UNCTAD/LDC/2006

UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT
Geneva

THE LEAST DEVELOPED COUNTRIES REPORT, 2006

PART II, Chapter 5

UNITED NATIONS
New York and Geneva, 2006

The Infrastructure Divide

Chapter 5

A. Introduction

Poor physical infrastructure is a major constraint on faster economic growth, substantial poverty reduction and the development of productive capacities in the LDCs. Physical infrastructure encompasses a diverse range of structures, equipment and facilities, including the following: power, plants, transmission lines and distribution lines; telephone exchanges, telephone lines and transmitting facilities for mobile phones; roads, railways, bridges, harbours and airports; dams, reservoirs, water pipes, water treatment plants and sewers; and garbage dumps and incinerators for solid waste collection and disposal. The mere existence of these structures and facilities does not bring economic benefits or contribute to human welfare. But the services made possible by the stock of physical infrastructure increase the productivity of other productive resources (land, machinery and equipment, and labour) and are essential for the exercise of entrepreneurial capabilities and the development of production linkages. They contribute to increasing enterprise-level productivity and profitability by reducing input costs, removing supply bottlenecks which lead to capacity underutilization and augmenting the productivity of other factors of production. Infrastructure investment can also play a catalytic role in crowding in investments in directly productive activities because it opens up new investment opportunities for entrepreneurs. Infrastructure services can also contribute to household welfare (for example, through releasing time previously spent in fetching water) and enhance access to schools, health centres and jobs.

Poor physical infrastructure is a major constraint on faster economic growth, substantial poverty reduction and the development of productive capacities in the LDCs.

New infrastructure investment has some immediate beneficial effects by creating demand for labour and construction materials. But the major positive effects of such investment on enterprise performance often take longer and are not automatic. They depend firstly on the efficient operation of physical facilities and their maintenance. Furthermore, the beneficial effects of infrastructure will not occur automatically if there are other strong constraints on firm-level investment and profitability. The services generated by new infrastructure will not have positive effects on productivity and investment if domestic entrepreneurship is oriented to unproductive activities; if institutions, particularly financial and knowledge systems, constrain investment and innovation; or if the demand stimulus which animates investment in general is weak. Infrastructure services will also not have positive effects if the financing of investment in physical infrastructure facilities or the provision of infrastructure services is done in such a way that it causes macroeconomic instability or limits the availability of financial capital for the private sector, or undermines private sector incentives. Investment in physical infrastructure should thus be seen as part of a wider package of policy measures to develop productive capacities within LDCs. It is a necessary basis for developing modern production within a global economy. But it is not sufficient for that.

Investment in physical infrastructure should be seen as a part of a wider package of policy measures to develop productive capacities within LDCs.

This chapter discusses three types of physical infrastructure which are critical for economic growth, structural change, better trade integration and more productive employment within the LDCs — namely, transport, energy and telecommunications. It focuses on the physical facilities rather than the organization of infrastructure services. Although the latter issue is vital for realizing the benefits of infrastructure investment, infrastructure services simply cannot exist without the physical facilities.

The chapter is divided into three major sections. Section B provides an overview of the level and trends in the infrastructure stock in the LDCs. Section C focuses on trends in infrastructure financing, including trends in public investment, ODA and private investment. Section D completes the analysis by examining the mechanisms through which increased public investment and ODA in infrastructure can support the further development of productive capacities in the LDCs. It examines rural infrastructure, large-scale national infrastructure and cross-border infrastructure, and includes discussion of the links between infrastructure investment and international trade. Section E summarizes the main points of the chapter.

B. Physical infrastructure in LDCs: Current status and recent trends

1. The magnitude of the infrastructure divide

Available data on transport, energy and telecommunications indicate that most of the LDCs have the worst stock of physical infrastructure in the world.

The world's infrastructure stock has been valued at about $15 trillion. Of this total, about 60 per cent is in high-income countries, 28 per cent in middle-income countries and 13 per cent in low-income countries. (Fay and Yepes, 2003) There are no estimates of the proportion of the world's infrastructure stock in the LDCs. But available data on transport, energy and telecommunications indicate that most of the LDCs have the worst stock of physical infrastructure in the world.

Chart 37 shows the latest available data for some basic indicators of provision of transport, telecommunications and energy infrastructure. It shows that:

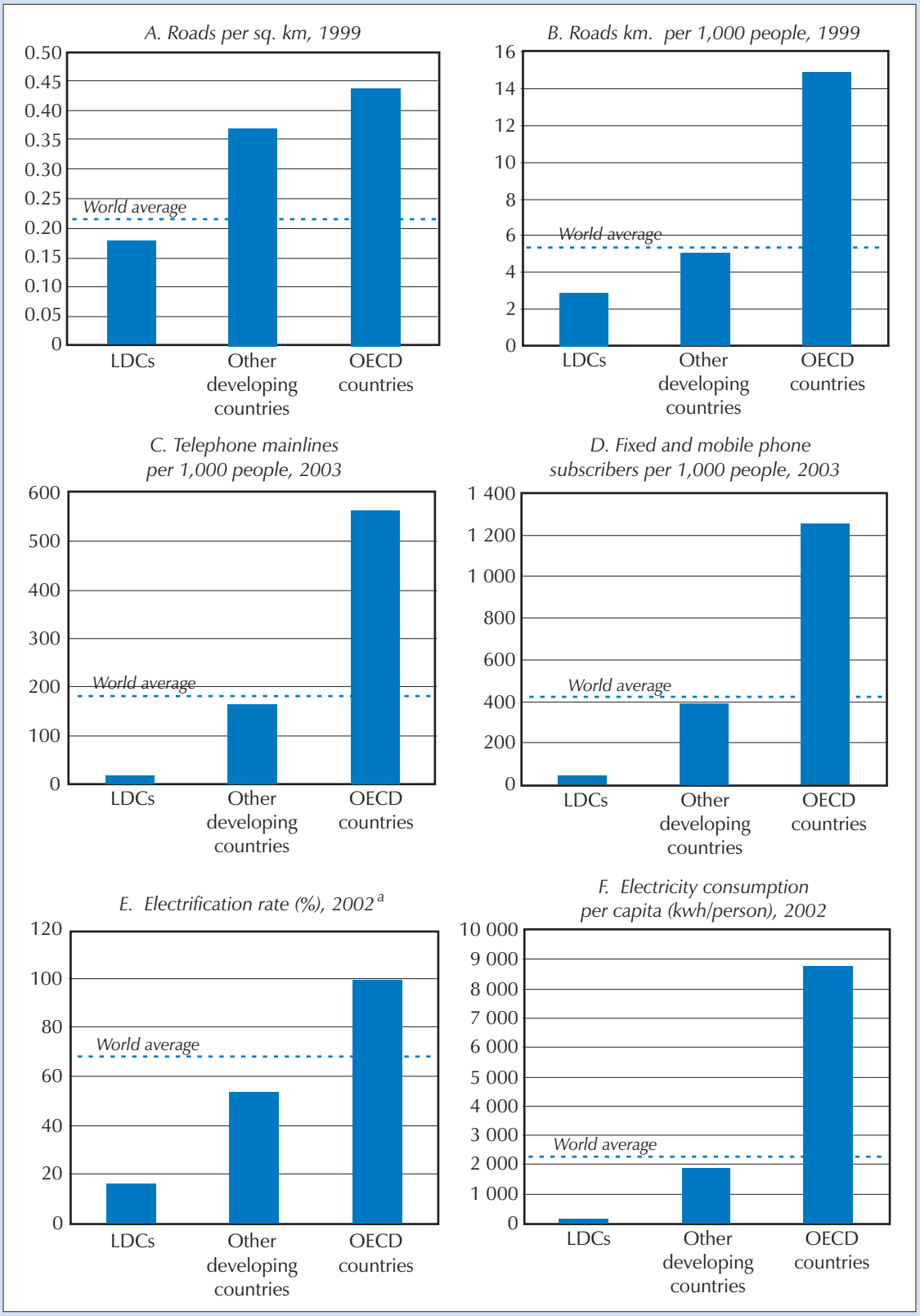
- In 1999, the length of roads per square kilometre and per capita were about half the level in other developing countries and the per capita road stock was one fifth of the level in OECD countries.
- In 2003, telephone mainlines and fixed and mobile phones per 1,000 people were 11 per cent of their level in other developing countries and 3 per cent of their level in OECD countries.
- In 2002, electricity consumption per capita in the LDCs was 7 per cent of the level in other developing countries, and 1.6 per cent of the level in OECD countries. Only 16 per cent of the LDC population are estimated to have had access to electricity in that year, compared with 53 per cent in other developing countries and 99 per cent in OECD countries.

The quantity of investment in infrastructure facilities is the lowest in the LDCs, and the quality of infrastructure services is the poorest.

Not only is the quantity of investment in infrastructure facilities lowest in the LDCs, but also the quality of infrastructure services is the poorest. As chart 38 shows:

- In 1999, only 22 per cent of LDC roads were paved compared with 43 per cent in other developing countries and 88 per cent in OECD countries.
- In 2003, there were 65 telephone faults reported for every 100 telephone mainlines, twice the level in other developing countries and 8 times the level in OECD countries.
- In 2003, the cost of Internet access per month was almost 3 times the monthly GNI per capita in the LDCs compared with one third of monthly

CHART 37. SELECTED INDICATORS OF AVAILABILITY OF TRANSPORT, TELECOMMUNICATION AND ENERGY INFRASTRUCTURE IN LDCs, OTHER DEVELOPING COUNTRIES AND OECD COUNTRIES

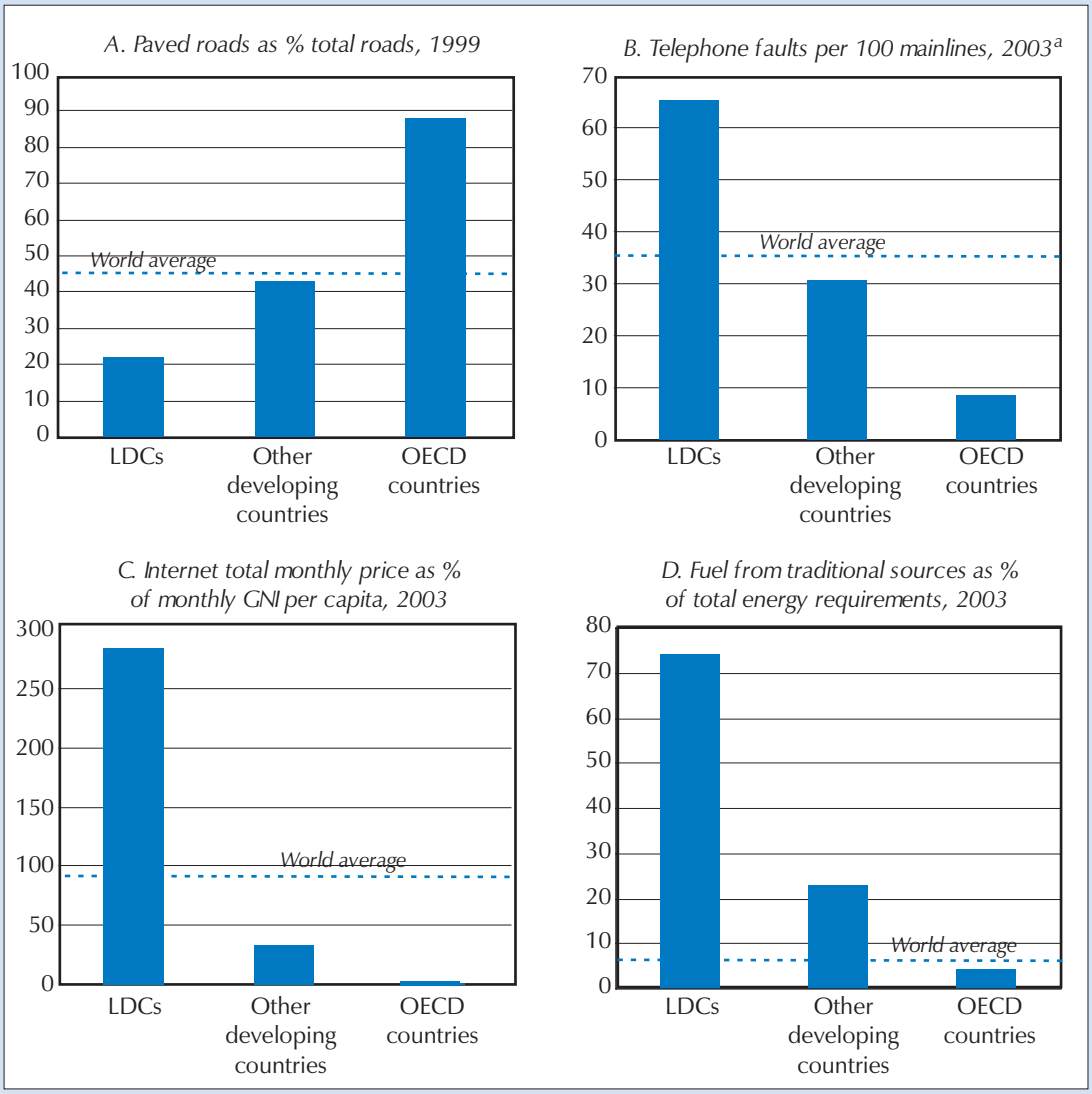


Source: UNCTAD secretariat estimates based on World Bank, *World Development Indicators 2005*, CD-ROM; IEA, *World Energy Outlook 2004*, CD-ROM.

Note: Averages are simple averages.

a Electrification rate is defined as the percentage of the population with access to electricity.

CHART 38. SELECTED INDICATORS OF THE QUALITY OF TRANSPORT, TELECOMMUNICATION AND ENERGY INFRASTRUCTURE IN LDCs, OTHER DEVELOPING COUNTRIES AND OECD COUNTRIES



Source UNCTAD secretariat estimates based on World Bank, *World Development Indicators 2005*, CD-ROM.

Note: Averages are simple averages.

a Defined as the number of reported faults per 100 mainlines.

74 per cent of total energy requirements were met by traditional sources and 20 per cent of total electricity output in the LDCs was lost in transmission and distribution.

GNI per capita in other developing countries and just one per cent of monthly GNI per capita in OECD countries.

- Within the LDCs, 74 per cent of total energy requirements were met by traditional sources (charcoal and firewood) rather than coal, oil, gas and electricity as compared with 23 per cent in other developing countries and 4 per cent in OECD countries.

Data available for 14 LDCs also show that on average, in the period 1999–2001, 20 per cent of total electricity output in the LDCs was lost in transmission and distribution, compared with 13 per cent in low- and middle-income countries and 6 per cent in OECD countries.

Chart 39 shows the nature of the infrastructure divide between LDCs and other developing countries. Using various indicators it ranks all developing countries, including the LDCs, from those with the best infrastructure to those

CHART 39. RANKING OF DEVELOPING COUNTRIES[a] ACCORDING TO THEIR INFRASTRUCTURE PROVISIONS

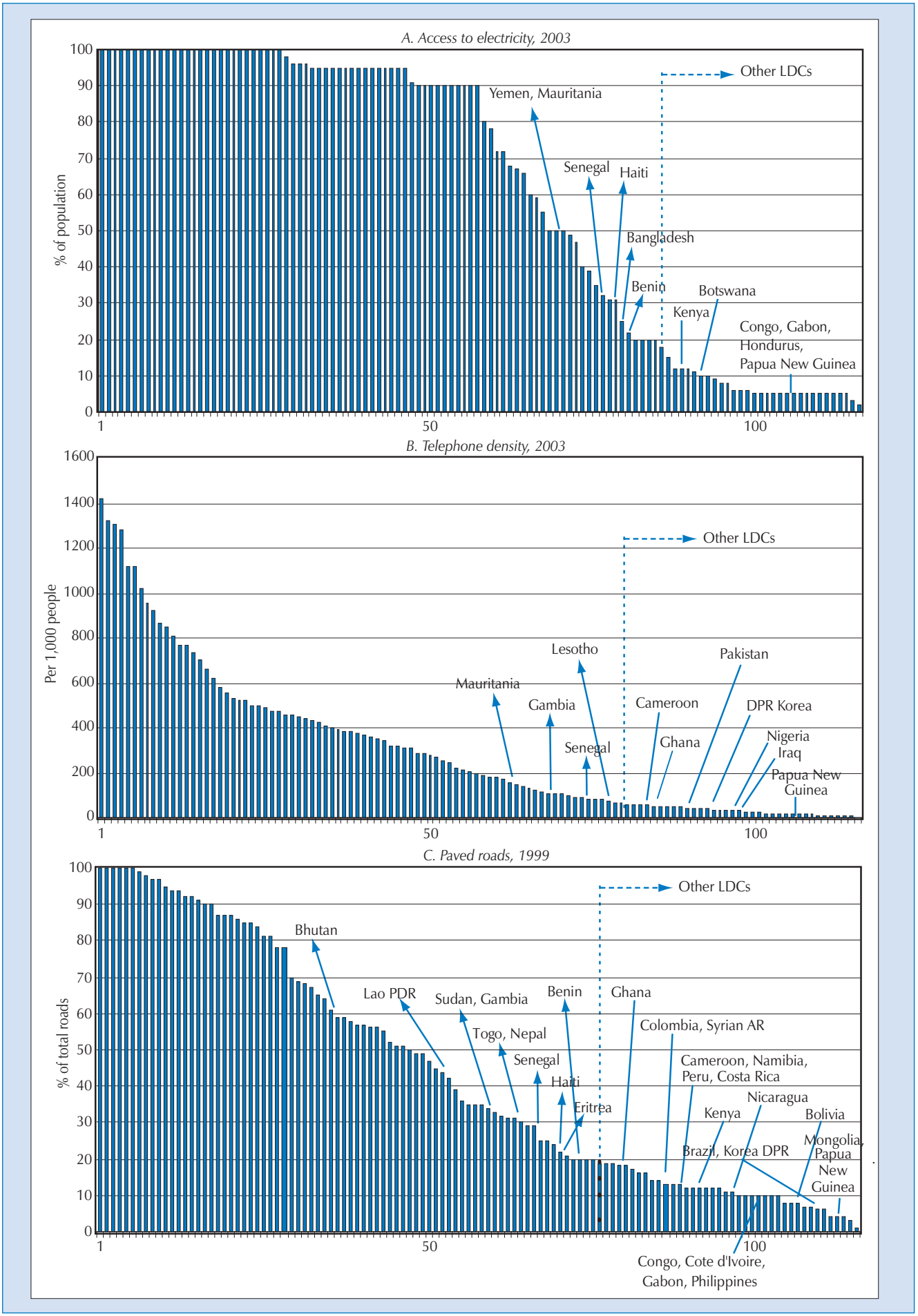
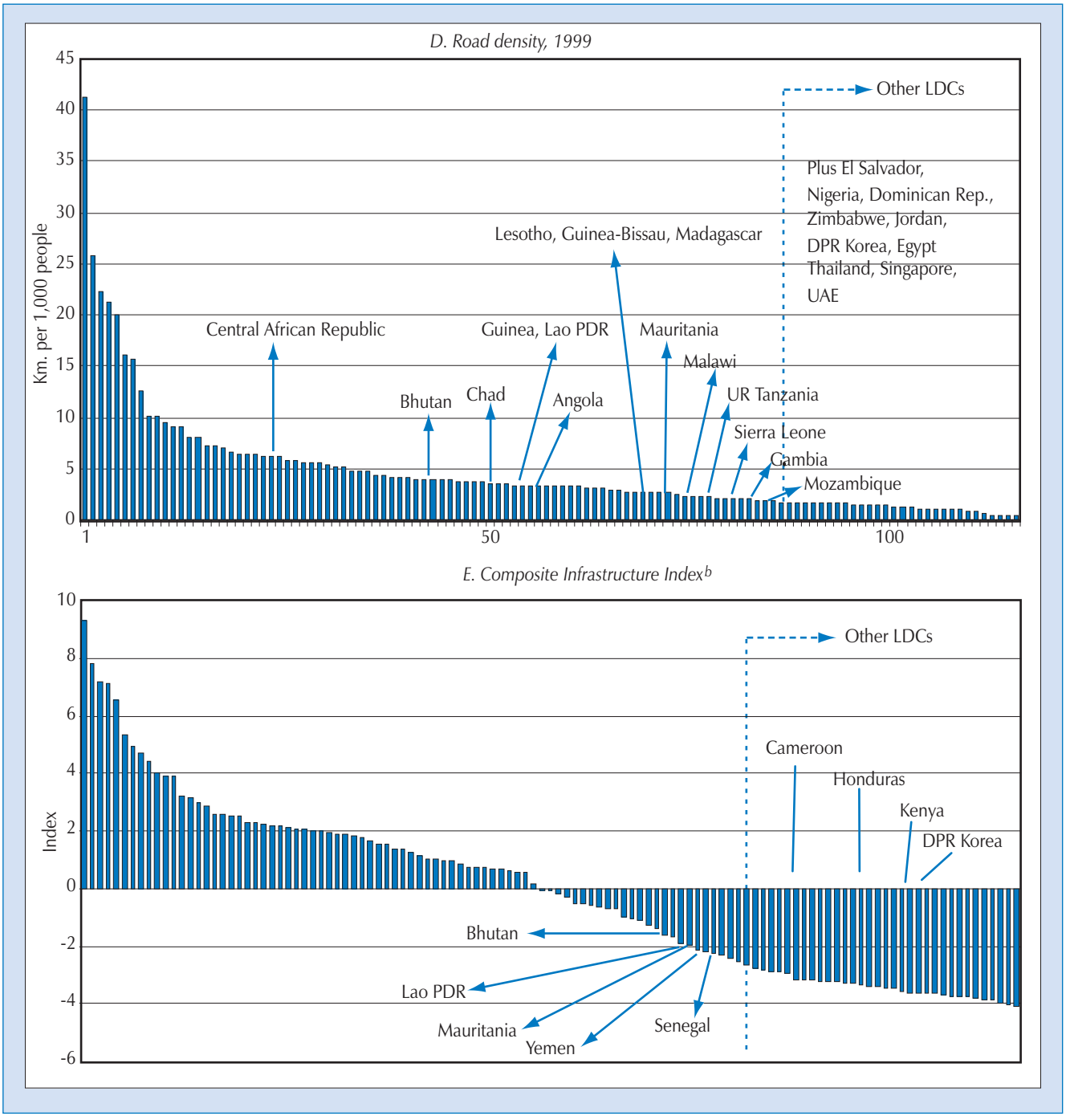


Chart 39 (contd.)



Source: Borgatti (2005a).

a Transition economies have been included in the sample.

b Based on latest available data.

with the worst infrastructure. Most of the LDCs are at the bottom of the ranking, although it is clear that on some of these indicators (notably length of roads per 1,000 people and the share of the road network which is paved) there are a number of other developing countries which have infrastructure that is as bad as that of most of the LDCs, and that there are a number of other developing countries that have better infrastructure than most of the LDCs. Chart 39E shows the results of a composite infrastructure index constructed on the basis of all indicators.[1] Twenty-seven of the 31 LDCs included in the sample are located between 80th and 115th (the last) place in the ranking, with the exception of Bhutan, the Lao People's Democratic Republic, Mauritania and Yemen. All the LDCs are below the sample average and are located in the bottom 40 per cent of all the developing countries considered (for fuller discussion see Borgatti, 2005a).

The shape of these charts is also striking. For roads per capita, telephone mainlines per capita and paved roads as a percentage of all roads, infrastructure provision declines gently after an initial drop from the best-provided developing countries. But for access to electricity there is a sharp drop from the top half of the sample, in which over 90 per cent of the population have access to electricity, to the bottom quarter of the countries, in which most of the LDCs are clustered. In the latter countries, less than 10 per cent of the population has access to electricity. This "electricity divide" has not received the attention that the digital divide has received (see box 14). But it is at least as significant, and probably more significant, for economic growth, poverty reduction and the development of productive capacities in the LDCs.

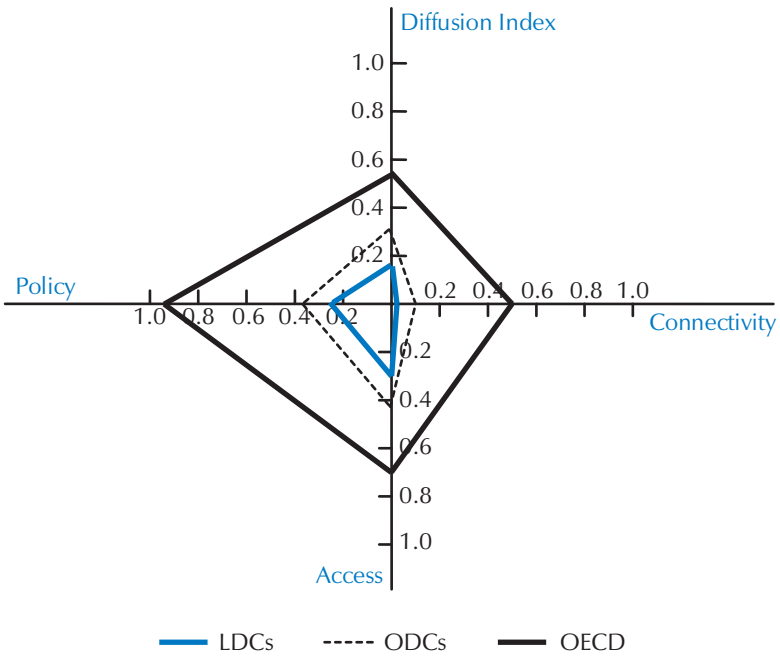
The "electricity divide" has not received the attention that the digital divide has received.

Box 14. LDCs and the digital divide: The UNCTAD ICT Diffusion Index

The UNCTAD ICT Diffusion Index measures the digital divide on the basis of the following three dimensions of ICT development: (i) connectivity, which measures the extent of telecommunications infrastructure development; (ii) access, which measures the opportunity to take advantage of being connected; and (iii) policy, which measures the level of competition in telecommunication and the Internet service provider market. Specific indicators have been used to assess and measure each of the three components. Connectivity is measured by the number of Internet hosts per capita, the number of PCs per capita, the number of telephone main lines per capita and the number of mobile subscribers per capita. Access is measured by the estimated number of Internet users, the adult literacy rate, the cost of a local call and GDP per capita in purchasing power parity terms. Policy is measured by the presence of Internet exchanges, and the levels of competition in telecommunications and Internet service provider markets. The ICT Diffusion Index is obtained by estimating the value achieved in a country as a proportion of a maximum reference value and then calculating an average of the scores for each indicator and for each dimension.

Box chart 5 shows where LDCs, other developing countries and OECD countries stand in the ICT Diffusion Index and also its different dimensions. From the box chart 5, it is clear that the area in which the LDCs lag behind most is connectivity — that is, the level of telecommunications infrastructure development.

Box chart 5. ICT diffusion index for LDCs, other developing countries and OECD countries, 2002



Source: UNCTAD secretariat estimates based on UNCTAD (2005).

Amongst the LDCs, Maldives stands out as having a higher degree of ICT readiness than the other LDCs. Its ICT Diffusion Index (0.3565) is twice as high as that for the LDC average (0.1778). The level of competitiveness in the domestic telecommunications sector is low in most LDCs, with some notable exceptions, namely Guinea-Bissau, Madagascar,

Box 14 (contd.)

Malawi and Sudan. Interestingly, in spite of its relatively high policy index, Guinea-Bissau has the lowest ICT diffusion ranking amongst the 165 countries considered.

Data are available to show how the ICT diffusion ranking of 19 LDCs changed between 1995 and 2002 (box table 6). It is apparent that the majority of the LDCs are losing ground with respect to other developing countries and developed countries. Sixteen of the 19 LDCs show a decline in their ranking, whilst the ranking improves in only three LDCs, namely Sierra Leone, Maldives and the Central African Republic. In terms of ICT diffusion ranking, Lesotho, the United Republic of Tanzania, Madagascar and Malawi lost over 50 positions over the period 1995–2002.

From these data it is apparent that despite a fast-growing mobile phone network in many LDCs, these countries are still falling behind other developing countries in terms of ICT readiness. The digital divide and the electricity divide reinforce each other and result in a lack of technological congruence with the rest of the world, which is a major barrier to the acquisition of modern technologies for mass production.

BOX TABLE 6. CHANGES IN THE ICT DIFFUSION RANKINGS FOR SELECTED LDCs[a] BETWEEN 1995 AND 2002

	1995 ranking (a)	2002 ranking (b)	Difference (b-a)
Angola	114	143	29
Bangladesh	107	145	38
Burkina Faso	140	159	19
Cambodia	105	119	14
Cape Verde	63	87	24
Central African Republic	156	144	-12
Chad	138	155	17
Djibouti	113	147	34
Lesotho	64	117	53
Madagascar	80	131	51
Malawi	88	138	50
Maldives	86	50	-36
Mali	132	157	25
Rwanda	89	134	45
Sierra Leone	150	103	-47
Sudan	99	129	30
Uganda	144	154	10
United Rep. of Tanzania	76	165	89
Yemen	102	136	34

Source: UNCTAD, 2005b (table 3, p. 8).

a These rankings are available for 165 countries in 2002, and for 154 countries in 1995. The closer to the bottom rank, the worse the ICT diffusion.

2. DIFFERENCES AMONGST LDCs

African LDCs are below the LDC average for every indicator of infrastructure access and quality of the service.

Although the LDCs are, as group, much worse off than other developing countries, there are also significant differences amongst the LDCs. Island LDCs have better physical infrastructure than either African or Asian LDCs. African LDCs are below the LDC average on almost every indicator of physical infrastructure and its quality. The length of roads per square kilometre is particularly low in the African LDCs (0.12 kilometres per square kilometre in 1999 compared with 0.29 in Asian LDCs and 0.33 in island LDCs).[2] In terms of the electrification rate, only 14 per cent of the population had access to electricity in 2002 in African LDCs compared with 21 per cent in Asian LDCs. Moreover, only 15 per cent of the roads were paved in African LDCs compared with 27 per cent in Asian LDCs and 49 per cent in island LDCs. African LDCs are below the LDC average for every indicator of infrastructure access and quality of the service. They have, however, the same roads per capita and a higher number of fixed and mobile phone subscribers than Asian LDCs (table 46).

TABLE 46. INDICATORS OF THE STATUS OF TRANSPORT, TELECOMMUNICATION AND ENERGY INFRASTRUCTURE IN AFRICAN, ASIAN AND ISLAND LDCS, MOST RECENT YEARS

	Year[a]	African LDCs[b]	Asian LDCs	Island LDCs
Roads per sq. km	1999	0.1	0.3	0.3
Roads per 1,000 people	1999	2.7	2.7	3.9
Telephone mainlines per 1,000 people	2003	9.0	13.4	61.2
Fixed and mobile phone sub. per 1,000 people	2003	33.0	27.2	111.7
Electrification rate (%)[b]	2002	14.2	21.3	..
Telephone faults per 100 mainlines[b]	2003	61.9	116.5[c]	48.4
Paved roads % total roads	1999	15.5	26.7	48.5
Internet monthly price % monthly GNI per capita	2003	355.0	130.1	131.5
Energy consumption per capita (Kwh/per person)	2002	148.4	105.9	..
Energy from traditional sources(% of total energy requirements)	2002	78.5	68.0	..

Source: UNCTAD secretariat estimates based on World Bank, *World Development Indicators 2005*, CD-ROM; International Energy Agency, *World Energy Outlook 2004*; UN *Energy Statistics Yearbook 2004*, CD-ROM.

a Most recent year for which data are available.
b For definitions, see charts 37 and 38.
c This is due to the way the series is calculated. The humber of telephone faults per 100 mainlines is calculated by dividing the total number of reported faults for the year by the total number of mainlines in operation, and multiplying by 100.

A more detailed picture of the diversity amongst LDCs was obtained through statistical analysis which classifies 31 LDCs for which data are available according to their physical infrastructure using the indicators in chart 39.[3] This analysis identifies three groups of countries:

- Relatively good infrastructure amongst the LDCs — Benin, Bhutan, Gambia, Haiti, Lao People's Democratic Republic, Lesotho, Mauritania, Senegal, Sudan, Togo, and Yemen;
- Average infrastructure amongst the LDCs — Bangladesh, Burkina Faso, Cambodia, Eritrea, Ethiopia, Malawi, Mali, Mozambique, Nepal, Niger, Rwanda, Sierra Leone, Uganda and United Republic of Tanzania;
- Relatively bad infrastructure amongst the LDCs — Angola, Central African Republic, Chad, Guinea, Guinea-Bissau, and Madagascar (Borgatti, 2005a).

The fastest-growing LDCs had relatively good or average physical infrastructure.

The LDCs in the cluster with the relatively bad infrastructure amongst the LDCs are large African countries with a low population density. Some of them have also experienced civil conflicts. Both Angola, which has been an oil-exporter for a long time, and Chad, which started exporting oil in late 2003, are in this group. The cluster with relatively good infrastructure includes a number of LDCs which have the highest urbanization rates within the group (for example, Mauritania and Senegal, with 62 per cent and 50 per cent of the total population living in urban centres in 2003). The fastest-growing LDCs had relatively good or average physical infrastructure, whilst those LDCs with relatively bad infrastructure are economies which have either weak growth or are regressing economically.

During the 1990s the infrastructure divide between the LDCs, other developing countries and OECD countries was widening.

3. TRENDS IN INFRASTRUCTURE PROVISION

Lack of data make it difficult to analyse trends in infrastructure provision in detail.[4] However, during the 1990s the infrastructure divide between the LDCs, other developing countries and OECD countries was widening (table 47). This is particularly apparent for road infrastructure. Measured by length of the network, the stock of roads per capita in the LDCs was actually lower in 1999 (the latest year for which comprehensive data are available) than in 1990. The percentage of paved roads in the LDCs also declined over the same period. The road stock

TABLE 47. CHANGES IN INFRASTRUCTURE IN LDCS, OTHER DEVELOPING COUNTRIES AND OECD COUNTRIES, BETWEEN 1990 AND 2003

	Year[a]	LDCs	ODCs	OECD
Roads				
Per sq. km.	1990	0.1	0.2	0.4
	1999	0.2	0.4	0.4
Per 1,000 people	1990	3.1	3.1	15.1
	1999	2.9	5.1	14.9
Paved % total roads	1990	23.0	38.5	72.8
	1999	22.0	43.2	88.0
Fixed and mobile phone subscribers (per 1,000 people)	1990	6.2	86.6	478.0
	2003	45.1	390.5	1254.7
Telephone faults (per 100 mainlines)	1992	148.7	78.9	16.0
	2003	65.0	30.7	8.5
Electricity consumption per capita (kwh/person)	1990	104.0	1153.8	7187.6
	2002	136.3	1870.1	8769.3
Fuel from traditional sources (% of total energy requirements)	1990	77.5	25.8	4.8
	2002	74.2	22.9	4.1

Source: UNCTAD secretariat estimates based on World Bank, *World Devleopment Indicators 2005*, CD-ROM; UN *Energy Statistics Yearbook,* 1993 and 2004; IEA, *World Energy Outlook 2004*.

a Or closest available year.

per capita declined in both African and island LDCs, and the percentage of roads which are paved declined in African LDCs. In contrast, for the LDCs as a group, the number of fixed and mobile phone subscribers per 1,000 people increased eightfold between 1990 and 2002. But LDCs are still falling behind other developing countries and OECD countries as there were more new subscribers in these country groups. The gap has also increased for electricity consumption per capita. But the difference in the share of total energy requirements supplied by traditional fuel between LDCs and other developing countries has interestingly stayed constant over time. This suggests very little change in the diversification process towards non-traditional sources of energy in both the LDCs and other developing countries.

The poor infrastructure stocks of the LDCs reflect inadequate maintenance of existing infrastructure and under-investment in new infrastructure.

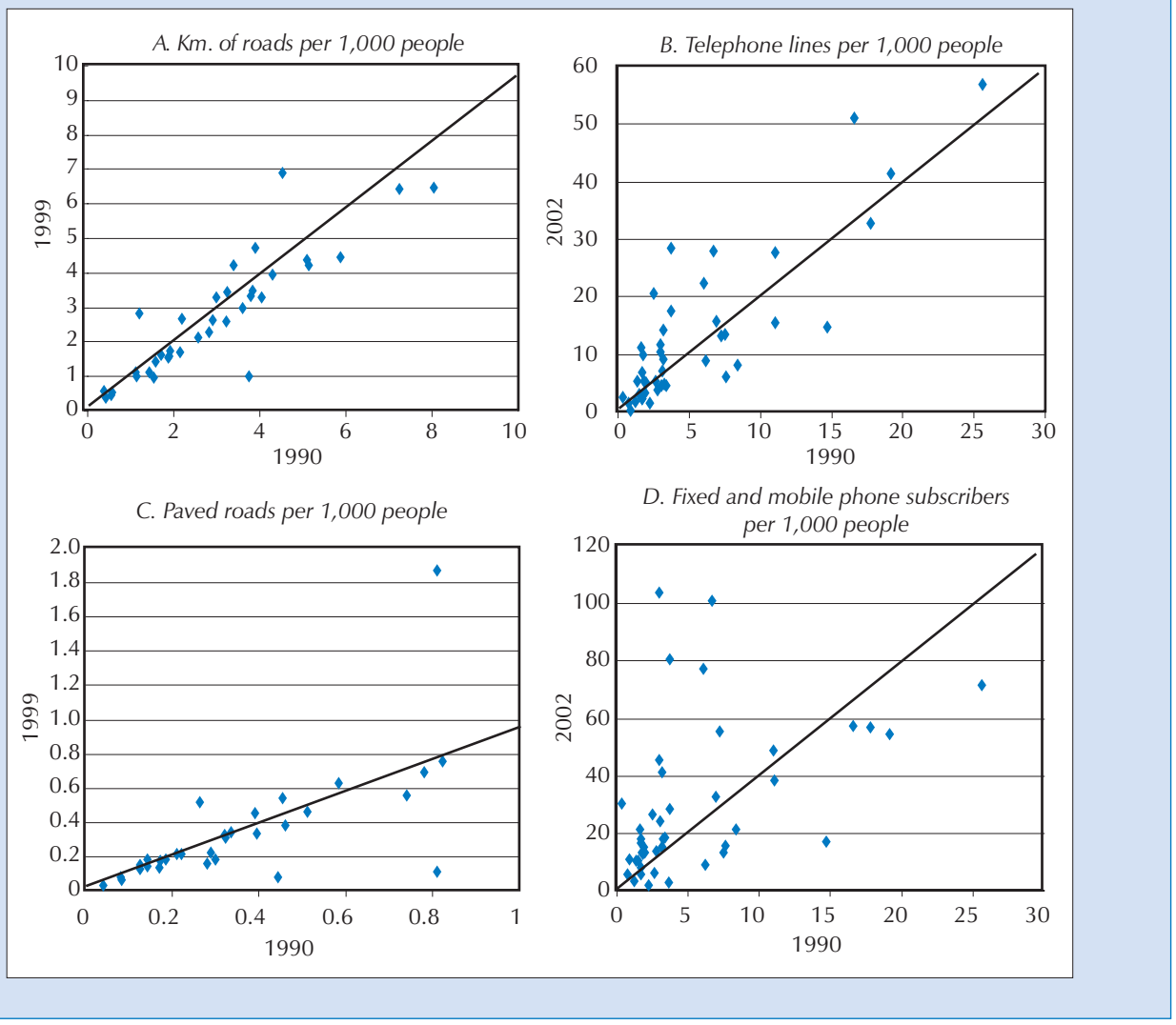
Focusing on differences amongst the LDCs (chart 40), the data show that in terms of the length of the network the situation as regards road stock and paved road stock per capita worsened in many LDCs during the period 1990–1999. In contrast, the data on telecommunications infrastructure show a dramatic improvement between 1990 and 2002 in all LDCs.

C. Financing infrastructure investment

While the private sector has financed some economic infrastructure in the LDCs, it has not filled the gap created by declining public investment and ODA.

The poor infrastructure stocks of the LDCs reflect inadequate maintenance of existing infrastructure and under-investment in new infrastructure. These two features are a particular manifestation of the general problem outlined in chapter 2, with few domestic resources being available to finance investment of any kind. The share of resources allocated to economic infrastructure also declined (i) as Governments reduced such expenditure to balance budgets in the context of first-generation economic reforms, and (ii) as donors switched their aid to social sectors, thus allowing the volume of aid for economic infrastructure to decline sharply in real terms. As the Commission for Africa (2005) has observed for sub-Saharan Africa in general, "This was a policy mistake founded in a new dogma of the 1980s and 1990s asserting that infrastructure would now be financed by the private sector" (p. 234). In practice, although the private sector has financed some economic infrastructure in the LDCs, it has not filled the gap created by declining public investment and ODA.

CHART 40. CHANGES IN TRANSPORT AND TELECOMMUNICATIONS INFRASTRUCTURE PROVISIONS IN LDCS BETWEEN 1990 AND 2002[a]



Source: UNCTAD secretariat estimates based on World Bank, *World Development Indicators 2005*, CD-ROM.

Note: Cape Verde has been excluded from the charts on paved roads, telephone mainlines and fixed and mobile phone subscribers, while Maldives has been excluded from the last two only.

a Data on roads and paved roads refer to the year 1999, while the remaining data refer to the year 2002.

According to Torero and Chowdhury (2005), over the period from 1980 to 1998, infrastructure spending decreased from 6 to 4 per cent of total government expenditure in Africa, from 12 to 5 per cent in Asia and from 11 to 6 per cent in Latin America. Although there are no equivalent figures available for LDCs, data available for 13 LDCs[5] during the second half of the 1990s show that 5 of them spent less than 1 per cent of GDP on economic infrastructure and 7 of them spent less than 2 per cent. In 5 of the 13 LDCs, public expenditure on energy, transport and communications is one third of the level of social sector expenditure on education, housing, health and social protection.[6]

During the 1990s, there was a strong shift in resource allocation away from economic infrastructure towards social infrastructure and services.

This orientation towards social sector expenditure is also evident in ODA trends. For the LDCs, this is the primary source of financing for infrastructure. But during the 1990s, there was a strong shift in resource allocation away from economic infrastructure towards social infrastructure and services. Between 1992 and 2003, aid for social infrastructure and services to LDCs increased by 14.6 per cent per annum in nominal terms, while aid for economic infrastructure increased by a mere 3 per cent over the whole period. In real

terms, aid flows commitments to LDCs for economic infrastructure in 2003 were 51 per cent lower than in 1992.

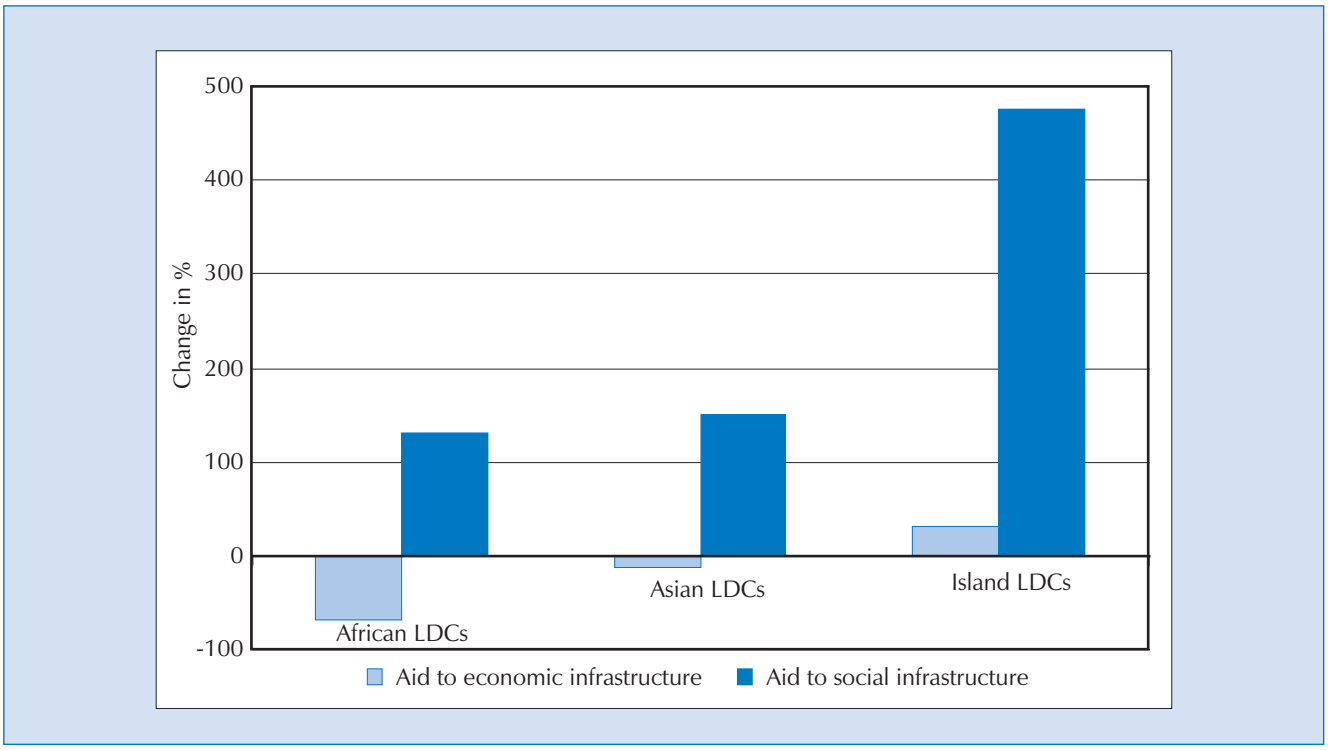
The fall in ODA allocated to economic infrastructure was particularly marked in African LDCs, which in 2003 experienced a fall in real terms equivalent to 68 per cent of the ODA received in 1992. Chart 41 shows that Asian LDCs have experienced a less substantial fall in their ODA for economic infrastructure. This resulted in the Asian LDCs receiving in 2003 an inflow of ODA for economic infrastructure which was one third higher than the amount received by African LDCs. This last group of LDCs appears to be the greatest loser as a result of this shift: ODA flows for economic infrastructure going to African LDCs in 1992 were double those going to Asian LDCs. On the other hand, aid flows for social infrastructure have more than doubled over the same reference period in both African and Asian LDCs, and have increased fivefold in the island LDCs.

The decline in ODA allocated to economic infrastructure was particularly marked in African LDCs.

In theory, it might be expected that the private sector would fill the infrastructure financing gap which was created as public investment and ODA for economic infrastructure declined. But although private finance can contribute to infrastructure investment and offers a potential new source of investment finance, physical infrastructure often has the characteristics of a public good. Consumption by one user does not reduce the supply available to others, and users cannot be prevented from consuming the good. There are also sometimes indivisibilities in the scale of infrastructure facilities, and thus a minimum initial investment, which can be quite large, is required in order to establish such facilities. In addition, the benefits of infrastructure investment often depend on the existence of a broad network, and creating all the links which make this network effective will involve a minimum threshold level of investment. For all these reasons physical infrastructure is likely to be under supplied if left to private investors alone.

CHART 41. CHANGE IN BILATERAL DAC AID COMMITMENTS TO ECONOMIC AND SOCIAL INFRASTRUCTURE IN LDCS BETWEEN 1992 AND 2003

(Percentage increase)



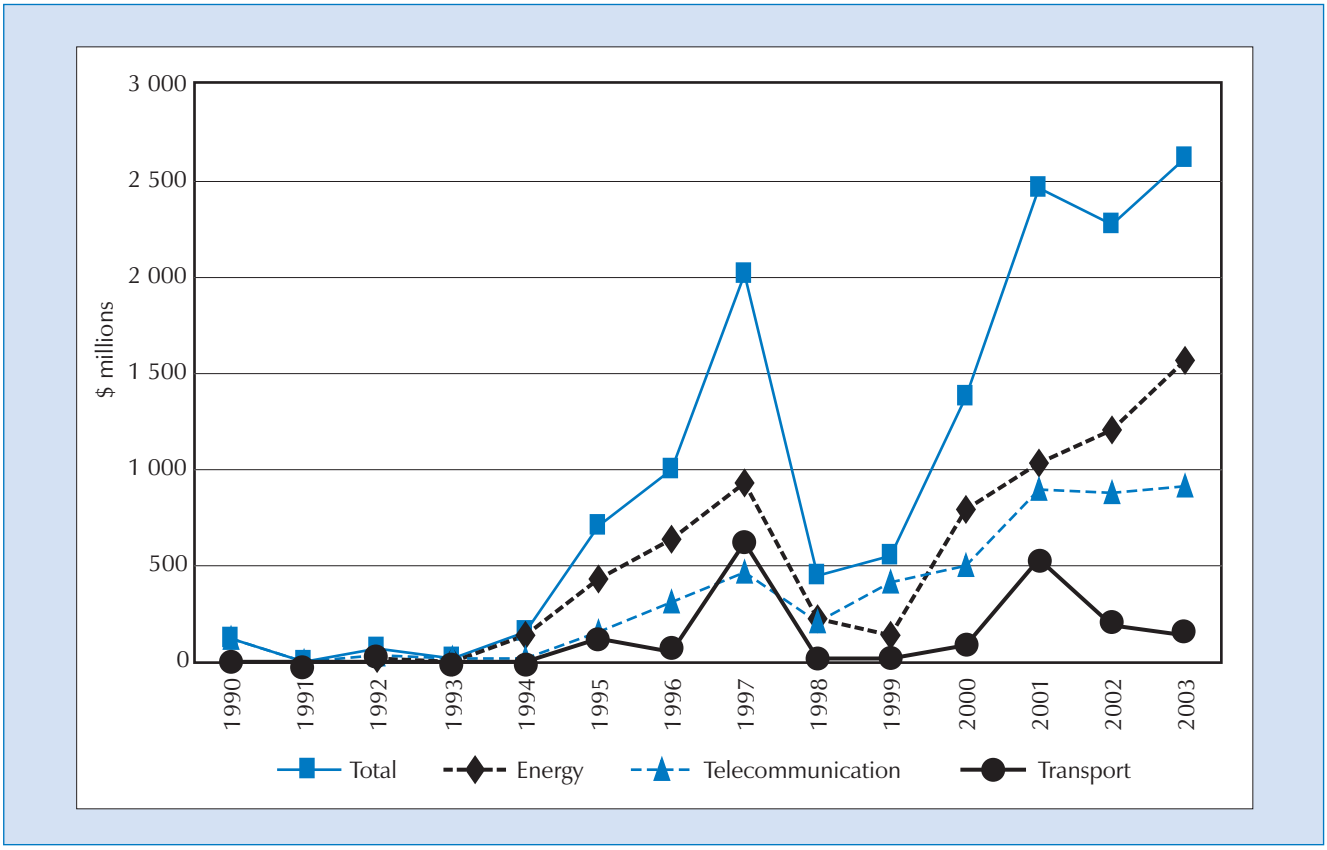
Source: UNCTAD secretariat estimates based on OECD/CDE database online, March 2006.

Private investment in infrastructure in the LDCs has certainly increased (see chart 42). But there are limits to the types of assets and countries to which it is attracted. In general, infrastructure investments which are attractive to private capital are ones in which there is a growing market and scope for monopolistic power. Where it is difficult to restrict access to the services generated by infrastructure facilities, they are unattractive to private financing. There has thus been a sustained increase in private sector investment in telecommunications, particularly in building the light and cost-effective infrastructure required for mobile phones, and also electricity-generating plants. Within the transport sector, private capital inflows have been much smaller and focused on infrastructure projects for which (a) access can be limited (as in airports, tunnels, bridges and major highways); (b) the projected volume of traffic is high (container ports, rail freight and a few trunk roads); (c) the generation of cash is expected to be reliable; and (e) foreign exchange earnings are possible.

Telecommunications and energy constituted 90 per cent of private investment infrastructure in 10 out of the 14 years and of that over 70 per cent was absorbed by African LDCs.

During the period 1990–2003, telecommunications and energy constituted 90 per cent of private investment infrastructure in 10 out of the 14 years for which data are available (chart 42). Private investment in transport infrastructure has been not only much lower but also much more highly concentrated geographically. During the period from 1993 to 2003, Mozambique absorbed 59 per cent of private capital flows to transport in the LDCs. From 1999 to 2003 over 70 per cent of the private investments in energy and telecommunications were absorbed by African LDCs. This marks a clear change from the previous period, 1992–1998, when the majority of private flows were invested in Asian LDCs.

CHART 42. PRIVATE INVESTMENT IN INFRASTRUCTURE PROJECTS IN THE LDCs, 1990–2003
($ millions)



Source: UNCTAD secretariat estimates based on World Bank, Private Infrastructure Project database online, March 2006.
Note: Based on a varying sample of LDCs, which include a maximum of 31 LDCs.

Foreign investment interest in infrastructure in LDCs is also limited by various structural weaknesses, notably high levels of indebtedness and instability of foreign exchange earnings associated with commodity dependence, both of which have a negative influence on credit ratings and increase uncertainty regarding future profit remittances whatever the legal framework. Small countries also face a catch-22 situation. On the one hand, large projects are considered risky because they can dominate economic performance and profit remittances can become too large in relation to available foreign exchange. On the other hand, small projects (those costing less than several hundred million dollars) are not big enough to justify the high development costs of project finance.

Foreign investment interest in infrastructure is limited by high levels of indebtedness and instability of foreign exchange earnings.

There is now a consensus on the need to increase ODA for physical infrastructure, and a realization that private finance can at best play a complementary role in infrastructure investment. This is evident in the World Bank's Infrastructure Action Plan, launched in July 2003 to revitalize the World Bank Group's support for meeting unmet infrastructure investment needs, as well as in the Commission for Africa Report (2005), the Asian Development Bank et al. (2005) and Faye et al. (2004). Estimates of future financing needs for infrastructure investment vary.[7] But if one assumes that estimates for low-income countries can be applied to the LDCs, annual infrastructure investment needs have been roughly estimated to be equivalent to between 7.5 per cent and 9 per cent of GDP (Briceño-Garmendia, Estache and Shafik, 2004). This includes new investment and operations and maintenance requirements, including the main networks (roads, rail, electricity, water and sanitation, telecommunications). A preliminary estimate of the investment needed to meet the Programme of Action transport and telecommunications infrastructure target (which is to increase, by 2010, the stock of such infrastructure in LDCs to the level which other developing countries had in 2000) suggests that annual infrastructure investment needs should be equivalent to 3.3 per cent of GDP (Borgatti, 2005b). This is lower than the other estimates as it is based on a different methodology (calculating unit costs to upgrade the LDCs' infrastructure to the level of the other developing countries in 2000) and ignores elements such as energy, water and sanitation included in other estimates.

Some of the financing needs could be met from private investment, but most would have to be financed by public investment and ODA.

The infrastructure investment required is a major increase over past levels of investment. For low-income countries, it implies an increase from historical levels of 4 per cent of GDP. The financing gap is likely to be larger in the LDCs on the basis of historical levels of public investment presented earlier in this chapter. Some of the financing needs could be met from private investment, but most would have to be financed by public investment and ODA. In 2004 ODA for transport, telecommunications and energy infrastructure amounted only to $1 billion. This was equivalent to 0.5 per cent of the LDCs' GDP. This is far below the estimated infrastructure investment needs, even for achieving the less comprehensive POA targets required with regard to transport and telecommunications. Private investment in these types of infrastructure contributed a further $0.4 billion. But together ODA and private investment were equivalent to only 0.7 per cent of the LDCs' GDP in 2004.

D. The benefits of public investment and ODA in physical infrastructure in the LDCs

This section examines the benefits which can accrue from increased public investment and ODA in economic infrastructure in the LDCs. It focuses on three levels of infrastructure investment:

- Rural infrastructure, particularly rural roads, which is required at the local and district level;
- Large-scale national transport, communications and power infrastructure (such as trunk roads and major electricity transmission lines), which benefit different regions of a country and not simply specific localities or regions;
- Large-scale cross-border infrastructure.

National and cross-border infrastructure which supports international trade is essential. But on its own, it will exacerbate structural heterogeneity, dualism and an enclave pattern of development within a country.

These different levels of investment — rural, national and cross-border — are distinguished here as they bring different types of benefits. Rural infrastructure is particularly important for enhancing agrarian commercialization and productivity growth, as well as for fostering rural growth linkages between agricultural and non-agricultural activities in small towns. Large-scale national infrastructure is important for the growth of the formal, non-farm economy and fostering structural change and progressive international trade integration. Large-scale cross-border infrastructure supports regional integration, as well as the transit trade of landlocked countries.

In a comprehensive approach to the development of economic infrastructure, all these levels would be included. That is to say, a "joined-up approach" to infrastructure development is necessary. National and cross-border infrastructure which supports international trade is essential. But on its own, it will exacerbate structural heterogeneity, dualism and an enclave pattern of development within a country. Similarly, feeder roads in isolated rural localities are essential for facilitating the market access of small farmers. But unless these feeder roads link to an efficient national transport network connecting major urban centres, their impact will be limited.

1. Rural infrastructure

The low productivity and subsistence orientation of agriculture are closely related to poor rural transport infrastructure.

The low productivity and partial subsistence orientation of agriculture in most LDCs are closely related to lack of local market access, which is related to poor rural transport infrastructure. Smallholder producers are usually enmeshed to some degree within product and labour markets, selling and buying foodstuffs throughout the year on a seasonal basis, producing cash crops for exports, hiring labour, working for other farmers on a casual basis and seeking off-farm employment. However, their degree of engagement with the market economy is often limited because production for the market has high transaction costs and risks. In terms of production costs, it may be rational for the farmer to specialize in high-value export or food crops. But the high transport costs of getting agricultural produce to market, coupled with uncertainty about the prices which will prevail at the moment of sale, and the costs and risks of buying foodstuffs with the earnings from the sale all lead farm households to stick to low-yielding staples to meet their basic subsistence needs (see Omamo, 1998a, 1998b).

These costs and risks are related mainly to poor local-level transport systems. The problem is particularly marked in African LDCs (Hayami and Platteau, 1996). Rural road densities are very low; and much of the rural road network is

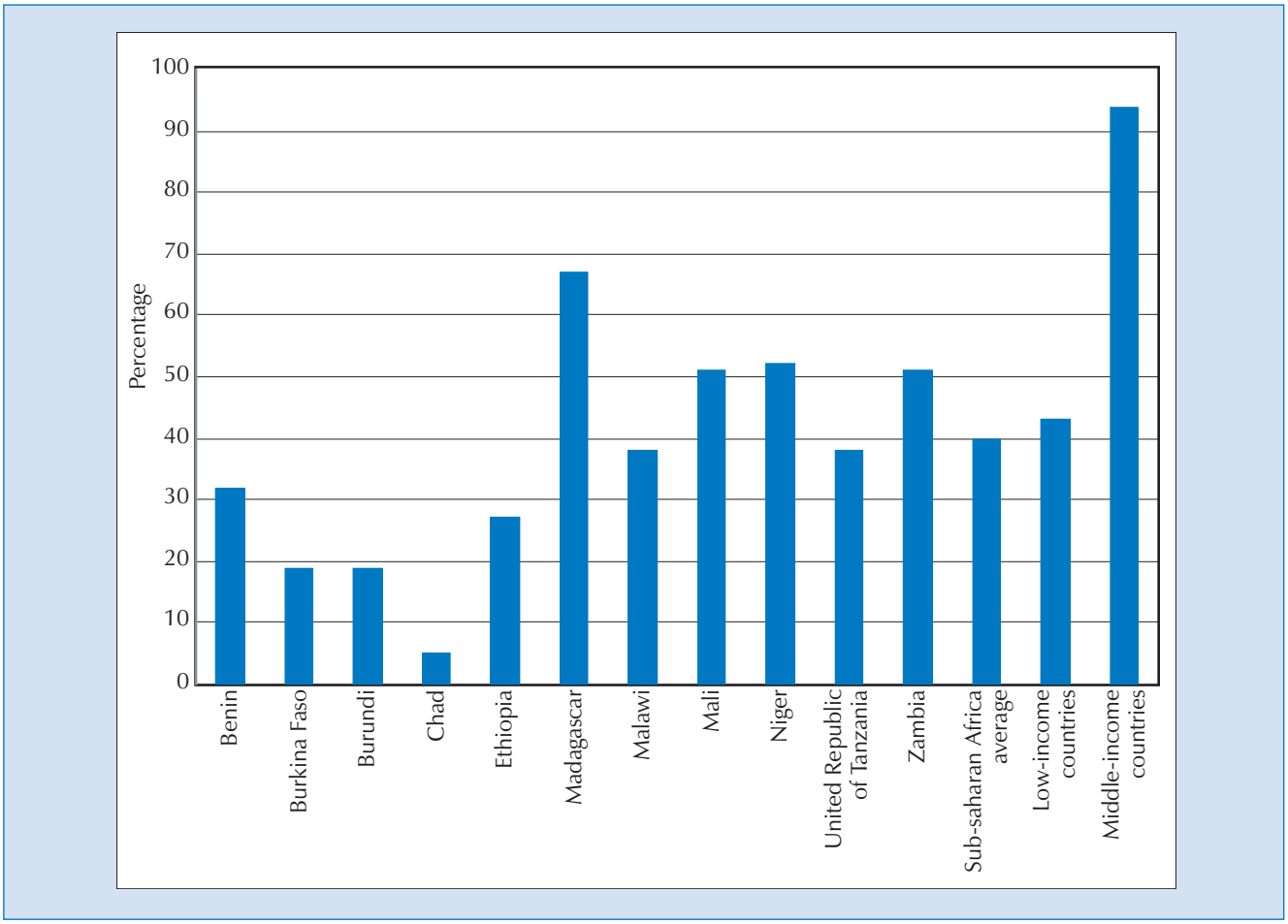
of low quality, with some rural roads becoming temporarily impassable in the rainy season. Estimates for 11 African LDCs indicate that, in 6 of these countries, over two thirds of the total rural population live 2 kilometres away from an all-season passable road, and in 10 out of the 11 countries more than one third of the rural population face this level of inaccessibility as regards good road facilities (see chart 43). With very poor roads, the availability of transport capacity is also a problem, and there is a notable underdevelopment of intermediate forms of transport such as carts, donkeys and bicycles, which can considerably relax rural transport constraints.

With very poor roads, the availability of transport capacity is also a problem.

In poor rural areas, lack of incentives to specialize and invest reinforces a stagnant rural economy in which poor infrastructure, weak market access and thin markets for agricultural inputs and output and finance, high costs of information, weak technological development and weak market institutions all reinforce each other in a low-level equilibrium trap (Kydd and Dorward, 2003). These areas are featured by "a business environment characterized by weak information (on prices, on new technologies and on other potential market players), difficult and weak contract enforcement, high risks (not only in production and prices but also in access to inputs and markets and in enforcing contracts) and…costs that buyers and sellers incur in protecting themselves against risks of transactions failing (due to absence of suppliers or buyers)" (Kydd and Dorward, 2003: 8).

CHART 43. ACCESSIBILITY OF ROAD NETWORKS[a] FOR RURAL POPULATION IN SELECTED LDCS AND OTHER COUNTRY GROUPS

(Percentage of population)



Source: Desmarchelier (2005).

a Percentage of rural people who live within 2 km of an all-season passable road as a proportion of the total rural population. Latest available year.

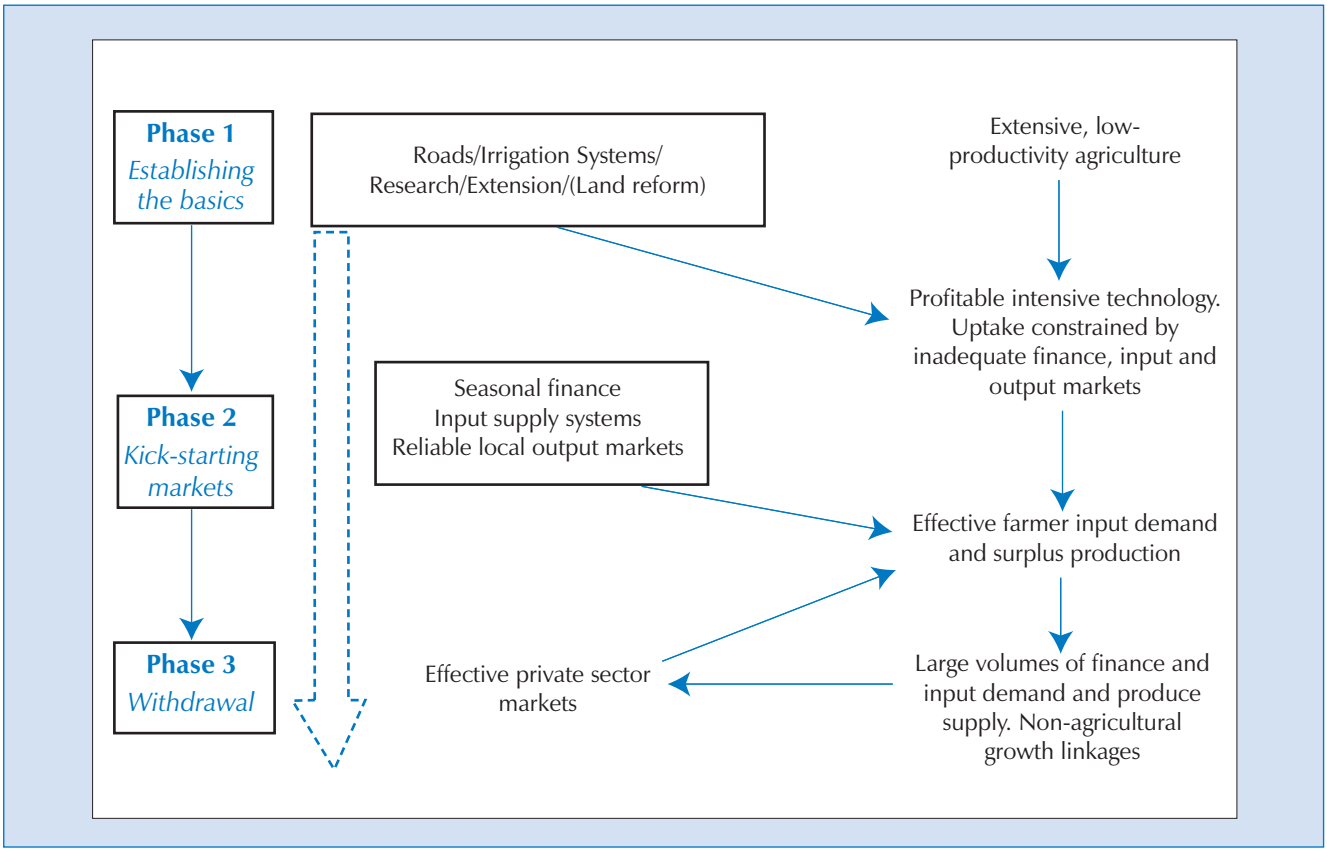
High transport costs also mean that many agricultural products are effectively non-tradable not simply internationally but also nationally. The scale of local production is then limited by the local market demand, which is low because of the weak development of the local market economy. When surplus crops are produced (because of favourable weather conditions) they may simply rot in the fields.

This is a daunting complex of interrelated constraints. However, public investment targeted to improve rural infrastructure is essential for escaping this trap. Investment should not only improve rural feeder roads, but also seek to focus key economic and social infrastructure on small market centres and market towns, and foster linkages between these small urban centres and the rural areas. The lower transport costs and risks resulting from improved infrastructure can open up new frontiers in areas with higher agricultural potential in which production was previously economically unviable because of physical isolation, as well as convert some non-tradables into tradables in already-settled areas. This vent-for-surplus can also be enhanced to the extent that improved infrastructure increases market competition by encouraging more buyers and sellers. The linkages between rural areas and small towns can also open up opportunities for local and district-level off-farm employment, which can increase the incomes of rural households. Finally, the process of rural road construction itself can also bring positive demand-side effects if maximum use is made of local materials, labour and methods of construction (Tajgman and de Veen, 1998; Bentall, Beusch and de Veen, 1999).

High transport costs mean that many agricultural products are effectively non-tradable not simply internationally but also nationally. The scale of local production is limited by the local market demand.

Public investment in rural infrastructure is a particularly important component of policies to promote agricultural intensification through the adoption of high-yielding varieties. Analysis of successful Green Revolutions shows that different policies are important at different stages of agricultural intensification (chart 44). In the first phase, it is important to "establish the

CHART 44. POLICY PHASES TO SUPPORT AGRICULTURAL TRANSFORMATION IN FAVOURED AREAS



Source: Dorward and Kydd (2003).

basics" for the adoption of new technologies through investment in rural infrastructure, including roads and irrigation systems, and research and extension. In the second phase, it is important to "kick-start markets" through government interventions to enable a broad spectrum of farmers, not simply the large ones, to have access to seasonal finance and inputs, and output markets at low cost and risk. As the volumes of credit and input demand and of produce supply increase, transaction costs and risks will fall and so in the third phase, it is important that the Government withdraws from public action in these markets and lets the private sector take over (Dorward et al., 2004).

Improved rural infrastructure is at the heart of building a market economy in rural areas where the population is still partially subsistence-oriented.

Evidence which quantifies the marginal returns to different kinds of public spending during different decades of the Green Revolution in India supports this pattern (Fan, Hazell and Thorat, 1999; Dorward et al., 2004, 32–36). In the 1960s, the highest returns in terms of increased agricultural output from public spending were derived from road and education investments. In the 1970s, the returns to most of these investments and subsides declined, but road investments, education, fertilizer subsidies and agricultural R&D all provided relatively good returns. In the 1980s, fertilizer subsidies provided much lower returns than earlier. But roads, education, credit subsidies and agricultural R&D still yielded relatively good returns. Finally, in the 1990s, the returns from all forms of public spending were lower and only roads and agricultural R&D still yielded relatively good returns. Significantly, the policies which yield the highest returns in terms of agricultural production growth are also estimated to provide the highest returns in terms of numbers of people lifted out of poverty. There is little comparative evidence for the LDCs. However, studies on the returns to public spending in Uganda and the United Republic of Tanzania indicate that investment in agricultural R&D, roads and education provide the highest returns in terms of agricultural output and productivity gains (see box 15).

From this discussion, it is clear that one should not look upon rural infrastructure investment as a quick fix which will solve all problems. It needs to be complemented with other policies which provide agricultural R&D and which address institutional weaknesses in input, output and credit markets if it is to be successful. However, improved rural infrastructure, including local feeder roads as well as links to small market centres and small towns, is at the heart of building a market economy in rural areas where the population is still partially subsistence-oriented. Moreover it is an essential first stage in promoting the type of agricultural intensification which characterizes Green Revolutions. Without the rural infrastructure basics in place, the supply response to agricultural pricing reforms has inevitably been less than expected.

Large-scale national infrastructure provides the foundations on which economic growth for the formal, non-farm economy is built as it not only increases the productivity of firms but generates significant structural changes.

2. The linkage effects of large-scale national infrastructure

Whilst small-scale rural infrastructure is vital for agricultural productivity growth and commercialization, large-scale national infrastructure — national trunk roads connecting major urban centres, national power plants and transmission lines, and the infrastructure for fixed-line or mobile telephones — "provides the foundations on which economic growth for the formal, non-farm economy is built" (GRIPS, 2003: 84). It increases the productivity of firms and also can generate significant structural changes in national and regional economies.

There is greater potential for attracting private investment within some elements of large-scale infrastructure, particularly as noted above for telecommunications and electricity-generating power plants. However, public investment is still necessary because large-scale infrastructure can have

Box 15. Returns to public investment in Uganda and the United Republic of Tanzania

Fan et al. (2004; 2005) have conducted studies on Uganda and the United Republic of Tanzania, which examine benefit-cost ratios for different types of public investments in different regions of each country. Both studies show that investment in agricultural research and development has the highest benefit-cost ratio and that investments in roads were associated with the second highest benefit-cost ratio, followed by education (see box table 7).

In addition, the studies indicate that investment in agricultural research and development has the strongest poverty-reduction effects. But evidence was mixed on poverty-reduction effects regarding roads and education. In the United Republic of Tanzania, where the studies focused on roads in general, the poverty-reduction effect of education was considerably higher than the poverty-reduction effect of roads. In Uganda, however, where the study focused on different types of roads, the poverty-reduction effect of feeder roads was more than twice as high as the poverty-reduction effects of education. But while the study on Uganda showed a relatively high poverty-reduction effect for feeder roads (i.e. relatively low-grade roads), it showed a relatively small poverty-reduction effect for murram and tarmac roads (i.e. relatively high-grade roads). Along the same lines, other studies on infrastructure development have highlighted the fact that the poverty-reduction effect of basic rural infrastructure projects tends to be higher than the poverty-reduction effect of more sophisticated rural infrastructure projects (Asian Development Bank et al., 2005). This has to do with the relatively high labour intensity of basic infrastructure projects, which leads to more off-farm employment opportunities and higher household incomes, especially for the duration of the projects.

Box table 7. Benefit-cost ratio and poverty-reduction effects of alternative public investments in Uganda and the United Republic of Tanzania

	Fiscal year/ year of evaluation	Agriculture research	Roads/ feeder roads	Education	Health
Benefit-cost ratio					
Uganda	1999	12.4	*7.2*	2.7	0.9
United Rep. of Tanzania	2000/2001	12.5	9.1	9.0	..
Number of poor people lifted above poverty line per million shillings					
Uganda	1999	58.4	*33.8*	12.8	4.6
United Rep. of Tanzania	2000/2001	40.4	26.5	43.1	..

Source: Fan, Zhang and Rao (2004); Fan, Nyange and Rao (2005).

Note: Unlike the study on Tanzania, the study on Uganda assessed the impact of different types of roads. The road-related data in the table refers to feeder roads.

The study on the United Republic of Tanzania also examined investment in electricity, but data were too limited to permit precise conclusions. That study did not investigate the effects of investment in health.

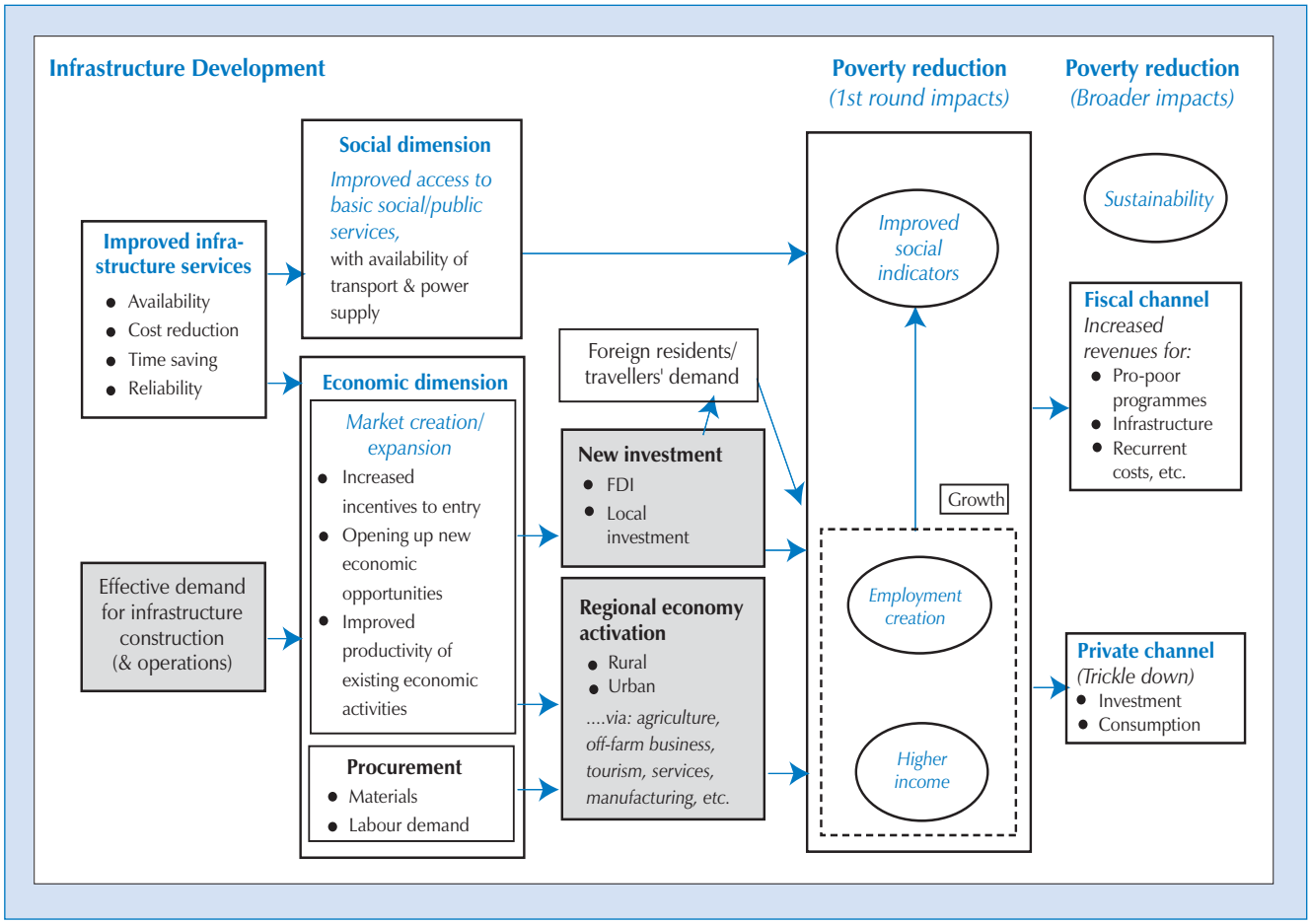
significant positive externalities which mean that the social returns from infrastructure investment are much higher than the private returns.

The linkage effects of large-scale infrastructure occur through both supply-side and demand-side effects (chart 45). On the supply side, large-scale infrastructure lowers costs of inputs, makes existing businesses more profitable, opens up new opportunities and enables economic actors to respond to new types of demand in different places. This can generate investment, both foreign and domestic, which leads to higher industrial growth and output and the creation of factory employment, which in turn, through the procurement of local inputs, and expansion of supporting industries and of related services, lead to greater economic growth, employment creation and higher incomes. The improved infrastructure services can also activate regional economies, improving the productivity of existing agriculture, opening up greater opportunities for non-farm business and promoting more diversified agriculture.

The linkage effects of large-scale infrastructure occur through both supply-side and demand-side effects.

The increase in the reliability of electricity is likely to be particularly important for the development of the non-agricultural economy, affecting both investment and innovation levels. An analysis of Ugandan firms, for example,

CHART 45. LINKAGES BETWEEN LARGE-SCALE INFRASTRUCTURE, GROWTH AND POVERTY REDUCTION



Source: GRIPS (2003).

shows that for firms without their own electricity generator, there is a clear relationship between their investment rate and the number of days lost to production due to power cuts. The greater the number of days lost due to power outages, the lower the investment rate. But even firms which have invested in their own generator lose out as it is estimated that they invest, on average, 25 per cent of their total investment funds in generators (Reinikka and Svensson, 2002). The low level of access to electricity within LDCs is also likely to be a major reason for the lack of technological congruence which hinders the acquisition and use of modern technologies (see part II, chapter 3).

The low level of access to electricity within LDCs is likely to be a major reason for the lack of technological congruence which hinders the acquisition and use of modern technologies.

On the demand side, effective demand from public works during construction can generate jobs and income during the construction period both directly and indirectly through the procurement of local materials, inputs and services. The growth of the local construction sector is one important outcome.

These supply-side and demand-side effects can also have broader impacts. The increased level of economic activity increases fiscal revenues. Moreover, private spending from increased incomes and employment generates further multiplier effects, whose magnitude depends on the extent to which new income is spent on domestically produced goods and services. Both these channels can reinforce the poverty-reducing impact of investment in large-scale infrastructure, which can also be attributed to the higher incomes and employment as well as better physical access to social facilities.

The case of Viet Nam illustrates many of these linkages and also how quickly it is possible, with commitment, to reverse poor infrastructure (GRIPS, 2003). Expansion of the electricity network has enabled the country to sustain high economic growth rates at an annual average of 7.5 per cent and to meet the

rising demand for electricity of the order of 10–19 per cent per annum. The proportion of people using electricity as a source of lighting in the North rose from 47 per cent in 1993 to 80 per cent in 2002, whilst in the South the proportion rose from 22 per cent to 82 per cent over the same period. Similarly a major project to rehabilitate National Highway No. 1, the only road that links the Mekong Delta at the southern end of Viet Nam with the rest of the country has resulted in travel times between the capital, Ho Chi Minh City, and the Mekong Delta being cut by one third. This has enabled the economic activation of the Mekong Delta economy.

Trade performance and competitiveness are affected by both international transport costs and internal transport costs.

3. The international trade effects of infrastructure investment

One further important impact of public investment in large-scale national and rural infrastructure is that it reduces the costs of international trade. Parts of the large-scale national infrastructure, such as seaport and airport facilities, can be identified as being specifically related to international trade. However, economic activity which uses infrastructure can be oriented to different markets — local, national, regional and international – and thus it is difficult to isolate that part of the infrastructure which is specifically related to international trade. What constitutes investment in "international trade-related infrastructure" should thus not be too narrowly defined. For example, rural feeder roads may be important in enabling a vent-for-surplus in certain cash crops.

Trade performance and competitiveness are affected by both international transport costs (the costs of moving goods between countries) and internal transport costs (the costs of moving goods within a country). High transport costs for moving goods from the production point to their destination can price producers out of export markets. This is particularly relevant in natural-resource-based and labour-intensive activities, where transport costs represent a large share of the final price of the products. Lengthy transport times also have negative effects. Hummels (2001) estimated that each extra day of shipping time reduces the probability of trade by 1 per cent for all goods, and by 1.5 per cent for manufactures. High transport costs for imports inflate the prices of imported goods, including food, capital goods, intermediate inputs and fuel, and this increases the cost of production. This has particularly negative consequences for the competitiveness of manufactured exports which use imported inputs (Livingstone, 1987). Radelet and Sachs (1998) argue that the inflated costs of capital goods also dampen the incentive to invest and reduce the financial surplus available for investment. Payments to foreign carriers for transport services can also have significant balance-of-payments effects. Landlocked African countries have to face freight costs that absorb 30 per cent of export earnings, compared with 11 per cent if Africa is considered as a whole (Amjadi and Yeats, 1995).

Landlocked African countries face freight costs that absorb up to 30 per cent of export earnings, compared with 11 per cent in Africa.

The available evidence suggests that LDCs, and particularly landlocked African LDCs, face high transport costs (UNCTAD, 1999). A recent estimate of the transport and insurance costs faced by the LDCs exporting to the United States shows that they amounted to some 6 per cent of total imports (valued f.o.b at US ports) and that these costs were higher than import tariffs for all product groups except beverages (Borgatti, 2005b). But the extent to which this is attributable to poor infrastructure is difficult to identify. The low volume of exports limits their ability to achieve economies of scale in transport. For landlocked LDCs, high transport costs are related to geographical disadvantages and the difficulties of establishing cross-border transit systems, including both physical infrastructure and related services.

The low volume of exports limits their ability to achieve economies of scale in transport.

One of the few attempts to estimate how transport infrastructure affects trade volume was made by Limão and Venables (2001). They found that improving infrastructure from the 50th percentile to the top 25th percentile of the sample of countries increases the volume of trade by 68 per cent and that it would be equivalent to bringing a country 2,005 kilometres closer to other countries (p. 13).

Much of the research relating infrastructure to trade has focused on the effects of high transport costs on the volume on trade. But the availability of power, and particularly electricity, is important for the composition of trade. Box 16 extends analyses which have been made of how the share of manufactures within merchandise exports is related to the land abundance and skill abundance (measured by level of schooling of the population) of countries. Within these analyses, countries with a high ratio of land to skills tend to be more specialized in primary commodity exports, whilst countries with high skills to land ratios tend to be more specialized in manufactures. However, electricity availability also seems to be important. The inclusion of electricity as a factor of production shows that an increase in electricity production is closely correlated

Box 16. Energy infrastructure and the composition of merchandise exports

Wood and Berge (1997) tested the hypothesis that countries with high skill/land ratios tend to export manufactures, while those with a low skill/land ratio tend to specialize in the production of primary products. They conclude that African and Latin American countries will not be able to follow or replicate East Asia's export performance because they have a ratio of skill to land that is too low to give them a comparative advantage in manufactures. Owens and Wood (1997) included processed primary products in the analysis and found that the chances of developing countries replicating the East Asian export miracle have been improved for some of those countries only, and that the least developed countries are likely to be excluded. Their models account for only three factors of production, namely skills, land and labour force.

The "augmented" Wood and Berge (1997) model adds electricity production, a proxy for energy infrastructure, to the above three factors of production, in the original model. Three dummy variables have also been used in the model to test the impact that electricity production would have on three separate groups of countries: the LDCs, the ODCs and the developed countries. The estimated equation is:

$$\left(X_m / X_p\right)_i = \alpha + \gamma h_i - \delta n_i + \beta e_i + \sigma e_i \times D_c + \varepsilon$$

where X_m is export of manufactures

X_p is export of primary products

h represents the years of schooling per worker

n represents land per worker

e represents electricity production per worker

i identifies the countries

D_c identifies the dummy variables for the LDCs, the other developing countries and developed countries.

The export data are taken from the UN COMTRADE database, electricity production is taken from UN Energy Statistics, and land, labour force and number of pupils in secondary school (used as a proxy for skill) are taken from the World Bank's *World Development Indicators 2005*. X_m is calculated by taking the exports of manufactures, chapters 5 to 8 less chapter 68 of the SITC revision 2, while X_p is calculated by taking the exports of agricultural goods, SITC, chapters 0 to 4 plus chapter 68. Export figures include estimates calculated by UNCTAD. All variables are in logs.

Owing to the high positive correlation between electricity and skills, a variance inflation factor model was used to remove the collinearity problem.

The model was run for the full period 1990–2001 and for two sub-periods: 1990–1995 and 1998–2001. The results of the cross-county regressions are listed in box table 8. As expected, $\gamma > 0$, , >0.

Box 16 (contd.)

BOX TABLE 8. ESTIMATION RESULTS OF THE "AUGMENTED" WOOD AND BERGE MODEL

	1990–2001	1990–1995	1998–2001
LDCs			
C	-3.55*	-4.90***	-4.27***
e_i	0.36*	0.51***	0.47***
n_i	-0.19***	-0.21***	-0.14**
h_i	0.14	0.10	-0.10
$e_i * D_{LDC}$	-0.04	-0.02	0.002
Adj. R^2	0.24	0.27	0.17
F-statistics	10.04***	10.74***	7.07***
Log-likelihood	-208.62	-195.91	-219.78
Other developing countries			
c	-3.35**	-3.57***	-3.57***
e_i	0.42***	0.48***	0.48***
n_i	-0.21***	-0.17**	-0.17**
h_i	0.10	-0.07	-0.08
$e_i * D_{ODC}$	-0.11***	-0.13***	-0.13***
Adj. R^2	0.29	0.23	0.23
F-statistics	12.3***	9.63***	9.63***
Log-likelihood	-205.25	-215.68	-215.68
Developed countries			
c	-3.35**	-4.45***	-3.57***
e_i	0.30*	0.43***	0.35***
n_i	-0.21***	-0.23***	-0.17**
h_i	0.10	0.07	-0.08
$e_i * D_{Developed}$	0.11***	0.10**	0.13***
Adj. R^2	0.29	0.30	0.23
F-statistics	12.3***	12.4***	9.63***
Log-likelihood	-205.25	-193.51	-215.68
No. of countries	**114**	**106**	**115**

Notes: * 10 per cent significance level; ** 5 per cent significance level; *** 1 per cent significance level. All variables used in the regression are per worker and in logs. The estimations are White heteroskedasticity-consistent.

a Residuals from a Variance Inflation Factor model with electricity as dependent variable and skills as independent variable.

The coefficients for land and electricity are significant, while the coefficient for skills is insignificant.[1] Box table 9 shows that the elasticity for electricity is positive and that it has decreased for the other developing countries and developed economies over time, while it has remained constant in the LDCs. This shows that the elasticity for electricity production in the recent period is higher for the LDCs than for the other developing countries; and this indicates that an increase in electricity production would increase LDCs' exports of manufactures more than for the other developing countries.

BOX TABLE 9. ELECTRICITY ELASTICITY, 1990–2001, 1990–1995, 1998–2001

	1990–2001	1990–1995	1998–2001
LDCs	0.327	0.496	0.471
ODCs	0.303	0.426	0.347
Developed countries	0.416	0.527	0.476

In absolute terms, the slope coefficients for both land and electricity per worker were larger in the sub-period 1990–1995 than they were in 1998–2001 for the three groups. This could be explained by the large increase in the log (labour force) that occurred during the periods 1990–1995 and 1998–2001.

The elasticity for electricity is higher than that for land for the three groups of countries. This implies that an increase in electricity production pushes up the *Xm/Xp* ratio by more than a rise in land would push it down, leading therefore to a net increase in the export of manufactures versus the exports of primary goods. Although this net effect has decreased over time for the three groups of countries, its net impact on *Xm/Xp* for the LDCs is the greatest of the country groups considered.

Source: Borgatti (2005c).

1. Although a likelihood ratio omission test showed that the skill variable could be safely removed from the sample at 5 per cent significance level, it was kept in the model since its exclusion would not have much affected the statistical significance of the model.

with an increase in the manufactures share of merchandise exports (see box 16). This finding is significant as it implies that energy infrastructure is as important as transport infrastructure for trade development.

An increase in electricity production is closely correlated with an increase in the manufactures share of merchandise exports implying that the energy infrastructure is as important as transport infrastructure for trade development.

4. Large-scale cross-border infrastructure

Investment in cross-border infrastructure is also important for LDCs. This applies particularly to landlocked LDCs whose transit trade is affected by cross-border infrastructure. However, cross-border regional infrastructure is also important in general for encouraging regional trade (Ndulu, Kritzinger-van Niekerk and Reinikka, 2005). Regional cooperation in transport infrastructure financing can also be important for reducing infrastructure financing requirements and mobilizing financial resources (UNCTAD, 1999).

Investment in cross-border infrastructure is particularly important for landlocked LDCs.

An important innovation for this is the corridor development approach adopted in Southern Africa. This approach seeks to address the fact that transport development is a chicken-and-egg problem at low income levels. On the one hand, infrastructure investment may not be economically viable until economic activity justifies it by creating a demand for transport. On the other hand, economic activity cannot emerge and develop unless there are adequate transport facilities and traffic flows on a scale sufficient to achieve economies of scale and competitiveness in transport services. The corridor approach addresses this problem by seeking to concentrate industrial investment projects within selected corridors connecting inland production areas to ports at the same time as infrastructure investment takes place. The synchronous development of directly productive activity and infrastructure ensures a revenue stream which renders infrastructure investment attractive to private business. At the same time, the infrastructure investment attracts economic activity and helps to promote the agglomeration process. Government policy aims to attract "anchor investment" which ensures the basic viability of infrastructure investments and then seeks to attract other investment. Special attention is paid in this process to small and medium-sized enterprises, which deepen the production cluster.

The Maputo corridor, which links Maputo to Johannesburg, has been particularly successful in attracting private sector investment. It covers the development of roads, railways, border posts and ports.

The Maputo corridor, which links Maputo to Johannesburg, has been particularly successful in attracting private sector investment projects, which in 1997 constituted over 60 per cent of total transport-related projects in Africa (UNCTAD, 1999). This corridor covers the development of roads, railways, border posts and ports and runs through two very productive regions in Southern Africa. It has increased trade between South Africa and Mozambique as well as traffic of Southern African goods through the renovated ports of Maputo and Matola (Horne, 2004).

Another example of a successful cross-border transport corridor is the one created in the Greater Mekong Subregion (GMS) to facilitate intraregional flows of goods and services between Viet Nam, Thailand, Cambodia, the Lao People's Democratic Republic, Myanmar and a number of Chinese provinces. The transport corridors that are in the process of being created include a highway between Phnom Penh and Ho Chi Minh City, and two (North–South and East–West) transport corridors to better link the countries in the region. As the new transport infrastructure projects were built, cross-border transport agreements were signed in order to harmonize customs procedures, visa requirements and other administrative costs. Even though the transport corridor within the GMS is due to be completed by 2007, trade and FDI inflows have already increased (Fujimura, 2004).

E. Conclusions

This chapter has shown that there is an infrastructure divide between the LDCs, other developing countries and OECD countries. Most of the LDCs have the lowest and poorest-quality stock of transport, telecommunications and energy infrastructure in the world. The infrastructure divide is particularly important with respect to energy. The "electricity divide" has not received as much attention as the digital divide. But it is at least as significant — indeed, probably more significant — for economic growth and poverty reduction. A major constraint on the adoption within LDCs of mature modern technologies already available in developed and other developing countries is a low level of technological congruence between the LDCs and other countries. The low level of electrification is a central aspect of this lack of technological congruence and thus contributes to the maintenance of the technological gap.

The infrastructure divide between the LDCs, other developing countries and OECD countries is not only wide but also widening.

The infrastructure divide between the LDCs, other developing countries and OECD countries is not only wide but also widening. This is particularly apparent for road infrastructure. Measured by the length of the network, the stock of roads per capita in the LDCs was actually lower in 1999 (the latest year for which comprehensive data are available) than in 1990. The percentage of the total roads which are paved in the LDCs also declined over the same period. The road stock per capita declined in both African and island LDCs, and percentage of the roads which are paved declined in African LDCs. In contrast, for the LDCs as a group, the number of fixed and mobile phone subscribers per 1,000 people increased eightfold between 1990 and 2002. But LDCs are still falling behind other developing countries and OECD countries as there were more new subscribers in these last two country groups.

ODA commitments for economic infrastructure declined by 51 per cent in real terms between 1992 and 2003.

The low level and the poor quality of infrastructure stocks in the LDCs reflect weak maintenance of existing facilities and underinvestment in new facilities. This reflects declining public investment, the shift of ODA away from economic infrastructure towards social sectors, and limits to the interest of private investors in physical infrastructure in the LDCs. In real terms, ODA commitments for economic infrastructure declined by 51 per cent between 1992 and 2003. The decline in ODA committed to economic infrastructure was particularly marked in African LDCs. During the 1990s, there was an increase in private sector investment in energy and telecommunications. But private capital flows to transport have been much lower and mainly concentrated in Mozambique, where they have been associated with cross-border corridor development projects.

LDCs will need annual infrastructure investment, including new investment and maintenance costs, equivalent to between 7.5 per cent and 9 per cent of GDP.

Global estimates of future financing needs for infrastructure investment in developing countries vary according to their assumptions. But available estimates for low-income countries suggest that the LDCs will need annual infrastructure investment, including new investment and maintenance costs, equivalent to between 7.5 per cent and 9 per cent of GDP. A preliminary estimate of the transport and communications investment needed to meet the Programme of Action's infrastructure target (which is to increase, by 2010, the stock of infrastructure in LDCs in these types of infrastructure to the level which other developing countries had in 2000) suggests that annual infrastructure investment needs should be equivalent to 3.3 per cent of GDP.

An increased level of ODA inflows is required in order to meet these investment needs. Private finance can make a useful contribution to infrastructure investment in public–private partnerships, where the profit motive can be reconciled with the national interest. However, the small scale of private

flows in relation to requirements, and limits on the types of assets and countries to which it is attracted, mean that private finance will at best be a supplement to public investment programmes and ODA, rather than an independent solution to infrastructure financing, as was sometimes assumed in the 1990s. In 2004, ODA commitments for economic infrastructure amounted to $1 billion and private capital inflows for energy, telecommunications and transport amounted to $0.4 billion. Together this was equivalent to 0.7 per cent of their GDP. This is far below the estimated infrastructure investment needs, even for achieving the less comprehensive POA targets required with regard to transport and telecommunications.

Diversification into manufactures exports in LDCs is likely to be facilitated by closing the electricity divide with the rest of the world.

Increased public investment and ODA in physical infrastructure can play an important role in supporting the development of the international trade of LDCs. With improved transport and communications infrastructure, transport costs and time can be reduced, thus enabling increased trade volumes. However, this chapter also shows that investment in electricity is significantly correlated with export composition. Diversification into manufactures exports in LDCs is likely to be facilitated by closing the electricity divide with the rest of the world.

The best results from increased public investment and ODA are likely to come from a "joined-up" approach to the development of infrastructure in which international trade-related infrastructure forms an integral part.

However, it is important that increased public investment and ODA in physical infrastructure within the LDCs do not focus on trade-related infrastructure alone. The best results from increased public investment and ODA are likely to come from a "joined-up" approach to the development of infrastructure in which international trade-related infrastructure forms an integral part. Such an approach should encompass the development of rural infrastructure, large-scale national infrastructure and cross-border infrastructure. Rural infrastructure is vital for agricultural commercialization and productivity growth and the development of local off-farm activities. Large-scale national infrastructure is vital for enabling economic diversification, the exercise of entrepreneurial capabilities and the development of production linkages as well as international trade. Cross-border infrastructure can reduce financing requirements, open new trading opportunities in intraregional trade and provide the basis for better transit facilitation for landlocked LDCs.

Notes

1. The composite infrastructure index is constructed by (i) normalizing the indicators for access to electricity, telephone density per 1,000 people, paved roads as a percentage of total roads and road density per square kilometre so that for each indicator the mean is zero and the variance is one, and (ii) summing up the normalized data with equal weighting for each infrastructure indicator.
2. This partly reflects low population density in the African LDCs. But studies which have sought to adjust for this factor show that African countries generally have a poorer rural road infrastructure (see Spencer, 1994).
3. The statistical analysis is a non-hierarchical K-means cluster analysis which classifies countries according to their similarity or dissimilarity on multiple indicators.
4. The efforts by Estache and Goicoechea (2005) in providing a snapshot of the infrastructure sector at the end of 2004 are notable, although they do not fill all the gaps. Certain series suffer from data unavailability problems more than others. Transport statistics are plagued with data unavailability problems and energy statistics are totally rudimentary, but data on telecommunications are readily available for a large number of LDCs.
5. Bangladesh, Bhutan, Burundi, Democratic Republic of the Congo, Ethiopia, Madagascar, Maldives, Myanmar, Nepal, Uganda, Vanuatu, Yemen, and Zambia.
6. These figures are based on IMF (2004).
7. Using the MDG targeted 7 per cent growth rate, Estache (2004) found that sub-Saharan Africa requires investment of the order of $20 billion per year in 2005–2015, including both capital and maintenance expenditures. Fay and Yepes (2003) estimate an annual infrastructure investment need for sub-Saharan Africa equivalent to $13 billion per year in new investment and $13 billion per year in maintenance costs between 2000 and 2010. World Bank (2000) estimates an infrastructure financing need of $18 billion per year to improve infrastructure services and competitiveness in sub-Saharan Africa.

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