

Do demographic factors influence investment in infrastructure?

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Infrastructure in the news!

- “It is time to invest massively in infrastructure, in research, in innovation , in education, in training people, because it is now or never.” Pres. Sarkozy, November 28, 2008
- China is accelerating plans to build more nuclear power plants and a vast natural gas pipeline. Italy may erect the first bridge connecting Sicily to mainland Europe. W. Post, Nov 29, 2008
- “Obama suggested that an expansion of wind and solar power generation would be part of his stimulus plans...[also] a plan being circulated...that would offer government loans to help schools update their heating and cooling systems” W. Post Nov 29,2008

Defining infrastructure: a broad concept

- **Spatially universal** infrastructure: housing, water, sanitation, social services
- **Economically productive** infrastructure: energy, ICT, irrigation, ports, transport
- **Spatially connective** infrastructure *within* a country
- **Regional** infrastructure (whether to regional markets or to global markets)

Distinguish

New investment

VS

Rehabilitation investment for existing
infrastructure

VS.

Operations and maintenance (O&M)

- Substitution possibilities: increase quality of infrastructure investment changes level of demand and periodicity of demand for O&M, with obvious fiscal consequences

Four Issues to Examine

- How might demographic factors influence the demand for infrastructure?
- Have demographic factors played a key role in the past in influencing infrastructure investments?
- What do projected demographic trends suggest about infrastructure needs, particularly in LICs?
- What are the policy implications?

Issue 1

**How might demographic factors
influence the demand for
infrastructure?**

In principle, many demographic variables influence the *need* for infrastructure

- Population size
- Age structure of the population
 - Share of young? Elderly?
- Population dynamics: what stage of the demographic transition?
- Density: smaller cities (<100,000; 100,000--1 million, rural settlements) vs. mega-cities
- Extent of migration: urban-rural; international
- Basic econometric models typically include: population size, density, urbanization rate

Population size and age structure

- Population *size* influences the demand for basic service infrastructure (though influenced by economies of scale):
 - Water and sanitation
 - Basic social services infrastructure
- Age structure of population:
 - Young population: obvious bias toward demand for educational infrastructure
 - Working age group: public infrastructure to provide complementary inputs for private sector productivity
 - Elderly population: need an elderly-friendly infrastructure

Dynamics of population structure

- Stage of demographic transition determines appropriate composition
- *Not yet in transition*: need to scale up educational infrastructure
- *As overall dependency rates decline and growing labor force*: need infrastructure to foster job creation
- *With aging population, increased elderly share and possibly declining population*
 - Downsizing may be necessary
 - Need infrastructure appropriate for elderly

Mixed evidence on implications of increased urbanization for infrastructure

- Economies of scale and benefits of higher density in reducing per capita costs for water, sanitation, power, transport infrastructure, and possibly social services.
- But greater overall costs per capita in urban areas for basic services (higher quality/quantity of services)
- BUT urbanization will strain the fiscal capacity of urban areas to respond to new infrastructure needs:
 - Note significant disparities within urban areas between urban poor and other groups; slums;
 - Also. urbanization not just mega cities. Differential in infrastructure costs per capita with rural areas may be less in smaller cities.

Urbanization has other effects

- The need to feed an urban population creates pressure for
 - infrastructure to support domestic agricultural production
 - capacity for supplying a city (ports, railways, transport networks to the city)
- As city grows, existing infrastructure becomes inefficient and needs to be replaced
 - investments in new approaches for supplying water or sanitation

Urbanization & climate change

- Increased urbanization, particularly coastal cities, also puts pressure on ground water and causes ground subsidence
 - Forces consideration of alternative sources of water & requires better urban water demand management
- *Even without climate change in the future,* infrastructure needed to limit risks posed from storms, wind damage, storm surges
 - Higher likelihood of residual damage from the occasional extreme storm event.
- **Coastal protection infrastructure** will be a key element in reducing risk

Migration will also shape expected demand for infrastructure

- Will migration be to smaller cities? To mega cities? To peripheral exurbs?
- Sources of internal migration and effects on infrastructure needs in exporting areas
- *Endogeneity factor*: provision of infrastructure may induce in-migration! What are the policy implications?
- Is immigration likely from neighboring countries?
- Conversely, will out-migration dampen domestic demographic pressures and influence population size and age structure?

But *other factors* shape demand and level of infrastructure investment: Technology!

- **Technological change** affects the nature of demand for infrastructure: can *induce or create demand* for new kinds of infrastructure or *substitutions*, particularly for big ticket items: energy, transport, ICT
 - Dedicated urban bus lanes vs auto-driven transport network in urban areas
 - ICT: role of land lines—cable optic fibre vs cell phone towers; do conventional technologies become outmoded?
 - Energy sector: Is there a shift towards renewables
- Is there a potential for economies of scale?
- Are infrastructure substitutions possible even for universal services--WSS

Level of development and growth imperatives

- Infrastructure can facilitate/stimulate growth
 - Provide complementary inputs to private sector
 - Key policy issue: what infrastructure appropriate at different phases of development?
 - Role of FDI
- But reverse causality: growth and rising PCI will stimulate demand for infrastructure
 - Need to upgrade infrastructure to meet pressures and demands for energy; ICT; water; transport networks, etc
 - Demand for higher standards of infrastructure

Stage of development *itself* fosters demand

- In LICs and MICs, major differential between infrastructure in urban and rural areas. *Major backlog of need!*
- In industrial countries, *convergence* of basic infrastructure (WSS, medical, roads, education) per capita in urban and rural areas
- WEO (2008) notes rapid growth of demand for car ownership as PCI approaches a given threshold: intensifies demand for associated infrastructure: urban and interurban
- *WDR 2009* notes policy reactions *against* excessive growth of megacities and efforts to develop alternative urban centres. But still new demands for infrastructure.

Another factor to consider: the MDGs!

- MDG 7 relates to “ensuring environmental sustainability”
 - Target 7c: Reduce by half the proportion of people without sustainable access to safe drinking water and basic sanitation
 - 7.8 Proportion of population using an improved drinking water source
 - 7.9 Proportion of population using an improved sanitation facility
 - Arguably Target 7d: Achieve significant improvement in lives of at least 100 million slum dwellers, by 2020
 - 7.10 Proportion of urban population living in slums
- **Simply to meet MDGs, particularly with rapidly growing urban populations, need to invest significant sums in infrastructure**

Climate change as a factor

- Future climate change may significantly exacerbate pressures from urbanization.
 - Undercut viability of some areas for settlement
 - Increased risk of flooding, major disruption of trade
 - Looking forward, may engender migration or resettlement, creating new demands for infrastructure
 - May influence the viability of existing infrastructure
- *Difficult to separate out the pressures from demographic change from the associated developments that can accompany such demographic change*
 - *viz., subsidence; socioeconomic development; etc*

One last important factor: fiscal constraints limit whether infrastructure investments respond to demographic needs !

- Infrastructure: usually a *public good*—*subject to economies of scale; externalities; spillover of benefits (and costs)*
 - Externalities often large and capacity for excludability may be limited--- such infrastructure may not be viable on commercial terms for much of the population
 - *Some exceptions:* some infrastructure, e.g., satellites, telecommunications, can be undertaken privately;
- At all PCI levels, fiscal constraints dictate adequacy, quality, and magnitude of the infrastructure to be provided.

Fiscal constraints (continued)

- *These constraints are more binding for LICs with low tax ratios, limited capacity for debt absorption, and heavy reliance on external assistance*
- Even where public-private-partnerships (PPPs) are used, fiscal contingent liabilities engendered;
- *Public policy thus critical in influencing what infrastructure choices are made: where?; how much? what technology? what policy issues dominate?*

Issue 2

Have demographic factors played a key role in the past in influencing infrastructure investments?

Raw facts suggest otherwise. Look at Africa's infrastructure deficit relative to other low income countries (Foster, 2008, p.2)

Africa's infrastructure deficit	SSA	Other LICs
Paved road density (km/km ²)	31	134
Total road density (km/km ²)	137	211
Mainline density (lines/1000 inhab)	10	78
Mobile density (lines/1000 inhab)	55	76
Internet density (lines/1000 inhab)	2	3
Power generation capacity (MgWt/M ³ inhab)	27	326
Electricity coverage (% of population)	16	41
Improved water (% of population)	60	72
Improved sanitation (% of population)	34	51

Recent World Bank “Africa Infrastructure Diagnostic” studies reveal that

- Power consumption in Africa only 10% that in developing world *and falling* (124 kwh per capita per year)
- Since 1990, little change in share of population with access to land-line telephones, flush toilets or piped water. Only small improvement in population share with access to electricity (22% to 28%)
- Rapid urban growth “leaving infrastructure service providers severely stretched,...resulting gap [in water and sanitation] filled by lower cost alternatives such as boreholes and pit latrines”

Source: Foster 2008

Issue 3

What do projected demographic trends suggest about infrastructure needs, particularly in LICs?

A few key demographic factors to consider

- Growth of population
- Projected urbanization rates
- Projected growth in the size of school age and working age populations
- Projected growth of elderly--in LICs and MICs; in industrial countries

Africa: Seeking to catch up

Asia: moving to the next level

Compare two recent estimates of infrastructure needs over next 5 -10 years in Asia (Yepes, 2008) and Africa (Foster (2008))

	Africa		Asia		
Annual required spending as percent of GDP per annum	New	O&M	New	O&M	
ICT	.1	.1	.5	.9	
Irrigation	.2				
Power	4.2	2.4	2	1	
Transport	1.7	1.5	.9	.5	
Water and Sanitation Services	.4	1.2	.2	.4	
Total	6.9	5.2	3.6	2.8	

In considering linkage between demographic projections and infrastructure needs, policy makers should differentiate need for:

- **Basic infrastructure:** WSS and infrastructure for basic social services (education and health)
 - A function of overall population growth
 - Recognize “need” and “effective demand” are different
- **Economic infrastructure:** *complementing* workforce in manufacturing and services & facilitating growth and employment in urban areas
 - Will be influenced more by urban growth
- **Connective infrastructure:** WDR2009 emphasizes need to facilitate growth in non-urban areas through transport connections

What do demographic projections portend about the overall need for infrastructure?

	2005-2025				2025 - 2050			
	0-14	15-59	60+	urban	0-14	15-59	60+	urban
Africa	+124	+306	+42	+285	+53	+434	+117	+584
Asia	-26	+521	+346	+795	-132	+80	+886	+1046

- **First**, start with **absolute growth of population** between 2005-2025: Africa 482 million Asia 841 million
- Whether in absolute population increase, level per capita of infrastructure, and even in terms of capital complementing increased workers, the major focus: Asia through 2025
- *But, after 2025, Africa will be focus for the major increase in infrastructure required for economic growth*
- Minimal increase in working age group in Asia after 2025 and large increase in the number of elderly

Define three categories of country

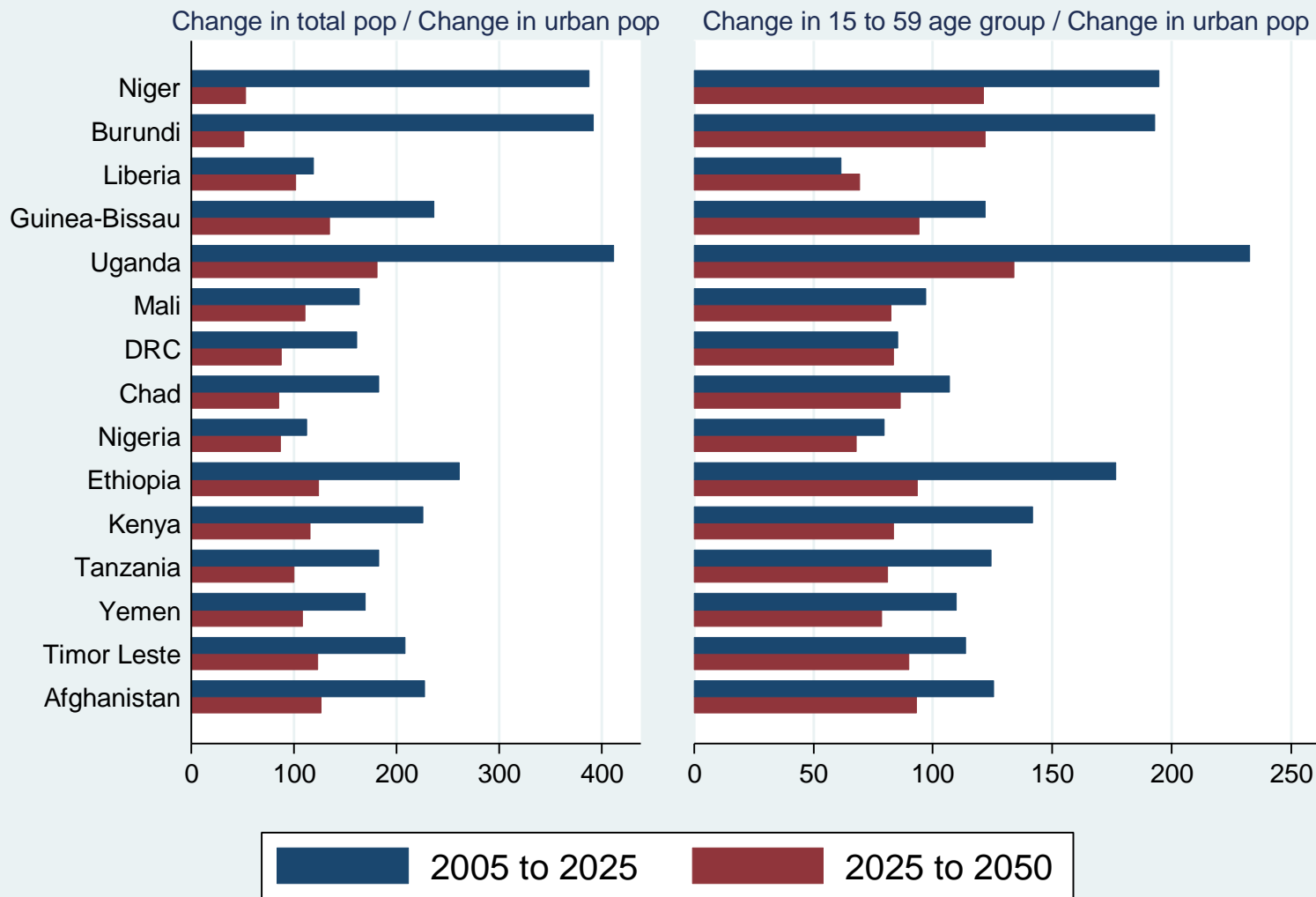
- 1. Early in demographic transition**
- 2. Mid-demographic transition**
- 3. Late demographic transition**

First category of countries: those experiencing fastest rates of population growth : early in transition

- Niger, Burundi, Liberia, Guinea-Bissau, Uganda, Mali, DR Congo, Chad, Afghanistan, Timor Leste, Yemen, Nigeria, Ethiopia, Kenya, Tanzania.
- **For these, a need for basic services infrastructure**
 - UN Population projections (med variant) assume gradual reduction in fertility rate over time.
 - *If this holds*, countries will observe classic early phase of the demographic transition:
 - falling dependency rates,
 - rising shares of the population in the 15-59 working age group.
 - Higher fertility assumption would imply need for additional infrastructure for schooling and less domestic resource availability with higher dependency burden!

- These are also countries where a significant percentage of the increased population will be in urban areas, *particularly* during 2025-2050
- In some countries, the increased urban population will be dominated by the working age group,
 - Suggests *relatively greater importance of infrastructure*—power, telecommunication, transport—that facilitates increased investments for services and manufacturing, relative to “universal services” infrastructure.

Rapid urbanization dominated by working age group population

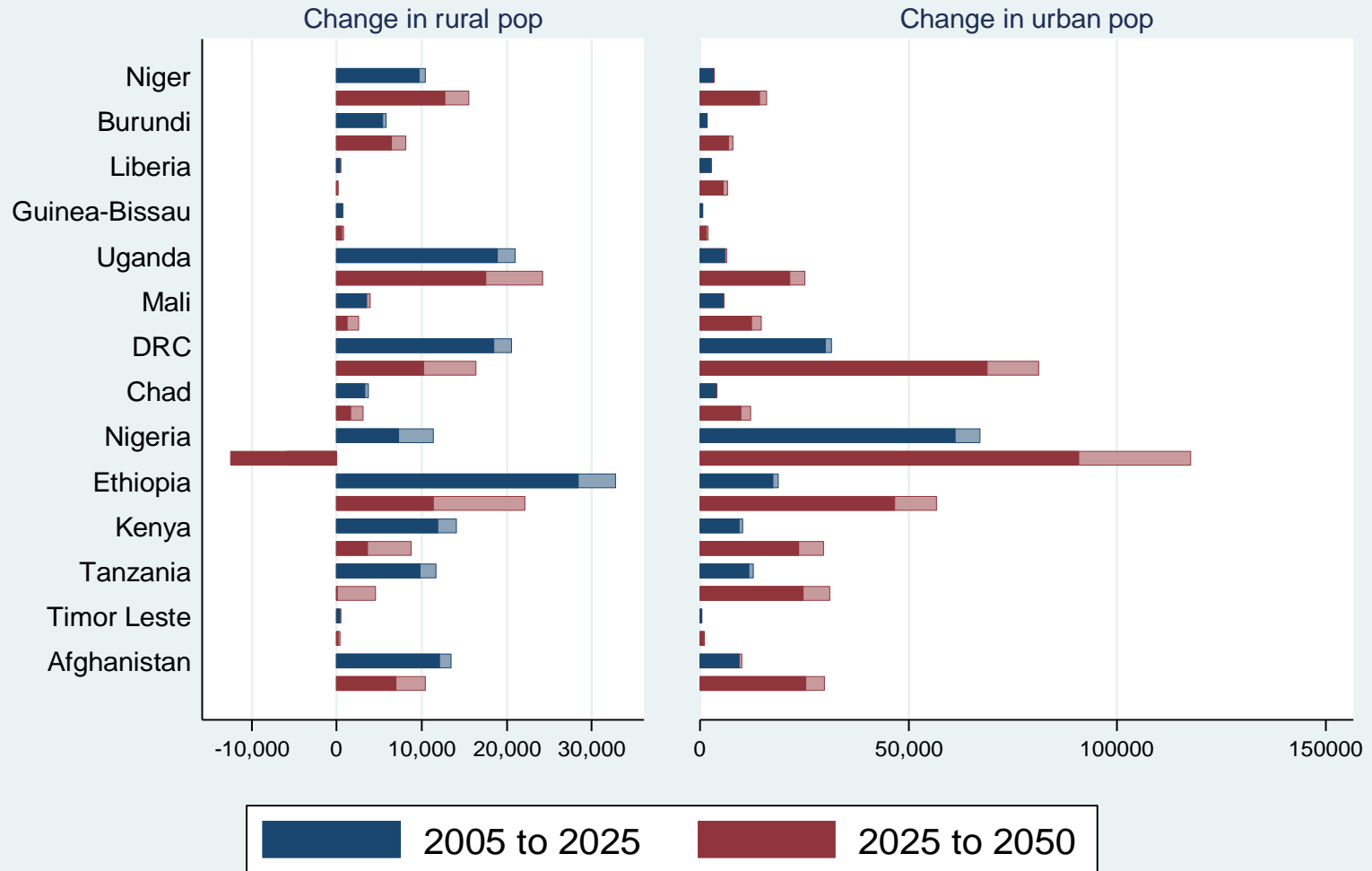


Source: United Nations Population Division

Despite urbanization, for many countries, also a growing number living in the rural areas needing basic infrastructure

- *Particularly for next 20 years*, before urbanization process in these countries picks up scheme
- Rural infrastructure needed *both* to address dramatic existing deficiencies as well as to respond to growth in rural population
- For rapidly growing population countries—Niger, Burundi, Guinea-Bissau, Uganda, Ethiopia, Kenya and to lesser extent Tanzania, DR Congo, and Afghanistan, connective transport routes will also be important
- Number even larger if one accepts that median population variant probably too optimistic

Countries in early phase of demographic transition: rapid urbanization but rural areas still important



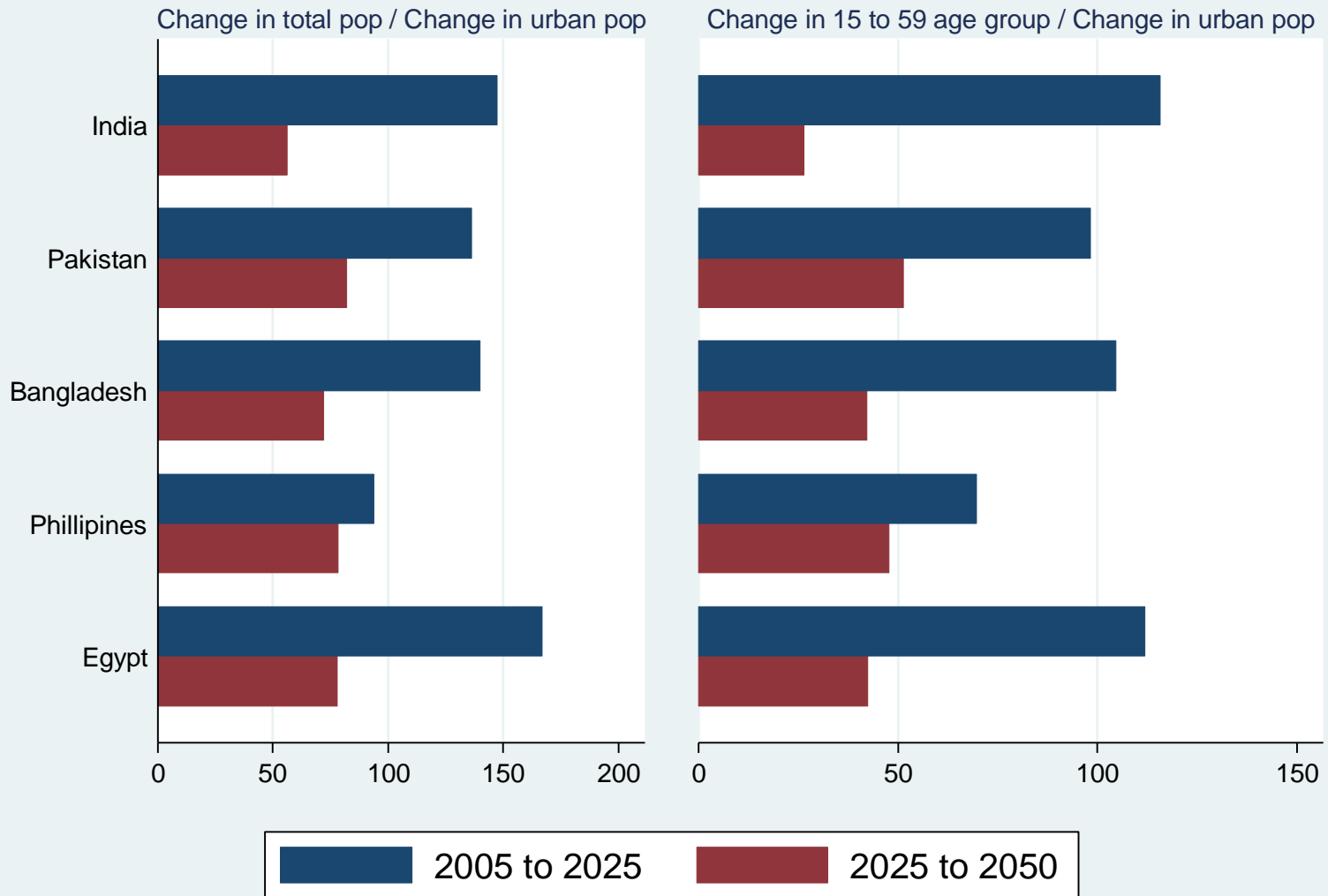
Source: United Nations Population Division

Light areas indicate high variant projection - Population in 1,000s

A second category of high population growth countries: but with fertility declining

- **Further along the demographic transition:** India, Pakistan, Bangladesh, Philippines, and Egypt.
- Significant *absolute* increases in population through 2050.
- Share of working age population will remain roughly unchanged (as will the dependency rate),
- But *significant shift* in population structure towards elderly and away from youth populations.
- Also a dramatic shift, particularly after 2025, in urbanization rate, with sharp fall in rural population.
- **Higher urbanization in these more lower-middle and middle income countries may entail higher per capita infrastructure costs**

Countries where urbanization starts to deplete rural areas and include all age groups



Source: United Nations Population Division

- **For 2000-2025, growth of rural population will still be substantial**, particularly for India, Pakistan and Egypt, even though dwarfed by growth in urban areas. **Basic infrastructure required as well as connective transport**
- However, dramatic decline in rural sector post-2025 suggests limits on quantity and quality of infrastructure needed for next decade or so

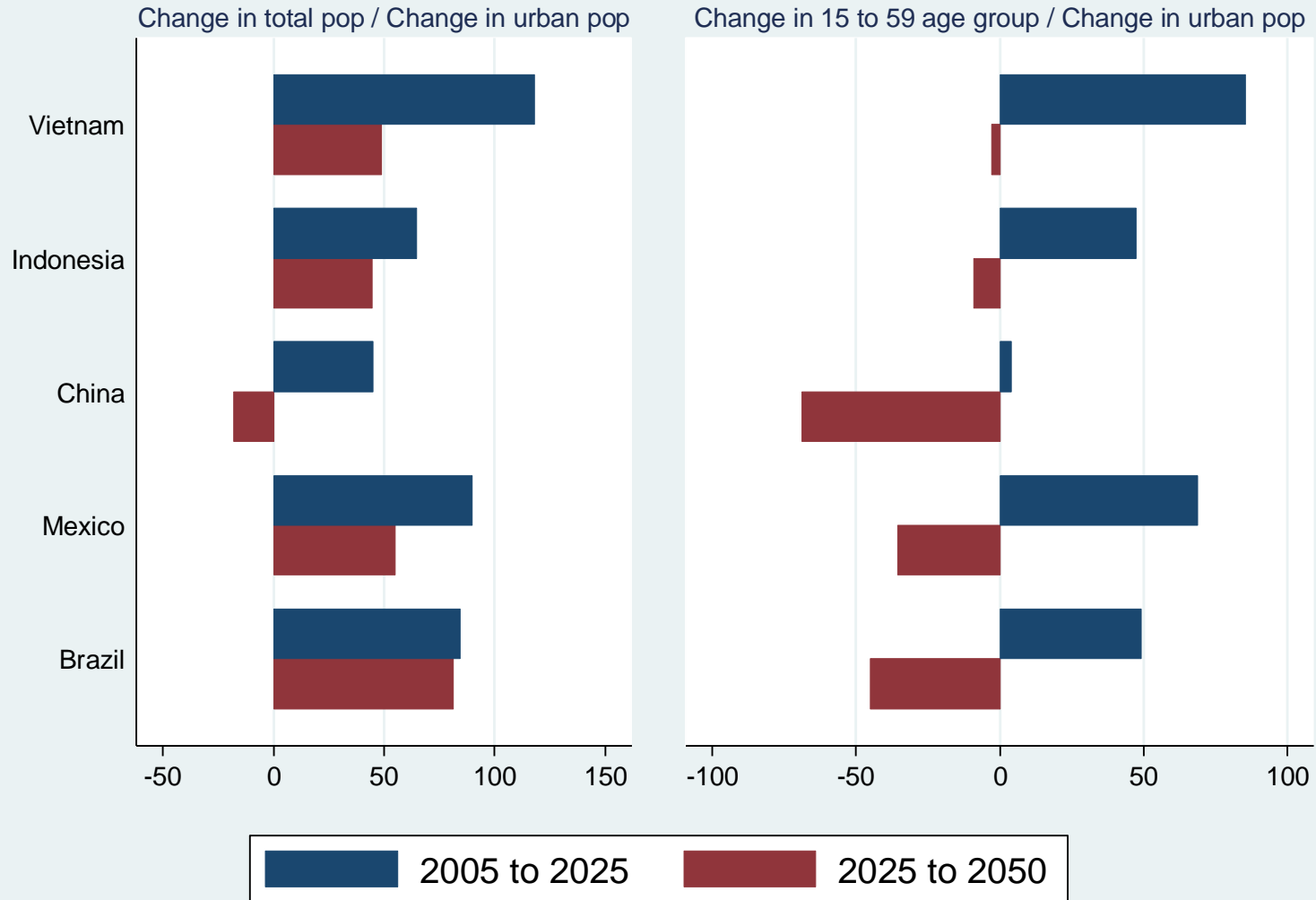
Third category of country: low fertility rates and well advanced in demographic transition.

- Project increase in overall population in coming decades
- But *sharp decrease* in share of young, increase in elderly
- Large drop in working age population share \Rightarrow an increase in overall dependency rate
- Substantial increase in urbanization rate
- *Absolute population decline* in rural areas, even in next decade or so
- Category includes: China, Vietnam, Mexico, Brazil, Indonesia

Third category of country (cont)

- Expect, over time, deceleration in the growth in demand for productive infrastructure
- Demand for more basic infrastructure services may be greater, reflecting higher level of urbanization
- With rising incomes, demands for upgraded quality of infrastructure in rural areas: convergence factor

Advanced demographic transition: rural areas losing population and shift of urban population towards the elderly



Source: United Nations Population Division

Footnote issue: the elderly and infrastructure

- In many industrial and middle income countries, will see a large increase in the both the share and absolute numbers of elderly, relative to other segments of the population.
- Many retired, many working part-time
- How would this population transition be reflected in demands for infrastructure?
- Singapore: one of the few countries that have actively considered this issue and asked what policy/spatial/infrastructural changes would be needed to cope with an aged society (Committee on Ageing Issues: Report on the Ageing Population (2007))

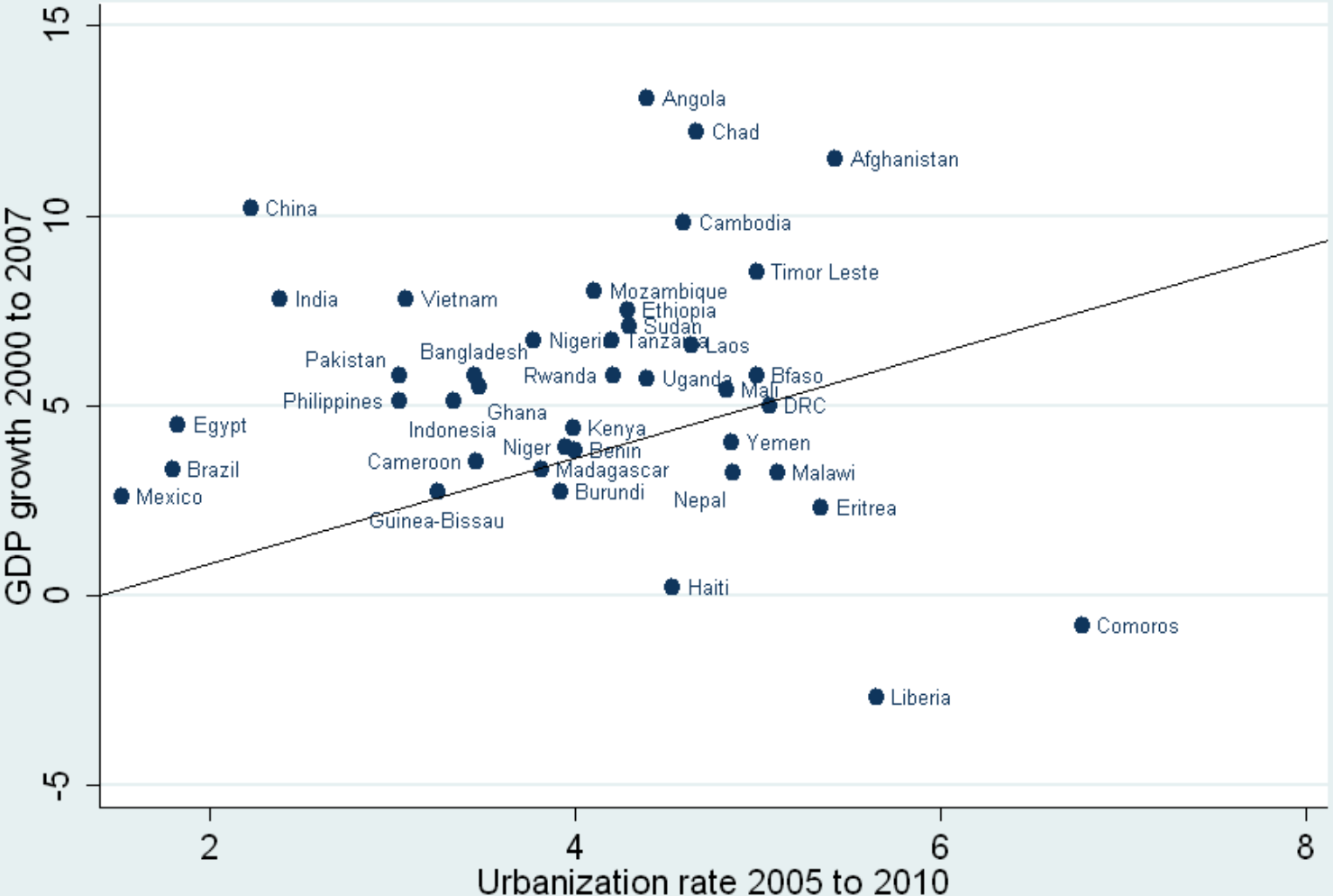
Example: Recommendations of Singapore's Commission on Aging

- Guidelines needed on providing accessibility and safety features in the homes for seniors,
- Make all new public buses low floor step-free and wheelchair-accessible to allow everyone to use the public transport system.
- Expand and accelerate the upgrading and improvement of existing barrier-free measures on road facilities to enhance accessibility between destinations
- Establish a new intermediate government residential care facility to address the current service gap in intermediate residential care for seniors.
- Develop integrated models of day care and day rehabilitation centres, based on market driven needs, to provide more client-centric and efficient services.

But fiscal constraints will determine whether infrastructure needs can be met

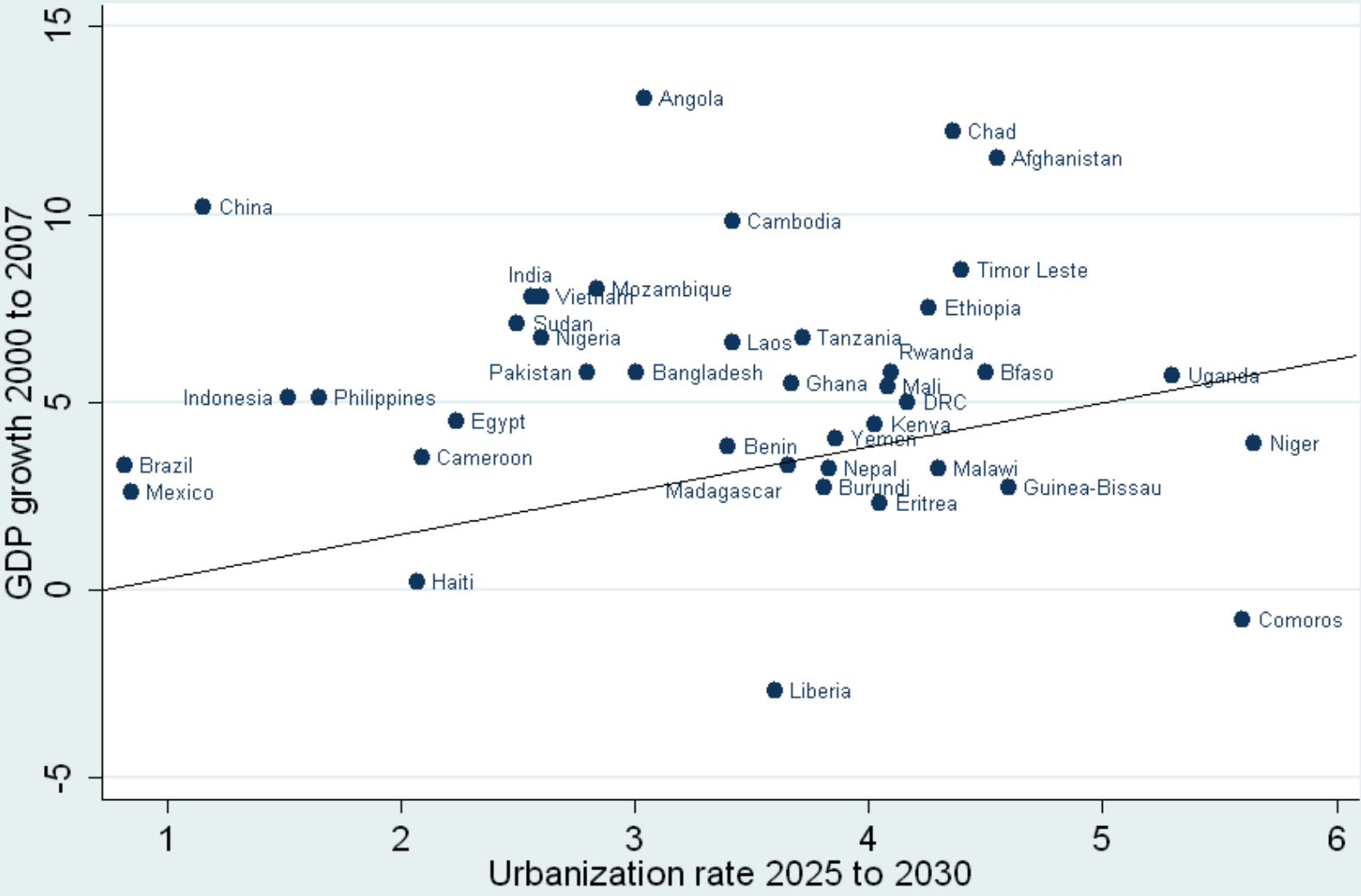
- How to finance higher urban infrastructure spending?
- Many high population growth, rapidly urbanizing countries, have economic growth rates *less than* rate of urbanization.
- Issue: projections of urbanization presumed *not* to be a function of an assumed higher rate of economic growth

Will growth be sufficient to meet the needs of rapidly urbanizing population: 2005-10?



Source: United Nations Population Division

Will growth be sufficient to meet the needs of rapidly urbanizing population: 2025-30?

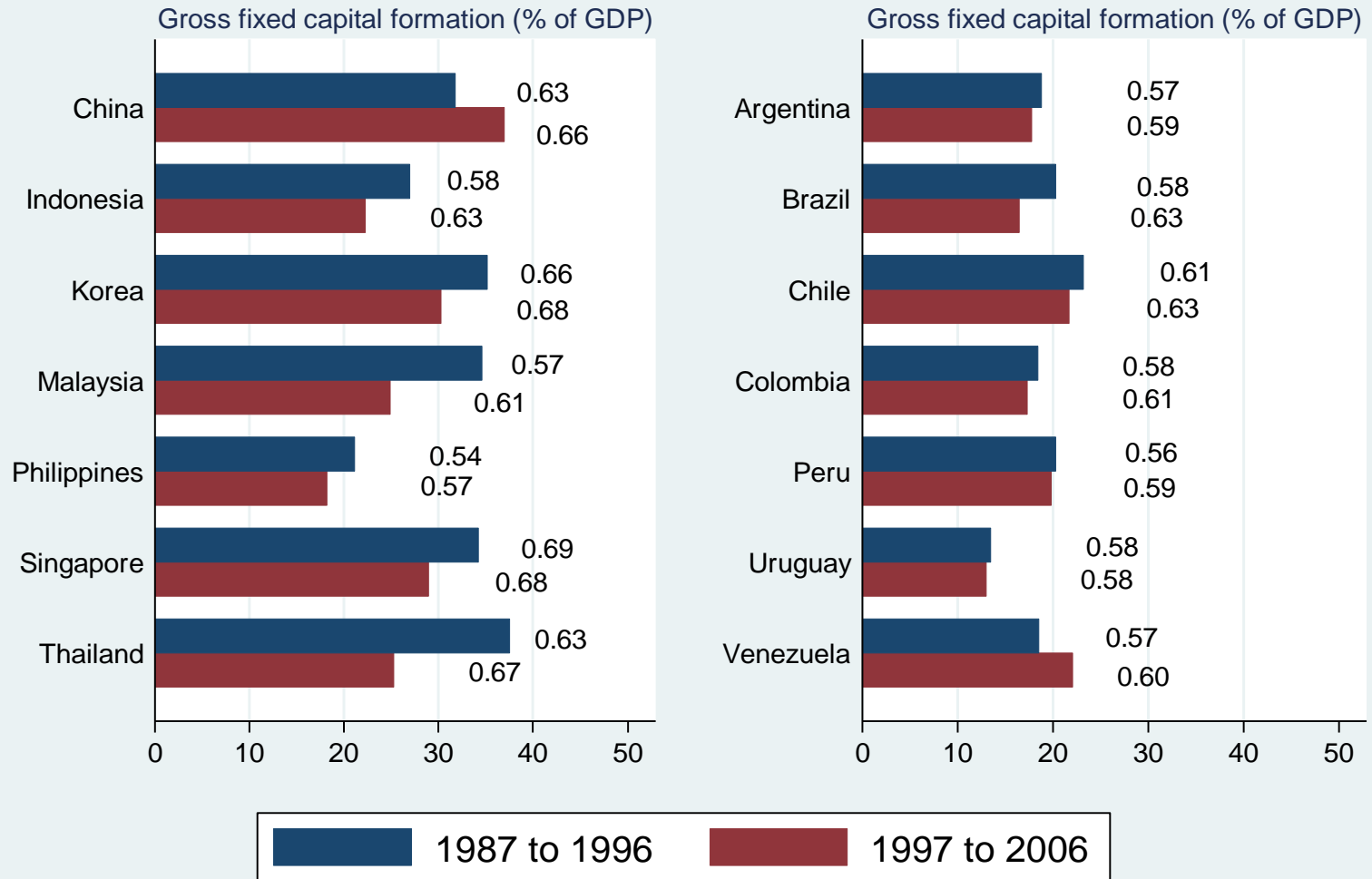


Source: United Nations Population Division

In principle, demographic transition can allow for higher savings and investment rate

- Higher working age group shares and lower dependency rate: *potential* for increased savings rate and higher rate of capital formation (including of infrastructure), *and* economic growth rate.
- As with Asia, higher growth in labor force might prove attractive for foreign investment. Also financing infrastructure
- But note difference between Latin America and Asia in level of investment associated with lower dependency rate
- *So*, higher growth may not materialize commensurate with higher level of productive age work force

Contrast Asia and Latin America: A lower dependency rate not necessarily associated with higher investment rate



Source: World Development Index

Numbers indicate Ratio of 15 to 59 age group to total population

Links of demography with climate change and urbanization will influence infrastructure spending

- Significant concentration of major urban areas in coastal or river ports or in deltaic regions.
- Combination of socioeconomic development, population growth, and possibility of human-induced subsidence in these urban centres will dramatically increase the risk of their exposure-- both in terms of population numbers and value of assets--to the impact of flooding, storm surges and wind damage *even in the absence of the higher sea level and increased storm intensity associated with climate change* (Source: OCED (2008))

- Population increases alone would see a 150% increase in number of population exposed to risk of 1:100 year storm, even with no other factors involved (40 million in 2000 to 95 million in 2070);
- Including storm enhancement, sea level rise, human-induced subsidence, population at risk rises to 140 million
- Assets at risk rise from \$3 trillion to \$35 trillion over the period

The largest increase in exposure to such risks will be in LICs in Asia and Africa

- Significantly exposed in terms of population at risk if not value of assets Reflecting minimal existing flood/coastal protection infrastructure; sharp increases in population centres; limited urban land-settlement programs; and rapid socioeconomic development
- In terms of magnitude of exposure, Asian cities will be among the greatest at risk
- But a number of African countries as well will be

Among top 30 cities with maximum exposure in terms of population at risk

- Asian non-MDC cities at risk (population)
 - Kolkata
 - Mumbai
 - Dhaka
 - Guangzhou
 - Ho Chi Minh City
 - Shanghai
 - Bangkok
 - Rangoon
 - Haiphong
 - Tianjin
 - Khulna (Bangladesh)
 - Ningbo
 - Chittagong (Bangladesh)
 - Jakarta
 - Shenzhen
 - Qingdao
- Africa
 - Alexandria
 - Lagos
 - Abidjan
- South America
 - Guayaquil

NOTE: 13-17 deltaic cities found in top 20 rankings

Source: OECD (2008)

Among top 20 world cities with highest proportional increase in exposed assets at risk by 2070 relative to current situation, 19 are in Asia

Asia

- Ningbao
- Dhaka
- Kolkata
- Fuzhou
- Tianjin
- Surat
- Xiamen
- Guangzhou
- Mumbai
- Hong Kong
- Jakarta
- Zhanjiang
- Haiphong
- Bangkok
- Shanghai
- Ho Chi Minh City
- Shenzhen
- Guayaquil

Africa:

- Alexandria

Source: OECD (2008)

Issue 4

Policy Implications

What are the implications for policy makers in considering infrastructure investments?

Projecting infrastructure needs: yes, consider demographics *but*:

- Cannot simply project growth of population and apply existing per capita infrastructure to the growth in the population: backlogs may be substantial!
- Nature of demographic change--dynamics of age structure; aging population or young population; urbanization profile and trends; migration--all will influence infrastructure priorities
- And, infrastructure may influence demographic trends--fertility rates as well as migration patterns

Demographics only takes you so far in considering policy

- Fiscal constraints force choices--may require a balancing in responsiveness to demographic factors vs other factors, such as:
 - Providing preconditions for growth
 - Responding to new technological developments
 - Climate change impacts
 - Choosing among *alternative technologies* and *standards* in providing basic infrastructure
- And no easy out on fiscal constraints: PPPs typically entail significant contingent liabilities

Indeed, economics and policy literature predominantly focus on how infrastructure can contribute to growth!

What are good choices? Bad choices? WDR 2009 would say:

- In considering whether to invest in infrastructure, *follow the market, don't lead it!*
- In LICs, issues of equalization /convergence assumes much less prominence than arguments that offer prospect of higher economic growth.
- Equalizing infrastructure per capita only assumes importance when countries become sufficiently developed that it becomes politically unacceptable to have significant inequalities

Other policy considerations

- What infrastructure is needed to become or maintain competitiveness? To attract FDI?
- What infrastructure required to restructure modes of energy generation? To adjust to higher future carbon prices? Geo engineering? Clean coal? etc
- What is required to achieve greater efficiency in use of water resources?
- What may be required to adapt to climate change (to maintain economic viability)? Will your coastal cities need to adapt to respond to effects of higher sea level?

And *policy choices* on infrastructure can be made for the *wrong reasons*

In LICs, large scale of infrastructure spending contracts can lead to

- Rent-seeking
- Inappropriate absorption by the public sector of contingent fiscal risks in negotiation of PPP contracts
- Corruption inducing
- Collusion between donors (seeking export promotion favoring industrial interests) and politicians seeking graft
- Prestige projects (politicians; donors)-ribbon cutting

What countries have been more successful in thinking about infrastructural implications of demographic change?

- Bombay
- Bangkok
- Korea--particularly re decentralization
urbanization through transportation linkages
- Shanghai
- Singapore: re elderly issues

Two final questions? Is there a link from infrastructure to demography? Should it motivate policy on infrastructure spending?

- Might the availability of infrastructure *influence* the extent, focus, and direction of migration (e.g., China's strategy for employment creation in eastern regions?)
- *Absence* of infrastructure: clean water, sanitation, medical care infrastructure—may increase mortality and morbidity rates. Might it *delay* decline in fertility associated with demographic transition?
- Provision of infrastructure, e.g., facilitating girl's education (separate toilets), may indirectly influence fertility decisions

The *cost* of infrastructure may influence policies towards fertility

- Awareness of cost of infrastructure--and need to meet basic needs and provide basic infrastructural services--may sensitize policy makers to the importance of policies shaping demographic situation
- Failure to limit population growth, resources will be preempted by need to respond in terms of more infrastructure for schools, etc