Infrastructure, Public Goods and Markets

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– A. D. Shroff
1899-1965
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Forum of Free Enterprise

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Kirit S. Parikh*

Inadequate Infrastructure – A major bottleneck

The Indian economy is plagued by inadequate infrastructure. Power shortages are widespread in the country. The shortage in peak capacity is estimated to be 10 percent. The quality of supply and its reliability are poor. The ports are congested. When ships wait in the Mumbai harbour to be unloaded, we pay additional demurrage charges. For petroleum imports alone these run into hundreds of crores of rupees per year. In Singapore the turnaround time for a tanker is less than a day. In Mumbai it is more than 12 days. Roads are over-crowded and in poor condition. Traffic in large metropoles now crawls which apart from the time wasted, adds to air pollution. Air is highly polluted in our cities. Almost all our rivers are so polluted that water is not suitable for bathing, let alone for drinking. The telephone density is low and information infrastructure grossly inadequate.

The economic costs alone, not counting the substantial intangible costs of this inadequacy, are staggering. Power shortages and failures, disrupt production and discourage

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investment. Poor quality supply requires voltage stabilizers for expensive equipment and back-up generators by the thousands. Fluctuating voltage damages equipment and wiring. It also leads to overdesign of motors which in turn use more electricity.

Cost of road congestion or poor road quality can be very high. If you go out of Mumbai towards Ahmedabad on a working day, you are likely to encounter bumper to bumper truck traffic crawling in both directions at five kilometers an hour and the line does not end for an hour or two. The costs of fuel and wasted truck hours as well as loss of man hours is enormous. A small example will illustrate this.

> It is a matter of day to day experience, that infrastructure facilities affect economic efficiency even though econometric studies give ambiguous results. Here is an example from the immediate environment of the Indira Gandhi Institute of Development Research.
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> The Indira Gandhi Institute of Development Research is located on Film City Road in Goregaon East in Mumbai. The distance to the Western Express Highway is around 3 km. When the institute was inaugurated in 1988, it used to take about three minutes by car to cover this distance. In 1996, it takes seven minutes to cover that distance even at midnight when there is no traffic on the road. The delay is due mainly to 39 cuts made in the road not repaired properly. Each one of this constitutes an unauthorised speed breaker. To repair all these satisfactorily would cost no more than Rs. 50,000/=.

What is the social cost? Every day there are 500 bus trips, 100 car trips, 5000 scooter trips and 500 trips by other vehicles (trucks, tempos, etc.) on this road. We can assume very conservatively that the additional fuel consumption would be double as the time of travel is more than doubled. The total cost of additional fuel alone would be Rs. 3,00,000 per month. If we add the cost of increased fuel consumption and wear and tear of braking and accelerating 39 times, the cost would be perhaps doubled to Rs.6,00,000 per month.

For years, with a misguided notion that telephones are a luxury, we did not invest enough in it. Today, we know that telecommunication and information that it brings are important inputs for production, economic efficiency and competitiveness (for some empirical evidence, see Norton, 1992). The telephone density in India is pathetic. In 1991, we had 13 telephones per 1000 persons as opposed to the world average of 110, more than 300 in Korea and around 550 in the USA. One should also recognise that usefulness of a telephone line increases as more and more people have telephones. Fortunately, technological innovations have made it much easier to introduce competition and expand telephone network.

Inadequate infrastructure has constrained the growth of the Indian economy. To produce efficiently, to export competitively and to use our resources effectively, we must improve the infrastructure. Only then can rapid growth take place.

Why do we have the Problem?

The main reason for inadequate infrastructure is inadequate investment, which in turn is because these sectors do not generate adequate surplus because as public sector enterprises they are not free to charge appropriate user fees.

Take for example, power. The targeted capacity increase over the 8th plan was some 31,000 MW, but not even 16,000 MW was added. The reforms initiated in June 1991 have unwittingly created an infrastructure bottleneck in the country. The primary aim of the reforms was and is to make the Indian economy efficient and fast growing. For efficiency, competition is essential. Domestic deregulation, carried out in the June-July 1991 was to provide domestic competition. Trade liberalization, carried out gradually over the years, was to provide international competition. Along with these, a reduced emphasis on public sector was considered necessary. Because of the political interference to which it is subject to as also the difficulty of imposing effectively a hard budget constraint, the probability of inefficiency in public sector is high. Thus public sector reforms and privatization were parts of the reform strategy. A lowering of public sector investment was also called for, by the need to reduce fiscal deficit. Control of inflation and price stabilization are needed to stimulate investment and protect the real incomes of the poor. Thus, the reforms led to a significant reduction in public investment in infrastructure. As a consequence, in the Eighth Plan (1992-97) we added less than 16,000 MW compared to the revised and lowered target of 31,000 MW.

The government had recognized the problem that reduced investment in infrastructure can lead to. It had hoped, however, that private investment would come forth to take

place of the public investment. Thus, shortly after the initiation of the reforms process in June 1991, the Government of India in October 1991 (Ministry of Power, 1991), opened up the power sector for foreign private plants. 100 per cent ownership was permitted and the requirement to balance dividend by export earnings was waived. Unfortunately, only 3 private power projects have come up till today. Apart from the ideology of reforms, the need for private power was also called for by the inability of SEBs to generate financial resources.

The sickness of the power sector is directly attributable to the financial sickness of State Electricity Boards (SEBs), which is a consequence of the political power of the agricultural lobby. Electricity is provided to agricultural users at highly subsidized rates. The agricultural lobby was able to extract this subsidy since initially electricity demand by agriculture was a small part of the total demand. It was 3.9% in 1950-51, 6% in 1960-61 and has grown to 29.8% in 1993-94. The burden of subsidy till mid seventies was relatively small and spread out over a large number of other users who did not oppose it. The farm lobby had no difficulty getting electricity (and other agricultural inputs) at concessional rates. Perhaps there was also some social justification for such subsidy as it accelerated diffusion of new technology.

Though the farm lobby is not organized as such, its political power is substantial. The rural rich, and relatively large farmers, exercise considerable influence over the smaller farmers and agricultural labourers. They constitute vote banks which are sizable, though somewhat less now, controlled by the rural rich. The political parties which got

their support had to concede their demands for various agricultural subsidies.

Apart from agricultural subsidies, overstaffing and large transmission and distribution (T&D) losses contribute to the financial sickness of SEBs. These are also the outcomes of political compulsions. An SEB with geographically widespread distribution system provides an ideal opportunity to give jobs to party workers spread all over the state. Elected representatives belonging to the ruling party from all over the state could dispense favours to their supporters. The SEBs have nearly a million employees and are grossly overstaffed. Also the overstaffing varies across states. Thus, in 1990-91 Gujarat had 9 employees per million units of electricity sold, Bihar had 30, Orissa had 44, U.P. had 24 and West Bengal had 27. Overstaffing creates a vested interest in clandestine sale of electricity. It is common knowledge that a substantial part of T&D losses are in fact theft of power.

Over the years, the situation has changed and new political pressures are developing for reforms. Power consumption by agriculture is now nearly 30 percent of the total, and the burden of cross-subsidy is biting other users who are beginning to resist. At the same time, these subsidies have so crippled SEBs that their ability to meet demand is severely limited. Even farmers feel the loss due to unreliable and frequently interrupted power supply. Some of them would be willing to pay more for better quality power. Thus, reforms can be politically popular. We have in fact, seen privatisation of Orissa SEB in early 1996.

Today, the subsidies for agricultural power given by all SEBs add up to Rs. 7,000 crores per year, i.e. if farmers

were to be charged only the average cost of power, the SEBs would get Rs. 7,000 crores more per year. When leveraged into capital markets that would become Rs. 35,000 crores/year, enough to install 9,000 MW per year. Even without any inflow of private capital, power shortages would disappear.

Yet such reforms are not likely to take place soon. We will need to rely on private power. After the first Enron deal was signed in 1993, within six months some 240 memoranda of understandings were signed by various SEBs with private parties willing to set up generating plants. Yet, as mentioned earlier, only 3 plants have come up by December 1998 and no other is under construction. The reason is we have not used competitive market principles.

In fact, it is possible to creatively use markets to deal with many infrastructure and other public goods such as air quality, urban road space, forests and other natural resources.

Using Markets for Infrastructure and Public Goods

The development of capital markets in the recent years opens up a whole new set of opportunities to develop new markets for public goods.

The development of market mechanisms on financial markets, and the advent of the computerised "open electronic limit order book market", have yielded markets which are close to the economists' ideal of competitive markets. In the open electronic limit order book market of the National Stock Exchange, the price and quantity of all offers to sell and bids to buy each stock are displayed anonymously on the computer screen so that the demand and the supply

curves are known to all. The ideal competitive market has many players, none of whom can affect the price significantly, one price prevails at any time, all the players know the price, and transaction costs are negligible. The modem automated trading practices have brought us close to fulfilling these conditions.

The availability of technological and human skills that have gone into these markets opens up the possibility of using economic incentives for efficient use of public goods such as environmental resources, road space, etc. Some of these markets could have trading volumes which are extremely large.

What I propose to do is to illustrate how we can use economic principles and markets to provide efficient infrastructure or preserve the quality of public goods. Our objective is to provide infrastructure services at cheapest prices and to manage public goods at least cost.

Power Sector

Electricity is not a public good in the sense that you cannot exclude users. However, it is a merit good as one thinks that everyone should have electric lighting. It has also large economies of scale through network externalities which almost makes it a natural monopoly. It is also not importable.

While new technological options of decentralized small power have become available, they are still expensive. But they do provide an option and an upper limit on what can be charged for electricity.

For a large natural monopoly how can we use markets and competition to introduce efficiency?

An electrical system has three components: generation, transmission and distribution. First of all we recognize that for a large grid with many generating plants, the economies of scale are not dominant in generation. We can introduce competition in generation. Thus generation can be carried out by a number of private plants competing with each other.

Trading for Electricity: Endemic and widespread shortages of power is a major problem for the economy. Our one great hope to get out of this mess is large-scale involvement of private power producers. Some 240 MOUs have been signed, but only 3 have been cleared.

In the short run, captive plants and co-generation are attractive options. A captive plant is one which is owned by industry. Usually the industry does not need power round the clock and over parts of the day, and on many days of the year, it has idle capacity to generate power. It would like to do this and sell the power to the grid or to other users.

Co-generation is a slightly different process. Many factories require heat or steam for their process. If a power plant is attached to such a factory, it can use the heat which is currently wasted; it can thus generate electricity at a lower marginal cost.

Once we have a rich set of private producers, captive power plants, and cogeneration, a question arises: who will the buyers and sellers be, and at what price will they trade electricity? There are large amounts of money involved in these decisions, and if regulators are required to set these prices and contractual arrangements, the pressures to favour one or the other can be large.

Markets are an ideal way to resolve this problem. Potential suppliers of electricity would convey their intentions by bidding prices and quantities for each half-hour slot in the day. Consumers would bid prices and quantities at which they are willing to purchase electricity.

Such a market would provide power at the least cost to consumers, it spontaneously generates the economically efficient time-of-day pricing, and it will bring enormous efficiency gains to the economy. The controversies about the load factor guaranteed to Enron would be side-stepped: indeed, in such an environment, there would be no Power Purchase Agreements (PPA) to be signed by each independent power producer. In an environment where signing of PPA is time-consuming and fraught with political complexities, the market approach appears to be a dramatically simpler way of reaching for economic efficiency.

The electricity market can be organised as an open electronic limit order book market where the distributing company may act as the market marker. Of course there may be some large sellers (with large generating plants) and one might worry that they may dominate the market.

However, electricity cannot be stored and the sellers have an incentive io make a successful offer. At the same time, buyers may be able to shift their demand to off-peak hours with some cost. This will provide a limit to which a large seller can exploit its dominance. Nonetheless, the few large players may collude and one needs to develop a regulatory framework to ensure a fair and a competitive market. One also needs to develop the necessary legal framework for smooth functioning of the market. The prices discovered by this market would be used as a "reference

rate" for contracts with producers who have no control over their production, like wind power producers, and with many small consumers who want fixed price contracts.

The trading volume expected in a market like this is enormous. A 100 MW unit generating at Rs 3 per KWH has an output of Rs 200 crore per year. India's power system is expected to be about 100,000 MW in 2000 AD, which yields a daily delivery volume of Rs 600 crore/day.

Futures and options markets are required in assisting production planning given the price volatility which such a system entails. As is the case with pollution permits, the lack of storage facilities of electricity means that the futures market reveals information to the economy which is just not revealed in the spot market for the permits. The futures prices would give signals to both, the producers and consumers of electricity and guide their future investments in generation, electricity conservation, choice of alternative technologies, etc.

The approach proposed here is not without precedent. Spot and futures markets for electricity exist in UK, Finland and in some parts of the US.

Transmission: The transmission network has economies of scale and by and large a single owner of the transmission network is desirable. Regulation of the monopoly is, however, somewhat easy as the operating costs of a transmission line are very small and involve little uncertainty. The main cost is the capital cost. Thus all one needs is a competitive bidding process for building transmission lines and generally agreeable charges for wheeling (carrying electricity from a generator to a distributor usually at a high voltage) can be

computed. One should ensure that the regulator and the owner of this monopoly are not the same, viz. same government agency. An independent regulatory agency should be set up. Who pays the wheeling charge is a matter of convention. It may be payable by the generating company or the distributing company. The wheeling charge may be fixed as Rupees per million KWhr of electricity carried over a km at a given voltage. The rate may vary with the transmission voltage.

Competition in Distribution: The distribution system supplies electricity at a low voltage to individual consumer and collects bills. In a given area having more than one distributor would lead to wasteful investment in distribution lines. So distribution in a given area has to be a monopoly. However, the local area can be relatively small and for a state as a whole we may have many distributing companies. While these companies do not compete with each other, their performance can be compared with each other and normative yard-stick and public pressure can be brought on the relatively inefficient companies.

We should consider setting up separate distribution companies at taluka or a district level, whichever is practicable (the smaller the better) and let the local body buy electricity from generators and sell it to the consumers, collect bills and retain profits. Such a framework might provide a visible connection between what consumers, such as farmers, pay and what they get in return. The local body can be expected to invest the surplus in socially desirable ways (schools, roads, health clinics, etc.). This way, there may be less reluctance to pay for electricity.

Roads: Our objective is to get a road of given specification

(number of lanes, permissible speed, strength, etc.) at minimum cost. If the state had the money, it could just invite bids for contribution and select the lowest credible bidder. But the state does not have finance and we need private finance.

The attempts to privatize roads by asking private firms to build, operate and transfer (BOT) route has not been successful.

The main problem is non-excludability of users. The road network has to cater to all users. A toll road cannot be the only road between two points. We must provide a road for the users, unwilling or unable to pay the toll. Once an alternative is available, the projected traffic on the toll road becomes uncertain and more price elastic.

If the bid is for the toll price for a fixed period of time, one would not get the lowest toll price – it would include a risk premium. One way to get around the situation and not let the uncertainty bid up the toll price is to invite bids for minimum present discounted value of the revenue stream at a prescribed discount rate. The period over which the builder operates the road, depends on the actual growth of traffic and the toll rate charged which the builder is free to set. Essentially, this scheme brings about a risk-incentive trade off. Though it will not completely eliminate the risk component, it has the merit of minimizing it. Of course, the discount rate has to be set correctly. If it is higher than what one can earn in alternative investments, the operator would have an incentive to stretch out the period of operation.

For an open access road where toll is not to be charged we need another mechanism. A road generates value. Usually

land prices go up. So one can offer a private builder vacant land that the public authority may have, to develop for profit in exchange for building the road/bridge/flyover. Bids may be invited for the amount of such land for development that the builder would like to have. The one who bids for the minimum amount of land gets the bid. If you do not have land, you can offer tradable right to build floor space index (FSI). For example, if an express-way is built to connect Vasai in the North to South Mumbai's business district, land prices in Vasai would go up. An accepted way is to tax landholders in Vasai with a betterment levy. However, the present land-owners may not have adequate resources to pay that levy and the levy that can be collected today may not be sufficient to cover the cost.

But the municipal corporation/government can increase the permissible buildable area by increasing floor space index, and retain the right to additional FSI with the corporation/government. This FSI can be auctioned off as and when needed to raise resources. This can also be offered to private builders of transport links so that they may finance it.

Telecommunication : This is one area in which we see considerable improvement in the quality and amount of service provided. Even then, this is only so when compared to situation that existed in India a few years ago. When compared to what exists elsewhere, the price Indian consumers pay is too high and the access and quality are too low.

The progress we have seen is the result of technological innovations which has destroyed the natural monopoly that a telephone network provided. The cellular phone revolution

has made it possible for a number of operators to provide service in the same area, each with a modest amount of initial investment. Thus, competitive pressures are generated. In addition, the e-mail, internet and internet-telephones have generated even more competition.

A second important technological factor is the revolution in communication technology. A single optical fibre can carry all of India's communication traffic, phones, televisions and data. Carrying capacity can be increased by changing endpoint equipment at relatively very small cost compared to the cost of laying cables. The result is that the marginal cost of telecommunication is almost zero.

In such a situation the economist's welfare maximizing solution is to require only a connection fee from the users with virtually no use charge.

Without fully appreciating the implications of technological change in this sector, we did take some steps to introduce private entry into this sector. Bids were invited to allocate different areas into country to operators to provide basic telephone service. One who offered to pay the highest license fee was to be awarded monopoly rights to operate. This was an attempt to capture all monopoly rent for the government.

There were two problems with this approach. One, the consumers still faced a monopoly and the mechanism is not likely to provide them cheapest telephone services. Two, those who offered to pay very high license fees got the contract (after some post-bid change in the rules of the game). Two years later, they are now asking for re-negotiation of the fees and the government has the difficult choice of

either renegotiation or taking them to courts and delaying expansion of telecom services.

If we realize the potential of real competition that the new technological developments provide, what we should do is complete deregulation. *Let any one enter who wants to provide service.*

The only scarce commodity is band-width which the government should lease out at modest, internationally comparable, rates.

Air Quality Markets: The quality of air in the Indian metropolises – Delhi, Mumbai and Calcutta – is very poor and is deteriorating rapidly. The level of suspended particulate matter (SPM) in Delhi is eight times the standards specified by the World Health Organisation (WHO). What is worse, the concentration level has increased by 40% in the last two years.

How can we control these in a cost-efficient way? The normal response of regulators is to impose emission standards on various polluters: factories, vehicles and commercial establishments. Yet, how does one fix these standards for different users?

A common practice is to use the standard that corresponds to the best available technology (BAT). There are many problems with this approach:

- Even when every polluter meets the emission standard, if the number of polluters is large enough, ambient air quality may be inadequate.
- Industry would always challenge the assumed BAT

standards. Industry always knows more than regulators about technology, but it would never reveal what it knows.

- Even if full information on BAT is available, it is not cost effective for all companies to follow it. A cost-effective solution, from the viewpoint of society at large, is one where the marginal cost of reducing emission by one unit is the same for all emitters.

An example will illustrate matters. Suppose there are two industries A and B. A emits 100 tonnes of pollution per year, and faces a cost of Rs. 1 crore per ton in order to obtain reductions. B emits 200 tonnes of pollution a year, but faces a cost of Rs. 5 crore per ton to obtain reductions. In this situation, it is best for society (which ultimately pays for pollution control) if A first implements pollution control.

Using Tradable Permits: A system of tradable emission rights would accomplish the task in a cost-efficient way, without the need for regulators to know the technical options available to various industries and the associated costs. Such a system would also reliably accomplish the desired ambient air quality.

Suppose we know that Mumbai air can absorb or dissipate 100 tonnes of a particular pollutant per year. The government would make a public issue of 100,000 permits, the ownership of each of which entitles the holder to issue 1 kg of pollutant in the year. These permits would trade on the secondary market just like shares.

The secondary market trading for the permits would make the prices sensitive to information about the industry

in real-time in a way which does not take place with fixed regulations.

Such schemes have been tried in some cities such as Los Angeles in the West, but with limited success. The main problem has been that secondary-market trading was not well developed, and transaction costs were large. The institutional arrangements which are used on stock markets in India can be easily re-deployed into these areas.

Monitoring and enforcement are the prerequisites for tradable permits to work. However, it should be pointed out that monitoring and enforcement are also required if *any kind of pollution control is to work. The only difference, with tradable permits, is that prices are more flexible, the total cost to society is lower, and adherence is obtained for scientific standards about the* total quantity of pollution that is tolerable.

Pollution Control at the Company Level: Regulators would no longer need to become knowledgeable about pollution control technology in different industries. These decisions would be made in a decentralised way by each company which is a polluter.

Each company would face a choice of (a) buying permits from the market and/or (b) installing pollution control equipment in order to avoid buying the permits. When it makes these choices, based on its own self-interest, it would compare (it's own) marginal cost of pollution control against the (common) price of the permits. On the margin these would be equal, thus ensuring economic efficiency. The total cost to society of obtaining the desired level of air quality would be minimised.

The Role for Derivatives: Since pollution control

equipment is long-lived, the companies making decisions about permits vs. equipment would be greatly assisted in their work by the existence of futures and options markets in the permits.

In markets with storable goods (e.g., wheat), futures markets assist market efficiency, but they do not completely reveal new information (the futures price is linked to the spot price by cost of carry). In contrast, pollution permits cannot be stored, and a market which trades pollution permits for the coming year reveals information to the economy which is just not revealed in the spot market for the permits. Of course, speculators can cause bubbles in markets and when markets are thin, large players can distort and exploit them. Yet, there are some natural constraints on markets for pollution permit. Polluter has an option to take abatement measures. The abatement cost, thus provides a ceiling on the market price.

How can such markets be monitored? Monitoring pollution is indeed a problem. However, this is a problem faced by any system that seeks to lower pollution. The monitoring requirements are no more for a market of tradable permits as for any other approach including command and control measures.

The futures market would also convey the future possibilities for permit prices to companies involved in research and production of pollution control equipment. If futures prices of permits were high, then the market would be sending out signals for enhanced research and manufacture of pollution control equipment.

Derivatives would also help in risk management. A

company which makes the bet of not installing pollution control equipment is at risk that the price of the permits may flare up next year. By purchasing the permits on a future date on the futures market, or by purchasing options to buy these permits, the company can protect itself against surprises. Conversely, a company which makes a bet by spending on research in pollution control suffers from the risk that permit prices might be lower in the future: it would benefit by being able to sell permits on the futures market, or by buying options to sell these permits on the options market.

A Global Market for Greenhouse Permits: This idea can be logically extended to the most serious global environmental problem facing us, namely that of climate change. A globally cost-effective way to deal with this is to issue each human being his share of the emission quota.

The global environment can absorb 5 billion tonnes of CO_2 in the atmosphere. Hence each individual on earth should be given a quota of 1 tonne of CO_2 per year. These permits can be made tradable.

The trading volume is expected to be very large, given the basic fact that individuals in the US emit more than 5 tonnes per person per year while those in India emit less than 0.3 tonnes per year.

The global carbon emission market would have permits for 5 billion tonnes of emission per year. The permits are estimated to cost between $20 to $200 per tonne. The capitalization is expected to be between $100 to $1000 billion per year.

Futures markets are also needed in order to help firms and individuals plan for the future.

Using Markets for Sustainable Forestry: Another example where financial markets can play an allocative role is in sustainable exploitation of forests. Today, a forest contractor has no incentives to nurture the forests assigned to him. He would like to fell it. The forest department is forced to micro-manage his actions, but the forest department officials are only human. Over the last 50 years, the area under *the forest department has risen, but the area under* forests has gone down.

The problem arises from the fact that ownership of the forest is not with the contractor. If forests were privatised, however, there is no guarantee that they would be maintained as forests. Even if the land contained trees, the private owner may prefer a commercial plantation with inferior bio-diversity.

One can think of giving our forests on long-lease to private firms with a stipulation that a forest of the same quality (as defined by some objective metrics about bio-mass, bio-diversity, etc.) will be returned in 15 years. The failure to do so would evoke substantial penalties. However, how would we ensure that the terminal conditions generate altered behaviour today? One way is to require that these leases are only given to joint-stock companies with shares which are meaningfully traded on the stock market.

The stock market would know that a large penalty awaits the company if the forest is not maintained in adherence of certain minimal standards. Security analysts today visit the plants of companies that they cover; it is not unreasonable

to think that they would visit the forests which are comparable productive assets. The stock market would do this monitoring in a more efficient and corruption-free fashion as compared with any bureaucratic organization.

Similarly, it is feasible for voluntary environmental groups to visit a given forest once in 15 years and verify the correct calculation of penalties. In contrast, it is infeasible for them to ensure the honest day to day micro-management by the forest department which is required to produce good behaviour on the part of forest contractors. Of course, markets are not a perfect and infallible monitoring instrument. Yet, they offer a much better chance of success than our current system of control by fallible human bureaucrats.

Markets for Urban Road Space: Traffic congestion in Mumbai worsens every day. City administrators have tried various ways to discourage cars. One approach is to use administrative fiat: e.g. use of cars on only alternate days (which generates incentives to own two cars, to switch license plates, etc). Entry permits are used in downtown Singapore with some success. However, the question of what is the fair price of these permits remains unanswered. Using modern electronics on the car coupled with the *open electronic limit order book market,* a superior market-based solution can be visualised:

- Permits would exist for each four-hour slot of the day and would be valid for a month.
- Each car would have a plastic card which obtains access at the few entry points into South Mumbai. A few minutes would be lost to each motorist in inserting the card and typing in a password, but many hours would be saved in

the decongested city. A more sophisticated set up would automatically read the car numbers and bill it every month as is done in New York city bridges with what is called EZ pass. The car does not stop but merely slows down at the gate.

- The government would do a primary market issue of the permits six months in the future. The permits would trade on the stock market. Car owners could either buy permits at the primary market or (through brokerage firms) on the secondary market. When a person "takes delivery" of the permit (whether on the primary or secondary market) his card would get replenished with the required permissions. This is not unlike the electronic settlement which takes place with the depository.

- If a person appears at the gate with a plastic card which has not been enabled with a permit, the human attendant at the gate would require him to pay cash equivalent io 50% or more than the current secondary market price of the permit.

More automated systems can simplify and streamline the operations of the car at the gate; however the main point here is that such a system is remarkably simple in implementation and yields the most economically efficient solution to congestion in cities.

The revenues thus raised would yield data to the government about the extent to which citizens value road transport. This information, coupled with futures prices, would guide future investments into roadways. The role for regulation in such a system would be to ensure that government does not auction 'too few' permits in an attempt

to maximise revenues: the number of permits sold should be consistent with an engineering understanding of how much traffic the city can bear.

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"People must come to accept private enterprise not as a necessary evil, but as an affirmative good".

– **Eugene Black**

616

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