The Under-provision and Under-capitalization of Road Maintenance, Rehabilitation and Upgrading in South Africa: Analysis and Measures toward Improvement.

A study commissioned by the Southern African Bitumen Association

EXECUTIVE OVERVIEW

This paper sets out to show that for at least some spending on roads, the present way of looking at matters is mistaken in terms of the government's own stated priorities and its commitment (dating back to the Freedom Charter) to deliver on "second generation" rights such as housing, healthcare and education. In particular, it demonstrates that far from expenditure on roads being in competition with expenditure on other basic needs, it is in some crucial cases essential for the most efficient securing of precisely those basic needs. In other words, efficient delivery on housing, schools, clinics etc requires, in some clearly identifiable circumstances, that some new money be spent now on roads which service these items of essential infrastructure, rather than being added to the budgets for the provision of more housing etc. This is because such expenditure will save government from having to spend more than is necessary in the future on the provision of housing, schools, clinics etc and to ensure that the beneficiaries of expenditure on these items get the best value now in terms of delivery on their basic welfare needs.

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The starting point for any discussion of roads policy in South Africa must be the well-known fact that funding for the construction, maintenance and rehabilitation of roads in the country has been inadequate for at least the past decade.

Some of the cost to the country of inadequate and inefficient expenditure on roads is to be measured in terms of lost investment and other damage to the much-needed process of wealth creation. It is also clear that the lives of the poor are made worse by inadequate roads and the consequent absence of a safe, convenient and cheap form of travel.

The Shadow Line

It is highly relevant that failure to spend money efficiently on roads maintenance in the short term has the consequence of making it more expensive to retrieve the situation in the medium term by spending on rehabilitation. In the long term, as is sadly evidenced in other parts of the world, a point of no return is reached and it becomes impossibly expensive to rehabilitate the roads infrastructure.

This, consequently, declines to the point of disintegration. In turn, this means that the now enormous amounts of money cannot be found to rehabilitate the roads because the roads are too bad to attract the necessary investment and facilitate the necessary wealth creation. There is thus a "shadow line" in respect of inadequate expenditure on roads, which South Africa has been moving towards for some time. Once crossed, this shadow line makes recovery well nigh impossible. Obviously, it is imperative to avoid crossing this shadow line altogether.

Even so, it is tempting for government to think that, while sub-optimal provision of roads for the purposes of wealth creation and meeting the basic transport needs of the poor is indeed regrettable, both these things are inevitable for the time being, given the scarcity of public funds. Priority must therefore unfortunately be given to the more urgent demands made by the need to improve housing, health care and education for South Africa's previously disadvantaged communities.

Only when these other and more pressing welfare needs, or economic rights, have been adequately secured, can attention and resources be directed to provide adequate roads infrastructure. It is this prioritisation which needs to be urgently addressed.

A central point made in the paper is that "Even someone who takes the very extreme view that all investment should be foregone in favour of immediate transfers for the upliftment of the disadvantaged, should approve of efficient maintenance of roads" (p 25). No-one in government, we believe, does take the extreme view.

In fact government does not believe that investment in infrastructure should wholly ignore such concerns as wealth creation in favour of an exclusive concern with providing basic goods and services to the poor. Consequently, the case for more expenditure on roads is even stronger.

We have, however, concentrated only on what needs to be done in order to deliver on the second-generation rights of all South Africans. In practice, this means ensuring delivery, to the least advantaged communities, of the most basic goods and services or a minimum standard of living.

Pending more detailed field research, it is reasonable to estimate the amount of additional spending needed to meet only these clear and most basic needs of the least advantaged members of society as being in the neighbourhood of R6-billion per annum over ten years.

This is the shortfall in expenditure on roads as calculated by the DBSA in 1998 (p 10). It will serve as a guideline figure pending establishment of a more exact and up-to-date estimate. However, it is recognised that before any government could commit to such expenditure they would need to know where the money was coming from. Here, there are three possibilities:

- Raising new taxes;
- Reallocating existing taxes away from other budgets to budgets for roads;
- More efficient use of existing resources.

Fortunately, it can be shown that the more efficient use of existing resources by both the private sector and by government departments would result in savings sufficient to pay for the entire proposed increase in roads expenditure. We explain why this should be so.

In addition to our central economic argument for thinking that additional expenditure on roads is necessary for meeting the government's commitment to delivery on basic welfare needs for the poor, it is useful to mention two other considerations which are relevant to the discussion of roads policy.

Constitutional obligations

Given the legal obligation of public authorities now established in South African courts to ensure that roads are ***safe***, government cannot afford ***not*** to invest in roads at least to the point where they minimise their exposure to being found culpably negligent by the courts.

If they are found to be negligent they will have to meet claims for damages with all the collateral expenditure involved in litigation and this may well cost more than spending the money on making the roads safe.

We estimate that in 1999, there were 700 000 road accidents in South Africa, with road surface conditions contributing to up to 20% of these accidents.

If the roads situation is left unattended, the State could find itself "as a potentially unsuccessful defendant in between 70 000 and 140 000 accidents per annum" (p 14). We assume, of course, that the state is motivated to observe its obligations for the provision of safe public goods even in the absence of the economic argument. However, this argument can help to bring on board those sectors of society whose commitment to second-generation rights is more doubtful.

Congestion

While there is undoubtedly a role to be played by toll roads and other “user-pays” strategies in financing expenditure on roads, this is mainly appropriate where the value of the road is ***not*** connected with enhancing the value of other forms of infrastructure such as hospitals and schools etc.

Where the value of roads is so connected, this means in effect that there needs to be public provision of an integrated and efficient ***urban*** roads infrastructure. (Without an efficient overall system of urban roads, the result will be congestion and – worse – "ghettoisation" around the good roads, which service the hospitals, schools etc.) South Africa can ill afford this phenomenon.

Opportunity Value

We do not work here with standard cost-benefit analysis, since, for reasons explained in the paper, this technique undervalues the interests of the poor and so is not appropriate for evaluating commitment to public goods in developing countries. Instead, we use `opportunity value’ as our core concept, and show with it that investment in roads may be the best way of efficiently delivering the assets needed for meeting both second generation rights and basic welfare needs.

"Opportunity value" measures the costs saved on maintaining a primary non-roads asset by investing in good roads and the contribution to the value of the primary asset as a result of its being serviced by good roads.

Consider a hospital, which is poorly serviced by roads. First, additional demands will be made on the ***hospital*** budget by the fact that difficulty of access makes it more costly to supply goods and services to the hospital. It will be more time-consuming and therefore more expensive than necessary to deliver to the

hospital the staff and workers, building materials and all the goods that hospitals need for their day to day running. Secondly and perhaps more obviously, since the ability of hospitals to deliver the best possible kind of health services will depend on the ability of both patients and health care staff to get to the hospital quickly and easily, it follows that roads which facilitate this are promoting not just safer and more congenial travel but better health care.

For these reasons, we are able to identify situations in which *"if* the (responsible public) authority is currently not investing in the road (i.e. the network of roads which service the hospital), then the most efficient thing to do *for the hospital* … is … to bring the road maintenance schedule closer to its efficient optimum." (italics original.)

The Next Step

We have supplied formulae for calculating when such investment decisions favour roads and when they favour other assets. In order for these formulae to serve the needs of political decision-makers by providing accurate and objective calculations of how best to secure the interests of the least well off, further research should be done to establish the basic economic data.

Whatever number finally emerges, however, it is desirable to ensure that additional expenditures on roads come, as far as possible, from the more efficient use of existing resources.

At present an excessive proportion of the money allocated for expenditure on the actual maintenance and improvement of roads infrastructure is actually spent on administrative costs such as salaries, overheads and expenses by local and regional authorities. This is so for structural reasons, which do not give these authorities adequate incentives to allocate their resources efficiently in respect to roads expenditure.

The private sector has been markedly more efficient in this regard, although its performance could be improved also through the use of better contracts which prevent private contractors from offloading risk they ought to bear onto the public authority. We show how such optimally efficient contracts ought to be designed.

Hyperbolic Discounting and the infinitesimal margin

Two problems are endemic to provincial and municipal government funding of roads. First, the benefits of funding roads and the social damage caused by not funding them only gets to be noticed by the voting public at a point comparatively distant in time from the moment when the funding decision has to be made.

This remoteness in time reduces the pressure on both politicians and the public stakeholders they serve to make the right choices now in terms of what is in the long-term interests of society, and inclines them to accord much greater weight to achieving smaller but more immediately recognisable public gains. Technically, this is called the problem of hyperbolic discounting.

Smokers, for example, hyperbolically discount when they evaluate the benefits of quitting differently depending on whether they have or haven't recently satisfied their craving. This tendency – which arises in all people – is often compounded by the so-called "problem of the infinitesimal margin."

For example, our smoker might sincerely want to quit, but can never settle on any particular cigarette to be the last one because, after all, "What is one more cigarette going to hurt?" It is this which best describes the second problem endemic to the public funding of roads.

The evil which follows from every decision not to spend what ought to be spent on roads now is always very small in comparison with both the pain of doing it now and the evil of making the same decision tomorrow. Consequently decision-makers always seem to have good reason for postponing doing the right thing when other obligations weigh heavily. It is this tendency – again, common to all people - which is taking South Africa closer to the shadow line every year.

Rational people take steps to get around these problems just as Ulysses did when he bound himself to the mast before sailing past the sirens he knew would otherwise tempt him to his doom. That is, they find ways of "pre-committing" themselves. We discuss strategies by which public authorities in South Africa can manifest the wisdom of Ulysses, and ensure that provincial and local governments are motivated to spend existing budgets much more efficiently.

Taking the High Road

Such strategies will need to include mechanisms, most notably capital grant transfers tied to service to **the national good**, which will reward decision-makers who are efficient over the long term and penalise those who pursue inefficiently short-term policies, or alternatively promote their own local political interests at the expense of the national public interest. In this way, decision-makers could be prevented in advance from yielding to the temptations of the sirens.

Some progress in this direction may be made by extending the jurisdiction of SANRA and reducing the centres of decision-making from nine to four, based on SANRA's regional offices. More generally, ways have to be found consistent with the constitution for transferring capital to local and regional authorities on a conditional basis, i.e. one that ensures that local authorities forfeit revenues if they don't spend what they are allocated for roads efficiently.

A model could be fairly easily developed for enabling government to incentivise role-players throughout the system to invest in roads with maximum efficiency. It is worth noting that such a model would be worth developing in any case, since it would enable government to maximise efficiency in public expenditure generally and not just in relation to roads.

Such a model would uniquely take account of the special economic and political circumstances of South Africa and the public spending decisions, which are consequently appropriate. The adoption of this model will prove vital in ensuring adequate funding for the provision and maintenance of South Africa's roads, less the country move across the shadow line, beyond which the restoration of the country's road network becomes unattainable.

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A 21-point summary of the following survey begins on p. 36.

1. Motivating remarks

Among the most visible and distressing symptoms of a collapsed infrastructure is a network of ruined roads. The visitor to a number of large African cities, such as Nairobi, is immediately struck by the sight of broad roads, of clearly superior design, engineering and capacity in their origins and intended steady states, that are now covered with potholes, large areas of stripped surface, wholly degraded shoulders, and puddles of standing water resulting from the deterioration of drainage systems.

Untutored common sense expects that an environment characterized by such vivid signs of decay in its transport infrastructure will be a poor attractor of investment in whatever other assets it might have, and in this respect common sense is right. Any business contemplating location in such an environment will have to factor into its expectations higher delivery costs, greater risk of failure to maintain efficient inventory, and reduced customer flow due to inconvenience of access. Difficult to quantify, but perhaps most costly of all, is the effect of such highly salient urban blight on community confidence and morale, which are the fundamental prerequisites of economic and social flourishing.

Potential investors base their decisions more on broad consilience of perceptions than on over-subtle economic analyses that may exaggerate particular variables of evaluation through forced commitment to precise weightings within degrees of modeling discretion. There is no doubt that such investors will be heavily discouraged by the sight of Nairobi's roads. Discouragement is deepened by the sheer evident magnitude of the problem; substantial recovery of the system is quite obviously beyond the resource capacity of the Kenyan public sector in the absence of international assistance, and it is unlikely to grow a private sector capable of fixing the problem as long as its transport web is so strikingly inadequate. Similarly bleak prospects confront travellers to Haiti, Zambia, Azerbaijan and many other countries.

South Africa is not in this situation at present. Many of its roads, both in quality and extent, are above the average African standard, and its network in the inner cores of its two large cities is superior to those in some of the less developed parts of Europe (though in many rural areas roads are as inadequate as anywhere else in Africa). However, the point at which deterioration rates exceed the growth of capacity to recover typically comes well before advanced general blight reveals itself to casual observation. South Africa has been allowing this point to get closer for some time.

Three years prior to the change in South Africa's fundamental political dispensation, Mirrilees (1991), writing on behalf of the Department of Transport, noted that "funds for road provision have already fallen to a level where they would have to be utilised exclusively on maintenance, were the network to be maintained at the levels of service and safety generally accepted in developed countries." He warned then that "a continuation of the recent trend of increasing government expenditures on services at the expense of capital investment will inevitably be detrimental to future economic growth," and that "the unavailability of funds for road provision … is likely to have detrimental consequences for future income distribution and the economic development of backward communities, by limiting opportunities for participation in the formal economy."

Since recognition, within government and society generally, of the extent of the shortfalls in fundamental public services such as housing and education, along with the degree of commitment to make up these shortfalls, has increased very substantially over the decade since Mirrilees's remarks above, no one should find it surprising that disinvestment in capital assets involving substantial positive externalities, such as roads, has accelerated. The Development Bank of SA estimated in 1998 that R15.2 billion would be needed per year, for 10 years, to erase backlogs in general national road provision and to correct for accumulated deterioration in the existing network. However, it calculated that only 60% of this figure was then being spent. The same source estimated that the proportion of roads deemed to be in good condition fell from 25% to 5% between 1993 and 1996, representing R100 – R150 billion in lost capital assets. However, the standard of measurement against which this calibration was made is not reported.

More informative figures are given in AA RSA (2000). The scale used in this report categorises roads not against an arbitrary evaluative standard, but in terms of the extent to which regular or extraordinary maintenance investment would be required to prevent the road from becoming unserviceable. Since this measure is less demanding than that used by the DBSA appears to have been – while being more relevant because it is defined in terms of investment requirements – it finds a higher proportion of roads to be in good or very good condition. However, what is directly significant here is the question as to whether the *total expected cost of standards preservation is or is not rising as a result of under-maintenance.* The answer, unfortunately, appears to be `yes'.

AA RSA (2000) partially reports a procedure for calculating the dynamic state of South African road investment. Define `very good' roads as those that will remain serviceable for 15 years without further maintenance, and `good' roads as those that will remain serviceable for 8 years without further maintenance. Roads in all other grades either require immediate intervention if they are to be salvaged, or cannot be made serviceable except through outright reconstruction. The threshold between `good' and `fair' is therefore the salient one, since this represents the point at which we *know* that the capital reinvestment strategy applied to a road has not been efficient *if* there is no intention to abandon the road.[1] Of course, this does not imply that reinvestment *has* necessarily been efficient for all `good' or `very good' roads.

AA RSA (2000) uses a procedure to compare the current investment strategies for the national (SANRA jurisdiction) roads and in five out of nine provincial networks with ideal (efficient) values. Unfortunately, a crucial variable is missing from the description of the procedure, so we cannot verify its adequacy.

With this caveat in mind, the situation as reported may be summarised as follows. In the national network, the proportion of `very good' roads has increased since 1993. This appears to reflect the impact of outsourced tolling on some roads. However, for the national network as a whole the proportion below the efficiency threshold increased from 34% in 1993 to 54% in 1999. In the Northern Cape, 74% of paved roads were above the efficiency threshold in 1993; the 1999 figure is 64%. Free State figures are 41% (1993) and 21% (1999). In Kwazulu-Natal, site of a decline that is hard not to describe as `catastrophic', the figures are 39% (1993) and 6% (1999). In Gauteng the figures are 57% (1993) and 43% (1999). In Mpumalanga the figures are 50% (1993) and 26% (1999). Data for the remaining four provinces are either missing, or are insufficient to permit clear comparison. These numbers indicate a quite serious under-investment problem across the country, and a virtual collapse of the network in Kwazulu-Natal.

South African public authorities, along with road industry participants, journalists and many members of the general public, are aware of the general problem, and the risks, of under-resourced roads. The present Minister of Transport, Dullah Omar, recently acknowledged in a speech that "one of the primary problems hindering both economic and social development in our country is the steadily deteriorating condition of our rural road network." Nor should it be supposed that authorities and stakeholders have been idle in the face of the threat. Measures aimed at alleviating the current shortfalls in capitalisation have included privatisation, outsourcing, road pricing, reincentivization of discretionary authority, and private-public partnerships aimed at maximising efficiency in the sourcing of capital. Section 3 below will review some of the problems and

[1] AA RSA (2000) allows that on an efficient reinvestment strategy 20% of roads *intended to be kept* will be in `fair' condition. From the sketch of the report's analytical framework that is provided, this does not appear to make sense. However, as noted, crucial components of the evaluation procedure are not given.

advantages associated with these approaches in the specifically South African context. A variety of special difficulties encountered in this environment make it impossible for South Africa to simply borrow schemes from more developed economies off the shelf and copy them.

2. Rights to safe roads and public responsibility

Prior to the adoption of the present Constitution, government commitments to allocations for road investment were essentially political in character. They could thus be reduced in favour of other priorities without this raising direct legal issues. By no later than 1989, it is clear that the pre-Constitutional government had given housing, education, health care and other aspects of social infrastructure priority over investment in economic infrastructure such as roads. This policy was the source of the alarms raised by Mirrilees in his 1991 report noted above.

It is not clear to what extent the administrators of the Constitutional state have maintained the former view that roads and other major aspects of economic infrastructure are in `competition' with the leading components of social infrastructure. However, what is certain is that the demands on public resources have very substantially increased over the past decade, and that constraints on the availability of public funds resulting from enhanced recognition of social obligations have interfered with the availability of the capital required for efficient investment in public assets. **It will figure among the main contentions of this report that placing politically salient social infrastructure in `competition' with basic economic infrastructure such as roads, either deliberately or accidentally, is fundamentally irrational.**[2]

Whether or not administrative views of the relationship between public spending and public investment have changed since the last years of the pre-Constitutional regime, what is certain is that approaches to basic infrastructure provisioning can no longer be regarded as purely political. The Constitution of 1996 commits the State to obligations of respect and protection and, arguably, economic maintenance of a number of so-called `second-generation' rights. That is, South Africans are no longer merely legally protected from interference in non-criminal pursuit of their private welfare; in addition, they are now beneficiaries of

[2] It must be noted here that the distinction between `economic' and `social' infrastructures, though common in some of the development literature, doesn't really make sense. We can make a clean distinction between public goods – those whose consumption involves ineliminable externalities – and private goods – those which yield utility that can be entirely enjoyed by their owners. But is a factory, for example, *not* social infrastructure? Its activity pays the salary that buys the linen and food brought into the hospital for a patient by her relatives. Without this input, the public purse would have to pick up these costs. The intended line between the `economic' and the `social' is entirely arbitrary. And if even factories are part of the social infrastructure, it should be patently obvious that roads must be too. However, we will use the distinction here because no point made here requires that we argue with it; and our argument is that much stronger to the extent that we allow such hostages to potential opponents who are suspicious of economists' way of conceptualizing the world.

obligations on the part of the State to ensure access to housing, medical care, education, basic security of their persons and property, and a level of economic well-being consistent with fundamental dignity.

The exact practical force of these Constitutional obligations on the part of the State remains incompletely resolved by legal precedent. The strongest possible interpretation of them would imply that the State bears a prima facie obligation for provision of all second-generation rights regardless of their cost. We would then need to confront the question (to be discussed below) as to whether access to safe and adequate transport facilities constitutes a second-generation right. If this question were answered in the affirmative, then it would follow from the strong interpretation of second-generation rights that the economist's task with respect to road maintenance and adequate provision becomes a purely technical one of assembling the variables and considerations necessary for evaluating the relative efficiencies of different possible provisioning schemes and of their financing.

This being said, it would be seriously misleading to imagine that the question of State responsibility for road investment is therefore to be left hanging in suspension while legal verdicts and precedents accumulate. On *no* plausible interpretation of second-generation rights would government be required to provide *optimal* transport access to all citizens regardless of overall efficiencies in the broad provision of the package of second-generation rights. For example, the State would not be obligated to build an isolated community a new road to a hospital if it were more efficient to build that community its own hospital instead. However, this implies only a very weak conclusion, namely, that the State will not be legally *required* to indulge in a binge of construction of new rural and other low-use roads. Of much greater practical importance is the fact that recent court decisions *have* considerably expanded the State's obligations with respect to roads through emphasis on a standard second-generation right, namely, public safety from consequences of negligent administration of public assets and services.

In a recent decision (*Graham versus Cape Town Metropolitan Council*) concerning the sensational, and (so far) twice-fatal, deterioration of Chapman's Peak Drive, the High Court of South Africa declared, inter alia, that

> … the defendant was under a duty to exercise such due care and to take such reasonable precautions as circumstances, particularly weather conditions, might require in order to avoid or minimize the risk of injury to road users…
> … Wrongfulness of in terms of the sense of justice and legal convictions of the community now applies to omissions by a public authority…
> … A duty of care towards road users should now apply to the controlling public authority unless there is a valid basis for its exclusion …

> Differently put: The norm to be applied in cases such as this **is whether the sense of justice of the community should view the failure of the local authority to take positive action is wrongful**, subject to the qualification that the local authority is not required to do more than may be reasonably expected. [Emphasis added.]

This and other recent verdicts strongly suggest that an expectation of safety in the use of publicly provisioned goods and services is a second-generation right, which it is therefore the State's obligation to establish, maintain and protect.

The implications of this where road *maintenance* is concerned are quite far-reaching. Myburgh (1998) colligates national survey data to conclude that the road environment contributes to 20% of all accidents in South Africa, and that specific road condition contributes to half of this 20%. `Road environment' incorporates a number of factors – road surface, but also sign visibility, markings, lighting, adequate dilemma zones at robots - which are clear responsibilities of the local authority. It also includes factors such as weather conditions that may interact with gradients and other alterable features to contribute to accidents.

There were nearly 700,000 road accidents in South Africa in 1999. Therefore, if a justicible public obligation is found to obtain in only a *narrow* sense – that is, only with respect to provision and maintenance of safety with respect to *specifiable* accident-contributing factors, then the State could find itself as a potentially unsuccessful defendant in between 70,000 and 140,000 accidents per annum. To the extent that interpretations of responsibility for the right to safe use are interpreted more broadly (so that, for example, standards of justicible adequacy with respect to gradients, angles of curves and general skid resistance vary with the severity of local weather conditions) then the figure is likely to fall near the top of this range.

Myburgh (1998) uses these data to support cost/benefit estimates of road resealing and other standard maintenance measures, which yield highly positive benefit: cost ratios, sometimes in excess of 9:1. Here, issues related to cost/benefit calculation will be deferred to Section 3. For the moment, we will instead consider the data in the light of the potential liability to the national, provincial and local authorities arising from the establishment of a second-generation right to expectations of reasonably safe use.

The average damages awarded to successful plaintiffs in tort cases related to road accidents in South Africa in 1999 were approximately R450,000. (This average includes a large number of R10,000 – R15,000 settlements to poorer South Africans, but is pulled up very substantially by a non-negligible incidence of spectacular bus and truck crashes in which awards run into the millions of rands.) Of course, this figure is not representative of the actual expected average award, since accidents involving death and serious injury have traditionally been much more likely to come to court, whereas if general knowledge of the public

authority's liability with respect to safety rights spread as a result of reportage of successful suits then a higher proportion of less serious accidents would find incentive to be brought forward. On the other hand, the average award figure does not factor in any legal or employee person-hour costs associated with unsuccessful defence against suits, and very rough averaging over incomplete data suggest that these add about 40% to expected liability.

The present survey does not have access to enough data on the present net value of the South African road system, relative to areas in which accidents are concentrated, to try to generate a quantified relationship between the cost to the public authority of liability for a second-generation right to expectations of safety, on the one hand, and the revenue disbursement associated with standard and regular road maintenance, on the other. However, a procedure for performing informative and policy-relevant calculations can be suggested:

1. For a given road *r*, apply Wright's formula (see Section 3 below) to calculate its present opportunity value.
2. Find the recurrent investment rate (maintenance costs per annum, expressed as a proportion of opportunity value in the initial period, i.e., subtracting sunk costs incurred in earlier periods) that maximises *r*'s lifetime opportunity value.
3. Given data on expected accident rates (including a measure of expected accident severity, if possible) and assuming a recurrent investment rate of 0 (i.e., no maintenance) over *r*'s lifetime, calculate the per annum expected cost to the public authority of damages awarded as a result of accidents on *r*. This establishes a baseline.
4. Recalculate expected accident rates for various candidate rates of recurrent investment in *r*, and repeat calculation (3) for these values.
5. Compare the results of the calculations in (4) with the output of (2).

This procedure is intended to be sensitive to the philosophical foundations of the concept of a *right*, and so very deliberately avoids implications of cost-benefit analysis. (General issues relevant to CBAs will be taken up in Section 3 below.)

This is important because, whereas CBAs must assign costs to particular expected injuries resulting from accidents, the assignment of a right implies an obligation that trumps any costs incurred in protecting it. (Of course, a legal standard of `reasonableness' is always assumed in reality to prevent commitment to practical absurdity; but the value of this standard cannot be costed in advance without undermining the idea of a right!) The suggested procedure is designed to avoid weighting the costs of accidents differently for poor people (i.e., as pedestrians and users of more dangerous rural roads) whose economic productivity-value is lower, which is also inconsistent with the

idea of a right. Steps 3 and 4 respect the concept of a right by, in effect, ignoring the economic values of either roads or lives and treating public investment in roads for the sake of safety as an imposed expenditure on rights. But, of course, what we would like to compare with this `cost' for purposes of political argument is a `cost' of road maintenance *given an optimal investment strategy*; and this is the point of the procedure in Step 2. Where the value of the output of iterations of (4) exceeds the value of (2), one has in effect shown that even if issues related to the opportunity cost of *political* capital, or simple institutional inefficiencies, cause investment expenditure to be treated as if it was a deficit, public revenues will nevertheless be maximised by regular maintenance. One can then add, in the course of a more general policy argument, that the revenue expenditure recommended by (2) is not really a cost. But at no point in this exercise has one implied that a right can be traded off as though it carried some particular maximum relative cost. This matters if economic advocacy is to avoid talking past principles of jurisprudence.

It is sometimes implied that when rights are at issue, economists should leave the conversation, since the value of a right to its holder may not, like an entitlement to damages or use of property, vary with personal productivity weights. But this goes too far, and does no favour to the maintenance of rights in implying that expenditure for their sake should be *literally* infinite. The procedure suggested here reflects concern with efficiency *as between different means of achieving the end* mandated by the public authority's constitutional obligation, but avoids making the end itself hostage to efficiency considerations.

Of course, what is of crucial importance in the present context is the question of whether outputs of iterations of (4) really *will* be higher than outputs of (2) for many or most South African roads. Given the presently escalating sizes of torts and of legal costs, and the fact that optimal investment rates on roads with expected life spans of 20 years are only +/- 2% of initial capital value, this seems overwhelmingly likely in almost all cases except where a given road has very low use or has such exogenously favourable use-conditions (i.e., straightness, width, absence of rainfall) that it remains safe even under considerably deteriorated conditions. It will always be true in the cases of urban roads and roads along major transport routes.

We have so far considered the implications of a second-generation right to expectations of safety only for *maintenance* of existing roads as they are. We must also consider the possibility that this right could be invoked to require the upgrading of some roads, from, say, gravel to paved.

There seems to be little question that pavement improves safety relative to gravel: collision rates in South Africa in 1988 were approximately 2.3 times higher on gravel roads than on two-lane paved roads (SABITA 1989). Accident severity is also reduced by paving, with the probability of fatality resulting from a collision being 3% higher on gravel. Now, it seems unlikely that the standard of

reasonableness would permit courts to find that the State's obligation to provision of safety would require all gravel roads to be paved on merely general and prima facie grounds such as are provided by these figures. However, the prevailing interpretation of the Constitution very clearly supports second-generation rights to basic housing, medical care, education and gainful employment. Where rural people can access the facilities necessary for effective provision of these rights only by means of demonstrably unsafe gravel or dirt roads, there is probably a Constitutional obligation to upgrade, and the occurrence of a suit that will test this claim is a statistical certainty.

Summary of Section 2

Recent court decisions suggest that a right to expectations of safety in use of publicly administered goods and services is among the second-generation rights guaranteed by the Constitution. State obligations to maintain roads so as to preserve safety are therefore likely to be enforced through torts. This yields an argument for increasing maintenance expenditure on roads that is strictly independent of the investment value of such expenditure.

Comparisons of opportunity values with expected liabilities from torts should be made, on a road-by-road basis, using the procedure outlined above. This would almost certainly indicate that, for a majority of South African roads, the existence of the right to safety makes increased maintenance rational *even where the political opportunity cost of such investment does not make it rational* as *investment.*

Of course, this conclusion in no way implies a concession to the effect that greater investment in roads is politically or economically irrational but for the impact of Constitutional rights. This issue is now taken up in Section 3.

3. The political economy of South African road maintenance

The present survey opened with general considerations suggesting that failure to adequately maintain roads is economically irrational. We now return to that issue in greater specificity, concentrating on the special circumstances and problems prevailing in South Africa.

There is no shortage of sophisticated models designed for calculating economically rational approaches to road-building and maintenance. The most complete of these is the Highway Design and Maintenance Standards Model (HDM-IV), developed and regularly updated by the Transportation Department of the World Bank. (World Bank 2000). Because this instrument has been designed specifically for application in developing countries, its design is sensitive to two crucial respects in which the utility functions of the governments and planners in such countries typically differ from those of their first-world counterparts:

1. Conventional cost-benefit analysis of roadwork is highly sensitive to parameters measuring the expected costs in vehicle wear-and-tear, loss in human productivity from accidents and congestion, and the value of productivity gains (losses) due to increased (decreased) transport efficiency. All of these parameters tend to favour construction and maintenance of roads that move larger numbers of wealthier, and therefore more productive, urban residents than roads in rural areas. In first-world countries, whose governments often wish to incentivize rural dwellers to relocate to more productive areas, or at least to areas peripheral to national roads, this may be thought entirely appropriate. In a country such as South Africa, however, where urban centers have already attracted higher and faster rates of in-migration than their infrastructures can immediately accommodate, this may be economically inappropriate. Furthermore, and in general, CBA techniques that have the effect of giving lower weight to the utilities of poorer citizens than to those of wealthier citizens may be regarded as politically impractical, or ethically improper, or both. Finally, standard CBA in effect rules out redistributional aims through a technical assumption, which confuses value with measurement.

2. Developing countries, South Africa in particular, may conceive of themselves as facing threshold effects with respect to provision of certain basic goods and services that cause their national utility functions to take forms fundamentally different from those prevailing in the developed world. That is, a government may be of the view that until substantially increased levels of housing, educational, medical, electrical and security infrastructure have been provided, no marginal improvements or even maintenance of other assets is justified. Mirrilees (1991) claims that this sort of reasoning had a significant impact on road-servicing provision even during the final years of the pre-Constitutional government, and it has clearly influenced the Constitutional government's policies a good deal (though it is very far from being unequivocally accepted by this government, either in word or action). Often, this is reflected in policies that emphasize direct-taxation and self-financing through user-payment schemes of utilities deemed to be above threshold in their availability, and cross-subsidization of those deemed to be below threshold. It may be represented in a *consistent* utility function by invoking the concept of *political capital*: there may be large numbers of citizens who will be incentivized to disrupt political and economic stability and plunder assets, either through crime, neglect or political activity, if subsidies are not used to increase their stake in these goods. In other words, some resources may build political capital in one use to an extent that outweighs losses through opportunity cost against alternative uses that would more efficiently maintain or build financial capital.

Both of these issues will be revisited at various points throughout this section. For the moment, we simply note that they argue against attempts to copy CBA approaches from the developed world.

The Ministry of Transport in Kwazulu-Natal – the province noted above as the site of the most acute under-investment in roads in South Africa – has developed an instrument of its own, Community Access Road Construction and Maintenance (CARCAM) 2000. This mechanism has some important democratic virtues, gathering the preferences of local stakeholders to a degree that is seldom achieved in conventional CBA approaches. However, CARCAM seeks to maximize a very complex objective function, since it aims at finding the mix of labour-intensive and machine-capital-intensive maintenance strategies that will expand regional employment opportunities.

It is not clear, from the standpoint of efficiency, whether this should be regarded as a *social benefit* that carries an *economic cost*, or as an economic benefit from the perspective of a wider social utility function. Technical issues of this sort would need to be clarified before CARCAM could be integrated with conventional economic analysis of the sort reflected in HDM-IV. Since CARCAM has been developed with sensitivity to local variables that could strengthen the viability of delivery on schemes it recommends, achieving such clarification and integration would be a worthwhile exercise.

As noted above, HDM-IV incorporates techniques that allow standard CBA parameters to be adjusted to the demands of non-standard utility functions. It may be used to study single roads, groups of roads with similar characteristics, or entire networks of roads. In all of these contexts, the model may be applied to the following questions (inter alia):

- Is a proposed construction or maintenance project economically justified?
- What is the construction or maintenance alternative that yields the highest benefits to society?
- What is the economic benefit of spending another rand on maintenance, compared with spending it on new roads or improvements to existing alignments?
- Is it more economical to construct a strong, expensive pavement initially, thereby permitting the use of larger, more economical vehicles and reducing future road maintenance outlays, or to follow a staged construction strategy economizing on initial costs, restricting vehicle axle loads, and paying more for maintenance, with the intent of upgrading the road later on when traffic growth warrants it?
- How should priorities be defined among roads to be included in a proposed work program?
- How much should be spent to maintain paved roads, and how much to maintain and upgrade earth and gravel roads?
- How much does it matter if certain road maintenance expenditures are deferred during years of financial stringency?
- What combination of maintenance strategies yield the lowest overall economic costs for a specified level of maintenance funding?

HDM-IV can, in addition, be used as a modular component in a more generic decision-making system, such as the AGRIPPA model described in Mirrilees (1991). This allows a planner some discretion over whether to treat a nationally idiosyncratic goal – say, inter- population group equity – as something to be captured by finding proxy parameters endogenous within HDM-IV, or as a consideration best modeled explicitly in the wider decision-making framework.

The very power and flexibility of these tools for questions that have *already* been isolated, however, can create problems in contexts where wide strategic issues are at stake. While HDM-IV should *surely* be used to analyze *particular* projects within relatively settled strategic parameters, neither it nor any tool allowing even wider modeling discretion (e.g., HDM-IV as a module in AGRIPPA) will tell us how to make trade-offs between, e.g., subsidizing hospitals and investing in roads if revenues are limited and access to capital is constrained. This sort of question is fundamentally political in nature – but it can and should be economically informed. It is highly likely that in South Africa at the present time some politically *intended* strategic aims are being subverted by less than optimal economics governing their implementation. We will therefore turn to considerations that suggest this.

3.1 Privatization, road pricing and direct taxation of use

The South African National Road Agency (SANRA) has heavily emphasized user-payment and outsourcing schemes as the leading solution to under-capitalization of the system. These initiatives include several measures: Build-Operate-Transfer (BOT) arrangements for new construction, Fund-Rehabilitate-Operate-Maintain (FROM) contracts for maintenance, public-private development partnerships such as that created for development of the Maputo Corridor road, and various forms of increased direct taxation of road users through increased fuel levies and vehicle licensing fees.

Congestion charging is another mechanism of this type that has been used elsewhere and could be implemented on certain South African roads, such as metropolitan highways. In pursuing these initiatives, South Africa is unquestionably following the world model, and the principal focus and recommendation of the international transport economics literature. This has been generally successful: SANRA's maintenance of the major national roads under its administration emerges as the only unqualified bright spot in the survey of South Africa's road system.

It will be argued here that while the idea that roads should in one way or another pay for themselves is often valuable and, indeed, essential, it is not a panacea in this country at this time. The general considerations relevant to this point are quite familiar to most participants in the South African debate; certain specific ones, related to incentivization of both public and private actors, are less so.

First, on privatization strategies. These have already been used to considerable extent with respect to national and trunk roads. As of 1999, 1 in every 7km of national roads was tolled. Virtually all new construction at this level is carried out via BOT arrangements. Government has recently been encouraging unsolicited bids for participation in FROM schemes at an accelerating rate. In the Maputo Corridor project, a private consortium began by assuming responsibility for road capitalization, construction and cost-of-use recovery, but ended by taking on responsibility for a range of other related project components, including provision of slip-offs to hard areas in which local traders can merchandise to road-users, education of local public opinion, and even rehabilitation of the Port of Maputo! (Taylor 2000).

There can be no serious doubt that without this commitment to privatization and outsourcing, the situation of under-capitalization of both construction and maintenance would be very much worse, perhaps absolutely intractable. However, some clear limits to the reach of these policies can be identified:

1. Few provincial or local roads carry sufficient traffic volume to be profitable as toll roads unless alternative avenues of transport were restricted; but
2. the negative externalities that would be involved in such restriction, including loss of productivity due to reduced flexibility and dislocated congestion patterns and inestimable redistribution of inconveniences, make tolling these roads impractical and uneconomical.
3. Positive externalities associated with the road system (as made vivid in Section 1) make it impossible for the public authority to fully transfer risk to the operators of BOT schemes and, especially, FROM arrangements. That is, if maintenance costs rise, private operators can readily blackmail authorities into providing compensation. As a result, private operators may have insufficient incentives to perform maintenance efficiently or to practice adequate quality assurance. In any case, inability of government to fully off-load risk is a major aspect of the under-capitalization problem in the first place, since the carrying of this risk contributes to the relative capital-starvation of provincial and municipal authorities (see below). These problems can be alleviated to some extent, but not eliminated, by paying operators of FROM schemes on a for-work-completed basis, subject to predetermined ceilings on recoverable costs, and by reducing total risk through awarding FROM tenders only to well-capitalized consortia rather than single, vulnerable, operators. The possible efficiencies that could be recouped through these measures cannot be estimated without access to the specific private contracts presently in force between authorities and operators of FROM schemes. However, Australia has begun implementing contracts of this sort on a substantial

scale. Emery (1999) has modeled their impact on several industry parameters, and discovers two shifts that are dramatic (if not surprising): the share of the market going to large contractors is predicted to increase by 13-18%, and efficiencies in industrial plant utilization are predicted to double over what prevails in the absence of the contracts. The second measure is a particularly good proxy for general efficiency, and thus provides a partial benchmark against which the success of a particular contract scheme could be tested.

4. While the operators of FROM or BOT schemes may be insufficiently incentivized because of non-transferable *commercial* risk as just explained, the public authorities may simultaneously be under-incentivized to respect agreements because of inappropriately transferable *political* risk. This problem clearly seems to have undermined the efficiency of the Maputo Corridor road project. A key contribution of (provincial) government to that project was to have been management of local education in the justification of the project, and buy-in to distribution of costs (tolls) and benefits (job creation and new business opportunities for local traders). Taylor (2000) documents the series of lapses by which government reneged on these commitments, effectively transferring them to the private consortium. Since the price of buying local political support even came to include construction of new facilities, the costs incurred by the consortium were allowed to escalate well beyond expectations. At one point a provincial minister even told local residents that the consortium would supply them with housing! Simultaneously, politicians did not assist their private partners in resisting local pressure groups drawn from among the more affluent, which successfully lobbied for lower toll rates than had been agreed in the original concession. Finally, failure by national governments (of both South Africa and Mozambique) to carry out complementary development programs to which they had committed themselves resulted in lower traffic volume than the original business plan had anticipated, substantially increasing capital costs and threatening profitability. A major source of these problems appears to have been misalignment of incentives. The national government's concern for the credibility of private/public partnership arrangements was apparently not shared by provincial authorities, who preferred to invest instead in opportunities for rent-seeking by their constituents. The costs of the resulting loss of government credibility, not only in Mpumalanga but in South Africa generally, cannot be quantified but, given the scale and visibility of the project, are likely to be considerable.

The implication of these considerations, taken together, is that a national strategy for optimizing investment in roads must acknowledge that some level of responsibility for capitalization out of public revenues will continue to be necessary. (Encouragingly, this fact has been unequivocally noted by the present Minister of Transport.) However, the extent of this responsibility can be reduced to the extent that incentive compatibility issues as identified in (3) and (4) above are addressed. This point will be incorporated in later recommendations.

We now turn to issues related to road pricing. As noted above, the economics of these measures have been thoroughly studied in a large literature. (See Johansson and Mattsson [1995] for a particularly useful compendium.) Tolling is and has been an effective measure in South Africa where national and trunk roads are concerned. Here, what is crucial is the fact that transport alternatives are limited, so potential externalities can be controlled and endogenously costed. This does not apply to most provincial roads, or to any urban roads. In these cases, existence of widespread alternatives turns pricing strategy into a general equilibrium problem that is almost certainly administratively intractable under even the most optimistic assumptions concerning organizational efficiency. Furthermore, road pricing in these areas potentially conflicts with equity considerations and redistributional aims, since it amounts to a flat tax on assets that have a significant public good component.

The interaction of road-use costs and incentives with those governing public transport systems also tends to put welfare optima out of reach, creating relevance of other prices to road prices that cannot be equalized to marginal social costs. This is a common phenomenon in urban markets throughout the world. Thus, for example, de Borger *et al* (1993), studying road pricing strategies in Belgium, report that if public transport systems there were required to cover their private financial costs, then peak period bus fares would have to be increased by 141%, which would force road prices over *their* social optimum to partly offset welfare losses.

In general, then, even if the general equilibrium problem represented by urban transport networks could be given a policy-relevant solution, the surrounding web of externalities leaves little confidence that the result would be a social optimum. This consideration militates *only* against trying to gain efficiencies through over-precise calibration of pricing. It certainly does not imply that charging road users for both their purely private and (some of) their external costs is an unsound practice. But here we encounter another problem in the South African context.

Stander and Pienaar (2000) show that road users in South Africa are already *over-paying* for the social costs they impose, and that, relative to this context, car owners – the principal contributors to urban traffic volume – are subsidizing truck operators. Their analysis indicates that, through fuel taxes and other direct levies, road users contribute +/- 70% in excess of the costs they cause to general State revenues (and account for about 12% of total budgeted State revenues).

We estimate licensing fees to be the source of about 50% of total provincial revenue in all nine provinces; and since no province devotes close to that proportion of expenditure on roads, it is clear that road-users are providing further cross-subsidization of other goods and services through this channel as well. To the extent, therefore, that efficient mobility is a major contributor to national economic factor-productivity (see Section 1), *`user-pays' approaches to road financing already constitute a productivity tax*. Since it is utterly implausible to suppose that productivity taxes are efficient relative to announced macroeconomic priorities and principles emphasizing growth, the limits to additional taxing of use, with or without more incentive-sensitive pricing arrangements, as a mechanism for financing maintenance and construction, should be clear.

It is therefore generally concluded that an efficient mechanism for the financing of road maintenance in South Africa requires increased direct contributions of public capital.

3.2 The political economy of South African public capital investment in roads

So far, it has been emphasized that road maintenance (and, often though not always, road construction) constitutes investment rather than simple cost. To this point, in order to give full weight to complex political utilities and social welfare functions, the import of this has not featured centrally in arguments. However, it has just been argued that *insofar as it constitutes investment*, the capital financing efficient road maintenance must be generated from public resources to some extent. For reasons discussed in Section 3.1, this is mainly and particularly true of provincial and urban roads.

As discussed in Section 1, the claim that South Africa presently suffers from under-investment in maintenance of its road network *from the point of view of efficient use of capital already invested in the network itself* is not controversial. This point is so generally conceded that a defense of the continued under-investment would have to, at least implicitly, proceed as follows. It would have to be argued that, relative to the opportunity costs of finite *political* capital (as defined earlier), some portion of the financial capital already embodied in the road network represents a sunk cost that is to be written off. As will be argued later, it is unlikely that belief in this proposition is the only reason for present under-investment. However, to the extent that it *is* a reason, we can ask whether the belief makes sense.

Let us assume that the public utility function seeks to maximize, along some trade-off frontier, a bundle mainly consisting of goods associated with the basic second-generation rights to housing, educational, medical security and opportunities for gainful employment. These are the goods against which a defender of under-investment in road-maintenance would have to treat existing

roads as sites of sunk costs. Investment in all of these goods must consist to a considerable extent in creation of various physical assets, especially buildings and equipment concentrated in buildings. The value of these assets lies in expectations of their continuing efficient use in the future.

We can determine whether financing of these assets is efficient by asking whether, given a particular investment strategy, they would attract freely chosen investment by an investor able to deploy capital in any use, but who shares the public authority's utility function. An asset will attract such investment to the extent that the stream of investment in it over its lifetime minimizes deadweight losses due to depreciation of the original capital stock.

In this context, the following idea will be made explicit: houses, schools and hospitals that cannot be safely and reliably accessed by residents and service providers, or sites of economic activity that cannot be safely and efficiently reached by customers and employees, will bear avoidable deadweight losses. Put most succinctly: a housing development, hospital, school, business park or commercial center serviced by inadequate roads is an economically silly thing to build. *It will therefore be shown that even someone who takes the very extreme view that all investment should be foregone in favour of immediate transfers for upliftment of the disadvantaged should approve of efficient maintenance of roads.* Obviously, then, anyone whose opinion on social priorities is less radical – that is to say, almost all public and private authorities in South Africa – should be that much more fully persuaded.

Since we are now investigating the investment value in roads as a function of the investment value of other primary assets, we must use a model of `value in use', or *opportunity value.* This concept was introduced in Section 2 above, but will now be made explicit. (The presentation here follows that of Wright [1964].) We will first present the argument mathematically, so as establish its authority. It will then be summarized in more generally accessible terms.

The opportunity value of a secondary capital asset (e.g., a road) is the cost, loss or sacrifice which would have to be incurred if the primary infrastructure did not have the secondary asset. Replacement cost of the secondary asset is found by solving for *R* in the following equation:

$$C = \sum_{n=1}^{r} [RQ(n) - E(n)](1 + i)^{-n} + S(T)(1 + i)^{-T}$$

where;

C is the capital cost of the substitute road or alternative transport mechanism;
Q(n) is the contribution to the value of the network of primary assets provided by the road during the *n*th period of its life;
E(n) is the operating expense of the road during that period;

i is the rate of interest, expressed as a fraction per period;
S(n) is the salvage value of the road at the end of the *n*th period;
and
T is the economic life of the road; that is, that life which leads to a minimum value of the average unit cost of *R*. Hence the value of the existing road at the end of the *t*th period of its life is given by

$$V(t) = \sum_{n=t+1}^{T} [RQ(n) - E(n)](1+i)^{t-n} + S(T)(1+i)^{t-T}$$

and depreciation during the *t*th period is given by

$$D(t) = V(t-1) - V(t)$$
$$= RQ(t) - E(t) - i(V(t-1)$$

This formulation permits us to make a general qualitative comparison of depreciation values on primary assets and on secondary assets that influence the former.

Suppose that *n*1 denotes the primary asset (a school, hospital, etc.), which itself contributes to maximisation of the value of the favoured bundle of primary goods, while *n*2 denotes our secondary asset, the road. Now suppose, in keeping with the reasoning above, that $D(t)_{n1}$ is partially a function of $D(t)_{n2}$. What will this function be like, given certain plausible assumptions?

First, for simplicity, set *S(n)* to 0, since the salvage values of both roads and major public assets fall so far beyond typical government planning horizons that their political-capital value is generally ignored. Second, in calling some assets `primary', we mean that their political capital value is perceived to dominate the utility function (i.e., their opportunity cost in financial terms is perceived to be low). We may therefore assume that $Q(n1) > Q(n2)$.

Now, for every primary asset relevant to the trade-off under consideration, *E(n*1) will be substantially higher than *E(n*2). Suppose that if, for some reason, *E(n*2) is not paid (i.e., the road is not maintained), then *Q(n*2) falls. In that case, *Q(n*1) must fall also. Then, assuming that *i* is uniform and independent of the use to which borrowing is put, C_1 must rise faster than C_2 if $R_1 > R_2$.

Therefore, if the opportunity value of the road contributes to the opportunity value of something regarded in the political utility calculus as a primary asset; and if the marginal cost on initial capital of maintaining the road is less than the marginal cost on initial capital of maintaining the primary asset; and if the interest rate on funds used to build roads is the same as the interest rate on funds used to build primary assets, then failing to minimise the capital cost efficiency of the road (i.e., failing to pay *E(n*2) to maintain it, thus making *d(t*1) **and** *d(t*2) larger than

necessary) must always produce an avoidable dead-weight loss on return to total capital [*C(n*1) + *C(n*2)].

What have we just shown, in plain terms? For every road, there exists an optimal rate of investment in maintenance (which can be calculated using HDM-IV) that minimises the overall cost of the road relative to the initial capital outlay in building it (assuming that this cost is not written off as sunk). The argument above shows us (given some very plausible empirical assumptions) that if a road is contributing to the opportunity value of another asset (a `primary' asset), but investment in the maintenance of the road is presently below the efficient threshold, then the most efficient way of investing in the primary asset is to bring investment in the road up to the efficient threshold.

So, for example, suppose that a given road provides access to a hospital. We consider the allocation of an additional marginal rand to the capital budget of the hospital. This could be invested directly in the hospital's maintenance, or in the maintenance of the road. Then the point of the argument is this: given relative costs of flattening depreciation in things that are typically regarded as primary social assets – such as hospitals – and such costs as associated with roads, *if* the authority is currently not investing efficiently in the road, then the most efficient thing to do *for the hospital* with that marginal rand is to use it to bring the road-maintenance schedule closer to its efficient optimum.

The implication of this argument is that even *given* a utility function and an estimation of the value of political capital such that immediate social infrastructure demands are lexicographically favoured over investment in economic infrastructure, inefficient maintenance of roads that service the social infrastructure hubs is irrational.

It might be supposed that this shows only that *some* roads, namely those directly carrying people and goods to and from sites of public asset concentration, should be efficiently capitalised in the short term. However, this would be inconsistent with the key assumption on which the need for provision of public capital to maintain urban and provincial roads rested in the first place. Roads that have their value in isolation are appropriate sites for self-financing. It was argued, however, that pieces of the urban road network cannot be so isolated. Were one to attempt to adequately maintain only those roads needed by the users of public services, the result would influence locational and route preferences amongst all urban citizens.

It is not likely that less affluent citizens would be well served by the encouragement of high congestion on those routes that are, by hypothesis, deemed most important as contributors to social welfare. A more alarming possibility is that such a strategy would incentivize users of public assets to concentrate closer to them. It is highly unlikely that many South Africans would regard incentives to further ghettoization of the less affluent as a happy

consequence of a public policy. In any case, we can appeal to a family of general theoretical results here to the effect that attempting to selectively `pick winners' amongst components of an interconnected urban transport network destroys the inference basis needed to try to compute any economic optima at all (Holden 1989, Takeuchi 1999).

The argument of this section seems sufficiently important to be worth re-stating in the clearest possible terms. Someone might believe, on political-economic grounds, that there are some public assets such as schools and hospitals that are worth so much in themselves that no marginal dollar should be invested in anything else until they are fully and efficiently capitalised. Nevertheless, the most efficient way of capitalising these assets, given certain restrictions that are highly unlikely not to apply in any realistic case, requires efficient investment in the road network that services them.

3.2.1 Incentives of public authorities

The argument just given has force in a context where the public authority operates with an unusually categorical utility function that values bricks-and-mortar social infrastructure over all else at almost any cost. It is very unlikely, however, that the actual preferences of South African national, provincial or municipal authorities are nearly so categorical. Officials are probably as good as their word when they say that they attach considerable value to economic infrastructure for its own sake (that is, for the contribution it makes to general productivity and growth); but their sincere preferences are then subverted to some extent by inefficiencies resulting from the institutional incentives landscape. In this section, we will first review two leading probable subverters, and then discuss mechanisms by which their influence can partly or wholly be overcome.

Ulysses and the sirens

Elster (1979) drew attention to a widespread phenomenon that undermines rational planning in many instances. This is the tendency to fail to bring knowledge about one's own discount function to bear in planning. In the Homeric myth, Ulysses does not make this mistake; realising that he will value the sirens' song at t+1 so highly while hearing it at t that its utility will outweigh everything else in his future, but recognising at t-1, when it hasn't yet started, that while it still lies in the future he doesn't so value it, he defends himself against his own hyperbolic discounting by binding himself to his mast, and survives.

Put less technically, Ulysses realises prior to hearing the sirens that once he does hear them he'll value their charms so highly that he'll throw away his concern for everything else and steer his ship onto the rocks, so at that point he takes steps to make it impossible for himself to give in to temptation when the singing starts.

His *commitment measures* at *t*-1 thus prevent his anticipated preferences at *t* from subverting his rational planning at *t*-1. People are often less wise than Ulysses; many smokers genuinely attach high utility to quitting at *t*-1 when their urges for nicotine have recently been satisfied, but never do so because at every *t* they attach enough value to the next cigarette to swamp their earlier evaluation.

This *hyperbolic discounting* effect is typically (though not in Ulysses' case) compounded by *the problem of the infinitesimal margin*: the cost to the smoker's expected longevity of *just one more cigarette* is trivial in comparison to the pain he will endure by declining it. As this applies to every cigarette, he can rationally believe both that he should quit smoking, and that he should never stop at any particular point. In many cases, such as that of the typical smoker, these two problems compound each other to create a difficulty greater than the sum of its two parts.

Politicians and public planners are often beset by one or both of these problems. It is, for example, notoriously difficult for environmental advocates to shake loose what they regard as adequate curbs on pollution. First they encounter the problem of hyperbolic discounting: the cost of anti-pollution measures, both direct and in terms of lower present returns on productive activity and capital, must be borne now, while the benefits lie well in the future; but politicians are elected for short terms relative to the environmental time-scale, and the (by hypothesis, greater) costs of present inaction will be someone else's problem. (Of course, the politician only has this incentive structure because her constituents are hyperbolically discounting; if they weren't, they'd reward the politician for present decisiveness. So blaming politicians in the case of this phenomenon is hypocritical.)

Then the problem of the infinitesimal margin compounds the difficulty. One more year of, say, carbon emissions, won't make any measurable difference to the global environment, so in any given year it seems reasonable to squeeze out one last increment of uncontrolled productivity and start cutting back *next* year. But in the compound grip of the two problems, next year never comes. This sort of conundrum is sufficiently widely appreciated and significant that Elster, during the 1990s, found himself hired by the new governments of ex-communist countries in Eastern Europe to design mechanisms for their constitutions that will enable them to follow Ulysses's example and commit themselves in areas where hyperbolic discounting and infinitesimal margins threaten.

Often, this mechanism takes the form of constitutionally ring-fencing a proportion of the annual budget to pay for identified long-term goals. Elster's native Norway, for example, has constitutionally committed itself to setting aside 12% of each year's budget for foreign aid, something which is regularly victimised by the two problems in other democracies. (Since this figure was fixed prior to Norway's discovery of offshore oil, it has provided some African countries with an unexpected windfall!)

The twin problems are especially likely to arise with respect to regular maintenance of assets that depreciate relatively invisibly while the marginal cost of restoring them to efficient functioning rises with every period. Roads are perfect examples of such assets. Users are unlikely to feel inconvenienced while they deteriorate, until their decay is so far advanced that the expenditure required to restore them has become significant. Meanwhile, competing calls on public funds have immediate urgency, and political capital can be swiftly recouped if road maintenance is deferred for one more year, or inefficient patches are applied in lieu of genuine investment, until the result is crisis of ruined roads for which the repair budget is insufficient. To this point, the problem of the infinitesimal margin is at work. The fact that politicians, facing limited terms of office and inattentive publics, are incentivized to have foreshortened planning horizons, brings hyperbolic discounting to bear as well; and then the two influences compound one another.

To acquire direct evidence that these phenomena are contributing to under-investment in South African roads would require an ability to peer into the minds of planners and politicians. However, we have enough honest testimony by *former* politicians from around the world, and the logic behind the effects are so compelling, that it would be literally astonishing if South African road authorities are not subject to them.

Moral hazard in decentralised political structures

The logic urging decentralisation of control in complex allocation networks such as bureaucracies is at the very heart of economic reasoning. The inefficiencies in information processing and coordination caused by centralisation are both so massive and so reliable that no one since Stalin has supposed it sensible to try to run a large country from a single site of control. Thus all countries are decentralised to a degree, and some are federations.

South Africa, with its weak provincial governments, is not quite a federation, but a good deal of policy-making and fiscal authority is devolved to provinces and, especially, to the new metropolitan councils. Under the 1996 Constitution, both provinces and municipalities are guaranteed authority over a range of local matters, and are assigned a degree of protected budgetary autonomy. The sphere of municipal power incorporates, inter alia,

> The construction and maintenance of arterial roads that transcend more than one metropolitan local council boundary, including
> (a) roads with significant traffic volumes;
> (b) roads forming major public transport corridors;
> (c) roads used extensively by traffic from outside the metropolitan local council within which such roads are situated;
> (d) roads in respect of which access and egress have been limited in accordance with a law;

(e) roads of a major nature linking significant urban growth points or potential growth points;
(f) the construction and maintenance of storm-water drainage systems and infrastructure that transcends more than one metropolitan local council boundary;
but excluding national roads, provincial freeways and provincial arterial roads
[Cameron 1999].

For reasons discussed in Section 3.1, the most acute part of the national problem of under-investment in road maintenance and construction concerns these roads falling under metropolitan responsibility. This is not *because* of peculiar weaknesses in municipal government incentives – as has been argued, tolling, the easiest though not necessarily the most efficient response to budgetary pressures concerning roads, is not available to municipal authorities in the way it is to national ones – but its correction is compounded by incentive problems typical of decentralized governance.

South Africa's municipalities are heavily dependent on provincial revenues. The provinces are in turn subject to national fiscal discipline. This encourages manifestations of the basic problem of moral hazard in decentralized government: recipients of funds raised and controlled (at least as to level) elsewhere have incentives to overspend on relatively invisible sources of their own utility, and to under-spend in more visible areas.

The logic behind this pervasive effect has been explored in a large literature, some of whose recent highlights are Cremer *et al* (1996), Raff and Wilson (1997), and Wildasin (2000). Boadway *et al* (1999) prove some robust results in a highly general setting; we can colligate these by saying that if costs of service-provision by a recipient of public funds on a public good are partly unobservable to the funds-provider, the marginal benefit from the spending will not equal the marginal cost multiplied by the marginal cost of public funds. This happens in part because the funds-provider will be uncertain as to whether it is providing more or less than the optimally efficient funding rate. Observation of a higher level of the good than would be produced at the transparent equilibrium leads the funds-provider to assume over-generosity. The recipient, knowing this, has an incentive to inflate costs and under-produce the good. Funds recipients also have incentives to increase their discretionary scope for spending by over-recovering costs, which can then be used to cross-subsidize their own preferred activities. (These may sometimes, of course, include salaries.)

In the case of goods, such as roads, which have externalities outside the jurisdiction of the individual spending agencies, this possibility encourages attempts at free riding by agencies on one another, and can manifest itself as prisoner's dilemmas (d'Aspremont and Gérard-Varet 1997). In particular, given mobile taxpayers municipalities will be reluctant to raise their own revenues for

public-goods expenditures involving positive externalities, out of fear of inducing income effects and reducing their own tax-bases.

A number of structural features of the South African political economy make these effects likely. Municipalities can raise capital funding for roads and other public infrastructure on shared funding schemes with provinces in which the latter provide 60% of outlay. This encourages cost inflation; indeed, given the generally poor credit ratings of South African municipalities, it practically compels it. Political pressures on both municipal and provincial governments to provide direct social infrastructure and secure employee and agency cooperation through salary augmentation are frequently considerable, and encourage attempts to free ride, to divert funds and to enhance spending discretion through cost inflation. Estimating the quantitative scope of these problems would be an extremely complex exercise, since relevant data on developing world practices in this area are sparse, and developed world structures are inappropriate models. Anecdote in the road-maintenance industry and within government itself, however, suggests widespread awareness of the relevant incentives; and it is unlikely that this awareness stems from a local passion for abstract problems in game theory.

Strategies for improved alignment of incentives

The compound effect of hyperbolic discounting and the problem of the infinitesimal margin can be controlled by one or a combination of two devices. One of these, following Ulysses's approach, is commitment. In the case of a government or public agency, this would require placing revenues in pre-allocated baskets that cannot be opened in the face of later temptation. Virtually the only device that can genuinely place a government's revenues out of its own subsequent reach is a legal contract.

Where South African municipal and provincial road maintenance is concerned, the only obvious second parties to binding contracts are private companies with both the incentives and the resources to credibly threaten action in response to breach. This point connects interestingly with one raised in Section 3.1. There, it was noted that private participants in FROM arrangements can be most efficiently incentivized by payment on a for-work-completed basis with pre-stipulated ceilings on allowable cost-recovery claims, since they will otherwise be encouraged to seek rents on non-transferable risk held by the public authority. This mechanism would clearly require that binding contracts be concluded in advance between governments and companies. Three specific features of these sorts of contracts, originally motivated by the need to incentivize private contractors, can simultaneously discourage myopic government planning.

First, the need to pre-specify cost-recovery grounds would require that particular road-maintenance projects be prioritized, announced and budgeted, and this would make subsequent deferral more difficult. Second, contractors forced to bear risks of cost-overruns that could not be charged back to government would

offer the most efficient rates only if they could spread these risks by concluding contracts in batches. This would incentivize governments to budget for road maintenance and to commit to particular projects less incrementally, and this would in turn reduce the extent of problems of infinitesimal margins. Third, governments could only credibly transfer risk by contracting with consortia or large firms rather than with vulnerable individual companies. This in turn increases the credibility of threats of legal action against public authorities that practice undue deferral or fail to provide promised capital on time. (It is noted that contracting with consortia might also be thought by some to have favourable implications for `empowerment' initiatives in South Africa, since it would encourage the involvement of younger companies with more restricted access to capital.)

This mechanism, then – **the contracting of road maintenance in pay-for-completed-work contracts with pre-stipulated ceilings on cost-recovery claims** – has attractive equilibrium properties. Governments using such mechanisms would effectively trade risk for reduction of their own discretion. To the extent, however, that discretion encourages Elster-type myopia, and that this is recognized by public authorities themselves to be problematic, the trade-off is only apparent; in the longer view, it has more in common with having and eating one's cake.

It is particularly interesting, in this regard, that the present Minister of Transport, Dullah Omar, recently hinted in a speech to road industry representatives that SANRA's authority might be extendable from its current 7,000 km. of road to 20,000. The point of this, of course, would be to take a structure that has proven its effectiveness and widen the scope of its application. The recommendation just broached for dealing with hyperbolic discount rates and infinitesimal margins, however, suggests that the Minister's idea has even more going for it than the obvious. Use of FROM and BOT schemes has a major component of SANRA's success. We have just seen that extending such devices more widely across the road system, *with the right sorts of contract mechanisms*, could help to offset some built-in diseconomies associated with the present dispensation. Any extension of SANRA's mandate consistent with the Constitutional division of powers is therefore to be encouraged.

The contract mechanism, however, would be effective only where governments already recognized the desirability of greater levels of investment in roads, such that they could then also recognize the desirability of committing themselves against political temptations. This then raises the issue of finding ways of dealing with the misaligned incentives arising from South Africa's governance structure.

The large economic literature on the principal-agent problems associated with fiscal decentralization referred to above tends to favour only one stone for killing all birds, namely, transfer schemes. (Indeed, Wellisch [2000] shows that given incomplete tax instruments in the hands of regional governments, as in South

Africa, no taxation policy can solve the problem of temptations to free ride.) Under the transfer-scheme arrangements advocated in the literature, the funds-provider – here, the national government to provincial governments, or provincial governments to municipal ones – announces a fixed budget to all potential recipients, which must balance. (This need not, of course, balance at 0, but could balance at a threshold over some guaranteed minimum.) Recipients are then rewarded or punished at each round of allocation based on their performance against visible, measurable and pre-announced targets set in the previous round.

d'Agremont and Gérard-Varet (1997) show that, contrary to intuitive assumptions in much of the previous literature, in a restricted setting with risk-neutrality and complete information about preferences, a transfer-scheme mechanism exists which can induce regional authorities to `tell the truth' about their spending preferences and allows the funds-provider to allocate in accordance with the social optimum. The general (practical) problem then consists in finding fully visible and measurable targets in a particular case. Where road maintenance is concerned, this might simply be the delivery of successful contracts of the incentive-compatible sort described immediately above, under an overall investment strategy amongst roads developed using HDM-IV.

Unfortunately, it is not clear that this sort of mechanism is constitutionally legal in South Africa. Provincial budgetary autonomy is protected through a provision that prohibits the national Finance and Fiscal Commission from attaching conditions to operating transfers. This restriction does not, however, apply to capital grants. Since current economic science seems to know of no other general mechanism for aligning regional incentives with respect to spending on public goods, it would seem to be worth pursuing the possibility of a capital grant scheme, based on a fixed and balanced budget, that implemented a transfer-scheme incentive system such as that identified above.

It is possible to be more specific about the form of capital-grant scheme that would be necessary to do the trick. The formulation here follows Wellisch (2000). Suppose that each municipality i contributes a lump-sum tax T_i to central revenues. Suppose that the grant rate S_i is proportional to the capital tax prevalent in i, so that if k_i is the fraction of the exogenously given capital stock K of the country, and t_i^K is the source-based tax on capital levied in i, then the grant is $S_i t^K_i$. If the central government's grant scheme then satisfies the constraint

$$\sum_{i=1}^{I} S_i t_i^K = \sum_{i=1}^{I} T_i$$

then there exists a matching capital grant scheme that will incentivize the regions to produce investment in a public good – e.g., maintenance of roads – at whatever the central government's utility function deems to be the (constrained) nationally efficient rate.

So much for theoretical possibility. The procedure for calculating actual grants given in Wellisch (2000) is probably not applicable in South Africa, because it depends on approximate similarity of both population sizes and capital stocks across regions, conditions from which SA massively departs. Even more problematically, it assumes that the government measures utility by maximisation of the utility function of the median taxpayer, which in South Africa would likely be viewed as incompatible with equity-related goals.

The logic of the idea, however, can be stated straightforwardly: regions can be discouraged from free-riding by a system of capital grants that rewards them for the positive externalities their provisioning activities bestow on other regions. Calculating a particular such scheme that would approximately accord with South Africa's complex interregional political-economic dynamics would require an immense econometric exercise, and a fraught selection of proxy variables for the sorts of simple private-utility maximands used in theoretical demonstrations; but no economic impossibility stands in the way of such an enterprise.

Whether or not there is an easier way of aligning regional incentives depends mainly on how the problem is understood. If the goal of increasing investment in roads is perceived mainly as a matter of convincing public officials that present rates of investment are irrationally low within very broad bands of measurement, then concentration on simple qualitative arguments and policy measures as described in this survey is recommended as being most immediately plausible. If, in addition, an advocate sought to offer government a recipe for *most* efficiently investing in roads through properly incentivizing public actors throughout the system, then a modelling exercise would have to be funded that would require (i) access to HDM-IV, (ii) full and detailed collaboration from Ministry of Transport officials and other central government authorities, so that proxy variables for key components of the national utility function were not chosen arbitrarily, and (iii) an adaptation of existing models built for first-world use to the South African political-economic context. Given the sophistication of these models *and* their present conceptual distance from developing-country (particularly South African) circumstances, it is estimated that this would involve an effort roughly on the scale of a doctoral thesis.

In the meantime, however, there is another measure, also anticipated by the Minister, which could help. Aligning incentives amongst regional governments can be thought of, for purposes of economic modelling, as inducing them to form a cartel. A classic result in game theory, owing to Selten, shows us that cartels become inherently unstable – because rewards from free-riding begin growing exponentially – at more than four members. South Africa has nine provinces. It is thus very interesting – and striking to the economist, given his professional appreciation of four-member cartels – that the Minister has suggested, in the same speech cited elsewhere in this survey, that the present nine provincial roads agencies might be collapsed into four, "distributed into zones of comparable road provision conditions … which to an extent approximates the

subdivision of regional offices of SANRA [and] cuts across provincial boundaries" (Minister Omar, speech to the Road Pavements Forum, 2000). The Minister's idea is that the executive responsibilities of provincial authorities could be accommodated to this structure by having them serve as members of the Boards of Control of the new concentrated agencies. For reasons that have been made clear in this survey, such a restructuring should be warmly welcomed and encouraged by anyone concerned for the state of South Africa's roads.

Summary

The preceding survey emphasised the following points:

1. There is an overwhelming, prima facie and common sense argument for the claim that under-investment in roads in a country, especially a developing one, undermines that country's general economic prospects (pp. 9-10).

2. There has been significant under-investment in roads in South Africa since at least 1989 (pp. 10-11).

3. Recent court decisions suggest that the South African State bears a constitutional obligation in act in accordance with a second-generation right of all citizens to expectations of safety in the use of goods and services regulated under public jurisdiction. This explicitly includes roads (pp. 11-12).

4. It is philosophically and legally inappropriate to cost obligations to rights using CBA. A procedure is given that enables the expense to the State of failures of duty to be entered into economic calculations without prejudice to this philosophical fact (pp. 13-15).

5. Failure to maintain safe roads through under-maintenance has a higher expected cost to the State, through anticipated successful suits for damages, than does adequate maintenance of the road network (pp. 14-15).

6. The World Bank's HDM-IV model can and should be used to assess the economic merits of road maintenance, rehabilitation, upgrade and construction possibilities (pp. 16-18).

7. Developing countries, such as South Africa, face special problems that make first-world utility functions on road maintenance and construction inappropriate. However, HDM-IV can incorporate these special elements of utility (pp. 16-17).

8. Privatisation and outsourcing have been important measures for capitalising South African roads, but are not panaceas, particularly as regards urban and low-use provincial roads (pp. 19-20).

9. BOT and (especially) FROM schemes encounter problems associated with the fact that government cannot fully off-load risk onto private contractors. This undermines the incentives of such contractors. It is recommended that FROM schemes pay on a for-work-completed basis, with predetermined ceilings on recoverable costs, and that consortia be preferred, ceteris paribus, to single companies (p. 19).

10. Government has damaged the credibility of its commitment to its end of public-private partnerships through highly visible abdications of contractual obligations, as in the case of the Maputo Corridor road project (pp. 19-20).

11. Road pricing is not a *generally* viable solution to South Africa's under-maintenance problem, though it may often be useful for national and trunk roads where convenient alternatives can be blocked without upsetting general transport equilibrium (pp. 20-21).

12. Extension of `user-pays' approaches to road financing are limited in the extent to which they alone represent a solution by the fact that charges levied on road-users, through fuel taxes and license fees, are already heavily cross-subsidising other public goods and services. This amounts to a productivity tax that is almost certainly inefficient already. Were revenues stemming from levies on users to be *dedicated* to road maintenance, this would not represent an increase in such a tax beyond its current levels. However, since provinces would presumably see the need to replace the resulting diverted revenue in such a case, this approach will not substantially solve the under-maintenance problem *by itself* unless greater efficiencies in general expenditure could be achieved (p 21).

13. Even if government believes that the capital investment embodied in existing roads constitutes a dead-weight sunk cost that should be written off until various primary social goods are provided above some threshold, under-investment in roads serving these primary assets is economically irrational. This is demonstrated algebraically (pp. 21-24).

14. The above argument cannot be used to justify the maintenance of some roads and the neglect of others. Determination of efficient road-investment levels is a general equilibrium problem (p. 24).

15. Roads are likely to be under-maintained due to the compounding effects of hyperbolic discounting and the problem of the infinitesimal margin (pp. 25-26).

16. In federal and semi-federal systems, adequate investment in roads tends to be undermined by moral hazard and regional free-riding problems. These are exacerbated in South Africa by the problems of capital-access faced by provincial and (especially) municipal governments (pp. 26-28).

17. The mechanism identified in (8) above can help to offset the problems identified in (13) above (pp. 24-25).

18. The measure identified in (17) would be particularly well-complemented by action on a recent hint by the present Minister of Transport that an extension of SANRA's mandate from its current 7,000 km. of road to 20,000 km. might be possible (p. 29).

19. Transfer schemes are necessary to offset the problem identified in (16) above. In South Africa this is impeded by constitutional restrictions on conditional transfers. However, it is a provable result that a system of matching capital grants exists that would promote efficiency with incentive-compatibility (pp. 29-31).

20. Existing models for calculating capital grant systems as in (16) above are ill suited to the South African context. The development of such a model would likely be a tractable task on the scale of a doctoral thesis (pp. 30-31).

21. The Minister has suggested that the present nine provincial road agencies be collapsed into four, and has proposed a mechanism that could make this compatible with the constitutional division of powers. Game-theoretic principles indicate that this would also help to alleviate the problems identified in (16) above (p. 31).

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