-économiques au-delà de trente ans et notamment les évaluations à très long terme (au-delà de 100 ans). S'appuyant sur les travaux théoriques de Weitzman et Gollier, qui montrent que le taux d'actualisation peut être décroissant dans le temps lorsqu'on intègre l'incertitude dans les prévisions de croissance, l'administration britannique retient ainsi pour les évaluations au-delà de 30 ans un taux décroissant par palier de 3 % (après 30 ans) à 1 % pour des évaluations au-delà de 300 ans.

En France, le rapport Lebègue (2005) a repris la base théorique utilisée par le Trésor britannique en proposant un calibrage spécifique en cohérence notamment avec les anticipations de la croissance de l'économie française. Il préconise un taux d'actualisation sans risque de 4 % jusqu'à trente ans et décroissant jusqu'à 2 % au-delà. Le taux de 4 % ($\alpha = 1\% + 2*1,5\%$) est obtenu en retenant un taux de préférence pure pour le présent $\delta = 1\%$, une élasticité de l'utilité marginale de la consommation $\gamma = 2$ et une croissance économique de référence $\mu = 1,5\%$. La décroissance proposée est obtenue en prenant une prévision de croissance économique par tête qui peut varier entre deux extrêmes, 2 % avec une probabilité de 2/3 et 0,5 % avec une probabilité de 1/3.

Actuellement, le taux d'actualisation français fixé par la Commission Quinet (2013) reprend le cadre théorique du rapport Lebègue développé dans le rapport Gollier et propose un taux d'actualisation sans risque de 2,5 % passant à 1,5 % au-delà de 2070. À ce taux, s'ajoute une prime de risque de 2 % pondérée par un coefficient spécifique à chaque projet en

fonction de la sensibilité de sa rentabilité à la croissance économique. Cette prime de risque dite systémique de 2 % est augmentée à 3 % pour les périodes d'évaluation au-delà de 2070.

Ces derniers éléments sont le résultat des arbitrages successifs qui ont eu lieu au regard de la croissance économique estimée de la France et de l'intégration du risque dans le calcul économique. Le système d'actualisation doit tenir compte en même temps des anticipations de la collectivité sur l'augmentation de la richesse nationale, des incertitudes liées à cette croissance économique et des risques que font courir les différents projets sur les finances publiques dans le cas où cette richesse anticipée ne serait pas aussi forte qu'espérée. Le système recommandé par la Commission Quinet (2013) consiste à actualiser les différents flux générés par un projet à un taux différent en fonction des betas socioéconomiques de ces flux. En pratique, plusieurs projets ont présenté leurs bilans avec les deux chiffrages : avec un taux d'actualisation fixe et avec des taux comportant des primes de risque.

Le colloque du 29 mars 2017 :

- fait le point sur les controverses théoriques autour du taux d'actualisation et de son usage ;
- explique comment ces controverses modifient ou pas les référents officiels et les pratiques des administrations ;
- revient, dans la table ronde finale, avec plusieurs représentants d'administrations, sur les enjeux associés au choix du taux d'actualisation pour discuter *in fine* de la meilleure pratique à retenir.

Presentation

The issue

Discounting is the usual method used to compare the future value to a present value. This is a key parameter for evaluating the socio-economic impact of public investment projects decades in the future.

The use of the discount rate when determining the socio-economic impact of projects varies widely depending on the country, as is the case with the US, the UK and France.

In the **United States**, the discount rates are multiple. Since 2003, the Office of Management and Budget (OMB) recommends that project costs and benefits be discounted at two constant rates: 3% and 7%. The first is the average return to 10 years government bonds, taken as an estimate of the social rate of time preference. The second is the average before-tax rate of return to private capital, taken as an estimate of the opportunity cost of capital.

In the **United Kingdom**, the discount rate is based on the Ramsey formula ($\alpha = \delta + \gamma\mu$) and declines over time. The first term of the formula ($\delta = 1.5\%$) is interpreted as a combination of pure time preference and risk of catastrophe, under which the future effects would be eliminated or severely altered. The elasticity of the marginal utility of consumption (γ) is set to 1, and the economic growth rate (μ) is estimated at 2.0%, yielding a discount rate of 3.5% ($1.5\% + 1 \cdot 2.0\%$) for 30 years. For periods of time longer than this – or even beyond 100 years – the UK Treasury considers a high discount rate would be a problem. The UK government draws on the theoretical works of Weitzman & Gollier, which show the discount rate may decrease if the uncertainty of growth forecasts is taken into account, when evaluating over more than 30 years. It uses a discount rate that decreases in increments from 3.0% beyond 30 years to 1.0% beyond 300 years.

In **France**, the Lebègue Report (2005) proposes using the theoretical base used by the UK Treasury while adapting it to forecasts for French economic growth. It recommends a rate of 4.0% up to 30 years, decreasing to 2.0% beyond this. The 4.0% rate ($1.0\% + 2 \cdot 1.5\%$) is obtained by applying the Ramsey formula, with the pure time preference rate $\delta = 1.0\%$, elasticity of marginal utility consumption $\gamma = 2$ and economic growth $\mu = 1.5\%$. The proposed discount rate is obtained by using two scenarios of economic growth: 2.0% with a 2/3 probability and 0.5% with a 1/3 probability.

Currently, the French discount rate set by the Quinet Commission (2013) draws on the theoretical framework of the Lebègue Report, which was further developed in the Gollier Report (2010). The Quinet Commission (2013) recommends a risk-free discount rate of 2.5% to 2070, gradually declining to 1.5% beyond 2070. A risk premium, specific to each project, is added according to its macroeconomic sensitivity (β) and systemic risk premium. It is set at 2.0% up to 2070 and 3.0% beyond 2070.

This was the result of decisions made in light of France's economic outlook and by incorporating risk in the economic calculus. The discounting system must take into account the country's expectations as to the increase in national wealth likely to take place, the uncertainty of these expectations and the risks the different projects represent for the public purse in the event the expectations are unfounded. The discounting system recommended by the Quinet Commission (2013) consists of discounting the different monetary flows a

project generates at different discounting rates, according to the socioeconomic risk premiums on the flows. In several projects, two calculations were undertaken with a constant discount rate and with discount rates taking into account risk premium.

In terms of the aims of the conference, they are as follows:

- discuss the theoretical controversies surrounding the discounting rates and their use;
- look at how these controversies influence government guidelines and practices;
- explore the challenges related to discounting rates and the best existing practices in a round table with government representatives.

Introduction

Roger GUESNERIE

*Professor at Collège de France
Honorary President, Paris School of Economics*

Anne-Marie LEVRAUT

*Vice-president, The General Council
for the Environment and Sustainable Development*

Fabrice LENGART

Deputy Commissioner general, France Stratégie

Roger GUESNERIE

Good afternoon, welcome to everybody. Our meeting is entitled “The discount rate in the evaluation of public investment projects”. This is a very general subject, but our prospect today is original in the sense that we aim at comparing what is done in different countries outside France. People will inform us about what is done for the cost-benefit analysis in the UK, the US and at the European Commission, and so on. Thanks to everybody for being there. The program is composed of three parts:

1. The discount rate: economic theory and the controversies surrounding its use;
2. The discount rate in practice and in different countries;
3. Round table: what is the best discounting system?

This morning, we had some ideas of what will be said this afternoon since there was a preliminary meeting in which discussions started. We will certainly come back to these discussions further on. Also, the round table has a very open program: what is the best way to do with the discount rate? We will certainly come back to a firm conclusion! But I am not entirely sure. If we do not do that, I however suppose that we will do something useful this afternoon.

I will not go any further for this presentation since we have the pleasure to welcome Anne-Marie LEVRAUT, vice-president of the General Council for the Environment and Sustainable Development (CGEDD). She will tell us a few words.

Anne-Marie LEVRAUT

Ladies and gentlemen, it is both a pleasure and an honour to open this seminar attended by such distinguished scholars and economists from all over the world. I must confess that I am not an expert in socio-economic evaluation of public infrastructures, but no need to be an expert to understand what is at stake behind the technical debates around the choice of a discount rate determination of economic hypothesis on which you base your studies.

To put it in a nutshell, what is at stake is the perception of the future, and more than that the preparation of the future. In this respect, I would like to present our Ministry of Environment, Energy and Sea as the Ministry of the Future. The areas of public action we are in charge of are mainly characterized by long-term perspective. In order to study the life cycle of a public infrastructure, or to analyze the effects of a collective decision regarding environment, the relevant period must be measured in decades. The method for evaluating the discounted monetary flows characterizing the studied project decisively influences the socio-economic evaluation of this project.

The General Council for the Environment and Sustainable Development therefore pays a special attention to the implementation of the discounting method, but it takes into account the various stakes in sustainable development and the interest of future generations, in particular the conservation of scarce natural resources. Though, it is tempting to simply transpose the tools of finance into the public economic calculation; it is necessary to carefully check the applicability of such tools in this particular domain.

The criteria for the choice of a discounting method for public investments gave rise to numerous reports in France and abroad. Today, we have the privilege to welcome the authors of such French reports, Christian GOLLIER and Émile QUINET. With Daniel LEBEGUE, they have defined the principles to be applied for this kind of exercise. To correctly apply these principles, several questions must be answered. First of all, it is necessary to specify the multi-annual macroeconomic framework in which we are situated. For the future, the value of the good or the service depends on the foreseen context and on

the system of relative prices in particular for the scarce goods or the ecological services.

The economic works of these last years have shown us that it is not enough to simply make forecast. It is also necessary to take into account hazards around the average values. Furthermore, we must take into account the probability of major crisis or disruptions which are not possible to neglect given the long periods of analysis involved in the public socio-economic calculations. Firstly, how can we take into consideration the climate change consequences and the occurrence of major technological changes?

Secondly, it is necessary to be able to determine the sign of the correlation of the effects of a project being studied with the evolution of the macroeconomic framework. Doing this, we could diversify the risks, but not deciding systematically on projects that look more profitable, but in fact that magnifies the consequences of a global crisis. However, we would be incited to invest in no regret projects.

Thirdly, it is useful to refine the ways of determining the discount rate before having reduced the uncertainties around the effects resulting from this investment project. For example, from inadequacies in the models of traffic forecast. Having suggested the adoption of conservative discount rates, the QUINET report recommended complementary works in these various directions. About four years after this report, it is high time to achieve it. It is all the more urgent to do so as the same report wisely recommended to update the public discount rate approximately every five years in order to take into account the inevitable updating of macroeconomic forecasts. We hope that today's conference will allow us to move forward to operational prescriptions. Thank you.

Roger GUESNERIE

Thank you very much. The second presentation in this introduction is not Michel YAHIEL who is the general commissioner of France Stratégie: as it has been told this morning; he is outside France. So, the speaker is Fabrice LENGART; he is deputy general commissioner of France Stratégie.

Fabrice LENGART

Good afternoon everybody. I must excuse Michel YAHIEL, who was to come to say a few words of opening for this seminar, but unfortunately he has gone to Guyana overseas department in France which is in social unrest presently and he is part of the ministers' delegation. This is why I am replacing him today. I am much honored to welcome you for a very attractive seminar on the discount rate.

As some of you may know, France Stratégie used to be the Commissariat général au plan which was first headed by Jean Monnet after World War II more than seventy years ago.

He was in charge of the reconstruction and the planning of the French economy. Since that period, we have been involved in socio-economic evaluation even if the words were not probably the same by that time. We have been involved in the discussions regarding discount rates to be used in the French evaluation of public investment projects. There is no use to come back to the importance of the discount rate.

First, let me say that in France, United Kingdom and the United States, we presently have three different discounting rates. In the United States, since 2003, the Office of Management and Budget has recommended that project cost and benefits be discounted at two constant rates, 3% and 7%. The United Kingdom uses a discount rate that decreases from 3.5% to 3% beyond thirty years to 1% beyond 300 years. In France, according to Christian GOLLIER works, we presently use two different terms for the discount rate; first, a risk free discount rate of 2.5% up to 2070, and gradually declining to 1.5% beyond 2070 and a risk premium

specific to each project and is added to this risk free discount rate. This risk premium is the product of the macroeconomic sensitivity of the projects, the beta coefficient, and a systemic risk premium. The latter is set up at 2% up to 2070 and 3% beyond. When the beta macroeconomic sensitivity of the project is not known in France, we recommend the rate of 4.5%.

To summarize, we have five different discount rates. We have constant rates of 3% and 7% in the United States; we have a decreasing rate in the UK starting from 3%; in France, we have the discount rate of the global economy at 4.5% and a discount rate taking into account the beta of the project.

As you can see, the result can be as followed: we have taken a real project case in France of some hundred kilometers of highway in the South of France to have a better vision of the differences between the different methods assessing what are the discount rates. We have extended the calculation to 2170; and we obtain the cumulative social net present value for the five discount rate method. In each case, the cumulative value is of course negative at the beginning; because at the beginning of the period, there are spending and no benefits, but at the end for two of them, the social net present value is negative, and for the two others, the same project has a social net present value strongly positive.

Of course, that result is not a satisfactory situation for the policy-maker; or alternatively should we consider it as too satisfactory for him? In fact, that is the reason of our seminar. At the end of this day, what I would like to know if we must launch the works of that project in the South of France in the region of Toulouse, or to stop them. By the way, I have been told that Christian GOLLIER and James HAMMITT have worked in Toulouse. So, they should be very interested into that question.

More precisely, during this seminar, we are looking forward to discussing the theoretical controversies surrounding the discounting rates and their use, looking at how these controversies influence governing guidelines and practices, and looking in the end at the best practices and the best way to go further.

A last word to give my thanks to Luc BAUMSTARK and Christian GOLLIER who have prepared this seminar and now I give them the floor. Thank you.

The discount rate: the economic theory and the controversies surrounding its use

Christian GOLLIER

*Professor of economy
University Toulouse Capitole and London School of Economics*

James HAMMITT

*Professor of economics and decision sciences
Director, Harvard Centre for risk analysis*

Nicole EL KAROUI

*Emeritus Professor of applied mathematics
Pierre and Marie Curie University*

Roger GUESNERIE

We have a very heavy program. The first part of the day concerns the economic theory and controversies surrounding its use. There are three speakers: Christian GOLLIER, James HAMMITT and Nicole EL KAROUI. You will have fifteen minutes; I have been instructed to be firm!

Christian GOLLIER

Thank you very much. Let me tell you why indeed I am in Toulouse, but currently I am in London. So, my conflict of interest concerning this project is between Toulouse and Castres which is indeed a contention to my home!

I would like to apologize I think there is so much misunderstanding between academics and practitioners on this topic of discounting. I do a lot of very complex stuff in my research; I did that for the last twenty years. I want to go back here to the real basics of the foundation of discounting.

When we think about the long-term discount rate, we are talking about our responsibility towards future generation. If we select a large discount rate, we will not do much for the future generation; this means that our responsibility is quite limited. If we reduce it, we will do much more for them and that means we are more concerned by long-term future. So, the discounting problem is related to our duty towards long-term future and distant generation.

To illustrate the current dilemma in controversies that are not solved, here is a recent report of the White House for climate change, in particular trying to make a proposal for the social cost of carbon; it was published less than two years ago. In the US, they still do not have any agreement about what discount rate to use for this estimation and they propose 5%, 3%, 2.5%. You can see the big difference between the estimation for the social cost of carbon. We are still disagreeing about how to do that.

There are two basic approaches to estimate discount rate. There is one approach I would call it "positive approach"; there is an opportunity cost of capital. If you decide to invest in windmills or photovoltaic panels to fight climate change, you will not be able to use this capital for schooling or investment in hospital. We need to organize this opportunity cost of capital. This is one approach to estimate the discount rate.

The other approach is particularly useful for long maturities and so for future generations. This normative approach is based on social preferences. If we are talking about our responsibility towards future generation, here we are talking about ethics. What is our duty here? How do you model this duty? How do we balance the need to improve the welfare of the different generations who will live on this planet? So, we need to fix a social objective in determining in a second step what discount rate is to support those objectives.

I will approach these two approaches sequentially. The positive approach is very classical. As a discount rate, we should use the rate of return observed on the market of investment projects with a similar risk profile compared to the risk profile of the project you are evaluating. It is just a pure arbitrage argument. You must have the same price for two identical goods. If you have two investment projects with the same cost, the same maturity and the same risk profile, if there is one whose return is larger than the other, you should invest in that project. So, you should use a discount rate, the rate of return observed on the market for those other assets for investment with the same risk profile. The simplest case is for risk free project. We know the opportunity cost of capital for risk free project is the interest rate you observe on sovereign bonds of the corresponding country. But if the project is risky, you need to take into account that risk; you need to evaluate the riskiness of your project that you will measure the beta of your project and look at price of assets with similar beta on the

market and see what is the expected return or average return of those assets and use that as a risk-adjusted discount rate. That kind of arbitrage or positive argument leads to relatively low risk free discount rate. On page 7, you have the data for different countries over a long period. You can see that those risk free discount rates are very low.

On the contrary, for risky projects, if you have a project whose risk profile is similar to a portfolio of diversified equity, the reference discount rate should be the average rate of return of those portfolios of equity in those different countrywide markets; that leads to relatively large discount rates.

The problems with this approach are many. First, are those markets efficient? Asset price is the right price signal of the scarcity of capital in the economy. There is a lot of writing to think it is the case. Look at the vast literature on corporate finance; all the agency problems we have on financial markets. But moreover in particular for long horizons, there is a very basic fact we have known it since 1956 with Robert SOLOW paper on overlapping generation model; we know that when future generation cannot trade today on market with us there is a simple market friction here. The fact that future generation cannot trade on the market today imply that prices on those markets do not well recognize the interest of all present and future generation; therefore, the price that equilibrates supply and demand on this market are not socially efficient; they do not recognize fully the diversity of preference and interest on the market. That kind of argument suggests that the positive approach could be useful when the maturity of your project is relatively limited. But when it is large, when you have a long maturity it becomes quite problematic; moreover, for very long maturity we just don't observe risk free rate on the liquid market for maturities above thirty or forty years. I speak under the control of Nicole here!

This is why we need to go to a normative approach. I just wanted to list a bunch of papers and I will not cover them, but this is just to give you an idea of how lively this area of research is. It is between environmental economics, asset pricing theory and also applied macro. There is a very nice recent paper by GIGLIO, MAGGIORI & STROEBEL published in the Quarterly Journal of Economics. They have tried to estimate discount rate from the real estate market for maturities of 350 years. In the UK, you can be the owner of a land or a house for 300 years or 301 years. After that, you lose your ownership; it goes back to the original owner. So, you can compare houses with 300-year maturity of property rights and typically the same house, but with 301 years. You can look at the reduction price when you purchase the 300 years rather than the 301 years. From this difference in price you can evaluate the fact to hold the house for one more year. Typically, they get a discount rate for real estate assets at 2.6% for maturities above 100 years.

The main point I want to make in this presentation when we talk about discount rate, we are talking about ethics. When we are talking about discounting for long maturities, we are basically asking how much sacrifice the current generation should do for the benefit of future generations in order to determine whether it is socially desirable to do so, we need to fix an objective. In economics, to determine the global inter-generation objective when we evaluate a project, action or policy, we take the sum of the utility of the different people who will be stakeholders. Here, we are talking about the flow of different generations who will live on this planet. You get something like an objective function like the one on page 11. You take the sum, this is an integral, and I should have said it, but this is in the honour of Nicole who prefers integration and continuous time models!

If you look at this weighted sum of flow of future expected utility, because of uncertainty, it is of course important when we think about 300 years. If we note C_T , the consumption of generation 300 years, we don't know what it is today. We don't know how prosperous future generation will be; so we need to recognize this by taking the expectation of that assumed expected utility.

In order to determine whether a specific investment project characterized by a structure of cash flow could be stochastic, whether this project increases or reduces at the margin this objective function; this is equivalent and it is very easy to check; testing whether a marginal project like this one increases or reduces welfare V_0 ; this is exactly equivalent to determine whether the net present value of the flow of expected benefit is positive or not. The net present valuation test is a test of welfare. That is completely crucial to keep in mind. We can talk about deeply finance arbitrage condition and all the same kind, but at the end of the day, we are talking about whether we improve the global common wealth in the society. The rate at which you need to discount a flow of expected future benefit is given by this complex formula. Depending upon the assumption you make on the utility function, or on the stochastic process governing the growth of the economy, the growth of C_T , you get different solutions for the risk-adjusted discount rate represented here. If you give me your beliefs about the growth of the economy, it could be probabilistic with a stochastic process, it can be very complex; you give me your representative utility function and I will be able to compute this right inside and I will give you the discount rate. Over the last fifteen years, France Stratégie has been examining exactly that question and only that question when it was concerned by the discount rate. It is not more complicated than that. This is the idea.

Let me give you the basic idea from this formula, this general idea that the net present valuation test is a test of welfare improving or not. Let me give you the main ingredient for whether this investment project makes the job or not. The main reason why ρ_t is positive is because in a growing economy, investing for the future increases intergenerational inequality. In a growing economy, we are the poor guy. The future generations are the wealthy guys. We have asked us, the poor one, to invest for the benefit of the wealthy future. If we are inequality-averse, I think we are, we should accept to investing for the future only if the rate of return of the project is large enough to compensate for this negative-adverse effect of investing for the future in a growing economy. Discount rate is the minimum internal rate of return of a safe project if we are talking about safe project that compensates for the fact that you increase intergenerational inequality when you do this investment. Depending upon your degree of inequality aversion, depending upon your belief how fast the growth will be in the future you get a small or a large discount rate. That is the main ingredient, it is risk free; you add risk to this idea, and I have done that along my research over the last fifteen years, but the main ingredient is that one.

The ingredient in this formula comes from the concavity of the utility function. Here, I have represented the utility of consumption and its ingredient concave. If we are in a growing economy we are currently consuming this; the future generation will consume that, and so transfer in consumption from us, the poor to the wealthy, it is one to one, it will reduce some utility of the different generations. That is the main ingredient. On top of that, you can add risk. The simplest way to do that is to recognize a geometric Brownian motion; if you do that you don't get much. Of course, introducing risk in the main idea of inequality aversion, in which direction do we go in terms of risk free rate? This is quite relatively easy to understand. If your future becomes more uncertain, do you want to sacrifice more the present or do you want to sacrifice less of it? Here, I am talking about saving. When your future income is uncertain, you want to save more; this is a precautionary saving.

What you do and this is a common factor we have seen and tested for many years, when there is more uncertainty, people save more. What we see at the individual level, we should also do it at the collective level. How do we force the community to save more and invest more? We do it by reducing more the discount rate and more investment projects will pass the test of positive net present value. If you represent uncertainty by a geometric Brownian motion that does not much reduce the interest rate. There are many ways to force risk to be a more important ingredient to drive the choice of the discount rate; one possibility is to recognize that for long maturities, geometric Brownian motion is not a good representation of

what we believe about a decent future. There may be catastrophes. We could go back to Stone Age because we lose all this knowledge due to wars and epidemic or other events; we could imagine a lot of things, Markov process, or Poisson process with discontinuities. If you do that, risk becomes very important and the kind of calibration that has been done in my commission, in the QUINET commission, we came out of this kind of computation with numbers that become quite credible.

I agree that it is very hard to try to describe the complexity of our belief about the prosperity of the future generation who will live on this planet, but we need to do that. At the end of day, our responsibility towards future generation strongly depends upon what we believe about whether in the business as usual those future generations will be much wealthier than us, or may be no so much, or maybe they will be much poorer than us. Recognizing that and calibrating that kind of ideas in a model like the one I have just presented on the previous slide give you the technique to go from the ideas, from the basic ingredients of inequality aversion risk and believes to the choice of the discount rate. Thank you very much.

Roger GUESNERIE

Thank you very much. The next speaker is James HAMMITT who is Professor of economics and decision sciences, Director of Harvard Centre for risk analysis. You have also fifteen minutes.

James HAMMITT

It is a pleasure being here. Christian shared with me some draft slides which cover a lot of material that I have covered. I thought I will just address two topics complementary to what he was talking about:

- The first one is discounting when outcomes of policy interest are correlated with that kind of growth; here I want to talk about a specific approach proposed by US National Academies of Sciences Committee which I was a member. We released our report in January 2017. The subject of the report is how the US should calculate the social cost of carbon. It did not tell what the number should be, but we have made a lot of suggestions for models they could use and ways they could calculate better than they have been in the past.
- The second one, we talked about it and Christian had his own C_T which meant real consumption, real in the sense that any inflation has been adjusted out, but we always talk about real consumption and discounting, but it is a pretty complex entity. We hear consumption as made up of many different components and that matters that I want to highlight all about that.

So, on the first topic, Christian did show, I think he re-explained that the Ramsey formula where the idea is that the discount rates are equal, so future utilities are to be discounted at δ , and then the second term which depends on two factors, γ , the degree of inequality aversion between periods and g , the growth rate of real consumption. Of course, the growth rate of consumption is uncertain; that implies that the real discount rate is also uncertain because of the function of this uncertain growth rate.

Now, imagine we have some future consequences, v_T . We want to calculate the present value if we want to know it is worth to spend there to get that future value. So, that of course is also uncertain and we have been talking so much in our discussions today about uncertainties others than the discount rate, but obviously in projecting consequences centuries on the future there are many things around uncertainties.

What we want is the expected present value which is the expected value of the product and the discount factor, and the future value itself, so e^{-rt} is a discount factor; v_T is the future value. Principally, we want to multiply those and then take the expected value of that. In practice, what we often do is to take the expected value of the uncertain discount factor which decreases with time. That is the γ discounting, the idea that Martin WEITZMAN introduced and Christian GOLLIER contributed a lot to; multiply that expected future consequences, or perhaps the certainly equivalent account for risk aversion on those. So, that is simplifying this expected value of the product as the product of the expected values; that's correct if and only if those two terms are independently distributed which will be true sometimes, but it will often not be true. If there are not independent, then in principle we want to discount different realizations of the outcome at different discount rates. This is essentially what I thought Christian was going to talk about and that others will about the paid risk premium and the risk adjustment. But what we suggested in this National Academics Study was that you could actually simulate the fact that the growth of the economy, the magnitude of climate changes, how they are mutually dependent, and use that to calculate the expected present value more directly.

On page 4, this is a simple illustration representing uncertainty about future growth as there are three possible constant discount rates which are equally likely: 1%, 2.2% and 3.3% per year; t in the Ramsey rule, we adopt that δ equals 1.1% and a degree of inequality aversion 0.88; if you use those values, you then get three possible values for the real discount rate, 2%, 3% and 4% which are equally likely.

On the graph page 5, I am showing you the discount factor; note the vertical axis and its ladder of net scale, "1" at the top and "0.00001" at the bottom. The highest line, the blue one, is the discount factor at 2% discount rate; the bottom line is the discount factor at 4% discount rate; then, we also calculated the average discount factor which is the yellow line that starts out where the average discount rate 3%, but this is the result essentially the average discount rate converges to the average discount factor, and converges to the discount factor corresponding to the lowest discount rate; so, it starts off relatively steep and the 3% rate and then it gets flatter and flatter; that's the yellow line that is asymptotic towards the blue 2% line of the method. It goes over to 2300, it is three centuries roughly.

Assume these are the possible climate damages (page 6) that are associated with different degrees of economic growth. The way it is calculated was from a grid assessment model and they have the features that damages are larger when the economy grows more rapidly which is plausible, but not necessarily true. But if the economy grows more rapidly, then we might have more risk of damage to climate change. Again, with such a ladder, by 2300, we see climate damages varying between ten and one thousand of magnitude.

Then, on page 7, we want to discount each of these damage pairs at a discount rate that corresponds to the same rate of economic growth; so multiply a discount factor from the previous page by these damages, and you see what we get. You have three curves almost identical; again it is the same order of scale, "1" at the top and "0.01" at the bottom; so the factors were essentially using a high discount rate when economic growth is rapid which is the case where damages are large, and those large damages are discounted at a high rate, that doesn't matter so much to climate change. Inversely, when the economic growth is low, damages are low; the discount rate is also low so that the present value of those damages is actually quite similar across the three scenarios. This is not drawn here, but the expected present value which has been the vertical average of these three curves, it goes quite similarly to those curves.

I will illustrate our recommendations for how the US government and others might be trying to calculate social cost of carbon taking into account uncertainty about how it is discounted.

Other topics, I will just say a few words about the idea of what do we mean when we say real consumption and how could we measure and calculate projected in the future. The point is that consumption is a portfolio of many things, market goods, non-market goods and the like; over time the relative prices, the relative value of these different components shift quite radically. On health, it is clear that the monetary value of health increases with income, so health is a good thing, longevity is a good thing; if you are richer you want to pay more for your health and longevity.

Imagine when we think of longevity, imagine the valuable life year right now is V Euros and we are thinking of what is the value of an additional life year in some point in the future; if the discount rate on consumption is r , growth rate in income is g ; I will assume that the value of life here is growth roughly at the rate of income which is reasonable given what we understand. So the present value of one life here in T years will be our discount factor e^{-rT} , a continuous time difference; times the future value which is V which will have grown by a factor e^{gT} , T being T years. This obviously simplifies the V times, $V \cdot e^{-(r-g)T}$; so, the effective discount rate on health is $r-g$, it is not r ; the discount rate is, Christian explained, the question of how much we sacrifice now to get something in the future; so how many life years we will want sacrifice now to get one more life year in the future; the answer to that question involves discounting at a rate $r-g$, not on r , not on g .

If you think about components of real consumption they have changed radically over time. Real consumption means that if our consumption is constant, individual wellbeing is constant; different portfolios of goods can lead to the same total utility wellbeing. Obviously, a lot of things we all used daily in our life did not even exist a hundred years ago. You could say their prices a hundred years ago were essentially infinite; the services they produce were either available only through some technologically very inferior means or not available at all. Bill NORDHAUS did a great study of the cost of domestic lighting. People have wired their homes or their caves for millennia. He tried to construct an index of the real price of lighting and found even over the relatively recent past from 1800 that the price of domestic lighting relative to other consumer goods and relative delivering common-like fell by a factor of more than a thousand; so radical changes on relative prices.

If we take another example from health in the United States and similarly in France, over last century, life expectancy at birth increased by several decades; so in terms of lifetime wellbeing, how long you live is clearly an important contributor to that; consumption also increased very substantially. Then, these numbers have served for another paper by Bill NORDHAUS where he calculated that the monetary value of the gain on longevity over the period 1800 and 1990 was approximately equal to the monetary value of the gain and pre-calculated consumption. If you could ask the question: would you rather keep your consumption and go back to longevity of a hundred years ago, or would you prefer to keep your current longevity and go back to the consumption of about a hundred years ago? If you say, that is a relative hard choice; that's essentially his point that the two gains are comparable in magnitude.

As Christian did show, for a single good, the discount rate depends on future growth and consumption, and also depends on uncertainty about that future growth and consumption. When you recognize the real consumption is made up of many different components, the problem gets more complicated and the discount rate even for any one of those components like consumption of lighting or other depends on the growth rate of all the other components and the uncertainty in the growth rate of the other components.

Thinking in historical terms about interest rates over the last century we might be trying to understand how much of that interest rate might have done the changes in health and longevity rather than only changes in material consumption which had been measured; as

we think about this kind for the future we want to think about quietly changes on health and longevity, environmental poverty, all kinds of other things that are likely to change. With that, I will just summarize by saying there is a need to incorporate the dependence between future consequences and economic growth; one way to do this is explicit simulation as I illustrated; it can also be done by other models like the risk premium using consumption based capital pricing model and so remind us all that the real consumption depends on many components and maybe we are trying to think a lot more carefully about the factors involved. Thank you.

Roger GUESNERIE

Thank you. The third speaker is Nicole EL KAROUI, emeritus Professor of applied mathematics at the Pierre and Marie Curie University.

Nicole EL KAROUI

I have some advantage because the presentations of Christian GOLLIER and James HAMMITT were a good preparation for these questions. I want briefly to introduce myself as in some ways I am an outsider in this place because I have no experience and culture in macroeconomics in particular in the evaluation of the long-term public investment project. I cannot use your vocabulary; my work is essentially based on the financial market. The question of vocabulary is very important because in general economists and probabilists have not the same vocabulary to speak of the same things, but we will try to have a mutual understanding. I have some long experience in financial markets and for twenty-five years I have been working on interest rate problems. I started at la Caisse des dépôts a very long time ago on bond problems. By that time, there were no yield curves in the market at the Banque de France. At that period, I was responsible of a well-known Master Program and I contributed to the abstract theory of interest rate, change of numeraire and yield curve dynamics for a very long time. And also, during ten years, I was a consultant in model validation in the French bank still on the interest rate products. In a more academic point of view, I wrote some different papers about theoretical problems, optimization problems in portfolio/consumption optimization.

This is the reason when some friends spoke to me about this conference I was very interested in assisting to. There was a little move and I am now presenting some remarks on what we know about this discounting interest rate for the evaluation of long-term public projects.

With a long experience in the financial market, we have a very different time horizon. In the finance, we have a very short-term horizon; we can readjust our evaluation every day as well as hedging. It is very complicated to understand what the meaning of very long-term project is when we have to invest for twenty-five or thirty years, and only after that period to see some benefits. At the same time, there is some common background in some sense. One example is the Ramsey rule and thanks to the previous speaker who developed precisely these different notions.

The first time I saw the application of the Ramsey rule, the fact we could discount at constant interest rate for fifty or eighty years, I was very surprised. I understood that we had some fluctuation in the discount rate, but I thought it was too complex to be used, but it worked may be in this case. We have the discount interest rate, but I do not understand if the question is to find exactly the good constant interest rate or propose some model or some situation where it is possible to obtain this kind of representation, in particular the choice of the utility function of the dynamic of the underlying.

The main question for me and I see it is the main one: what a wrong discount rate for public

policy is. As we can observe very different representations and motivations, I have no intuitions of how people in the economy measure the difference between the use of some particular discount rate or another, and when we can say that such discount rate is not a good one. What is the measure of this one? I know and I understand the basic theory that can explain what the motivation is or how we can explain this kind of dependence of time preference for the present and also the risk aversion, the growth of consumption, but I do not decide how we can say that this one is not the good one. Obviously, we want to use this discount rate to evaluate public projects, it is not clear for me why we can decide to use such one and the consequence of this choice is because we are selecting some particular projects with reference to another. I think that it is also very important to have more intuition of the impact of the discount rate, and also political discount rate because if not, it is difficult for me to agree with different values of parameters for so long-term projects for five years, ten years or twenty years. This is may be the main question I have.

I have also some more technical interrogations, but they are not so important. As a probabilist, I still have big difficulties to consider all parameters as constant for a very long period. In particular, it is not clear for me how you can estimate a rate of preference for the present, the δ , but it is not very important. I want also to remark that consumption rate c_t as an initial value of c_0 , we have also to define the marginal utility of consumption $u'(c_t)$; this is the basic tool to define the theoretical discount rate. To establish the previous formula given by Christian, we obtain the rate by some small perturbation method which gives this formula R_t ; this is the rate at time zero for the discount rate for the time T ; this is a δ minus the logarithm of the expectation of the marginal utility of the consumption normalized by this marginal utility taken at the level c_0 .

To obtain a constant parameter as in the Ramsay rule, it is essentially obtained if you assume that the log of the dynamics of the consumption rate is a Brownian motion, not depending on the time very stationary in some sense and also that the utility function is a power utility.

What is the main merit of the power utility? It is easier to make some calculations, but also when we make the question of $u'(c_t)$ divided by $u'(c_0)$, c_0 disappears from the formula. We have also a normalized parameter only by expressing some rate of different quantity, but by not introducing the importance of how do you see the level of consumption, the level of the economy; I think this is not completely indifferent.

The second point is in fact that there is a strong link between the point of view of the discount rate for this economic point of view and the same kind of calculation in finance because if you put the ratio between $u'(c_t)/u'(c_0)$ with a discount $-\delta_t$ as a $Y_t(c_0)$, depending on c_0 , this process in some sense is a stochastic pricing kernel. What is the meaning of this one? If you have some cash flow at t , if you want to know the present value of this cash flow as developed by Christian, we take the expectation of the cash flow $Y_t(c_0)$. This is a standard pricing rule in financial market, but in this particular case $Y_t(c_0)$ in other interpretations played exactly the same role. By applying this point of view, we obtain the net present value of any cash flow in the future obviously because we calculate the expectation of B_t times $Y_t(c_0)$. We have to introduce correlation dependence and covariance in some sense. If you try to recover the R_0 of this operation, we can recover the β and this is a big question.

This pricing rule in financial market, when the market is incomplete, i.e., when everything is not explained by this formulation, this pricing rule is called the marginality pricing rule. In fact, it is very important to know as a marginality pricing rule that it is essentially for small cash flow. This is when the size of the cash flow is not big. When we have large cash flow to evaluate in incomplete market, we have then to introduce indifference pricing; the main thing which happens is that we have some second order risk premium to introduce. This second

order risk premium is in the order of the variance in reference to the sharp ratio as before, and it has a big impact on the size of the position. I am still surprised that in economy we still speak in terms of economic ratio; when we try to calculate the value of risky positions in the future, in particular for the long-term one; may be if the size of the position is very large, it might be important to introduce some specific risk premium in this case to deal with.

The last point I would like to address is in general if we have to apply the theory, it is not so robust if you use as a consumption process for utility, the optimal consumption; this is the consumption that can lead to equilibrium in the economy. This point is very important because if not, we can have some difference between capitalization and this C_t . When we try to use this optimization point of view, it may be interesting for Pareto optimality when we want to allocate different amounts of wealth for these different sectors for example; in fact, there is a very limited situation with the optimized solution; it is linear with respect of the initial condition and when the value function of the problem is very simple. In general, the utility of the representative agent in this case with different kinds of agents and optimization at the equilibrium is more complicated than a power utility. If you try to obtain power utility, it is necessary to say that all agents have the same power utility.

May be, the landscape is more complex. I do not say that it is necessary to take into account this global complexity, but to test what is the impact of this more complex representation of the economic landscape to be sensitive to some parameters of the situation, and how you can say that this representation is still valid.

I just want to remark that at the equilibrium, the problem is a backward point of view. In fact, we start from the end and we try to retro-propagate the information in the estimation, but when we try with the optimal consumption as given, this is a forward point of view. It is better if you have to adapt or modify with different information in your studies; it is more flexible and it is relative also to the dynamic decision and modification, but it is also more complicated because we have no comparable possibility in the forward sense, and technically it is more difficult.

How to use this remark? This is only to test some indicators concerning the more important risk or parameter of deformation in the non-linear representation. I think that we have to keep in mind the various smooth representations. Sometimes, we have to know that the problem is more non-linear than our model and try to define some indicators or some vigilance to detect in advance strong evolution and adapt your view consequently. Thank you for your attention.

Roger GUESNERIE

Thank you. We have no time for discussion, may be at the end of next topic. The point in the three contributions is often coming back on the simplicity of the utility function with the constant elasticity of marginal utility; also Christian claimed that if you take into account uncertainty in the long run you should take into account the possibility of serious accident with the related issue of the possibility of transferring the investment to the future generation James put the emphasis on the relative price argument. It is a more general issue. In the long run, relative prices change. Then, part of the criticism relates to the simplicity of the utility function argument used in the standard theory to think about the discount rate and the Ramsey formula. We will discuss that later on.

The discount rate in practice and in different countries

Ben GROOM

*Associate professor, Environment and development economics
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Lynn KAROLY

*President, SBCA (Society for Benefit-Cost Analysis)
Professor, Pardee RAND graduate school*

Massimo FLORIO

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Roger GUESNERIE

The second part of this conference is devoted to the discount rate in practice and in different countries. The first speaker is Ben GROOM who is an associate Professor in environment and development economics at the London School of Economics. He will say something about the UK case.

Ben GROOM

Thank you. Je suis désolé, mais je ne peux pas parler en français ! J'ai abandonné le français à l'âge de treize ans, c'est donc impossible pour moi ! So, I am sorry we have to do it in English.

I just wanted to talk to you about what is happening internationally. How the policies on social discount have changed over time, how academics have influenced this and how political circumstances have affected this process? But mostly, I want to tell you what other countries are doing in relation to social discounting.

This slide on page 2 takes a long time to get through if we want to go into any details. We are going to skip through. The purpose of this slide is the following: on the top of the time line, you see some of the publications which have come out on social discounting. On the bottom, beneath the timeline, you see some policy changes that took place. What I usually do here is that I present this picture to academics to encourage them to carry on with their work, because there appears to be a clear correlation between policy changes and academic work. The real story is certainly more complicated, but it is just interesting to see how receptive governments have been to academic work. I start with this picture of the characters that have been important in these processes. This is David PEARCE, he was my PHD supervisor. He was very connected to the British government and he wrote a couple of influential papers on social discounting. Then we have Martin WEITZMAN from Harvard University who wrote a several papers on the topic in the late nineties. Finally, in this period of time, Christian GOLLIER also contributed a number of pivotal papers, as you know he has been working on this for a long time, I could not say exactly how long!

These were the chief publications that I became aware of when I was doing my PhD in 2002; In addition were the related empirical applications by Billy PIZER and co-author Richard Newell that you can see there, which also turned out to be influential publications. Following these contributions several meetings took place in the UK. For one, David PEARCE invited Christian GOLLIER to present his discounting work at the Department of Economics at UCL. Seeing this, members of the UCL department offered to summarise the literature for an upcoming publication by David PEARCE. David PEARCE then organised a piece of consultancy work that fed into the UK Treasury's revision of the Green Book guidelines on Cost Benefit Analysis. Subsequently, and very rapidly, UK government changed its policy on discounting. First of all, it changed discount rate from 6% to 3.5% and then it also included a declining term structure of discount rates which is based on the theory of Martin WEITZMAN, Christian GOLLIER, Billy PIZER and so forth.

Then, (2000-2005) various other papers come out; this is what I have loosely referred to this 'Gamma Discounting' Era probably to the chagrin of Christian, but anyhow. Then, the LEBEGUE report came out in 2005. It was really driven by the work of Christian in Toulouse. The French guidelines changed in relation to risk-free discount rate and a declining term structure was recommended following the recommendations of the academic literature.

Here is the STERN review which takes place in 2006. I call this the "STERN era" as well,

since there was a lot of interest in discount rates in the academic work, lots of arguments about the positive and normative approaches to social discounting, and of course in the background here we have climate change; the chief long-term policy question which has really driven the discounting literature for a long time now, mainly because of the sensitivity of investments in climate change mitigation to the choice of the discount rate.

Then, you have some more papers by Martin WEITZMAN followed by an important paper by Thomas STERNER and co-authors (Michael HOEL and Martin PERSSON) who wrote two important papers on some of the issues that James HAMMITT brought up on relative prices. Then, Christian published a number of papers here and his book at around this time (2008-2012). At this point (2010) the USEPA, the Office of Management and Budget changed its guideline to embody the literature on DDRs, citing all the previous papers. In 2011, Maureen CROPPER organized a meeting with the late Ken Arrow, as well as other important figures in academia. There we talked about how to change the US policy from what was in the guidelines at that point (a lower but constant rate for intergenerational projects) and to try and include declining discount rates. Norway changed its policy in 2012, and included a declining term structure of risk free *and* risky interest rates. The Danish government followed the Norwegians. Then, in 2013, we had a meeting in the UK Treasury; it basically summarized what had been done over the past ten years in the discounting literature. The UK Treasury ended up sticking to the policy they had in the first place in 2003: declining discount rates. So, UK Treasury keeps going with that.

Then we have various other publications. CROPPER et al in 2014 was another attempt to change the US guidelines to include declining term structure. In the end, the guidelines remained as they were, with a lower fixed rate for intergenerational projects in the USEPA guidelines; so no declining discount rates there. But in the Netherlands in 2015, they *did* change their guidelines. The Netherlands has accepted the *principle* of declining discount rates for risk free projects; we will see what they do in a minute. Most recently, as James HAMMITT just told us, the National Academy of Sciences report on social cost of carbon reviews all this literature on discounting and recommends among other things looking at declining discount rates and the Ramsey rule, which is a new thing for the US.

So, you have papers being written; and you have governments responding on some level, and it seems likely that the academic research has really been very important in driving these policy changes along the way. Today's meeting is an example of the kind of meeting that appears to be the outcome of new academic research; when I extend the timeline in the picture here, our meeting today would be on the end. It very much fits into this type of interaction between academics and policy-makers that we have witnessed over the years.

So, what does the UK do precisely? The UK uses the social time preference rate, the Ramsey rule (page 3). The δ pure time preference plus the wealth effect which is the elasticity of marginal utility multiplied by growth. There is no risk premium there per se. The UK government has a declining term structure influenced by Martin WEITZMAN and Christian GOLLIER. They thought about time horizons of 300 years, but it is going to be 125 years in the new guidelines. This is the theory, but where in practice do the parameter values come from? The pure time preference δ component has two elements. It is actually the pure catastrophic risk component, the "L", it is a bit odd, but it is supposed to reflect the catastrophic risk loss of benefits, the failure of the project, obsolescence of the project, that sort of thing. It is set equal to 1%. The preference aspect of the parameter is regarded to be 0.5%, leading to a $\delta = 1.5\%$. Expected growth is assumed to be 2% and the elasticity of marginal utility is assumed to be 1, leading to a discount rate of 3.5% ($= 1.5\% + 1 \cdot 2\%$); risk is dealt with by looking at different scenarios and systematic risk is not really part of this appraisal process. The UK Treasury Green Book argues that in any event it was very small

for government anyhow. So, this is for UK.

In the US, they tend to use the opportunity cost of capital approach, Christian talked about two different ways of discounting the opportunity cost or a more normative approach looking at social welfare; the US is firmly in the opportunity cost camp, 7% or 3% as we saw before. Does it have declining rate? No, it recommends 2.5% for inter-generational projects, which is lower but constant for all horizons.. This recommendation was influenced by empirical the work of Richard NEWELL and Billy PIZER. The practice is reflected in the OMB circulars and guidelines posted by the Inter-Agency Working Group; the USEPA has various legal requirements to evaluate climate change to undertake cost-benefit analysis; these are recommendations for regulatory changes not infrastructure per se. Finally, there is no specific risk component in the discount rate, although the high 7% opportunity cost rate relates to average corporate returns and so contains some elements of risk

In Norway, they again follow the opportunity cost and CAPM type approach; they have declining discount rates for the risk free rate. It was based on work by Christian GOLLIER, by WEITZMAN, by NEWELL and PIZER. The risk component comprises of a positive risk premium, and the risk-premium term structure is declining on the basis of the paper by Martin WEITZMAN in 2011. So, in the guidelines the risk free rate is 2.5%, declining to 2% after forty years, and the risk premium is 1.5% declining to 1% after forty years.

In the Netherlands, there is a slightly different story. They are very much in the opportunity cost of capital camp; they accept the principle of declining discount rates following the papers by ARROW, et al (2014), and CROPPER et al (2014), yet they chose a 0% flat term structure for the risk-free discount rate, reflecting the current low values of the real interest rate. The Netherlands has recommended a risk premium for the evaluation of government projects and also of the literature we have seen over the past ten years, they focused not on the risk and DDR side of things, but more on dual-discounting, the idea James HAMMITT presented, where relative prices for things like health, environment and so forth that are likely to change radically over time can be incorporated into the discount rate. In particular for environmental goods, for which scarcity is increasing over time the relative price compared to other consumption goods is going to rise. This effect can be reflected in the discount rate or in the valuation of environmental benefits, but should be accounted for. Now the Netherlands are undertaking research looking at these relative price elements, but they don't want to include them in the discount rate. They want to separate them and include that in the calculation of benefits rather than in the discount rate. So, this is what they do in practice.

This is how I want to conclude. In terms of policy implementation what do we see here across time? We see a lot of theories that have been very influential, whether they were correct or not. WEITZMAN considered discounting "one of the most critical problems in the whole of economics". The papers and book by GOLLIER are extremely important. On the empirical side, you have works by NEWELL and PIZER. Even I have some papers which have been in some way influential in determining the parameters and determining the term structure of discount rates. Yet in practice, these contributions are implemented often in a very ad hoc way, as these four examples illustrate:

- In the UK, we were pioneers in terms of introducing declining discount rate, but we are very poor on the empirics. In fact, the declining term structure comes from the work done by NEWELL and PIZER on US interest rates. That term structure of discount rate is imported from the US. Quite apart from anything else, this has little to do with the social time preference, which is the basis of their social discount rate.
- In the US, you don't have declining discount rates; you have a 2.5% constant rate

which introduces inconsistencies that were pointed out by ARROW et al (2013) and CROPPER et al (2014).

- At least initially, Norway used an incorrect theory of the term structure of its risk premium, citing a a working paper by WEITZMAN which remains rather unsubstantiated; it doesn't fit the general theory of term structure. Why they did do that? Who knows? Christian, Martin and I were at that meeting where we informed the Norwegian government.
- The result of the guidance in the Netherlands is that they would discount risk free projects using a risk premium. It is a constant risk premium for all projects; that is the way they do it, and again it is contentious.

So, the point is there has been some very influential theory and empirics, but the way in which these contributions are applied is something of a mess. So now, in France, you have a chance now to do it well, without messing it up like in some other places have. I think this is the place to end up! Thank you.

Roger GUESNERIE

Thank you. The next speaker is Lynn KAROLY who is President of the Society for Benefit-Cost Analysis and Professor at the Pardy RAND graduate school.

Lynn KAROLY

Good afternoon everyone. It is a real pleasure to be here. I am actually wearing two hats today. As you heard I am the President of the Society for Benefit-Cost Analysis and I want to say a few words about that organization and then talk a little bit about the work that I am aware in the United States on benefit-cost analysis so I might take on the current perspective in the US particularly around the discount rate.

To start with the Society for Benefit-Cost Analysis, we tend to say BCA in the United States rather than CBA. It dates back to 2007 with a mission to improve the theory and practice of benefit-cost analysis and to support evidence-based policy decisions. This really came out of a growing use of a whole array of economic evaluation methods, not just benefit-cost analysis, for cost-effectiveness analysis, cost of analysis, largely with a goal of supporting evidence-based decision-making at all levels, either public or private sectors. Consequently, we structured the organization as one that would drive together scholars and practitioners not only in the US, but globally from a wide array of different sectors including the government in the United States that include Federal state and local, individuals, academia as well as non-profit and private industry. So, it was really a forum that brings together both practitioners in the field of economic evaluation, but also consumers or those who use the results from these types of analysis.

One of our functions is to hold an annual conference. I know that a number of you here in the room were just at our meeting a few weeks ago in Washington DC. Last year, we had over 300 attendees. We are governed by a Board, and two of our Board members are here today in addition to me, it includes Émile QUINET and Massimo FLORIO. They are indicators of the fact that we do have a broader rich beyond the United States, and James HAMMITT you heard earlier also goes back to the founding of the organization.

Another key function for SBCA is publishing the Journal of Benefit-Cost Analysis (JBCA) which is published by Cambridge University Press. It started in 2010. It is too a forum for publishing works in this field as a way of contributing to the advancement both in theory and

practice of these economic evaluation methods.

Just to illustrate this chart list some of the presentations specifically around issues relating to the discount rate from recent conferences. You can see that they touch upon a number of the issues that are being talked about today. Again, we view this as an opportunity to hear from the latest research in the field as well as those who are applying the tools of benefit-cost analysis and issues such as the discount rate in a wide array of policy areas. One of the features of this organization is that we really are focusing on a method or series of methods with application to a wide array of policy areas.

Likewise, the conference status on the full array of topics that are relevant for the fields. In addition to discount rate which I have just mentioned, topics you will see in conferences in the Journal include issues like the value of statistical life for use and benefit-cost analysis, the aspects of addressing uncertainty beyond issues such as the discount rate, various shadow prices that arise in application of benefit-cost analysis, international comparison you have just heard was given in our conference. As I mentioned we have this broad policy relevant topics for which these tools applied. I think that in some senses may be broader than some of the applications currently in Europe, but I think it illustrates the fact that in the United States we are increasingly using these methods to support decision-making across not only traditional areas like in transportation and infrastructure, or the environment, but also in social policy realms.

On page 5, you have some of the articles that have appeared in the Journal, again specific to the discount rate. Just to give you a flavour of this publishing in the Journal and the type of topics being taken up. Of course, this is all searchable and accessible on line.

I think that the Society reflects the state of practice and application of economic evaluation methods such as benefit-cost analysis in the United States. First of all, there is a wide application in the public sector, and of course there is a longstanding relevance with the Federal government for use specifically in regulatory policies, probably one of the main areas that we see interest of those who belong to the Society and our conferences in the Journal, but also infrastructure decisions and social program investments.

What is interesting for the US is that increasingly we are seeing interest in these tools at a State and local level. It has moved down to different levels of government. Decisions that are made in many cases in the same areas particularly in infrastructure and the social policy realm are developing down to the State and local level; so these tools become equally relevant in those contexts. Often in context where they don't have the underlying capacity or infrastructure to undertake this analysis.

We also see application in the private sector in ways that stem because of the growing interest in evidence-based policy making and decision making. An example there includes the fact that as an economist of the RAND Corporation which a private non-profit, we get requires all the time from those who are implementing programs, often at a community level, may be at larger levels, State or national levels. What to have a benefit-cost analysis done? They think that it will help make the case for investments in their particular program or program model whether that's being done with public funds or with private funds. Likewise, when we look in the profit world in the United States, we have large foundations and small foundations. They two are starting to see that this is a tool that they can use to apply in making decisions about where their investments, where their foundation, their philanthropic investments will go both in the direct investments they are making programs, but also in various particular policy areas.

Another development in recent years in the United States is the use of pay-for-performance contracts, sometimes also called social impact bonds as a mechanism for investing private dollars in programs that eventually have a public return and a public sector which pays back the private sector investments. Underlying those mechanisms is usually a benefit-cost analysis because the case has to be made that particular intervention in our program model is going to generate impacts that produce economic benefits that are more than enough to outlay the investments. So, in each of these areas, we see these issues around the discount rate as well as the various other methodological issues and the use of these tools coming to play.

When we talk about guidance in the US, of course we have circular A-4 of the Office of Management and Budget guidance you have already heard reference to. Clearly, this is a key reference for the federal sector and particularly those analyses that are done through the administration, the well-known guidance around 3% and 7%. Because of the broader applicability of these methods, we also have another guidance coming through other mechanisms. James mentioned the National Academy of Sciences work on the social cost of carbon. I was part of the panel that produced the report in 2016 to improve the use in quality of economic evidence, economic evaluation to inform investments in children, youth and families. This broader applicability of using these methods where one of our goals was to improve the quality of these methods and build a greater standardization. A set of recommendations for the approach that would be taken on any given economic analysis that would serve as a reference point that will allow analyses being done by different organizations whether there are a public or private sector to be more comfortable, and particularly with the focus on investments in children, youth and families. That means everything in the United States from earlier intervention programs which address children and families; pre-school programs and visiting programs set with a focus on youth and development of youth who are at risk and investments on adults for example and job training programs.

Another example of this kind of guidance comes from a second panel on cost-effectiveness in health and medicine. In this case, this is specifically on the application to the health policy arena where cost-effectiveness is the primary tool rather than benefit-cost or cost-benefit. This is a panel that is a second incarnation of an earlier effort again to establish standards for the use of these methods in the application and the health policy arena. Just to illustrate what came out of these different efforts, OMB the reference already to the 3% and 7% rates, the National Academies report focused on children, youth and families, our recommended real rate was a 3% rate, but with the expectation that sensitivity analysis would be done. As a matter of course in doing analysis in many cases you may justify higher or lower rate, but their base rate of 3% will be used for the analysis. Likewise, the second panel on cost-effectiveness analysis in health arena also chose a 3% rate with the expectation of sensitivity analysis.

There is a number of other guidance that come from other sectors both public sectors as well as other actors in this field and you have a couple of other ones here; because the Congressional Budget Office or the General Accountability Office are independent and separate from the administration, they don't have to follow the OMB guidelines. So, in each case, they have established guidelines in many cases, guidelines that have been in place for a number of decades now. You can see here CBO traditionally recommend the use of a 2% real discount rate with a sensitivity analysis $\pm 2\%$; the General Accountability Office is recommending using the real yield of treasury debt at the same maturity as the project being invested, so referencing real returns currently, but also with the expectation of sensitivity analysis and including the possibility of declining rates on projects that have longer term consequences and general consequences.

Then, you have another example with the Washington State Institute for Public Policy. It is a research of the Washington State legislator. One of the things they have done is to develop their own benefit cost model that allows them to look at the evidence for a real investment whether in education, in criminal justice or in youth violence prevention, and for each of those different types of programs they can look specifically at cost and benefits. Another thing they have built into their model is a 3.5% real discount rate and they used Monte Carlo simulation to look at presumed distribution of discount rate from 2% to 5%. So, into their simulation the likelihood of a positive economic return includes some uncertainty about the discount rate itself.

I want conclude by offering my observations as to where I think things are developing in the United States especially given this wide array of application of benefit-cost analysis and related methods as well as the differences between public actors and private actors at various ways in which these methods are used. I think that one approach is clearly the use of what we might call reference case or base case; this is because we don't just have one entity or one Agency producing these results, but in many cases results are being produced by a multiplicity of organizations and analysts, and so providing that base case provides a way in which we have some standardization, some reference point on which we have a comparable way to compare different analyses. But at the same time recognizing that there is a need for sensitivity analysis that whatever that base case rate may be, it is not necessarily always applicable given the nature of the particular investment program or policy being considered. So, that may involve sensitivity analysis using discrete changes in the discount rate or as the example I gave with the Washington State Institute using Monte Carlo simulation to look at a distribution of discount rates being varied along with other parameters for which there is uncertainty. Ultimately, when policies involved multiple generations there is a clear movement towards the idea of allowing for lower discount rates to be applied in those cases, but it has not been necessarily formalized into the guidance we have at the Federal level, but increasingly other analyses are taking that approach. Thank you very much and I look forward to our ongoing discussion.

Roger GUESNERIE

Thank you, Lynn. The next speaker is Massimo FLORIO, Professor of public economics at Jean Monnet chair of EU Industrial Policy, University of Milano.

Massimo FLORIO

Thank you very much. I will start by confessing a capital sin; I am an applied economist, this basically means that as an applied economist I am fascinated or challenged by trying to transfer theory to practical decision-making in the real world. In that perspective, my claim to glory is there! This fifth edition of the European Commission guide to cost-benefit analysis of investment projects.

There are some interesting facts in these simple slides. The first one is that this particular story started in 1994, so more than twenty years ago. It started with a first edition which had the main characteristic of being short, twenty pages. When we discussed it with people at the evaluation unit of regional policy, it was not clear which would have been the status of that guide. While there is the European flag in the cover, however there was nothing more than a box in the first pages saying that this is a very tentative document recommended, but certainly not compulsory. In fact, it was a tremendous intellectual challenge and success to get there because what happened in this context was that the Member States gradually realized that the different projects they were presenting to the Commission in order to get substantial funds and forms of grants under the structural funds had to speak the same

language.

The same language in Brussels when we started was really needed because in fact each Member State could present the application in their own language. There were projects in Greek, projects in Portuguese and Italian, and so on. In the case of Greece, I was lucky because I studied ancient Greek at high school; I was also lucky because they use Arabic numbers, so I could at least read the tables and try to understand, so I was happy. This is a joke, but it is a joke about the fact that cost-benefit analysis is very much about establishing a language among different interests, different intellectual histories and different backgrounds. We gradually were required to expand the guide. The bad news is that the last edition is 364 pages which compared with the first one means that we have not been able to be as compact and concise as we used to be. But probably the good news is that now when you open the guide there is a nice picture of the commissioner and he says that this is the “guide” and there is a reference to legislation which makes compulsory using cost-benefit analysis for a project appraisal in the Member States.

The geography of the Member States has been changing between 1994 and 2014. I think it will change again in the next edition with some subtractions and some additions. The other interesting point about the guide itself which is shown by the cover is the expansion of the sectors included; this is not the European Commission work. I have been in charge for the OECD here in Paris to check the practical use of cost-benefit analysis in different OECD Member States. I was surprised to see how the traditional domains are no more transport or energy, or water supply so that if you compare the object on the left which would have been familiar to Jules Dupuit at the École des Ponts et Chaussées which is a bridge. Jules Dupuit would be surprised to find other things in the cover of the latest edition such as windmills, microscopes, robots and so on.

Trying in this changing geography, changing history and change of perspectives, trying to have consistency was the main point. Sometimes, I think that consistency is the most difficult part of the historic way you try to apply ideas into the real world. Yet sometimes, I have been able to convince myself that I am right, but it is much more difficult to convince other people sitting around a table that they should agree about something. The social discount rate is part of this issue in my perspective of consistency. Let me just give you a couple of numbers and then something which is not actually in the guide itself, but some calculations which have not been published and that are of some interest.

The fundamental objective of the cohesion policy or if you wish the original policy is to try to achieve some kind of real convergence across Member States which are so different in terms of economies. We ended up with a recommendation which was retained of having two different social discount rates, a 3% and a 5% for the cohesion countries which are the countries below a certain threshold of the GDP per capita in purchasing power parity. This comprises mainly the new Member States plus Portugal, Spain and Greece, and some regions including Southern Italy and originally the Eastern Landers of Germany. For these countries and regions, we suggested having a 5% social discount rate while for the remaining countries we suggested a 3% rate.

We tried to justify, and I believe that the recent argument to justify the effect of this fundamental difference could be based on a social rate of time preference approach. I will tell you something about some calculations which are certainly unofficial. As you know and as it has been wonderfully reminded in the theory part of this session, the core ingredients of the time preference approach are basically three. The first one has to do with a pure time preference; the second one has a parameter elasticity of utility to consumption; the third one is the growth of consumption per se. If you go to the first component, the pure impatience,

possibly combined as it has been advocated with the catastrophic risk, you have a conundrum. The basic conundrum is that impatience if considered as a fundamental individual preference, by definition it changes across individuals. The point by Ramsey himself about the setting zero to that component in my view has some good argument while the original idea by PEARCE for instance of considering catastrophic risk has also a good argument.

A short cut to considering something which is individual in this catastrophic is the notional debt; certainly, there is a possible catastrophe in our life which is death. The only thing that we likely do not know is when it is to happen, but we know it will happen. It has been suggested even if you can dispute a lot about this that taking a crude death rate for the first part of the Ramsey formula could be a good empirical short cut. I am not discussing it, but let me tell you what it happens if you get that.

If you get that in the context of the twenty European Union countries which are also members of the OECD, not all of them, just the ones for which we have certain data about the tax part of the story, you get a little bit less than 1% for that. In fact, you get 0.97% for the cohesion countries and 0.91% for the more developed countries. The main difference is that the mortality rate is higher in some of the new Member States. For a while, suppose you accept this point and you evaluate rather one for the pure preference component of the formula. Then, there is the elasticity of utility parameter. There are many empirical ways to work with that. We tried to use a suggestion in an old paper by Nick STERN. In fact, it probably depends from whom I learn some cost-benefit analysis when I was at LSE many years ago. In that paper, the idea is just to take the progressivity of taxation, a parameter based on the progressivity of taxation as a way to estimate the durability of the preference of the society for distribution from the rich to the poor. If you get the OECD tax database and you consider marginal and average tax rate, in fact you take the complement to one of those tax rates and the logarithm of them, and you take this ratio, you end up with a very similar value of 1.5 for the elasticity; it is 1.51 for long cohesion countries and 1.49 for the remaining ones with a certain variability across countries with some stronger ability, but not so much.

Then, and this is my conclusion, there is the issue of the growth rate. The growth rate is certainly the most important part of the story not just because it dominates the dynamics, but also because the variance of the growth rate across countries is much higher than the variance for instance of the mortality rate, or the risk of catastrophe or individual preferences, and so on. In that case, we used the International Monetary Fund forecast for the long run of our countries. This is important because you need the forecast not the past values to understand whether the growth is sustained, and we ended up with a lot of differences. For instance, in Italy, the parameter you get is a bit more than one while in countries such as Poland you get more than four. So, when you end up with this variability, you will get something as around a 2% rate of growth for the cohesion countries and it is likely less than 1% for the old Member States in Western Europe. In the end, you end up with two different rates which are dominated by the forecast on the growth rate.

What this has to do with cost-benefit analysis? Clearly, it has an influence on your economic net present value, but the most important point is that you should not confuse in my opinion this kind of variability and the uncertainty you might have about this variability with the risk specific variability. The risk specific variability is risk specific so that what the guide suggests is to do risk analysis in probabilistic form for each of the critical variables so that in the end your expected net present value is distributed as it is shown there in some way after some Monte Carlo extraction, so you do not collapse the information of risk in the social discount parameter, but you have both things. If you are uncertain about growth you should add uncertainty about growth to top up your uncertainty about the cost of the highway, the

passenger traffic demand, the effect of exchange rates and so on. Then, you combine the two things. Thank you.

Roger GUESNERIE

Thank you. We have not a long time, but five to ten minutes for questions. Are there any questions?

Questions & answers

Jean-Pierre ARDUIN

I am Jean-Pierre ARDUIN. I am surprised to have not heard any word on interest rate from the financial market. I remember my lesson from Mr. Malinvaud in the Statistical Institute saying at the equilibrium we have an equality of the internal rate of return to the growth rate and the interest rate. He explained us that it is the investment has been widely and wisely done and analyzed, then we will get a growth, and the growth will be sufficient to pay the interest of the debt. Then, we will also participate on the wellbeing of people, on the capacity to exchange time for wellbeing and save some money to invest and not to be spent immediately.

Roger GUESNERIE

May be, there is a second question.

Jean-Jacques BECKER

I am Jean-Jacques BECKER from the Ministry of Environment. My question is for Mr. HAMMITT. I am not sure to have understood the implication of having to consider economic activity as the aggregation of different components. Is it just a problem of forecasting growth as you have relative prices that are different according to the components, may be you have problems of weighting the different components to get a real figure or a realistic figure for what is the general growth rate, or has this implication on the way you determine the discount rate? Does it mean that the formula usually used is no longer valid? Could you please develop a little bit that? Thank you.

Roger GUESNERIE

Thank you. Is there another question before James HAMMITT answers?

Yan KERVINIO

Thank you for your presentations. I am Yan KERVINIO from the Ministry for Environment in France. I just wanted to pursue on one question. I saw on Nicole EL KAROUI's presentation which is the net present value on accurate objective. It was not first selected. When we go to the Ramsey rule, we start from the initial objective which is to maximize inter-temporal utility of the representative agent. Actually, I wonder whether when you write that you did not already make all the important normative choices. Does it mean that you have potential alternative criteria? And just to quote one, one which has been argued for is the Chichilnisky criterion for those who follow a little this debate. Basically, those criteria do not lead you to renounce to all present consumption which is one of the reasons why it has been argued that discounting could be an important thing to do in socio-economic assessments. My question will be mainly addressed to the first presenter, Christian GOLLIER. It has been argued that we should take a prescriptive normative approach, so what are the main reasons why these alternative criteria are to be discarded from the analysis at the beginning?

Roger GUESNERIE

Two questions are specific. One question is general. Who wants to answer the general question?

Christian GOLLIER

On the first question, the positive approach did with interest rate. With the positive approach, if you have a risk free project and short maturities, look at the interest rate on the market for that save assets, look at the return and if the return of your project is larger than that one, you should invest. It means that you should use the risk-free discount rate. Related to your question is also the Ramsey rule. This rule put a link between the interest rate on the left-hand side of the equation and the growth rate of consumption on the right-hand side. It is not true in general that interest rate and growth rate of consumption, they go together, but they do not need to be equal. Depending upon the value of δ and γ , or g , we have different notations here the interest rate could be larger or smaller than the growth rate of consumption.

Roger GUESNERIE

The second question is for James HAMMITT.

James HAMMITT

I think that both of your points are things I was trying to include; one it just to remind us, we always talk about real discount rate, real interest rate, real consumption; it is not such a simple thing to calculate. But the second is in fact it does matter, think about the personal level. Uncertainty about future wealth leads to precautionary savings mode of. What about uncertainty about future health? Let's assume that medical bills will be covered by the government or something; you do not care about the financial consequences. But does the amount of money you want to save for your retirement depends on how long you think you will be retired? I would say clearly, yes. How uncertain you are about whether you will be healthy and active versus very unhealthy, I think probably it does. If we have got a climate change trying to put a money value on our ecosystem damages is very hard to do. So, does our uncertainty about what the future ecosystems will look like cause us to want to save more in order to have higher material consumption for future generations than if we were more certain about the future ecosystems will look like. I think possibly the answer is that it could be important in that context.

Roger GUESNERIE

Thank you. The third question is again for Christian GOLLIER.

Christian GOLLIER

Thank you. I like your question very much, but I don't know who has asked this question. In fact, I am publishing a book with Columbia University Press; it will be released at the end of this year answering precisely that question. Why discounted expected utility of representative agent makes sense as a representation of our collective objective, intergeneration objective? There are two ingredients to that. The first reason is impartiality. It is the first element and the second ingredient is independent axiom. I will not go into the details of independent axiom, but very quickly the independent axiom means if you prefer to go to theatre tonight or to restaurant, you prefer to go to theatre with a probability of 0.9% than going to restaurant

whose probability is 0.1%. This independent axiom is criticised not only by Maurice Allais, but by many others doing non-expected utility framework. But in a normative ground I believe that collective preference should satisfy this rationality condition.

The impersonality is brought by the will of ignorance. Of course, we have a conflict of interest between different generations. Of course, the future generation wants us to solve the climate change problem. We don't want to do that. If we are not altruistic towards future generation, we don't want to do that as it is costly for us. So, we have conflicts of interest between generations. So, the only way to solve this conflict of interest when we make the decision about whether we should invest or not, let us put ourselves under the will of ignorance. In such case, deciding to invest for the future or transferring consumption, or economic growth under the will of ignorance we don't know whether you will be born tomorrow or in two hundred years from now; consumption growth is risk. If you are born tomorrow you will not consume a lot, if you are born in 200 years in a growing economy you will consume much more. So, risk and inequality are the same things under this will of ignorance.

Therefore, if we accept the independence axiom, we should accept expected utility as a representation of rational behaviour under uncertainty and because under the will of ignorance, risk and inequality are the same things. Expected utility is summing utilities of the different generations as a representation of a collective preference, it is the socially desirable objective function. This is why I consider that discounted expected utility is the only ethically justified representation of our collective preference when we think about transferring consumption through different generations.

Roger GUESNERIE

Thank you, Christian. This is a comprehensive answer. We can take one or two more questions.

Ben GROOM

I want to follow on Christian about the question you asked about the preferences that we wrote down. It is difficult to follow on from Christian after that, but it is worth to go any further a little bit. In environmental economics, there is a classic problem with that preference structure, this is the optimal solution and it does not guarantee sustainability at all. When you write down an ethical framework like that, you have to be aware of this sort of practical outcomes. It is all very well to add here a sort of strict ethical position, but you still have to work through all the implications in practice.

So, the utilitarian solution to many problems leads to consumption going to zero at some point in the actually distant future. The Chichilnisky criterion imagined is something that is away of trying to short-circuit that by having in addition some prerequisite that future generation wellbeing does not fall below some level. There are a lot of other frameworks which you could use which either fitting to a sort of quasi-utilitarian structure or we can ask some philosophers about this and say ethically speaking what should we do about this?

I have actually recently done in a survey of economists on the one hand about how they will treat the Ramsey rule and so forth, but also we did the same survey on a group of philosophers who work on intergenerational ethics. First thing to note, it is very difficult to get numbers out of philosophers! Some of them did, but most of them did not. Second thing to note, there were huge objections to the standard classical utilitarian framework both from the economists and the philosophers. So, what you are asking is a life question.

When I presented this stuff, I actually curated the qualitative comments we got from the philosophers and the economists and I asked the audience to guess whether it was a philosopher or an economist who made this statement. Invariably, they got it wrong. My point of mentioning this is there is some agreement and it is not just the head-banging economists who object to using this framework; a lot of economists disagree with this as well. At the same time there is a lot of overlap between people from other disciplines.

Roger GUESNERIE

Thank you. One more question.

Michel LEPETIT

Michel LEPETIT, from Shift project. First, I was surprised that no speaker did show any curves of interest rate for the last fifty years which is at the heart of the problems and the reason why we are here. Why do we have such a low historical background for real interest rates at the level we have not seen for the last one thousand years? It is a long time during which we have not seen such incredible rates. I have not seen either the name of Mr. NORDHAUS. You talked about Mr. STERN, and there was some discussion about the rates used thirty years ago or twenty years ago which were wrong, 7% or 10%. You could see a curve with public interest rates in France; they were around 12% just thirty years ago or twenty years ago. Why haven't you talked about that? The issue could be we should have not a 2% interest rate, but maybe we should have a 0% interest rate for discounting rate. I have two very practical questions. Works were mentioned for UK and Netherlands. Does anybody know something about discount rate used for instance for the Hinkley Point seventy-year project in the UK? Will it be 3% or 4%, or something lower?

The other question is on Netherlands for the adaptation to climate change. What do they use for their 300 or 500 adaptation project they have done on the polders? Do you know the answer? I would be very glad to know that. Thank you.

Roger GUESNERIE

Thank you. A broad question and a quick answer. Who wants to answer?

Christian GOLLIER

On the current value of the interest rate and what happened over the last fifty years; implicitly, when we present the Ramsey rule we are talking about what you are talking. Over the last ten years, the expected growth rate, the anticipated growth rate was very low. The use of the Ramsey rule forces to reduce the discount rate. If we limit just to the analysis of the Ramsey rule, in the past for the growth rate of the French economy that has been so low, we would have used something similar to what the function market has been using for the interest rate recently. So, we are on the same page, but on the other side of the Ramsey equation, the right-hand side part of the equation.

Roger GUESNERIE

Thank you. I think we have to stop. We have a fifteen-minute break. So, we reconvene at 4.25pm.

Roundtable

What is the best discounting system?

Roger GUESNERIE

*Chair of the roundtable
Professor, Collège de France
Honorary President, Paris School of Economics*

Émile QUINET

Emeritus professor, Paris School of Economics

Arnaud BUISSÉ

Head of public policies, French Treasury (DG Trésor)

Joseph LOWE

Head of economics branch, Public Spending Group, HM Treasury

Burt PORTER

Senior Economist, Council of Economic Advisers, The White House

Davide SARTORI

JASPERS (Networking and Competence Centre), European Investment Bank

Roger GUESNERIE

We enter into the next session which is the final one. It is a Round Table. The participants will tell you what is the best discounting system? This is the question. I propose the following order: Émile QUINET, Arnaud BUISSÉ, Joseph LOWE, Burt PORTER and Davide SARTORI. Émile QUINET is emeritus Professor at the Paris School of Economics; Arnaud BUISSÉ is Head of public policies at the French Treasury (direction générale du Trésor); Joseph LOWE is Head of economics branch, Public Spending Group, Her Majesty Treasury; Burt PORTER is senior economist, Council of Economic Advisers, Washington and Davide SARTORI is a member of JASPERS, Networking and Competence Centre at the European Investment Bank.

The question is simple! I suppose that the answer has certainly two dimensions. The first one is what will be a satisfactory cost-benefit analysis from the theoretical viewpoint, given new theory insights supposed to provide us an improved understanding of the problem (and I think it is the case). The second dimension should take into account the fact that the cost-benefit analysis has to be operational; it can be so only if it is simple enough. So, can we reconcile these two conditions? This is what is behind the question today. I will leave Émile to start and tell us what his way to reconcile them is.

Émile QUINET

I am terrified by the difficulty of the question! So, I will not answer directly. I will do some slalom if you agree.

The first point I wanted to stress is that we have spoken of very sophisticated and complicated models with high mathematics; besides many of them, we have even the most sophisticated part. In my view, it is both necessary and possible to translate the sophisticated methods in simple and comprehensive words. It is a task which should be done, but it cannot be done in such a meeting. It is a work which will take days and months, but it is quite necessary.

Second point, I think that those sophisticated methods and calculation go to results, but we have to judge them to the light of expert wisdom. Finally, we will make calculation about the discount rate, about the risk free rate and risk premium for instance, but at the end of the day we have to choose a value, and such value should be enlightened by wisdom of expert whatever difficult it is, but it is necessary. It is a virtue of the commission we are accustomed to in France, the GOLLIER commission, the LEBEGUE commission and my commission, taking all around people who are coming from various points of view and various ideas, we can come at the end to a value or a method which is approved by everybody.

In the case of my commission, on the risk assessment we had fierce discussions and at the end of the day we recommended two methods which are the β method Christian explained, and the scenario method. In my view, there are not so much contradictory. The β method uses scenarios, the scenario of the random motion of GDP and the random motion of benefit and random motion of cost; those are scenarios. On the other side, if you choose scenarios, you have to fix a scenario in a very standardized manner otherwise the scenario method is a way to manipulation and subjectivity which can be very dangerous. Secondly, the scenario method should take into account the fact that when you change the GDP, the discount rate changes also which is not often the case. Very often, you devise designed scenarios where GDP changes, discount cost changes, but these changes are not linked with each other.

In my view, the problem of the β can be solved. The β can be reckoned, it must be made carefully as it should be made for any econometric estimates, but they can be estimated, we have done it in 2013. The beta calculation should be periods updated, but the principle is rather sound in my view and the results are clearly differentiated. β can be calculated, not for a whole range of projects such as transport projects, not also perhaps project by project because it would be very difficult and time-consuming, but for specific classes of projects for instance mass transit projects.

The last point I would stress on is that we do not think about the discount rate for its own sake, but to help decision-makers. What are the decision-maker questions in terms of long-term investments? Should we make such investments or shouldn't we? If I make it, when should I make it? Between this investment and other alternative ones, which one should I choose? We should spend time on this type of question. They involve stochastic dynamic programming. The method exists and can be implemented. It has been implemented in other cases which are not transport cases, but it can also be used in transport. In my view, it is important to deepen this point because it would show that not only the net present value is important, but also the optimization date. It can be shown that very huge error can be done if you rely only on the criterion of net present value when it is positive. I will not go into details, but I have examples of that kind. To do this stochastic optimization, it is possible to derive rule of thumb. I think that we should go into that direction, into the rule of thumb for project decision for the decision-maker who has to know not only what the discount rate is, but he has to know whether he must do such investment, when he should make it, which investment should be made if he has two investments which are alternative or competitive.

Roger GUESNERIE

Thank you, Émile for this opening of the discussion. May be we can go to Davide SARTORI.

Davide SARTORI

The question is how to reconcile the theory of the CBA in practice.

Roger GUESNERIE

Yes, but what do you say about the best discounting system?

Davide SARTORI

In our case, the answer is easy. We use the European Commission guide that has been presented! By the way, at that time, I was also an advisor and I contributed to draft several major parts of that guide. I know what the spirit of that kind of guidance from the point of view of the Commission was. The idea was exactly to have a common language, something that can ensure consistency across different Member States and across projects from different sectors and different countries. The idea was to set some specific principles that could be valid for everybody and some application rules that could be used in practice in order to develop the CBA. In JASPERS, we support Member States in preparing cost-benefit analysis and the project design, and we use these principles. Obviously, it is not possible to have in a guidance document two specific rules because any project is project specific. This specificity has to be dealt with at the project level. But there are some common rules that can be used and applied.

The spirit of the guidance was that of setting these common rules and then giving freedom to the Member States to specify those rules into some sector or country specific parameters or values. For all the Member States, we define how the value function should be evaluated and then each Member State is encouraged to carry out their own specific analysis and define a value of time that is pertinent for a specific mode of transport in a given country. It is the same for the other sectors, we have encouraged them to value their willingness to pay for a cubic meter of water supply to households or for a kilowatt of electricity generated through solar power plant, and so on. Some countries are doing better than others. For example, Poland is very proactive in this sense. They already have developed a set of more specific guidance at sub-sector level and they also have developed a number of parameters. Other countries are lazier, but they can rely on the general principles. My opinion is that CBA can be used in a very practical way keeping in mind there is a general conceptual framework that has to be adapted case by case according to the specificity of the country and of the project.

Roger GUESNERIE

So, you use different discount rates across countries.

Davide SARTORI

Yes, but for the discount rate, we use the discount rate that has been calculated by Professor FLORIO for the European Commission guidance; it has been transposed into the European regulations. The regulations of the Commission for the use of the structured funds are clearly set a 5% discount rate for the cohesion countries and a 3% for the non-cohesion countries. For me, it works because the regulation also provides the possibilities for those countries to set their own specific discount rate based on their macroeconomic forecast and conditions. So far, none of them has asked for a revision downward or upward of the discount rate. It means that it is working. Up to now, we basically use these as a benchmark. The Member States seem to be happy with that. The only case where Member States have been asking for a revision of the discount rate is in the so-called financial analysis where we measured the financial profitability from the point of view of the investor. In that case, the discount rate used has the impact of affecting the intensity of the grant. This is something Member States are very interested in. In this case, we have received a lot of requests to change the discount rate in order to maximize conditions. All the requests were going into the same direction. But from the social point of view for cost-benefit analysis, the 3% and 5% are always accepted as a good benchmark.

Roger GUESNERIE

Thank you. It is a key point. May be I ask Joseph LOWE to come back on the UK case as a candidate to be the best discounting system...?

Joseph LOWE

Although I come from the Treasury in the UK I was not part of the team that wrote the 2003 Green Book guidance on appraisal including CBA and discounting. I did not work in the Treasury when it was published in in 2003. I would have been proud to claim some authorship for the 2003 edition but I cannot. I have been looking after the Treasury Green Book guidance on the appraisal of alternative uses of public resources since 2006. Last year I finished drafting an updated version of the Green Book in which the discount rate remains completely unchanged from the 3.5% rate which declines in a series of steps after 30 years

just as in the 2003 edition. That new version is not yet published and it has to go through various stages of approval before it is published. You may wonder what is going on and why is it so constant.

The reason why the discount rate was not changed is because of the rather different and more limited role that it plays in public finance than in the theoretical model of the profit maximising firm or individual. In the abstract model discounting including the cost of capital plays a central role in determining how much investment will be made. The total invested being the sum of many separate profit maximising decisions with the discount rate and a including capital costs and a risk premia playing a crucial role in each decision.

Public finance is necessarily not like that. In fact a set of macro level decisions determine the money that is available for public investment. Similarly, there is a politically mediated rationing process which determines how much of this predetermined total will go to health, and how much will go to transport, and so much to welfare and so on. The history of repeated macro level decisions it is arguable is an expression of social choice on resource use.

From the perspective of the analyst it is fortunate that the democratic political process takes care of these macro decisions on taxation and spending policy. It leaves the analysis free to consider the more tractable but still challenging issue of the opportunity cost of alternative uses of public investment and existing assets.

Within this process the role of cost-benefit analysis is not simply to advise on a binary choice between go or stop for a proposal, more importantly it is to support choices between options in scoping and designing a proposal to optimise its value delivered for resources used.

We try to focus not on asset ownership but on service deliver because assets of all kinds are just a means to an end and it is the service delivered that constitutes welfare value. We also look at whole life costs and service delivery for example. If build a hospital to provide medical health services and it has a life of thirty years, you will find the cost of building a hospital is very small compared to the cost of providing health services for thirty years. The question is also do you need one hospital there for thirty years or three smaller health units? Have you looked at the demographic projections for the service area and do you understand clearly what is happening now?

Cost-benefit analysis is wonderful because you can look at the cost and the benefits and the offsets and the trade-offs, and if you are diligent, consider your assumptions and may be unintended consequences. So, it is a wonderful framework if you use it well.

What is the role within that of the discount if already the amount of money available is pre-determined? It is to allow you to compare one proposal with another when they have different lengths and cost benefit profiles. The role is to allow these different proposals to be compared on a common basis even if they are made at different times. This means that stability in the discount rate is very valuable in managing public resources. It makes no attempt to comment on how much you should tax or borrow in total because that decision is made at macro level. There is also no need for the micro discount rate to considering effects on the financial markets because that has already taken place at the macro level when the budget was set, this simplifies the problem considerably for the micro analyst. It simplifies but does not make appraisal and use of cost benefit analysis of cost effectiveness analysis easy, it leaves all the very difficult challenges of how to value different things and plans.

It is arguable that some of the elements that make up our social discount rate could be changed upwards a little here and downwards a little there. There are however uncertainties following the 2008 crisis for example over the average long term growth rate in per capita real incomes and that also influences the wealth element of the discount. We know that any change would be likely to be modest and that it would have only a marginal effect very few long-term projects. But it would however destroy the ability to make comparisons with past decisions on a common basis which would be a material loss to managing public resources. We also know that there are huge challenges in the design of public projects and in the valuation of different welfare costs and benefits and particularly understanding optimism bias and valuing and managing specific risks. There is therefore no gain from a change in the rate and much to lose if we do so we choose to maintain consistency.

We do not usually provide for risk by use of a risk premium. The reason is that in the public sector we cannot insure or totally avoid many risks by cherry picking our projects nor can we manage our portfolio to balance risk. Risk comes with the territory provided by democratic choices about what the state will and will not do. A manager of a pension fund would be concerned to have a balanced portfolio. It would have some high yielding investments and some that were less risky but lower low yielding safe investments. In public finance, we need to find the best way of implementing policies we are given by ministers to minimise and manage their particular risks. The emphasis is on identifying, valuing and managing risks rather than a statistically informed guess at a risk premium. By costing risks of alternative implantation options the this helps support provision of advice on right choice of scope and design of project between many possible alternatives. The different options are to be analysed objectively and any gaming that may happen can be challenged and pushed back through transparency and rational argument and reference to objective facts.

That is why our discount rate is so different yet still important. The work of academic colleagues is also important but they have necessarily to wrestling with the wider macro problems and so their framing of the problem is different. This is where a theoretical academically framed cost-benefit analysis must attempt to deal with the macro level decisions on borrowing inside the discount rate. Our analysis has the burden of these other problems removed by the macro decisions which are already taken by the democratic process. The work done by academic colleagues is immensely valuable to us however for example the issue of hyperbolic discounting or of intergenerational wealth transfers. We learn from these discoveries and attempt to provide solutions in our decision process but not inside our discounting policy.

Roger GUESNERIE

Thank you. And now, I should ask Arnaud BUISSÉ to react.

Arnaud BUISSÉ

I share a lot of what Joseph just said on the importance of the cost-benefit analysis or its dimension, the discussion around the process dialogue, but I have some difficulties in the French case. I don't know if we are maybe less democratic and more technocratic. The fact is how are the chains in the public policy department at the Treasury to have not only the sectoral policies, but also the public finance. So, the balancing of the total is my portfolio with also a lot of other colleagues. The fact is that in France the total part of spending on everything is more or less under the control of the Finance Ministry, but the distribution between investment and other spending is more or less, and rather more than less, in the

hand of the spending ministries.

The fact that you have a discount rate which reflects properly the differences between the different investments is a more critical point. When you look at the case in the GOLLIER and QUINET reports, it is actually quite compelling. If you are taking a discount rate which is the same for every investment, then you will invest too much in riskier projects and less in the less risky projects. This is an issue. It can be an issue right now if we spend too much money on things which will not deliver what you thought, or it can be an issue for our future successors which is not good either.

The other point is that some of the computation shows in some cases that it really creates a difference. In your file, there is a very nice short paper done by Sylviane Gastaldo which takes the recent projects which have gone through the analysis of the CGI. For example for the line 18 of the Grand Paris, it shows that NPV can go as low as 13 and as high as 146. Such a difference is more than ten times; so it does matter.

Of course, there are difficulties. You should not do something too difficult when you are doing public policies. My favourite example is the structural deficit. I don't know if you have looked into the European regulation. For economists, potential growth is fine, but the structural deficit gives you an impression of where you want to go in your policy mix, but when you look at the regulation, frankly even myself, when I came back to these issues in public finance, I had to take a two-hour lesson to understand what were the new rules as you have five different ways of computing things and it is a complete nightmare. Of course, it is completely impossible to explain to a minister, even the current Minister of Budget who is actually an academic in mathematics; he has given up!

So, we have to stay simple, but I think the β is quite easy to understand. Saying that transports are more correlated with GDP than health or education, this is frankly something I can take on myself to try to explain to a minister. I am pretty sure I will succeed.

The question would be if it is not that difficult, and if it is relevant, why are we still discussing it? Why haven't we done the computation? The reports got back to five or six years ago now, but in administrative time, it is a long time, but not that much unfortunately. When I see the fascinating diagram that Ben GROOM projected, we really do want to incorporate academic works into the public policy decision world, but it takes time for good reasons. When there are uncertainties we should take time to think about them, and for not as good reasons in the technocratic world, things take time.

I think we do also have a small technological transfer issue and political economic issue. Most of the cost-benefit analyses are done in the transport sector, so there the technology is completely mastered by the Ministry, but the betas are probably above one. The ministries which would benefit from extending and refining the computation of the discount factor would be actually health and education. It is fair to say that they do not use the cost-benefit analysis frequently, but at the same time they are not pushing for computing betas because they don't see the value of it, even if they were the ones which would benefit from it.

How do you get rid of these barriers to implement it? I think we are on the right path. We have just set up a technical committee for everything on cost-benefit analysis area, not only on the betas. It is a group of people under France Stratégie and the CGI which will be able to design something which is pragmatic. I would even go as far as to say if that this group of people is not able to produce something which is really pragmatic and useful; then we will

drop the idea because there will be no other solution. At the same time, we are revising the Green book for the CBA. Once, all the thinking around is done, it will be easier to explain it in a few words in a pragmatic manner to people who have to use those data in their cost-benefit analyses.

Roger GUESNERIE

Thank you. Now, Burt PORTER, he is a senior economist at the Council of economic advisors. Can you tell us that the American way to do is the best?

Burt PORTER

First, my background is a little bit different than that of my colleagues on the panel. My experience with CBA is primarily through the regulatory space. I came to the Council on secondment from U.S. Securities and Exchange Commission. My experience with CBA is all in that space as opposed to project finance. Second, I would like to point out the 3% and 7% that my colleagues refer to as the two rates that are used in the US, which are discussed in the OMB document A-4, apply strictly to regulatory cost-benefit analysis, and more specifically, apply to executive department regulation cost-benefit analysis.

The financial regulator that I came from is an independent agency, so while actually not subject to those requirements, as a matter of course, we do adhere to them.

The last point I would like to make is more relevant to the discussion about what is the correct discount rate. A white paper published in January 2017 by the Council of Economic Advisers re-examined the 3% and 7% rates and argued for using more current data to update those numbers. Whether or not it is going to happen in the current political environment in the U.S., I have no idea. But our current thinking can be found in that document.

Roger GUESNERIE

Thank you. Is it not a little bit strange sometimes in the US to have those two discount rates, i.e., 3% and 7%?

Burt PORTER

I like to think that it reflects the academic literature because of the difference between the social time preference for consumption and the shadow cost of capital because of market frictions. This is actually the source of those two numbers, an attempt to bracket the two possibilities.

Roger GUESNERIE

The question is what investments do you put in the first line and what investments in the second line? What are the investments financed by the consumers and the ones by the financial market? It is not so clear.

Burt PORTER

Yes, but it gives you a range of what the possibilities are: if the decision hinges on whether or

not the investment will reduce consumption, investment or not.

Roger GUESNERIE

Thank you. After this first set of interventions, I will ask Émile to react on what has been said.

Émile QUINET

In my view, there is a general agreement about the fact that CBA is useful for communication with the public. It is useful for addressing the big issues of each project, and also this is my personal opinion, it is useful in setting programs of investments. We have a two-side improvement to make. A first side is to make things able to be understood by everybody. In France, these issues are especially relevant because there is no economic culture as it is the case in the UK and the US. It is becoming the case at the level of European Union thanks to Massimo. I think there is some improvement to do on this point. On the other point, we should not give up sensitivity analysis and discussion on the value of another parameter. In France, we say « Jeter le bébé avec l'eau du bain » (throw out the baby with the bathwater). We should also go on improving the methods and their use. We have a lot of improvements to do on two sides. Firstly, on the past, we need to have good data for statistical analysis. It appears very clearly when we have to retain betas because we need good data to have a good statistical basis. Secondly, on the future as it will not be what we are thinking of today. Up to now, and too often, we are thinking of a continuous growth or a continuous growth of traffic, but there will be breaks; there will be new ways, new technologies, for example automated vehicles, which should induce us to look more to the future to a more prospective approach.

Roger GUESNERIE

Thank you. One of the issues behind our discussion is the increased sophistication for which you argue create obstacles to the operational use of the cost-benefit analysis. If you have a small number of indicators, it is clear that people can get used to, but if you multiply the number of indicators for cost-benefit analysis, people will be certainly reluctant to go into your story. Where is the right balance? Should we have a very simple central cost-benefit analysis and sophistication for variant risks? Do we have to take into account risk and the variation of relative prices? Everything is important, but what is your view on that?

Émile QUINET

I can give a first answer. We have a dilemma between big models and small models. We have to make a clear distinction of when small models should be used and when big and complex models should be used. It is one of the tasks before us. We have to make the choice between both. Big models will gain through big data as it will induce big models.

Roger GUESNERIE

Davide, what do you think of that in the European case?

Davide SARTORI

How to sort out that trade-off between sophistication and pragmatism? We use a financial threshold for projects that are of a financial significance; it means for projects which

investment cost is larger than 50 million Euros, we carry out a cost-benefit analysis. I would say that it is rather sophisticated in the sense that in the cost-benefit analysis, we always convert labour cost into shadow wage; we always convert the output that the service rendered by the project into an economic value with the willingness to pay methodology; we always evaluate the externalities for example the environmental externalities again by means of willingness to pay or willingness to accept; we use the hedonic methods to measure some effects on properties. So, we do our best. Sometimes, we are probably more lenient, more tolerant on defining shadow prices for input that should be according to the theory converted from market to economic variables. We are more tolerant because the methodology to convert this input is complicated and elaborated. In the end, you usually come up with a conversion factor that does not really affect the result of the projects. But we are carrying out quite an elaborated analysis only for the projects that are worth of. Otherwise, for the projects which are lower than 50-55 million Euro, the Member States are free to decide whether to carry out a cost-benefit analysis or not. The good tendency that has been experienced in the very recent past is that even when it is not mandatory, many countries are starting to apply the cost-benefit analysis even for the projects for which it is not required because they want to have a higher control on their spending and to make sure they are going to investing good value for money projects.

Roger GUESNERIE

Thank you. In the US, you don't face this difficulty to trade-off between sophistication and operational capability or operational value given your use of the regulatory sector.

Burt PORTER

I think that Davide made the point that sometimes using intellectually more satisfying, more complex models do not affect the final results. So, it is much easier to communicate something that is simple, but a little bit wrong than an approach that is much more sophisticated, but it gives you the same answer anyway.

Roger GUESNERIE

Is it the same in the UK?

Joseph LOWE

I think the UK buys in to that idea. There is a general guidance in the Green book that it is repeated in the new one. The resources put into for appraising proposals should be in proportion to the cost and the risk of the proposal, both the cost and the risk of the public sector looks other risk to the public also. So, for the regulation, it might be quite inexpensive if there is quite a high risk to the public or to some sections of the public; therefore, in that case, it would be worth to have more attention, but the departments are then free to interpret that. It is interesting to say that in department like culture, media and sport which has a relatively modest budget compared to defence. Every department has a limit. So, the defence limit is around 500 million. Anything below that amount they should use the guidance, but they don't have to show the Treasury what they are doing unless it is very novel or very contentious. So large spending, novel and contentious, where the culture, media and sport is 10 million, but they have a much smaller budget. That influences the thinking in the departments as well. They all know that the Treasury reserves the right to ask to see something any time, and of course when projects go wrong the Parliamentary

committees that we have can call the most senior civil servant in the department to Parliament and subject him to public humiliation and really questioning. If the thing has gone wrong and they have not employed the methodology, it is a lot more difficult for them. This is an incentive to behave well which helps.

Roger GUESNERIE

This is part of the UK culture.

Joseph LOWE

Yes, it is.

Roger GUESNERIE

Arnaud, what is your point of view?

Arnaud BUISSÉ

I fully agree on the fact that the means put into the evaluation should be appropriate to the risks and the financial size of the project. It is the most sensible thing to do. Public policies are complicated. There are a lot of other dimensions which even play a role in cost-benefit analysis, for example growth forecast over thirty years. I have spent quite a lot of time on that also. There is not one way to solve this question because it was too difficult. For example, in France, we need to monitor the pension system and we need to have 30, 40 to 100-year forecast. We have several scenarios and a discussion with all the trade-unions, the administration and the ministers. At the end of the day, people decide on five scenarios they are comfortable with. I am not sure we can do better than that. We ensure that each scenario makes sense and is intrinsically coherent. After that, there is not much more than we can do.

I do think that refining the discount rate as I said, I do not think the beta is as complicated as that. This is the feasible way to explain it. The question will be: can we robustly assess the beta by sector? Does it create a difference which is sizeable enough to be worth refining this methodology? I think that we have already the answer to the last question because as I mentioned in some recent projects we see it can change the NPV by ten times. For the robustness, we have to do the work and to be sure it is relevant.

Joseph LOWE

There is one thing I did not mention. We may say we have one discount rate, but when it comes to risk to human life or risk to human health, we don't think it is appropriate to take the wealth effect into account because we think that people still care about their life even if they are wealthier; may be they care more, I don't know. They choose time preference and whatever is in there for risk cannot. So, in fact we would discount the value of the risk to human life or the risk to human health at 1.5% and not at 3.5% because this 3.5% rate is set to be for the wealth effect.

Roger GUESNERIE

On a last point, we could discuss on the fact that cost-benefit analysis aims at providing a one dimensional view on the project. We incorporate a maximum of information on the

project and we get some aggregate which provides a summary view. Some people may argue that other aspects of the project should be taken into account, for example the effect of the project on employment. In 1981, I remember that after the change of government in France there was a lot of pressure on the administration to integrate the effect of project on unemployment. A committee discussed this issue and I wrote a report on that subject. What is your view on that? If you multiply the indicators of profitability of a project you decrease the strength of the recommendation. Do you have any view on that?. My question was first on unemployment.

Joseph LOWE

It depends what you think the multiply is about, but economic multipliers in the Treasury view are macro effect which when the Minister says this is what I am going to spend, it will happen. We do not have the day term, we are not super intelligent enough to know the difference between spending the money on this project or that project. There will be a multiply, but we do not know what the difference is, so therefore we do not allow it because it would just be used for gaming purposes and we do not want to do that.

What we do, we have a concept of business as usual which is not doing anything. Somebody said to me what is business as usual? I said it is a reflex. You put a bucket to catch the drifts and you empty the bucket before it is full, so you do something. But if you have a project to mend the roof this is another thing. For every proposal, we want to know what business as usual is if you do not do the proposal. And what is the minimum you have to do to make the absolute core need you have identified. I see two other options both of which might work. If I would see options that won't work because they just put up to make a thing you thought about this and you haven't. We want to see real options and then we can compare them with business as usual, and we do minimum because it allows us to identify gold-plating. If those had opportunity to do extra things and the mode is constant, it is a real benefit and that's good, but if they just take extra things you would like to do and there is not much benefit, then it is gold-plating and we don't want it. So, we insist on three to four options and we want business as usual and do minimum as two of the options.

Roger GUESNERIE

Thank you. Does anybody want to react on that?

Arnaud BUISSÉ

I fully agree. We are very reluctant to add other dimensions. We have spent a lot of time on thinking about the multipliers, but as Joseph just said more on the macro side of the Treasury. For all those projects, we are thinking on long-term issues. Employment within a few years, it is certainly important locally and I can understand the political pressure to have some assessment of what will be the impact. We have to find a way to integrate it properly in a cost-benefit analysis, but I am not sure that we can. I am not sure we can differentiate properly between one project and others. If we could, why not, but I am not sure it should be a priority of research. As soon as you leave the one-dimensional NPV metric, then you cannot compare anymore. For me, this is one of the strengths of the cost-benefit analysis. You want to be able to compare between projects. Of course, as we have said before it goes with the whole dialogue on the projects that doing properly the cost-benefit analysis provides and you want to be able to discuss all the lines, all the sensitivity analyses, the various hypothesis or assumptions. At the end of the day, once you have discussed all that, you

have one single number which is computed in the same way for all the projects and makes you able to compare. I do think it is really one of the main policy-oriented assets of the method.

Roger GUESNERIE

Thank you. Davide SARTORI, what is your point of view?

Davide SARTORI

In our case, we are not reluctant to use multiplier effect, it is forbidden! It is not written everywhere, but in the guide it was one of the key principles which are mentioned in the introduction of the guide. It is said we adopt the macroeconomic approach. There is no attempt to link the project to macroeconomic effect and we actually convince the European Commission to never accept the use of multiplier effect or other type of macroeconomic dynamics into the cost-benefit analysis. This is something that we achieved. Again, we think it is right. At least, this is something that is consistent. Everybody has agreed and everybody follows this approach in order to have consistency in the appraisal of the project.

Building on Joseph's intervention, another key principle is always comparing our options including common options against a business as usual scenario. Again, it is not doing anything; it is continuing the operations at a minimum level as it was done before. This has to be your reference case against which to compare incremental way the benefits and cost of the project or the different options. In that case, we are fully consistent with the British approach.

Roger GUESNERIE

I come back on the first point you made, evoking the multiplier effect. In line with your comment, one of the conclusions of our post 1981 committee was that sometimes you might indeed have good reasons to increase expenditures, but that these reasons were somewhat orthogonal to the project: in a sense; differentiating them within projects was too difficult and probably not so interesting.

Joseph LOWE

We do allow productivity effect, it is objective evidence. If somebody builds a plant to produce microchips in an area previously devoted to sheep farming; clearly, the productivity of the area can arise. That is an obvious supply, you can produce an evidence for and we will allow that, but it is very limited. The other thing is that in the past under the 2003 Green book it was very difficult to give advice to ministers on a regional policy or difficulties such as "oh, the steel works in October may close. What can we do for that area even if it is not to support steel works or whatever it is? What can we do? The new Green book says, this is a species of distributional analysis; we do the national analysis as now and then we say, but we care about this town or this area because these industries are closing and it is a big problem. So, we do a distributional analysis for that area. In that case, additionality with all the other things about substitution and so on coming to play; we say we want some objective evidence; so, we have two streams of numbers, the national one may be neutral, but this is this distributional analysis which is the reason for doing it. It is just to give a workable framework so we are not embarrassed and we can actually help ministers.

Roger GUESNERIE

Thank you. Émile, do you want to make any comments?

Émile QUINET

I am also reluctant to take into account consideration and employment for one reason. It is very difficult to know the effect of specific projects on employment. It will be probably rather low, even very low. We don't know exactly what is to happen. There may be feedback of general equilibrium which comes to the conclusion that the employment created in such region will be offset by unemployment on the other reason. I see only two cases where unemployment could be put into consideration. It concerns remote areas, marginal areas, the exclusion zones (les zones d'exclusion) which are out of the normal economic circuits. Then, it could perhaps improve transport in these zones and their situation, but it is more a distributional effect.

Roger GUESNERIE

Your remark goes further; it concerns also the distributional effect and you don't argue for taking them into account.

Émile QUINET

Except on the distribution side or if it is proved that it will increase employment in these areas, but it is very difficult to prove.

Roger GUESNERIE

Thank you. Is there any other remark? Or have we found unambiguously the best discounting system? I suppose it is the case. If somebody disagrees you might raise the question; we can take one question.

Ben GROOM

I have learnt a lot from this session, thank you, but I want to bring you back to discounting! Mainly partly for self-worth; somebody works on discounting I want to make the argument, but it does matter a bit. I am going to argue Joseph a little bit here. In 2003, the discount rate in the UK changed from 6% to 3.5%. By that time, it changed for political reasons; the Blair government was in, they wanted investment and competitiveness; the 6% was a sort of in the way of that. That suggests to me that on some level it does matter within the departments. Some departments found it difficult to argue for funds and amongst each other for funds when there is a discount rate like that which makes many of their projects sort of marginal or negative net present values. This is one point I would make about all of that. There is an internal kind of negotiation that takes place; there are a lot of things that determine that, but I think that cost-benefit analysis is used as a negotiation in that process.

Joseph LOWE

The folklore in the Treasury which is one I have to rely upon because you think it has already been done. Is that the change? Obviously, high discount rates make it tougher on long-term projects clearly. So, the higher the discount rate, the more it passes decision in favour of

short-term projects. Intuitively, public welfare is often about taking long-term decisions on all kinds of things and brings in to structure other things which may be not particularly commercially attractive, but may be in welfare terms it is efficient. Optimism bias was introduced at that point. I have a colleague who insists that it was taking into account of before. If you look in the guidance actually optimism bias came in with a real ban in 2003. There was some new research done at that time, just before that time, based on analysis of government projects. I would like it to have been more and better. It is what it is. That says all kinds of values for different spaces of proposals. It was said “you must do this” unless you have been observing your own projects and you have shown the evidence you have better numbers that apply more to you. Of course, nobody does that, so they have to use the generic numbers that the Treasury supplies. That was the reason given in the Treasury; optimism bias was the really big thing. There was a bit of debate as well that risks have been there of course, but at the same time because of optimism bias there was more emphasis placed on risk pricing because there is a lot more pressure to say “*We want to see a list of the risks you have identified; we want to know what they arise from, what their likely size is, what their likelihood is, what your proposal is to manage these things, who can do it, can you avoid some, can you manage some, what will you do if some materialized, the contingent factors and so on.*” So, there is a lot more emphasis on risk. That has been carried on and re-emphasised in the new guidance. It is to force people away from the lazy way into actually looking in details because when you get used to deal with numbers with lots of notes on the end, you come a bit blasé as if it were your money; you might be a little less blasé and the whole idea is to focus people’s mind on it.

Roger GUESNERIE

Thank you. I think there is still a last question.

Questions & answers

Baptiste PERRISSIN-FABERT, France Stratégie

I am Baptiste PERRISSIN FABERT from France Stratégie. I have a very practical question regarding climate-related projects. I just want to know what's your opinion is if we apply the β method; do we pick a negative or a positive β ?

Roger GUESNERIE

Christian will certainly say something. For climate policy, the main issue is the value of carbon and the relative price of the value of carbon through time. The view comes from a reflection which is partly orthogonal to the computation of climate preserving investment. This is about a general problem. So, one may not be too much concerned, here, with the beta matter?

Christian GOLLIER

We have seen numbers where climate beta was one. I agree with this. Climate beta is positive as someone told. In the business as usual, if the growth is large, consumption in the future will be large and at the same time, emission will large; concentration of CO₂ will be large; marginal damage will be large and therefore reducing emission today as a strong effect in reducing damage at the time where consumption is large. Most of the benefits of fighting climate change will materialize in the best state of nature, so that this dispositive correlation suggests a positive beta. Of course, there is some other story for a negative climate beta coming from the fact that if the main source of uncertainty is a climate sensitiveness, then if you learn in future that climate sensitiveness is large, at the same time we will go back to Stone Age, consumption will be low; reducing emission today has a large positive effect and therefore you have this negative correlation between the benefit of fighting climate change and consumption, so a negative beta. When you calibrate the standard integrated assessment model there, the first story, the positive beta stories is dominated by the large one.

Roger GUESNERIE

This will deserve more discussions. One issue behind is to which extent consumption and good climate are substitutes.

James HAMMITT

I just want make a remark on the climate beta. If I understand it has a relationship between climate damages given some amount of climate change and economic growth. It could be positive because with economic growth there will be more couple of risk; but it could be negative because with economic growth, a lot of our economy becomes less and less climate-sensitive and we often talk about the developing countries being more sensitive to climate risk because they rely on agriculture and things like that. So, I think there is a lot of uncertainty about that sign.

Christian GOLLIER

What is the typical assessment model? In itself, it is a Dice (Dynamic Integrated Climate-Economy) model and when you calibrate this model you get by large a positive beta, but you are right in the Dice model you don't name that kind of argument. It should be added and we should look at those effects too.

Roger GUESNERIE

Is there any other question?

Alain TERNOT

Alain TERNOT. My question is a very large one, too large to have a detailed response, but I am disappointed to have not heard any terms of risk science. Syndemic science is a scientific theory about the great cataclysm. I don't know if any financiers or economists know this science; generally, only scientific engineers do. I think the risk analysis is not significant as it is not done globally as sustainable development and social responsibility are.

Roger GUESNERIE

Who wants to answer this question or has understood this question?

Christian GOLLIER

A syndemic approach is useful. It is risk-management multi-disciplinary. It is definitely something that needs to be integrated in the evaluation of project, but we don't see it. Doing risk management of a project is a crucial element of the management of a project.

Roger GUESNERIE

As no one around the table is willing to add something, this is the end of this round table.

Conclusion

Christian GOLLIER

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Roger GUESNERIE

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Roger GUESNERIE

We have come to the conclusion of this session and I will be very short. We have got a lot of information on many aspects. What happens in other countries and in France? What are the progresses of theory and where do we go? What are the problems of implementation? Does sophistication facilitate implementation? What is the exact balance between all these elements? I think the three problems we have got a lot of information. We have to digest what we have heard along this session. Everybody will be welcomed to send to Dominique AUVERLOT or Luc BAUMSTARCK their comments or remarks, or send a special paper commenting what has been said today. I will personally stop here and ask Christian to say a few words, and in this case, I do not think he will necessarily contradict me!

Christian GOLLIER

Thank you very much. I think it has been a very exciting afternoon. When I started working in cost-benefit analysis in the public sector in France, I was quite shocked not only by the theory part, when I looked at the literature where I found almost nothing helping public decision-makers and academics trying to advising them what the discount rate should be, it was a really very limited literature. I was also quite shocked by the limited culture of making those things operational. This afternoon session illustrates the radical transformation of that situation. Things become much more complex. I think also that many more people seem to be concerned about what we do is good or bad; whether the kind of instruments we are developing are useful to assist politicians or more generally the decision-makers to make sure that each Euro of public money is spent in the most efficient way.

I think that pedagogy is essential. I still see a lot of misunderstanding although some of them have been eliminated recently. For example this afternoon, some people suggested that in order to determine the discount rate we should use the WACC (weighted average cost of capital) of the funding institution. This is a misunderstanding. The WACC is the average discount rate. Within the funding institutions, it does not eliminate to discriminate the beta of the different projects and the use of the different discount rates for these different projects. The important letter in the WACC is the "A" letter, the average. Pedagogy and clarity are crucial in a world where things become more and more complex. Let me take the parallel here with the Basel III or Solvency II. Under Solvency I or Basel I, risk was not in the picture. For each Euro of liability, we just needed to have this amount of capital and whatever the riskiness of your liability and assets. This was completely crazy. Of course, the evolution to Basel III and Solvency II is a good thing. I am not sure that all the bankers and insurers here in the room will agree, but I think it is something very important to be able to evaluate risk, managing risk and making sure that only the projects that have the best cost-benefit ratio including the price of risk are implemented.

Of course, we need to take into account the complexity. When I tried myself to estimate the climate beta to take an example or the beta of a project to build high-voltage line between France and Spain, I realized myself that it is quite complex and we need a lot of imagination and skills to build up a model in order to have an idea of the beta of this and that. It is not easy. At the same time, there would be a very large cost of going back to situations where they would be a single discount rate independent of the riskiness of the project. As it was said earlier in the round table, if we take only one discount rate, we will over-invest in risky projects and we will under-invest in risk free projects. On top of that, it will be extremely difficult to determine what discount rate we have to use when there is only one.

The problem is that France is completely isolated on this subject. We are basically the only country where we have this sophistication of discriminating the discount rate with respect to

risk and maturity, so it is difficult. It forces the evaluators to spend much more time trying to estimate the risk profile of the project. At the same time, it is useful to do that because it forces the evaluators to really improve the way they present the case and try to explain pluses and minuses to the decision-makers. I think it would be nice to convince the UK, The Netherlands and the US to use the French model! France has a tradition to have a role for democracy, human rights and also for the discount rate! It would be a nice exercise to be performed in order to see what the social cost of using a single rate is. I am trying to do that in my research.

Let me finish with one thing. I am haunted by the reading of a book by ACEMOGLU and ROBINSON; its title is “Failed States”. We know that investment is the main engine of growth. In particular, in our economies where the public sector plays a more and more important role in this dimension of investments, it is really crucial to have the right procedure to evaluate public investment projects and make sure that each Euro of public money spent is the most efficiently used. If we don't do that, it is not of course the only reason, but this is one reason why in fifty years, France will not be on the map anymore. Thank you very much.

Roger GUESNERIE

Thank you to all participants and thank you to all speakers; have a nice evening.

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