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The Social Discount Rate:

Estimates for Nine Latin American Countries

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Abstract

The social discount rate measures the rate at which a society would be willing to trade present for future consumption. As such it is one of the most critical inputs needed for cost-benefit analysis. This paper presents estimates of the social discount rates for nine Latin American countries. It is argued that if the recent track record in terms of growth in the region is indicative of future performance, estimates of the social discount rate would be in the 3-4 percent range. However, to the extent that the region improves on its past performance, the social discount rate to be used in the evaluation of projects would increase to the 5-7 percent range. The paper also argues that if the social planner gives a similar chance to the low and high growth scenario, the discount rate should be dependent on the horizon of the project, declining from 4.4 percent for a 25-year horizon to less than 4 percent for a 100-year horizon.

This paper—a product of the Office of the Chief Economist, Latin America and the Caribbean Region—is part of a larger effort in the department to to understand the causes, consequences and possible solutions to the challenges created by climate change. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at hlopez@worldbank.org.

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I. Introduction

The social discount rate measures the rate at which a society is willing to trade present for future consumption. As such it is one of the most critical inputs used in cost benefit analysis of public projects (and more generally public policies), and it is especially relevant when considering projects whose benefits are only apparent over the very long run (such as for example interventions to adapt to or mitigate climate change concerns which by their own nature have an intergenerational dimension).

For example, with a 2 percent discount rate a project with a cost of $1 today producing benefits of $2.7 in 50 years from now would be socially acceptable. However, this would not be the case if the discount rate is 5 percent in which case the break-even benefit would be almost four times as large ($11.5). More dramatically, these discrepancies increase markedly as the time horizon expands. With a 2 percent discount rate the break-even benefit of a $1 project that has a pay off in 100 years is $7.2 but it increases more than twenty-fold (to $131) when the discount rate is 5 percent. As a result, social planners using a high discount rate will have a tendency to favor projects with short-run benefits over those with payoffs in the long run, whereas those using low discount rates will be more amenable to finance the latter type of interventions.

Given the relevance of the discount rate for policy making, it should not be surprising the interest that the topic has generated in the economics literature going back to (just to name a few) Ramsey (1928), Feldstein (1964), Baumol (1968), or Stern (1977). More recently, the issue has also received renewed attention following *The Stern Review on the Economics of Climate Change* and among others, the reviews of the *The Stern Review* by Nordhaus (2007) and Weitzman (2007). Among some of the recent empirical works, it is worth mentioning Eavns and Sezer (2004), Kula (2004), or Evans (2005).

In practice, two types of discount rates have been advocated. One is the use of the social opportunity cost (SOC) of the investment (Baumol, 1968, Harberger, 1972), defined as the value to society of the next best alternative use of the resources devoted to the project in question[1] (i.e. the real rate of return that would be earned on a marginal project in the private sector). The motivation for this discount rate is that the decision to invest in a public project means that the resources devoted to the project in question will be unavailable for private investment. Thus, on efficiency considerations, projects should be undertaken when their potential social benefit is larger than the loss resulting from the removal of resources from the private sector.

However, a number of authors (among others Sen, 1961 and Feldstein, 1964) have argued that an individual's preferences in collective saving and investment are likely to differ from his or her preferences in individual decisions as public investment and consumption by future generations can be viewed as public goods. Put in other words, an individual's time preference may depend on whether s/he is acting alone or as part of a group and hence if others are willing to save s/he may be willing to do it as well. For these authors a more appropriate discount rate is one based on a social time preference (STP) that assigns

[1] Note that this will typically be larger than the public sector borrowing rate.

current values to future consumption based on society's evaluation of the desirability of future consumption.[2]

In practice, it is likely that a single rate -whether an SOC or an STP- is not appropriate in all cases and that the analysis of different public interventions requires the use of different discount rates. For example, the European Commission (EC) recommends the use of an SOC rate in those cases where the financial return of the project is an important public concern (e.g. investment by a public enterprise that is expected to operate without subsidies). On the other hand, the EC recommends the use of an STP[3] for the more standard cost benefit analysis of public projects.[4] Similarly, Spain uses a 6 percent[5] for transport projects but a lower STP based 4 percent for water projects. In the U.S., the Office of Management and Budget recommends a real rate of between 2.5-3 percent (depending on the horizon of the project under consideration) based on the costs of borrowing for the government to assess the cost effectiveness of potential interventions and a 7 percent for cost benefit analysis (Spackman, 2006).

In this paper we enter this debate and present empirical estimates of the social discount rate for nine Latin American countries (Argentina, Bolivia, Brazil, Chile, Colombia, Honduras, Nicaragua, Mexico, Peru) that are based on the STP hypothesis. To this end, we rely on Ramsey's formula (Ramsey, 1928), an equation that relates the social discount rate to: (i) a pure time preference rate; (ii) the growth rate of per capita income/consumption; and (iii) the elasticity of marginal utility of income/consumption. Below we present estimates of this last parameter for the countries under analysis that are based on the tax regime and the principle of equal absolute sacrifice (Evans, 2004).

To anticipate some of the results of the paper, it is found that if the recent track record in terms of growth in the region is an indicative of future performance, our estimates of the social discount rate would be around 3.5-4 percent. To the extent that the region improves on its past performance, which admittedly has been quite dismal and therefore may bias the results, the social discount rate to be used in the evaluation of future projects would increase. In this regard, estimates in the 5-6 percent would be more appropriate. These STP rates are slightly higher than those estimated for six major developed countries by Evans (2004) using the same methodology (4-5 percent). Thus, in principle, it will be possible to find projects that are acceptable in the developed countries but are not in Latin America.

The rest of the paper is structured as follows. In section II we review the theoretical background underlying the STP. In sections III and IV we discuss the calibration of the components of the social discount rate (section III) and of the discount rate itself (section IV). Finally, in section V we close with some final reflections.

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[2] Implicit in this discussion is that the fact that typically country based STP rates are lower than SOC based rates.

[3]Admittedly, since the European SOC and the EC estimated STP are both close to 5 percent (in real terms), the EC suggests the use of this rate for both type of projects.

[4] In turn, other authors have argued that the appropriate discount rate should be a weighted average of the SOC and STP rates.

[5] Unless otherwise noted, all rates are in real terms.

II. The social discount rate

There are at least two arguments that can be put forward to justify STP discounting. First, individuals seem to have a preference for immediate rather than delayed gratification,[6] and hence to the extent that governments take into account the preferences of the members of society, they should discount the future costs and benefits associated to public projects. This preference for near term gratification may be related to psychological factors such as impatience or mere myopia[7], to the fact that individuals do not have an infinity life span which in turn implies that rational individuals will prefer $1 today than $1 in the future because there is always a non-zero probability of not being able to enjoy the future income, or to risk considerations (beyond project specific risk) associated to the possibility that the future cost or benefit will not occur because of a natural (or man made) catastrophe.

True, one could argue that for intergenerational projects, the use of pure time preferences is perhaps not that much justified, especially if governments have also responsibility for future generations even if they have not been born yet.[8] In that case, there would be good reasons for policy makers to be more patient than private citizens although the extent of the patience to be shown has been the basis for a debate on the issue that goes back to the 19th century. At the one extreme of debate we can find a number of authors such as Jevon (1871), Rae (1905), Ramsey (1928), Pigou (1932), Harrod (1948) or Price (1989) (just to mention a few) who have criticized pure time discounting as irrational and/or unethical and argued for a pure time preference rate of zero. At the other end of the spectrum it also possible to find authors such as Fisher (1930), Koopmans (1960), Eckstein (1961), Henderson (1965), Hirshleifer (1970), Parfit (1971), or Arrow (1995) who have noted that there is nothing irrational with positive time discounting and in fact argued for it on both technical and logical/philosophical grounds.

For example, Koopmans (1967) noted that without a positive time discount factor the integral of the utility of consumption over an infinite future will not converge for most of the paths to be compared.[9] Also on the economics front, Koopmans (1960) argues that a

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[6] For example, Warner and Pleeter (2001) analyze the US military drawdown of the early 1990s, when more than 65,000 military personnel were offered the choice of an annuity or a lump-sum payment with break even discount rates exceeding 18 percent. They found that the vast majority of personnel opted for the lump sum. This would imply personal discount rates of at least 18 percent (at a time when interest rates on government bonds were about 7 percent) and lend support to the idea of a preference for immediate gratification. Similarly, Frederick, Loewenstein, and O'Donoghue (2002) calculate that the average personal discount rate of 21 empirical studies (all with horizons of more than one year) on the topic is around 25 percent.

[7] As early as 1834, John Rae already pointed out that one of the factors that limited accumulation was the prospect of immediate consumption and the discomfort associated to delaying instant gratification.

[8] After all, if we were able to ask future generations they may have a different view of the problem.

[9] In his 1928 paper, Ramsey solved this problem by assuming the existence of a finite "bliss" or maximum conceivable state of satisfaction that can be achieved by consumers. However, Chakravarty (1962) agued that unless there is a finite level of consumption corresponding to this "bliss", the usual qualitative restrictions on utility and production functions are not enough to ensure that a solution to the problem exists.

zero time discount factor would result in an unrealistically high savings/investment rate. On the philosophical front, Parfit (1971) observed that individuals change over their lifetimes and hence in principle one cannot assume that there is an enduring entity over time to which ascribe future utility. This in turn implies that to some extent we would give our descendent future selves the status of other people and hence what matters to an individual in the future should logically be less important than what happens today. As such, it would not be irrational to care less about the future.

A second argument to discount future costs and benefits associated to projects goes beyond pure time preferences. If one assumes that (i) the marginal utility of consumption declines with the level of income/consumption (a standard assumption in economic analysis); and (ii) future generations will benefit from increasing levels of income/consumption (i.e. we are in an economy experiencing growth), then it would not be efficient to adopt an egalitarian approach that trades one unit of consumption today for one unit of consumption in the future. To the extent that future generations are richer then one would expect them to contribute more to their welfare. But clearly, the discount rate in this case will depend on the social planner priors regarding future growth, and on the elasticity of marginal utility of consumption.

The previous discussion on the social discount rate (*r*) is elegantly formalized in what is known as Ramsey formula. Under a standard constant relative risk aversion (CRRA) utility function such as

$$\mathrm{U(C)} = \frac{C^{(1-\varepsilon)} - 1}{1-\varepsilon}, \qquad \varepsilon > 0 \tag{1}$$

where C is per capita consumption,[10] the Ramsey formula can be expressed as follows:

$$\mathrm{r} = \beta + \varepsilon \times \sigma \,. \tag{2}$$

In (2) β is a pure time discount rate and σ is the growth rate of per capita consumption.[11]

III Calibration of the STP components

III.1 The pure time preference

As discussed in the previous section, the debate regarding the appropriate value of the pure time preference is long-standing in the economics literature, perhaps motivated because choosing a value for β requires inferring how much today's society cares for, in

[10] Note that from (1) -ε is the elasticity of marginal utility of consumption.

[11] In discrete time the Ramsey formula follows from the fact that along the optimal path small reallocations in consumption between time t and t+1 must leave welfare unaltered. As Ramsey (1928) agued this can be formally expressed as $\mathrm{U'(C_1)} = (1+\beta)^{-1}(1+r)\mathrm{U'(C_2)}$. Taking derivatives in (1); substituting; and applying logs, (2) follows immediately.

Parfit (1971) terminology, future societies. Thus it should not be surprising that empirical studies on the issue rely on very different values for β.

On the low side of the spectrum we have the time preference rate used in the Stern Review: .1 percent. The Stern review argues for this near zero rate of time preference on ethical grounds, as it would imply intergenerational neutrality. However, it is worth mentioning that with this choice, the savings/investment rate tends to $1/\varepsilon$.[12] As we discuss below, typical values of ε are in the 1-2 range, something that in turn would imply saving rates of between 50 and 100 percent. In other words, a near zero time preference rate would imply that current generations should dramatically reduce their levels of consumption, in some plausible cases, to subsistence levels. This is, clearly, totally unrealistic.

At the other side of the spectrum Little and Mirrless (1974) put an upper bound for this parameter at about 3 percent. However most of the existing applied work relies on values of β that fall in between these extremes -with typical values hovering around 1-1.5 percent. These values are in most of the cases based on average death rates, a reflection of the possibility that individuals' discount rates are affected by the probability of survival from one period to the other (see Pearce and Ulph, 1999 for a discussion of a mortality based discount rate), or a combination of mortality rates and pure time discounting.

For example, for the UK, Kula (1987) puts β at 1.2 on the basis of the probability of death in 1975, whereas Scott (1989) estimates it at about 1.3 percent by merging mortality data with a pure time preference rate derived from more than one century of data on UK savings behavior. Also for the UK Pearce and Ulph (1999) use an estimate of 1.1 percent. For countries other than the UK, the typical values are also in this range. Kula (2004) in his study of the social rate of return for India uses a value of β at 1.3. Similarly, in their study of the social rate of return in six developed countries (Australia, France, Germany, Japan, UK and US) Evans and Sezer (2004) use values that range between 1 and 1.5 percent on the basis of different catastrophe risk considerations for each country.

In this paper, we use a common time preference rate for all the countries in our sample, and rely on the lower end of the typical range for the time preference rate (i.e. $\beta=1$) as the most appropriate value. This choice is the result of correcting downwards the middle point of that range. The correction is motivated by the fact that Latin American countries have lower mortality rates than developed countries. Table 1 presents crude death rates (defined as the number of deaths occurring during the year per 100 population) corresponding to the nine Latin American countries under analysis in this paper and to nine major developed countries. The source of the data is World Development Indicators 2007. Inspection of this table indicates that death rates in the Latin American sample are around .6 whereas in the developed countries are around .8.[13] This would imply that on

[12] Strictly speaking the expression $1/\varepsilon$ corresponds to the case $\beta=0$.

[13] The averages reported by the World Development Indicators for the full sample of Latin American and the full sample of high income countries are also .6 and .8 respectively.

average, the time preference rate of the Latin American countries would be .2 percent lower than that of the industrial countries.

Table 1. Crude death rates (%)

Latin America		Developed	
Argentina	0.8	Australia	0.6
Bolivia	0.8	Canada	0.7
Brazil	0.7	France	0.9
Chile	0.5	Germany	1.0
Colombia	0.5	Italy	1.0
Honduras	0.6	Japan	0.9
Mexico	0.4	Spain	0.6
Nicaragua	0.5	UK	1.0
Peru	0.6	US	0.8
Average	0.6	Average	0.8

Source: WDI (2007)

III.2 Per capita consumption growth rates

The second element that is needed in the calibration of the STP is the expected growth rate of per capita consumption. A standard approach taken in much of the existing empirical literature (Pearce and Ulph, 1995; Kula, 2004; Evans and Sezer, 2004; Evans, 2004) relies on generating the expectations of the future rate on the basis of past per capita consumption growth rates. For example, in their studies, Kula (2004), Evans and Sezer (2004), and Evans (2004) proxy expected future growth with the average consumption growth rate observed over the previous three decades, whereas Pearce and Ulph (1995) rely on four decades of data.

While in principle this is a simple and transparent way to operate, in the Latin American context can be problematic for two reasons. First, if one views the lost decade of the 1980s as an outlier not likely to be repeated in the future, averages that include the 1980s can be way too low. For example, between 1981 and 1990 Nicaragua experienced a decline in per capita consumption of almost 60 percent. In Peru the decline was less marked but still above 25 percent. Similarly, during the 1980s consumption per capita fell by more than 10 percent in Brazil. It is worth noting that of the countries under analysis in this paper, only Chile and Colombia had in 1990 per capita income levels higher than in 1980.[14]

The first column of Table 2 reports average per capita consumption growth rates for the countries under consideration over 1961-2006 whereas in the second column, we replicate those averages but now ignoring the growth outcomes of the period 1981-1990. Inspection of these two columns shows that the 1980s contributed to lowering long run

[14] For Argentina we lack real per capita consumption data from 1980 to 1993. Yet, if we note that per capita GDP during the 1980s declined by 25 percent, it seems reasonable to assume that per capita consumption did not increase in this country either during the lost decade.

growth in every single country under analysis. On average, the 1980s would have detracted more than .7 percent *per year* from the 46- year average growth rate. In other words, if the 1980s are seen not only as part of the past but also as part of the future, then estimates based on the first column of table 2 are likely to be appropriate. However, if the 1980s are just seen as part of the past, then growth estimates based on the second column in table 2 may be more appropriate.

Table 2. Per capita consumption growth rate calibration

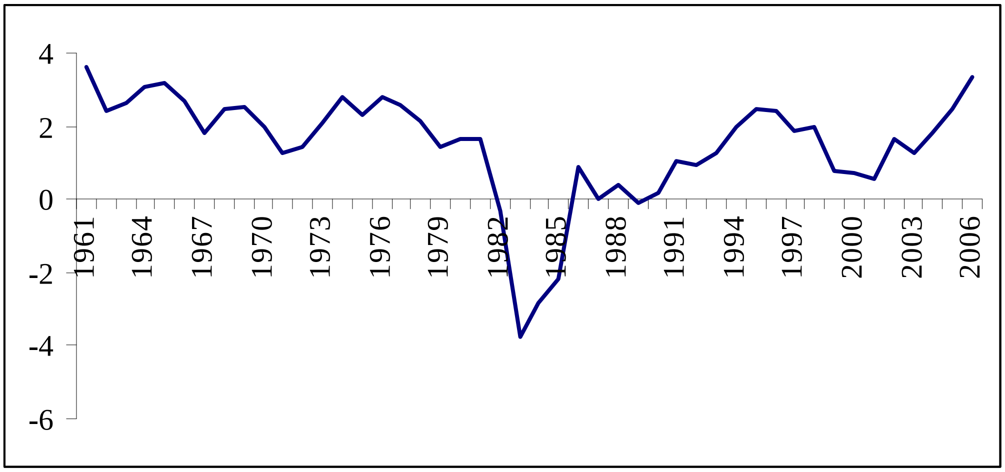
	Averages		Projections		Mix	
	1961-2006	1961-2006*	FCT	FDC	FCT1	FDC1
Argentina**	1.4	1.4	1.5	3.9	1.5	2.7
Bolivia	0.6	1.1	1.6	5.5	1.1	3.1
Brazil	2.3	3.2	3.7	4.7	3.0	3.5
Chile	2.7	3.4	4.0	4.3	3.4	3.5
Colombia	1.8	2.1	1.7	2.4	1.7	2.1
Honduras	1.0	1.5	0.9	3.2	1.0	2.1
Mexico	1.8	2.4	3.1	3.7	2.4	2.7
Nicaragua	-0.1	2.1	2.8	5.4	1.4	2.6
Peru	1.1	2.2	2.2	3.0	1.7	2.1
Average	1.4	2.1	2.4	4.1	1.9	2.8

* Excludes the 1980s to compute the average growth rate.
** Data from 1980-1993 are missing.
FCT. Projections of growth under a continuous trend of reform scenario.
FDC. Projections of growth under a dramatic change reform scenario.
FCT1. Projections of growth resulting from merging FCT1 and average growth over 1961-2006.
FDC. Projections of growth resulting from merging FDC and average growth over 1961-2006.
Sources: Own calculation using data from WDI and Loayza et al. (2005).

A second reason of why past growth rates in per capita consumption are a poor proxy for expected growth rates in the Latin American context is because of the potential role played by the reforms implement by the region in 1990s. Comparing the situation in the early 2000s and early 1990s, Latin American countries have better macroeconomic frameworks, are more open to trade, have more developed financial sectors, and in virtually all countries public spending in education has increased. All these elements are usually considered in the growth literature as growth enhancers. Moreover, per capita consumption growth in the region over the past three years has been at a four decade high. Figure 1 indicates that whereas the per capita consumption growth rates were on a declining path between the early 1960s and the mid 1980s, since then they have been trending up. Thus, is it possible that as a result of the implemented reforms the region's growth prospects[15] have improved?

[15] Strictly speaking when talking about growth prospects we are referring to *GDP growth* prospects. Moreover, most of the analytical studies looking at the evolution of growth focus on GDP growth, something that in principle could pose a problem in this context. However, it is worth noting that, at least in the countries under analysis in this paper, per capita consumption and per capita growth rates are extremely similar. Beyond the fact the average consumption and GDP growth rates over 1960-2006 are the same, the regression line in the scatter plot of annual per capita consumption growth rates against per capita GDP growth rates has a slope of .92 (s.e. .06). In this regard, below we base our per capita consumption growth projections on per capita GDP growth projections.

Figure 1. Per capita consumption growth rates*



* Each point corresponds to the median growth rate of the nine Latin American countries under analysis. The series has been smoothed with a three year backward moving average.
Source: Own calculations using WDI data.

The question of whether growth prospects have improved for the region is addressed by Loayza, Fajnzylber, and Calderon (2005) who consider two different future policy scenarios. One (denoted FCT in table 2) assumes that the reforms started in the early 1990s continue over the 2000s at the same pace as that observed in the 1990s. The second scenario (denoted FDC in table 2) assumes a dramatic acceleration in the observed pace of reform in the region, especially for those countries lagging with their reform agendas. Inspection of the growth rates under these two scenarios reveals that in principle there are some reasons to expect an acceleration of growth in the region. Under the FCT scenario the average per capita growth rate would accelerate to 2.4 percent. Under the FDC scenario, reflecting the more ambitious reform agenda implicit in the scenario, the growth rates would accelerate to 4.1 percent.[16]

Clearly, one could also argue that these projections are too optimistic. There are two types of arguments that can be given in this regard. First, the estimated accelerations in per capita growth are very significant (especially under the FDC scenario): these countries only achieved an average growth rate of 2.4 percent in the early 1960s and early 1970s. The second reason is that, as argued in World Bank (2005), the cross country econometric models on which these projections are based, tend to overestimate the positive impact of reforms on growth prospects. As for the performance of the region in recent years, it is likely to have been the result not only of the reforms implemented during the 1990s but also of a good external environment (i.e. high growth in the world) and of high commodity prices. That is, virtue may have played a role in the growth outcomes observed in Latin America in recent years, but there seems to be also a luck component.

[16] It is worth noting that the Intergovernmental Panel on Climate Change (IPCC) A1 scenario relies on an annual per capita growth rate for Latin America and Africa (both regions are grouped for scenarios purposes) of 4 percent from 1990 to 2050.

Thus against this background, we also generate a third set of projections that now merge the potential positive impact of the reforms, with the historical growth rates observed in the region (i.e. the average over 1961-2006). These projections can be found in table 2 under the headings FCT1 and FDC1. Note that by construction they fall in between those in the previous scenarios.

On the whole, table 2 contains six growth scenarios with per capita growth rates for the group as a whole ranging from 1.4 percent (historical average) to 4.1 percent (dramatic reform projections) and averaging 2.5 percent. Below we will experiment with the two extreme cases as well as the two mix cases (i.e. FCT1 and FDC1).

III.3 The elasticity of marginal utility of consumption

The third ingredient needed to calibrate the STP from equation (2) is the elasticity of marginal utility of consumption. Stern (1977) offers a good review of approaches to estimate this parameter and gives a plausible range for ε of between 1 and 10. However, this range is narrowed by Pearce and Ulph (1995) who explore the implications of different values of this parameter for egalitarian judgments and note that values above 5 seem totally implausible; and further narrowed by Scott (1989) who gives a plausible range of 1 to 2 on the basis of UK long run saving data. More recently, Evans and Sezer (2004) estimate it at between 1.3 and 1.7 in six developed countries whereas Evans (2005) finds an average value of ε of 1.4 in 20 OECD countries. Beyond developed countries, Kula (2004) estimates ε for India and finds a value of 1.64.

In this paper we follow Evans and Sezer (2004) and Evans (2005) who in turn follow Stern (1977) and assume that the personal income tax structure reflects the principle of equal absolute sacrifice, or

$$\mathrm{U(Y)} - U(Y - T(Y)) = \kappa \qquad (3)$$

for any value of *Y*. In (3), *T(Y)* is the personal income tax corresponding to the income level *Y*, and *U(.)* is a utility function. Differentiating (3), substituting (1), and simplifying it follows:

$$\varepsilon = \frac{\ln(1 - \frac{\partial T(Y)}{\partial Y})}{\ln(1 - \frac{T(Y)}{Y})}. \qquad (4)$$

Thus, equation (4) indicates that it is possible to estimate the elasticity of the marginal utility of income on the basis of two elements: (i) the effective marginal tax rate; and (ii) the average tax rate.

In practice, however, one has to face two difficulties. One is that *de jure statutory* tax rates may be quite different from *de facto paid* tax rates. This is likely to be the case in countries where tax evasion is a serious issue, particularly if individuals with different income levels have different chances to evade. In this regard, to the extent that those at the higher end of the income distribution evade more than those at the lower end (i.e. the system is in practice less progressive than intended), estimates of ε based on official tax schedules will be upward biased. We tackle this issue by relying on de facto tax rates.

A second difficulty is that in principle the value of the marginal income tax is likely to change with the income level, and hence (4) is sensitive to where it is computed along the income distribution. To address this concern we proceed to compute (4) on the basis of the effective marginal tax rate along the income distribution, and for consistency on the basis of the effective average tax rate also along the income distribution. More specifically, we rely on the following expression:

$$\varepsilon = \frac{\ln(1 - N^{-1}\sum_{i=1}^{N} \frac{\partial T(Y_i)}{\partial Y_i})}{\ln(1 - N^{-1}\sum_{i=1}^{N} \frac{T(Y_i)}{Y_i})} = \frac{\ln(1 - \overline{\frac{\partial T(Y)}{\partial Y}})}{\ln(1 - \overline{\frac{T(Y)}{Y}})}, \qquad (5)$$

where N is the number of tax data points used in the calculation. From an empirical point of view, for each country we rely on four point estimates corresponding to the 20, 40, 60 and 80 percent of the income distribution. These point estimates are computed from income tax data[17] at the quintile level. That is, marginal tax rates are computed as:

$$\frac{\partial T(Y_i)}{\partial Y_i} = \frac{T_{i+1} - T_i}{Y_{i+1} - Y_i} \qquad \text{i=1,2,3,4} \qquad (6)$$

where T_i and Y_i are the average taxes and average per capita income level of the i-th quintile, whereas the average tax rates are computed as

$$\frac{\partial T(Y_i)}{\partial Y_i} = \frac{T_{i+1} + T_i}{Y_{i+1} + Y_i}. \qquad \text{i=1,2,3,4} \qquad (7)$$

With these elements in mind table 3 reports the estimates of ε. On the whole, the results of this exercise are quite satisfactory. Inspection of this table indicates that the estimates of ε range from 1.11 in Honduras to 1.89 in Peru with an average value of 1.49. Thus the values that we obtain are in line with those commonly reported in the literature, although in comparison with the values in Evans and Sezer (2004) and Evans (2005) for a sample of developed countries (about 1.4), our estimates of the elasticity of marginal utility of income are slightly higher (about .1 on average). This in principle will contribute to a higher social discount rate in Latin America than in the developed countries.

[17] I would like to thank Breceda et al. (2006) for providing me with their tax data.

Table 3. Calibration of ε

Countries	t	T/y	ln(1-t)	ln(1-T/y)	ε
Argentina	0.0216	0.0161	-0.0218	-0.0162	1.3
Bolivia	0.0015	0.0010	-0.0015	-0.0010	1.5
Brazil	0.0144	0.0080	-0.0145	-0.0081	1.8
Chile	0.0056	0.0042	-0.0056	-0.0042	1.3
Colombia	0.0379	0.0212	-0.0386	-0.0214	1.8
Honduras	0.0269	0.0243	-0.0273	-0.0246	1.1
Mexico	0.0357	0.0287	-0.0364	-0.0291	1.3
Nicaragua	0.0251	0.0185	-0.0254	-0.0186	1.4
Peru	0.0229	0.0122	-0.0232	-0.0123	1.9
Average	0.0213	0.0149	-0.0216	-0.0151	1.5

Source: Own calculations

True, it would be possible to argue that one could alternatively compute ε at different points of the income distribution and then proceed to average these values. That is, compute ε using the following alternative to expression (5):

$$\varepsilon = \bar{\varepsilon} = N^{-1}\sum_{i=1}^{N}\varepsilon_i = N^{-1}\sum_{i=1}^{N}\frac{\ln(1-\frac{\partial T(Y_i)}{\partial Y_i})}{\ln(1-\frac{T(Y_i)}{Y_i})} \qquad (8)$$

This is explored in table 4 where we report values of ε_i (for i=1,2,3,4), together with the sample average of these estimates. The last column of the table contains the average of these values for each country, whereas the last row contains the cross country average of each of the ε_i and thus offers information regarding the constancy of ε along the income distribution.

Two main elements emerge from table 4. First, on average the values of ε obtained using (5) and (8) are very similar: 1.5 and 1.6 respectively. This is despite some significant differences at the country level. For example, whereas for Brazil ε is estimated at 1.8 in table 3, table 4 reports a value of 2.7.[18] Similarly, in Colombia table 3 indicates a value of 1.8 and table 4 of 2.1. Second, the cross country average values of ε_i appear quite stable especially for values of i>1[19] when they range between 1.5 and 1.7. Thus this exercise would somewhat reinforce the findings in table 3.

IV. Calibration of the STP rate

Section III has discussed the range of plausible values behind the ingredients of the STP for Latin America. Thus with these elements in mind we are now in the position to compute the STP. This is done in table 5 using the values of ε estimated in table 3.

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[18] Admittedly, this could be due to the fact that in Brazil we are using only 2 data points for the caulculation.

[19] For i=1 ε tends to be lower in all country cases.

Table 4. Calibration of ε at different points of the income distribution

Countries	ε1	ε2	ε3	ε4	ε
Argentine	0.7	1.0	1.5	1.6	1.2
Bolivia	1.3	0.7	1.8	1.6	1.4
Brazil 1/			3.5	1.8	2.7
Chile 1/		1.9	1.5	1.3	1.6
Colombia	1.2	3.2	2.5	1.5	2.1
Honduras	1.1	1.1	1.2	1.1	1.1
Mexico	0.6	1.5	0.5	1.7	1.1
Nicaragua	1.0	1.6	1.5	1.4	1.3
Peru	1.5	1.8	1.8	1.9	1.8
Average	1.1	1.6	1.7	1.5	1.6

1/In the cases of Brazil and Chile there are consecutive quintiles that report no income tax and thus both expressions (6) and (7) are 0.
Source: Own calculations

The first noteworthy point from this table is the dramatic impact of the different growth scenarios. Judging from averages for the group, we find that under the most pessimistic growth scenario the social discount rate would be around 3 percent. Similarly, under the FTC1 scenario (reform under a continue trend scenario mixed with the past track record for the region), the discount rate would be close to 4 percent. On the other hand, under the dramatic reform scenario we estimate discount rates of about 7 percent and in the cases of Bolivia and Brazil above 9 percent. Finally, under the FDC1 scenario we obtain an average discount rate of 5 percent.

Table 5. Calibration of *r*

			r			
			Growth rate scenario			
	β	ε	Average	FDC	FTC1	FDC1
Argentine	1	1.3	2.9	6.2	3.0	4.6
Bolivia	1	1.5	1.9	9.4	2.7	5.7
Brazil	1	1.8	5.1	9.5	6.4	7.3
Chile	1	1.3	4.6	6.7	5.5	5.7
Colombia	1	1.8	4.2	5.3	4.1	4.7
Honduras	1	1.1	2.1	4.5	2.1	3.3
Mexico	1	1.3	3.3	5.6	4.0	4.4
Nicaragua	1	1.4	0.9	8.4	2.9	4.6
Peru	1	1.9	3.1	6.7	4.1	4.9
Average	1	1.5	3.1	6.9	3.9	5.0

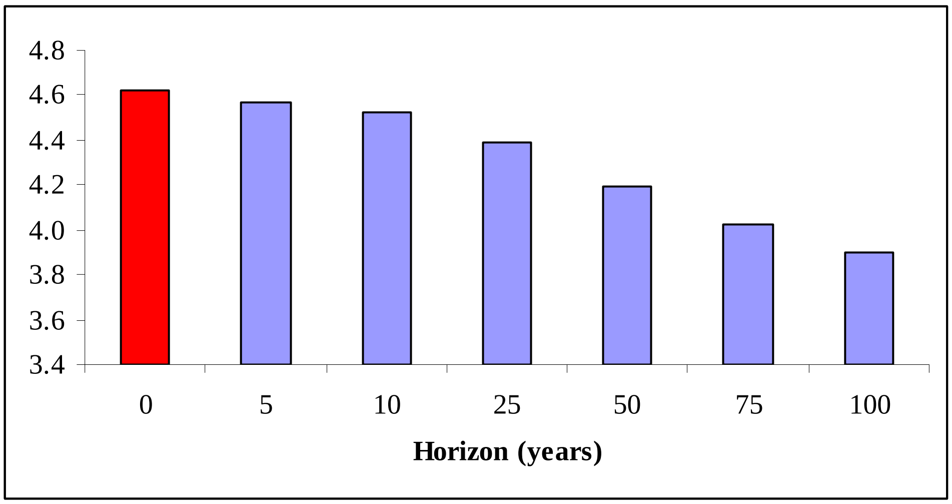
Source: Own calculations

Thus if the recent track record in terms of growth in the region is an indicative of future performance, our estimates of the social discount rate would be in the 3-4 percent range. However, to the extent that the region improves on its past performance, which taking into account how dismal it has been in principle should not be that difficult, the social discount rate to be used in the evaluation of future projects would increase and estimates in the 5-7 percent would be more appropriate.

Clearly, the discussion in the previous paragraph raises the issue of which is the most appropriate discount rate to use when there is uncertainty about potential growth outcomes. In principle, given a probability density function for the growth rates, one may be tempted to compute the expected value of this growth rate and proceed to plug it in (2). It should be noted however that for cost-benefit analysis what it matters is the discount factor 1/(1+r) and that in general

$$E(\frac{1}{1+r}) \neq \frac{1}{1+E(r)} . \qquad (9)$$

Figure 2. Effective discount rates



The discount rates in the figure are computed under the assumption that a social planner attaches a probability of .5 to a per capita growth rate of 1.5 percent per year, and also .5 to a growth rate of 3.33 percent per year. The effective discount rate at time 0 is the E(r). The simulation assumes β=1 and ε=1.5.

For example, assume that a social planner believes that there are equal chances of long run growth being 1.5 and 3.33 percent per year and that β=1 and ε=1.5 (so that the discount rates turn 3.5 and 6 percent respectively). The average discount rate is in this case 4.63 (horizon 0 in figure 2). However, as figure 2 shows the effective discount rate resulting from the average discount factor declines as the horizon increases. Moreover, as noted by Weitzman (2007) it asymptotically tends to the discount rate associated to the lowest growth rate.[20] Put in other words, when there is uncertainty regarding growth rates (the rule more than the exception in practice) as the horizon under consideration expands, we find that the lower interest rate dominates. Thus in this example uncertainty in future

[20] It is enough to note that the effective discount rate (r^e) is given by $r^e \approx -n^{-1} \ln(\sum_j p_j (\frac{1}{1+r_j})^n)$ and that this expression tends to min (r_j) as n tends to infinity.

growth rates puts the effective discount rate somewhat in between the discount rate corresponding to the minimum growth rate and the average discount rate.

V. Conclusions

Cost benefit analyses based on high discount rates will have a tendency to favor projects with short-run benefits over those with payoffs in the long run. As the discount rate falls, we will find more and more projects with benefits emerging in the long run. Thus public investment programs can be dramatically different -both in terms of overall envelope and nature of projects- depending on the specific discount rate used in practice.

In this paper we have estimated social discount rates for nine Latin American countries and highlighted that depending on the growth expectations of the social planner, these discount rates can vary dramatically from about 3-4 percent in a future low growth scenario to 5-7 percent in a high but still reasonable growth scenario. We have also noted that if these two scenarios are considered by the social planner as having the same chances in practice, the appropriate discount rate in these countries should depend on the horizon of the project: around 4.4 percent for 25 year horizons, 4.2 percent for 50 year horizons and 3.9 percent for 100 years horizon.

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