The new (but old) approach to the Economic Opportunity Cost of Capital

by

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The New "Old" Approach to the Economic Opportunity Cost of Capital

1. Introduction

In the practice of the conduct of the economic appraisal or cost-benefit analysis of projects and programs in the public sector, the approach of defining the economic opportunity cost of capital (***EOCK***) as a national parameter has become widely used. This approach estimates the real (or inflation-adjusted) opportunity cost of capital as a weighted average of the economic value of the forgone domestic investments and the economic cost of additional domestic and foreign savings supplied to the economy as a result of the capital markets responding to a project using more capital funds over some future long time horizon.[1] This approach has had the strength of encouraging the use of one ***EOCK*** for all public sector project selection. It simplifies communication, control and calculation of the ***EOCK*** within the public sector of a country. As long as the bulk of projects that are being evaluated are not self-financing (ultimately paid for by the revenues their services generate as in the private sector), but rather are financed out of the general revenues, this approach appeared sound as the marginal funds for these projects arguably are sourced through the government going to the capital markets for added public sector borrowing.

The criticisms of the national parameter approach primarily focus on the lack of risk adjustment of the single ***EOCK*** for the differential costs of risk of a project on the economy, thereby either penalizing less risky projects or favoring more risky ones. The ***EOCK*** as a single national parameter has come under greater pressure of criticism as more governments have decentralized public sector investments. This results in greater private sector involvement in the risks and returns from public sector investment through various partnership and regulatory approaches that include private investment in public sector ventures. The criticism also predated the growth in recent decades of the public private partnership approach to the extent that governments were investing in commercial ventures, actively or passively, or were taking decisions to affect the viability of commercial businesses through guarantees, regulations or tax preferences. At the same time, in the field of corporate finance, models and methods used to identify and measure risk premiums have developed and become more widely used. This led to the realization that the variation in the size of risk-adjusted discount rates for investments in different sectors and countries was large and a significant, and often dominant, factor in evaluating investments.

[1] The issues of the appropriate approach to estimating the EOCK in this note is purely with in the context of the "Harberger" framework for the conduct of cost-benefit analysis of investment project – the weighted average economic opportunity cost measured in domestic currency units as the accounting numeraire. It is not raising any of the issues of other frameworks using other numeraires such as consumption values. See for example, GP. Jenkins and AC Harberger, "Manual on Cost Benefit Analysis of Investment Decisions" Chapter 12 for different discount rates applied in different analysis frameworks.

While these criticisms of the national parameter approach have been recognized for some time, the difficulty in moving away from this single-value ***EOCK*** has been as much a practical estimation difficulty as a conceptual one. What is a feasible method to correct the ***EOCK*** for the risk and other characteristics of the particular project?

This paper presents a new approach to estimating the ***EOCK*** in a country for a specific project that can be readily adopted and is consistent with and even strengthens the overall framework for undertaking the appraisal of public sector projects and programs. The new approach will also be shown to be "old" in that it uses techniques that have been adopted over recent decades at the advocacy of Professor Harberger for dealing with similar problems in the estimation of the economic opportunity cost of labor where market wage rates are affected by job-related risks as well as other differentials arising from job and location specific conditions. It will also provide a formulation of the ***EOCK*** that is consistent with the general approach to economic pricing: namely, any economic price equals the market price plus externalities. The note first lays out the issues that cause concern with the single national parameter, second discusses the alternative approaches, third gives the suggested approach and discusses it application in different situations, and finally shows its strengths in improving the distributional analysis of investment projects.

2. Issues with a single-valued *EOCK*

There are three issues that raise concerns with the national parameter or single-valued *EOCK*:

Costs of risk of project

The first and largest in magnitude, as already mentioned above, is the lack of risk adjustment for the risk factors related to a specific project, particularly the systematic market or sector risk in the case of self-financing projects.[2] The lack of appropriate costing of risk can result in either overestimating the economic value of a high-risk project or undervaluing a low risk project. It is noted that the typical estimate of the ***EOCK*** excludes the costs of risk on the incremental savings (except country risk on foreign savings), but includes the risk premiums implicit in the forgone product of capital investments displaced. This means that the typical ***EOCK*** contains some element of market risk such that it overcharges less risky public sector projects in situations where most of the capital is ultimately drawn from forgone investments.

Transactions cost of supplying capital to project

A second issue, but usually of less consequence, is the issue of the differential transactions costs in raising capital for a project. Raising capital has mobilization costs that are contained in the market costs of capital. To the extent that a project has markedly higher transaction costs implicit in its costs of capital, as would typically be the case in

[2] Self-financing projects are projects where the revenues from sale of the project services are adequate to cover the full costs of the project over its life. This includes private or commercial ventures or regulated utilities or infrastructure projects funded out of user charges, irrespective of whether the project receives tax assistance or some public subsidy. In such cases the revenues will be subject to demand risks and possible real price fluctuations.

projects financed by the micro-finance sector, for example, then using an ***EOCK*** that assumes these costs have not been incurred by the economy over states the value of the project. For most large scale projects, the differentials in the costs of capital may be closer to the market average except where large upfront expenditures may be required to organize project finance arrangements. In such cases, however, these soft costs may be built into the upfront capital investment cash flow costs and not be captured in a cost of capital premium. While these transaction cost differentials may typically be of less consequence, the new approach is designed to capture them.[3]

Distribution of gains and losses in economy

The third issue that arises from a national parameter ***EOCK*** is in the context of conducting the distributional analysis of a project. Conceptually, the net present value of an investment from an economic perspective captures the aggregate net gain or loss experienced by all stakeholders in the project. The distributional analysis identifies these gains and losses to the stakeholders. The financiers of a project are always key stakeholders and the gain or loss that they expect is the NPV based on their weighted average risk-adjusted discount rate. At the same time the capital invested in the project needs to generate positive externalities to offset the externalities forgone by the economy by investing capital in this particular project. When the ***EOCK*** does not capture the costs of risk and transaction costs actually born by the financiers, then the difference between their cost of capital and the ***EOCK*** does not capture properly the externalities forgone by the project that need to be offset by the project externalities. For example, if the real private cost of capital is 15%, say, because of high risk and capital mobilization costs, this cost may exceed a national ***EOCK*** of 11%, say, which contains the tax and other externalities incurred by the economy. The meaning of the difference between the private and economic costs of capital is then not clear. This issue will be returned to again once the new method has been discussed further below.

3. Two approaches to adjusting the EOCK

Two approaches can be taken to adjusting an economic price when market prices differ because of compensating differentials for risk, transaction costs and other related features between two market situations as often occurs in labor and capital markets. For example, the market wages at the factory gate for two jobs may differ because of different risks inherit in doing the two jobs, or the relative attractiveness of the different work or location conditions, or the different costs of commuting to the two jobs, and so on. Similarly, the costs of capital can vary between financial investment opportunities because of differences in risks or capital mobilization costs. In labor markets, one approach to estimating the economic cost of labor is to systematically make adjustments for all the differential conditions plus the fiscal externalities (taxes, and unemployment and social security contributions and benefits) between the new jobs and jobs from which labor is sourced.

[3] Note that the focus here is on transaction cost differentials within a country. Large transaction cost differentials exist between countries reflecting the technical efficiency and regulatory cost differences between the capital markets of countries. Much of these differentials are often captured as part of the country risk premium of a particular country relative to the least risky countries.

The second and more elegant approach to estimating the economic opportunity cost of labor is referred to as the *supply price of labor approach*. See for example, Harberger (1972)[4] and Jenkins and Harberger, Chapter 13.[5] In this approach, the competitive market gross wage rate for the new project job is taken as the starting point. As long as this market wage can be taken as the wage rate that is just sufficient to attract workers to the new job, it must offset all the compensating differentials between the new job and labor market alternatives internalized in the workers decisions. If it is a riskier and more unattractive job, then the higher wage rate required to attract workers should be just sufficient to offset these added costs of the job. By contrast, if the job has more attractive features the minimum wage rate required to attract workers may be lower than those in the alternatives. The minimum supply wage therefore offsets for all the different features between jobs and leaves workers indifferent between them. Hence, a lower supply wage can be taken as economically equivalent to forgoing a higher paying job because of the compensating differentials between the jobs. To get the economic costs of hiring workers into the new job, the supply price approach takes this minimum supply wage and then adjusts it for the fiscal differentials (or tax, unemployment and social security differentials) between the project job and the alternative jobs from which workers are ultimately sourced. Another way of stating this **economic cost of labor** is that it is the **minimum or competitive supply wage** plus **the economic externalities.**

In the capital markets, the first approach of making all the adjustments for compensating differentials plus other externalities could be followed. This requires subtracting out all the cost of risk saved on investment forgone and adding them to the added savings induced into the market plus the added costs associated with the specific project financed. One such approach is to derive a weighted average ***EOCK*** removing the systematic risk saved on the forgone investments and adding back the systematic risk associated with the project. This approach leads to a "risk adjusted" national ***EOCK*** to which the systematic risk has to be added.[6] It is not entirely satisfactory as it does not deal with the full range of costs of risk or capital mobilization costs associated with a project.

The second approach of the minimum supply price plus externalities holds more promise of generality, flexibility and practicality. As with the economic opportunity cost of labor, the minimum supply price in capital markets is the minimum cost of capital required in a competitive market by the financiers of the investment project. This minimum required rate of return by financiers would adjust for all the differential costs of risk and capital mobilization that would make them indifferent between financing the project and alternative investments in the economy and withdrawing their savings from the capital market of the economy. Hence, it implicitly captures all the compensating

[4] Arnold C. Harberger, Project Evaluation, Chicago: University of Chicago Press (1972), Chap 7, "On the Social Opportunity Cost of Labor."

[5] G.P. Jenkins and AC Harberger, *Manual on Cost Benefit Analysis of Investment Decisions*, Chapter 13, "The economic opportunity cost of labor"

[6] This approach is discussed in G. Glenday, "Economic Opportunity Cost of Capital: Financing Infrastructure in Emerging Markets", a paper prepared for the Inter-American Development Bank , June 2003 (mimeo)

differentials for the specific project without explicitly having to analyze and account for them. On the other hand, in the case of a long run investment, given the general fungibility of funds over the long run, the externality associated with the long run investment of capital in an economy can be taken to be more a function of the characteristics of the economy rather than the project itself. Hence, the externality per unit of capital invested over the long run can be thought of as a national parameter. This approach to estimating the ***EOCK*** captures the specific characteristics of the project financed as well as the general externalities arising from the long run use of capital funds by the project. The ***EOCK*** then differentiates between non-self financing projects, which are financed by general government revenues, and self-financing projects in different sectors of the economy and the other project-specific characteristics that may cause added costs to the financiers. At the same time, explicit recognition is made of the externalities arising from using capital funds. The formulation is also consistent with the general specification of economic prices, namely, they are the sum of the financial or market prices of the project plus externalities per unit.

4. Simple derivation and specification of *EOCK*

The supply price approach can be seen to be consistent with the standard economic pricing model in competitive markets with a single price, that is, markets that contain no compensating differentials for the market good or resource traded. Consider a capital market with all costs of capital equal to a single market interest rate, i_m.[7] Capital investments are subject to a uniform income tax on their returns at tax rate t_c such that all investments have to generate a gross-of-tax return on investment of $\pi_c = i_m/(1- t_c)$. If i_m = 7% (real or inflation-adjusted rate) and t_c =25%, π_c =9.33%. On top of this gross-of-tax return the products of capital investment yield indirect taxes that have to be paid for by the consumers or users of the products. These indirect taxes become part of the economic return on the investment so that the gross return on investments becomes $\pi = i_m/(1- t_c) (1+ t_i)$ where t_i is the effective indirect tax rate expressed relative to the gross-of-tax return on investment.[8] If t_i = 15.4%, then π = 10.77%. Alternatively, this gross return to the economy could be expressed as $\pi = (i_m + t_d)$, where t_d is the tax generated per unit of capital invested or $t_d = i_m (t_c + t_i)/(1- t_c)$. For the parameter values in this example, t_d = 2.33% + 1.43% = 3.77%. Savers in this capital market are willing to supply capital based on their net-of-tax returns or $r = i_m (1- t_p)$ where t_p is the income tax rate charged on personal savings. If t_p = 15%, then r =5.95%. Alternatively, this can be expressed as $r = (i_m - t_s)$, where t_s is the tax generated per unit of capital saved or $t_s = i_m t_p$ = 1.05%. The ***EOCK*** of the capital used by a project under the standard weighted average formulation is the economic cost of share of capital coming from forgone investments, where ω^d is the share from forgone investments that would have earned π,

[7] All interest rates are expressed here on a real or inflation-adjusted basis.

[8] An estimate of t_i can be gained from the share of indirect taxes attributed to capital ((VAK/TVA)*(Indirect Tax)) relative to the net-of-depreciation value added earned by capital (NVAK) or t_i = ((VAK/TVA)*(Indirect Taxes))/NVAK = VAK/NVAK*(Indirect Taxes)/TVA = $(\pi_c + \delta)/\pi_c$ *(Indirect Taxes)/TVA where δ = depreciation rate and TVA = total value added or GDP at factor cost. If (Indirect Taxes)/TVA = 10%, δ = 5%, and π_c =9.33%., then t_i = 15.4%

and the economic cost of the share coming from savings, where $\omega^s = (1- \omega^d)$ is the share from added savings at the cost r, or

$$\begin{aligned} EOCK &= \omega^d \pi + \omega^s r \\ &= \omega^d i_m \frac{1+t_i}{1-t_c} + \omega^s i_m (1-t_p) \\ &= \omega^d (i_m + t_d) + \omega^s (i_m - t_s) \\ &= i_m + \omega^d t_d + \omega^s (-t_s) \end{aligned} \qquad (1)$$

The expressions for the ***EOCK*** in (1) above show the equivalence of different ways of expressing the ***EOCK*** given the assumptions about the capital market in the economy made above. The initial expression of $\omega^d \pi + \omega^s r$, or the weighted average of the economic value of the forgone product of capital and the cost of additional savings supplied characterizes the traditional approach to estimating ***EOCK*** as a national parameter. Taking $\omega^d = 0.75$, then ***EOCK*** = 0.75*10.77% +0.25*5.95% = 9.6%. The final equivalent expression of ($i_m + \omega^d t_d + \omega^s(-t_s)$) gives the same value of ***EOCK***, or ***EOCK*** = 7% +(0.75*3.77% + 0.25*-1.05%) = 7%+ 2.6% = 9.6%, but breaks out the components in a different way that are important both from an estimation point of view and from a "reinterpretation" of the meaning of the components of the ***EOCK*** to allow for the direct re-entry of issues of the costs of risk and transaction costs back into the estimation of the ***EOCK.*** Importantly, the final expression breaks out the private market cost of capital or interest rate from the economic externalities of using capital in a project. In addition, the two components are expressed as a rate per unit of capital – in the simple example, 7% for the private market cost of capital and 2.6% as the economic externality per unit of capital, which, in this simple case, represents the net forgone taxes in the rest of the economy by using the capital in the particular project under consideration. The proposed new approach focuses on each component separately, namely, the minimum required rate of return by the investors and the economic externality.

Minimum required private rate of return

First, the assumptions above assume that all capital is the same and earns the same return or costs the same per unit. This is clearly a gross over simplification of capital markets that mobilizes capital at varying costs and invests across many investments with varying costs of risk arising from a variety of factors: liquidity of the investment, inflation and exchange rate or currency risk, industry or systematic risk, project specific risk and country risk. All these risk factors result in persistent and large differences in rates of return across investments and countries. At the same time any particular investment is typically financed by a set of different financiers through different types of debt and equity instruments that bear different shares of the risk inherent in the project. In a competitive market, it is expected that suppliers of capital, both domestic and foreign, will seek the highest returns on supplying capital to investments with a given risk characteristics, while project owners or sponsors will be seeking the lowest cost of capital and will seek out the lowest cost of mix of capital. In a competitive market, on the marginal investment we expect the return and the cost of capital to converge. In addition, we expect all the players in the market to be reallocating

their investments across all the investment opportunities to their own net benefit given the returns and risks perceived across all investment opportunities. Hence, when a new project is brought into the market to be financed, existing financiers have to make their judgments about the risk characteristics of the new project and how it fits into their portfolios, and based on this, decide upon how they trade off the new with existing investment opportunities. Hence, they decide upon the minimum returns they require from the new project for different types of debt and investment instruments available to invest in the new project. The importance of this competitive private capital market assumption is that this trade-off and pricing process results in investors internalizing or taking into account all the risk and transaction cost differentials between the new and existing investment opportunities. Hence, the minimum price of capital that private investors require to be willing to supply capital to a project, takes into account the costs of investing in the particular project and leaves them at least as well off as investing in the alternative opportunities. From an economic perspective, this allows the minimum supply price of capital terms to capture the economic cost borne by the private investors including differentials in the costs of risk and transactions.

The implications of the above are that the competitive or minimum required rate of return becomes the first component of the ***EOCK*** and this component captures the added costs of risk and transaction costs of supplying capital to the project. Importantly, from an economic perspective, the capital invested is the total capital investment. The relevant cost of capital is therefore the weighted average cost of capital (***WACC***) where all the components are being priced at their minimum supply prices. For a project being financed in a competitive market the actual ***WACC*** [9] can be used in the ***EOCK***. This includes an estimate of the minimum required return by equity holders, which may require some sophisticated or difficult estimate of the cost of equity for projects outside of well developed capital markets. There are four cases that should be noted where the interpretation of i_m as the competitive ***WACC*** needs some added considerations:

a. If **capital funds are raised by the project in a non-competitive situation** (possibly a regulated market or non-arms length investment) such that the whole or parts of the ***WACC*** are above the minimum required by private investors in a competitive market, then the price premiums should be removed from the ***WACC*** in the economic and financial analyses, unless the higher costs of capital arise from added risk or transaction cost incurred by the specific investors. In the former case, the financiers gain a windfall, but in the latter, the economy loses by the added costs of uncompetitive financing. This case is elaborated on below in the distributional analysis.
b. If part of the **capital funds are subsidized or at concessional rates**, then unless these are external funds that are completely tied to the particular project (they have no possible alternatives available or uses in the economy), the subsidy element should be added back into the ***WACC*** in the economic analysis, but not in the financial analysis. In the distributional analysis, this

[9] Note that WACC here includes the full or gross-of-tax interest rates. It is not adjusted for any tax shield from tax deductibility of interest expenditures which are already taken into account in the cash flows.

will be recognized as a transfer to the project owners from the payers of the subsidy (typically the government).

c. If the **project is financed by and wholly owned by a government** such that the **marginal capital finance is coming from the general budget**, then aside from the considerations in "b" where a share of the investment is financed with a concessional loan, the financial opportunity cost of capital for a government investment is taken as the long-term borrowing cost of the government which would contain the country risk premium on sovereign debt. The economic opportunity cost of such budget financed projects would effectively become the long-term borrowing cost of the government plus the economic externality of capital. *This implies an effectively constant **EOCK** for budget financed public sector projects*. Where the government is assuming large risks relative to the size of its resources, however, then project risk premiums should also be included or the cash flows adjusted to reflect these risks.

d. If a **public sector project receives user charges**, then a market systematic risk (beta) premium should be included in the minimum supply price of capital. As beta's are typically estimated for the cost of equity, the equity beta should be adjusted for (i) the share of equity financing or (1-d), where d is the share of debt financing to obtain an asset beta, and (ii) the share of the total cost covered by the user charge or u, or the share of the market premium included should be (1-d)$u\beta$, where β is the equity beta for the type or sector of the project. For pure budget financed projects, then u=0 and case "c" above occurs, whereas for fully commercialized projects, u=1 and the full premium for systematic risk becomes included.

Economic externality per unit of capital

The second component of the ***EOCK*** is the aggregate economic externality arising from the use of capital funds in the project. From an economic perspective, the capital funds used by a project come from three basic sources. A share of the capital is sourced from forgone investments (ω^d) as the market cost of capital increases; and shares from increased domestic savings (ω_d^s) and from increased foreign savings (ω_f^s) in response to higher market returns. Compared to the simple assumptions presented in (1) above it is recognized that within these sources of capital are market segments with different degrees of responsiveness to changes in the rates of return and that different segments face different tax rates. The estimation of these weights and the different tax and other distortions essentially follows the same logic and methodology as used in the traditional estimates of ***EOCK*** as shown in the first expression in (1) above, except that here the externalities are separated out from the economic returns of forgone investments and economic costs of the added domestic and foreign savings. The unbundling of the externalities in some situations simplifies and some complicates estimation of the externalities, but importantly once an estimate has been made of the economic externalities it can be considered as a national parameter. While different investment projects generate different risks and different investment instrument bear different amounts of risk, given the long-run fungibility of money and the interconnectedness of capital markets, that aside from the differential premiums that are paid for using capital in different uses, the long run response of the economy to removing marginal capital funds

into a project is independent of the use of the funds. This means that the economic externality per unit of capital from using capital funds can be regarded as a national parameter. Given this is an external cost suffered by the economy, the use of the funds in the project needs to earn internal and external surpluses sufficient to offset this loss. This balance is discussed further in the distributional analysis below.

The estimation of the economic externality per unit of capital needs to follow the same structure as the traditional estimation of the ***EOCK*** except the focus is only on adding up the net economic externalities arising from using capital funds over the long term. The added savings are drawn from different sources, S_i, which is the existing value of savings of that type that responds to increasing returns according to a long-run (or stock adjustment) price elasticity of supply, ε_i^s. Savings could be drawn from national sources (personal, corporate and government savings), and from foreign sources as debt or equity. S is the total savings available in the economy. Similarly, capital is drawn from forgone investment in different sectors, I_j, depending upon how responsive investment in a sector is to increases in the cost of capital as captured by the long-run (or stock-adjustment) price elasticity of demand for investment, η_j^d. Investment could be displaced from private, corporate and non-corporate investment in the primary, secondary and tertiary sectors or from public sector investments. I is the total investment in the economy and equals S. If the externalities in each savings and investment sector per unit of capital are e_i and e_j, respectively, then the ***EOCK*** can be expressed as

$$EOCK = i^p_{\min} + \frac{\sum_{i=1}^{m} \varepsilon_i^s(S_i/S)\, e_i - \sum_{j=1}^{n} \eta_j^d(I_j/S) e_j}{\sum_{i=1}^{m} \varepsilon_i^s(S_i/S) - \sum_{j=1}^{n} \eta_j^d(I_j/S)} \qquad (2)$$

or

$$EOCK = i^p_{\min} + \sum_{i=1}^{m} \omega_i^s e_i + \sum_{j=1}^{n} \omega_j^d e_j$$

where

$$\omega_i^s = \frac{\varepsilon_i^s(S_i/S)}{\sum_{i=1}^{m} \varepsilon_i^s(S_i/S) - \sum_{j=1}^{n} \eta_j^d(I_j/S)}$$

$$\omega_j^d = \frac{-\eta_j^d(I_j/S)}{\sum_{i=1}^{m} \varepsilon_i^s(S_i/S) - \sum_{j=1}^{n} \eta_j^d(I_j/S)} \qquad (3)$$

Here $i^p_{\min}$ is the minimum competitive supply price of capital or ***WACC*** of the project. On the demand side, the externality in any sector, e_j, allowing for income tax

rate, t_c, tax-deductible taxes on property values of t_{prop} per unit of capital, and indirect taxes earned on the gross-of-tax return on capital at the rate of t_i,[10] then the externality per unit of capital investment is

$$e_j \quad = \quad t_{dj} \quad = \quad \frac{t_{prop}(1+t_i)(1-t_c)+i_m(t_i+t_c)}{1-t_c} \qquad (4)$$

Note that here the tax rates in all investment sectors are taken to be equal. In practice, tax rates may vary by sector. In addition, in some countries, significant monopoly premiums may be earned in sectors where entry is regulated or restricted, or some sectors may receive significant subsidies either as financial transfers, tax breaks or as underpriced or subsidized inputs. Monopoly premiums per unit of investment would need to be added to the unit externality but removed from the supply price of capital, while subsidies per unit of investment subtracted from the unit externality generated by a sector.

On the supply side, two major sources of capital are national and foreign savings. Taking private savings out of total national savings as being price responsive to returns on its investment opportunities, the externality is the tax gain (hence, a reduction in the ***EOCK***) or the average return on market investments (r_m^{av}) multiplied by the effective tax rate on these investments (t_p). Foreign savings that is responsive to changes in the domestic market returns (these exclude unresponsive capital flows such concessional loans to governments or fixed interest rate loans) can generate tax gains to the extent that withholding taxes are charged on repatriated funds, but can also generate losses to the country to the extent that foreign savers earn higher returns on their infra-marginal savings as interest rates rise in the domestic market in response to the added demand for capital funds. The marginal economic cost of foreign capital becomes $i_m^f(1-t_{wh})(1+\phi/\varepsilon_f^s)$ where i_m^f is the market price of foreign savings, t_{wh} is the effective withholding tax rate, ϕ is the price responsive share of foreign savings, and ε_f^s is the price elasticity of supply of foreign savings. Hence, the externality has two parts: a tax gain, $(-t_{wh}i_m^f)$, and the loss of surplus to foreign savers, $i_m^f(1-t_{wh})\phi/\varepsilon_f^s$. Importantly, this externality *declines* as the price elasticity of foreign savings increases, but at the same time, the share of the overall economic externality of using capital that arises from the cost of added foreign savings *increases*. In an open economy faced by a fixed price of foreign savings, this share approaches 100% and dominates the ***EOCK*** which in the limit becomes $i_m^f(1-t_{wh})$, assuming i_m^f includes any project-related risks and transaction costs. At the other extreme, in a closed or high risk country, this external cost of foreign savings per unit of capital *rises* as ε_f^s declines, but its share of the overall externality also *declines*. In such cases, the externalities related to forgone investments tend to dominate.

[10] With taxes on the capital value of property at the effective rate of t_{prop} and with these taxes being deductible from income taxes, the gross-of-income and property tax return earned by investments becomes $\pi_c = (i_m + t_{prop}(1-t_c))/(1-t_c)$

Some hypothetical examples of estimates of the economic externality per unit of capital invested are provided below in Table 1 for three countries in different country risk ranges. To estimate the externalities three market ***WACCs*** are used at 6% for a very low risk country, 9% for a moderate to low risk country, and 12% for a high to very high risk country. For simplicity all countries are assumed to have the same effective tax rates: t_c =25%, t_{prop} = 0.5%, t_p = 15%, t_{wh} =5%, and indirect taxes of 10% of total value added. [11] In the investment sectors 85% of investment is taken to be responsive to changes in market costs of capital at a price elasticity of demand of -1. On the savings side, 70% of total savings is national savings that is responsive to rates of return with a price elasticity of supply of 0.3. For a high risk country, 20% of foreign savings is responsive to market rates of return at a price elasticity of supply of 1; for the moderate risk country, 40% is responsive to market rates of return at a price elasticity of supply of 3; and for the very low risk country, 60% is price responsive at a price elasticity of supply of 6. This means that high returns to foreign savers result in an externality being earned by foreign savers in the high risk country of some 2.3% per unit of capital, but forms only 16% of the source of capital or an externality of only 0.4% per unit of capital invested. By contrast, in the very low risk country the foreign savers externality falls to 0.6%, but foreign savings form 77% of the source of capital, or 0.4% per unit invested. The very low risk country is taken to have an open capital market that is highly integrated in the global capital market making for high international capital mobility in response to changing rates of return. By contrast the high risk country has an open capital market, but is poorly integrated into the global capital market causing limited capital mobility.

In the high risk country, tax externalities are a positive 6.6% of forgone investments, but are -1.8% from taxes on added national savings and -0.6% on added taxes on foreign savings. The combined tax externality is 4.1% per unit of capital. In the very low risk country, the tax externality on forgone investment is 3.8%, while on added national savings, it is -0.9%, and on added foreign savings, it is -0.3% giving a combined tax externality of 0.4% per unit of capital invested.

[11] Following footnote 8, t_i is 15.01% for a very low risk country, 13.95% for a moderate to low risk country, and 13.01% for a high to very high risk country

Table 1. Hypothetical illustrative examples of estimates of Economic Externality per unit of capital

Country risk	High/ Very High	Moderate/ Low	Very Low
Market WAAC	12%	9%	6%
Elasticity of supply of foreign savings	1	3	6
Shares of capital from			
Investment	67%	38%	18%
National savings	17%	9%	5%
Foreign Savings	16%	53%	77%
Sector externality:			
Investment taxes	6.6%	5.2%	3.8%
National savings taxes	-1.8%	-1.4%	-0.9%
Foreign savings taxes	-0.6%	-0.5%	-0.3%
Foreign savers surplus	5.7%	1.1%	0.6%
Tax externality	4.1%	1.6%	0.4%
Foreign savers externality	0.4%	0.6%	0.4%
Economic Externality per unit of capital	**4.4%**	**2.2%**	**0.8%**

For the three hypothetical countries, the combined economic externalities are 4.4% per unit of capital invested in the high risk country, 2.2% in the moderate to low risk country and 0.8% in the very low risk country. This illustrates the importance of openness and country risk in determining the economic externality from capital investment. In practice, actual countries will have somewhat different economic, tax and capital market structures that will yield their own estimates of the national parameter that measures the **economic externality per unit of capital invested** in projects in the country. This national parameter, however, can also be expected to change over time as the economic structure, tax policy, tax effectiveness and capital markets develop and as such should be estimated on a prospective basis.

The economic externality from capital investment is then added to the minimum supply price of total capital or the minimum competitive WACC of the project, $\boldsymbol{i}^{p}_{\min}$, to get the ***EOCK*** for the project as in expressions (2) or (3) above to estimate the ***EOCK*** as:

$$\boldsymbol{EOCK} \;=\; \boldsymbol{i}^{p}_{\min} \;+\; \boldsymbol{Economic\ externality\ per\ unit\ of\ capital} \qquad (5)$$

The minimum supply price of capital to the project ($\boldsymbol{i}^{p}_{\min}$) will capture the country risk, project risk and industry or market risk premiums and transaction costs in mobilizing capital for the project. If the project is a non-self-financing project, that is it is financed out of the general budget revenues, then the supply price of capital would be the long-term cost of market borrowing by the government, which would include any country

risk premium on sovereign debt. Where projects are very large relative to the revenue capacity of a country, then project risk should also be reflected either in $i^{p}_{\min}$ in the ***EOCK*** or as risk adjustments to the cash flows. If a project is self-financing or commercial, then the systematic industry risk premium needs to be included in $i^{p}_{\min}$. [12]

5. Implications of new approach to distributional analysis

Distributional analysis is critical to understanding the gains and losses to the various stakeholders or parties involved in or affected by the operations of a project. Economic analysis aggregates all the winners and losers to give an aggregate net benefit or net present value (***NPV***) for all these stakeholders or interested and affected parties. Distributional analysis, by contrast, breaks out the net benefits or ***NPV*** of each group of stakeholders. Key stakeholders include the financiers (the equity holders or sponsors and the debt holders), government as a tax collector and provider of subsidies, consumers, suppliers, labor and other parties positively or negatively affected by environmental impacts, as examples.

Distributional analysis typically expands the net economic benefit that is internalized in the project accounts to an economic perspective. It takes the net benefits accruing to the debt and equity holders and adds in the external net benefits accruing to the government, consumers, and other stakeholders. On an annual basis the economic net benefits (***ENB***) can be taken to be equal to the financial or private net benefits (***PNB***) of the project plus the sum of all the external costs and benefits, or in any year t:

$$ENB_t = PNB_t + \sum_i external\ NB_{t,i} \qquad (6)$$

Given this identity holds in every year, then it holds if all of its components are discounted to the present by the same discount rate or ***EOCK.*** In that case the present value of the present value of the ***ENB*** discounted at the ***EOCK*** gives the net present value of the project from the economic perspective (NPV^{econ}_{EOCK}) or

$$NPV^{econ}_{EOCK} = NPV^{tot\,cap}_{EOCK} + \sum_i PVExt_{EOCK,i} \qquad (7)$$

[12] Bailey and Jensen (1972) developed a risk-adjusted version of the Harberger weighted-average ***EOCK*** that is somewhat analogous to the formulation presented here, but also has some fundamental differences. Bailey and Jensen proposed an EOCK composed of a risk-free ***EOCK*** plus a risk adjustment component that reflected the systematic risk of the new investment project. This formulation results in the capital market externalities in the ***EOCK*** from the new project absorbing capital funds from other uses being a function of the riskiness of the new project rather than being independent of the riskiness of the new project. The new approach presented in this paper separates the foregone externality of using capital funds from the riskiness of the new project. It also allows for a wider range of types of risk and transactions costs (not just systematic or market risk) to be recognized in the supply of capital to the new project. See Bailey, Martin J. and Michael C. Jensen, "Risk and the Discount Rate for Public Investment," in Michael C. Jenson (ed.), Studies in the Theory of Capital Markets, New York: Praeger, 1972

The first right-hand side term gives the financial net cash flows to the total capital investment discounted by the ***EOCK*** and the second term sums up the external costs and benefit flows arising from the project discounted by the ***EOCK***. Typically, these externalities would include the added consumer surplus captured by project beneficiaries (particularly in public sector projects delivering services at no or low prices), and the tax externalities from the direct taxes paid by the project and the indirect taxes arising from the net production of foreign exchange or the net products or services delivered by the project. Now, while this expression for the distribution of the aggregate losses and gains is correct and useful in checking the consistency in the overall analysis, it does not show the actual gains and losses to certain key stakeholders. Critically, the actual gains and losses of the financiers can only be captured if their actual values are included. To do this (7) is transformed first by adding and subtracting the net present value expected by the project financiers from the expected total cash flows of the project discounted by their ***WACC*** ($\boldsymbol{NPV}_{\boldsymbol{WACC}}^{\boldsymbol{tot\,cap}}$). Initially, assume the financiers are operating in competitive capital markets and their ***WACC*** is the minimum private supply cost of capital funds, $\boldsymbol{i}_{\min}^{\boldsymbol{p}}$. Hence, (7) becomes

$$\boldsymbol{NPV}_{\boldsymbol{EOCK}}^{\boldsymbol{econ}} \quad = \quad \boldsymbol{NPV}_{\boldsymbol{i}_{\min}^{p}}^{\boldsymbol{tot\,cap}} + (\boldsymbol{NPV}_{\boldsymbol{EOCK}}^{\boldsymbol{tot\,cap}} - \boldsymbol{NPV}_{\boldsymbol{i}_{\min}^{p}}^{\boldsymbol{tot\,cap}}) + \sum_{\boldsymbol{i}} \boldsymbol{PVExt}_{\boldsymbol{EOCK},\boldsymbol{i}} \quad (8)$$

The first right-hand term now captures the actual net benefits (surplus or loss) going to the financiers. What is the meaning of the second term, the difference between the same project cash flows from the total capital perspective discounted by the ***EOCK*** and by $\boldsymbol{i}_{\min}^{\boldsymbol{p}}$? From expression for the ***EOCK*** in (5) above, this difference in the second term measures the forgone economic externalities caused by investing capital in the project. This precise interpretation of this term only arises under the new approach to the ***EOCK*** that adjusts the ***EOCK*** for the costs of risk and capital mobilization transaction costs related to the project investment. It is a useful result as it allows the forgone externalities (typically, largely taxes) to be compared with the surplus made by the project and the externalities captured by the government (often largely taxes) and by consumers and other stakeholders. For example, in cases where a project gets a tax holiday it allows a comparison of this tax forgone by the government (both directly through the tax holiday and indirectly by the use of capital) with the surplus captured by the project and the direct and indirect tax externalities going to the government. This allows important questions to be answered such as whether the tax holiday was needed by the project or whether the government suffers a net loss of tax revenues. To go further and explore the distribution of the gains and losses from a project that provides public services at no or low user charges as well as cases where project financiers are not facing competitive market conditions (by, for example, having access to low-interest rate debt), further expansion of expression (8) is desirable, but before doing that it is useful to gain insights into this expression for simple private sector investments.

Private sector projects

Consider an investment of 100 in a commercial project that yields perpetuities of 6 to the private financiers and direct tax externalities of 4 (all in a constant price terms.) The private cost of capital is 6% and the economic externality per unit of capital investment is 4% (primarily forgone taxes), and hence, EOCK = 10%. Clearly, this

project is marginal from both private and economic perspectives, or $\boldsymbol{NPV}^{\boldsymbol{tot\ cap}}_{\boldsymbol{i}^{\boldsymbol{p}}_{\min}} = -100 + 6/6\% = 0$ and $\boldsymbol{NPV}^{\boldsymbol{econ}}_{\boldsymbol{EOCK}} = -100 + 10/10\% = 0$. The private fanciers are just indifferent to taking on this marginal investment.

If the distribution of the gains and losses is explored using the consistency expression (7), then it is not clear that the private investors actually break-even. According to (7), $\boldsymbol{NPV}^{\boldsymbol{econ}}_{\boldsymbol{EOCK}} = (-100 + 6/10\%) + (4/10\%) = -40 + 40 = 0$, whereas expression (8) shows that the private investors breakeven, that the economy forgoes 40 in externalities by investing 100 in the project, but the project generates 40 in direct tax externalities so that the economy also breaks even. To gain further insights into the second term in expression (8) it is useful express this simple investment in more general terms.

Let $\boldsymbol{p}$ equal a private perpetuity captured by the private financiers, $\boldsymbol{ext}$ equal the annual direct economic externality generated by the investment, and $\boldsymbol{e}$ gives the rate of forgone economic externalities, or $\boldsymbol{e} = \boldsymbol{EOCK} - \boldsymbol{i}^{\boldsymbol{p}}_{\min}$ in terms of expression (5) above. Now expression (8) for the 100 investment becomes

$$\boldsymbol{NPV}^{\boldsymbol{econ}}_{\boldsymbol{EOCK}} = (-100 + \boldsymbol{p}/\boldsymbol{i}^{\boldsymbol{p}}_{\min}) + [-100 + \boldsymbol{p}/\boldsymbol{EOCK} - (-100 + \boldsymbol{p}/\boldsymbol{i}^{\boldsymbol{p}}_{\min})] + (\boldsymbol{ext}/\boldsymbol{EOCK})$$

or

$$\boldsymbol{NPV}^{\boldsymbol{econ}}_{\boldsymbol{EOCK}} = (-100 + \boldsymbol{p}/\boldsymbol{i}^{\boldsymbol{p}}_{\min}) + [(\boldsymbol{p}/\boldsymbol{i}^{\boldsymbol{p}}_{\min})(-\boldsymbol{e}/\boldsymbol{EOCK})] + (\boldsymbol{ext}/\boldsymbol{EOCK}) \qquad (9)$$

Now for a marginal private investment, $\boldsymbol{p}/\boldsymbol{i}^{\boldsymbol{p}}_{\min} = 100$ or $\boldsymbol{NPV}^{\boldsymbol{tot\ cap}}_{\boldsymbol{i}^{\boldsymbol{p}}_{\min}} = 0$, then

$$\boldsymbol{NPV}^{\boldsymbol{econ}}_{\boldsymbol{EOCK}} = +(-100\,\boldsymbol{e}/\boldsymbol{EOCK}) + (\boldsymbol{ext}/\boldsymbol{EOCK}) \qquad (10)$$

or the project needs to generate direct externalities (such as added direct taxes) at a rate as fast as economic externalities are forgone (or $\boldsymbol{ext}/100 \geq \boldsymbol{e}$) for it to be economically attractive or $\boldsymbol{NPV}^{\boldsymbol{econ}}_{\boldsymbol{EOCK}} \geq 0$. In the simple example above, the forgone externalities are -40 that are offset by the direct externalities generated of 40.

If the private investors expect to capture a surplus or $\boldsymbol{NPV}^{\boldsymbol{tot\ cap}}_{\boldsymbol{i}^{\boldsymbol{p}}_{\min}} > 0$ such that $\boldsymbol{p}/\boldsymbol{i}^{\boldsymbol{p}}_{\min} > 100$, then the forgone externalities $(\boldsymbol{p}/\boldsymbol{i}^{\boldsymbol{p}}_{\min}\,\frac{-\boldsymbol{e}}{\boldsymbol{EOCK}})$ increase over those in (10), as the economy now loses access to the surplus captured by the private investors. These forgone externalities are offset by both the surplus captured by the private investors and the direct externalities. To illustrate, staying with the same simple investment as an illustration, assume that the private perpetuity increases from 6 to 7.2, but otherwise generates the same perpetual externality of 4. From (9),

$$NPV^{econ}_{EOCK} = (-100 + 7.2/6\%) + (7.2/6\% \frac{-4\%}{10\%}) + (4/10\%)$$
$$= \quad (20) \quad + \quad (-48) \quad + \quad (40) \qquad (11)$$
$$= \quad 12$$

Note that the forgone externalities have increased from -40 to -48, but in this case the private gains are 20 and more than offset this increased external loss of 48. Importantly, the external loss on the capital invested increases by the financiers surplus of 20 times the externality forgone per unit of capital or 20*4% = 8.

What if the government offered the marginal investor a tax break that increased the private perpetuity by 2.4 from 6 to 8.4, but this tax break cuts the direct annual externality generated by the project by the same amount from 4 to 1.6? Again using (9),

$$NPV^{econ}_{EOCK} = (-100 + 8.4/6\%) + (8.4/6\% \frac{-4\%}{10\%}) + (1.6/10\%)$$
$$= \quad (40) \quad + \quad (-56) \quad + \quad (16) \qquad (12)$$
$$= \quad 0$$

In this case, the tax break transfers added 40 to the private investors' gains raising $NPV^{tot\ cap}_{i^p_{\min}}$ to 40 at the expense of a loss of direct externalities of 24 (=40 –16) and indirectly losing an added 16 (=56-40) such that NPV^{econ}_{EOCK} is reduced to zero (= +40 – 16 – 24)). Note that the added forgone externality on the capital is 40*4% or 16.

Public Sector Projects

In the case of many public sector projects, the project service is delivered at no or a low user charge such that from a financial perspective the project is financially unattractive and requires significant government subventions from general tax revenues. From the economic perspective, the external gains to the users of the service need to be high enough to offset the financial losses and any other external net economic losses. In such projects, it becomes important to be able to identify the service beneficiaries and how much they gain separately from other externalities, typically due to tax distortions. To do this expression (8) is expanded to recognize the net benefits or losses by the various external stakeholders as follows:

$$NPV^{econ}_{EOCK} = NPV^{tot\ cap}_{i^p_{\min}} + (NPV^{tot\ cap}_{EOCK} - NPV^{tot\ cap}_{i^p_{\min}}) + \sum_j PVExt_{i^p_{\min},j} + \sum_j (PVExt_{EOCK,j} - PVExt_{i^p_{\min},j}) \qquad (13)$$

Here, the first and third right-hand terms capture the actual present value of the gains or losses experienced by the financiers and by the external stakeholders, respectively. The second and fourth right-hand terms capture the forgone externalities (mainly tax related) arising from the capital investment adjusted for the transfers of surplus between stakeholders caused by the project.

A simple water supply project is used as an illustration. A government water agency invests 100 in a water supply project and incurs perpetual annual operating and maintenance costs of 10 each year in constant prices. It supplies the water services free of charge such that the gain to the consumers is a perpetual benefit of 25. This external gain forms the first externality. The operations and maintenance are financed by government revenues and the economy suffers the external economic cost of raising these public funds annually of 20% of the revenues.[13] This results in the second externality of a perpetual cost of 2 each year. This is the loss in market surplus or dead weight loss suffered by the private sector as taxpayers. The private or financial cost of capital ($i^{p}_{\min}$) is 6%. With forgone economic externalities of 4%, the EOCK is 10%. For simplicity sake, it is assumed that all the stakeholders have the same discount rate as the project financiers. Table 2 shows this water supply investment project from the financial, economic and distributive perspectives.

Box A of Table 2 gives the regular financial and economic appraisal of the project. It shows that financially, the government-sponsored water agency invests 100 and incurs perpetual annual costs of 10 to maintain and operate the project. From a financial perspective, the $NPV^{tot\ cap}_{i^{p}_{\min}} = -100 - 10/6\% = -266.7$. From an economic perspective, the $NPV^{econ}_{EOCK} = -100 + (25 - 10 - 2)/10\% = 30$.

Box B of Table 2 applies expression (7) to check the consistency of the analysis. The present value at EOCK of the externalities of the project experienced by the consumers and private sector as taxpayers amount to (+25/10% -2/10%) or 230, and the present value of the costs of the water agency amount to (100+10/10%) or 200, so that the difference is the $NPV^{econ}_{EOCK} = 230 - 200 = 30$.

Box C of Table 2 applies expression (11) to provide the distributive analysis, while Box D regroups the gains and losses so as to recognize the actual gains and losses. Now, the present value of the actual gain to consumers is 416.7 (which exceeds the gain to the economy of 250). The gain to consumers is reduced by the present values of the loss of the private sector from the economic cost of the public funds used to finance the operations and maintenance (-33.3), the financial loss of the water supply agency (-266.7), and the net economic externality forgone through the use of the capital funds adjusted for the changes in stakeholder surpluses (+66.7-166.7+13.3=-86.7). Again, these add up to the overall present value of the net economic gain of 30. Box D also presents the distribution of these gains and losses as annualized amounts (rather than present values). The annual consumer gain of 25 is reduced by the economic cost of public funds (-2), the rental and operating cost of the water supply agency (-16) and the forgone externality on the capital invested (-4) leaving a net economic gain of 3 per year (or 30 in present value terms.)

[13] The marginal economic cost of public funds is taken here to be 20%.

Table 2. Finacial, economic and distributional analysis of a public sector water supply project

Private or financial discount rate (priv)	6%				
Economic discount rate (EOCK)	10%			Present values (PV) at	
				6%	10%
A. Project appraisal	**Construction period**	**Operations period (perpetual)**		**Financial**	**Economic**
Benefits					
Economic benefit of free water (Ext 1)		25		416.7	250
Costs					
Capital cost	100			100	100
Operating and maintenace costs		10		166.7	100
Cost of public funds (Ext 2)		2		33.3	20
NPV consumers (Ext 1) - NPV priv sector (Ext 2)				383.3	230.0
NPV water suppliers (total capital investment perspective)				**-266.7**	-200.0
NPV economic					**30**
B. Consistency check					
NPV total capital at EOCK					-200.0
NPV Ext (1+2) at EOCK					230.0
NPV econ at EOCK					**30.0**
C. Distribution of gains and losses					
NPV water suppliers (tot cap) at priv				-266.7	
NPV water suppliers (tot cap) at EOCK - same at priv				66.7	
NPV consumers (Ext) at priv				416.7	
NPV consumers (Ext) at EOCK - same at priv				-166.7	
NPV priv sector (Ext 2) at priv				-33.3	
NPV priv sector (Ext 2) at EOCK - same at priv				13.3	
NPV econ at EOCK				**30.0**	
D. Distribution of actual gains and losses		**Annual net benefits**		**Present values**	
Consumers (Ext 1)		25		416.7	
Private sector (Ext 2)		-2		-33.3	
Government as sponsor or agency (investor & operator)		-16		-266.7	
Government as receiver of revenue		-4		-86.7	
Economy		**3**		**30.0**	

Uncompetitive financing

Further refinements can be added to the distributional analysis in cases of uncompetitive financing of a project. Two common situations arise. The first, and possibly more common situation, is that of the project owners or sponsors getting access to low-interest rate loans. Usually, this arises where some national or multi-national agency either provides below-market interest rate loans or provides loan guarantees that lower interest rates. The second situation is where the equity holders have above market costs of capital. This may arise where a government is awarding a contract or concession in an uncompetitive fashion.

Low interest rate loan

To analyze the effects of a low-interest rate loan case, the first step is recognize the cash flows to total capital are allocated to the different equity and debt holders. Typically, where debt is supplied at a competitive market interest rate, it is taken that the debt holders just cover their costs and receive zero net present value (or the net present value of the debt holders' cash flows is zero at the interest rate paid on the debt or $\boldsymbol{NPV}_{\text{int}}^{\boldsymbol{debt}} = 0$.) This means that all the residual gains and losses from the project go to the

equity holders or $\boldsymbol{NPV}^{\boldsymbol{tot\ cap}}_{\boldsymbol{i}^{\boldsymbol{p}}_{\min}} = \boldsymbol{NPV}^{\boldsymbol{equity}}_{\boldsymbol{equity}}$, or the net cash flows to the equity holders discounted at their discount rate or supply price of equity.[14] In the case of a project receiving guaranteed, concessional or subsidized debt, however, the project ***WACC*** will be less than $\boldsymbol{i}^{\boldsymbol{p}}_{\min}$ to the extent of the lower cost of debt. Hence, expression (8) needs to recognize this difference between the actual costs of finance in the ***WACC*** and the minimum supply price in the ***EOCK*** as follows:[15]

$$\boldsymbol{NPV}^{\boldsymbol{econ}}_{\boldsymbol{EOCK}} = \boldsymbol{NPV}^{\boldsymbol{tot\ cap}}_{\boldsymbol{WACC}} + (\boldsymbol{NPV}^{\boldsymbol{tot\ cap}}_{\boldsymbol{i}^{\boldsymbol{p}}_{\min}} - \boldsymbol{NPV}^{\boldsymbol{tot\ cap}}_{\boldsymbol{WACC}}) + (\boldsymbol{NPV}^{\boldsymbol{tot\ cap}}_{\boldsymbol{EOCK}} - \boldsymbol{NPV}^{\boldsymbol{tot\ cap}}_{\boldsymbol{i}^{\boldsymbol{p}}_{\min}}) + \sum_{\boldsymbol{i}} \boldsymbol{PVExt}_{\boldsymbol{EOCK,i}} \quad (14)$$

The first term remains the surplus accruing to the project owners (which is now larger because of the subsidized debt). The second term is negative ($\boldsymbol{WACC} < \boldsymbol{i}^{\boldsymbol{p}}_{\min}$) as it is the value of the low-interest rate debt captured by the equity holders relative to paying market interest rates. The third term remains the forgone economic externalities on the capital used by the project. One of the externalities is now the present value of the negative cash flow of the cost arising from the low interest rate loan to the government or funding agency bearing the cost of the low interest rate loan.

A simplified case of a low interest rate loan can be illustrated using the example in (11) above of a perpetual investment project except the project is not financially attractive to private investors with market financing, but is generating above average externalities. Now $\boldsymbol{p}$ = 5.4, $\boldsymbol{WACC} = \boldsymbol{i}^{\boldsymbol{p}}_{\min}$, and ***ext*** = 5, with the same costs of capital such that:

---

[14] $\boldsymbol{NPV}^{\boldsymbol{tot\ cap}}_{\boldsymbol{i}^{\boldsymbol{p}}_{\min}} = \boldsymbol{NPV}^{\boldsymbol{equity}}_{\boldsymbol{equity}}$ is a useful expression to find the ***WACC*** of a project where the structure of debt is complex and the debt-equity ratio varies over time. If $\boldsymbol{NPV}^{\boldsymbol{equity}}_{\boldsymbol{equity}}$ is estimated, then the ***WACC*** or $\boldsymbol{i}^{\boldsymbol{p}}_{\min}$ can be found by finding the value of $\boldsymbol{i}^{\boldsymbol{p}}_{\min}$ that would have the same ***NPV*** as $\boldsymbol{NPV}^{\boldsymbol{equity}}_{\boldsymbol{equity}}$ for the net cash flows to total capital. See Graham Glenday and Joseph Tham, "What weights in the WACC?" Sanford Institute Working Paper Series, Paper No. SAN03-01 2003

[15] Note that $\boldsymbol{NPV}^{\boldsymbol{tot\ cap}}_{\boldsymbol{WACC}}$ in (14) can be disaggregated into the ***NPVs*** accruing to the different financiers. Assuming two classes of financier, equity and debt holders, and dividing the cash flow to total capital between them, then $\boldsymbol{NPV}^{\boldsymbol{tot\ cap}}_{\boldsymbol{WACC}} = \boldsymbol{NPV}^{\boldsymbol{equity}}_{\boldsymbol{equity}} + \boldsymbol{NPV}^{\boldsymbol{debt}}_{\boldsymbol{debt}}$. For example, in the case of the perpetuity of 6 to total capital of 100 at a cost of 6%, if debt receives 1.2 from investing 40 at an interest rate of 3%, equity invests 60 and receives the balance of 4.8, then all parties have ***NPV*** =0 and ***WACC*** is 6%. Instead of adjusting the ***WACC*** in (14) for subsidized interest rates or other changes in the private costs of capital, if the financiers' ***NPVs*** are disaggregated, then the changes in their net benefits can be accounted for directly. If an external agent (such as a government) is funding the interest rate subsidy, then this external cost is also explicitly recognized in the externalities of the project. The second term in (14) would be similarly disaggregated into the ***NPVs*** of the different financiers so that it would capture the gain to the equity holders and loss to the debt holders relative to paying market interest rates on the debt.

$$
\begin{aligned}
\boldsymbol{NPV}^{\boldsymbol{econ}}_{\boldsymbol{EOCK}} &= (-100 + \boldsymbol{p}/\boldsymbol{i}^{\boldsymbol{p}}_{\min}) + (\boldsymbol{p}/\boldsymbol{i}^{\boldsymbol{p}}_{\min})(\boldsymbol{i}^{\boldsymbol{p}}_{\min} - \boldsymbol{EOCK})/\boldsymbol{EOCK} + \boldsymbol{ext}/\boldsymbol{EOCK} \\
&= (-100 + 5.4/6\%) + (5.4/6\%\,\frac{-4\%}{10\%}) + (5/10\%) \\
&= (-10) \quad + \quad (-36) \quad + \quad (50) \\
&= 4
\end{aligned}
\tag{15}
$$

Expression (15) shows that the private financiers lose 10, the economy gains 4 from the high direct externalities generated by the project relative to those forgone. Now, the government offers a low interest rate loan that costs the government 1.2 each year to finance the low-interest rate loan which lowers the externalities from 5 to 3.8 each year. With the low interest rate loan and possibly higher leverage, the ***WACC*** falls to 4.8%.[16] Expressing (14) in terms of the perpetuity:

$$
\begin{aligned}
\boldsymbol{NPV}^{\boldsymbol{econ}}_{\boldsymbol{EOCK}} &= (-100 + \boldsymbol{p}/\boldsymbol{WACC}) + (\boldsymbol{p}/\boldsymbol{i}^{\boldsymbol{p}}_{\min})(\boldsymbol{WACC} - \boldsymbol{i}^{\boldsymbol{p}}_{\min})/\boldsymbol{WACC}) + \\
&\qquad (\boldsymbol{p}/\boldsymbol{i}^{\boldsymbol{p}}_{\min})(\boldsymbol{i}^{\boldsymbol{p}}_{\min} - \boldsymbol{EOCK})/\boldsymbol{EOCK} + \boldsymbol{ext}/\boldsymbol{EOCK} \\
&= (-100 + 5.4/4.8\%) + (5.4/6\%)\frac{-1.2\%}{4.8\%} + (5.4/6\%)(\frac{-4\%}{10\%}) + (3.8/10\%) \\
&= (12.5) \quad + \quad (-22.5) \quad + \quad (-36) \quad + \quad (38) \\
&= -8
\end{aligned}
\tag{16}
$$

Now the equity-holders expect a gain of 12.5 rather than a loss of 10 (or a net improvement of 22.5 as shown the second right-hand term), but the economy loses 12 in external gains and the externalities drop from 50 to 38 as it has to finance the forgone interest of 1.2 a year.[17] Note that this lower interest rate could be achieved by the government financing the interest loss by tax revenues; or by the government using guarantees to some financial institutions to provide the lower cost debt (where the expected cost of the guarantee would be draw on government revenues)[18]; or if the government received low interest rate financing from a foreign donor agency, and instead of using this to pay off existing debt at market interest rates, it passes on this low rate to the investment project and forgoes tax savings or benefits from added expenditures. It would only be in the case of the foreign donor agency providing the low interest rate financing for a specific project that could not be used for alternative uses and the funding

[16] Without low interest rate loan, if equity finances 40% at a cost of 9% and debt the remaining 60% at 4%, then ***WACC*** = 6%. If the interest rate is lowered to 2% then this costs 1.2 per 100 investment in total capital (or 2% * 60% = 1.2%) and the ***WACC*** =4.8%.

[17] A similar net gain could have been passed on to the equity holders of the investment by cutting its tax burden by 1.35 per year. This would also reduce the external gains from the project by 13.5 such that the economy suffers a loss of 9.5.

[18] Estimating the costs and benefits of loan guarantees is fairly complex in two respects. The gains to the beneficiary requires knowledge of what the supply price of a particular risk-class of debt would have been in a competitive market to the project, the probable costs of default under the conditions of the guarantee and the amounts of these costs recoverable from the guarantor. The cost to the guarantor becomes these expected claims under the guarantee conditions.

would not be available for other purposes that the interest loss would not be experienced as an externality.

Uncompetitive equity supply

Typically, suppliers of equity are not expected to invest if they do not expect to achieve their minimum supply price. They may, however, expect to receive returns above the market minimum supply price or above their own supply price. This may occur where project gets offered an above market return as could happen in a regulatory regime guaranteeing a specified return, or where there is a lack of competitive bidding. For example, in the case of bidding for a public concession providing access to income-generating public assets, the government agency may accept a below market bid. Two difficult-to-distinguish situations may arise, namely, either (a) the equity holders except a windfall gain ($\boldsymbol{NPV}^{\boldsymbol{tot\,cap}}_{\boldsymbol{WACC}} > 0$) even with $\boldsymbol{WACC} = \boldsymbol{i}^{\boldsymbol{p}}_{\min}$, or (b) the actual ***WACC*** exceeds $\boldsymbol{i}^{\boldsymbol{p}}_{\min}$ because the equity holders only have access to high-cost debt and/or have high cost equity (as may be the case with a small undiversified company with risk averse owners) such that in the extreme the private bidders are, in fact, only just willing to do the project or $\boldsymbol{NPV}^{\boldsymbol{tot\,cap}}_{\boldsymbol{WAAC}} = 0$. In this latter case, arguably the real added costs of capital are being incurred by the financiers by allowing above-market-cost capital to be used and following (5), $\boldsymbol{EOCK_{uc}}$ = ***WACC*** + **economic externality per unit of capital.** At this higher ***EOCK,*** $\boldsymbol{NPV}^{\boldsymbol{econ}}_{\boldsymbol{EOCK_{uc}}}$ is lower than $\boldsymbol{NPV}^{\boldsymbol{econ}}_{\boldsymbol{EOCK}}$ (where ***EOCK*** is based on $\boldsymbol{i}^{\boldsymbol{p}}_{\min}$) and the difference ($\boldsymbol{NPV}^{\boldsymbol{econ}}_{\boldsymbol{EOCK_{uc}}}$ - $\boldsymbol{NPV}^{\boldsymbol{econ}}_{\boldsymbol{EOCK}}$) captures the economic loss from uncompetitive bidding. Taking the example in (11) above, if the project generated a private perpetuity of 7.2 and externalities of 4, then the private gains are 20 with $\boldsymbol{i}^{\boldsymbol{p}}_{\min}$ = 6% and economic gains are12 with ***EOCK*** =10%. If investors with a minimum ***WACC*** of 7.2% were allowed to undertake the project, then $\boldsymbol{EOCK_{uc}}$ becomes 11.2% (7.2%+4%) and (11) becomes

$$\begin{aligned}\boldsymbol{NPV}^{\boldsymbol{econ}}_{\boldsymbol{EOCK\,uc}} &= (-100 + 7.2/7.2\%) + (7.2/7.2\%\frac{-4\%}{11.2\%}) + (4/11.2\%) \\ &= \quad (0) \quad + \quad (-35.7) \quad + \quad (35.7) \qquad\qquad (17) \\ &= \quad 0\end{aligned}$$

Here the economy loses 12 by allowing high-cost investors to undertake the project. Clearly, in (11) competitive bidding could have extracted an upfront transfer of 20 from the investors with a ***WACC*** of 6% to the government (a direct lump sum externality) and left the net economic gains unchanged at 12.

7. Summary Remarks

In summary, the new, but old approach to the ***EOCK*** as the minimum or competitive supply price of capital to a project plus a national parameter estimate of the economic externality per unit of capital is both flexible and feasible. It unifies the insights and techniques coming from the capital market finance experts of the business school in estimating the minimum supply price of capital with the economic insights of the public finance economist in estimating the economic externalities of using capital. It removes the increasingly weighty criticism of the lack of risk adjustments in the single-valued ***EOCK***, while it contains the ***EOCK*** estimate of the cost of public investment

funds for the pure public sector project as a special case. In the latter case, however, the ***EOCK*** is likely to be somewhat lower than the traditional single valued estimate as the costs of risk and transaction cost included would only be those included in the cost of long-term public debt. Finally, it allows a more precise disaggregating of the gains and losses to the project financiers, government treasury, public service beneficiaries and other stakeholders of a project for public sector projects and for projects with private participation under a variety of tax and capital investment incentive arrangements.