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A sector that cannot be ignored

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Infrastructure investment has grown strongly over the last 20 years and, in particular, since 2000. While there has been a sustained increase in investment in advanced economies, the growth in developing economies has been particularly strong. Infrastructure Industry Report 2014 by David Hale Global Economics (DHGE) indicates that this will continue over the next two decades and beyond. In order to facilitate this growth, the role of the private sector will increase dramatically. Hence, infrastructure investment is a secular trend providing long-term opportunities.

INFRASTRUCTURE INVESTMENT HAS GROWN STRONGLY IN THE LAST TWENTY YEARS

Infrastructure assets have shown significant growth in the last twenty years:

- Electrical capacity has grown by 3.2% Compound Average Growth Rate (CAGR).
- The total length of paved roads has grown by 1.8% CAGR.
- Rail network length has grown by 0.4% CAGR.
- Port traffic has grown by 9.9% CAGR.
- Airport runway capacity has grown by 1.2% CAGR.
- Water and sanitation connections have grown by 2.7% and 3.1% CAGR respectively.

The rapid economic growth of emerging economies, in particular in Asia, has been a driver of much of this growth. But, advanced economies have also shown strong growth in particular in port throughput. Investment trends are likely to be higher than these figures, as quality of infrastructure has also improved.

GROWTH IS SET TO CONTINUE

DHGE has developed a detailed model relating historic infrastructure investment across the world to underlying economic, demographic, urbanisation trends and other data. Using this, it has made forecasts of regional and sectoral growth rates, showing that while overall rates of growth in underlying infrastructure are likely to slow from those observed in the last 20 years, nevertheless there will still be strong underlying growth. The value of global infrastructure assets will grow by 5.4% CAGR (or 3.1% in real terms) over the period to 2030.

This is driven by a growth in electrical capacity (2.5% CAGR); a 2.2% CAGR increase in road network length; a 0.6% CAGR increase in rail networks; a 5.2% CAGR growth in port traffic; 0.6% increase in runway capacity; and a 1.8% to 2.3% increase in water and sanitation connections. Again, future growth will be higher in emerging economies.

This analysis suggests an overall spend on infrastructure of US$67 trillion over 2010-2030 (in constant 2010 US$). This is similar to the estimate made by McKinsey (2013) which projected US$62-67 trillion based on a top-down methodology.

INFRASTRUCTURE IS IMPORTANT AS A WAY OF FACILITATING ECONOMIC GROWTH

Infrastructure investment has become a focus of public debate, in particular because it is believed to facilitate economic growth. Indeed, as part of its role in hosting the G20 meetings in 2014, the Australian government highlighted infrastructure investment as one of the elements in its plan to raise global growth by 2% over the coming five years.

There has been much research analysing the relationship between economic growth and infrastructure investment. The relationship goes both ways - infrastructure investment can cause growth, because it contributes to raising productivity, but growth prompts investment infrastructure as existing facilities become congested. There is, however, good quantitative evidence of the impact of investment on growth. The most thorough was published by the World Bank in 2011, analysing data from 88 countries over 40 years (1960-2000). The study found that a 10% increase in infrastructure investment leads to a 0.7% to 1.0% increase in GDP.

The Infrastructure Industry Report 2014 presents analysis by DHGE of more recent data, covering 57 countries over the period 1990 to 2011, and found that a 1.0% increase in the capital stock leads to over 0.1% increase in GDP in the following five years (which could be expected to be sustained).

Because infrastructure and growth are intimately related, it is increasingly becoming reflected in government policy in both advanced and emerging economies.

THE ROLE OF THE PRIVATE SECTOR WILL INCREASE

Private investors have been involved in development of economic infrastructure for centuries, but public ownership was dominant in many countries until the latter part of the twentieth century. From the 1980s, policy changes in the UK and other countries highlighted the benefits of private ownership, combined with more effective economic regulation of infrastructure and/or move to greater role for markets. Subsequently, many billions of assets have been sold by governments to the private sector, and governments have also been actively finding ways to facilitate new private investment in infrastructure assets. With all these moves, the role of the private sector in electricity, gas, water, road, rail, airport and other infrastructure industries has become well accepted. DHGE estimates that the private

sector owns between 50% and 75% of all infrastructure in advanced economies. In developing economies, the value of investments in infrastructure with private sector participation grew from US$10bn in 1990 to US$180bn in 2012.

There is enormous scope for further private sector involvement. For example, in the US, private road ownership is very limited and no airport is yet in private hands, although there is a long history of private ownership of electricity, water and rail assets.

Government debt as a share of GDP in advanced economies has risen from 60% in 1995 to 107% in 2012 and, as a result of the Global Financial Crisis, many countries have entered a period of fiscal consolidation. There is, however, a need for infrastructure investment in these very countries, but fiscal consolidation is related to lower not higher public infrastructure investment. There is evidence, for example, that maintenance spend (e.g. in transport) in the US has been a casualty of poor public finances. In addition, pressures on governments' fiscal positions will increase as a result of aging populations and the related transfer and subsidy payments for social services including healthcare and social security. At the same time, the appetite for infrastructure investment from the private sector has increased markedly.

DHGE (2014) suggests that the private sector share of infrastructure assets could rise from 56% to around 66% by 2030. This would increase the value of private infrastructure investments from US$15 trillion in 2012 to US$40 trillion or more in 2030. With large pools of capital available from listed equity markets, the share of listed investments is likely to at least triple over this time period.

A SECTOR THAT INVESTORS CANNOT IGNORE

Infrastructure Industry Report 2014 highlights that:

- There is a long-term secular trend for investment in infrastructure. The strong investment growth observed over the last 20 years is set to continue for the next 20 years and beyond. Investment volumes are likely to be around 4% of global GDP, and asset values are expected to rise at around 3.4% CAGR.
- Due to the high level of government debt following the GFC, the role of the private sector will increase. Private investment will be needed for investment in new projects, and in addition governments will sell existing assets. As a result of these trends, private sector investments in infrastructure will grow from US$15 trillion to US$40 trillion by 2030, with potentially more rapid growth in listed infrastructure.
- Governments now recognise the importance of infrastructure in facilitating economic growth and are actively developing policies to encourage investment. This includes establishing appropriate regulatory and contractual frameworks, and supporting

specialist financing. Supporting infrastructure growth is being spearheaded at top level inter-government summits, including the G20.

- The need for investment means that regulatory and contractual frameworks to support investment and transfers to the private sector are likely to have a balance of risk and reward that will be attractive to investors. The current characteristics of the sector – long duration assets, inflation protection – will continue, and will match the long-term cash flow needs of investors.

The infrastructure sector is now one that investors avoid at their peril.

Read "Infrastructure Industry Report 2014"

REFERENCES

1. David Hale Global Economics Inc (2014), "Infrastructure industry report 2014".
2. G20 (2014). Communique from February 2014 meeting in Sydney
3. McKinsey (2013). "Infrastructure productivity: how to save $1 trillion a year."

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INFRASTRUCTURE INDUSTRY REPORT 2014

DAVID HALE GLOBAL ECONOMICS, INC.

DAVID HALE GLOBAL ECONOMICS

Infrastructure Industry Report 2014

KEY CONCLUSIONS

- Every infrastructure sector outside of the telecom sector will see a larger absolute increase in the supply of new assets during these next two decades compared to the previous two
- In inflation adjusted terms, annual global infrastructure investment will rise from $2.7 trillion between 1997 and 2013 to $3.8 trillion between 2014 and 2030
- The value of infrastructure assets around the world will rise from $13 trillion in the early 1990s and $40 trillion in 2010 to $114 trillion by 2030
- The growth in infrastructure assets will be driven by the power, road, and water and sanitation sectors
- The private sector plays a significantly larger role in infrastructure investment than is commonly perceived, and its assets could rise from under $16 trillion in recent years to $44 trillion in 2030
- The listed share of high income private infrastructure assets has risen swiftly during the past two decades to approximately $6 trillion in 2012, which represents over two-fifth of total high income private infrastructure assets
- Improved macroeconomic stability, exchange rate stability, and an increase in the number of democracies should help facilitate increased infrastructure investment, and especially private sector investment, in the coming years
- Maintenance records indicate that the level of maintenance spending on transportation infrastructure networks is below the rate that is economically optimal and has been falling since the mid-2000s
- The UK and Australian experiences in the 1980s and 1990s can be considered models for how global infrastructure investment could evolve going forward in industrialized countries due to the growing demands for social spending and need to reduce debt burdens
- Infrastructure has a positive impact on growth around the world based on the findings of hundreds of academic papers and a new proprietary study
- There has been a significant increase in private infrastructure projects in the developing world in the last two-plus decades, but significant room for growth remains based on previous trends

By David Hale and Mark Zoff

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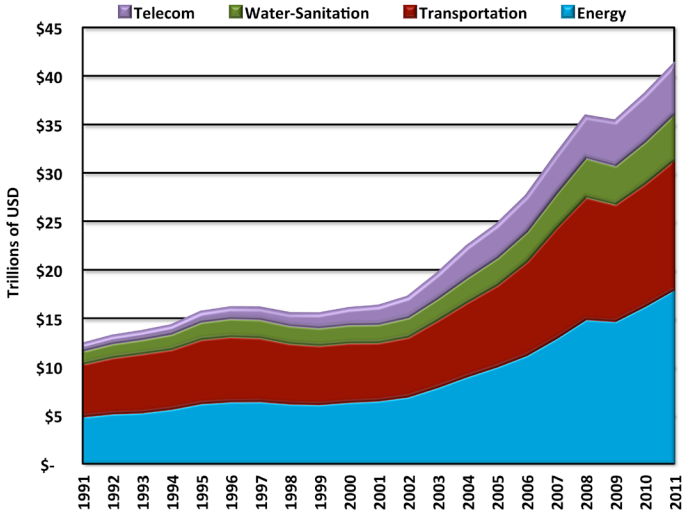
INTRODUCTION

Infrastructure investment has experienced a renaissance of interest since the turn of the century. After a decade where investment failed to keep up with global GDP growth during the 1990s, there was a surge of infrastructure investment that was driven across all types of infrastructure sectors during the 2000s. Our model estimates that infrastructure assets rose in value[1] from approximately $13 trillion in 1991 to just approximately $16 trillion in 1999. Between 1999 and 2010, however, we estimate that these assets skyrocketed in value to around $40 trillion. This growth was driven by emerging market economies, which experienced their fastest GDP growth rates in decades, and there was a renewed interest in increasing the quantity of infrastructure assets in the industrial economies as well. Despite this surge of new supply of infrastructure assets around the world, significantly more investment is needed across almost every asset class in the coming decades in order to keep up with population and wealth trends. Our model projects that the value of these infrastructure assets will rise to a mean estimated value of $114 trillion by 2030. This entails approximately $97 trillion in investment between 2014 and 2030 after around $43 trillion of investment occurred between 1994 and 2013. We project total infrastructure investment flows will average approximately 4.3% of global GDP from 2014 through 2030 after averaging around 4.8% of GDP since 1992. Infrastructure assets as a share of GDP rose from below 45% of global GDP in constant 2010 US dollars at the beginning of the 2000s to approximately three-fifths of GDP by 2013. This share is set to decline modestly through the 2020s, but will still end 2030 far above the early 2000s' nadir. While the geographical growth drivers of infrastructure investment varied in the previous two decades, Asia is expected to assume growth leadership for most assets in the coming years.

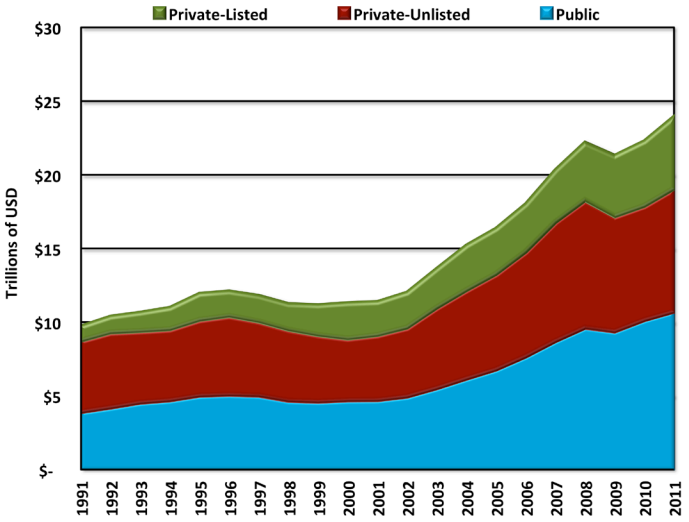
Value of Global Infrastructure Assets by Sector: 1991-2011



Sources: DHGE, World Bank, Various

Advanced economies will see continued significant investment needs due to projected wealth gains, population growth, and declining household sizes in those economies across the world. The ongoing efforts to deleverage in advanced economies after a large run-up in debt over the previous three decades, however, will seriously threaten the ability of governments in these countries to meet the infrastructure needs of its citizens. Recent improvements in governance and macroeconomic stability in many developing economies will help facilitate continued strong investment flows in the coming decades.

Value of High Income Country Infrastructure Assets by Ownership Type: 1991-2011



Sources: DHGE, World Bank, Various

As events such as the Japanese tunnel collapse in 2012, the Minneapolis bridge collapse in 2007, and multiple sinkholes developing around the US show, the transportation and water and sanitation infrastructure assets in advanced economies are aging and either need to be replaced or to receive significantly more maintenance investment. Recent maintenance spending trends do not indicate that such a turnaround is in the offing anytime soon. There has been an ongoing downtrend in road maintenance investment in the US and Japan for over a decade now, and maintenance investment in the Eurozone has fallen in most countries as the region's crisis intensified.

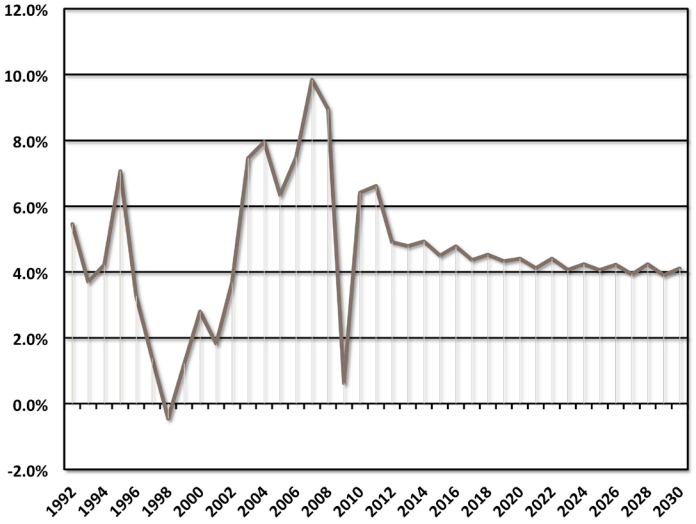
All of this is setting the stage for the private sector's role in infrastructure in both advanced and developing economies to continue to increase going forward. While it is a common misconception that the infrastructure sector is dominated by the public sector in advanced economies, the private sector actually is responsible for anywhere between a little under half to three-quarters of all infrastructure investment in most of the developed world. We estimate that private infrastructure assets around the world went from representing approximately $6 trillion in 1991 to around $17 trillion in 2013.

[1] *For full explanation of how value and infrastructure assets are defined and derived, please see methodological box on page 5*

In particular, we calculate that listed infrastructure assets during that same span of time rose approximately from just over $1 trillion to an estimated value of nearly $6 trillion.

With governments reluctant to curtail healthcare and social security services to its citizens when making spending cuts, programs considered optional such as infrastructure investment and R&D spending, which help propel growth, are often put on the chopping block. With the growth in demand for nearly every type of infrastructure service during the previous two decades exceeding the growth in supply of new infrastructure, the market for infrastructure services clearly exists both now and going forward. Investors have increasing options to participate in this development, as the share of private sector assets that are listed has steadily risen over the previous two decades. Our model estimates that the listed infrastructure share of private infrastructure assets in high income countries increased from under 20% during the early 1990s to over 35% in the early parts of this decade.

Net Global Infrastructure Investment as a Share of GDP: 1992-2030



Sources: DHGE, World Bank, Various

While the private sector domination of infrastructure investment that many forecasters predicted two decades ago did not materialize as quickly as expected, the private sector was already playing a larger role in the sector than commonly understood. Furthermore, the factors that have been shown to lead to increased private sector involvement are present in the world now in a way that they simply were not two decades ago. The experiences of the UK during the 1980s and Australia during the 1990s are instructive for how the private sector could play a larger role in global infrastructure investment going forward. Additionally, the trends that drove increased infrastructure investment such as growing per capita wealth, rising populations, and increasing urbanization will all persist during the coming decades in both the advanced and developing world.

SECTION I:

TRENDS IN RECENT DECADES

Examples of Countries with Increased Private Sector Infrastructure Investment

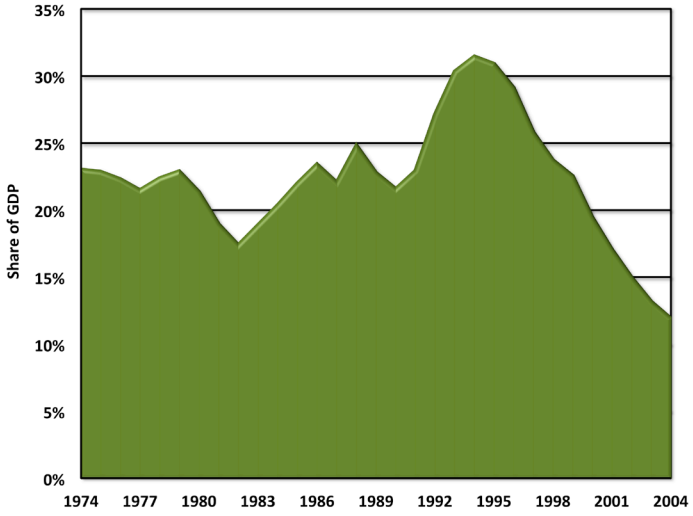
The examples of the United Kingdom and Australia in the 1980s and 1990s are enlightening in providing examples of outliers then that could be considered models today. Margaret Thatcher's quest to privatize infrastructure assets in the 1980s broke new ground in demonstrating the possibilities of and benefits derived from an increased private sector role in infrastructure. The push for privatization was born out of the high inflation witnessed during the 1970s. During their time out of power, the Tories, with their ascendant leader, ascribed a material share of this inflationary environment to the excessive power yielded by unions and the public sector. It was in this time that the Ridley Report was drawn up. The Ridley Report placed the greatest emphasis on suppressing wages in order to prevent inflation from continuing to run rampant, but privatization was initially pursued by the incoming Thatcher administration as a means to raise revenue and reduce the country's debt. After obtaining a third election victory in 1987, the Thatcher administration pursued an aggressive privatization agenda that privatized British Steel, British Petroleum, Rolls Royce, British Airways, and various utilities. Not coincidentally, public investment as a share of GDP peaked in the mid-1970s at around 5%, and then entered a structural downtrend which bottomed at 1% of GDP in the early 2000s. The country's public debt load entered a structural decline during this same time. UK public debt went from over 70% of GDP in 1970 to 42% in 2005.

To meet the country's infrastructure needs, the private sector needed to play a bigger role than it previously did. Between 1995 and 2003 the signed value of PPP contracts as a share of public investment was significantly greater in the UK than in any other European Union country. The value of PPP contracts in the UK exceeded 30% as a share of public investment during this time. This was more than double and almost 50% higher than the next two closest countries, Greece and Portugal, respectively, and no other eurozone country exceeded 5%. These PPP endeavors included prominent projects such as the London Underground and Channel Tunnel Rail Link. By the end of 2005, 70% of the value of signed PPP contracts in the European Union was concentrated in the UK. As would be found elsewhere, myriad benefits for consumers resulted from privatization. Not only did prices fall in the utility industries that were privatized, with the fall in price being positively related to the extent of the sector's privatization, but the quality of service also increased after privatization.

A half a world away, a similar development was taking place in Australia that would see the country successfully nurture a role for private sector infrastructure investment and become a world leader in the field. An acute financial crisis that began in 1989 eventually set the stage for a consolidation of government finances that necessitated an increased private sector role for infrastructure investment in the country. Not unlike the run-up to the global financial crisis, financial sector deregulation and financial "innovations" set the stage for a debt crisis.

Excessive and imprudent lending led to the dramatic failures of the State Bank of South Australia and the State Bank of Victoria, and Australia's last recession occurred during the aftermath of the crisis. The share of problem loans to total assets rose to between 4% and 9% in Australia's four largest banks. During this time general government debt went from below its long-run average to almost 50% greater than it in just four years. In order to help pay off this debt, Australia privatized many state-owned assets, including those in the financial sector, electricity and gas sector, transport sector, and communication sector. All told, Australia privatized assets representing over one-tenth of 1997 GDP by the end of 1997. The first major specialist infrastructure funds were set up by Australian investment banks during this period, with the national pension plans providing early capital. By 2000 government debt was back below pre-crisis levels despite the fact that government expenditures actually increased slightly compared to the beginning of the decade. Almost as importantly, privatization of the electricity sector led to falling costs for consumers and businesses.

Australian Public Debt: 1974-2004



Source: IMF

Methodological Note:
Estimating and Valuing Infrastructure Assets

For figures in this paper, we utilized a mixture of bottom-up and top-down approaches to estimate traditional infrastructure asset endowments across the world. These endowments covered electricity, water, sanitation, paved roads, railways, ports, airports, and telecom assets. These endowments factor in associated network apparatuses, which is a particularly relevant consideration for the energy sector. Social infrastructure assets, such as hospitals and schools facilities, were excluded from these calculations. Although we discuss the evolution of pipeline infrastructure elsewhere in this report, these facilities are not included in the valuation of infrastructure assets. The US dollar valuations used in the report are in replacement/functional cost value terms.

We created our estimates by chronicling the individual endowments of infrastructure components for over 180 countries between 1991 and the early 2010s. The data was drawn from leading sources such as the World Bank, CIA, Energy Information Administration, and various other national and international organizations. Missing data was estimated using proprietary algorithms that modeled the missing values as a function of past and future values of infrastructure endowments, population variables, macroeconomic variables, and governance variables. Up to thirty simulations were run for each backwards-looking estimate, and the mean value was used for a missing country-year variable.

When forecasting future values of infrastructure variables, we created a transfer function model to forecast future spending out to 2030. Seventeen individual country-region buckets were created according to income endowment and geographic location. We estimated the future value of each infrastructure component as a function of the past values of each component, forecasted future real GDP per capita growth based on US government estimates, forecasted future population growth based on United Nations estimates, and in certain cases forecasted future urbanization rates based on United Nations estimates. These forecasts are our estimates for the level of infrastructure assets that we believe will prevail around the world by 2030 based on those factors. In order to ensure that we met strict Box-Jenkins best practices, we created 187 individual models where the degrees of homogeneity facilitated stationarity within the explained and explanatory variables.

We also optimized the ARIMA specification based on a combination of goodness of fit statistics (AIC/SBC), parameter significance, white noise tests, and low correlation coefficients with other model parameters. Once we created a database of past and future estimates of the endowment of physical infrastructure assets, we valued the assets in nominal current US dollar terms. Utilizing best practices estimates from leading international organizations such as the World Bank and the OECD, we then valued the infrastructure endowments in replacement cost terms. In most cases, the replacement cost terms were adjusted as a function of the income tier of the country. In order to account for price and market fluctuations, we also adjusted the dollar value as a function of inflation and exchange rate movements during a given year in order to standardize the value.

When estimating the private and public sector share of advanced and developing economy infrastructure assets, we combined the bottom-up estimates of individual country infrastructure endowments with a top-down perpetual inventory model estimate of the capital stock as a function of national accounts data and a proprietary model in the case of advanced economies and World Bank private infrastructure investment data for developing economies.

Advanced economies' private and public infrastructure asset endowments were created utilizing national accounts data and proprietary models. For the US and select European countries, we chronicled the gross fixed capital formation expenditures on infrastructure structures and equipment for both the overall economy and public sectors. We then estimated the private and public sector shares of overall infrastructure spending in those economies. As many advanced economies did not have such data broken out, we created a proprietary model that estimated the private-public share as a function of explanatory variables such as the public share of gross fixed capital formation spending, GDP per capita, when the investment occurred, and dummy variables for geographic location and the occurrence of a financial crisis. For countries where the infrastructure spending as a share of GDP was not available, we then created a propriety model that estimated this value as a function of explanatory variables such as total gross fixed capital formation as a share of GDP, when the investment occurred, and a dummy variable for whether the country was located in Eastern Europe. The infrastructure related capital stock was then created using a perpetual inventory method with a disequilibrium formula-created initial capital stock. From there we overlaid the private and public sector share of flows in a given year, which provided us with estimates of the private and public sector shares of infrastructure capital stock in a given year.

With developing economies, we utilized the results from the World Bank's Private Participation in Infrastructure Database when estimating the private and public sectors' share of infrastructure assets. We created infrastructure capital stocks through the use of the perpetual inventory method with the initial capital stock estimated using the disequilibrium formula. This figure was then overlaid upon the US dollar value of developing country infrastructure assets after we made valuation adjustments to account for valuation differences between top-down and bottom-up methods.

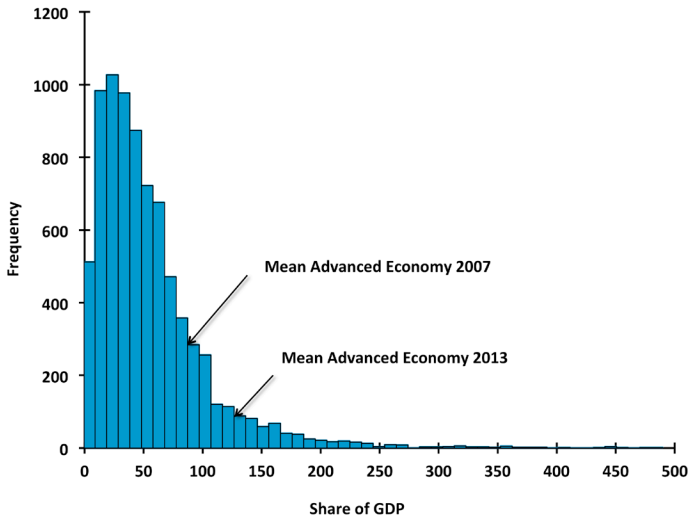
Private listed infrastructure assets are derived from the property, plant, and equipment assets of up to 366 listed infrastructure companies from around the world. Around 200 of these companies were located in the energy sector in recent years, along with around 88 telecom firms, 68 transportation firms, and 14 water and sanitation companies. A decided majority of these companies are found OECD economies. While many infrastructure indices do not include telecom operators in their construction, such firms are included in this study both because of the associated network infrastructure that traditional phone companies needed to build to support non-infrastructure operations and in order to compare our study's results to those of other leading infrastructure studies. We implemented adjustments to the value of these PPE assets to normalize the values of private listed infrastructure assets with the other figures in this study.

Our investment projects align closely to those made by other organizations. We project that overall infrastructure investment will total $67 trillion in constant 2010 US dollars between 2013 and 2030 based on historical investment patterns, historical and projected real per capita GDP growth, historical and projected population growth, and historical and projected urbanization rates. This is quite similar to the $62-$67 trillion range of future investment that McKinsey estimated in their 2013 report. Other external estimates place the future investment value at around $57 trillion. In general we project larger investments in energy and relatively less investment in rail and water and sanitation.

Why the Public Sector Is Increasingly Unable to Meet Needs for Infrastructure in Advanced Economies

Although the demand for increased infrastructure investment is present, the public sector's capacity to provide it in advanced economies is severely constrained. Research from the European Investment Bank has shown that the one statistically significant explanatory factor in determining the level of infrastructure investment is periods of prolonged fiscal consolidation. They found that declines in the level of infrastructure investment were associated with periods of governments attempting to stabilize or decrease their countries' debt loads. Given that government debt as a share of GDP in advanced economies rose 78%, from 60% of GDP in 1995 to 107% in 2012, many governments in advanced economies are either choosing to or are being strongly encouraged to enter into a period of fiscal consolidation. This increase in debt in the run-up to and aftermath of the Global Financial Crisis was around double the increase in the prior fifteen years in terms of percentage of GDP. All told, public debt is three-to-four times greater now than when it bottomed in the mid-1970s.

Public Debt Level in Economies as a Share of GDP: 1900-2011

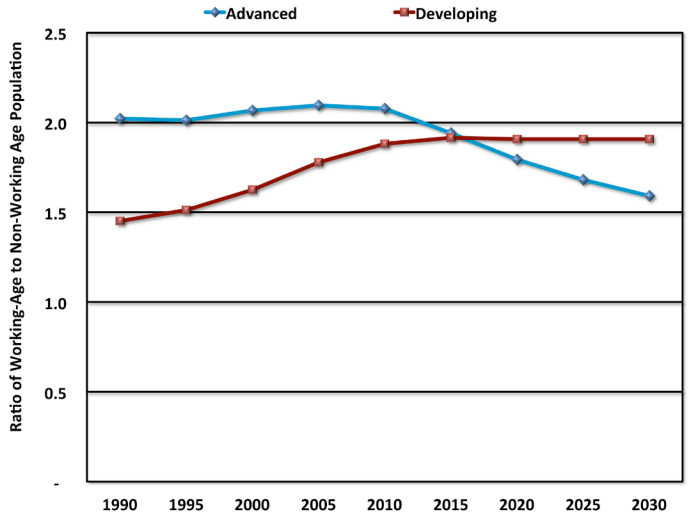


Source: IMF

The aging of the developed world's population will put further budgetary pressures on the public sector that will likely presage an increased role for the private sector in meeting their countries' infrastructure needs. An increasingly large share of government expenditures is being devoted to subsidies and transfer payments for social services such as healthcare and social security. These transfers have gone from representing 56.6% of public expenditures in 1995 to 62.9% in 2011.

Given that the working-age population of developed economies increased marginally during this time frame and that the ratio of working-age to non-working-age population is projected to decline by over 23% between 2010 and 2030, the likelihood of an increased need for subsidies such as healthcare and social security is only expected to increase. This structural factor will place a further squeeze on the public sector's ability to supply adequate levels of infrastructure investment to meet the needs of advanced economies. There is, however, no evidence of a saturation point for public investment, so the investment flows that would usually have been supplied by the public sector can instead be supplied by the private sector.

Dependency Ratio of Advanced and Developing Countries: 1990-2030



Source: United Nations

Drivers of Private Infrastructure Investment across the World

The macroeconomic environment for developing countries has become dramatically more stable and prosperous in recent years. Since 2000 low and middle income countries have grown 4%-points faster annually than their high income peers. In fact, while growth has decelerated in high income economies every decade since the 1960s, low and middle income GDP growth has accelerated from 3.5% in the 1980s to 5.9% since 2000. More important than the stronger growth performance, however, is the fact that the macroeconomic environment has become significantly more stable since 2000. The volatility of GDP growth in low income countries since 2000 is over 20% less compared to the 1980s and 1990s while it is more than 30% less in the middle income countries. Crises occurred in all three time periods, so the materially improved stability indicates that real, sustainable improvements have occurred in developing countries.

Average GDP Growth by Income Class by Decade: 1960-2012

Decade	High	Low	Middle	Low and Middle
1960s	5.50%		5.20%	5.10%
1970s	3.70%	2.40%	5.80%	5.70%
1980s	3.00%	2.70%	3.50%	3.50%
1990s	2.40%	2.50%	3.80%	3.80%
2000s*	1.90%	5.30%	5.90%	5.90%

Source: World Bank

Research on the determinants of infrastructure FDI flows has shown that exchange rate fluctuations—and particularly devaluations—increase the investors' demanded rate of returns on given projects. When it comes to reducing exchange rate volatility, developing countries have made dramatic progress in the last decade despite the incidence of the global financial crisis. The Bank for International Settlements tracks the real-effective exchange rates (REERs) of twenty-seven developing country currencies on a trade-weighted basis and sixty-one countries total. A comparison of the volatility of these exchange rates reveals that there has been a significant improvement in stability in recent years. The standard deviation of the annual change in the REER for the twenty-seven developing countries went from 11.3% on average between 1994 and 1999 to just 6.0% between 2007 and 2013. Furthermore, exchange rates were less volatile between 2007 and 2013 than between 2000 and 2006 despite the lack of any notable crises during the latter time period. The average standard deviation in the change in REERs was 9.5% between 2000 and 2006 compared to 6.0% during the most recent period. The exchange rate volatility of developing countries has gone from being 124% greater than advanced economies between 1994 and 1999 to 24% between 2007 and 2013. This represents a reduction of the order of four-fifths even though major crises occurred in developing countries during both periods. Assuming further improvements in exchange rate stability occur in emerging economies, the increasingly stable exchange rate environment should reduce the returns demanded by investors for future projects. Not only will this increase the number of projects undertaken, it will also reduce the prices paid by end users.

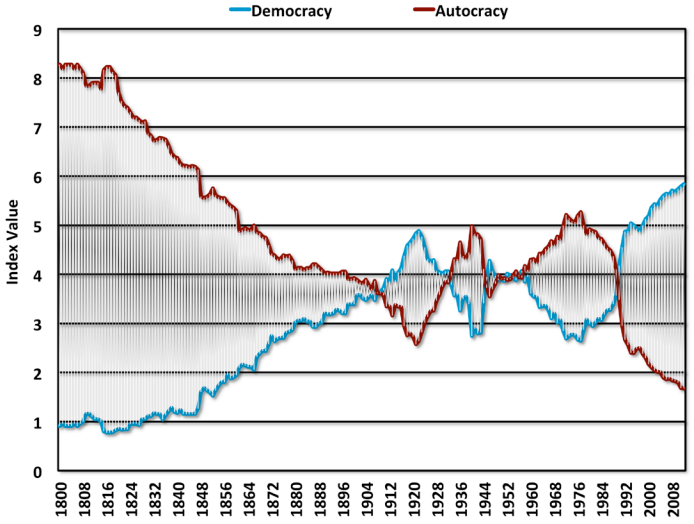
Annual Exchange Rate Volatility in Advanced and Emerging Economies: 1994-2013

Period	Developing	Advanced	Difference
1994-1999	11.3%	5.1%	124%
2000-2006	9.5%	5.9%	60%
2007-2013	6.0%	4.9%	24%

Source: Bank for International Settlements

Governance indicators in emerging market economies have largely improved as well in the last decade. In particular, according to the World Bank's Worldwide Governance Indicators, the average reading in individual emerging market economies has increased in five key metrics. The most dramatic increase has occurred in the "political stability and the absence of violence/terrorism" metric. That metric increased by a robust 30% in the last decade through 2011. "Regulatory quality" has increased by 9%, "government effectiveness" has increased 8%, and "control of corruption" has increased 6% since 2002. The "rule of law" metric has been a relative laggard, although it too has improved an average of 3% in emerging market economies in the past decade. These sorts of broad gains in governance should drive further private sector investment in infrastructure based on the findings of previous research on the subject.

Global Institutionalized Democracy and Autocracy Prevalence: 1800-2012



Source: Systemic Peace

Complementing this improved macroeconomic stability has been the increasing prevalence of democratic governments in developing countries. After hovering around eighty during the late 1970s and early 1980s, the number of autocracies has decreased dramatically. By 2012 the number of autocracies was limited to twenty. Conversely, the number of democracies has nearly tripled during that same span of time, going from approximately thirty-five at the turn of the 1980s to approximately ninety today.

Additionally, the average lending rate and interest rate spreads in developing countries have declined dramatically in the last two decades. After averaging over 30% in the early 1990s, the average lending rate has declined to under 15% since the beginning of 2010.

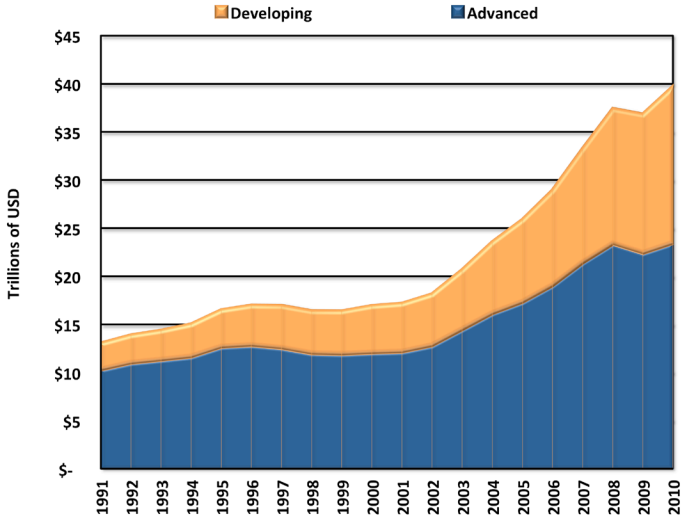
Another factor which will drive infrastructure spending all over the world is urbanization. In 2025, twelve of the world's fifteen largest cities will be in the developing countries.

They will include Delhi with 32.9 million people, Shanghai with 28.4 million. Mumbai with 26.6 million, Mexico city with 24.6 million, Sao Paulo with 23.2 million, Dhaka with 22.9 million, Beijing with 22.6 million, Karachi with 20.2 million, Lagos with 18.9 million, Calcutta with 18.7 million, Manila with 16.3 million, and Shenzhen with 15.5 million. The largest cities in the OECD will be Tokyo with 38.7 million people, the New York metro area with 23.6 million, and Los Angeles with 15.7 million.

Evolution of Infrastructure Assets in Recent Decades

Infrastructure assets have grown at a furious pace during the past fifteen years. While global output grew by 6.6% per year in nominal terms between 1999 and 2010, we estimate that the value of global infrastructure assets grew in excess of 9.1% per year during that same span of time. Our model indicates that infrastructure assets rose in value from just above approximately $15.5 trillion globally, or under half of global GDP, to around $40 trillion at the end of 2010. This figure was equivalent to over 60% of global GDP. Between 2001 and 2010, infrastructure assets went from representing 20% of global capital stock to 28%. While there were strong gains in both developing and advanced economies, there were particularly strong gains in developing economies, with infrastructure assets growing over 12% per year between 1999 and 2010. Standout sectors globally during that period included electricity capacity, paved roads, and telecom assets. Despite these strong gains, the growth in demand for transportation infrastructure assets exceeded the growth in supply of transportation assets during the previous two decades. Additionally, the per capita growth rates for many individual assets were quite reasonable and the ratio of developing world assets to advanced economy assets indicates that tremendous growth potential remains in order to facilitate the convergence of developing world economies to approach advanced economy wealth levels.

Value of Infrastructure Assets by Income Type: 1991-2010

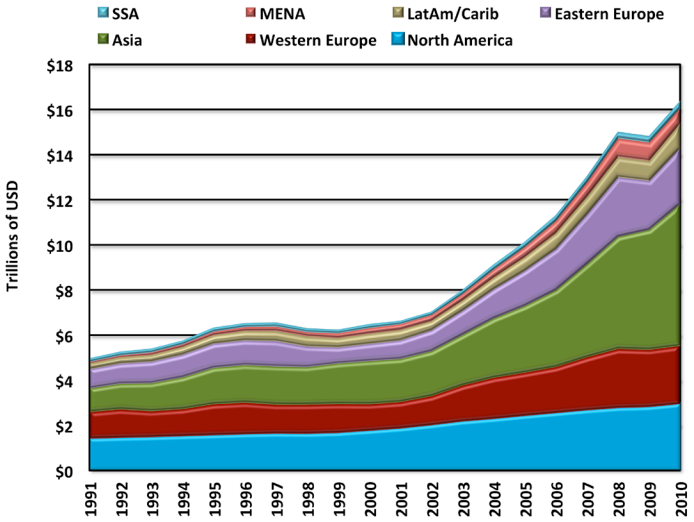


Sources: DHGE, World Bank, Various

ENERGY

Investment in global electrical capacity has grown dramatically since the late 1990s. Worldwide capacity increased by over 50% between 1999 and 2010 after increasing by just 19% between 1991 and 1999. Our model estimates that the total value of electricity assets globally went from less than approximately $5 trillion in 1991 to an estimated value in excess of $16 trillion in the early stages of the current decade. They also went from representing 22% of worldwide GDP to 26%, and grew at a 9.2% annual rate between 1999 and 2010 and over 10% per year between 2001 and 2010. By contrast, global nominal GDP grew by 6.6% and 7.6% on average per year over those same time periods. The large gulf between per capita electricity endowments in the advanced and developing economies at the beginning of this decade indicates that significantly more investment in this sector will need to occur in the coming decades.

Value of Electricity Assets by Region: 1991-2010



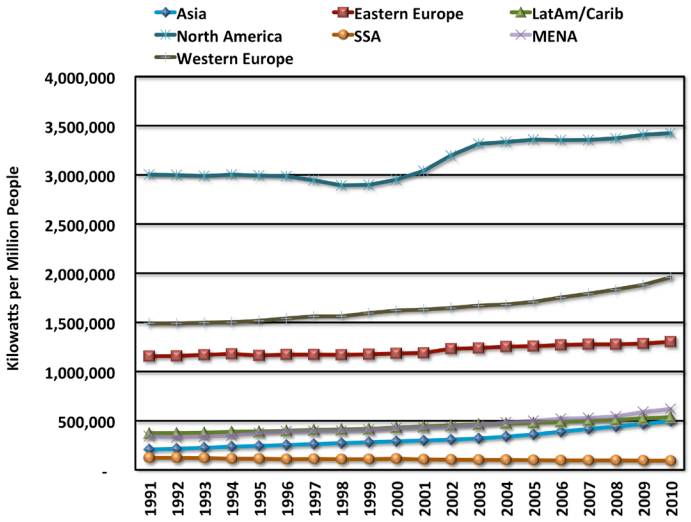
Sources: DHGE, World Bank, EIA, Various

On a regional basis there were tremendous divergences in per capita growth in electricity assets over the two previous decades. Between 1991 and 2010 global electricity capacity increased nearly 2% on a per capita basis every year, going from 517 megawatts of electricity capacity per million people to 733 megawatts. Asia experienced the most dramatic growth of nearly 5% on average per year, going from just above 200 megawatts per million people of installed capacity to nearly 500 megawatts at the start of this decade.

Electricity capacity also grew swiftly on a per capita basis in Latin America and the Middle East and North Africa. Eastern Europe's installed capacity grew weakly over this time period, although compared to other developing regions it started from a much higher base. In 1991 installed electrical capacity per capita exceeded 1,100 megawatts per million people compared to figures below 400 megawatts for every other developing region.

North American installed electricity capacity per capita consistently declined between the early 1990s through 1998 before growing 18% between 1998 and 2010. Per capita electricity capacity in Western Europe, by contrast, consistently grew at a rate that averaged 1.4% per year between the early 1990s and 2010, although this still left installed electricity capacity per capita at just 60% of the level seen in North America.

Per Capita Energy Capacity by Region: 1991-2010

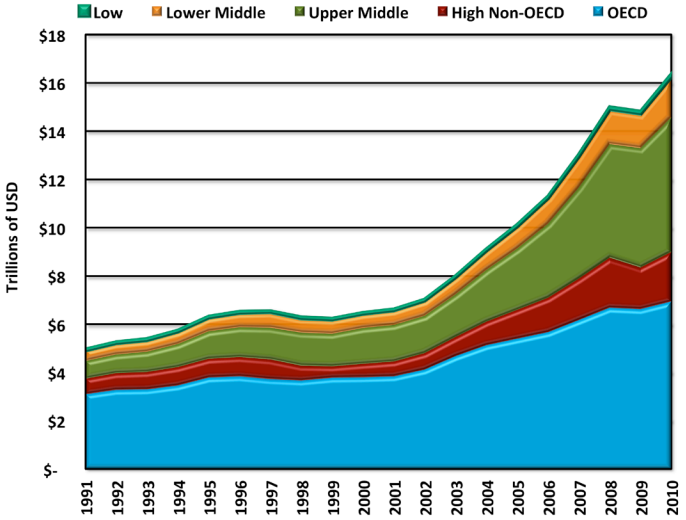


Sources: DHGE, World Bank, EIA, Various

Sub-Saharan Africa stands out as an outlier among the different regions. Total electricity capacity declined on a per capita basis between 1991 and 2010, going from 123 megawatts per million people to just 92 megawatts in 2010.

The average American fridge consumes more power than the average Sub-Saharan person. Even if Western Europe's more subdued per capita electricity profile is the future steady-state level of developing regions, those economies will still need to ramp up investment in the sector in the coming decades to reach those levels. Installed capacity in Asia is about one-fourth that of Western Europe, in Eastern Europe it is two-thirds, in Latin America it is a little more than one-quarter, in the Middle East it is less than one-third, and in Sub-Saharan Africa it is less than one-twentieth.

Value of Electricity Assets Value by Income Tier: 1991-2010



Sources: DHGE, World Bank, EIA, Various

When looking at the installed electricity capacity by income classification, a similar picture emerges as to the regional picture. Per capita electricity capacity fell in low income countries between 1991 and 2010. High income economies' capacity grew during those years, but below the average rate.

Lower middle income countries experienced the second fastest growth rate in electricity capacity per person, with installed capacity per million people going from 130 megawatts to 187 megawatts. Installed electricity capacity surged in the upper middle income countries. Total per capita capacity grew by 173% between 1991 and 2010, going from 253 megawatts per million people to 692 megawatts. The divergence between OECD and middle and lower income countries remained quite large for the various income tiers. Per capita electricity capacity in low income countries was barely more than 2% of the OECD level, in lower middle income countries it was less than 8%, and in upper middle income countries it was just 29%.

Case Study

KIVUWATT ENERGY PROJECT (RWANDA)

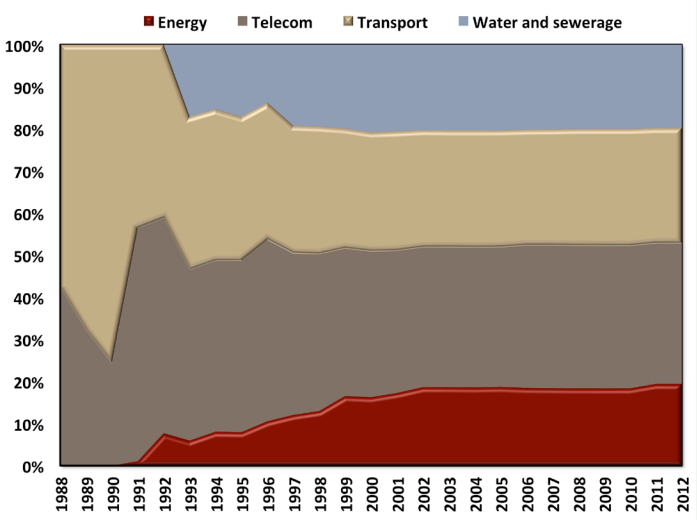
Sub-Saharan Africa suffers from very low levels of power generation and consumption, even by developing economy standards. The average refrigerator in the United States alone will consume more energy in a year than the average African consumer. The Kivuwatt energy project in Rwanda aims to more than double the power generation capacity in Rwanda over two phases. The first phase increased energy supplies by around one-third, while the second phase will increase energy supplies by an additional two-thirds. It also allows power to be produced utilizing less expensive methane instead of oil.

Think Piece: Why Do Private Infrastructure Projects Succeed or Fail?

Most formal studies of private infrastructure operations indicate that they are run more efficiently than comparable public infrastructure operations. Although not all private infrastructure projects have proven to be successful, the failure rate of privatizations is far less than media reports would lead you to believe. That is not to say that important lessons cannot be drawn for why certain projects failed and whether similar projects are likely to fail in the future. Projects can fail for a variety of reasons, including due to macroeconomic and microeconomic factors, and the reasons for these failures are often idiosyncratic.

An analysis of developing country infrastructure projects involving private funds reveals that failures are much less common than news reports would indicate, but that they occur more frequently in transportation and water and sanitation than in the other two major sectors. Of the over $2 trillion in investment pledged to infrastructure projects tapping into private funds between 1984 and 2012, only 4% of the total investments were involved in projects that failed. When deals since the turn of the millennium are considered, the share of total funds involved in projects that were cancelled drops to less than 1%. The composition of the failed deals is quite surprising, however. In particular, despite representing just 3% of total investment volumes over the previous twenty-eight years, failures in the water and sanitation sector represented 20% of total failed investment. Additionally, transportation projects represented 18% of total deal volume, but 27% of the value of total failed infrastructure projects. Conversely, energy and telecommunications projects were far more successful relative to overall investment volumes.

Sectoral Breakdown of Cancelled Infrastructure Projects with Private Participation: 1988-2012

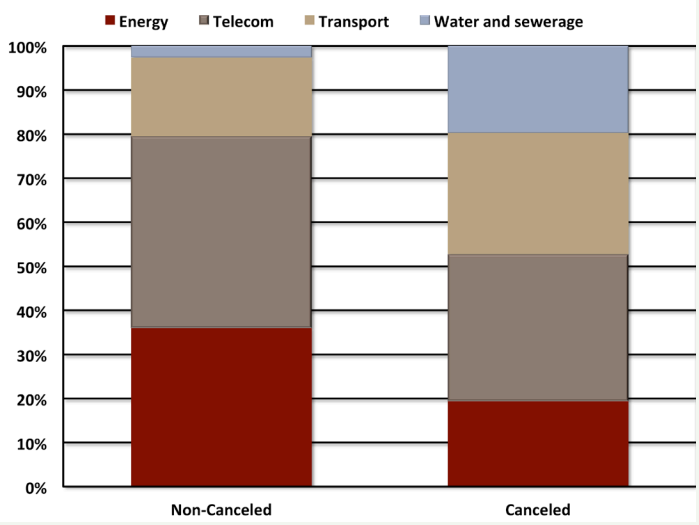


Sources: DHGE, World Bank

Recent research by Renato E. Reside, Jr. and Amado M. Mendoza, Jr. on the determinants of the successes and failures of PPP infrastructure projects in East Asia during the 1980s through the late 2000s revealed that certain factors were more likely to increase the failure rate while others were more likely to lower the failure rate. While strong macroeconomic growth during the period when the project was in operation unsurprisingly reduced the failure rate, strong growth prior to the financial closure of a deal actually increased the likelihood of a deal's failure. This is likely because unrealistic projections were more likely to be formulated during periods of excessive GDP growth and governments were more likely to be complacent in evaluating potential deals during periods of frothy growth. Additionally, material exchange rate fluctuations were associated with project failures. Exchange rate stability and appreciation, by contrast, lowered the failure rate of PPP projects. Government actions that raised the risk of failure included tariff freezes, parliamentary systems being in place instead of presidential systems, and government assumptions of risks and/or guarantees. Parliamentary systems have fewer checks and balances in place than presidential systems because of the merging of the executive and legislative branches, which make them more susceptible to actions such as tariff freezes. The presence of large FDI inward flows, governmental rules that facilitated open economies, and more extensive private ownership of projects all are associated with viable projects. Experienced governments that operate in systems with extensive checks and balances are also associated with more successful projects. This theoretical research on developing country PPP projects would be corroborated with the experience of many advanced economy private infrastructure projects as well.

While the failure rate of projects is quite low, renegotiations are much more common for projects with private sector involvement. There were frequent renegotiations of concessions projects in Latin America between 1985 and 2000. In fact, of the more than 1,000 concessions granted in Latin America during this time period, 30% of them were renegotiated, including 55% of transportation concessions and nearly three-quarters of water and sanitation projects. This likely resulted from the fact that projects in the transportation and water and sanitation sectors face less competition, and thus the bids more likely were not well formed beforehand and/or not properly understood by the government awarding these contracts. The operators in the transportation and water and sanitation sectors also had greater leverage to extract concessions due to the lack of alternative options for governments in those two sectors. Fully 85% of renegotiated projects were renegotiated within four years of the initial award. Similarly, of the 1,160 or so PPP projects in East Asia between 1986 and 2008, fully 71% of them were renegotiated.

Distribution of Successful and Failed Infrastructure Projects with Private Participation: 1988-2012



Sources: DHGE, World Bank

A prime example of a failure of an infrastructure project involving private sector actors is the Mexican toll road program during the late 1980s through the early 1990s. The program itself increased the country's toll road network to nearly 10,000 kilometers from 4,500 kilometers at the program's inception. The program cost nearly $13 billion, and more than half of the financing came from debt. Suboptimal tendering processes, undisciplined state-run banks, illiquid local financial markets, and underdeveloped institutional capabilities combined to set the stage for a program that would be at constant risk of failure. As was the case with other projects that have failed, traffic projections also far exceeded actual traffic once the toll roads opened. Excessive tolls, which rose to as much as $630 in mid-1990s dollars for a three hour trip for trucks on certain roads, also dampened the roads' usage. In December 1994 the Mexican central bank effectively devalued the peso by 35% over the course of a number of actions, which materially increased the debt burden of many toll road operators. The devaluation would eventually amount to 66%. Mexican GDP contracted by nearly 6% in 1995. Interest rates and inflation jumped dramatically. Eventually the Mexican government had to pursue a $2 billion bailout for the program. The Mexican experience illustrates the importance of investors being fully aware about the stability of the macroeconomic situation in a country prior to entering into a project as well as making sure that firms have a proper understanding of the future demand and challenges they will face in their operations. Certain roads were successful, mostly because they offered an alternative to highly congested non-toll roads that industrial users valued. This experience would not prove to be uncommon in other countries around the world.

While comprehensive data for renegotiations of private infrastructure projects in high income countries is not as readily available, the experiences of the Channel Tunnel project and toll roads in the United States indicate that these experiences are not confined to just developing countries.

The United States has suffered from a wave of toll road privatizations either grossly underperforming expectations or outright failing during the last decade. Despite being the home of the most advanced financial sector in the world, the financing of and forecasting of future demand for private toll roads during the previous decade left a lot to be desired. Between 2003 and earlier this decade, private investors financed $27 billion of toll road deals. In general these deals were primarily debt financed. Compounding this vulnerability was the fact that the forecasts underlying these valuations were often wildly optimistic. In one notable example, a bridge in Alabama that served around 2 million vehicles in 2002 was forecasted to serve 11 million vehicles in 2013 when the deal was struck in 2003. The Alabama bridge's experience was a common one for road privatization deals struck in the run-up to the global financial crisis. Of note, however, is the fact that the group that ran the Alabama bridge, in addition to other toll roads around the country, was profitable before debt servicing costs were factored in. Additionally, the toll road privatization deals struck after 2008 have been far more successful. The failures reveal that not only do future forecasting demands need to be realistic, but that a proper mix of equity and debt financing needs to be done in order to make sure the ventures are viable.

The Channel Tunnel ("Chunnel") project between the United Kingdom and France is a prime example of how a renegotiation of a privatized infrastructure project is likely to occur if the scope of the project is not properly defined in advance and all reasonable contingencies are not accounted for in the planning stages. The Chunnel project was the largest privately funded project to go into construction, and it involved constructing a 32-mile double-rail track underground tunnel between the UK and France. The winning bid for the project came in at $5.5 billion. The Eurotunnel's concession now runs through 2086. The project ended up being delayed by over a year and a half and incurred cost overruns resulted in the project's costs nearly doubling the initial estimates. These cost overruns resulted from a variety of factors, including not having the rolling stock designed at the time construction started, key details not being agreed to, and "unknown unknown" contingencies not being accounted for when the project implementation began. Additionally, scope creep set in, with the project's objectives not being fully agreed to when the contract was awarded. Billions of euros of debt had to be forgiven in 2006. Despite all of these problems, the Chunnel itself was labeled one of the Seven Wonders of the Modern World by the American Society of Civil Engineers, and it has become a profitable enterprise.

The Eurotunnel first turned a profit in 2007, and EBIDTA reached €449 billion during the most recent fiscal year. The Chunnel's experience is yet another example of the need for proper planning and project financing as opposed to an indictment of the viability of private infrastructure projects.

The failure of British Rail is a classic case of a misjudgment of how a privatization is structured is just as important as the macroeconomic environment in which the privatization takes place. The privatization of British Railway occurred in the third wave of privatization following John Major's victory in the 1992 elections. The tracks and train operations were decoupled, with the tracks being sold to one group and operations rights being sold to dozens of organizations ("vertical separation"). While the pre-nationalized rail system was run by four companies, each of which presided over its own geographic area while owning both the infrastructure and the train operations ("vertical integration"). Despite John Major's preference for reinstituting a similar setup, a much more diffuse arrangement prevailed after the privatization. This separation of the infrastructure, rolling stock, and operations would prove to be untenable. Within five years the system endured three high profile crashes which killed more than forty people and left more than six hundred others injured. The track itself was renationalized early last decade, and many of the original bidding operators have either been stripped of their domains or been forced to pursue more traditional vertical integration strategies. Given the interconnected nature between infrastructure and operations with functioning rail systems, a complete vertical separation of rail networks may not be optimal. However, the ongoing success of a private rail system in the US with vertically integrated operations shows that a proper post-privatization ownership structure is a vital matter that needs to be properly considered during the formulation and implementation of a privatized infrastructure project.

Box 1: Top Issues Facing Private Sector Operators in the Energy Sector

Staying ahead of the curve with regulatory compliance and climate change policy

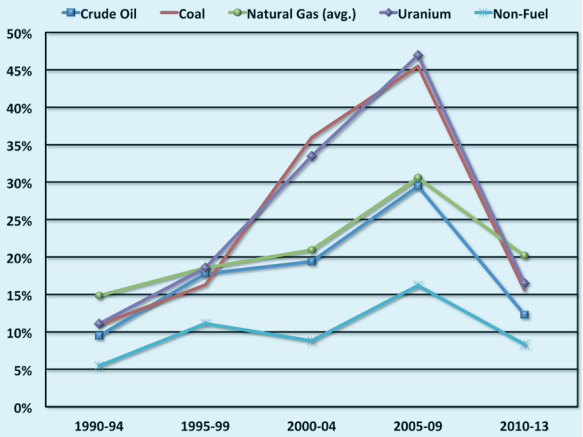
Regulatory uncertainty is an ever present concern in the energy sector. Consumers want their energy provided at the lowest price possible—and have an increasingly large number of ways to effect that desire—while public regulators are trying to avoid a climate change-driven calamity by boosting the share of energy that is provided by sources with a low-carbon footprint. These demands place operators in the power and utility sector in a difficult position. Depending on the evolution of multilateral climate change negotiations, electricity prices could easily rise 11% in real terms by 2030 according to European Union estimates with system costs rising by as much as 0.84%-points of GDP. Advanced economies are opening up increasingly large shares of the power and utilities sector to competition—including from telecom firms—while developing economies have to rewrite energy regulations concurrently with the maturation of the sector in their states. This forces operators in the sector to improve relations with both customers and regulators in order to ensure that the evolution of regulations is in everyone's best interests. Customers will complain to regulators if they feel they are being gouged, so—similar to the telecom industry—it is important to provide customers with as much transparency as possible. This is possible with new technologies, such as smart meters, which provides customers with real-time information on their consumption habits. It is also important for operators to cultivate productive relations with regulators in order to ensure that they optimize their capital investments given the shift towards renewable energy and respond appropriately to the evolution of carbon pricing.

Box 1: Top Issues Facing Private Sector Operators in the Energy Sector - continued -

Adequately managing supply price volatility and differentials

While the volatility seen during the run-up to and immediate aftermath of the global financial crisis has for the most part subsided since 2010, supply price volatility in the energy sector remains a top-tier issue facing operators in the sector. The rise of natural gas and variants thereof adds another element of uncertainty to operators in the sector. US supplies of natural gas cost $3.72 per Million Metric Thermal British Unit during 2013. Equivalent prices for Russian supplies for Europe were three times as much while Indonesian supplies were 366% more than the equivalent US supplies. Despite the US lagging behind many industrial peers in terms of ambition and action for climate change agreements, energy companies in the US have been much quicker in moving generators from coal-fired ones to gas-fired ones than their European peers in part because of the lower gas prices. EU utilities still by and large use coal generated facilities for base load purposes. Although Asia is in the process of building out liquefied natural gas facilities, which will lower natural gas costs in the future, this process remains many years away from completion. Natural gas prices for US and European price supplies have monthly volatility equal to approximately 21% and 15% of their average monthly price since 2010. This entails a tremendous amount of uncertainty. The equivalent figure for Asian supplies from Indonesia is 25%, which is actually a record amount of volatility compared to five-year periods during the 1990s and 2000s. Australian coal has a 15% volatility as a share of average monthly prices since 2010. Compared to non-fuel commodities prices, coal prices have been 87% more volatile, uranium prices have been nearly twice as volatile, and natural gas prices have been around 142% more volatile. This price uncertainty and volatility adds a serious amount of investment risk to energy companies across the world, as they do not know which type of facilities to invest in going forward and what sorts of prices they can charge and profits they can earn. An additional input that is vitally important to the energy industry, but is generally not considered as such, is water. In the United States in 2005 the power generation sector was responsible nearly half of water withdrawals. Reliable access to water supplies is, thus, a must for operators in the energy sector. Modular on-site water systems provide a possible path to obviate supply bottlenecks in the future and are relatively common in pockets of the developing world, but the development of this facility type remains in relative infancy in developed markets.

Monthly Volatility as a Share of Average Prices for Energy Supplies: 1990-2013



Source: IMF

Anticipating changes in government involvement

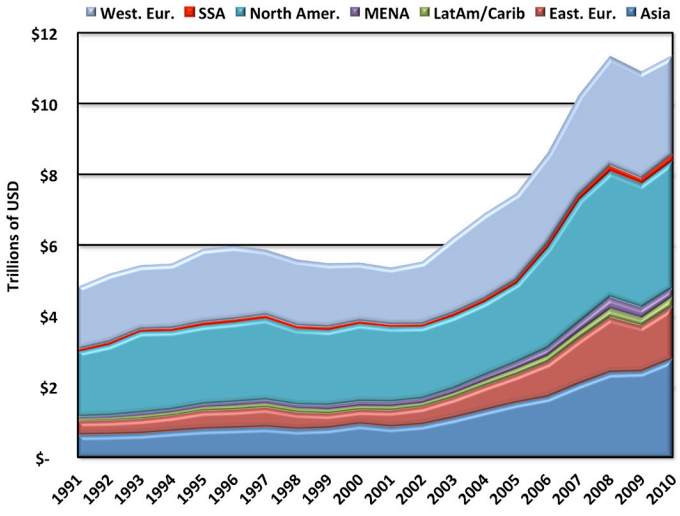
The modern electricity sector started off as a private firm-dominated industry in the six decades from the late 19th century through World War II. The demands for power as part of the war effort and other factors led to much of the sector becoming nationalized after World War II. Anton Eberhard and Katharine Nawaal Gratwick note that there were four major rationales for extensive state involvement following the Second World War: the network effects in the sector plus inherent economies of scale combine to turn the sector into a natural monopoly, the tremendous investment requirements needed in building out the network required some socialization of the risks of investing in this sector, the sector became an increasingly large share of the state economy, and the industrialization of many post-war economies gave the sector an outsized strategic importance relative to its burgeoning size. The US, Germany, and Japan led the way among advanced economies in instituting private-but-tightly-regulated energy sectors following the immediate post-war period. Over seventy countries had such regimes by the turn of the millennium. While energy sector privatization has progressed further in many emerging economies, Adaral et al. find that the lack of one common thread in political and institutional sectors of energy sector regulation across the world is the only common thread. Each country typically has a highly specialized and intricate set up. There is no one-size-fits-all policy for effective energy sector regulation, which places operators under difficult circumstance as their activities can be curtailed dramatically, capriciously, and rapidly by their public regulators. Germany abandoned nuclear power in 2011 after the Tohoku Earthquake and the series of disasters that followed in Japan. This decision greatly affected the utilities that were in the process of replacing and modernizing their nuclear facilities. Additionally, due to budget pressures many governments have chosen to withdraw energy sector subsidies for implementing renewable generation facilities. While the sense of crisis in many advanced economies about their debt situation has started to dissipate, public budgets in advanced economies will remain under pressure for some time. Navigating the evolution of these sorts of discrete interventions in the market is a major issue that all operators in the power and utility sector will need to confront in the decades ahead.

TRANSPORTATION

Roads

Global paved road stock increased dramatically during the past two decades, with the value of paved road assets going from approximately $4.8 trillion in 1991 to around $11.3 trillion at the end of 2010 according to our estimates. While we calculated that the value of these assets grew under 11% between 1990 and 2001, they more than doubled between 2001 and 2010, with compound growth of 8.4% every year. Globally, the paved road network increased by 45% between 1991 and 2010, with average annual growth in excess of 3% between 2001 and 2010. Asia's paved road network grew the fastest between the 1990s and 2010, with paved roads increasing from 2.7 million kilometers in 1991 to 6.7 million kilometers in 2010. To put this in perspective, the entire road system in Western Europe is just a shade greater than 4 million kilometers. The road networks in Sub-Saharan Africa, Latin America, and the Middle East and North Africa all increased materially between 1991 and 2010 as well. Eastern Europe was a relative laggard among developing economies, as its paved road network grew by just 9% between 1991 and the beginning of this decade. Similarly, Western Europe's paved road network grew under 5% between 1991 and 2010. Among the advanced economy regions, North America's paved road network grew by a robust 30% between 1991 and 2010, and its paved road network grew faster than the global average between 2001 and 2010.

Value of Paved Road Assets by Region: 1991-2010

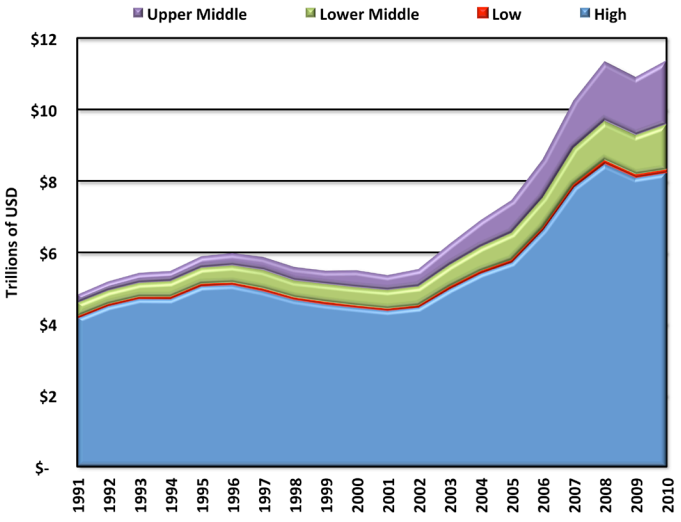


Sources: DHGE, World Bank, Various

When looking at the per capita growth in assets and the still remaining large gaps between advanced economy road endowments and developing economy endowments, it is quite evident that significant catch-up potential remains throughout the developing world. North American paved road stock per capita increased slightly between 1991 and 2010, growing by approximately 6% overall. By contrast, the paved road stock per capita in Western Europe declined during the past twenty years by nearly 10% from its peak in the early 1990s to 10,000 kilometers per million people in 2010. Asia's paved road stock per capita nearly doubled between 1991 and 2010, going from 859 kilometers per million people to over 1,750 kilometers. Sub-Saharan Africa's per capita paved road stock has declined by a little under one-fifth between the mid-1990s and the late 2000s. After declining during the 1990s and early 2000s, the paved road stock per capita in Middle Eastern and North African countries increased dramatically between the early 2000s and 2010. A similar trend was present in Latin America, although the resulting upturn during the 2000s was materially lower than in the Middle East and North Africa. The global per capita paved road stock increased by 13% between 1991 and 2010. The per capita paved road stock in North America is more than double that of Western Europe's. If Western Europe's paved road stock per million people of 10,000 kilometers is the potential steady-state level for developing regions, dramatic growth potential remains. Sub-Saharan Africa's paved road stock is one-twentieth of Western Europe's, Latin America's is one-eighth, Asia's is less than one-fifth, the Middle East and North Africa is less than one-quarter, and Eastern Europe's per capita stock is around 55% of Western Europe's.

Middle income countries have driven this growth when examined by income tiers while low income and high income countries have lagged. Nonetheless, the paved road stock continues to be heavily concentrated in OECD economies relative to most other asset classes, with almost 66% of paved road assets located in OECD countries at the beginning of this decade. Paved road stock assets in those economies rose from just over approximately $3 trillion in the early 1990s to around $5.7 trillion in 2010.

Value of Paved Road Stock by Income Tier: 1991-2010



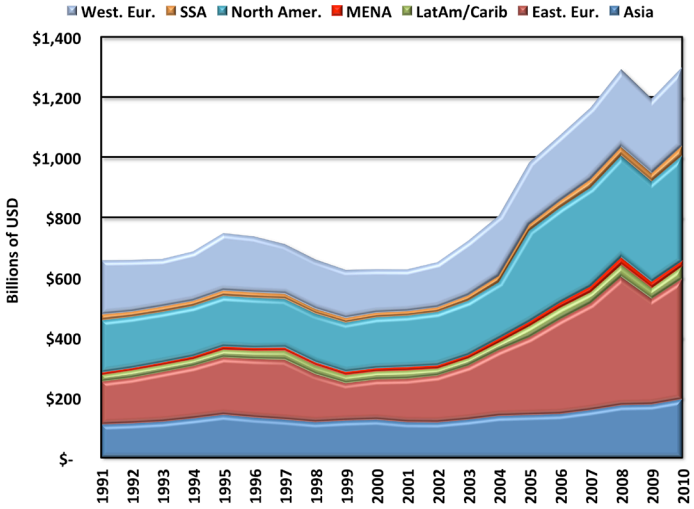
Sources: DHGE, World Bank, Various

Upper middle income economies' paved road stock grew at a blistering rate throughout the 1990s and 2000s. Overall we calculate that these assets grew in excess of 650%, going from under an estimated $250 billion in the early 1990s to around $1.8 trillion in 2010. Annual growth in the value of these assets in this income class was nearly 18% during the period 2001 until 2010. We calculate that the value of road assets in lower middle income countries also grew at a double-digit rate during the 2001 to 2010 period, and their road assets were worth approximately $1.3 trillion at the beginning of this decade. Low income economies had the second slowest rate of growth in asset classes, with the growth lagging all non-OECD economies in both the 1990s and the 2000s.

Rail

Rail assets grew the least of any major asset class during the previous two decades. Overall the total global rail network grew under 8% between 1990 and 2010. However, this was partially a result of declining rail stock in the United States and high income Eastern European and Asian countries during the 1990s. From its estimated nadir in 1999 of just barely more than 950,000 kilometers, the global rail network rose 15% through 2010, reaching a total length of just under 1.1 million kilometers.

Value of Rail Assets by Region: 1991-2010

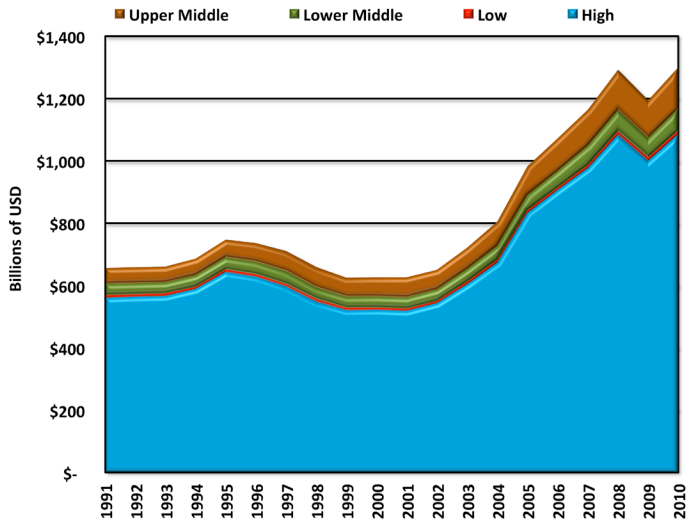


Sources: DHGE, World Bank, Various

The growth leaders during this time were all in the Western Hemisphere, with the rail networks in the United States, Canada, and Brazil all growing robustly. Overall, our model estimates that rail assets went from representing under $625 billion in 1999 to approximately $1.3 trillion in 2010. Nearly five-sixths of these assets were located in high income economies. The emerging market countries are experiencing an upsurge of railway investment which could change these ratios. China is spending trillions of renminbi creating a high speed railway network. Nigeria has signed contracts with the Chinese to spend several billion dollars upgrading its colonial era railway stock. China's Development Bank is also prepared to finance railway investment projects in other developing countries. North America is increasing railway investment to accommodate a large increase in shale oil production in regions which do not have adequate access to pipelines. Alberta had has problems developing pipeline connections to both the US and British Columbia, so its companies now depend heavily upon railways to ship out its increasing oil production.

The rail networks in high income economies outside North America grew minimally during the previous two decades. The growth in North American rail network between 1990 and 2010 represented nearly 80% of the global growth in rail assets during those two decades. High income Eastern European economies' and Japan's rail network declined during the previous two decades. Growth rebounded in high income Asia at the end of the decade while the Australian network grew quickly during the mid-1990s before largely stagnating for the next decade and a half.

Value of Rail Stock by Income Tier: 1991-2010



Sources: DHGE, World Bank, Various

Among the middle and low income economies and regions, Brazil was the standout in the growth of its rail stock during the previous two decades. Its total rail network increased over 500% during that time. China was a relative laggard when compared to its growth leadership in most other asset classes, as its rail network only increased 24%.[2]

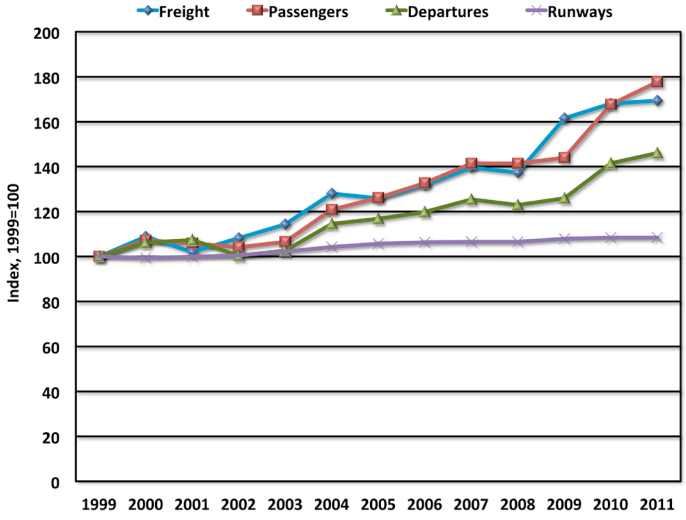
[2] There remains a startling gap in what the World Bank and China's national statistical agency report for the country's rail network (66,000 kilometers in 2010) and what China's national railway corporation lists as the length of the rail network (94,000 kilometers). World Bank and China's national statistical agency figures were used in this report.

India's rail network increased minimally while most other middle income regions rail networks either stagnated in size or declined during the 1990s and 2000s. Low income economies' rail networks grew between 1990 and 2010, but even those countries' rail stock appeared to decline towards the end of the 2000s.

Airports

Similar to railways, the demand for airport services during recent decades grew dramatically without a correspondingly large increase in the number of paved runways. Between 2000 and 2010 the number of airplane departures rose 33%, and the number of passengers and freight transported both rose around 55%. The growth in new runways, by contrast, was a relatively paltry 9%. Overall, we estimate that the value of these assets grew from around $857 billion in 2000 to approximately $1.3 trillion in 2010, but the average annual growth rate of new paved runways was under 1% per year. The geographical and income distribution of this growth was significantly more idiosyncratic than the growth seen in other asset classes.

Supply of and Demand for Airport Services: 1999-2011



Sources: DHGE, CIA, World Bank, Various

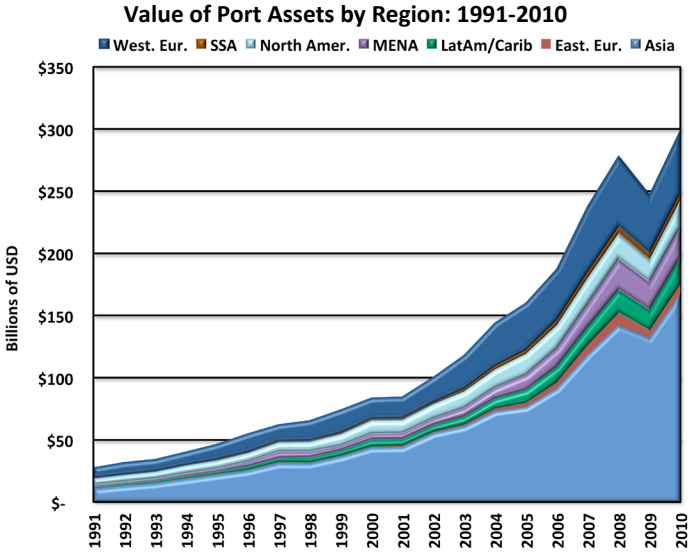
Nearly five-sixths of the growth in new paved runway capacity between 2000 and 2010 was concentrated in Asia, Latin America, and Eastern Europe. New Asian runways represented a little over one-third of the growth in new paved runway capacity around the world during the previous decade. Brazilian capacity expansion alone represented over one-eighth of the global expansion last decade with the remainder of Latin America contributing a little over 10%. Eastern Europe as a whole contributed nearly one-quarter of the growth in new assets. The United States, Canada, and Western Europe combined were responsible for just 4% of the overall growth in new runway capacity last decade.

From an income perspective, middle income countries were the primary drivers of growth last decade. Combined they were responsible for over two-thirds of the growth in new airport capacity during the previous decade. Growth was relatively spread out across multiple regions, although middle income countries in Africa and the Middle East were only responsible for 5% of the growth in new capacity last decade. Low income countries were responsible for a relatively large 6% of the growth in capacity during the previous decade. High income regions were responsible for a little over one-quarter of the new capacity last decade, and high income Eastern European countries were responsible for over half of this growth. Capacity in both the United States and Western Europe stagnated between 1999 and the beginning of this decade.

Ports

The value of port assets has risen tremendously in the last two decades. These assets were over six times greater in value at the beginning of this decade compared to the beginning of the previous decade. We estimate that the value of port assets doubled or more in size in every region around the world, and annual port traffic grew 9% or more between 1991 and 2010 in every region outside of North America and Western Europe. Nearly 90% of the growth in port assets was split evenly between high income countries and upper middle income countries in the 1990s and 2000s. Overall our model calculates that port assets grew in value 14% every year, approximately rising from less than $30 billion in 1991 to nearly $300 billion at the beginning of this decade.

Value of Port Assets by Region: 1991-2010



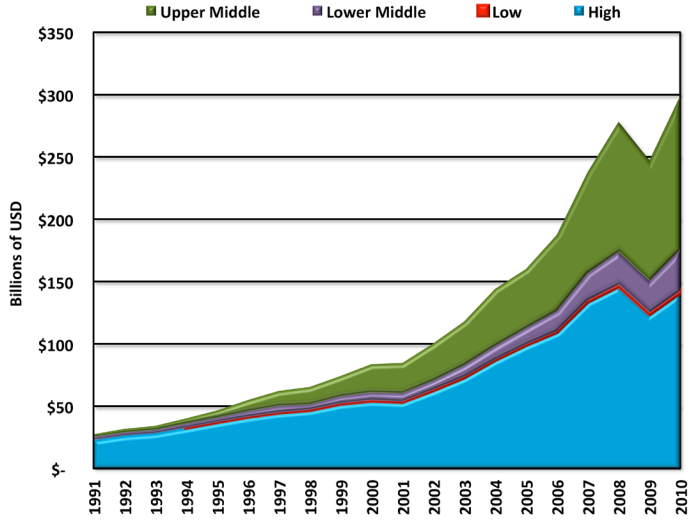
Sources: DHGE, World Bank, Various

The increase in port traffic throughout the world during the previous two decades was driven largely by Asia, although most other regions besides Eastern Europe and Sub-Saharan Africa provided meaningful growth in assets over the course of the 1990s and 2000s.

Asian shipments rose from just over 30 million TEUs (twenty-foot equivalent unit—the most common type of item shipped) at the beginning of the decade to nearly 300 million TEUs at the beginning of this decade. This represented nearly three-fifths of the global growth in assets during those two decades. Shipments in Western Europe quadrupled during the previous two decades. Middle Eastern, North African, and Latin American shipments all rose materially. North America shipments grew 170% during this time period. Eastern Europe and Sub-Saharan Africa had large growth rates during this time period, but each contributed just 2% to the growth in shipments during the 1990s and 2000s.

When broken down by income status, it becomes quickly apparent that high income countries and upper middle income countries dominate this sector. High income countries' shipments grew 279% during the previous two decades, rising from 65 million TEUs in 1990 to over 270 million TEUs by 2010. Similarly, shipments from upper middle income countries rose 2,500%, going from under 8 million TEUs in 1991 to over 200 million in 2010. Lower middle income economies were responsible for just over 10% of the growth in assets during this time period while low income countries contributed just 1% of the growth in overall shipments during this time period despite robust growth.

Value of Port Assets by Income Tier: 1991-2010



Sources: DHGE, World Bank, Various

Box 2: Top Issues Facing Private Sector Operators in Each Mode of Transportation

Airports: Modernizing relationship with airlines and customers

Airport operators that act as if the monopolistic positions they once held over the airlines and passengers are still in place increasingly do so at their own peril. Many airports used to have a captive customer base in the form of national airlines. The airline industry has been beset with bankruptcies and mergers in recent years, so the days of minimal commercial risk are long gone. The St. Louis airport went from handling 30 million passengers a year to 10 million following the TWA/American Airlines merger in 2001, which put the airport under great financial strain. Similarly, Brussels National Airport, which was among the ten busiest airports at its peak, saw traffic decline by one-third following the bankruptcy of its national airline in 2001. This trend of mergers and bankruptcies is not surprising given that airlines have the lowest return on invested capital among all participants in the commercial air transport value chain, with a return 4-7%-points below the cost of capital between 2002 and 2009. Despite these meager returns, airlines were responsible for nearly half of total investment in the industry in 2011. As of 2013 only three airlines had credit ratings above junk grade compared to fourteen airports with investment grade ratings. This means that airports must cultivate positive, productive relations with its major carriers, which have a much greater ability to change routes today than they did in the past. Airports should thus tread cautiously when raising airline-based fees during economic downturns, which has been a common practice for decades. Airlines face very elastic demand, with air travel demand contracting at approximately twice the rate of the local economy, so raising fees during a downturn exacerbates difficult conditions. Instead, airports should diversify their revenue base by goosing retail sales, parking fees, and other ancillary revenue streams. Passengers are also demanding more from airports, so it is of great importance for airlines to offer a user-friendly experience.

Roads: What is the optimal revenue structure?

Privatizing roadways offers the potential for deals that benefit all three of governments, private firms, and consumers if the structure of post-privatization revenue streams is planned properly. For consumers, although privatization means that consumers of roadway services incur more direct fees for their habits, privatization can also provide a large number of benefits when executed effectively. Congestion can decrease as a result of marginal users of roadway services choosing other routes and preventative maintenance can be more easily completed as a result of a private operator only needing to focus maintenance expenditures on one roadway. Traffic congestion in the US cost the country $121 billion in lost productivity, 5.5 billion wasted hours, and 2.9 billion gallons of wasted fuel in 2011 according to Texas A&M estimates. For the public sector, privatizing roadways can either provide lump-sum payments to help pay down debt or decades-long revenue streams depending on the form of privatization. For operators, however, what comes after the deal is struck is the most important factor in determining whether a privatization deal was a good idea or not. States have the option of increasing fuel taxes, user fees, and other tax and fee arrangements. Private firms, however, can generally not institute such revenue streams unilaterally. Electronic toll technology allows tolls to be collected while drivers can drive at full speed. The options available to toll operators are far more advanced than just open road tolling.

Box 2: Top Issues Facing Private Sector Operators in Each Mode of Transportation

- continued -

Singapore first implemented congestion pricing in 1975, and congestion decreased dramatically despite a tripling of the car population over the next three decades. Congestion pricing can base fees on both the time of day as well as congestion levels on a roadway at any given time. Roads with highest demand and congestion despite such pricing schemes being in place signal to the road operator that further investment in expanding the roadway will likely lead to greater profits. As many toll operators in the US have faced financial difficulties in part because of high debt loads and lower traffic volumes than forecasted, a more innovative system is clearly needed to both raise revenue and optimize investment decisions. Congestion pricing provides such a system. Congestion pricing schemes had 90%-plus approval in the state of Minnesota earlier this decade, so innovative schemes can be viable with consumers when implemented properly. If firms are able to raise more revenue while providing an improved user experience at the same time, the viability of private toll roads increases dramatically.

Ports: Is the port ready for a post-Panamax world?

A little over one century after first opening, the Panama Canal will unveil a new set of locks in 2016 that are already revolutionizing the shipping industry. The new locks will be able to accommodate ships that transport 12,600 containers compared to the previous locks that accommodated vessels with a maximum capacity of just 4,800 containers. This expansion will double the Panama Canal's capacity. Many ports around the world are in a rush to modernize their infrastructure in order to take advantage of the opportunities these new locks create. Industries outside of the port industry, including retailers, automobiles, airports, and commodities, are making logistical changes in response to these new locks. The share of ships that will be post-Panamax in size will rise from 16% in 2013 to 27% in 2030. Their share of global fleet capacity will rise from 45% to 62% during that same time according to the US Army Corps of Engineers. These ships can be as large as three-and-one-half football fields wide. Ports need to have a channel depth of at least fifty feet and other allowances for the increased size of the ships, new dock capacity that handles advanced cranes, and new crane capacity that can unload ships anywhere between eighteen and twenty-two containers wide compared to the current Panamax max of twelve containers wide. Only around two-thirds of North American ports are projected to be post-Panamax ready by 2015. Those ports that do not modernize their facilities will almost certainly be left behind. While environmental, labor, and intermodal access concerns are also important issues facing ports in the coming years, the acclimation to a post-Panamax world is the most pressing issue facing the industry today.

Rail: Are your technical systems cutting edge?

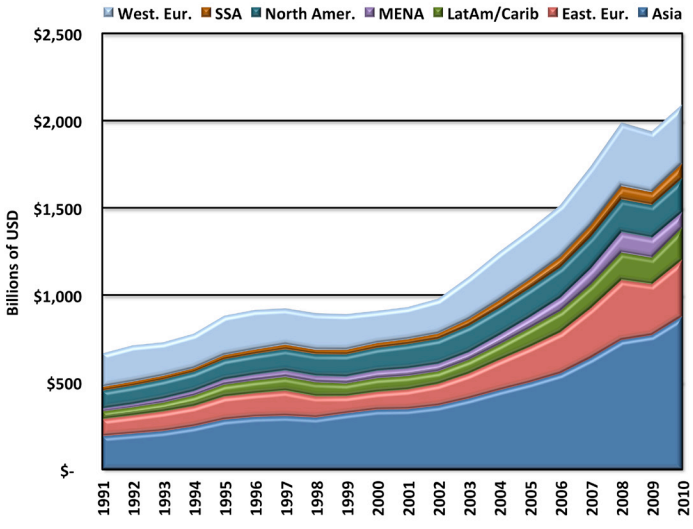
Until the mid-1990s railroad management calculated most railroad operating plans, including path and trip directions, manually. Not surprisingly, this was a highly inefficient way to operate a massive enterprise. During this time, train transportation was commonly referred to as a "black hole" due to endemic issues of delivery delays. Private rail operators in advanced economies experienced a malaise for much of the 1990s, with consistently declining passenger and freight volumes. Global rail freight only reached 1990 levels in the early 2000s following a multi-year decline as rail customers shifted delivery execution to more reliable options such as trucks and airplanes. When a new guard of more IT-oriented executives took over rail firms in the late 1990s and early 2000s and implemented long overdue reforms, the industry's prospects brightened immensely. What were once fixed costs became variable costs. Average train speeds increased. Manual operating plans became computer-based plans. These reforms resulted in a large number of benefits. Union Pacific estimates that each additional mile per hour in average train speed reduces the need for 250 locomotives, 5,000 freight cars, and 150 employees. Each one hour reduction in car terminal dwelling eliminates the need for 2,500 freight cars. Each one day reduction in car cycle reduces the need for a whopping 25,000 freight cars. During a nearly three decade period that saw component costs more than triple, operating costs of railroad companies actually declined by 3% in large part due to systems modernization. With a burgeoning demand for transporting liquid energy commodities, the opportunities for future growth in the industry have increased dramatically in recent years. The number of crude oil shipments via rail in the US rose 8,358% between 2006 and 2013. The strongest firms in the future will be the ones that continue to adopt the cutting edge technologies that are being developed today. Such technologies include driver advisory systems, centralized network control, advanced in-cab signaling systems, intelligent automated traffic management systems, and automated driver operations. These technologies will allow firms to improve revenues by gaining customers with greater on-time delivery capabilities while also reducing costs. This new decade offers many exciting opportunities to a rebounding industry, and the companies that adapt nascent technologies first stand poised to reap many benefits from doing so.

WATER AND SANITATION

Sanitation

Developing economies have made tremendous gains in increasing the share of their population with access to improved sanitation facilities during the past two decades while advanced economies have been able to maintain near universal access to such facilities. Improved sanitation facilities include all facilities that provide for excreta disposal while distancing humans, animals, and insects from any contact with the excreta. Improved sanitation is associated with improved health outcomes of populations. Recent estimates have shown that every $1 spent on improved sanitation facilities translates into $7 of economic benefits. Such facilities can range from as advanced as flush toilets with extensive sewerage systems to as modest as protected pit latrines, but proper construction and maintenance is necessary. Between 1991 and 2010 we estimate that the value of these assets grew 6% every year, going from under $650 billion in 1991 to around a value in excess of $2.0 trillion by the beginning of this decade. Growth was fastest in Asia, Latin America, and Sub-Saharan Africa, all of which grew by 7.5% or more during those twenty years. The plurality of these investments was located in Asia at the end of the last decade. Despite the significant amount of new investment that occurred in this sector during the previous two decades, over two billion people were left without access to improved sanitation facilities at the beginning of this decade. Thus there remains a tremendous amount of scope for significant investment flows in this sector in the coming decades.

Value of Sanitation Assets by Region: 1991-2010

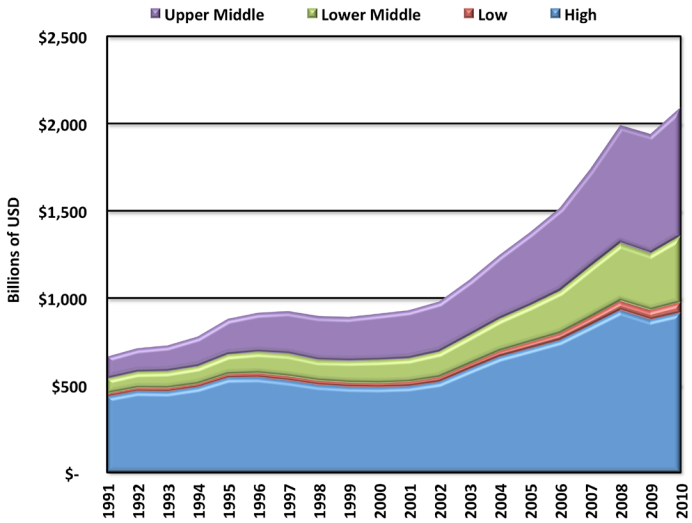


Sources: DHGE, World Bank, Various

Developing regions sanitation assets increased dramatically between 1990 and 2010. During those two decades the share of the population with access to improved sanitation facilities in East Asia and the Pacific increased 32%-points and in Latin America it increased 13% points. Access in the Middle East and North Africa increased 15%-points in the past two decades, reaching 90% by the end of 2010. Additionally, access in North America and Western Europe remained at near universal levels, while Eastern Europe approached universal access by the end of 2010.

The most notable developments are evident when the progress is charted across income tiers. The share of the population in high income countries with access to improved sanitation facilities rose to 96% in 2010 from 95% in 1990. Upper middle income countries experienced a 30%-point jump, with the share of population with access rising from 44% to 74%. Lower middle income countries experienced an 18%-point jump, rising from 29% to 47%. The share of low income country citizens with access to improved sanitation facilities rose 85%, going from 20% in 1990 to 37% at the beginning of this decade.

Value of Sanitation Assets by Income Tier: 1991-2010



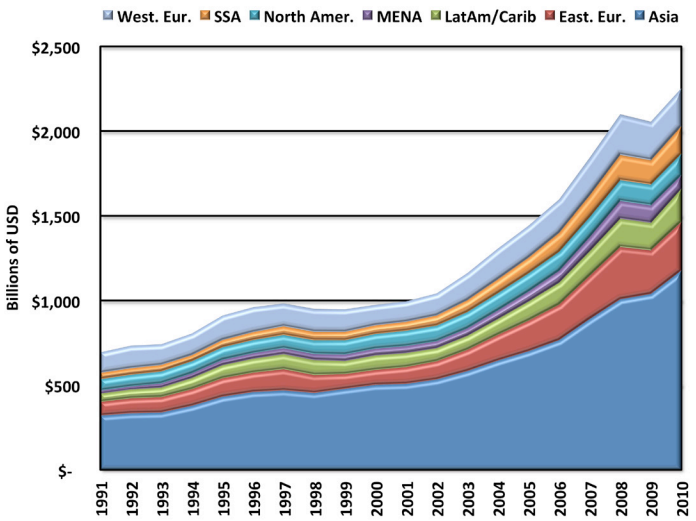
Sources: DHGE, World Bank, Various

Water

Reasonable access to safe water sources has a similarly beneficial impact on both health and economic outcomes as access to sanitation facilities. Studies have shown that improved access to safe water in the developing world has a positive impact on educational outcomes, which is known to drive faster economic growth, especially in countries in the middle of the development curve. Reasonable access to water from an improved source consists of access within one kilometer of the water source to at least twenty liters of water per day from a source such as a household connection, public standpipe, borehole, protected well or spring, or rainwater collection.

If people need to obtain their water from either an unprotected source or someone selling it directly, they are not considered to have reasonable access. Although water assets grew at a robust rate between 1991 and 2010, they grew slower than sanitation facilities. Our model estimates that the value of water assets grew 6.4% annually between 1991 and 2010, going approximately from less than $700 billion to around $2.2 trillion by 2010. The fastest growth was found in Sub-Saharan Africa, Asia, and Latin America. This divergence is likely to grow over time given that nearly 90% of the global population had access to improved water facilities at the beginning of this decade compared to less than two-thirds of the global population which had access to improved sanitation facilities. Nonetheless, over 800 million people did not have access to improved water sources at the beginning of this decade.

Value of Water Assets by Region: 1991-2010

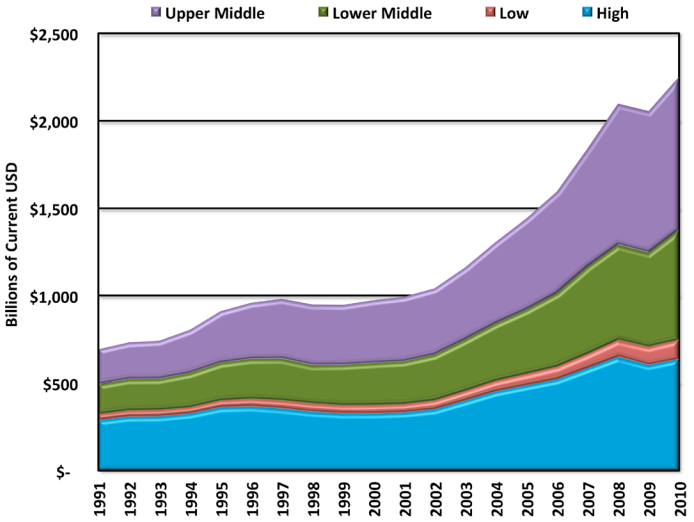


Sources: DHGE, World Bank, Various

The expansion of access to improved water facilities across regions of the globe generally followed the pattern of improved access to sanitation facilities. Sub-Saharan Africa experienced the largest percentage point gains in access, with the share of population in individual countries increasing 14%-points in the last two decades, going from 48% of households having access in 1990 to 62% in 2010. Latin American access rose nearly 10%-points to 94% in 2010 while East Asian access rose over 20%-points to 92%. The percentage point gains in Eastern Europe and the Middle East and North Africa were smaller, but access was in excess of 90% in both regions at the end of 2010. Western Europe and North America maintained near universal access to improved water sources during this time.

The pattern of growth in the share of population with improved access to water facilities during the 1990s and 2000s largely mirrored that of sanitation facilities, although at least two-thirds of the populations had access to water facilities at the beginning of this decade. The high income share was 98% in 1990 and 99% in 2010. The upper middle income share of population with such access rose 17%-points during the previous two decades, going from 75% of the population to 92%. Lower middle income countries experienced the largest increase in the share of population with access to improved water facilities rise from 71% in 1990 to 87% in 2010. The laggards once again were low income countries, with the share only rising from 53% in 1990 to 66% in 2010.

Value of Water Assets by Income Tier: 1991-2010



Sources: DHGE, World Bank, Various

Box 3: Top Issues Facing Private Sector Operators in the Water-Sanitation Sector

Structuring future privatizations properly

When privatizing water and sanitation facilities, it is of paramount importance that the following three factors be properly aligned: the form of private involvement, the competitive structure of the sector, and the post-privatization regulatory regime. Different forms of private involvement—divestment, BOT/BOO, contract/concession—make more fiscal sense under certain regulatory regimes and vice versa. Additionally, depending on the structure and/or level of competition within the water and sanitation sector in a given state, different risk-reward balances may be preferred. Complications have historically arisen whenever one of these three factors is not in proper alignment with the other two. It is also important to eliminate information asymmetries that can arise from both private and public organizations. This includes whether pipes are being maintained properly, what true cost recovery rates are, etc.

Box 3: Top Issues Facing Private Sector Operators in the Water-Sanitation Sector - continued -

Making sure that privatization agreements meet the needs of both firms and the general public

More so than most other infrastructure assets, water and sanitation services are natural monopolies. This means that in order to prevent firms from simply profit-maximizing as classical economics would predict, a strong, independent regulatory regime must be instituted that encourages private sector operators to employ least-cost production methods. However, the regulatory regime must also encourage innovation and investment from the private firms that do operate in this sector. This can be accomplished by allowing for variable prices that match or rise above cost recovery levels and reasonable profit opportunities when desired quantity and quality of water services are provided by the firm. Where private firms agree to take on greater risk—such as in the case of full or partial divestments or build-operate-own arrangements—they must also be provided with enticing rewards in the event that their operations are effective and investments are made prudently. This may involve providing monopoly operations in a specified area and/or exclusive rights to associated services in order to mitigate the commercial risk that private firms face. It also means ensuring that the private sector is given sufficient access to water resources. While it is quite important that private firms extract and provide water and sanitation services in an environmentally sustainable way, private firms in this sector must be given written assurances that upstream water users and land users, such as farmers, are prohibited from siphoning water supplies from them at specified quantities and qualities. This is a responsibility on the part of the regulatory regime that must be monitored carefully, and applicable laws need to be revised as conditions surrounding the supply and quality of water evolve. This is an especially pertinent issue for water and sanitation firms that have rivers as water sources.

Utilizing new technologies to maximize efficiency

In a manner similar to that of the energy sector, the water and sanitation sector is in the nascent stages of a technological revolution. Optimization opportunities exist for both the operators and the consumers. For operators in the US, infrastructure leaks result in around 14% of water treated by water systems to be lost. Metering and data issues also contribute to a higher-than-desired level of non-revenue water throughout the world. Properly managing water pressure both decreases absolute water consumption and results in fewer leaks. Operators have access to technologies that offer new data monitoring and analytical capabilities that aid in reducing water loss and optimizing water flow and system pressure. Private companies are also trying to convert wastewater into a usable resource for firms that do not need potable water for their purposes. General Electric has developed membrane bioreactor technologies that increase the energy efficiency of treating water by 30%. Smart meters provide both residential and commercial consumers with real-time data that aids their efforts in conserving the resource while still having access to adequate supplies. An Oracle survey of US and Canadian water consumers found that over three-quarters of them were concerned about conserving water while over two-thirds of the respondents were concerned about household water costs. The widespread installation of new technology is the best way to give consumers the tools to address these concerns.

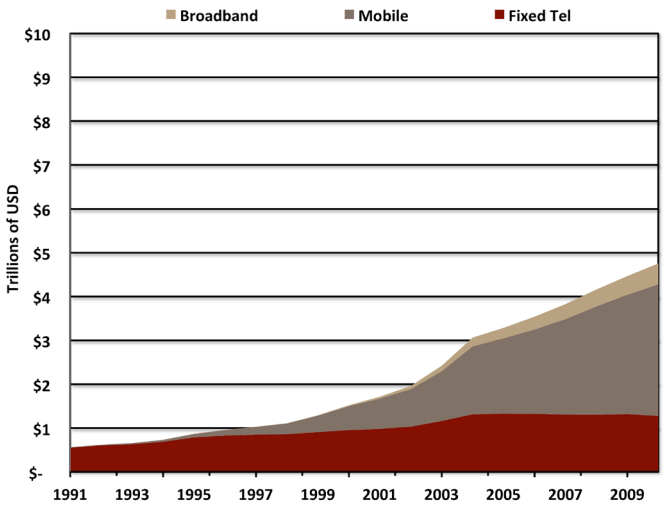
TELECOM

Telecom assets have grown dramatically in recent decades, with the sector's assets going from being worth less than an estimated $1 trillion in the mid-1990s to approximately $4.75 trillion at the end of the last decade. The sector has seen growth leadership evolve twice over the course of the past two decades. At the beginning of the 1990s, the sector's assets were almost entirely concentrated in assets related to fixed telephone lines, and around four-fifths of those assets were concentrated in advanced economies. Interestingly, although the OECD's share of capital assets stemming from fixed telephone lines over time declined, it was still nearly 60% at the end of 2010 around the world. Growth leadership would later be shared between assets associated with the proliferation of mobile phones and broadband lines towards the end of the 2000s.

Unlike any other major component of infrastructure assets, we estimate that the value of assets related to fixed telephone lines has been declining since the mid-2000s. The per capita stock of fixed telephone lines declined in every region, including even developing regions such as Sub-Saharan Africa and Latin America, which also peaked in the second half of the previous decade. Per capita growth in fixed telephone lines in low income countries around the world continued unabated through the beginning of this decade. Despite this decline in the cumulative value of capital assets related to fixed telephone lines around the world, the subsector still grew by 5% per year between 1991 and 2010. The fastest growth occurred in the early 2000s when middle income countries' fixed telephone lines grew dramatically. Asian per capita telephone lines increased over 50% between 2000 and 2004 while the Middle Eastern and North African growth almost reached that level. Globally, we calculate that the value of assets associated with fixed telephone lines approximately went from less than $1 trillion to more than $1.3 trillion during this time period. By the end of 2010, however, our model estimates that the value of these assets would decline to below $1.3 trillion.

The rise in the value of assets stemming from mobile phone subscriptions around the world during the previous two decades was stunning.

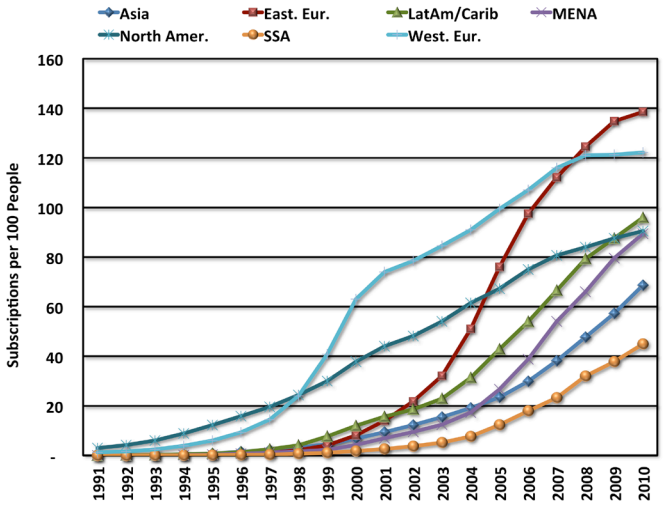
Value of Telecom Assets by Type: 1991-2010



Sources: DHGE, World Bank, Various

We estimate that the total value of these assets grew very slowly during the course of the 1990s before seeing explosive growth over the course of the 2000s. Our model calculates that the total value of mobile phone-related assets grew from around $10 billion in the early 1990s to an estimated value in excess of $500 billion by 2000. Between 2000 and 2010 our model estimates that these assets increased over fivefold, and globally they exceeded $3 trillion at the beginning of this decade.

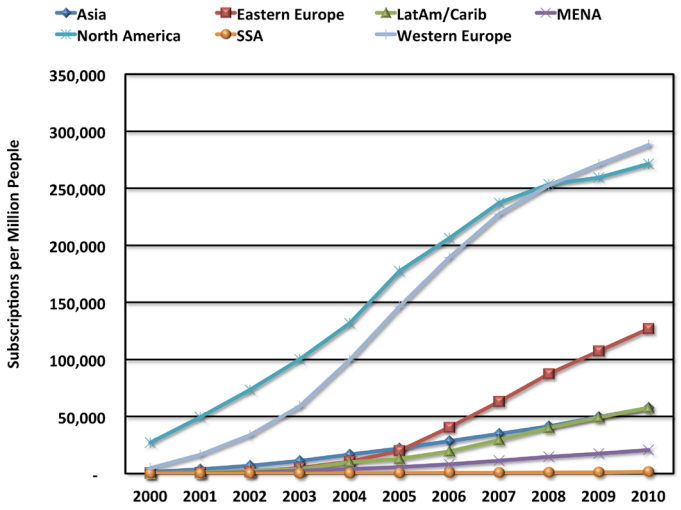
Per Capita Mobile Phone Subscriptions by Region: 1991-2010



Sources: DHGE, World Bank, Various

Cumulatively, mobile phone-related assets were worth 135% more than fixed line-related assets at the beginning of this decade, and subscriptions were greater than three-quarters of the population globally in 2010. Growth was robust in every region around the world. Subscriptions were equivalent to 89% or more of the population in every region except for Sub-Saharan Africa and Asia. There are more mobile phone subscriptions in Eastern and Western Europe than there are people. Among income tiers, subscriptions were greater than 70% of the population in every income tier besides low income countries, where they represented less than one-third of the population at the end of 2010.

Per Capita Broadband Subscriptions by Region: 2000-2010



Sources: DHGE, World Bank, Various

As the growth rate of new mobile phone subscriptions is already slowing and the number of fixed telephone lines is declining around the world, broadband connections are an emerging growth engine in the telecom sector that should continue to drive growth across many regions and income groups over the course of the this decade and the next. Globally fixed assets related to broadband connections went from being worth around $20 billion at the start of the millennium to nearly $500 billion at the beginning of this decade. Growth was particularly dramatic in both the OECD economies and upper middle income countries, although the number of connections represented less than 30% of the population in every region around the world, including North America and Western Europe. Connections in Sub-Saharan Africa represented one-six-hundredth of the population, and they were one-fortieth of the population in the Middle East and North Africa, one-seventeenth of the populations in Asia and Latin America, one-eighth of the population in Eastern Europe, and a little less than three-tenths of the population in Western Europe and North America at the end of 2010. Connections were equivalent to less than 10% of the population in every income tier except for the high income ones. They were also equivalent to barely more than 1% of the population in low income and lower middle income countries. Despite this relatively low diffusion compared to other telecom assets, the growth in this subsector was dramatic at the end of the previous decade and early portions of this decade. In particular, assets related to broadband connections grew in value by an average of 26% every year between 2006 and 2010.

Box 4: Top Issues Facing Private Sector Operators in the Telecom Sector

How to monetize the "data tsunami"

The days when telecommunications operators can focus their efforts exclusively on how many minutes of calls they sell to customers are largely over. With an increasingly large share of the global population having access to the Internet over either a fixed or wireless network, the demand for and traffic of data has risen exponentially in recent years. This insatiable demand represents the telecom industry's greatest challenge as well as its greatest opportunity. Tremendous investment needs to be made in order to satiate this demand, but an optimal way to monetize this opportunity has yet to materialize. Booz & Company has posited that there are four ways that telecom operators can monetize this opportunity: offload mobile traffic and redefine network architectures, invest in new data compression technologies, pursue growth opportunities in the business-to-consumer and business-to-business marketplaces, and monetize the wide variety of service levels that networks can provide to end-users. Many firms are in the process of experimenting with different ways to monetize this opportunity. AT&T recently announced plans to offer "sponsored" data plans where consumer are given access to increased data volumes in exchange for being exposed to additional advertisements. Cisco systems estimates that global mobile data traffic will increase 83% per year between 2009 and 2017, reaching 11.2 exebytes in 2017 from just 0.09 exebytes in 2009. Ernst and Young surveys indicate that customers are willing to pay a premium for data services if the value of these services is properly communicated to them. As of 2012, however, only 56% of people surveyed fully understood their options. Leveraging predictive analytics and big data to gain insights into what consumers want will aid in this process. While the "datafication" of processes that were once thought to be unquantifiable represents one of the greatest opportunities to gain insights into a multitude of processes, it will also place a tremendous strain on telecom networks to incorporate this new wave of data without compromising existing services.

Adapting to a smartphone-dominated telecom sector

Smartphones handled more data traffic than laptops in 2013 for the first time. This is a trend that will only accelerate in the future, given that over two-thirds of the projected growth in data traffic between 2012 and 2017 occurs in smartphones. Globally smartphones will go from representing 16% of the total mobile device market to over one-quarter of the market by 2017. Non-smartphone cell phones will still outnumber smartphones by a two-to-one margin, but their mobile data traffic will represent just a sliver of the overall market. An increasingly large share of this data traffic is being and will likely continue to be offloaded onto fixed networks. The traffic that remains on the global networks will increasingly be on more advanced 3G and 4G networks, with the share of mobile traffic on these networks going from less than one-quarter of the total in 2012 to 43% in 2017. The mobile 3G and 4G networks will be three times and six times faster than average by 2017. Average mobile speed will increase anywhere between five fold in advanced regions to between nine fold and thirteen fold in developing regions. Mobile data traffic over this span of time will grow between eight and nine fold in the advanced regions and between thirteen and seventeen fold in developing regions.

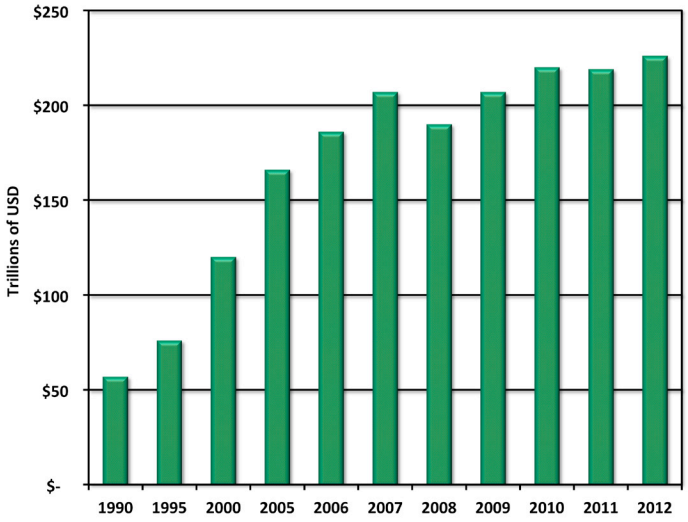
Is sharing the key to providing high quality, profitable Internet services?

Operators, governments, and consumers all want their telecom networks to be as fast as possible and as high quality as possible. The modern infrastructure necessary to compete—let alone thrive—in a data-driven telecom industry, such as fiber infrastructure and LTE networks, has become increasingly complex. It has also become increasingly expensive. At a time when investors demand that management maximize returns every quarter—over two-thirds of free cash flow of S&P 500 companies, nearly $450 billion, in the year through the end of September 2013 was consumed by stock buybacks—capital spending requests face tough ROI demands from management. In this environment network sharing becomes a win-win-win proposition for consumers, management, and investors. Ernst and Young estimates that network outsourcing can reduce operator costs by 20% or more. Booz & Company estimates that set-up costs can be reduced by 40% in sharing arrangements and utilization costs can be reduced by 20%. The forms of cooperation are becoming ever more diverse as well. Passive infrastructure sharing arrangements are evolving towards active arrangements. Such sharing arrangements, which have only been in existence for a little over a decade, will help to dispel fears of a looming "capacity crunch" that many industry observers have fretted about in recent years. There is an inherent tension between government regulators who want competition within the telecom sector, long-time operators that see infrastructure sharing as a source of new revenues, and startups that see sharing as a way to lower barriers to entry in the industry, but that does not mean that pursuing infrastructure sharing arrangements should be avoided. Such arrangements are most popular in advanced economies with mature telecom sectors. As Booz & Company outlined, infrastructure sharing reduces operators' investment requirements, offers operators a new source of revenue, decreases the barriers to market entry for startups, and shifts the focus from network deployment to service innovation.

Private Sector Share of Infrastructure Investment in Advanced Economies

One of the great challenges confronting the global economy during the next several decades will be the need to finance tens of trillions of dollars of infrastructure investment. The old industrial countries have a great deal of aging infrastructure which will have to be upgraded. The developing countries have an immense need to build new highways, airports, water systems, and telecommunications networks. The way countries finance infrastructure spending varies widely. The US has long had privately-owned railways, pipelines, and telecommunications systems, but it has excluded the private sector from investing in airports while greatly limiting its investment in highways and waterworks. Europe privatized its telecom companies during the 1980s and 1990s and has some private investment in highways and water systems, but not in railways. China has listed many of its airports, water companies, highways, and telecom companies on the stock exchange. Thailand has done the same. India has privatized its telecom companies, but done little to attract private investment to its transportation infrastructure. The Philippines has listed its telecom, energy, and water companies on the stock exchange, and is seeking public-private partnerships to build new transportation infrastructure. Latin America has privatized its telecom companies as well as some water and highway companies. Except for the telecom sector, Africa has not yet listed any of its infrastructure companies on the stock exchange, but Nigeria recently decided to privatize its electricity sector.

Global Financial Assets: 1990-2012



Source: McKinsey Global Institute

This could set the stage for a great deal of private equity investment and ultimately stock market listings. In many countries, it is difficult to attract private investment for infrastructure because of poor regulation. Some countries also restrict foreign investment on strategic grounds. These factors mean the world will satisfy its infrastructure needs through a diverse mix of financing vehicles encompassing both private and public spending. There is currently $225 trillion of financial assets in the global economy. The infrastructure sector could easily expand this number by $20-30 trillion during the next twenty years.

There has been private investment in infrastructure since the late 18th century. Many of the early highways in the US were funded by private investors. The first public investment did not occur until 1806, when Congress allocated funds for the National Road, which ran from Cumberland, Maryland to southern Illinois. British investors financed the construction of railways in the UK and US during the mid-19th century. They later played a role financing infrastructure in Latin America and Australia.

The creation of the telecom sector in the US was financed by private investors from the start, but in most other countries it was state controlled. The US was so far ahead of other countries that fourteen out of every one hundred Americans had a phone in 1914 compared to less than one in France. The private sector also played a dominant role building ports in certain cities. The pipeline sector was an offshoot of the energy sector and was thus financed by private investors.

During the past twenty years, there has been a revolution in the ownership of the infrastructure sector. Most industrial countries have privatized their telecom sectors and produced large market cap companies which often make foreign investments. Many countries have privatized their airports and listed them on stock exchanges. The highway and port sectors also now have many listed companies in Asia, Europe, and Latin America. China has privatized many of its water companies. The US has been an outlier in the infrastructure sector. It does not have any listed highway, port, or airport companies. State governments privatized $27 billion of highway assets ten years ago, but the deals were all financed by debt rather than equity. Many of the deals were done at high prices which could not be justified by future revenue growth and are now in default. The Macquarie Infrastructure Fund privatized Chicago's Skyway for $1.8 billion in 2005 and the Indiana Tollway for $3.85 billion in 2006. Chicago has also announced two deals to sell its Midway Airport, but both have collapsed. As the city is confronting a major fiscal crisis, it may try again, but it is not yet clear how it will go forward. Congress authorized the Airport Privatization Program in 1996, but only the small Stewart Airport in New York took part in the program. The great surprise during the fiscal crisis which confronted state governments four years ago was that they did not privatize any infrastructure assets. They could have raised billions of dollars by privatizing highways and airports.

Chicago Skyway (Chicago, IL) *Source: stvinc.com*

Forms of Privatization in Infrastructure: Low Risk/Low Reward to High Risk/High Reward

	Service Contract	Management Contract	BOT/BOO	Lease	Concession	Partial Divesture	Full Divesture
Arrangement	Firm undertakes a contract for a single function, in order to provide a specific service with fee-based revenue	Firm is responsible for maintenance and operations of an infrastructure asset under a short-term contract	Firm is contracted to construct an infrastructure asset Firm is responsible for capital investment, and either owns the asset outright (BOO) or transfers ownership to public sector at a specified time (BOT)	Firm undertakes medium term contract (one or two decades) to operate, maintain, and partially renew an infrastructure asset	Firm agrees to a long-term contract (more than a couple of decades) to operate and maintain an infrastructure asset as well as provide sufficient capital investment	Firm agrees to a joint venture on a corporatized infrastructure asset	Firm acquires an infrastructure asset and is responsible for maintenance, operations, and capital investment
Pros: Private Sector Operators	Contracts are for specialized functions Contracts are variable in length but short in duration Significant capital not expected Least regulatory burden Low barriers to entry Minimal commercial, political, and financial risks	Contracts are generally short term in nature Firms are not responsible for capital investments Moderate upside potential from efficient operations Limited barriers to entry Lower regulatory burden Manageable financial, regulatory, and political risks	Contracts are for specialized items Significant upside potential from prudent capital investments Manageable regulatory and political risk Cost overrun guarantees and take-or-pay arrangements can be negotiated to mitigate commercial and/or construction risks Generally limited competition for infrastructure services	Material upside from efficient operations Commercial, political, and regulatory risks can be mitigated with contracts that authorize price hikes to cover service cost increases Moderate upside potential from prudent capital investments Manageable construction risk Generally limited competition for infrastructure services	Significant upside potential from efficient operations Material upside potential from prudent capital investments Commercial and construction risks can be mitigated, as contract renegotiations are common Generally limited competition for infrastructure services	Material upside potential from efficient operations and prudent capital investments Regulatory and political risks are partially ameliorated by the fact that public sector maintains partial control over the infrastructure asset Incentives generally provided for innovative management and practices Generally limited competition for infrastructure services	Significant upside potential from efficient operations and prudent capital investments Generally limited competition for infrastructure services
Cons: Private Sector Operators	Limited upside potential from efficient operations Firms face unrelenting pressure to cut costs No upside potential from making prudent capital investments Moderate construction risk depending on type of service	Firms face unrelenting pressure to cut costs No upside from making prudent capital investments Moderate construction risk depending on type of service Moderate commercial risks	Material construction risk Moderate commercial and financial risk	Moderate financial risks Even with mitigation, some commercial, political, and regulatory risk remains Moderate construction risk	Even with mitigation, commercial and construction risks remain Moderate financial, political, and regulatory risks	Significant commercial risk Material construction and financial risk Even with amelioration, some political and regulatory risks cannot be eliminated Operations are partially constrained by regulatory environment	Significant construction, commercial, financial, regulatory, and political risks Operations are partially constrained by regulatory environment

Many countries have announced ambitious plans for infrastructure privatization. They include Greece for electricity and natural gas, Turkey for toll roads and airports, Brazil for airports, rails, and highways, and Mexico for toll roads. New Zealand and Australia plan to privatize power companies. Spain and France plan to privatize airports.

Airports have been a growth sector in both the industrial countries and developing countries because of steady growth in passenger traffic. Passenger traffic between 2008 and 2015 is projected to grow by 4.7% per annum on domestic flights and 4.9% per annum on international flights. Many airport companies also derive significant revenue from retail shops and parking garages. New airport concessions often include rights to develop real estate surrounding the airport, which can be used for ground transportation links, office space, hotels, and shopping centers. London's Heathrow airport and Singapore's Changi airport have become immense shopping malls.

Case Study

MANILA WATER PROJECT (PHILIPPINES):

The privatization of water services in eastern Manila in 1997 brought many benefits to the local residents. Water from the privatized source cost one-twentieth of what individual vendors charged residents, coverage increased 15%-points in just six years, and twenty-four hour access increased from 26% in 1997 to 99% in 2011. Water contamination was reduced by 95%.

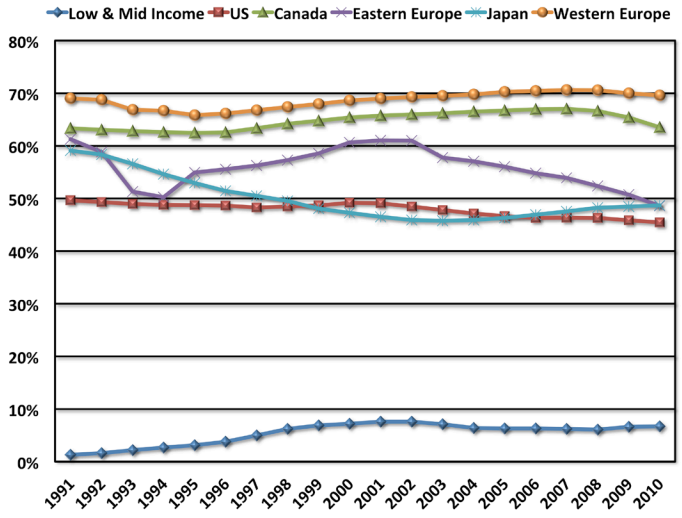
Charles de Gaulle airport shopping center by W&CIE, Paris
Source: retaildesignblog.net

There are listed water companies in Brazil, China, Greece, and the United Kingdom while France has a water company which is active in many developing countries, but the sector is still government controlled in most countries. In the US, for example, only 5% of the 54,000 publicly-owned water and wastewater systems contract their operations to private firms.

An investigation of investment flows in the US, Canada, Japan, Western Europe, and high income Eastern European countries indicated that just below half to nearly three-quarters of infrastructure assets are in private sector hands in advanced economies around the world according to our estimates. The Canadian private sector was estimated to be responsible for a little under two-thirds of total infrastructure investment over the course of the previous two decades. In Japan private sector investment in infrastructure was estimated to be responsible for a little under half of total infrastructure investment based on various indicators. Western Europe has the largest share of infrastructure assets in private sector hands, with anywhere between 66% and 71% of such assets being held by private sector operators based on our model's estimates.

The private sector share of high income Eastern European countries rose throughout the 1990s before declining over the course of the 2000s. At the beginning of this decade that still left around 49% of infrastructure assets in the region in the hands of private sector operators. The United States had the lowest share of infrastructure assets held by the private sector based on infrastructure investment flows of the high income countries and regions examined. The private sector share of US infrastructure assets began the 1990s at just 50% and steadily declined towards 45% at the beginning of this decade. Every advanced region's private sector share of infrastructure assets, including the United States' relatively modest private sector share, dwarfs the comparable figure in lower and middle income countries. In 1991 a little more than 1% of their infrastructure assets were held by private sector operators before rising to above 6% in 1998, where it would fluctuate in a range between 6.1% and 7.6% over the next thirteen years.

Private Sector Share of Infrastructure Assets by Country/Region: 1991-2010



Sources: Eurostat, BEA, European Commission, World Bank, Various

Western Europe's private sector dominance of infrastructure investment has largely been the result of the fact that the vast majority of energy and telecommunications investment occurs in the private sector based on an examination of private and public infrastructure-related investment flows.

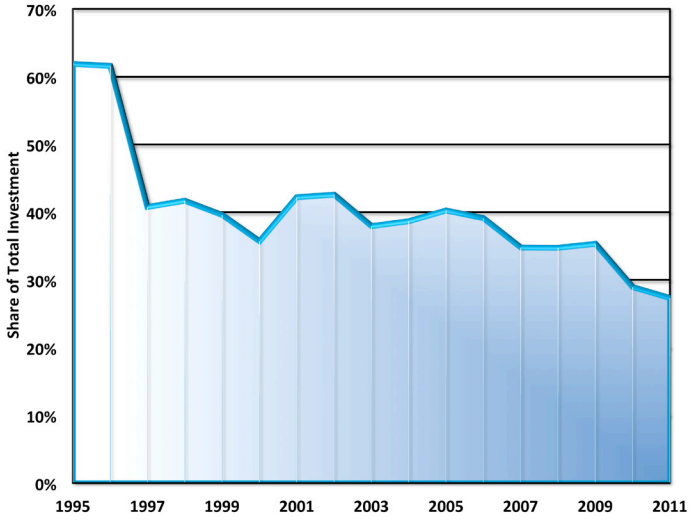
The only year in either sector where the government was responsible for 1% or more of the investment was 2009 in the telecommunications sector for countries which had individual breakdowns of sectoral investment available. Similarly, energy investment in Western Europe was largely dominated by the private sector in the sample, with 99.5% of the investment occurring in the private sector based on the 108 years of data from eight Western European countries. By contrast, transportation and water and sanitation assets have seen divergent trends in the private sector share of investment flows over the course of the 1990s and 2000s. In the mid-1990s over three-fifths of water and sanitation investment was conducted by the public sector. Beginning in 1997, however, the public sector was responsible for a little more than 40% of such investment before steadily declining to 27% of such investment by 2011, with noticeable declines occurring in 2010 and 2011. By contrast, the public sector's share of transportation assets has been increasing since the mid-1990s. Between the mid-1990s and 2003, between two-fifths and one-half of transportation related investment in the sample was conducted by the public sector. The public sector's share of such investment swiftly increased over the next eight years, rising to a peak of 82% in 2010 and averaging over 70% of such investment for the period as a whole.

Case Study

DUSSELDORF AIRPORT (GERMANY):

After suffering a debilitating fire in 1996 and unable to raise enough capital to fix the airport on its own, the city of Dusseldorf partially privatized its seventy-year-old airport in order to reopen it. After the airport became partially private, the new ownership group rebuilt the airport quickly, improved the service, and expanded capacity. They also invested hundreds of millions of euros in order to improve operations and customer service. These improvements resulted in the airport receiving a number of prestigious awards. Some of these awards include the fifth best airport based on number of departures and best regional airport.

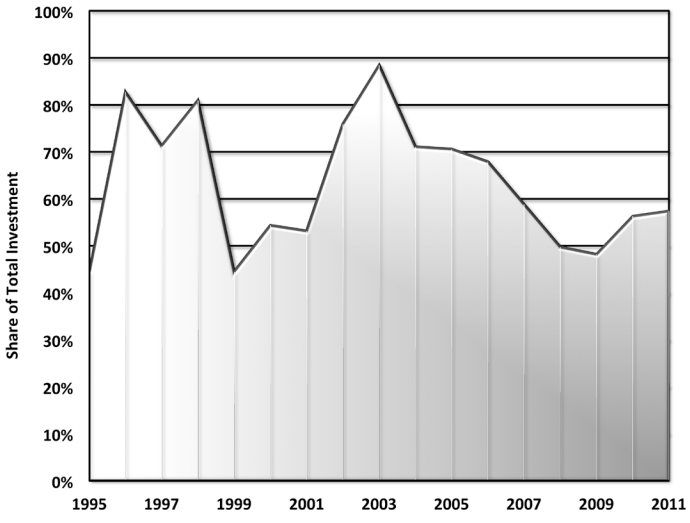
Government Share of Western European Water and Sanitation Investment: 1995-2011



Sources: Eurostat

Although the number of available high income Eastern European countries for which individual sectoral shares of public and private infrastructure investment was available was significantly smaller, the trends remain of interest. Poland and the Czech Republic represent about 70% of total economic activity among high income Eastern European countries—excluding Russia—and sectoral data in the Czech Republic was available beginning in 1995 while the corresponding data for Poland was available beginning in 2002. The public sector share of telecommunication investment began the early-2000s at negligible levels before rising over the 2000s and reaching nearly 2% of total investment at the end of 2011. Although the telecommunications sector in Eastern Europe is dominated by private sector actors, the public sector share is still four times that seen in Western Europe. Similarly, Eastern Europe's public sector plays a larger role in the energy sector than Western Europe's, but its overall share of investment is still miniscule in the sample. Public sector investment in the sector peaked in 2004 at 5.7% of overall energy investment, although it remained at approximately 3% of overall investment for the remainder of the 2000s.

Government Share of Eastern European Water and Sanitation Investment: 1995-2011



Sources: Eurostat

In contrast to Western Europe where the private sector conducts a material share of transportation investment, the public sector has been the dominant supplier of such assets in Eastern Europe.

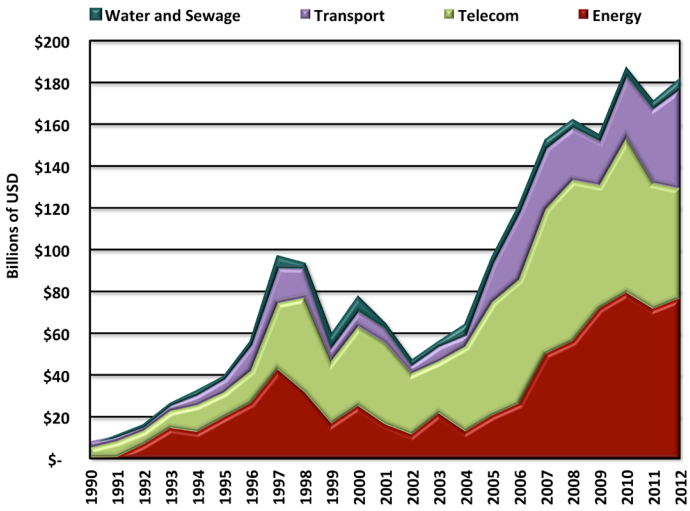
The trends in water and sanitation-related investment in high income Eastern European countries are similar to Western Europe, although the level of initial public sector involvement in Eastern Europe was considerably higher before the declines began. The public sector share of such investment peaked in 2003 at 88% of overall investment before declining over the next six years and reaching a trough of just 49% of investment in 2009. Public investment did rebound in the sector in 2010 and 2011 to 56%-57%.

In the United States the distribution of public and private sector infrastructure assets is broadly similar to those in Europe, but there are notable differences. In particular, around 90% of transportation and water and sanitation assets are held by the public sector, with notable dominance among streets and highways[3]. Both of these levels are materially higher than those seen in Western Europe. Additionally, the public sector share of energy assets is materially higher in the United States, and the share has been rising over time. In the early 1990s approximately 6% of assets were held by public sector entities. This share has steadily risen since that time, reaching 11% between 2010 and 2012. Similar to Europe, telecommunications investment in structures and equipment is completely dominated by the private sector in the United States.

Private Sector Investment in Developing Economies

Private sector participation in infrastructure investment in emerging markets has increased dramatically since 1990. In 1990 private sector companies were involved in projects with less than $10 billion in commitments to infrastructure in developing economies.

Value of Developing World Infrastructure Projects with Private Participation by Sector: 1990-2012

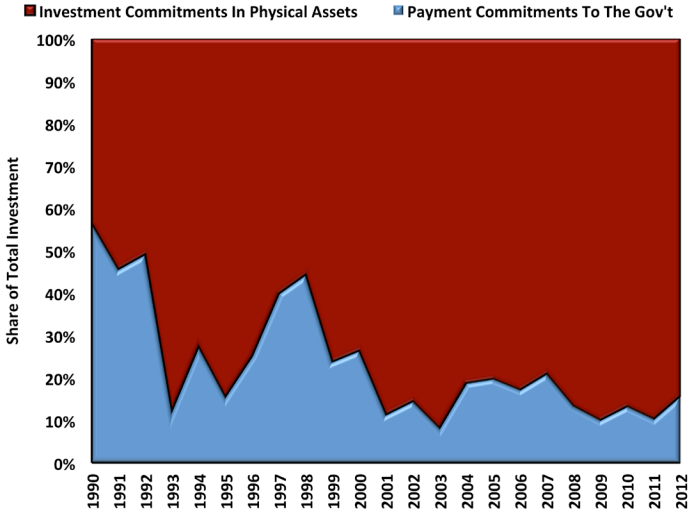


Source: World Bank

After rising to nearly $100 billion in 1997, the size of projects where private sector commitments were present more than halved through 2002. During the next decade, the level of projects with private sector investment commitments would quadruple, and reach $180 billion in 2012. Between 1990 and 2012 projects with private sector commitments to infrastructure investment grew almost twice as quickly as output in the developing economies. Despite this ramp-up in private sector investment in infrastructure projects in recent years, the private infrastructure investment as a share of GDP remains below peak levels in the late 1990s, and the overall share of private infrastructure assets in the developing world is significantly below the corresponding shares in industrial economies.

During these years the share of projects where new investment is taking place has increased dramatically relative to the share of commitments taking the form of payments to government entities. Between 1990 and 1991 the majority of commitments were completed in the form of payments to governments. The share of total commitments taking the form of payments to governments declined precipitously during the next two decades. In the last five years, commitments to physical assets represented seven-eighths of total commitments. This is a bullish development, as it signals that private investors are increasingly seeing breaking ground on new physical investments as a viable venture.

Share of Projects with Private Sector Involvement in Developing Infrastructure by Investment Type: 1990-2012



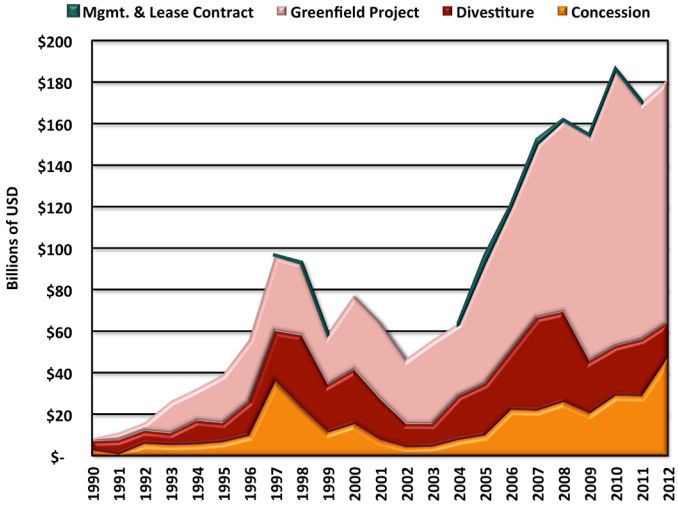
Source: World Bank

[3] *Private road and water and sanitation investment flows are lumped together by the BEA, so sectoral specific breakdowns disaggregating the two sectors is not possible*

Private sector firms have generally concentrated their investments in projects in the energy and telecom sectors. Between 1990 and 2012, around 40% of total project funds with private sector involvement were pushed towards telecom ventures. This number declined modestly during the five years through 2012. By contrast, although the 1990-2012 share of project commitments for energy ventures was just one-third, the plurality of investments has occurred in this sector since 2007. This broadly tracks with the large increase in overall electrical capacity in the developing world in recent years. Transportation projects have consistently received about one-fifth of total commitments during both time periods, but its share of total commitments was closer to 30% in 2012. Water and sewage projects, after seeing a bump in its share of activity in the late 1990s, have been a relative non-factor.

The trends in the type of private infrastructure investment participation largely track the form of commitments and the sector destination of commitments. In particular, as the share of divestitures has declined precipitously since the early 1990s, so has the share of private commitments being sent directly to governments. During that span of time greenfield investments have become an increasingly prominent form of private investment. After comprising less than 15% of total commitments in 1990, greenfield projects represented over two-thirds of all commitments between 2009 and 2012. The prominence of concession agreements has largely tracked overall private sector commitments to transportation projects. Since 2007 over two-thirds of transportation projects have come in the form of concession agreements. A similar ratio persisted between 1990 and 1999.

Value of Developing World Infrastructure Projects with Private Participation by Project Type: 1990-2012

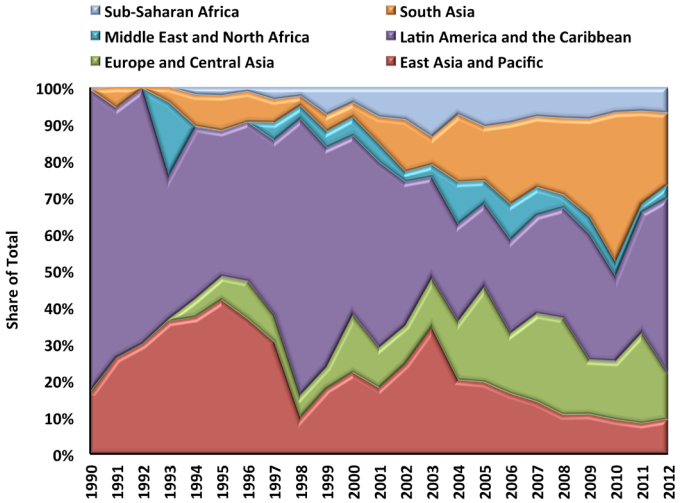


Source: World Bank

Not coincidentally, concession agreements were most prominent at the beginning of the 1990s and during the post-global financial crisis period. If the private sector's role in emerging market transportation operations continues to rise, so will the share of total commitments taking the form of concession agreements. Management and lease contracts have been a relatively negligible source of commitment funds throughout the 1990s and 2000s.

The regional distribution of projects with private infrastructure commitments has become increasingly diffuse over the last two-plus decades. During the first decade commitments were concentrated primarily in Latin America and—to a lesser extent—Asia. Latin America received on average 57% of commitments each year during this span of time while East Asia and the Pacific received 28%. Latin America's share has declined on average to about one-third of total commitments while East Asia and the Pacific's share has declined to around one-sixth, and it has been below 10% since 2010. By contrast, the share of private funds being committed to projects in developing Europe, Central Asia, and South Asia has risen dramatically since the early 1990s. After receiving negligible interest from private sector entities in the 1990s, projects in South Asia represented over one-quarter of total commitments during the most recent half decade while projects in developing Europe and Central Asia comprised a little less than one-fifth of total commitments. Sub-Saharan Africa has also seen a meaningful increase in its prominence as a recipient of private infrastructure commitments while the Middle East and North Africa has been a relatively consistent non-factor during the last two-plus decades.

Location of Developing World Infrastructure Projects with Private Participation by Sector: 1990-2012

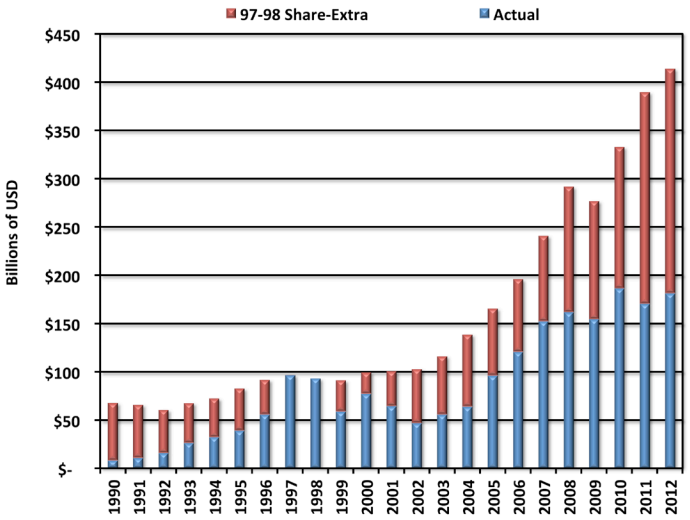


Source: World Bank

Despite the four-fold increase since 2002 in projects with private sector investment commitments in developing country infrastructure, there is significant scope for increased private sector commitments based on recent history.

The ratio of commitments to emerging market GDP remains less than half the ratio seen at its peak in 1997 and 1998. The commitments-to-GDP ratio increased dramatically between 1990 and 1997-98, going from below 0.20% of GDP to 1.52% of GDP. Since reaching the apex during 1997-98, the ratio has consistently fallen, and represented just 0.66% of GDP during 2011 and 2012. This is the lowest share of GDP since 1993. To have equaled the 1997-98 commitment-to-GDP ratio, the amount of private sector commitments would have had to more than double in 2012. Given the material improvements in financial, economic, and government conditions in developing economies in the last decade, such an increase is a reasonable prospect.

Value of Projects with Private Infrastructure Investment Commitments if 1997-98 Share Had Been Maintained: 1990-2012



Source: World Bank

Box 5: Pipelines: Recent Additions Have Fueled Dramatic Increases in Trade

Natural gas' rising prominence is reshaping pipeline policies

There has been a material increase in global pipeline capacity over the last decade, which has helped facilitate a reshaping of energy trade flows. This is particularly apparent with natural gas. Before the global financial crisis began, there were over 1.25 million miles of global pipelines. Over seventy percent of these pipelines were devoted to natural gas flows. Oil pipelines represented 18% of the total capacity and products pipelines represented the remaining 10%. The global pipeline network grew by approximately 6% between the global financial crisis and earlier this decade. Around three-fifths of this capacity expansion was devoted towards natural gas pipelines while around one-quarter was devoted to expansion of oil pipeline network. There has also been a dramatic expansion of natural gas liquefaction capacity, which largely complements the expansion of the global natural gas pipeline network. Although the growth rate of new capacity is expected to slow according to certain industry surveys, maintaining the expanded network and refurbishing ageing North American and Eastern European pipeline networks will still require significant expenditures. Global onshore pipeline expenditures are expected to be $216 billion between 2013 and 2017 according to Douglas-Westwood, which represents a 12% increase from the previous five-year period.

Expansion of global pipeline network is projected to slow in coming years

The Pipeline and Gas Journal reports that the total pipeline mileage under construction in 2014 is at the highest level since 2011 at 35,132 miles, and that an additional nearly 74,000 miles are in the planning or designing phase. This marks the sixth year in a row where over 100,000 miles of pipeline capacity are either in the construction or planning stages. Although most regions have displayed volatility in capacity additions, some trends are noticeable since 2008. North America has consistently had capacity additions in the planning or construction phase in a range of between 28,000 and 46,000 miles every year since 2008. Asia has seen a similar fluctuation, with pipeline additions in the planning or construction phase fluctuating between 32,000 and 41,000 miles every year. Western Europe has seen relatively steady capacity additions in either stage, but at a much lower level of around 2,000-4,000 miles every year. Eastern Europe has consistently seen the third largest amount of pipeline additions in the planning or construction phase every year except for 2013.The Middle East and Africa have seen consistent upticks in pipeline capacity additions in the planning or construction phase since 2008 while such capacity additions in Latin American have declined since 2008.

Concerning the 2014 findings, North America and Asia are the leaders in capacity that is either under construction or in the planning stages. Both regions have between 31,000 and 34,000 miles of pipelines at some point in the construction process. This does represent a decline in capacity that is either planned or under construction for both regions, however, from the 2013 levels. Eastern Europe, after seeing planned or in progress capacity additions plummet in 2013, rose back to 17,540 miles. Africa, the Middle East, and Western Europe are planning or implementing an uptick in capacity this year. Latin American capacity additions that are planned or under construction are projected to crater to just 5,665 miles this year from over 12,000 miles in 2013.

Box 5: Pipelines: Recent Additions Have Fueled Dramatic Increases in Trade - continued -

The Oil and Gas Journal also compiles an annual survey of planned pipeline construction both during a given year and in the future. Unlike the Pipeline and Gas Journal, they do not include pipelines in the designing phase. A total of 9,337 miles of pipelines are expected to be constructed this year, with a little over half of this construction being for natural gas pipes, around one-third of this construction being for crude oil, and the rest being devoted towards pipeline for products. Completed pipeline construction has been volatile from year to year. Even with that caveat, however, this represents a distinct reduction from the 2013 level of 15,358 miles of pipelines expected to be completed, which was a record since 2005. North American and Asian respondents account for the vast majority of the declining capacity additions. Latin America and Africa are the only two regions that report they will see an acceleration in completions this year. The 2014 level is still higher than the 2011 and 2012 levels, however.

When survey respondents are asked for their pipeline construction plans in the future, natural gas consistently emerges as the primary source of planned additions. With the exception of 2010, natural gas has consistently represented between two-thirds and three-quarters of expected future pipeline additions between 2005 and 2014. Some of the major natural gas projects that are expected to be completed in the next couple of years include the South Stream pipeline, which will transport natural gas from Russia to Italy, the Los Ramones project, which will transport gas from the US to Mexico, and the Ichthys project in Australia. All three of those projects are expected to be completed during 2015. India plans to add nearly 7,500 miles of capacity by 2017. The TAP/TANAP pipeline originating in Azerbaijan is expected to be completed in late 2018. Crude pipelines consistently represent between one-sixth and one-fourth of planned additions. A number of major Canadian oil pipeline projects are expected to be completed in 2017, including the Energy East pipeline, the Northern Gateway pipeline, and the TMX pipeline. Total expected pipeline additions have been declining since peaking in 2009, including a 23% decline this year from 2013's level. Asia and the United States have been the primary drivers of this decline over the years. Latin America, Africa, and Europe have also consistently declined, but from much lower initial levels in 2009. The Middle East and Canada bucked the global trend by reporting an uptick in planned completions in 2014 and beyond.

North American pipeline capacity has ballooned in recent decades

Although North America has not seen a dramatic increase in natural gas foreign trade flows because of legal prohibitions, there has been a dramatic ramping up of capacity of natural gas pipelines. Around 45% of the global pipeline capacity, including oil and products pipelines, was located in North America late last decade. Since 1994, US natural gas outflow capacity rose from less than 100,000 one million cubic feet of gas daily (mmcf/d) to nearly 143,000 mmcf/d by 2013. There has been consistent growth in capacity every year. Canada's capacity has nearly doubled over that time period, going from 10,374 mmcf/d to 18,229 mmcf/d. There has been no growth in capacity since 2009, however. Mexico's capacity has increased by over 300%, going from 350 mmcf/d in 1994 to 1,479 mmcf/d in 2013, but capacity has stagnated since 2007.

European natural gas pipeline network bigger than its gas network

Europe's natural gas pipeline network was in excess of 125,000 miles in 2012, and delivered 48,384 mmcf/d of natural gas. The European Union's oil pipeline network was much smaller in comparison at just around 20,500 miles at the end of the previous decade.

Intraregional Asian pipeline network continues to grow robustly

Asia's first intraregional gas pipeline was built in 1991, with a line providing Malaysian gas to Singapore. While only one other major line was built in the 1990s, a number of pipelines became operational in the 2000s. Between 1998 and 2013, intraregional Asian pipeline capacity grew by 12.6% per year, reaching 3,703 mmcf/d. Additionally, a pipeline connecting Turkmenistan and China added an additional 2,901 mmcf/d of capacity in 2011.

China in particular has seen a tremendous build out in pipeline infrastructure in recent years. China's natural gas pipeline was around 33,600 miles early this decade. That was around one-tenth as large as the pipeline grid in the United States, however. It plans to add another 27,300 miles by the end of 2015. This was more than the oil and products pipelines combined at that point. Its total natural gas pipeline capacity was nearly 9,700 mmcf/d by 2012. This build out has been crucial, as Chinese oil pipelines grew very quickly during the past decade. Between 2005 and 2012, Chinese oil pipeline infrastructure increased by more than 50%, going from around 8,100 miles to 12,400 miles. China also has built around 11,200 miles of products pipelines. China has had regasification facilities for less than a decade, so the sector still retains material growth potential. This is especially the case given the government's recognition of the urgent need to reduce the country's pollution.

Distinct trend in LNG and pipeline natural trade flows has emerged

The expansion of natural gas pipelines has accompanied a dramatic expansion of liquefied natural gas facilities across the world. Although in some cases LNG trade acts as a direct competitor to pipeline trade in individual regions, quite often LNG products complement the global natural gas pipeline network. LNG allows for the movement of natural gas in places where pipelines are unable to reach for various reasons. When LNG is transported from one locale to another, which commonly happens in tankers, it is often transported via pipelines after the regasification process occurs. Among the three major basin regions, liquefaction capacity grew by 45% between 2007 and 2012, and it is projected to grow by an additional 30% between 2012 and 2017. By 2017, total liquefaction capacity is projected to nearly double from 2007 levels. The Middle East was the growth driver late last decade and earlier this decade while the Pacific is projected to be the growth driver between 2012 and 2017. Growth is projected to be much steadier in the Atlantic-Mediterranean basin during both periods.

Box 5: Pipelines: Recent Additions Have Fueled Dramatic Increases in Trade - continued -

Rise in pipeline capacity has coincided with rise in natural gas trade flows

This dramatic build out of natural gas pipeline capacity has facilitated an even more dramatic increase in natural gas trade flows, both over pipelines and as a liquid product. Pipeline natural gas trade and LNG trade have dramatically different end-user compositions. LNG trade, in particular, has gone from being completed within regions a majority of the time to being completed between regions two-thirds of the time. Overall average annual growth in LNG trade between 2000 and 2012 was 7.4% per year, with the growth rate accelerating to 9.3% per year between 2008 and 2012. Trade flows grew dramatically faster than capacity. Over 80% of the total increase in LNG trade between 2000 and 2012 came from increased interregional trade. The average growth rate was a robust 11% during that time period, and accelerated to 12% during the four years through 2012. By contrast, intraregional trade grew just a little over 3% per year between 2000 and 2012, although it grew by nearly 5% per year during the last four years of the sample period. Pipeline natural gas trade remained a largely intraregional phenomenon, and this was especially the case during the four years after the onset of the global financial crisis. Overall pipeline trade grew by 5.1% per year between 2000 and 2012, and slowed minimally to 4.7% per year during the last four years. Even this reduced level was a growth rate 2.7 times faster than the global economy during that period. Intraregional trade was responsible for three-quarters of the growth during the overall period, including 88% of the growth between 2008 and 2012. While intraregional trade growth accelerated to 6.2% from 2008 to 2012 compared to the overall growth rate of 5.6%, interregional trade slowed dramatically during the final four years. Its growth rate slipped from an overall rate of 3.9% to just 1.7% during the final four years, which mirrored the global economy's average growth rate. Intraregional trade grew from being a little under two-thirds of total pipeline trade in 2000 to nearly 70% of such trade by 2012.

The regional growth drivers for pipeline natural gas trade have evolved over the course of the 2000s. Between 2000 and 2008, Western Europe was the primary driver of increased natural gas trade via pipelines. Intraregional natural gas trade flows rose by 6.5% per year during this period, and the region as a whole represented over one-third of the total growth in natural gas trade via pipelines during the 2000s. The Middle East and North Africa (MENA) and Eastern Europe both contributed around 19% of the total growth in pipeline trade flows during these first eight years, but the MENA growth rate approached 10% while Eastern Europe's lagged at a little over 3%. Between the end of 2008 and 2012, however, Asia and Eastern Europe became the clear growth drivers in natural gas pipeline trade. Pipeline trade in Asia grew a shade below 40% per year during those four years, and this increase represented 53% of the total increase in pipeline trade during that time period. Intraregional Eastern European pipeline trade flows grew 20% per year between 2008 and 2012, and these increased flows represented 41% of the global total. Western Europe was the only other country with non-negligible increases in pipeline trade flows during the post-crisis period, with intraregional Western European pipeline trade growing from 171 billion cubic meters (bcm) in 2008 to 191 bcm in 2012. This represented 17% of the global increase in pipeline trade. Every other region saw either negligible growth or outright declines during this time period.

While the Middle East and North Africa region—and specifically Qatar—was the primary driver of increased LNG trade flows between 2000 and 2008 and between 2008 and 2012, the second leading region shifted over time. MENA trade of LNG products rose 8.1% on average per year during the former period, and this growth rate accelerated to 12.3% per year between 2008 and 2012. It was responsible for nearly 50% of the global growth in LNG trade during the former period and 60% of such trade during the latter. Asia was the primary recipient of these flows during both periods. Sub-Saharan Africa (SSA) was the region that contributed the second most to LNG trade growth between 2000 and 2008. SSA trade growth represented over 20% of the global total, and trade was split approximately evenly between Asia and Western Europe during this time period. Sub-Saharan Africa's role as a growth driver would recede after 2008, however. Eastern Europe LNG flows were the second largest driver of increased trade flows, although it represented just 15% of the total during this time period. Asia, Latin America, Sub-Saharan Africa, and Western Europe all contributed between 6% and 9% to total growth in trade during this time period. North America was the only region that did not drive growth at all.

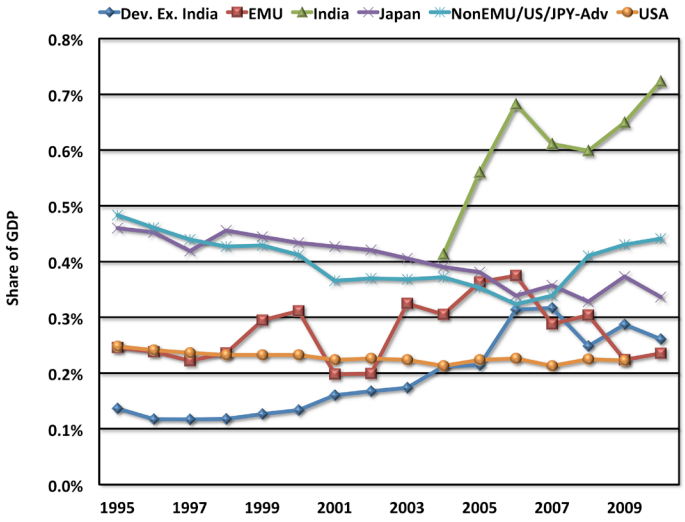
Pipelines' importance will continue to grow

Given the fact that natural gas trade flows have consistently outpaced the growth of new pipeline capacity during this century, the importance of maintaining and optimizing the global pipeline network will only increase going forward. The adoption of natural gas as an energy source has been slowed by institutional factors that are beginning to recede. The global adoption of lower-emissions natural gas prices has been slowed by the fact that a large share of natural gas prices continues to be priced in relation to prevailing oil prices. This has kept natural gas prices artificially high in Asia and Europe. The supply of natural gas—here considered the number of years of power that could be supplied by the prevailing level of recoverable reserves—has increased from around 60 years one decade ago to over 200 years earlier this decade. This should have forced the price of natural gas down. However, the fact that oil price has not declined precipitously in recent years has kept natural gas prices high in Europe and Asia because of pricing conventions. Although the global share of traded natural gas that is indexed to oil has declined in recent years from the 75% level that prevailed in 2005, the share remained at 65% in 2010. In Asia the share of natural gas trade where the price is indexed to oil remained at 88% in 2010, which was actually an increase from the 84% share in 2007. Indexation has declined at a fast pace in recent years in Europe, going from 94% in 2005 to 67% in 2010, but the share remained high at the beginning of this decade. North America is the only major region where gas is priced primarily by supply and demand factors, and natural gas is much cheaper as a result. As concerns about security of energy supplies recede across the world, natural gas is priced increasingly by supply and demand factors, and markets—especially Asian ones—become increasingly developed and mature, trade flows should continue to grow strongly in the coming decades. This will only enhance the importance of ensuring adequate and well-maintained pipeline infrastructure is in place going forward.

Transportation Maintenance Trends Between 1995 and 2011

As governments have come under increasing pressure to cut exploding deficits and rising debt, it is not surprising that public maintenance has been sacrificed in advanced and developing economies alike. This trend has been particularly pronounced in road maintenance expenditures as a share of GDP, but it has also occurred in most sub-regions and income classifications when it comes to rail maintenance, port maintenance, and airport maintenance based on the available data. This declining funding took place after a period when maintenance levels were already insufficient. Despite the fact that the American Society of Civil Engineers (ASCE) gave the American road network a D, the World Economic Forum ranked the American road network the 18th best out of 148 countries in its 2013 Global Competitiveness Index (GCI) rankings. Similarly, the D+ overall ranking for quality of overall infrastructure assets did not deter the World Economic Forum from ranking the United States' infrastructure quality 15th out of 148 countries in the most recent GCI. Although the ASCE is far from an unbiased arbiter on the matter, the fact that the US can rank so high relative to other countries, but so low on an absolute basis, indicates that the world's transportation maintenance needs are not being met. Academic studies have found that countries optimize their growth rates when they invest 2% of GDP in maintaining existing road stock. Even the sub-regions that had displayed strength when it came to maintaining or increasing maintenance spending in the early post-crisis period began to falter in 2010 and 2011. Enhancing and maintaining these transportation assets represents a tremendous opportunity for private sector operators in the future.

Road Maintenance Spending by Country/Region: 1995-2010



Sources: DHGE, World Transportation Forum, OECD

Road maintenance pre- and post-global financial crisis displayed varying trends across regions and asset classes, although there were noticeable declines in every sub-region in 2011 compared to the previous peak. Japan and the United States have seen a structural decline in maintenance spending since the 1990s. US road maintenance spending as a share of GDP peaked during the first year for which comprehensive data is available at just 0.25% in 1995. Over the following decade and a half it would decline steadily, and it represented just 0.22% of GDP in 2009. Japanese road maintenance expenditures as a share of GDP also declined over this time, with the spending as a share of GDP declining by over 25% between 1998 and 2010.

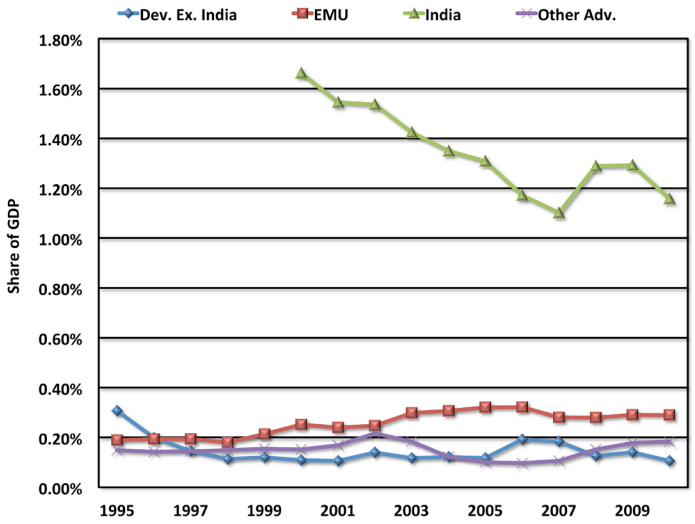
The roadway maintenance spending as a share of GDP in countries in the European Monetary Union rose between the mid-1990s and 2000s, but it would eventually drop as the global financial crisis and eurozone crisis intensified. Maintenance spending as a share of GDP declined in seven out of the nine countries for which data was available in 2011, with the Dutch share sinking to just 0.05% of GDP from 0.21% in 2010.

By contrast, road maintenance spending in other advanced economies, where government debt levels have risen much more modestly, rose as a share of GDP between 2006 and 2010, going from 0.32% of GDP in 2006 to 0.44% of GDP in 2010. However, such spending as a share of GDP declined in four out of the six countries in this group for which 2011 data was available, including marked declines in Canada and the United Kingdom. Developing economies, excluding India, devoted increasingly large shares of GDP to maintenance spending between the late 1990s and the late-2000s. Road maintenance spending increased over 250% as a share of GDP, although it too declined during the crisis and post-crisis period. Indian road maintenance spending rose dramatically between 2004 and 2010 and reached 0.72% of GDP in 2010. Similar to most other countries in the sample, however, spending as a share of GDP declined in 2011.

Rail maintenance trends reveal a similar pattern as those seen in road maintenance in both advanced and developing economies. Countries in the European Monetary Union generally devoted increasing shares of national resources to maintaining railroad tracks between the late 1990s and the mid-2000s. The share of national output devoted to maintaining rail stock then declined during the global financial crisis. Unlike road maintenance, however, there was not a drop-off in rail maintenance spending in 2011 in the countries where data is available. By contrast, developing countries devoted increasingly small shares of national resources to maintaining railways between the mid-1990s and early 2000s before ramping up spending in 2006-07.

From 2008 through 2011, however, a declining share of GDP was devoted to rail spending in most countries. For developing countries where data was available in 2011, rail maintenance spending as a share of GDP was less than half the pre-crisis peak level. Similarly, although the share of GDP devoted to rail maintenance in India was significantly larger than other countries in this sample at an average of 1.35% of GDP between 2000 and 2010, India maintenance expenditures as a share of GDP also declined after the worst of the global financial crisis. They have also been declining on a structural basis from the levels that existed in the early 2000s. Rail maintenance spending in other advanced economies has shown a much more diverse performance.

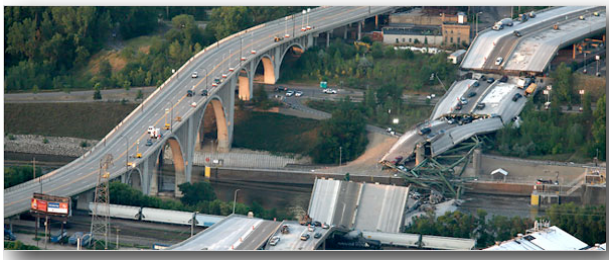
Rail Maintenance Spending by Country/Region: 1995-2010



Sources: DHGE, World Transportation Forum, OECD

Although the two series have shown significantly greater volatility than road and rail maintenance, port and airport maintenance trends have shown structural and cyclical declines as well in the post-great financial crisis period. Countries in the European Monetary Union devoted increasingly small shares of GDP to maintaining the port infrastructure, with the share of GDP declining over 30% since the onset of the global financial crisis. Similarly, airport maintenance spending has declined structurally with the occasional burst of increased spending. Between 1995 and 2000 airport maintenance spending averaged 0.24% of GDP, whereas this figure would decline to 0.18% of GDP between 2007 and 2010.

Airport maintenance spending in developing economies excluding India declined on a structural basis between the late 1990s and the late 2000s with the exception of a large uptick in spending in 2006 and 2007. Maintenance spending on airports declined by nearly 80% between 2009 and 2011 compared to the 1995-2008 average. Such maintenance spending in India, by contrast, increased materially in 2007 before also dropping between 2008 and 2011. Port maintenance spending in developing countries generally rose between the late 1990s and mid-2000s before declining since the global financial crisis. For the countries which data exists in both 2007 and 2011, the average maintenance spending as a share of GDP was 0.030% of GDP in 2007 compared to just 0.008% of GDP in 2011, including large declines in Bulgaria, Croatia, and Lithuania.



Minneapolis I-35 2007 Bridge Collapse
Source: nytimes.com

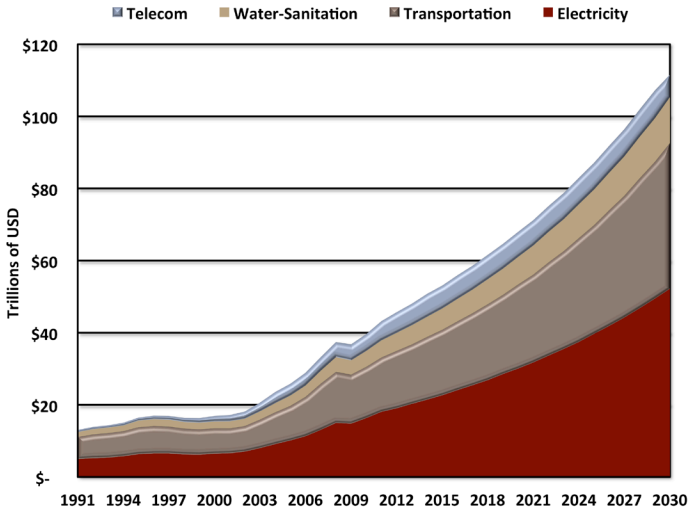
These trends make it clear that the public sector is increasingly unable to services its existing transportation assets despite rapid increases in demand for their services. Each year where maintenance spending declines increases the likelihood of additional accidents such as the Minneapolis bridge collapse or Japanese tunnel collapse occur. Provided that proper revenue can be assured, the private sector looks set to play an increasingly large role in the transportation sector as governments continue to be faced with making tough budgetary decisions in the years ahead.

SECTION II:

THE PROJECTED GROWTH OF INFRASTRUCTURE ASSETS TO 2030

The infrastructure sector is poised to see strong growth in assets across practically every sector based on income and population trends projected for the global economy during these next two decades. Our model projects that the value of the global capital stock of infrastructure assets will grow approximately 5.4% every year after growing 6.8% annually during the previous two decades.

Value of Infrastructure Assets by Sector: 1991-2030



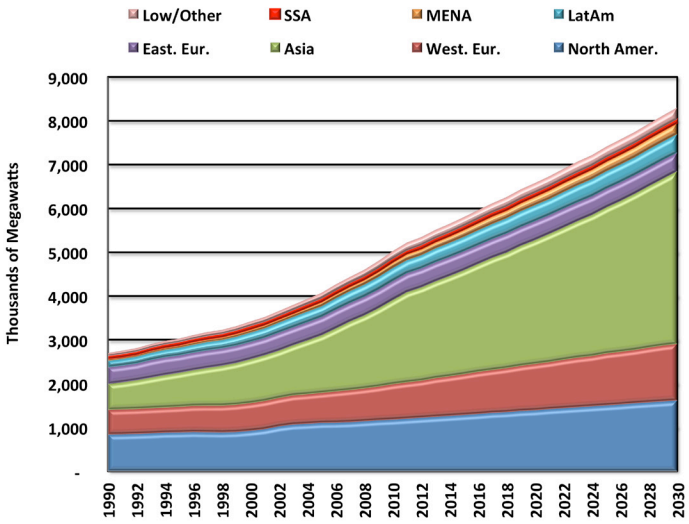
Sources: DHGE, World Bank, Various

If telecom assets are excluded, the growth in assets is projected to slow quite modestly, going from 6.3% during the previous two decades to 5.7% this decade and next. We project strong growth in electricity supply, paved roads, and water and sanitation facilities. All told, this will require around $97 trillion in new investment to both grow and maintain the infrastructure between 2014 and 2030 compared to estimated expenditures of just $42 trillion between 1997 and 2013. In inflation-adjusted terms, this represents an uptick in investment spending of 38% in the coming decades. We estimate that the value of infrastructure assets will rise from approximately $40 trillion in 2010 to around $114 trillion in 2030.

Energy

After growing by approximately 86% in value between 1991 and 2010, we forecast that global power capacity will grow approximately 65% in the coming years based on population, wealth, and urbanization trends. Our model projects that global electricity capacity will rise from a little over 2.7 million megawatts in 1990 to around 8.3 million megawatts by 2030. This translates into real annual growth of 2.5% during this decade and next, which is a modest slowdown from the 3.2% annual growth during the previous two decades. We estimate that the value of these assets will rise from approximately $16 trillion in 2010 to around $52 trillion in 2030. While concerns about climate change may require the energy mix to shift, the demand for new electricity capacity in both advanced and developing economies in the coming decades is undeniable.

Global Electrical Capacity by Region: 1990-2030



Sources: DHGE, World Bank, Various

Past and Projected Growth in Real Infrastructure Assets by Region: 1990–2030

Electricity (kW of Capacity)							
Growth	**Afr-ME**	**Asia**	**Europe**	**LatAm**	**North Amer.**	**Other**	**Total**
1990-2010	95%	227%	32%	97%	40%	138%	86%
2010-2030	61%	105%	38%	44%	37%	49%	65%
CAGR	**Afr-ME**	**Asia**	**Europe**	**LatAm**	**North Amer.**	**Other**	**Total**
1990-2010	3.4%	6.1%	1.4%	3.4%	1.7%	4.4%	3.2%
2010-2030	2.4%	3.7%	1.6%	1.8%	1.6%	2.0%	2.5%
Paved Road (Length in Kilometers of Network)							
Growth	**Afr-ME**	**Asia**	**Europe**	**LatAm**	**North Amer.**	**Other**	**Total**
1990-2010	96%	184%	8%	42%	16%	51%	43%
2010-2030	62%	147%	7%	42%	2%	107%	54%
CAGR	**Afr-ME**	**Asia**	**Europe**	**LatAm**	**North Amer.**	**Other**	**Total**
1990-2010	3.4%	5.4%	0.4%	1.8%	0.7%	2.1%	1.8%
2010-2030	2.4%	4.6%	0.4%	1.8%	0.1%	3.7%	2.2%
Rail (Length in Kilometers of Network)							
Growth	**Afr-ME**	**Asia**	**Europe**	**LatAm**	**North Amer.**	**Other**	**Total**
1990-2010	-1%	9%	-5%	20%	27%	8%	8%
2010-2030	40%	17%	-7%	18%	29%	10%	13%
CAGR	**Afr-ME**	**Asia**	**Europe**	**LatAm**	**North Amer.**	**Other**	**Total**
1990-2010	0.0%	0.4%	-0.3%	0.9%	1.2%	0.4%	0.4%
2010-2030	1.7%	0.8%	-0.4%	0.8%	1.3%	0.5%	0.6%
Port (Traffic in TEUs)							
Growth	**Afr-ME**	**Asia**	**Europe**	**LatAm**	**North Amer.**	**Other**	**Total**
1990-2010	403%	882%	332%	1414%	181%	631%	560%
2010-2030	158%	214%	107%	97%	120%	190%	176%
CAGR	**Afr-ME**	**Asia**	**Europe**	**LatAm**	**North Amer.**	**Other**	**Total**
1990-2010	8.4%	12.1%	7.6%	14.6%	5.3%	10.5%	9.9%
2010-2030	4.9%	5.9%	3.7%	3.5%	4.0%	5.5%	5.2%
Airport (Number of Paved Runways)							
Growth	**Afr-ME**	**Asia**	**Europe**	**LatAm**	**North Amer.**	**Other**	**Total**
1990-2010	34%	58%	72%	38%	1%	29%	26%
2010-2030	12%	37%	11%	21%	-1%	44%	13%
CAGR	**Afr-ME**	**Asia**	**Europe**	**LatAm**	**North Amer.**	**Other**	**Total**
1990-2010	1.5%	2.3%	2.7%	1.6%	0.0%	1.3%	1.2%
2010-2030	0.6%	1.6%	0.5%	1.0%	0.0%	1.8%	0.6%

Past and Projected Growth in Real Infrastructure Assets by Region: 1990-2030 - continued-

Sanitation (Number of Connected Households)							
Growth	**Afr-ME**	**Asia**	**Europe**	**LatAm**	**North Amer.**	**Other**	**Total**
1990-2010	117%	162%	21%	98%	27%	131%	84%
2010-2030	61%	82%	16%	56%	22%	87%	58%
CAGR	**Afr-ME**	**Asia**	**Europe**	**LatAm**	**North Amer.**	**Other**	**Total**
1990-2010	4.0%	4.9%	0.9%	3.5%	1.2%	4.3%	3.1%
2010-2030	2.4%	3.0%	0.7%	2.3%	1.0%	3.2%	2.3%
Water (Number of Connected Households)							
Growth	**Afr-ME**	**Asia**	**Europe**	**LatAm**	**North Amer.**	**Other**	**Total**
1990-2010	108%	90%	26%	80%	27%	115%	70%
2010-2030	59%	48%	20%	44%	24%	81%	44%
CAGR	**Afr-ME**	**Asia**	**Europe**	**LatAm**	**North Amer.**	**Other**	**Total**
1990-2010	3.7%	3.3%	1.1%	3.0%	1.2%	3.9%	2.7%
2010-2030	2.3%	2.0%	0.9%	1.8%	1.1%	3.0%	1.8%
Mobile (Number of Subscriptions)							
Growth	**Afr-ME**	**Asia**	**Europe**	**LatAm**	**North Amer.**	**Other**	**Total**
1990-2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2010-2030	86%	72%	24%	59%	24%	88%	62%
CAGR	**Afr-ME**	**Asia**	**Europe**	**LatAm**	**North Amer.**	**Other**	**Total**
1990-2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2010-2030	3.2%	2.7%	1.1%	2.3%	1.1%	3.2%	2.4%
Broadband (Number of Connections)							
Growth	**Afr-ME**	**Asia**	**Europe**	**LatAm**	**North Amer.**	**Other**	**Total**
1990-2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2010-2030	249%	316%	66%	230%	79%	288%	190%
CAGR	**Afr-ME**	**Asia**	**Europe**	**LatAm**	**North Amer.**	**Other**	**Total**
1990-2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2010-2030	6.4%	7.4%	2.6%	6.1%	3.0%	7.0%	5.5%
Fixed Telephones (Number of Lines)							
Growth	**Afr-ME**	**Asia**	**Europe**	**LatAm**	**North Amer.**	**Other**	**Total**
1990-2010	424%	402%	49%	307%	11%	186%	136%
2010-2030	13%	-7%	4%	6%	-19%	23%	-3%
CAGR	**Afr-ME**	**Asia**	**Europe**	**LatAm**	**North Amer.**	**Other**	**Total**
1990-2010	8.6%	8.4%	2.0%	7.3%	0.5%	5.4%	4.4%
2010-2030	0.6%	-0.3%	0.2%	0.3%	-1.0%	1.0%	-0.2%

Source: *DHGE, World Bank, Various*

Box 6: The Rise of Renewable Generation Leads to Increased Investment in Transmission and Distribution

Rise of renewable energy leading to increased demands for transmission and distribution spending

A confluence of factors is resulting in an increasing share of electricity resources being devoted to transmission and distribution (T&D) areas of the electricity network. The need to replace aging T&D facilities that are nearing the end of their useful life, the need to compensate for decades of underinvestment in such facilities, and a greater reliance on intermittent renewable sources of energy all augur for continued significant investment in such facilities going forward across the world. The International Energy Association (IEA) projects that the power sector will require $17 trillion of investment globally between 2013 and 2035, of which over two-fifths of this investment will occur in T&D facilities. Around two-thirds of the investment in T&D facilities will take place in non-OECD economies. Of the $10 trillion of projected investment in new generation capacity, nearly two-thirds of that will be towards renewable energy sources, which require greater T&D network expenditures than more conventional sources.

Transmission and distribution capex set to rise

Capital expenditures on T&D facilities are projected to increase by 22% between 2011 and 2016 according to NRG expert. By 2016 T&D facility capital expenditures will exceed $232 billion. Around two-fifths of this spending will occur in Asia alone in this time frame, while North America and Europe will also comprise around two-fifths of such spending combined over this period. Annual demand for T&D equipment is projected to rise by over 30% during this time period as well. In 2011 cables, transformers, and switchgear represented approximately half of this demand. Installed T&D length is projected to rise by 6.5-6.7% globally between 2011 and 2016. As is the case with most infrastructure assets, growth will be strongest in developing regions such as Asia, Africa, and the Middle East. The International Energy Agency projects that the length of T&D lines globally will rise by 25 million kilometers between 2012 and 2035, reaching 95 million kilometers by that time. Around five-sixths of this expansion will occur within the distribution subsector, and China and India alone will comprise half of that expansion.

Renewable energy facilities' characteristics driving T&D growth

The shift towards increasing reliance upon renewable sources of energy will accelerate the trend towards increased investment in T&D facilities. This is because renewable sources of energy are generally located much farther away from where power is consumed than traditional fossil-fuel based generation sources. These renewable generation sources also create complications during periods of peak demand that require additional network infrastructure to be in place to avoid either excess congestion or excessively expensive electricity costs. Power sector operators have to manually determine sources of electricity supply during times of high usage through curtailment and congestion management in order to maintain a reliable network. As variable and intermittent sources of renewable energy such as wind and solar power cannot be relied upon to generate maximum output at a given point in time, only a certain proportion of the fossil-fuel based generation infrastructure can be retired as new renewable electricity generation comes online. The IEA estimated in 2011 that solar and wind can only be relied on for a range of between 0% and 20% of their installed capacity at any given time, although some studies have indicated that solar power can be relied upon for upwards of two-fifths of its capacity at a given point in time.

This trend is one of the primary drivers in why a greater share of electricity sector investment will be devoted to T&D facilities in advanced economies compared to developing economies. In OECD economies the renewable share of electricity generation according to the Energy Information Administration (EIA), which includes intermittent and non-intermittent sources of energy, is projected to rise around 15%-points between 2010 and 2035, going from 18% to 33%. Intermittent sources of energy will be responsible for the majority of this growth. Renewables electricity generation is projected to go from comprising 21% of generation in 2010 to 43% in the EU. In the US it is projected to rise from 10% to 23%. Japanese power generation is projected to go from 10% renewable-based to 27%. Non-OECD economies are projected to see a more muted increase in the renewable share of electricity generation, with the share rising from 21% to 30% between 2010 and 2035. While China and India are both projected to see a material increase in the renewable share of electricity generation over this quarter-century period, the share of electricity generated from renewable energy sources is actually projected to decline in Brazil.

As increasing amounts of renewable electricity generation come online in an attempt to minimize climate change, this requires increasingly sophisticated T&D systems and operators. While market supply and demand forces can generally prevail during normal periods, operators face challenges during periods of low and high demand that force behavior to deviate from a pure supply-demand framework. Modern electricity distribution networks are designed to meet the needs of a country during peak usage, which can in certain cases represent just a few hours in a given year. During periods of peak energy demand, a sufficient amount of spare capacity that can be relied upon to provide power on demand is needed. Fossil fuel-based electricity generation will generally play a disproportionately large role during these periods relative to installed capacity. Additionally, during periods of low demand, a certain proportion of traditional power plants need to stay online and generating even if pure supply-demand factors would dictate that the power plant be inactive. It is during these periods when a sophisticated transmission network and network operator need to be present. Managing these flows requires a build out in the transmission network that was not previously necessary.

Box 6: The Rise of Renewable Generation Leads to Increased Investment in Transmission and Distribution - continued -

US needs to increase T&D expenditures to offset years of underinvestment

In the United States, a period of renewed investment in T&D is needed after a long period of declining T&D-related investment according to a Harris Williams & Co white paper. Despite electricity usage increasing by nearly 60% in the two decades before 2000, investment in infrastructure for transmission services dropped by 44% over the same period. According to the Department of Energy, at the beginning of this decade over 70% of transmission lines and transformers were a quarter-century old or older. Three-fifths of circuit breakers were over three decades old. From a distribution perspective, around half of distribution poles were between three and five decades old. This lag in investment has led to a strains being placed on the system. T&D losses rose to 6% of output in 2011 from just 5% in 1988. These power outages result in $80 billion of lost output per year according to the US Department of Energy. US utilities will need to invest $1.5-$2.0 trillion between 2010 and 2030, with T&D infrastructure investment representing nearly $900 billion of this investment. This represents an approximately 25% annual increase compared to the 2001-2010 period in real terms. Most of the transmission investment will be to increase reliability and integrate renewable generation additions. Transmission lines are projected to increase by 8% between 2008 and 2018. If current trend lines in electricity sector spending were maintained through 2040, an investment gap of $732 billion in 2010 dollars would emerge between 2011 and 2040.

Europe's decisive shift towards renewables driving T&D expenditure growth

Despite Europe's ongoing economic difficulties, the region will continue to need significant investment in the electricity sector in the coming decades. The European Commission projects that around 55% of electricity sector investment this decade will occur in the T&D subsectors. The IEA projects that there will need to be $1.9 trillion in investment by 2035. European industry is projected to spend 37% more on transmission, distribution, and downstream expenditures in 2020 compared to 2012. By contrast, renewable energy source expenditures are projected to nearly double over that same span of time. Conventional generation expenditures are projected to decline by 11%. Within the network, distribution is projected to receive an increasingly large share of expenditures. Distribution is projected to go from receiving two-thirds of investment relative to total T&D expenditures in 2020 in the European Union to four-fifths of such expenditures by 2050.

Asia's electricity investment will be more concentrated in generation

Asia will see the fastest growth in investment in the electricity sector in the coming years. China and India are projected to comprise half of the increase in the length of T&D networks between 2013 and 2035. China is projected to be relatively unique among countries in the coming years as nearly three-quarters of its power sector investment is projected to be devoted to new generation capacity additions according to Bloomberg New Energy Finance. All told nearly $4 trillion will need to be invested in China between 2013 and 2030 to support this dramatic expansion of the country's power sector. Likewise, India will also devote a majority of its future expenditures towards new generation capacity. Between 2010 and 2050, India will spend anywhere between $2.2 trillion and $3.6 trillion in its electricity sector, with approximately 47% of its investment occurring in the T&D sector in both scenarios according to the IEA. Bain and Company estimates that India will need $500 billion in investment in new power generation by 2032 with an additional $300-$500 billion in investment in T&D infrastructure. Between 2013 and 2035 Southeast Asia's energy consumption is projected to jump more than 80% according to the IEA, which is equivalent to Japan's current energy consumption. The IEA projects that this jump in consumption will require approximately $1.7 trillion of cumulative investment in the energy supply infrastructure, with 60% of that occurring in the power sector. Southeast Asia remains plagued by inefficient subsidy schemes that will need to be modified and a history of capricious changes to policy, both of which will need to be rectified in the coming decades in order for the region to unlock its full energy potential. Fully 22% of the region lacked access to modern electricity in 2011. T&D network investment will comprise a little over three-fifths of power sector investment through 2035. Indonesia, Thailand, and Malaysia are projected to see the largest investments made in the region.

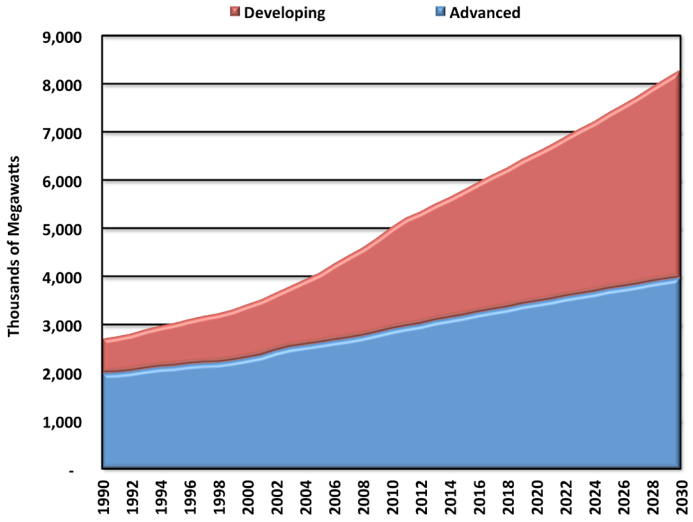
Electricity leakage remains a problem among all income strata

All of this investment is needed because T&D losses continue to plague every income strata, and remain an area of significant opportunity for the energy sector. For high income countries, after nearly three decades of steady improvement from nearly 10% in 1960, the share of electric power lost in the T&D phases reached a nadir of 5.8% in the late 1980s. Since that time it has risen moderately, and remained above 6% of total output in 2011. The trend among upper middle income countries has followed a much different trajectory. After beginning the 1960s with a nearly identical share of output lost compared to high income countries, the upper middle income countries' share of power lost in the distribution and transmission phases remained stagnant around 10% through the mid-1980s. The share of output lost during the T&D phases steadily rose over the next decade and a half, peaking at 11.6% during the late 1990s, before steadily declining. The share of power lost during these phases reached a fifty-two year low of 8.7% in 2011. For lower middle and low income countries, both income strata groups saw the share of power lost in the T&D phases rise swiftly from 12-13% in 1990 to 22% and 18%, respectively, in the early 2000s. The share of power lost steadily declined thereafter in both groups, but remained between 15-16% at the beginning of this decade.

Our model expects Asian demand will drive this strong growth in the coming decades. The growth in Asian assets will comprise over three-fifths of total growth in the next two decades. Among individual countries, India and China are unsurprisingly projected to be the growth leaders in the coming years, with the total combined capacity nearing three million megawatts by 2030. China's electricity capacity will approach 30% of the global total by 2030 after representing just over 5% of such capacity in 1990. While Japan's projected power capacity is not expected to increase substantially, the rest of Asia is also poised to see strong growth in new capacity. We forecast that high income countries outside of Asia will continue to see an expansion of capacity during the next two decades. Our model forecasts that the United States will see continued strong growth of electricity capacity, with the projected 39% growth in capacity between 2010 and 2030 coming in just a shade below the 42% growth in capacity between 1990 and 2010. We forecast that Western Europe, Australia, and Canada will also see continued growth in electricity capacity as well. The one exception to this projected strong growth is that high income Eastern European countries are expected to see capacity decline during these next two decades. This region's share of global electricity capacity is expected to decline from 9.6% in 1990 to 3.2% in 2030.

We calculate that Middle income countries will see continued strong growth in electricity capacity in the coming decades as well. Our model forecasts that Middle Eastern and North African countries' capacity will grow in excess of 80% during the next two decades. The forecasting model estimates that middle income Latin American countries, including Brazil, will grow more modestly between 2010 and 2030. In contrast to their high income peers, middle income Eastern European countries are projected to see capacity grow by nearly one-fifth.

Global Electrical Assets by Income Type: 1990-2030



Sources: DHGE, World Bank, Various

Middle income Sub-Saharan countries should see only middling growth in electricity capacity based on past increases in capacity, past and projected increases in wealth, and past and projected increases in population according to our model, but the region has significantly more upside potential than any other region for generating future demand. Middle income Sub-Saharan countries have gone from consuming 14% more electricity per capita than the average middle income country in 1990 to 55% less than the average middle income country in 2011. Although the decline in capacity per capita is less pronounced when South Africa is excluded, doing so makes the lack of electricity capacity in these countries becomes readily apparent. At the end of 2011 average electricity consumption per capita in middle income Sub-Saharan countries excluding South Africa was below the average level in low income countries. Recent governance improvements should allow Sub-Saharan power capacity to rise dramatically in the coming decades if the recent privatization of Nigeria's electricity sector is a sign of things to come.

Box 7: Electricity Capacity-The Sources Remain Largely Fossilized

Fossil fuel energy has retained dominance across the world

The death of fossil fuels' role in supplying the world's electricity has been greatly exaggerated. With the notable exception of Europe, the share of hydrocarbon-based fossil fuel electricity capacity remains approximately the same as levels that prevailed during the 1980s. Globally, a greater share of electricity capacity was based in fossil fuels in 2011 than was the case in 1985. This is not to say that renewable energy sources such as wind, biomass, and solar (wind and solar will henceforth be referred to as "intermittent") did not increase in prominence during the 2000s when it comes to installed capacity. Between 2000 and 2011, the share of intermittent renewable energy-based global electricity capacity rose from 2% to 7%. Between 1990 and 2011 the share of electricity capacity based on fossil fuel power oscillated within a narrow range of 64% and 67%. The sources of energy capacity that have ceded ground in recent years have been hydroelectric energy and nuclear energy. The share of electricity capacity supplied by hydroelectric power fell from 23% to 20% between 1990 and 2011. Similarly, after peaking at nearly 12% of global electric capacity in 1988, the share of capacity supplied by nuclear power declined to 7% in 2011. While the rise of intermittent renewable energy supplies is an inexorable one given the increasing focus on climate change, the demise of fossil fuel-based energy supplies remains many decades away. The International Energy Agency (IEA) forecasts that more than half of new installed capacity through 2035 will be renewables-based, with the total renewable share of energy capacity reaching 40% by that time. Installed solar and wind capacity will represent nearly 40% of EU electricity capacity while it will represent closer to 20% of total electricity capacity in the US, China, and India.

Fossil fuels retained a dominant role in generating global electricity during the previous two decades. The share of global electricity generated by fossil fuel sources rose from 63% in 1990 to 67% in 2010. While intermittent renewable energy sources and biomass represent an increasing share of global electric capacity, they have made very little progress in recent years in generating electricity. Those intermittent renewable sources and biomass generated less than 4% of global electricity in 2010 despite representing 6% of global capacity. This disconnect will likely persist going forward. The strength of wind varies over time and clouds and nighttime limit the period when solar facilities can generate power. This leads to lower capacity credits for intermittent renewable sources of energy, meaning that these sources cannot be counted on during high usage periods. These energy sources with low capacity credits are, thus, unable to displace existing fossil fuel facilities which do not have such limitations. Hydroelectric power also generated a disproportionately smaller share of total electricity relative to the installed capacity. By contrast, nuclear power generated 13% of total electricity despite representing just 7% of installed capacity.

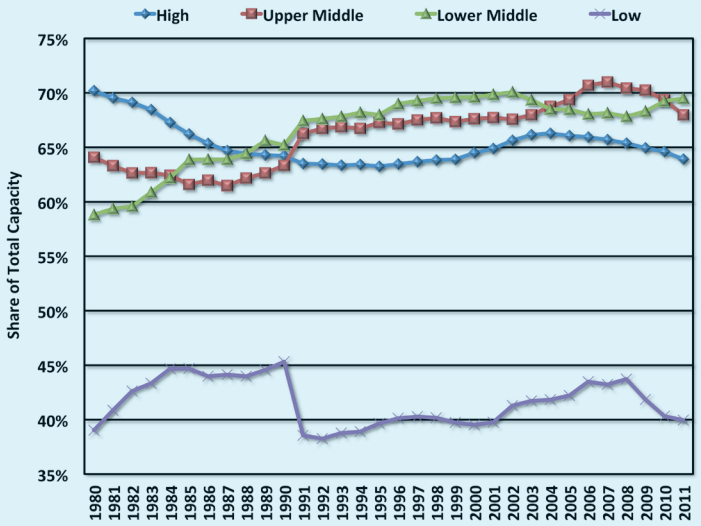
Europe has moved away from fossil fuel energy more quickly than North America

Among high income countries and regions there remains a decided schism in the movement away from fossil fuel supplied energy in both installed capacity and generation. For high income countries as a group a shift has been taking place. Although the share of fossil fuel-based electricity capacity in all high income countries was stagnant between 1990 and 2011, the shares within Western Europe and North America diverged. Western Europe's share of fossil fuel-based electricity capacity fell from 52% to 45% over that time span. Western Europe's fossil fuel-based electricity generation rose, however, from 43% in 1990 to 45% in 2010. North America's share of electricity generated and electricity capacity in 2010 rose to 64% and 66%, respectively, which was a 1%-point and 2%-point increase, respectively, from 1990 levels. In Western Europe the share of intermittent renewable and biomass electricity capacity quintupled from 4% at the turn of the millennium to 20% in 2011. The shares of hydroelectric and nuclear power have both declined by around 5%-points in Western Europe since 2000. However, the trends in the share of electricity generated from non-hydrocarbon sources are vastly different. Despite comprising 38% of total installed electricity capacity in 2010, renewable energy sources generated less than 26% of total electricity in Western Europe that year. By contrast, nuclear power generated nearly 28% of total electricity in 2010 despite comprising just 15% of total capacity. The difference between capacity and generation is also apparent, but far less dramatic, in North America. Nonetheless, nuclear energy's share of North American electricity generation was 10%-points higher than its 10% share of installed capacity in 2010. The share of intermittent renewable and biomass power has increased from 2% of the total in 2000 to 6% in 2011, with the corresponding shares of hydroelectric and nuclear power declining by 3%-points and 2%-points, respectively.

Western Europe's commitment to reducing its CO_2 emissions is one of the primary drivers for the reduction in its reliance on fossil fuel sources for its electricity capacity. The European Union in 2007 unilaterally committed to reducing its emissions by 20% from the prevailing levels in 1990. There has been a similar shift in renewable energy sources of electrical capacity in North America, although the magnitudes of the shifts have been much smaller. However, while Europe has moved away from fossil fuels and towards renewables, its shift within the fossil fuel sector has been towards coal and away from natural gas in recent years. Coal consumption increased in OECD-Europe in both 2011 and 2012 while natural gas consumption in the region declined both years. It was not until the first quarter of 2013, when the Large Combustion Plant Directive from the European Commission came to the forefront of operators' attention, that natural gas consumption increased while coal consumption decreased year on year. Natural gas production in the region also declined at a faster pace than coal during 2012. Coal consumption was up as much as 50% at annualized rates in certain European countries last year. This is in part due to the regional price of natural gas in Europe being much higher than the global price for coal.

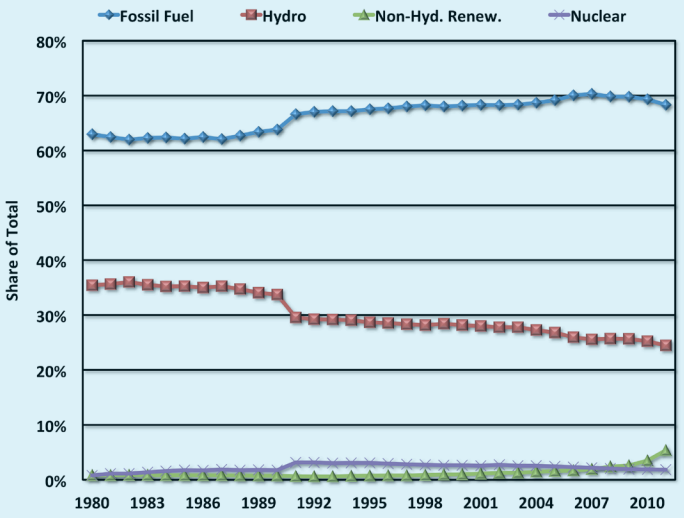
Box 7: Electricity Capacity-The Sources Remain Largely Fossilized
- continued -

Fossil Fuel-Based Share of Electricity Capacity by Income Tier: 1980-2011



Source: Energy Information Administration

Middle Income Electrical Capacity by Source Type: 1980-2011



Source: Energy Information Administration

Bloomberg New Energy Finance reported that in November 2012 that power utilities in Germany would lose €11.70 per megawatt of electricity generated compared to a profit of €14.22 per megawatt when obtaining power from coal. The priority of certain forms of electricity in various grid networks has also had the functional effect of ensuring that coal displaces gas-fired power generation in recent years. Coal was the dominant energy source for British electricity in the spring of 2012 for the first time since 2007. Germany opened its first coal-fired power plant since 2005 in late 2013 in part due to the huge price differential compared to natural gas and a large decline in carbon prices. Part of this jump in coal consumption is likely temporary due to an unintended consequence of a looming European Union directive that takes effect in 2016. Additionally, the European Climate Foundation reports that barely more than one out of five planned coal power plants in Europe from 2008 were still expected to be built as of mid-2013. Despite this recent bump in coal usage in Europe, the trend against fossil fuel energy generation and capacity will persist. In the short term, however, and barring a dramatic turnaround in European natural gas prices, coal will likely be the transitional energy source of choice among European utilities.

Given the rapidly increasing proved shale gas reserves in the United States, the marked decline in US natural gas prices in recent years, and stalled multilateral climate change negotiations, it is not surprising that fossil fuels will remain the major generator of electricity in the coming decades. Within the fossil fuel category, natural gas has taken clear supremacy over coal when it comes to being the preferred source of new energy generation in the US. Coal's share of power generation between 2007 and April 2012 fell from 49% to 32%. April 2012 marked the first month where natural gas' share of energy generation was equivalent to coal's in the United States. The US Energy Information Administration (EIA) reports that nearly 9% of coal-fired power plant capacity is expected to be retired within the next two years. This shift has occurred because of the increased profitability of natural gas powered electricity generation and the cumulative effect of environmental regulations within the energy sector. The jump in recoverable US natural gas supplies and natural gas production in the last half decade have been one of the primary factors driving down natural gas prices and making them a more appealing electricity source vis-à-vis coal in recent years. The EIA recently reported that no new conventional coal plants are expected to come online in the future, and power generation in advanced coal power plants is projected to be 75% more expensive than equivalent generation in new natural gas facilities. On the regulatory front, the strictness of the EPA's Mercury and Air Toxics Standards (MATS), which does not allow for carbon credit trading, is also playing a role in the switch from coal to natural gas power generation. MATS is scheduled to come into force in April 2015. Natural gas power has an emission factor 42-46% less than coal power. While other EPA rules and standards have been vacated by courts in recent years, the general animus of regulatory agencies towards the negative externalities associated with coal plants makes it clear that such plants will face a difficult operating environment going forward. In fact the EIA projects that natural gas will be responsible for a greater share of US electricity generation than coal by the mid-2030s in its 2014 Annual Energy Outlook.

Fossil fuel share of middle income electric capacity has increased in recent decades

In contrast to high income countries, middle income countries have become increasingly reliant on fossil fuel-based capacity and generation for providing energy to their citizens. Not surprisingly, coal accounted for 45% of energy demand growth between 2001 and 2011 according to the IEA.

Box 7: Electricity Capacity-The Sources Remain Largely Fossilized - continued -

Fossil fuel-based electrical capacity and generation rose from 64% and 65% in 1990, respectively, to 69% and 73% in 2010. While China, which controls over half of the electricity capacity of middle income countries, saw its share of fossil fuel-based capacity decline by 4%-points since 1990 to 70% in 2010, its share of fossil fuel-generated electricity stayed practically constant at 79%. The other middle income countries have become increasingly reliant on fossil fuels in both metrics. The non-China middle income share of electricity capacity rose from 61% in 1990 to 67% in 2010 while the share of electricity generated from fossil fuel sources rose from 60% in 1990 to 68% in 2010. Nuclear power was a relatively constant source of capacity and generation during the 1990s and 2010s in non-China middle income countries at around 3-4%. Nuclear power is a relatively negligible factor in China, with its share of capacity and generation less than 2% at the beginning of this decade. The decline in non-China middle income hydroelectric power's prominence has been quite dramatic. It declined from 35-36% of capacity and generation in 1990 to 25-27% in 2010. The corresponding declines in China have been much smaller in magnitude, with the capacity and generation falling from 26% and 21%, respectively, in 1990 to 23% and 18% in 2010, respectively. Intermittent renewable energy sources and biomass were still a relatively negligible factor in generation and capacity in middle income countries at the beginning of this decade. They represented less than 3.5% of both capacity and generation in 2010 in non-China middle income countries. By contrast, despite representing nearly 4% of capacity in 2010, intermittent renewable sources and biomass generated less than 1.5% of total Chinese electricity.

Low income countries are surprisingly the greenest in electricity capacity

Interestingly, low income countries have far and away the cleanest sources of energy among all income groups. Nearly three-fifths of low income electricity capacity and generation is supplied hydroelectric power. By contrast, fossil fuels sourced only around two-fifths of total electricity capacity in low income countries in 2011. Intermittent renewable energy sources and biomass are a negligible supply of both electricity capacity and generation in low income countries. There are no installed nuclear facilities in low income countries.

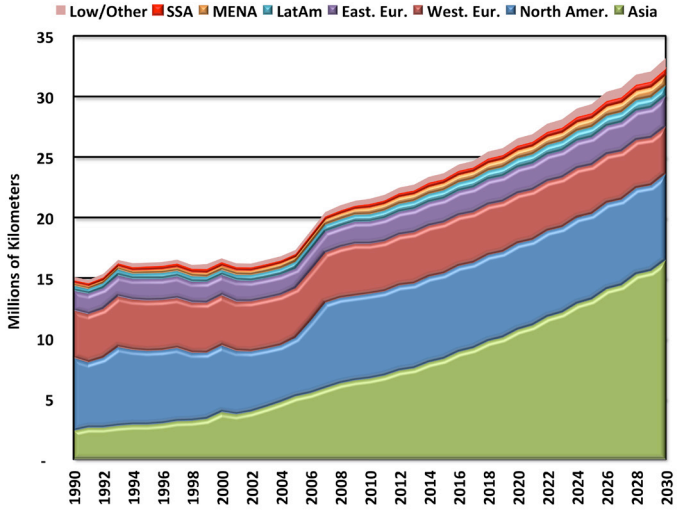
TRANSPORTATION

Paved Roads

Paved roads and rail stand out as the only asset groups in which we project an acceleration in the real growth rate of the assets between 2010 and 2030 compared to the growth between 1990 and 2010. Our model projects global paved road assets to rise from around $11 trillion in 2010 to approximately $33 trillion in 2030. Middle income countries such as China and India will be the primary growth driver in paved road assets. Overall we forecast that the kilometers of paved roads will increase 54% in these next two decades compared to growth of 42% in the two previous two decades. There are projected to be roughly 33.2 million kilometers of paved road globally in 2030 compared to 21.5 million in 2010 and 15.1 million in 1990. Paved roads' annual growth will accelerate to 1.9% per year between 2010 and 2030 from 1.5% during the 1990s and 2000s.

High income countries will see relatively middling growth in overall assets according to our model, although certain countries will see stronger growth than others. We project negligible growth in both the US and Western Europe in the coming two decades. Other high income economies will see growth in paved network assets in the coming decades. By 2030, advanced economies will see their share of global paved roads decline to around 45% from nearly 80% in 1990 and over 60% in 2010.

Paved Road Network by Region: 1990-2030

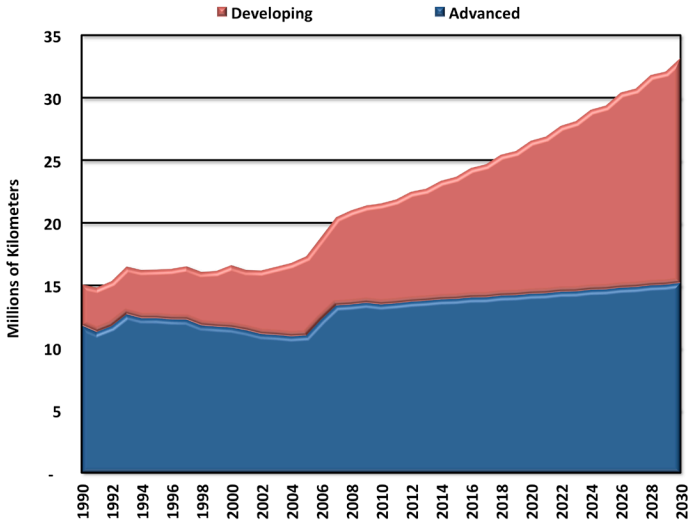


Sources: DHGE, World Bank, Various

We project strong growth in the length of paved road networks in middle income economies in the coming decades. They will be responsible for the lion's share of the growth of such assets in the world. China will represent nearly half of the growth in paved road assets in the coming decades, and its paved road assets are projected to exceed those of the United States by the end of the sample period.

Our model forecasts the Indian paved road network to rise from just over 2 million kilometers in 2010 to nearly 5 million by 2030. The paved road networks in middle income Asia, Latin America, the Middle East, and Africa will grow materially in the coming decades according to our model. Combined they will be responsible for over 20% of the overall growth in paved road assets between 2010 and 2030.

Paved Road Network by Income Type: 1990-2030

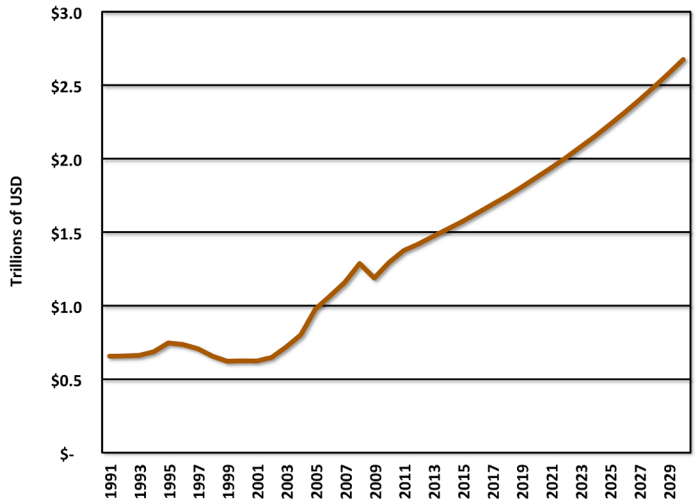


Sources: DHGE, World Bank, Various

Rail

While our model projects the growth rate in rail assets between 2010 and 2030 to be larger than the growth rate in the previous two decades, the projected 13% growth will be less than the 15% growth in rail network recorded between the early 2000s and 2010. We forecast that the value of railway assets will rise from approximately $1.3 trillion in 2010 to roughly $2.7 trillion in 2030. The global rail network will grow a moderate 13.4% between 2010 and 2030 compared to 7.8% between 1990 and 2010. This translates to an increase in real annual growth in these next two decades of 0.6% compared to real growth of 0.4% in the previous two decades. The demand for rail services has significantly outpaced the supply of new railway. Passenger traffic around the world has increased by around 60% and goods traffic has increased by nearly 30% around the world since 1990 despite a less than 10% growth in total railways. Growth will be split evenly between high income and middle income countries, with robust projected growth in China and middle income Africa, Latin America, Asia, and the Middle East. Among high income economies, the rail networks in North America, Canada, and Australia will grow in these next two decades. Rail networks should remain concentrated in high income economies, with this sector's share remaining relatively constant in the 57%-58% range between 2010 and 2030.

Value of Railway Assets: 1991-2030

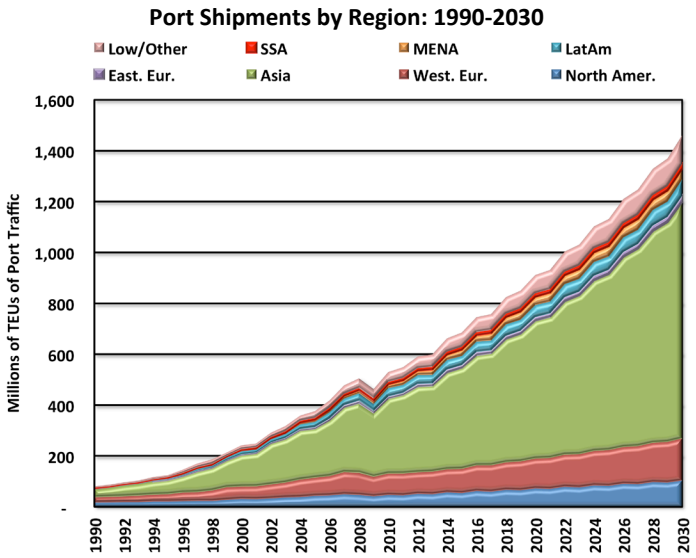


Source: DHGE, World Bank, Various

Ports

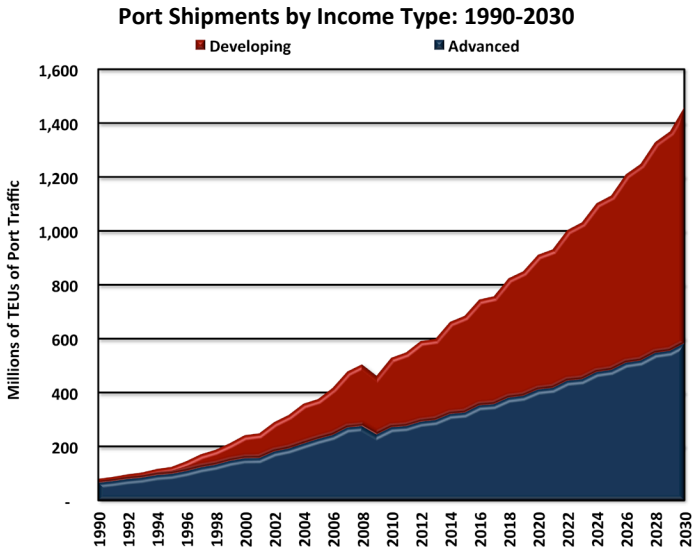
We forecast continued strong growth in port facilities in the coming decades based on recent trends and expected developments between now and 2030. Port traffic exploded in the two decades through 2010, going from under 100 million TEUs of shipments in the early 1990s to over 500 million by 2010. The projected growth rate of port traffic will slow from the 560% growth of the last two decades according to our model, but port assets around the world will still grow by approximately 176% between 2010 and 2030. This translates to annual asset growth of 5.1% per year between 2010 and 2030 after growing just below 10% annually during the previous two decades. Our model projects that growth will exceed 50% in all but one of the seventeen country-region subgroups (Japan) for which we estimated future traffic flows. The total value of these assets will rise from nearly $24 billion in 1990 and nearly $300 billion in 2010 to around $1.6 trillion in 2030.

Port traffic will grow in excess of 75% in every high income country-region subgroup with the exception of Japan according to our model. After rising from 15 million TEUs of traffic in 1990 to 42 million units in 2010, port traffic in the US will approach 100 million units by 2030. The dramatic gains in unit labor cost competitiveness in the United States in recent years could help push the United States' port traffic growth even higher. We forecast that Western European port traffic will nearly double between 2010 and 2030 after quadrupling during the previous two decades. High income Asian economies, which had among the highest per capita growth rates of traffic in the world, will see traffic more than double by 2030 based on our model's calculations. Australia and Canada should see growth in port traffic in excess of 75% between 2010 and 2030. Japan is the laggard among all country and region buckets with a forecasted growth of just under 50% between 2010 and 2030.



Sources: DHGE, World Bank, Various

We forecast that port traffic will basically double or more in every middle income region around the world in the coming decades. China will see the largest growth in expected shipments, although the rate of growth projected is being threatened by continued declines in unit labor cost competitiveness. It is eminently plausible that some of the projected growth will shift to other low-cost Asian economies and Sub-Saharan African economies as cost-sensitive industries such as textile become more profitable if they are located elsewhere. We project port traffic in India to grow at the fastest rate among our country-region groups between 2010 and 2030 with an average annual growth rate of 8.2%, but this will still leave the Indian share of port traffic at just 3.2% of the global total by 2030. Most other regions will see shipments double or more between 2010 and 2030.



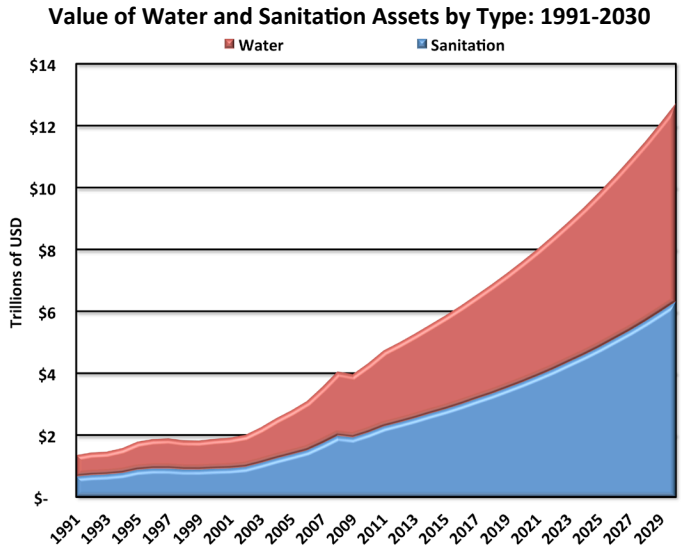
Sources: DHGE, World Bank, Various

Airports

Our model forecasts that new airport capacity growth will be a relatively muted 13% between 2010 and 2030. We project annual growth to slow to 0.6% during these next two decades after growing by 1.2% between 1990 and 2010. Growth will once again be concentrated in middle income countries, with Chinese growth expected to be responsible for a little under one-sixth of the growth in total assets. Latin America is projected to be responsible for around 20% of the growth in new assets while Asia as a whole will be responsible for nearly two-fifths of the expansion in new paved runways. Middle income countries will be responsible for around two-thirds of the growth in new capacity between 2010 and 2030. Low income countries should see their share of global growth accelerate to 8.3% these next two decades. High income countries will again be responsible for around one-quarter of the growth in new capacity between 2010 and 2030. The total value of these assets will rise from a little over $1.3 trillion in 2010 to around $3.1 trillion in 2030 according to our model. The projected ongoing divergence between robust growth in demand for airport services and tepid growth in new paved runways points to investment in airports being a strong bet.

Water and Sanitation

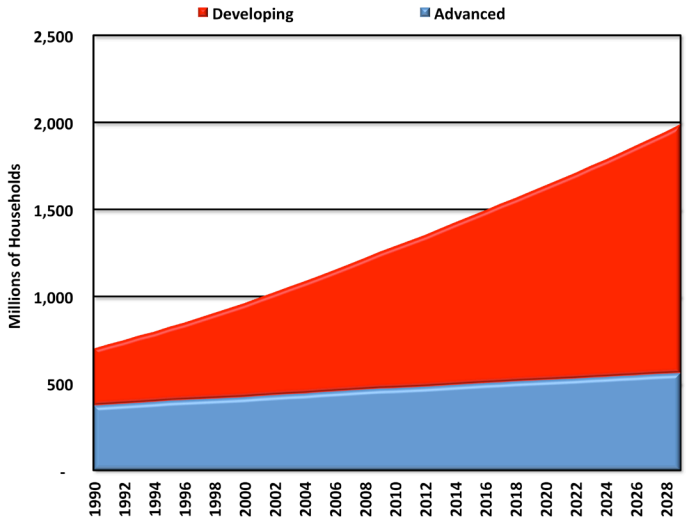
Sanitation assets will continue to grow strongly in the coming decades despite a tremendous increase in spending during the previous two decades according to our model's projections. This is vitally important as a recent United Nations report revealed that more people have a cell phone than have access to a toilet. While the share of the global population with access to water was 88% in 2011, under two-thirds of the global population had access to improved sanitation facilities.



Source: DHGE, World Bank, Various

Overall, the number of households with access to sanitation facilities globally will to grow by approximately 57% during this decade and the next according to our model after rising 84% during the previous two decades. Annual growth in sanitation assets between 2010 and 2030 will still be a robust 2.3% compared to 3.1% annual growth during the previous two decades. After an additional nearly 600 million homes were provided with access to good sanitation facilities in the 1990s and 2000s, we project over 700 million new households will be given access to improved sanitation facilities. Although new water supply facilities will grow more slowly compared to new sanitation facilities and compared to the growth of new water supply facilities during the previous two decades, households with water connections will still grow by 44% during the next two decades. This means annual growth will slow only modestly from 2.7% between 1990 and 2010 to 1.8% annually during the 2010s and 2020s. Middle income countries will be the driver of growth in both asset classes according to our model, but every sub-region is expected to see growth in assets of 10% or more in the next two decades. In total, we forecast the value of water and sanitation assets to increase from just over $4.3 trillion in 2010 to roughly $12.7 trillion in 2030.

Sanitation Connections by Income Type: 1990-2030

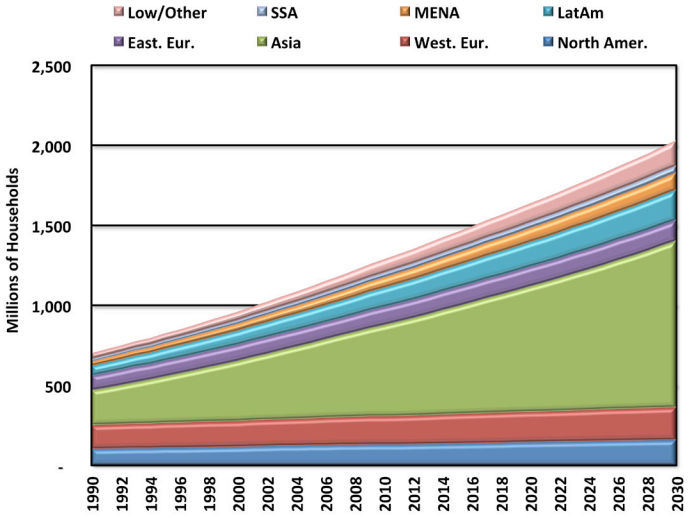


Sources: DHGE, World Bank, Various

High income regions will see continued growth in water and sanitation facilities in the coming decades based on our model's estimates, but the growth rate will be much less as a result of the prevailing near-universal access. New sanitation facilities growth will be driven by population growth and the structural trend of declining household sizes across both the advanced and developing world. Average household size has declined precipitously in many high income countries during the past two decades. Households in high income Asian economies excluding Japan declined in size from 3.72 people in 1990 to 2.83 people in 2010. High income Eastern European economies' households declined in size from 3.34 people to 2.57 people during that time period. Australian and Canadian households both declined by over 0.2 people while Western European households declined on average by 0.3 people. The United States was a relative outlier, as its average household size declined by just 0.04 people over the two decades and rose after the global financial crisis. The combination of expected continued declines in average household size and moderate population growth will drive projected growth in water and sanitation assets of between 20% and 30% in Australia, Canada, and the US while population moderation will lead to growth in household connections of under 20% in Japan and Western Europe for both economies.

The growth leaders in new water and sanitation facilities will be the developing Asian economies according to our model. Over 60% of new sanitation facilities and 54% of new water connections will be found in Asia. We forecast that China alone will comprise nearly 40% of the growth in sanitation spending and 28% of water-related spending in the coming two decades. Recently announced reforms to the Hokou system in second-tier cities in China should help accelerate Chinese urbanization and drive particularly strong growth in this sector. Although the growth rate of sanitation facilities will slow, the total number of households receiving new connections to sanitation facilities is expected to be larger in these next two decades compared to the previous two. India and Middle income Asian countries such as Indonesia and Malaysia will also see strong growth in both asset classes during the coming two decades.

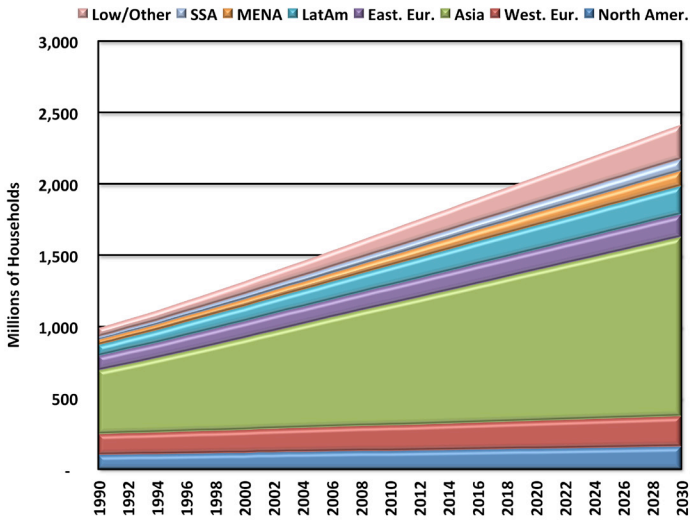
Sanitation Connections by Region: 1990-2030



Sources: DHGE, World Bank, Various

We forecast that middle income regions across the world will see continued strong growth in new water and sanitation facilities in the coming decades as well. Those countries in Africa, Asia, Latin America, and the Middle East will see growth in new household sanitation connections between 45% and 66% in these next two decades. Water facility spending is expected to be less across the board, but will still be in excess of 40% in every region's middle income countries with the exception of middle income Eastern European countries. Low income countries will see the number of sanitation connections double in the coming two decades while we forecast the number of households with water access will rise by nearly 100 million between 2010 and 2030.

Water Connections by Region: 1990-2030



Sources: DHGE, World Bank, Various

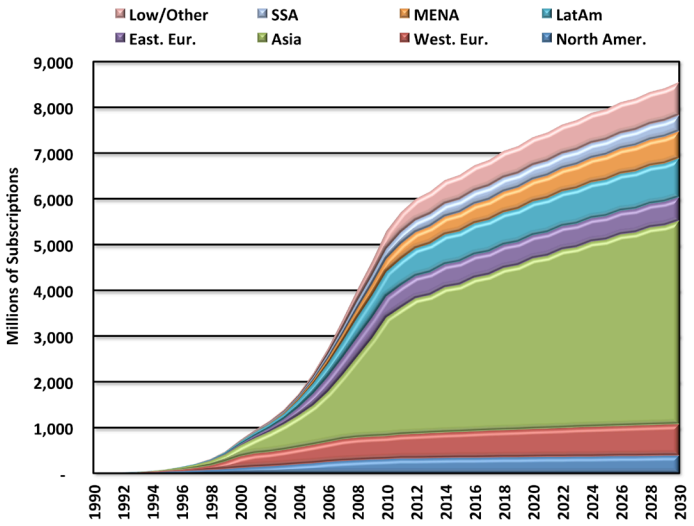
Telecom

Growth leadership in the telecom industry is shifting from being dominated by mobile phone-related capital investment to being shared between mobile phone-related and broadband-related investment. The telecom sector will require material servicing and maintenance repairs to service the more than ten billion combined connections they will need to maintain across fixed lines, mobile phones, and broadband connections. We forecast that the sector's capital assets will rise from roughly $4.75 trillion in 2010 to around $7.76 trillion in 2030.

The number of mobile phone subscriptions and broadband connections will continue to grow strongly in both advanced and developing regions this decade and next according to our model. Mobile phones subscriptions in the United States and Western Europe will increase over 30% between 2010 and 2030. The US will see broadband connections rise by 50% based on our projections while Western European broadband lines should see growth of two-thirds from the prevailing 2010 levels.

Global mobile phone-related assets will still grow 2.4% annually during the 2010s and 2020s. The Canadian market remains fertile ground for growth, with a per capita rate of mobile subscriptions below the global average. Correspondingly the sector is expected to see growth in capital assets stemming from mobile phone subscriptions in excess of 50% between 2010 and 2030.

Mobile Telephone Subscriptions by Region: 1990-2030



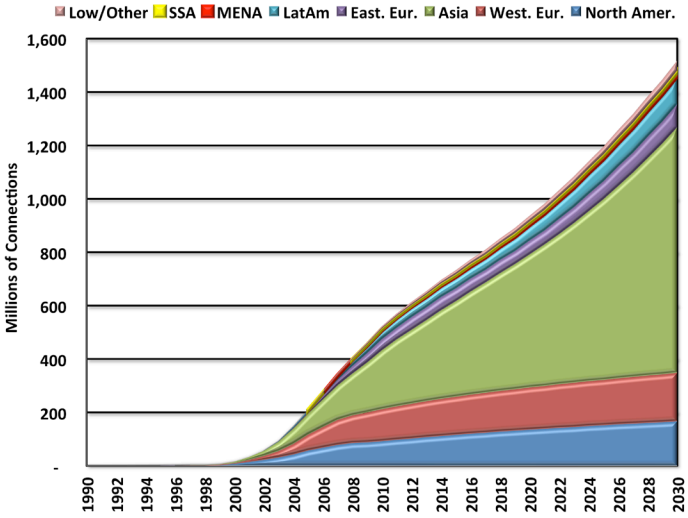
Sources: DHGE, World Bank, Various

With the exception of Western Europe, which had nearly 120 million broadband subscriptions at the beginning of this decade, and Eastern Europe, broadband subscriptions will rise between 78% and 111% in every other high income group. The number of fixed telephone lines will continue to fall in high income economies. Global broadband connections will grow by approximately 5.4% annually during this decade and next according to our forecasts. The total number of fixed telephone lines will decline slightly during the 2010s and 2020s after growing by 4.4% per year during the 1990s and 2000s.

Capital assets related to new telecom assets in Asia will grow robustly during this decade and next according to our forecasts, with China and India leading the way across both projected growth in capital investment related to new mobile phone subscriptions and broadband connections. While China is generally expected to be the growth leader for most assets, India will see the largest increase in investment in mobile phone-related capital assets, with the number of subscriptions projected to rise from 750 million in 2010 to around 1.7 billion in 2030. Although they will see their broadband connections quadruple in these next two decades, India will still approximately have just 44 million connections by 2030.

Chinese mobile phone subscriptions will rise to around 1.4 billion subscriptions by 2030 according to our model, which represents a 66% increase from the level of 2010. Interestingly, those two countries will see among the largest declines in fixed telephone assets in the coming years. Fixed telephone lines will decline between 22% and 25% in China and India. Chinese broadband subscriptions will represent over half of the growth in global broadband lines between now and 2030. Middle income countries in the region will see relatively tepid growth in new mobile subscriptions compared to most other asset classes of 35% as a result of many of the key countries in the region having subscriptions in excess of the population. Additionally, the broadband connections should jump by roughly 82% in the coming two decades in middle income Asia.

Broadband Connections by Region: 1990-2030



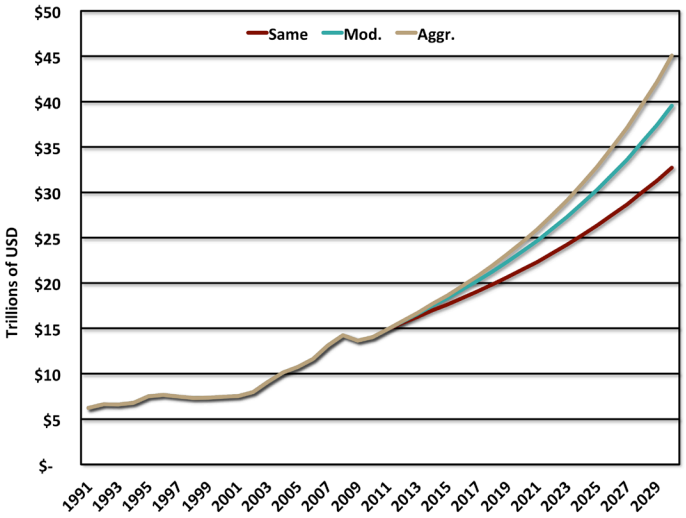
Sources: DHGE, World Bank, Various

We forecast mobile phone subscriptions in middle income countries in most other regions will grow between 50% and 106% between 2010 and 2030. The number of new mobile phone subscriptions in Eastern European economies will grow tepidly in the coming decades due to the fact that there are already more mobile subscriptions than people in the region. The growth in middle income country broadband-related capital assets will be dramatic across the world. New connection growth will be in the triple digits in all major regions according to our model.

The Potential Evolution of the Size of the Private Sector Infrastructure Universe

Given the increasingly perilous state of government finances in the advanced world and the meaningful reforms that have been instituted in the developing world, the private sector is poised to play an increasingly large role in infrastructure in both spheres. If the 2012 rates of private sector involvement in the advanced and developing world held through 2030, total private assets would be worth $33 trillion. High income listed infrastructure assets in this scenario would be worth $12 trillion. If the private sector shares of all three types rose 1% every year, then total private assets would rise to $40 trillion while high income listed assets would rise to $17 trillion. If we assume that the private sector share of advanced economies rises to two-thirds of infrastructure assets from around 56% recently by 2030 while the private share of developing assets rises from under 7% in recent years to one-sixth of developing infrastructure assets, then total private assets would rise to $45 trillion.

Value of Private Infrastructure Asset Scenarios: 1991-2030



Source: World Bank, Various, DHGE

Potential Scenarios for Future Growth of Private and Listed Infrastructure Assets (Billions USD): 2012-2030

Scenario	Year	Advanced	Developing	Total	Listed Advanced	Priv. Shr. Adv.	Priv. Shr. Dev.	Listed Shr. Of Priv. Adv.
Base	2012	$14,414	$1,322	$15,736	$5,967	56%	7%	41%
Base	2030	$28,679	$4,056	$32,736	$11,991	56%	7%	41%
Modest	2030	$34,648	$4,900	$39,548	$17,156	67%	8%	50%
Aggressive	2030	$34,648	$10,437	$45,085	$20,850	67%	17%	60%

Sources: DHGE, World Bank, Various

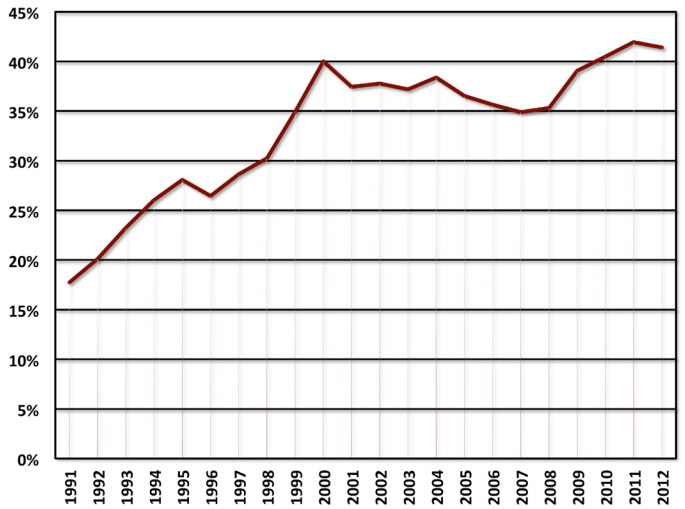
SECTION III:

THE EVOLUTION OF LISTED INFRASTRUCTURE ASSETS

Investors are attracted to the infrastructure sector because of its potential for steady predictable revenue growth and high dividend yields. As recent profit downturns in European highway companies will testify, the sector is not totally immune to the business cycle, but it is still viewed as less cyclical than industrial companies. The listed share of high income country private infrastructure assets have grown steadily over the past two decades, going from around an estimated $1 trillion, or under 20% of total private infrastructure assets, in the early 1990s to around $6 trillion in recent years, or more than two-fifths of total private infrastructure assets.

There are three major vehicles through which investors can participate in the infrastructure sector. The first is through private equity firms, which are mostly unlisted and closed-end funds. The second is through directly investing in individual infrastructure companies, which is generally referred to as unlisted investment. The third vehicle is listed infrastructure funds, which can either be open-ended or closed-ended.

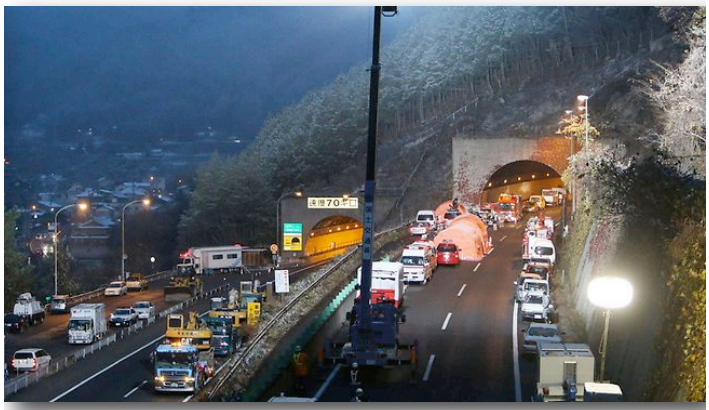
Listed Share of Private High Income Infrastructure Assets: 1991-2012



Sources: DHGE, World Bank, Various

There are two potential avenues for growth in the future. The first is in the old industrial countries which have aging infrastructure that will need to be upgraded. In 2011, the American Society of Civil Engineers estimated that the US would need to spend $2.2 trillion during the next five years to upgrade its infrastructure.

The sector suffered from the large fiscal deficits which hit the state and local government sector during the 2008-09 economic downturn. President Obama proposed creating a national infrastructure bank, but the Republicans in Congress rejected the idea. The collapse of a bridge in Minneapolis a few years ago demonstrated that there are high costs for inaction, but American politicians cannot agree on how to fund the repairs. There are also pent-up infrastructure needs in other industrial countries. Most of Japan's infrastructure was built in the two decades after 1945 and is now aging. In 2012, a tunnel collapsed and killed several people. The Japanese press was suddenly full of stories about the risks posed by Japan's deteriorating infrastructure and the new Abe government promised to spend several trillion yen addressing the problem. The governments in most industrial countries now have large debt burdens which could constrain their ability to spend adequately on infrastructure.



Japan Tunnel Collapse *Source: theaustralian.com.au*

It is unclear if governments will attempt to raise equity capital to carry out this infrastructure renewal process, but there would be a ready market for such opportunities because the industrial countries have large non-telecom listed infrastructure sectors[3]. The US has the largest with a market value of $717.5 billion, but most of it is concentrated in the power sector. Japan is next with $153 billion of listed infrastructure companies. It is followed by Canada with $121 billion, Spain with $113 billion, the UK with $62 billion, France with $52 billion, Australia with $48 billion, and Germany with $12 billion. Newly industrialized economies also have a significant infrastructure presence in its stock markets. Singaporean firms have a market cap of $53 billion. Taiwan follows with a market cap of $40 billion. Mrs. Thatcher went further than many other European governments in privatizing electricity, water, and telecom companies during the 1980s, but her experience demonstrates there is ample potential for privatizing infrastructure assets.

[3] *All figures as of the end of November 2013*

The other great opportunity will be in the developing countries. Investors regard the emerging market countries as potentially attractive because they will need trillions of dollars to finance their future infrastructure needs and many already have listed infrastructure companies in the highway, rail, telecom, port, and airport sectors. Brazil and Mexico have airports listed on their stock exchanges. Thailand has highways, airports, railways, and water companies listed on the Bangkok market. Indonesia has a listed toll way company. The Philippines has a listed port company which is active in several developing countries. China has airports, water companies, highways, and ports listed on its stock exchange or the Hong Kong stock exchange. All these countries and many others have listed telecom companies. In Singapore, the national telephone company has also diversified into several other Asian countries.

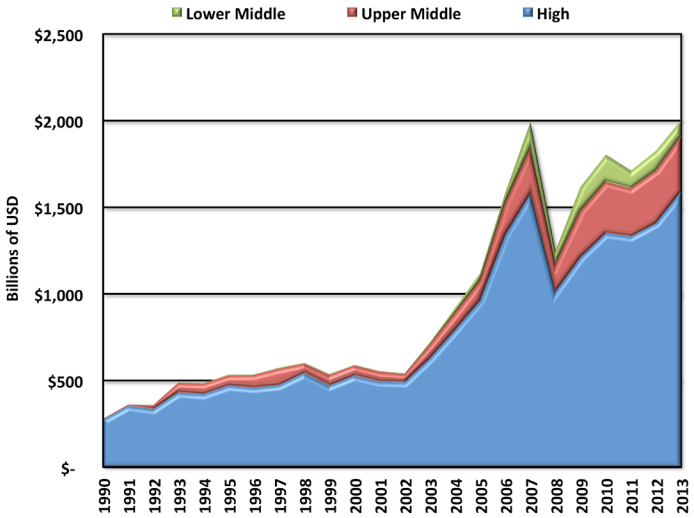
Private equity funds are poised to play a role financing infrastructure projects, especially in frontier markets such as Africa, but the public equity markets will play a major role in many countries because money is available from institutional investors with long-term time horizons.

There is already a large market capitalization for non-telecom infrastructure companies in the developing countries. China and Hong Kong lead the way with $181.5 billion. Brazil follows with $99 billion of listed infrastructure companies while Chile has $51 billion. Malaysia is next with $39 billion followed by Thailand with $18.6 billion, Colombia with $16.6 billion, Saudi Arabia with $16.2 billion, Indonesia with $13.3 billion, Philippines with $13.2 billion, and Mexico with $12.6 billion, and Turkey with $2.7 billion. The emerging market telecom sector will also be able to raise funds through equity markets because it already has a large market capitalization. China leads with a market cap of $302 billion.

The Port of New York and New Jersey *Source: npr.org*

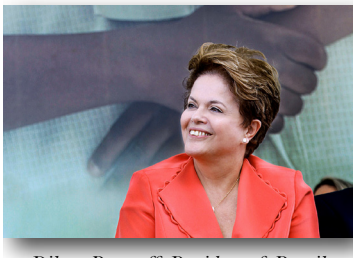
It is followed by Malaysia with a market cap of $51.6 billion. The next largest market caps are India with $35 billion, Thailand with $32 billion, Indonesia with $23 billion, and the Philippines with $18.4 billion. The telecom market cap in the US is $425 billion and in Japan it is $276 billion. Australia has only a $57.5 billion market cap. Korean firms have a market capitalization of $19.4 billion. Nippon Telephone used to be the largest market cap telecom company in the world, but it is now worth only $57 billion compared to $96 billion for Japan's internet and mobile company Softbank.

Market Capitalization of Non-Telecom Listed Infrastructure Firms by Income Tier: 1990-2013



Source: CAGR

Attracting private capital for the infrastructure sector is not a simple process. It requires countries to have clear and credible regulations for investors to have confidence in their profit assumptions. Both Brazil and Indonesia have talked about public-private partnerships in the infrastructure sector, but they have failed because of investor uncertainty about the quality of regulation. Brazil is confronting a possible crisis because it will need private capital to prepare for the Olympics in 2016. President Rouseff visited Goldman Sachs during her trip to New York in September 2013 to seek their help in raising money for infrastructure projects. She will probably have to seek Goldman's help in improving the quality of Brazil's regulatory policies for the sector.



Dilma Rousseff, President of Brazil
Source: atlanticsentinel.com

Some countries also restrict foreign investment in their infrastructure sector. In 2006 the US banned a Dubai company from bidding for some port assets being divested by a British company. There was a perception that an Arab investor might pose a security risk.

There was little recognition of the fact that at that time 80% of US ports were being leased and operated by foreign entities. The US might be also be suspicious of Chinese companies if they tried to make large investments in the US infrastructure sector. It is totally indifferent to investments by Australian and European companies.

There can be little doubt that the infrastructure sector will be a major engine for global capital formation during the 21st century. There will be opportunities for investment in both listed companies as well as through private equity. The public sector will play an important role as both an investor and regulator of private investors, but it will allow far more opportunities for the private sector than was possible during much of the 20th century.

Case Study

SAO PAOLO METRO LINE 4 (BRAZIL):

Brazil is a country that has long underinvested in infrastructure due to a variety of factors. A prominent success story for Brazil, however, has been the Sao Paolo Metro Line 4, funded via a private-public partnership. As of 2011 it served 3.6% of Sao Paolo's population, or 650,000 people. The line uses an innovative, driverless system, and helps to reduce pollution in the city.

One of the potential attractions of the infrastructure sector is its low correlation with other asset classes. The returns tend to be linked to long term economic growth rather than fluctuations in the business cycle. As infrastructure companies often offer high dividend yields, they are competing with real estate or long term bonds, but since real estate is very vulnerable to changes in monetary policy it has a weak correlation with the infrastructure sector. One study found a low correlation between infrastructure and REIT returns (0.23). The US infrastructure sector had a stronger correlation with foreign infrastructure equities (0.53).

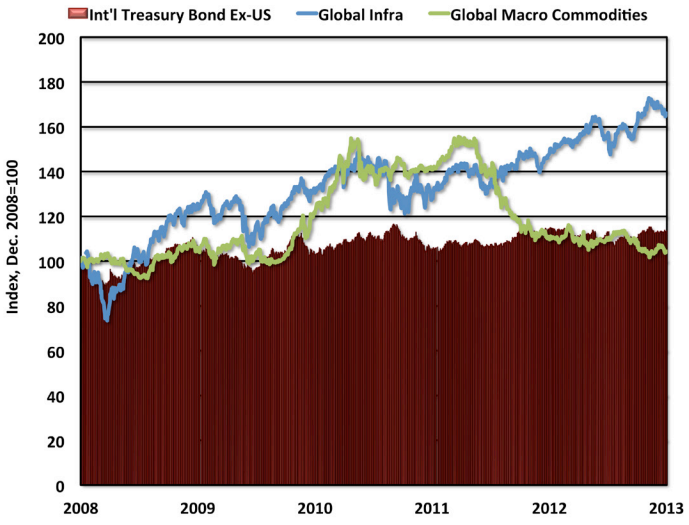
The returns for infrastructure assets will vary by sector. Yields from utilities can vary from 6% to 12%, depending in large part on the regulator. Roads can generate yields in the 6-10% range. Airports and ports can offer yields in the 4-9% range. One important factor determining returns is the price at which infrastructure assets are privatized. American investors lost billions of dollars in the highway sector during the past decade because they paid excessively high prices for the roads and could not generate a high enough return to cover the cost of their debt servicing payments.

Tolling Station *Source: ops.fhwa.dot.gov*

Privatizations which depend upon debt rather than equity will always be vulnerable to faulty return assumptions.

Pension funds are potentially important infrastructure investors because they have long-term time horizons. Canadian plans have been pioneers in the sector. The Ontario Municipal Employees Retirement System established a separate infrastructure entity, Borealis, to invest in infrastructure transactions. It is a separate entity with about fifty staff and plans to manage as much as $10 billion during the next few years. Ontario Teachers' Pension Plan has been investing in the infrastructure sector since 1997. It has bought a 10% shareholding in the Macquarie's Infrastructure Group Fund. It also participates in direct and co-investment deals and plans to invest between 12% and 15% of its portfolio in the infrastructure sector. Quebec's large state pension fund, Caisse de Depot, has invested $5 billion in the infrastructure sector.

Global Infrastructure Index Returns Versus Other "Alternative Assets": 2008-2013



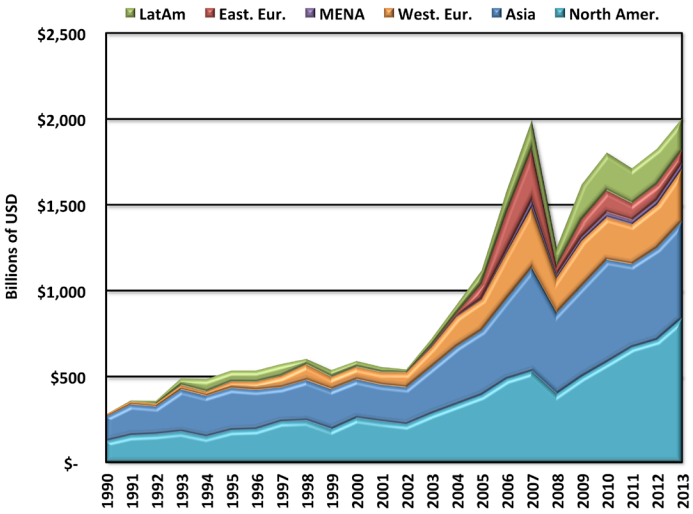
Source: Standard and Poor's

Australian superannuation funds are also active investors in the infrastructure sector. The infrastructure shares range from 2% to 15% of their portfolios. Many invested initially through Macquarie funds, but they are now diversifying. In Europe, the Dutch pension plan, ABP, has allocated 2% of its assets, or €4.2 billion to infrastructure. In the US, the Illinois State Board of Investment has allocated 5% ($600 million) of its portfolio to the infrastructure sector. It's investing only through funds.

As the US listed infrastructure sector is dominated by the power and telecom industries, some American pension funds may seek greater exposure to the sector through international funds.

There are a growing number of indices being used to track publicly-listed infrastructure mandates. The S&P Global Infrastructure Index is a free float adjusted market capitalization weighted index comprised of 75 of the largest publicly listed infrastructure companies. The index has a weighting of 20% for energy, 40% for transportation, and 40% for utilities. The index has exposure to emerging markets and shipping, but it does not have exposure to merchant power or telecoms. The index began in 2007.

Market Capitalization of Non-Telecom Listed Infrastructure Firms by Region: 1990-2013

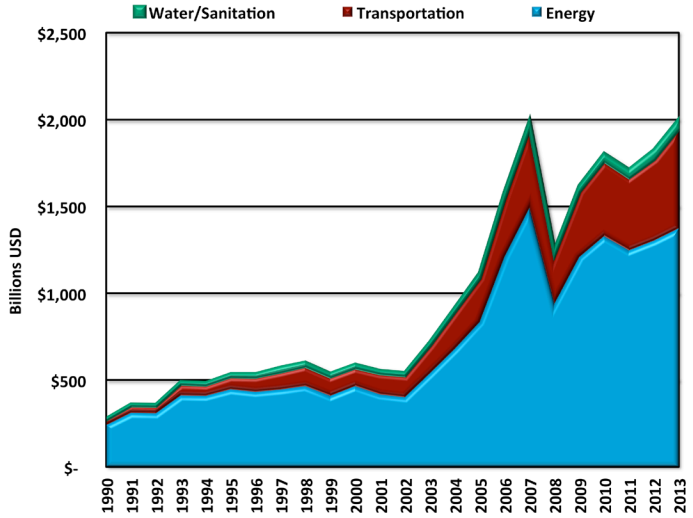


Source: CAGR

UBS has created two infrastructure indices. The first was created to track an industry benchmark to evaluate the performance of listed infrastructure and utilities sectors in developed markets. The second is the UBS Global 50/50 Infrastructure and Utilities Index. It is a global free-float adjusted market capitalization weighted index comprised of one hundred listed infrastructure companies. In order to ensure diversified exposure, it has a weighting of 50% for infrastructure and 50% for utilities, based on market capitalization. The index does limit individual security weightings to 5%. The index was started in 2006.

The final index is the Dow Jones Brookfield Global Infrastructure Index. It is a free float adjusted market capitalization weighted index whose constituent companies must derive at least 70% of their cash flows from infrastructure assets which include: airports, communications, transmission and distribution, oil and gas storage, transportation, and water. The index excludes all power generation utilities and does not restrict individual security weightings. The index began in 2008.

Market Capitalization of Non-Telecom Listed Infrastructure Firms by Sector: 1990-2013

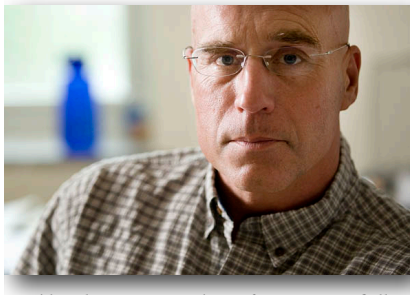


Source: CAGR

The obvious market for these capital needs is the immense pool of retirement savings which now exists in the old industrial countries and the growing pool in the developing countries. Such plans have long-term actuarial needs which can be satisfied by infrastructure companies which offer steady predictable returns tracking the growth rate of their national economies. Pension plans in Canada and Australia recognized this opportunity several years ago. Others are now following. In the decade ahead, the infrastructure share of pension assets will probably rise to the 5-10% range and could go higher in countries with large spending needs. The challenge for plan sponsors will be to find managers who understand the infrastructure sector and can help them to develop investment plans for it.

SECTION IV:
INFRASTRUCTURE INVESTMENT AND ECONOMIC GROWTH

David Aschauer began the modern era of investigating the relationship between infrastructure investment and growth in 1989 with his study on the impact of public infrastructure investment on US growth. His findings, while generally being deemed implausibly high since then, spurred what has since become a major area of focus of researchers across the world.

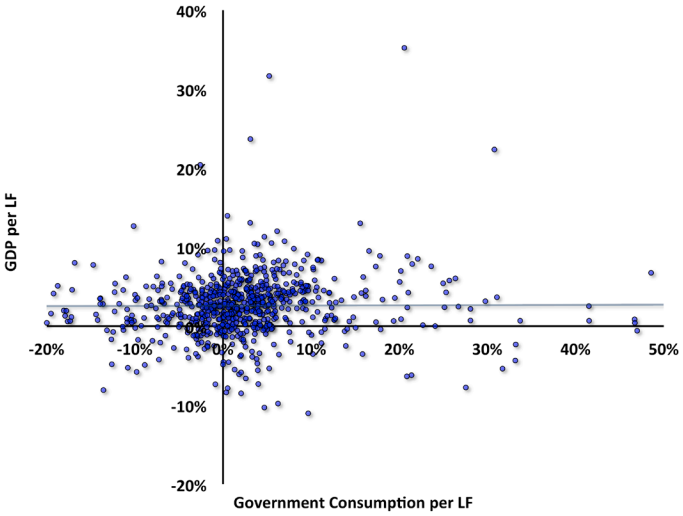


David Aschauer,, Eeconomics professor at Bates College
Source: bates.edu

As the relationship between infrastructure investment and growth was investigated by other researchers with more advanced techniques and larger samples of time and geography, a consensus has emerged that investment in infrastructure is associated with materially improved growth rates, if smaller than the impact estimated by Mr. Aschauer.

The Development Research Group of the Macroeconomics and Growth Team at the World Bank in 2011 published the most thorough and comprehensive study on the impact infrastructure has on economic growth around the world. The study included forty years of data for eighty-eight countries between 1960 and 2000. Regardless of how the model was structured, the research team of Cesar Calderon, Enrique Moral-Benito, and Luis Serven found that the long-run elasticity of output with respect to infrastructure stock ranged between 0.07 and 0.10. These results indicate that a 10% increase in infrastructure investment is associated with a 0.7%-1.0% marginal increase in GDP.

Relationship Between GDP Growth and 4-Year Lag of Government Consumption Growth: 1995-2011



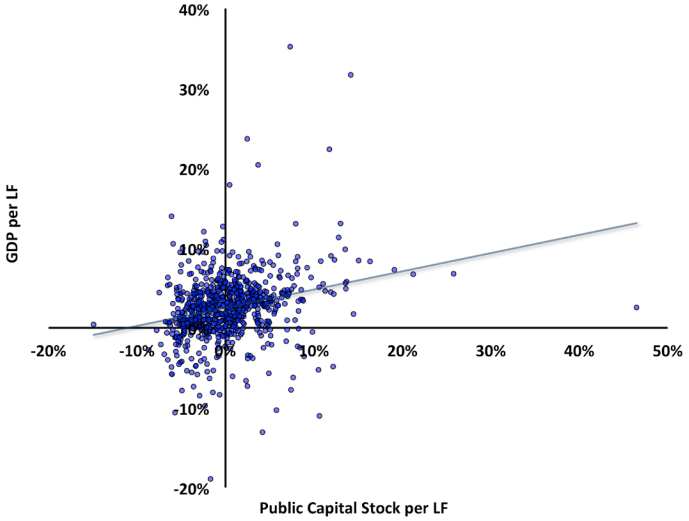
Sources: World Bank, DHGE

Out of the hundreds of studies that have attempted to answer the question of whether there is a meaningful relationship between infrastructure and growth, around three-quarters of them have found that there is a positive relationship between infrastructure capital and growth. Of the remaining studies, most found that there was no conclusive relationship and a very small minority found that infrastructure investment was associated with lower output.

An examination of the non-private and private investment flows of fifty-seven countries between 1990 and 2011 revealed that increases in both types of capital stock on a per labor force member basis are associated with stronger per labor force member growth many years after they are made. In particular, increases in private sector investment provide maximum benefits during the first two years after the investment are made, and they still provide meaningful boosts to growth for an additional three years. By contrast, the lagged benefits to growth of public investment peak three-to-five years afterwards. The study controlled for household and government consumption as well.

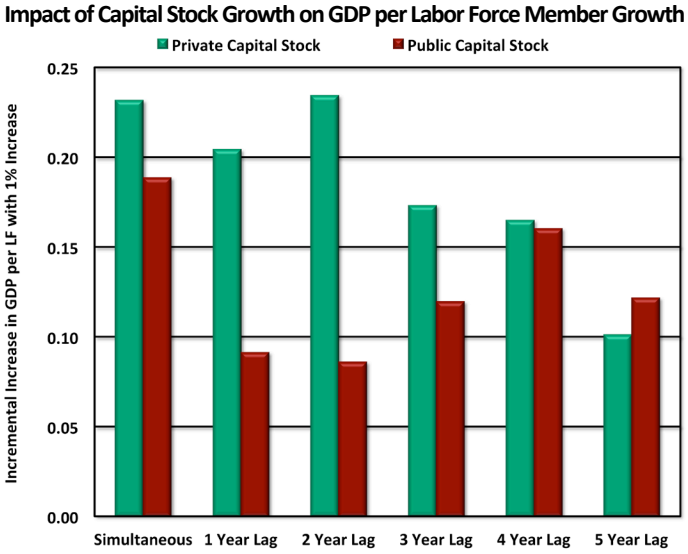
Public capital stock improvements are strong drivers of growth both during the year of the initial outlay as well as for many years afterwards. In fact, the lagged effects of investment in public capital stock peak four years after the initial outlay, and the marginal benefits of each additional unit of increase of public capital stock exceeds that of private capital stock in the fifth year after the initial outlay. Public capital stock includes traditional forms of infrastructure, such as roads, airports, rail, etc., as well as types of social infrastructure, such as schools, hospitals, courts, etc. In the initial year of the outlay, each additional 1% increase in the stock of public capital per labor force member is associated with equivalent GDP growth by 0.19%, which is 19% less than the marginal benefit associated with increases in the private capital stock, but 20% greater than household consumption and nearly 385% greater than government consumption.

Relationship Between GDP Growth and 4-Year Lag of Public Capital Stock Growth: 1995-2011



Sources: World Bank, DHGE

The marginal benefit drops to 0.09% in the first and second year after the initial outlays, however. Interestingly, the boost to growth on a per labor force member accelerates in the third and fourth years, rising to 0.12% and 0.16%, and is still at 0.12% in the fifth year. By contrast, the lagged boost to growth from per labor force private capital stock peaks in the second year, albeit at a far more economically significant level than the peak contribution from public capital. The coefficient values for public capital are statistically significant at the 1% level of significance or greater than for every period examined.



Sources: World Bank, DHGE

SECTION V: CONCLUSION

Global infrastructure assets will continue to grow strongly in the coming decades in order to meet the demands of a growing population that is becoming increasingly wealthy. The power, paved roads, and water and sanitation sectors will drive this growth in the coming years. Although the growth rates of new assets in most infrastructure sectors will slow somewhat in the coming years, the rate will still be robust due to the growing demand for the services that infrastructure assets provide. Middle income countries, especially those in Asia, will be the primary drivers of this growth, but infrastructure assets in advanced economies will continue to grow in size due to the population becoming wealthier and the household sizes declining.

While the ongoing debt crisis will constrain the ability of industrial economy governments to meet the demands of their citizens for infrastructure services, the private sector stands poised to play an increasingly large role in this sector. The private sector's share of infrastructure assets in the advanced economies should increase in the coming years as high income economies need to reduce debt and are unable to maintain their existing assets.

Source: 123rf.com

The private sector's share of infrastructure assets in developing economies stands poised to increase significantly so that these countries can reap the benefits of privatizing sectors that are generally in private hands in advanced economies. Investors will be provided with additional avenues to participate in this growing and dynamic sector as the listed share of private infrastructure assets continues to grow around the world.

Infrastructure's time is now, and it remains a sector whose prominence will only increase going forward. The demand for these services is already there. The demand for these services will continue to be there in the coming decades. Given the developments in the global economy over the past decade, the question is not whether the private sector will play a role in meeting this demand. The only question is how large a role the private sector will play in meeting future demand. Investors stand poised to have increasingly considerable options to participate in this trend.

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