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Transporting India to the 2030s: What do we need to do?

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Transporting India to the 2030s: What do we need to do?

RAKESH MOHAN



Key Findings

- India's transport growth trends suggest that share of railways in freight traffic has fallen from 90% in 1951 to 30% in 2010, annual deaths on roads have increased by 350% and domestic air passengers have gone up by 800% between 1991 and 2011.
- Though there has been road capacity improvement with the Golden Quadrilateral, East-West and North-South highways and transformations in civil aviation, more work is needed to create efficient port structures, reliable urban transport and large capacity railways.
- Achieving the target of 7% growth in the 12th Five Year Plan, followed by 9% till 2032 requires a seven-fold increase in transport investment from the 11th Plan to the 15th Plan.
- Urgent action is required to ensure that India's transport infrastructure can service the increasing needs for the movement of bulk energy commodities for the envisaged growth rates.

I. Introduction

The focus of this paper is on the transportation needs of the country over the next couple of decades, and what we need to do to satisfy them. This might seem to be a relatively narrow area of policy to address but, as will become clearer, if we do not make transport investments in the right manner, it will be difficult to achieve the kind of growth rates, around 7-9 per cent per year, that India should aspire to in order to reach middle income level by the early to mid 2030s, and to have any chance of eliminating poverty by then.

People of all ages use transport in their daily lives: for work, for leisure, for school, for fulfilling personal needs and for business requirements. The transport of both passengers and goods is essential for the functioning of any economy. Transport connects producers and consumers. As an economy becomes more complex, the transport needs become correspondingly more demanding. Furthermore, with the emergence of complex supply chains for almost all products—food supplies as well as manufactured goods—the need for sophisticated transport systems has become as important to the farmer as it is for a multinational company. The challenge for India is how we can generate a transport system that is efficient and reliable, but is also affordable and accessible for all. Given our energy dependency, energy efficiency is of the utmost importance in designing the Indian transport system. With transport emissions being key contributors to climate change and urban air pollution, this is another area of concern. As speeds have increased, and poised to increase further, fatalities and injuries have increased exponentially in the transport system, causing extreme levels of human suffering as also high economic costs to the system.

II. Trends in Growth of Transport

The daily experience of travelling in India, and the time taken for most freight transport, makes it evident that India's transport networks are severely constrained.

Since independence, the growth in freight transport has been broadly consistent with that of overall GDP, and particularly that of industrial growth. The elasticity of demand with respect to GDP has been near unity, if not slightly higher than that. Extrapolation of demand on a similar basis would suggest that if GDP grows at about 7 per cent a year, and freight transport demand grows accordingly, we can expect such demand to quadruple by the mid 2030s. If indeed the economy does grow faster as it did during the 2003-2012 period, such demand could be significantly higher—freight transport might grow by a factor of 6.

Moreover, if the "Make in India" campaign does catch on and we do succeed in increasing the weight of manufacturing in the economy, the growth in freight traffic can be expected to accelerate further. With railways' capacity expansion having been constrained over the whole period, there has been a consistent loss in the railways' share in freight traffic. It fell from about 90 per cent in 1951 to about 65 per cent by 1980, and further to about 30 per cent by 2010. The share of roads in freight traffic has, therefore, grown correspondingly. The railways have got increasingly specialised over the years in the transportation of bulk commodities like coal, iron ore, fertilizers, cement and food grains, though here also roads are beginning to increase their share. The traffic in industrial goods is being carried almost entirely by roads now. Such a pattern is not healthy from both the energy security and environmental point of view. The railways are clearly more energy efficient and less polluting than comparable road traffic.

The fall in passenger traffic share of the railways has been even more dramatic over time. The elasticity of demand of passenger traffic with respect to GDP has varied between 1.4 and 1.8 over the different decades since Independence, with the average being around 1.6 to 1.7. Once again, with the railways being capacity constrained, the long term elasticity for road passenger traffic comes out to be about 2.0, and for railways at about 0.9, though there has been some acceleration in recent years. Thus, passenger traffic growth in the railways has not even kept up with GDP growth: hence the daily experience of overcrowded trains and non-availability of reservations on a regular basis. The share of railways in passenger traffic was around 70 per cent in 1951; it fell to about half, 35 per cent by 1971, 22 per cent in 1991 and just about 10 per cent by 2011.



SHARE OF RAILWAYS IN PASSENGER TRAFFIC

With the expectation of passenger traffic growing at almost double the rate of GDP, it may grow in excess of 15 per cent per year over the next couple of decades, which implies that total passenger traffic might increase by a factor of more than 15 over this period. So, even if the railways accelerate their capacity expansion for passenger traffic significantly, they will keep losing their share to roads, and to air traffic for longer distances.

The relative loss of the railways in both passenger and freight traffic is understandable given the relative under-investment in recent years. It is interesting to note that the share of transport in total public sector investment has been relatively constant at around 13-15 per cent of the total: except that it was increased to about 17 per cent in the Fifth Five Year Plan. Until the mid-1990s, that is, till the Eighth Five Year Plan, the railways' share was consistently between 45 to 50 per cent, with a peak of 56 per cent in the Seventh Plan. However, since the mid 1990s, their share has fallen successively to 38, 36 and 30 per cent in the Ninth, Tenth and Eleventh plans, respectively. The roads' share has growth correspondingly from around 20-30 per cent till the mid-1990s to 45-55 per cent since then—consistently and significantly higher than the railways'.



The increase in road investment has taken place because of the two transformational initiatives taken by the previous NDA government of Prime Minister Vajpayee: the National Highway Development Project and the Prime Minister's Gram Sadak Yojana (PMGSY). The distinguishing feature of both these initiatives was that they were national in scope with the broad features of both the programmes being outlined ab initio—just as the original design of the US interstate highway system was in the late 1950s under the Eisenhower administration. Consequently, the acceleration of traffic growth on roads during this period is quite noticeable, as is the growth in motor vehicles—private motor vehicles as well as commercial vehicles.

This continuous erosion in traffic share of the railways is not healthy from a number of viewpoints. It is energy inefficient, with the railways being far more energy efficient on a like

to like basis as compared with road transport. With India being a net energy importer it is also undesirable for energy security considerations. Increasing pollution from motor vehicles is raising environmental and health concerns. The explosive increase in annual deaths, from around 40,000 in 1991 to almost 140,000 by 2011, and injuries from road transport is causing immense human hardship, apart from raising economic costs. More people die of road accidents in India than due to stroke or diabetes, and more than 1500 are disabled every day. Finally, increasing emissions from motor vehicles are also a climate change concern. A key transport policy objective for the future must therefore be to reorient traffic from roads to railways.



ANNUAL DEATHS FROM ROAD TRANSPORT

The lesson for the future is, therefore, clear: there needs to be a transformational initiative, similar in scope to the NHDP and the PMGSY, significantly enhancing public investment for capacity expansion of the railways. Some are also arguing that much greater investment should be made in inland waterways as freight traffic would be much more energy efficient in that mode. This is simply impractical in India except for the North East, and in the use of coastal traffic. Our rivers are essentially monsoon fed and hence seasonal. They simply do not have the draft necessary for reliable transportation on a year round basis. Expending policy focus and investment in this area would simply be a distraction.

The approach has to be much more systematic than has been the experience in transport planning so far, particularly in the railways. Just as the NHDP and PMGSY had a 20-year perspective when they were initiated, the railways now need a similar 20-year horizon in the planning framework. It is a pity that just when the railways need such a framework we have dropped the concept of planning from our development lexicon. The point to point convenience of carrying freight by truck is hard to beat. It is only if there is seamless transfer from truck to rail, or ship, or air, and back to truck can there be any chance of rail freight traffic regaining any share. Thus, future planning for transport has to be long-term, comprehensive and integrated, encompassing rail, road, ports and airports and logistics. The project centric and Passenger traffic by air is beginning to become significant for longer distances and higher fare

paying passengers. This trend accelerated in the 2000s with the partial deregulation of airlines, and the introduction of budget carriers. Although the sector is currently undergoing some restructuring, the future potential of large increases in traffic remains high. Domestic passenger traffic increased from about 7.5 million in 1990-91 to about 60 million in 2011-12. Observing the air traffic levels that have already been achieved in China, it is quite likely that domestic passenger traffic could be in around 300 to 400 million by the early 2030s. According to the International Air Transport Association, domestic traffic in China was already in excess of 350 million in 2014. International traffic could grow in a similar fashion from the current 40 million or so to over 200 million over the same period. With such large increases in the offing, the need for very significant and timely investments in airports, air traffic control, safety, and associated infrastructure is clear. There is also need for modernisation and reorganisation of the regulatory institutions that govern air traffic.

III. Investment for Growing Transport Needs

I have sketched a broad idea of the kind of growth in transport that can be expected if the country is to achieve sustained annual growth of around 7-9 per cent over the next couple of decades. It is important to understand that, while transport investment is a response to emerging demand, it is also an economic growth driver itself. In fact, in the absence of key transport investments economic growth at the rate envisaged just cannot fructify: for example, trade growth cannot take place without corresponding investment in ports; coal based power production cannot grow without the availability of rail based transport systems to carry coal from the mines or ports, to the power stations.

In other areas, inefficient and inadequate transport availability hinders the attainment of efficient production capacities that are internationally competitive. In a continental economy such as India's, both inland and international transport costs have to be minimised for its agricultural and manufacturing goods to be competitive in world markets. East Asian manufacturing capacity has become globally competitive on the basis of efficient transport provision and logistics expertise. But it is notable that much of the East Asian production capacity is based in or near the coastal regions. This is an additional challenge for India: its inland manufacturing capacity, which is considerable, is handicapped because the transport system is neither efficient nor cost competitive. The current "Make in India" campaign is unlikely to make much headway even in the medium term if focused attention is not given to making coordinated investments in transport infrastructure, and particularly for efficient freight traffic in the railways.

What then would be the broad parameters for investment in transport? In our work in the National Transport Development Policy Committee, we arrived at our estimates from two parallel approaches: a top down model based macroeconomic approach, and bottom up sectoral estimates based on informed projections by domain experts. We found reasonable correspondence between the two approaches for the initial 10 years, but significant divergence as we went further out. Interestingly, it seems that domain experts simply could not imagine the magnitude of demand increase, and hence in the investment required beyond 10 years or so: thus the top down estimates for the outer years of the two-decade projection horizon were higher than the bottom up estimates.

India recorded a per capita GDP of about Rs.75, 000 (US\$ 1550) and overall GDP of Rs 90 trillion (US\$ 1.9 trillion) in 2011-12, the terminal year of Twelfth Five Year Plan. If per capita income grows on a consistent basis at an annual rate of around 7 per cent, (GDP growth in excess of 8 per cent), it would double every 10 years, and grow by a factor of 4 by the early 2030s—to about US\$ 6000-6500 (2011-12 prices), and GDP would reach a level of about US\$ 9 trillion, levels that have already been reached by China. Thus, achieving such growth should be our minimum level of aspiration. But is it feasible? Annual growth in Indian GDP increased from about 3- 3.5 per cent during 1950-1980, to about 6-6.5 per cent during 1980-2010: we need another phase of acceleration to about 8-9 per cent over the next couple of decades.

What would be the implications for investment in the economy if such growth rates are to be achieved? We have already experienced such growth in the 2003-12 period. Gross Domestic Capital Formation (GDCF) levels were in the range of 35-38 per cent during this period, with corresponding domestic savings rates, supplemented by sustainable modest external savings of

about 1-2 per cent of GDP. Enhancement in savings was achieved in all the sectors: households, private corporate sector, public sector and government itself. This was achieved in the presence of broad macroeconomic stability: falling fiscal deficits, low inflation, financial stability, modest and stable current account deficits. Corporate savings and investments were fuelled by the reduction in crowding out by the public sector, low interest rates and increased profitability. For similar growth to be achieved on a consistent basis over the next couple of decades, similar macroeconomic pre-conditions will have to be maintained on an extended basis: We cannot afford the interregnum experienced during 2013-2015, when domestic savings fell to around 33 percent and GDCF to less than 35 percent. This is just a necessary condition, not a sufficient one. Beyond this minimum, investment has to be stepped up again in a purposive fashion in both the public and private sectors, with a certain emphasis on infrastructure broadly and on transport in particular.

The systematic projections made by the NTDPC suggest that the overall GDCF needs to increase from the current level of about 33-35 per cent of GDP to approach 40 per cent by the late 2020s and early 2030s. Correspondingly total infrastructure investments will need to increase from 5.8 per cent of GDP achieved in the Eleventh Five Year Plan (2007-2012) to about 8 per cent over the next three or four quinquennial periods, up to the early to mid 2030s. At this rate, total infrastructure investment would have to rise from about Rs 25 trillion (US\$ 425 billion) in the Eleventh Five Year Plan to about Rs 70 trillion (US\$ 1.25 trillion), Rs 100 trillion (US\$ 1.9 trillion) and Rs 150 trillion (US\$ 2.9 trillion) in the following quinquennial periods starting 2017 (all at 2012-13 prices). The corresponding investment in transport is envisaged to be about 3.7 per cent of GDP, 45 per cent of total infrastructure investment—up from about 2.7 per cent in the Eleventh Five Year plan (2007-2012). To achieve this, there will be a need to increase both public and private sector investment in transport.

Whereas the NTDPC projected increasing proportions of private investment in infrastructurefrom under 40 per cent of the total in the Eleventh Plan period to around 45 per cent in the late 2020s and early 2030s, there is need for tempering these expectations along with corresponding increases in public investment-which will have associated fiscal implications. The private sector share in roads investment was estimated at around 15 per cent in the later years in the Eleventh Plan: this was projected to increase to 25-30 per cent in succeeding quinquennial periods. In view of the various difficulties encountered in implementation of the public-private partnership (PPP) model, these expectations were too high, and certainly much higher than experienced in other countries. One consequence of the excess reliance on private investment in infrastructure that was attempted during this period is the emergence of stressed balance sheets of large private sector infrastructure firms and their reflection in non-performing assets (NPAs) of mainly public sector banks, which has now put overall economic growth at risk in the Indian economy. Furthermore, as the initial investments are made in the segments with the heaviest traffic, and as the roll out of highways extends to segments with less heavy traffic, there would, in any case, be reduced opportunities for realistic profitable private investment in the coming years. This again points to an enhanced role for public sector investment in transport infrastructure in the coming years, and the existence of adequate institutions and frameworks to make it happen in an efficient manner.

We need to understand that PPP or any other form of private involvement in large projects needs intelligent technical oversight from the government entities that award these projects. Furthermore, public sector managers who initiate these projects need to have the capability for innovation and knowledge of the use of latest techniques so that the private sector bidders are induced to adopt international best practice. So the increased participation of the private sector in infrastructure projects on their own, or in a PPP framework, does not obviate the need for the government and its public sector entities to acquire adequate expertise in all the areas connected with implementation of infrastructure investment. We need to have a clearer appreciation of the transport sectors that are more amenable to providing pecuniary returns to private investment and which are not. The key of course is the ability to levy user charges in the form of tolls, fees and the like, and the ability to exclude those who do not pay, or are not able to pay.

The key departure made by the NTDPC is in its strategy for much enhanced investment in the railways. There has been a very significant step up in public investment in roads from about 0.4 per cent of GDP up to the late 1990s to about 1.0-1.2 per cent in recent years, while investment in the railways has stagnated at around 0.4 per cent. The kind of traffic expansion that is required in freight haulage for a growing economy suggests a similar increase in annual railways investment to about 1.0 to 1.2 per cent of GDP on a sustained basis over the couple of decades. Only then can there be any reversal of the eroding railway share in freight traffic. There are some encouraging signs that there is a higher degree of realisation of the necessity of such a step up: witness the announced investment of Rs 100,000 crore for 2015-16 and Rs 120,000 crore for 2016-17 and Rs 850,000 crore for the 5 year period 2015-20, compared with only Rs 66,000 crore for 2014-15. If investments of such magnitudes do fructify they would be consistent with the kind of railways investment that we had recommended.

The implication of NTDPC's strategy is for total public investment in transport to increase from about 1.8 per cent of GDP in the Eleventh Plan to about 2.0-2.2 per cent over the next couple of decades, while private investment increases from 1 per cent in the Eleventh Plan to 1.3-1.6 per cent over the same period. Given the public investment requirements of the railways, and reduced private sector expectations in roads, total public investment in transport may need to be in the range of 2.2 to 2.5 per cent, with corresponding reduction in private investment. Such an increase in public investment can only be done if there is a corresponding increase in revenues and reduction in unnecessary current expenditures, particularly on non merit subsidies.

The achievement of such a strategy requires making strategic decisions in terms of relative allocation of resources between rail and road, accompanying pricing and taxation policies, and regulatory and organisational reforms, which can then be used to nudge transport demand toward the desired modal shares.

The detailed examination made by the NTDPC of needed investment in the railways gives primacy to investment in the Dedicated Freight Corridors (DFCs) and their continued expansion throughout the next two decades. Implementation of the Eastern and Western DFCs is well underway and we can expect their completion by 2019-2020. In a welcome mention in this year's budget speech the Railways Minister announced plans for three new DFCs: North-South from Delhi to Chennai, East-West from Kharagpur to Mumbai, and along the East Coast from Kharagpur to Vijaywada. If these plans are put in motion in real earnest the transportation map of the country will have been transformed by 2030.

As all the freight traffic on the main trunk routes gets diverted to these freight corridors, the capacity for passenger traffic will increase manifold. Moreover passenger train traffic speeds can be increased to a range of 150 to 200 km per hour on all these trunk routes benefitting the whole country. There will also be need for corresponding replacement of the existing antiquated rolling stock with modern wagons for freight as well as passenger coaches, along with significant modernization of the existing track and signalling infrastructure to enable higher speeds across the system, which will then be exclusively devoted to passenger traffic. These investments are essential if adequate transport facilities are provided for the emerging needs of the growing economy. These investment projections do not include wasteful very capital intensive projects such as high speed rail transport that are receiving much current attention: given the other needs it would be a mistake to divert attention to such prestige projects at the present time. Indeed, the diversion in attention would detract from the essential investments needed for transformation of the whole transport system. As the DFCs become operational so will a "Manufacturing India".

IV. Need for a Coherent Integrated Strategy

Much of transport planning and programming in India has been project centric, and has largely been done in silos, despite the existence of the Planning Commission. There has been little coordination across modes, thus making the system less efficient than it could be. Moreover, with the emerging needs for a modernized integrated logistical system that enables efficient and smooth inter-model transfers that are the most economical, there is now a clear need for an integrated system based approach.

At present, decisions on investments in highways and expressways on the one hand, and potential DFCs and even possible high speed trains are made in isolation of each other. Similarly, particularly from the freight point of view, investment decisions on ports are also not as closely coordinated with corresponding investments in inland connectivity by rail or road. A specific issue that best illustrates this problem is the transportation of what may be termed as energy commodities. The elasticity of demand for power with respect to GDP growth is around unity. Thus if we expect GDP to grow by a factor of around four over the next couple of decades, so will the demand for power. Given the dominance of coal as fuel for Indian power production, and even accounting for significant substitution by other energy sources, including renewable energy, the power sector demand for coal is likely to increase by a factor of around 2.7-2.8 over this period. It is expected that, at best, domestic coal production could increase about 2.5 times, from about 440 MT in 2011-12 to about 1110 MT over the next twenty years; imported coal may then have to increase by a factor of five from about 70 MT in 2011-12 to about 350 MT over the same period.

Similarly, just as has been experienced by China, the intensity of steel use can be expected to increase continuously in a growing modernizing economy aspiring to middle income status, particularly as industrialization and urbanization accelerates. The demand for steel is therefore expected to grow seven fold from around 70 MT in 2011-12 to almost 500 MT over 20 years: Chinese production in the last few years has been in excess of 800 million tones. Each ton of finished steel requires three to four tones of raw material, thus the transport requirements of the steel industry will be almost double that of coal.

There will also be a corresponding demand growth for petroleum energy resources, most of which will continue to be imported, combining the increasing demand for coal imports, petroleum and petroleum products, and steel related products, along with other containerised goods for export and import, the need for investment in a couple of mega ports on both coasts becomes clear. The Finance Minister's budget speech this year featured an intention to invest in one new greenfield port on each coast, but there is no clarity whether the intention is to set these up as mega ports.

The Indian transport system for bulk commodities is already heavily congested. A rail route is generally considered congested when capacity utilization exceeds 80 per cent. At present, almost all the major trunk routes over which such bulk commodities are transported are already operating at over 100 percent capacity: hence the frequent build up of coal stocks at pit heads and problems in coal linkages for power stations. Economic growth at the enhanced level envisaged simply cannot take place unless there is the kind of systemic and accelerated investment in railways emphasised.

This example illustrates the need for coordinated investment programming, encompassing both the public and private sectors, in power capacity, ports, railways, highways and pipelines. In order to avoid emerging bottlenecks it is essential in these areas to have appropriate time sequencing in each of these segments. Moreover, given the long time lays inherent in such large projects: rail tracks, large ports, pipelines, and highways, the need for integrated planning and programming becomes clear.

V. Governing Transport Development

How should this be done? Where do we go from here? It is clear that, despite the apparatus that India has had for planning for 65 years, the institutional framework for formulation of transport policy, planning and coordination is very weak. Now that this system is itself being overhauled with the abolition of the Planning Commission and formation of NITI Aayog, it is an opportune time to set up a technically competent system that is capable of addressing the increasingly complex transport needs of a growing economy that is continental in size and approaching middle income levels.

It is first necessary to recognise that the existing system is simply inadequate at all levels: centre, states and city. Whereas there is a general belief that India has highly technically competent professionals in all spheres, the reality in transport is that the country is bereft of expertise. Although the Planning Commission has had a specific Division responsible for transport for a very long time, it has little expertise and has always been small in size. Consequently, the Planning Commission appointed a "National Transport Policy Committee" at a high level around 1980 to formulate long term policy, and then again the NTDPC thirty years later in 2010. But there is little evidence of the government even having the capacity to process these reports in an integrated manner, let alone implement them. Integrated transport policy making is rendered that much more difficult with the existence of different ministries for each mode: roads, railways, ports and shipping, civil aviation and urban transport, with none really responsible for logistics and inter modal transport. It might have been expected that the lack of expertise in the Planning Commission could have been compensated by the ministries, but they also do not have such technical capacity, and are staffed by generalists with short tenures at the leadership level. Given the current Indian administrative governance system, senior officials, while being competent generalists, do not possess domain knowledge of the ministries that they are appointed to. They are essentially birds of passage. The situation at the state and city levels just gets worse.

For these considerations, it is necessary to set up coordinating policy and planning institutions with the requisite technical expertise. The NTDPC has proposed that a high-level "Office for Transport Strategy" be set up at both the central level and in each state to formulate integrated transport strategies, policies and programmes. "The OTS must have the resources to build a strong technical team, aggregate, manage and analyse transport data, and be able to assert itself as a compelling advocate of policies that leverage transport for development goals". Such a proposed OTS should be set up as an independent agency, but associated with the NITI Aayog. An institutional structure would have to be organised so that the proposed OTS is enabled to work with existing ministries and implementing agencies and NITI Aayog. Similar institutions should be set up in each state. At the city level, metropolitan urban transport authorities (MUTAs) need to be formed to plan and implement transport systems for the burgeoning needs of the expanding metropolitan cities in the country.

These institutions should be visibly technocratic, and be of adequate size. The European Commission, for example, has more than 2000 professional staff in its mobility and transport unit; and the US Department of Transportation has as many as 60,000 professionals. If this situation is to be addressed, and if we are to indeed contemplate technical staffed institutions at all levels, the country will need a greatly enhanced number of transport professionals,

researchers and educators in all fields of transport. India does not have any institutions in the governmental system, universities, or even standalone institutions that compare favourably with those in peer countries. So the country fares poorly in terms of knowledge production in comparison with peers such as China and Brazil. As an example, even the RDSO, as a dedicated research and standards organization of the Indian Railways, is staffed with regular railways staff rather than technical experts: it has few, if any PhDs on its staff. The situation is similar, if not worse, in other sectors.

This situation has to be addressed with some urgency if the challenges outlined in this paper, and in greater detail in NTDPC Report, are to be addressed over the coming years. Institutions take time to get built, as does the production of expertise. The NTDPC has suggested that just one per cent of investment in each sector be earmarked for institution and capacity building and these resources be channelled in a purposive manner for this end.

It will then become possible to set up the kind of planning, policy and strategy institution that are necessary for transporting India to 2032. If such an approach is not taken, and if there isn't the kind of step up in transport investment suggested, there is little chance for India to grow sustainably to middle income levels.

The Author



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Prior to joining Brookings India, Rakesh Mohan was Executive Director at the International Monetary Fund, Washington, D.C., representing India, Sri Lanka, Bangladesh and Bhutan. Till early 2014, he was also Chairman, National Transport Development Policy Committee, Government of India, in the rank of a Minister of State. Previously, Dr Mohan has held the positions of Deputy Governor of the Reserve Bank of India; Secretary, Department of Economic Affairs, Ministry of Finance, Government of India; and several key positions in Government of India including Chief Economic Advisor, Ministry of Finance, in 2001-02. Between January, 2010 and October, 2012, Dr Mohan was Senior Advisor to the McKinsey Global Institute and member of the Advisory Committee to the Competition Commission of India.

Dr. Mohan has researched extensively in the areas of economic reforms and liberalisation, industrial economics, urban economics, infrastructure studies, economic regulation, monetary policy and the financial sector. He is the author of three books on urban economics and urban development, co-author of one and editor of another on Indian economic policy reforms, and author of two books on monetary policy and central banking and of numerous articles.

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