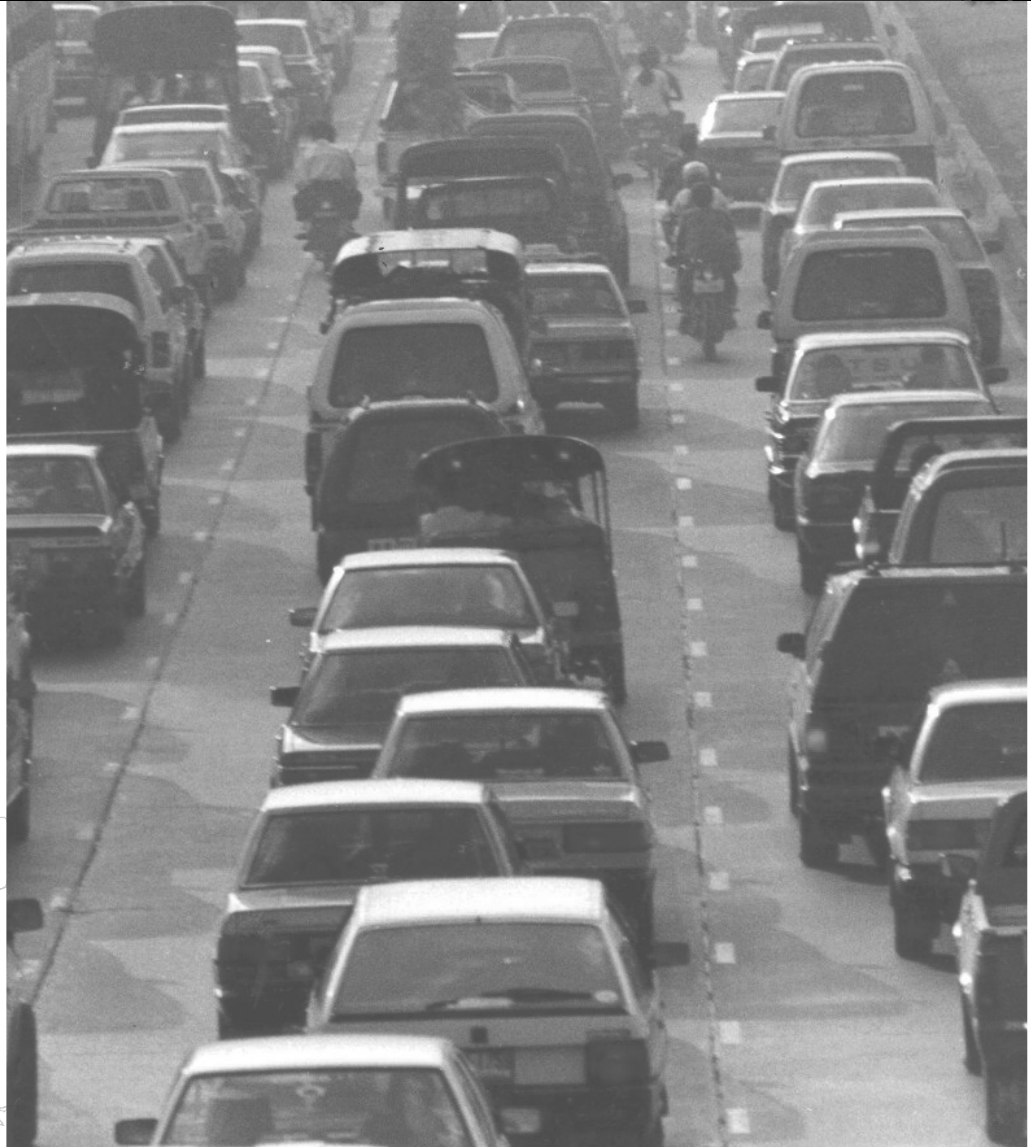




Transport: a case of systematic sclerosis?

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In 2006 the UK Treasury and Department for Transport commissioned Sir Rod Eddington to undertake a study of ‘the long-term links between transport and the UK’s economic productivity, growth and stability, within the context of the government’s commitment to sustainable development’. This commitment can be taken to be the most recent UK Strategy for Sustainable Development. It is however clear from a reading of the report that the review team had had little time to focus on this dimension of their work. For example, there is some discussion in conventional welfare economics terms of the environmental externalities of transport, but no discussion of the social implications. This paper is an attempt to partially redress the balance. The conclusions are not comfortable.

Poor process and unsustainable development

For simplicity in a self-complicating world, my viewpoint on sustainable development will be that of the World Commission on Environment and Development (the ‘Brundtland Commission’) in their 1987 report *Our Common Future*. The Commission is often credited with introducing the term ‘sustainable development’, although a little generously as the term does appear in its terms of reference. The report itself is a series of case studies of areas like energy and biodiversity. It also looks at issues that have since been edged out of the sphere of discourse, like population and arms control. A reading of the Commission’s findings is that governments and industry frequently have difficulty handling future issues, and that in particular the pressures to solve today’s problems as cheaply as possible tend to encourage shifting liabilities onto others or into the future. In serious cases, these accumulating liabilities can threaten to overwhelm a future generation. The liability is frequently, though not exclusively, environmental because no one takes ownership of the environment. Seen in this context, the so-called Brundtland definition of sustainable development – ‘meeting present needs without compromising the ability of future generations to meet their own needs’ – which has suffered several hundred restatements (and which has only recently been reinstated in the UK Strategy), actually meant exactly what it said.

Thus this viewpoint focuses on process rather than outcomes. In that sense it is only a subset of a wider sustainable development critique. Terms like ‘sustainable yield’ or ‘sustainable fisheries’ seem to have meaning and can be applied critically to real-world policies. The Commission’s terms of reference asked for ‘a strategy leading to sustainable development’, and if it had provided one for transport this paper could have compared it with the Eddington prescription. Instead, a Brundtland viewpoint invites



a less ambitious approach. It looks for dysfunctional processes that do not properly manage future liabilities. What Brundtland would expect us to find in conventional transport analysis are mechanisms that exaggerate the immediacy of immediate problems and dim the future consequences of proposed solutions, shifting the pain of externalities away from those who reap the future benefits. I offer evidence of these characteristics in the conclusions of the Eddington Transport Study.

Some preliminaries

The Study is a review of evidence, not new research, although some new studies were undertaken in parallel. Where the following text is critical it is therefore critical of transport analysis in general, not Eddington in particular. The Study first takes a high-level view of transport and the economy. Having concluded that transport investment can assist 'competitiveness', it then looks at some specific issues of current and future transport networks. The methodology used is almost exclusively in the 'neoclassical' economics tradition that dates from the modernism of the 1960s. Engineering issues appear only through reported costs. The criticisms in this paper are almost all traceable to well-known problems caused by applying general equilibrium economic models designed to describe the economy overall to real economic events in specific economic sectors where natural monopolies and sparse information are abundant. To make it clear that this is not a tirade against economics *per se*, there will be frequent unjustifiable assertions as to what a classical economist might have said faced with the same evidence! The paper concludes that while some of Eddington's findings are unchanged, even when explored in a sustainable development context, some outcomes become indeterminate and other findings are reversed.

Before looking at Eddington's conclusions in detail it is useful to look at the question the Study was set. It is safe to conjecture that Adam Smith would have thought it academic. In his time, transport infrastructure largely engaged private landowners and they bought as much of it as they thought they needed to develop their land. There was no issue regarding whether transport infrastructure added to the economy – if it took place it did. The same argument reappears 150 years later in Coase's so-called 'theorem'. Coase argued that if all property rights were allocated beforehand (and that would include the right to a good night's sleep as much as to a tract of land), then the resultant bargain between property holders could not be bettered. Indeed, we can find instances in the history of transport where such bargains were struck. Stephenson driving his rail line to London had to tunnel underneath the Earl of Essex country park at Watford as the only method of passage for which he could get agreement. The cost

in today's money was some £10 million (\$20 million). It was the longest tunnel on the whole line and a sizeable portion of the costs of the Euston-to-Scotland railway.

In our more enlightened times, governments seem rather reluctant to put themselves out of business by clarifying property rights, and we can see that the question is in some sense a first sign of dysfunction in government machinery. Once transport infrastructure is funded by taxation, or even worse by government borrowing, the question becomes real – ‘Does taxation-funded transport add to the economy?’ Governments may under- or overinvest in transport, because they themselves are proxy customers and do not, apart from the military (the ‘Ordnance Survey’ still maps the road network), need ‘transport’ themselves. Indeed, it is hard not to read ‘between the lines’ in the Study a concern, presumably by Treasury, that given the total funds distributed by the Department for Transport, was the current outcome of investment really an optimal balance between transport modes, whatever ‘optimal’ might mean? Then finally there is the issue of whether government has compensated those who suffer the social and environmental externalities of the investment or simply transferred wealth from one sector to another without compensation (as all governments tend to do).

If, like Eddington, we sharpen the focus of ‘transport’ costs to the resources consumed in moving goods and people from one place to another, transport is clearly an intermediate good. The proportion of transport used as a final consumption good in its own right (with the ‘drive in the country’ long-since passed, only pleasure cruises come to mind) is insignificant. The consequence is that once an economy is ‘developed’ in the sense that everywhere is connected to everywhere else, then the fewer resources devoted to transport – ‘everything else being equal’ – the more productive the economy. For example, China’s coal reserves are a long way from where the fuel needs to be burnt to power industrial production. This transport requirement reduces China’s industrial productivity compared with a country where energy resources are adjacent to point of use. There is an analogous position in energy discourse: energy analysts assume that expanding energy supply is a prerequisite of a healthy economy, but the transport economy sees energy as an intermediate good. The less energy a transport undertaking needs to move goods and services, the more productive and competitive it would be. When Eddington uses ‘time saved’ as the immediate return from infrastructure investment, the Study is arguably subscribing to the intermediate good proposition, although this is not the tone of the bullish conclusion of Chapter 1 of the Study. There is a further classical twist. If transport investment is to increase the productivity of a specific location, how



Environment on the Edge

do you stop (if you wanted to) the gains being collected in increased ground rent? *Wealth of Nations* and *Das Kapital* agreed on at least this – it is near impossible.

Transport seen as an intermediate service is rather more complicated than energy. While some journeys can take place any time, normally students have to arrive when classes start, passengers have to arrive when trains leave, goods have to arrive when the warehouse is open to receive them and so on. The service is thus partially ‘socially constructed’, which presents some algebraic difficulties for those inclined to general equilibrium algebra. Most transport modes for a given infrastructure have declining economies with scale of use because journeys simultaneously using the same infrastructure interfere with each other. This ‘repulsion’ effect as travel density increases is a key issue in urban economic models. The diseconomy progresses up to the point of severe congestion where almost no travel takes place. For example, because of the volume of travellers it is perfectly possible to spend more time on the ground stretch of a Delhi-to-London flight than in the air. Times from Central London to the centre of Paris were faster in the 1930s than in the 1990s. Where congestion occurs stochastically, the average travel time may be less important as a product characteristic than predictability. Reducing the average time to reach an airport is not generally helpful in catching the flight if the long tail of M25 congestion remains. Valuing journey changes just by ‘time saved’ is clearly a drastic simplification.

Formally, the market need for ‘transport’ is a consequence of an interaction between non-adjacent differentiated locations. If all locations were identical, there would be no motive for transport. So transport technology actually adds to the productivity of the economy’s assets by permitting gains from clustering (or dispersion). Clustering housing together makes it easier to have a nice place to live (unless of course you are under a flight path). It is common to speak of ‘land-use/transport interactions’ in a context of the land-use adjustments that take place after an infrastructure improvement. But this rather underplays the fundamental nature of the land-use driver that was much clearer in the 18th-century case. This driver causes a complicated response time structure to changes in transport costs that present some special analytic difficulties. The short-run elasticity will normally be very very high. As an extreme example, the market clearing price for taxis after a lightning strike on a commuter line would be vastly higher than the normal fare because (interacting) workers and workplace are instantaneously widely separated. But the ultimate long-run elasticity is very very much lower. Workers and workplaces readjust their locations if a commuter line is closed. There is thus a risk that we overestimate the long-run value of transport if we do not follow

through the analysis to equilibrium land use. Land use unfortunately adds its own analytic problem because, as Paul Krugman at Princeton argued, the land market cannot be assumed to be even approximately ideal competition. Place is by definition a local monopoly. Later this paper will look at the relationship between transport infrastructure investment and the rent-seeking behaviour of landowners.

More broadly, there is an even more general problem in answering the Study's question with the term 'economy'. In the late 18th century, Smith – 'the last solar-powered economist' – is observing a relatively simple economy with few layers of intermediate production. By the time of Marx, while the economy is still conceptually simple, in practice to calculate the 'labour value' of a product requires wrestling with inverting input-output matrices, not just counting the number of labourers attending a pin-making machine. By the time of Keynes, 'the economy' is being presented in economics almost as a thermodynamic system with myriad microstates brought together 'at national level' by aggregate economic data such as national product and unemployment levels. In this 'thermodynamic' viewpoint, it would seem legitimate by physical analogy to assume that there could be differential (marginal) relations between these aggregate quantities as there is for example between the pressure and temperature of a gas of countless molecules. None of these ideas loses legitimacy as models of economies, but it would be hard to deny the proposition that on the ground a modern globally trading economy is a complex system *sensu stricto* as argued by Paul Ormerod. Indeed, the Eddington Study demonstrates the point. Like the analysis supporting the 1997 transport White Paper, the complexity of the full transport market thwarts its attempts to complete a fully integrated multimode economic model for the UK land-air-sea transport market. The Study is in good company when it does not even contemplate adding a land-use/transport interaction to its market models, or fit them in a global context.

The Eddington Study concludes that GDP is an appropriate indicator for the 'economy'. As far as 'the government's commitment to sustainable development' is concerned, the Study can pray-in-aid the government's own sustainable development indicators (SDIs). These indicators use GDP to measure economic growth, although something odd seems to be happening, since all the economic indicators have recently been relegated to 'contextual'. GDP has been criticized (e.g. by Dasgupta and Pierce) because the index can increase (as in time of war when money is borrowed and spent on armaments production), yet no citizen (except perhaps armament manufacturers) sees things getting better as warfare destroys the capital stock. It is also rather telling that the Eddington GDP is not normalized per capita. It could be



Environment on the Edge

increasing simply through population growth, and then even when the average citizen is getting poorer, as is not uncommon in large-scale migratory movements. 'Population' has only recently appeared as a 'contextual' indicator in UK SDIs (it has been in the United Nations template for indicators for years), which is strange since variations in current projected increases are largely the result of alternative government policies, not private family planning. However, the really telling question is why only one measure of the economy is thought necessary.

For example, it would be extreme to use one index for the state of the environment or social capital or the health of the nation. If statisticians begin to create a composite index, it soon becomes evident that the battleground is in the weighting factors of the different components. Someone buying a company would want to look at the books, both the profit and loss account and the balance sheet – not just a single figure of merit like price-to-earnings ratio. Since the Brundtland critique is looking for creation of future liabilities, there could not be a worse single SDI measure than GDP, since this says nothing at all about the state of the assets. As Joseph Stiglitz points out, GDP could be high simply because assets (like North Sea oil) were being sold off. Net domestic product would have at least measured product after covering depreciation of existing assets. The United Kingdom did produce a trial set of National Environmental Accounts in 1997, but the exercise has not been repeated and is not referenced by Eddington.

The truth of course is that what 'the economy' is depends on viewpoint. GDP (and even more GNP) measure total economic activity in the 'legitimate' economy. It is therefore as Treasury sees the 'economy' (in the sense that if you can count it you can tax it). Since Treasury provides the SDIs for the economy it is no surprise that GNP appears there, but a little more surprising that the index has not been fiercely challenged. It also reasonably well approximates to the viewpoint of the very rich (i.e. as a measure of the nation's potential rental base). But it would not be expected to be how the economy looks to, say, a worker in a lower socioeconomic group. As Joseph Stiglitz has pointed out, in globalized economies using active interventions to control wage inflation, GDP hardly correlates with lower decile incomes at all. Many large developing economies have taxation bases that can afford satellite launchers and state-of-the-art military expenditure, while the poor see little of this wealth. The argument against the single index is traceable back to at least Malthus, who objected that Smith ignored the composition of national income when he assessed 'wealth'. The issue of composition even has bearing on transport projections. A richer nation could spend its money buying a new fashion watch every month or just a Rolex for life, with rather



different implications for road-haulage use. This paper will later argue that because GNP has been manoeuvred to be the index of choice, the Study by design does not pick up transfers of assets from poor to rich as a consequence of transport infrastructure investment. Similarly, the manoeuvre shuts down discussion about a particularly worrying off-balance-sheet liability in the form of future energy security.

The Study sometimes talks informally about productivity and competitiveness. If you are running a business the meaning is pretty clear. If you are uncompetitive you do not win orders. But as William Baumol has argued, preventing competitiveness (used in contrast to competition) from becoming destructive is as much a function of government as is avoiding the formation of monopolies. Unfortunately, governments are a little prone to lobbying so that they seek to be in trade surplus in everything! Consequently an industry might be internationally competitive (as in US agriculture) because taxpayers cannot find a way to stop it being subsidized. As a consequence, the overall economy performs less well. Destructive competitiveness is one common element in unsustainable development ('we just cannot afford to be sustainable'), but to be fair to the Eddington Study, it is not one created overtly by its style of analysis. Civil engineering and transport undertakings clearly see chucking public money at transport as improving competitiveness, and the analysis Eddington deploys is designed to be sceptical and see if they were right.

Eddington and history

What is evident from these extended preliminaries is that the questions posed to Eddington are not trivial and could have answers either way. Eddington commissioned a historical review of transport and the economy, and while fascinating, the arguments above show that unless one could assert that the structure of the economy was the same in the time of Smith (canals) or Marx (steam railways), in a modern economy (container ships and jumbo jets) the question as to the role of public investment in transport remains open to observation; the past is no guide to the present. Eddington actually conjectures that no future leap in economic activity is expected through transport. The earlier analysis here would concur because in its terms there are no new places left to access. It is not the means of transport itself but what can be accessed (e.g. the Chinese industrial sector via container ships) that creates the wealth. Significantly in the historical perspective, it was the technology of international transport that continually avoided 'limits to growth' by importing solutions and exporting problems. Space technology is arguably the next wave of transport technology but, apart from placing satellites in orbit (a not inconsiderable contribution to the world economy but out of scope here), there is nowhere new 'out there' that is profitable to go.



The Eddington Study draws an important conclusion for sustainable development from the recent academic literature. The relationship between transport infrastructure and the economy is not a matter of one leading the other. This conclusion is in distinction to ideas in the 1960s often labelled 'predict and provide'. In this model of public intervention, a macroeconomic relationship between a utility and an index of the economy is deduced from historical data. The government sets a future value for the index by dictat and then invests to close the gap between existing utility infrastructure and predicted. If the marginal cost of using the utility is low, demand will fill the new capacity – and the prediction algorithm will be fulfilled. The problem, of course, is that the method never incentivizes efficiency and runs roughshod over the externalities created by the utility. It has a long post-Great Depression heritage, with the construction of the Autobahns by Hitler seen at the time as a positive intervention to reduce unemployment. By 1997, when the UK government rejected the concept in transport planning, most infrastructure development was already in response to congestion rather than anticipating 'planned growth'. But presumably we can assume that artefacts like the United Kingdom's unique position on untolled motorways (the reason cannot be land-take, considering how much the motorway system has now taken since the 2+2-lane M1 was opened in 1976 from Watford to Luton) are signs of a past belief that the burden of proof favours transport infrastructure development. Eddington's conclusion on the neutrality between investment in transport infrastructure and the economy is therefore more important than it is given credit for in the Study. It essentially reverts the approach to public investment in infrastructure to the classical model and favours scheme-by-scheme analysis rather than national five-year plans. The sustainable development analysis here can only concur, but with the regret that no apology for past overinvestment is offered!

Valuing investment

Eddington values the benefits of an improvement in infrastructure by associating a value to time saved by travelling the same distance faster. These values are imported from estimates of the marginal value of time for private and business travellers. This is a model of the true valuation. There is clearly some disjunction between the imputed marginal value of time (effectively the opportunity to do something else) with the practicalities of when the travel savings actually occur. Travel diaries remind us that travel is frequently socially determined – the school day has to begin at a set time, trains have to leave on schedule, factories have to be open for delivery and so on. For journeys for which the arrival time is critical, it is easy to conceive of situations where reducing the dispersion in journey times (i.e. increasing the predictability) is more

valuable than reducing the mean journey time. But, more fundamentally in the context of this critique, this valuation method omits the actions taken by other economic players in creating or destroying assets.

For example, consider a firm that provides geographically located services (e.g. banking) that show economies to scale. The firm tries to cluster the service as much as possible, extending as far as possible the travel times of the marginal customer. Increasing travel speeds, say by providing a ring road, provides the opportunity to close some smaller clusters and build up larger clusters without losing customers. The customers needing the service never really had the opportunity to use the time saved. A well-documented example took place at Cribbs Causeway. The flagship retail group, John Lewis, closed its Bristol city centre store and relocated it on a site at the junction of the M4 and M5 to the north of the city, well connected via the M4 to the city's western and northern suburbs. The Study reports some new work by Daniel Graham that is some of the first to measure clustering gains. But it does not venture the possibility that these might sometimes be the only gains (and taken largely by landowners, not travellers). Another example is in modern distribution systems. The FedEx distribution system is a US success story, but not through thousands of short journeys across its network. Instead, overnight deliveries are all brought to a hub in Memphis, and then redistributed. This ensures high capacity of planes and greater dependability of available aircraft. Since the service is 'overnight', buying supersonic airplanes does not make it any more profitable. It means that, care of the UK road network, 'locally produced' vegetables in a supermarket will have had a round trip of several hundred miles via the central distribution site before they arrive on the shelves.

What is happening here is fully consistent with the classical case. Transport infrastructure is increasing the wealth of landowners. The only difference is that they are not paying for it. To try and quantify what is happening is a formidable task. In the Study, all the time saved was disposable at the discretion of travellers. Based on travel diaries this is hardly tenable, so let me take the alternative extreme view by assuming that investment by landowners in the long run means no new time is available. The evidence follows on from travel diaries. Yacov Zahavi asserted that realized travel times were invariant and remained constant (about 75 minutes a day). Essentially, infrastructure improvements change speed of travel, not time of travel. Recently, Robert Köbl and colleagues at Southampton have refined the argument by estimating the physical energy used by the traveller such as the strap-hanging commuter. Their argument is that the practicality of modal choice will reflect the constraint of how tired travellers

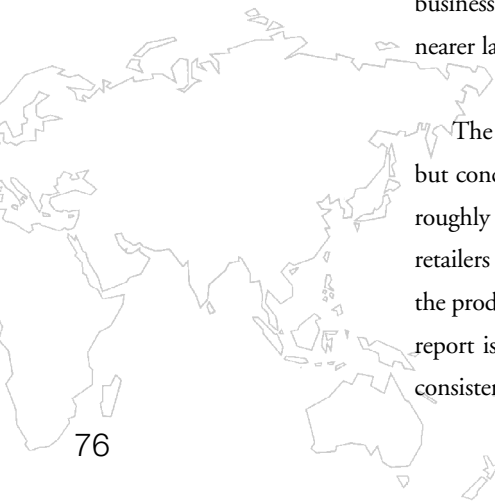


Environment on the Edge

can afford to be when they arrive. They estimate an energy budget of 600kJ/day with even less variance between travel budgets. These 'constants' imply around a 100 per cent rebound effect for some transport infrastructure development. This is of course hardly remarkable in economics. It is what is assumed in discussing increased labour productivity (i.e. other employers seek to take up surplus labour and increased speed means more deliveries, not fewer van drivers). More to the point here, it offers a way to understand how the land developer will view a change in travel speeds.

Developers working with a rule of thumb taken from experience or travel diaries will see an improvement in travel times as an increase in the total goods and services that can be accessed from their land. Let me go to Houston, which provides a textbook case because it has little or no planning controls. When the Katy Freeway is completed west of Houston, which at 24 lanes will be one of the widest freeways in the United States, the effect is to open up more land for commuter housing to the west, not more time with the kids. Clearly in an underdeveloped country (as indeed Sweden was at the time of Malthus), investment in transport infrastructure reaps real returns as productive land is brought into the economy, but the issue is more subtle in a developed country where in principle everywhere is connected to everywhere else. Eddington correctly raises a caution against the expectation that increasing the connections between two places necessarily raises the prosperity of both. This was another 'bright idea' of the 1960s. Ricardo is usually attributed with the theory of comparative advantage in trade between two regions, and he would have seen why. An investor might have dreamed that widening the A30 in the far west of Cornwall could create a new business park sending goods east. Ricardo would not have been surprised that the road simply moved the comparative advantage of small local industries to larger businesses to the east, and at the same time provided local warehouse space for more easterly firms already nearer larger markets.

The same argument applies to freight. Saving time for freight traffic is not more deliveries per van, but concentration of warehouse facilities. There is an economic gain here of course, but one that varies roughly as the square root of the warehouse area (from reducing stock variance), not value of time. Many retailers would like to use one central warehouse. Whether Eddington's just-in-time argument applies to the productivity of a service economy is another matter. The indicator of congestion used throughout the report is a road running at 80 per cent of free-flow speed. That is a contender, but an indicator more consistent with air or rail would have been reliability of journey time. The free-flow congestion measure



invites 'sweating the asset' with technologies like hard-shoulder running and peak spreading. Perversely, this actually risks pushing reliability outcomes in the wrong direction because reliability needs redundancy in the network. In systems theory, optimality and resilience are trade-offs against each other, and attempts to minimize costs in transport lead to increased variance in service delivery. This was the case with the early days of rail privatization and is certainly the case with many parts of the global air network. Taxpayers should be very suspicious as to whether 'sweating the asset' is really to intensify the congestion.

Collateral damage of transport investment

The area around Watford provides some interesting examples of contrasting approaches to the externalities of transport. Watford seems to specialize in being 'typical' to the point of being inundated with pollsters at election time, but for the purposes here has had transport investments from canals, rail, the North Orbital, the M25 and even a small airport. The rebuilding of its theatre is a typical set of decisions of anyone investing in land use. The theatre management could argue for an increase in seating capacity because the audience reach within around 30 minutes travelling time had been recently increased by a link road through a local park to exit 5 of the M1. The 30-minutes rule used by the theatre management is not capricious. A two-hour evening entertainment has to fit between when the audience returns from work, when they eat, and when they need to get home for sleep. They need to arrive fresh enough to enjoy the evening. The new audience is probably at the expense of smaller local venues, some of which will close. Now it could be that someone able to stay at work for 15 minutes longer care of the link could earn just enough extra to afford a theatre ticket, but they are not a central part of the land investors' model.

Unlike the world of Smith, where the good burghers of Watford would have had to buy the right to drive the road through the park from its owner, the theatre did not contribute to the new link road nor does it compensate the dwellings close by for the loss of amenity of their park or the nighttime noise. Indeed, while welfare economics often explores projects on a basis of Pareto optimality, where benefits need to outweigh dis-benefits, these transfers are seldom administratively realized. Until the 1970s, Parliament had not even given the executive the powers to pay compensation for those suffering from infrastructure 'improvements' (actually after the residents adjacent to – as in bedroom windows facing onto – Westway stopped the opening ceremony). A classic case was the semidetached housing cut in half by the widening of the North Circular Road because no parliamentary authority existed to buy land



that was not to be covered by tarmac. But then the Normans never asked the Saxons for planning permission to put up a castle.

As a consequence, the dominant effect of transport infrastructure investment – as far as other environmental and social capitals are concerned – is usually transfers from those with low-to-modest incomes to everyone else, and landowners in particular. All valuation techniques are by their nature a little fuzzy but, as we would expect from the above argument, they purposely err on the parsimonious as far as judging the bads of transport. Most of the environmental externalities valued in Eddington use ‘willingness to pay’ estimates rather than (as with the Earl of Essex) ‘willingness to accept compensation’. The latter is usually about three times larger and wipes out a noticeable fraction of the ‘economic’ transport cases explored in the Study. The consequence has been around 40 years of what historians may well later view as legalized vandalism in both the urban and natural environment, for which Brundtland would not be surprised that the nation has never found the funds to remediate. The Eddington report’s habit of talking down, or sometimes not mentioning, these downsides, is fully in this tradition. While growing the economy, transport for over a hundred years has been blighting the asset value of low-income housing.

Transport-related land development

Let me return to the issue of land development and transport infrastructure, but this time not the extension of commuting but the development of extra trips. One of the earliest examples was the proposal to build a large retail complex at junction 21 of the M25 as soon as it was completed, a development that had not figured in the original traffic flows presented to the planning inquiry. Time budgets were clearly the attraction, with a new market of around 3 million in range, although at the expense of local town centres. That enterprise failed at the planning inquiry stage, but other examples soon emerged, not least the shopping malls either side of the Dartmouth crossing. Possibly the classic example of provocative land use was Cribbs Causeway at the junction of the M4 and M5.

Again using the time budget, the M4/M5 junction is an obvious place for a large retail centre. The M5 after all sweeps round the whole west side of Bristol. For a while the land use at the junction had followed the classic rule of warehousing, but a Carrefour hypermarket created a chink that expanded into a very large development. It is usually notoriously difficult to establish that one retail development degrades another. It is for example hard to find out if rents have changed to accommodate competition.

But it is hard not to attribute the economic difficulties of Bristol's commercial city centre to the Cribbs Causeway development. The strongest evidence is that John Lewis Partnership, a commercial anchor store, closed its Bristol centre branch when it opened its flagship store at the motorway junction. Because we see transport in terms of time saved, not land use, this kind of story repeats itself many times over. The Bristol centre has arguably been regenerated with public money, but this seems a very roundabout way to run a sustainable major city.

Britain has seen a remarkable drop in its number of shops, and in many areas local shops have seen little of the nation's economic growth. Often all that is left of a small urban retail cluster is the hairdresser and the tobacconist. The style of free transport infrastructure provision must be part, if only part, of the story. Bizarrely, English village commercial life only seems to exist in rich enclaves in large urban centres that have retained some through traffic through wise estate management. Many tourists will have noticed that Georgetown in Washington is a vibrant (and expensive) middle-class community, but one that purposely does not have a metro station or freeway exit.

To be fair, examples do exist of using transport investment to provoke a desirable land-use outcome. The Houston Metrorail is an example from an unexpected quarter. Trams are usually viewed in transport economics (and Eddington) as poor value compared with buses, and are certainly less flexible to deploy. But to the land investor the inflexibility is actually the point. No point risking investment in Salford Quays if the capricious whim of a bus company can lose the connection altogether or Jim's Clapped Out Bus Company wins the franchise. Houston does not have a downtown traffic problem. Indeed if it has a problem it is that there is no downtown traffic (except for an unsavoury Greyhound bus station). The Houston Metrorail has served as a regeneration corridor along the full length of Main Street. The UK Department of Transport has funded a study of the Croydon Tram, but the rather inconclusive outcome is presumably because of the complicating factors rather than the benefits. The Eddington Study picks up none of this land-use gain, so not surprisingly ends up in a love affair with the bus.

Urban transport

Eddington notes that there is little projected growth in urban traffic levels. Then if all this transport investment is to make us more efficient but not much happens in cities, it is rather a mystery as to where we are exactly making all this extra GDP. The time-budget model above of course tells us that city



Environment on the Edge

congestion is self-limiting, with the lower limiting speed for personal travel effectively the total time of a public service journey. London traffic has moved at around 13-15 mph (21-24 kmph) for years, which is about the speed of an Underground journey if you see it from the traveller's point of view, not Transport for London's. Unless a congestion charge is so high as to make motorists penniless, its main role is to speed up the bus system. Drivers are right to complain about empty bus lanes, not because they are unused but because they imply slow average bus journeys. So it is that urban land use adjusts appropriately.

Much of the land developer's point of view is captured by following through a time-budget model. An urban area is characterized by the travel time budgets to critical services (say the local shops). On a dimensional argument, the scaling relationship from different urban areas needs to have the mean speed of travel varying as the inverse square root of the population density. If it is a fast-moving urban area, the developer naturally spreads the area out, if it is slow-moving it has to be packed together. The mean speed would be less than the free-flow speed because of interactions with other travellers. The proportion of the travel budget spent not actually travelling is going to be a slowly varying function of density, because low-density cities have a lower density of travellers but on a physically longer trip. More to the point here, an investor looking to place a service with a particular time budget estimates a market catchment area that is proportional to the square of the mean speed. But since mean speed was roughly inversely proportional to the root of the density, it follows that catchment size varies weakly, if at all, with urban density or free-flow speed. Cinemas are cinema-sized in most of the urban area. Consequently urban speeds would not be expected to have much long-run effect on urban productivity through clustering where there is only one mode of transportation. The conclusion would be different if the investor could persuade the public sector to fund a faster link that did not itself readjust the basic density of the urban area. That is one reason why, in part, out-of-town shopping located on ring roads is so competitive compared to the pedestrian high street, care of the generous gift of high-speed road capacity to the land banks that speculators have sited adjacent to the ring roads.

The Eddington Study believes it uncovered very high rates of return on urban transport projects. We can see one reason why from above. The idea is intriguing because, in engineering terms, urban projects have a reputation for being very expensive. The Boston Big Dig to bury Interstate 93 for 5.6 kilometres costs around \$15 billion (sic), making it the most expensive motorway in the world on a per-kilometre basis. Whether, had Bostonians had to pay for it themselves, it would have happened is a moot point.

Economic instruments

Before I end my discussion by looking at Eddington's future projections I should say a little more about the relationship between time budgets and traditional neoclassical models of consumer behaviour. Consumer behaviour is modelled by maximizing a utility function of all possible consumption goods subject to an income constraint and a vector of prices. It was introduced to make the 'big picture' general equilibrium model of the economy analytically tractable – not because of some new empirical evidence that escaped the insights of the classical economists (or for that matter Shakespeare). Almost 50 years ago, Simon cautioned about taking the model too seriously when dealing with detailed microeconomics because the implied optimization was impracticably complicated. Indeed, if you enter Wal-Mart with a \$100 dollar bill you would need to have sorted 10^{20} possible trolley loads before you got to the check-out. Making choices is a cost like everything else, and it is presumably why we distinguish in normal speech between 'choice' and 'decision'. If we dream of being rich it is probably about making lots of decisions based on whims, not having access to a thousand mail order catalogues to spend all day making choices. We do not face this problem in reality because we use narratives to frame decisions. Hamlet does try a multi-criteria analysis ('To be or not to be...'), but not until Act III. Up to that point he has made no end of decisions (not to go back to university, not to kill Claudius...) all of which the English literature undergraduate finds totally consonant with the narrative of a young man in a state of high anxiety. Real consumers are a patch of two behaviours: 'rich' and 'poor'. Where they feel 'poor' they make compromises, but where they feel 'rich' they don't. Product marketing has to get this right and it is a pity that we are beginning to isolate some branches of economics from its insights. Budget airline advertisements tell you the lowest price you will never get, car manufacturers put fuel consumption in the smallest font possible. The 'rich' consumer is not price insensitive, it is just that having decided on brand and product, it is only then that differing offer prices come into play. Motorists who have never asked about fuel consumption, when they buy a 4 X4 drive on 'empty' to get a better price per gallon. As Simon argued, this is perfectly rational in a complex world. And the economy is certainly complex.

The time budget is just part of this story. It is the physical realization of the consumer's narrative. What is perhaps ironic is that 'price signals' are becoming an increasing part of the intervention tools in transport, when at one time a rationale for the high levels of taxation on vehicles was that demand was inelastic and so the taxation caused little distortion in the economy's efficiency. Apart from the income effect, land developers are likely to ignore them because the degree to which they differentiate land uses



Environment on the Edge

becomes lost in rents. For example, it is conventional to ignore adjustments in rent as a consequence of road charges. Both Smith and Marx would have found that odd, since both found it difficult to see how to get the advantages of a location out of the pocket of the landlord. If you are the owner of a London car park then your charges need to just fill the spaces. If a congestion charge bites into your volume of customers you need to back off your rates to your customers' benefit. There is no reason why this should totally offset the charge but, as with the recent Oxford Street and Regent Street rent negotiations, do not assume that all the congestion charges' short-run, demand-stifling effects will be there in full in the long term. Thank heavens it pays for the buses!

The future

In Brundtland's terms 'sustainable development' is the *raison d'être* of future thinking. Much of the Eddington Study is focused on the distribution of current spend, but it does provide transport 'projections' that go out to 2025. The method computes a 'transport demand' from time series that are supplied externally for GDP and population. Now it is algebraically possible to iterate a capital growth model as many times as you like, but it is normal to rerun the model at least every five years, recalibrating it with the intervening years' data. Projecting capital growth for longer periods leads to problems because of the somewhat arbitrary way that GDP is converted to 'constant prices' when technological progress is assumed. The model has credibility in, say, forecasting over a comprehensive spending review period, but is arguably not the best way to talk about the longer term. In this approach, the future is essentially today only scaled up and physical constraints (e.g. constrained travel times, not everyone can be a truck driver, the 24-lane engineering limit to freeways) do not figure. When constraints begin to bite they influence the model through the recalibration of parameters, but do not form part of the modelling discourse. If Heathrow by 2025 has turned West London into a large *favela* (as the frequent traveller might have noticed can happen elsewhere), we will not know. The best way to boil a frog is slowly to increase the water temperature! This is in contrast to the spirit of Brundtland, which does not require us to model the future accurately, only to identify well ahead serious liabilities and constraints. The Eddington methodology tries to predict the future but without accounting for limits and liabilities.

The use of external series to drive the transportation models is also worth a mention because that may be a further 'Brundtland' failure. In transport we have seen population density as an important determinant of transport outcomes. At a given location density changes over time with migration, both

regionally and internationally. In classical or neoclassical terms, these movements are in part in response to economic incentives that are re-establishing balance across the economy in which there is free movement of people. The 'optimal local density' then only comes about if the diseconomies of inward migration are reflected in the marginal decision to migrate. But in the Eddington projection methodology this feedback is cut off. Commuters complaining that there are too few trains, causing overcrowding, may be confusing the situation with there being too many commuters from new cross-subsidized remote commuting centres. To rub it in, Eddington is using population projections significantly lower than the recent Office for National Statistics projections, though the latter have no economic feedback in them either.

The net effect of all this is that while Eddington discusses the long term, it is done in a way that obscures the important economics of what is actually happening. Thus the projections are subject to a sensitivity test of different constant oil prices. \$100 dollars a barrel is the high scenario – enough said. Jevons, who wrote at the very end of the classical period on the issue of UK coal reserves, would probably have noticed something else. It is not that we are running out of cheap-to-produce oil. It is that we are running out of suppliers. What is more (or as a result), the Middle East is a very politically unstable region. The transport sector is in something of denial about all this. A recent Royal Academy of Engineering review overstated the 'time to exhaustion' by almost a factor of two by misreading oil industry data. 'Peak oil' is not even discussed in Eddington.

The land-use interactions that have been described above have had one major effect. They have removed modal choice. Wide car ownership has not meant people drive to the local shop; it has meant because of investments elsewhere that the local shop has closed. In the example above, people who used to walk to their local theatre will now drive to the main town. Since the 1970s, oil has taken over from electricity as the strategic fuel in the economy, at a time when Middle East politics could not be more insecure. A small disruption in oil deliveries in the tanker drivers' dispute causes rational panic buying that empties the entire supply network. It is rational because changes in land use have eliminated travel alternatives for most workers.

Things get murkier. In conventional resource economics we work through reserves in order of increasing costs of production. But oil is a noticeable exception. One of the consequences is that we



Environment on the Edge

have a large reserve of cheap-to-produce oil and an even larger reserve of very expensive-to-produce oil, and not much in between. This is a recipe for an oil price even more unstable than normal commodity prices. It is also a recipe for asset transfer. Once the owners of cheap oil have bought all the Gucci handbags and jet fighters they can manage from the large rents that they are collecting they begin (as in the style of Norway) to buy assets with their income. Now in one worldview this is just trade. But Eddington's worldview is more jingoistic than this ('UK competitiveness...'). We are left wondering whether a prescription for infrastructure investment that leaves us increasingly strategically dependent on oil just as oil becomes more geopolitically risky and – to quote Warren Buffett – that leaves us a sharecropping society, has really advanced competitiveness and productivity for any useful purpose.

Conclusions

The Eddington Study had little time to look at the issue of whether it was proposing a policy suite that was consistent with sustainable development. Indeed if Defra (UK Department for Environment, Food and Rural Affairs) officials had inserted the reference to sustainable development in the terms of reference they might have done better not to have bothered. Eddington is an exemplar of conventional transport economics and rather unfairly suffers here from being the voice of a much larger school of thought. Transport is generally recognized worldwide as an area where the idea of sustainable development has made least practical progress in reconfiguring investment. In the absence of a sustainable transport template, this paper set out with a less ambitious objective of applying a 'Brundtland-style' critique to the Eddington Study that focused on process – how were future assets handled and was the future sold short? It may be that the problem in bringing into being a convincing sustainable transport policy is a fundamental flaw in process, a process that divorces land use from what connects land.

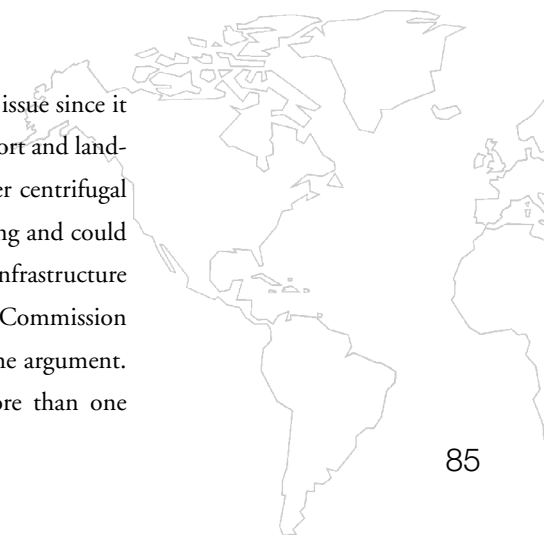
Some conclusions from the Study remain robust to this critique. The 1960s view of transport as a way for public funds to pump-prime the economy is not well founded. Similarly, transport investment can contribute to asset productivity, but unlike Eddington it is less clear if, when all factors are taken into account, anything like the Study's scale of investment is justified by the market. This is because the view taken here is that benefits are largely returns from clustering rather than time saved (because it isn't) and that compensatory transfers for collateral damage never materialize. If the Department for Transport had received public funds for all the projects it judged 'economic', then we could be fairly confident that the



public sector was overinvesting because of biases in the analysis. These are presumably an overhang from a 1960s dogma, creating damage and liabilities elsewhere in the economy.

As in many other countries, taxpayers in the United Kingdom have probably been buying the wrong kind of transport since the postwar years due to an exaggerated belief among parliaments and the executive in transport's medicinal value for other industrial ills. The casualties have been largely environmental and social capital, with the better off largely to gain. 'Twas ever thus. But as we move into tricky waters on global energy, this inherited infrastructure risks being written off as obsolete, and the land-use changes that infrastructure has induced will leave the United Kingdom materially disadvantaged. While the assumption that transport investment leads to growth in economic, social and environmental capitals has evaporated, the whiff of older thinking remains. Nothing is helped by using GDP as a single statistic surrogate indicator, and if that cannot be expurgated then it is hard to see where the brake in the system is to be found. This paper has persistently asserted hypothetical 'classical' economics positions partly as contrast to current orthodoxy, partly to emphasize that the argument is not against economics *per se*, but also to argue for the insights gained by working with a plurality of models. Twentieth-century academic economics has become unhealthily obsessed with making economics look like physics, but an engineer would never be comfortable working with just one model. The integrated circuits in my computer are designed with quantum mechanics and the power supply with Ohm's law, but it is electrons in both cases. For analytic convenience, neoclassical analysis puts a great emphasis on the competitive equilibrium approximation. That may be suited for the big picture, but the world of monopoly and rents is the real world of transport and land use. We need to get postmodern in economic theory if it is to do more good than harm.

It is difficult not to conclude that some part of transport is in fact entirely a land-use issue since it fundamentally affects rents and land prices. There have been two attempts to bring transport and land-use planning together in the UK public sector in the last 30 years, but both failed under centrifugal forces. Arguably, rail safety or seat belts or drink driving have little to add to land planning and could be in a transportation arm of government. What is not so easy to defend is treating the infrastructure of connection independently of the management of what is connected. The recent Royal Commission report on the urban environment comes to a similar conclusion from the other side of the argument. Land-use planning decisions have to take into account transport needs. There is more than one



Environment on the Edge

governance model for such a shift. In the United States, for example, some states have fierce and effective zoning rules that would have precluded opportunistic land development. In other states effective and binding treaties between land developers and land users perform the same task. Capturing 'windfalls' from transport infrastructure improvement, rather than funding it through taxation of players least able to do much about reducing use, would be a start. What we need least is a transport and land-use system chasing independently the wrong economic index in a race between tarmacking and bricking over either the whole country or at least one corner.

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