

ISQA 529

Logistical Infrastructure in Sixteen Countries: A Comparison



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Abstract

By comparing the transportation infrastructure of the United States to fifteen of its largest trading partners, we were able to detect meaningful differences and make some recommendations. After compiling data on more than 90 variables, we were able to divide the sixteen countries into three separate groups (Large and Mature, Small and Mature and “BRICM”¹), facilitating more meaningful and fair comparisons. We have also made a point of comparing the U.S. to the booming nation of China, and many interesting similarities and differences were found. Although there is no universal standard of what is an appropriate level of infrastructure investment (e.g. in relation to the Gross Domestic Product), our findings seem to confirm that the U.S. is under-investing in this area. Currently the nation is rated as one of the world’s most competitive, but to maintain this edge it will be necessary to invest more in the expansion and maintenance of road systems, railroads, airports and waterways, both for freight and passengers. Our report ends with a look at some recent technological trends and suggests seven summary conclusions and recommendations.

¹ The four countries comprising “BRIC” are Brazil, Russia, India and China, but for the purposes of this report we added Mexico to the group, creating “BRICM”

Scope and Methodology

This report compares and comments on investments made in the logistical infrastructure by 16 countries, including the United States. We discuss how these countries gain global competitive advantages from upgrading their logistical infrastructures, with particular emphasis on the different modes of transportation. A country's physical infrastructure has several components to it. To arrive at our scope – mainly transportation infrastructure – we needed to disregard public utilities (such as power, water, sewer, communications networks), and we needed to put aside investments in logistics facilities such as warehouses and distribution centers for the purposes of this report. What we are left with is the transportation infrastructure, limited to roads, railroads, seaports, airports, inland waterways and pipelines. We have not paid much attention to pipeline transportation, except noted that it is a crucial mode for natural gas transportation in North America and Eurasia. Our focus is on freight transportation, although we are aware that this type of transportation cannot be considered in a vacuum apart from passenger transportation. People and freight represent both competing and complementary demands on a nation's roads, railroads, and airports, and investments made in these areas tend to benefit both user groups. Lastly, we are also aware that investments in the transportation infrastructure are made by both the public and private sectors, and many of our statistics include combined figures from both sectors.

An analysis such as this must consider both quantitative and qualitative factors, and it is

unlikely that we can provide sweeping answers and recommendations solely based on numbers and statistics. We realize the complexity and interrelationships between a multitude of variables, many of which will be discussed in some depth later in this report. For example, factors related to the culture and historical backgrounds of different countries are described.

All in all, four main modes of transportation are considered:

Air

Airfreight is the most expensive of all the modes. It offers cost-effective transportation for the low weight but high value products. Air transportation is the newest of all the modes, but there is an ongoing need to upgrade and expand airports to handle ever higher freight and passenger volumes and larger aircraft. Most airports are still publicly financed. Our data table lists only the largest airports, with paved runways over 3,047 meters.²

Road

The road mode here indicates paved roadways. However, there is no detail data about the road conditions or whether the roads can be used for heavy shipments. Therefore, the road mode includes all paved roadways, including express highways. Our data table (from the CIA Fact Book³) lists paved roads, but anybody who has driven extensively in developing countries knows that the standards are quite different from American or European roads.

² This is the standard used in CIA's World Factbook to categorize large airports.

³ CIA's extremely helpful and reliable "World Factbook" is found on their website <https://www.cia.gov/library/publications/the-world-factbook/>

Water

The water mode includes both ocean and inland waterway transportation. Many countries don't have inland waterways due to their geography and sizes, while for some countries inland waterway transportation is a viable alternative to road or rail modes. Our ocean transportation indicators include the number of major sea ports and merchant marine vessels.

Rail

Railroads offer cost-effective transportation for large quantities of goods over long distances. Most countries have the standard dimension railway, but some also have railways with narrow gauge. In the report we did not distinguish the gauge and electrification from the general railways. Here the railway mode includes all kinds of railways, but our emphasis will be on hauling freight.

The importance of infrastructure

Basic requirements and economic growth

Transportation infrastructure or the “physical internet” as it was referred to once by *The Economist*,⁴ is one of the major prerequisites and enablers for a nation's economic development. “Economic development refers to progress toward a community's economic goals such as increased employment, incomes, productivity, property values, and tax

⁴ The British weekly *The Economist* is arguably one of the best sources of up-to-date information on international politics and business. This particular term was used in the June 15, 2006 issue.

revenues.”⁵ In general, the underlying rationale behind the following arguments follows a similar pattern. “Increasing economic efficiency (the ratio of benefits to costs) increases productivity (the quantity of goods produced), which increases economic development”⁶. In this chain of cause and effect, logistics is the discipline concerned with maximizing transportation infrastructure efficiency. As a matter of fact, infrastructure is a basic contributor to the effective and efficient functioning of an economy due to a variety of reasons.

First, a well-developed infrastructure accomplishes to reduce the negative impact of distance, which can cause challenges especially for big countries. Being the third largest country in the world, the United States has a territory of about 9.8 million square kilometers with the population spread all over the country and a concentration on the west and east coasts. Large countries such as Brazil, Canada, China and Russia share similar geographical fates. In order to transport goods between the economically vibrant areas within a reasonable time, a reliable and fast transportation network is needed. Thereby infrastructure is one of the most important factors for the level of integration of a national market.

Second, the availability and quality of infrastructure is a crucial determinant of the locations where businesses and whole economic sectors settle and thus economic activity is taking

⁵ Litman, T. (January 8, 2010). Evaluating Transportation Economic Development Impacts. Victoria Transport Policy Institute

⁶ Ibid.

place. If a nation is able to connect all parts of its country smoothly with one another, economic activity will be spread throughout the country. As infrastructure provides less-developed areas with the possibility to connect to the centers of economic activity, income inequalities and poverty can be reduced.⁷ For example, an investment in building a new road could stimulate a raise in agricultural productivity, nonfarm employment and productivity, and thereby directly increase the wages and employment of the poor. The consequently triggered raise in economic welfare is considered a direct income distribution effect. Moreover, higher productivity and employment levels can facilitate higher economic growth. The impact on the supply and prices of goods, which can hence lift the poor's well-being, is referred to as the indirect growth effect.⁸

Third, the quality of infrastructure determines the timeliness, reliability and overall cost of the logistics process. If goods and services are to be marketed in a safe and timely manner, one needs to consider that the overall logistics cost and performance are significantly impacted by the weakest link in the supply chain. Consequently, deficiencies in perceived minor areas can have a very strong implication for the facilitation of trade and hence a nation's overall economic output.⁹ Therefore, the removal of infrastructure bottlenecks is an

⁷ Schwab, K. & Sala-i-Martin, X. (2009). The global competitiveness report 2009–2010, p. 4-5. World Economic Forum.

⁸ Ali, I. & Pernia, E. (January, 2003). Infrastructure and poverty reduction: What is the connection? Asian Development Bank.

⁹ The World Bank. (2007). Connecting to compete: Trade logistics in the global economy- The Logistics Performance Index and Its Indicators.

especially important action to sustain current trade levels.¹⁰ In China for example, the primary energy source is coal supplying 70 percent¹¹ of the country's energy requirements. Since coal is primarily transported by rail, a rail transport bottleneck could cause power shortages and a temporary shutdown of production.¹²

Fourth, infrastructure is not only important for a country's internal exchange of services and goods. Furthermore, it constitutes the link to foreign markets for sourcing and sales activities.¹³ In these times of globalization the spatial dispersion of production and the strong dependence on trade require a high-performing value-creating network.¹⁴ Especially, low-cost sourcing has become the reason for a considerable volume traded between developing and developed countries in recent years. But with the rise of the middle classes in many emerging markets it can be expected that an increasing percentage of trade flows between those markets will contain product sales to emerging countries as well¹⁵. For instance, several Asian countries, in particular China and India, have reached their turning points with significant numbers of people entering the middle class; a phenomenon that will ultimately

¹⁰ International Transport Forum. (March 27, 2009). Workshop 3 conclusions: Strategic Transport Infrastructure Planning and Financing.

¹¹ U.S. Energy Information Administration. (July, 2009). Country analysis brief- China.

¹² World Bank, World Bank and China, Washington, D.C., September 2000, page 5.

¹³ The World Bank. (2007). Connecting to compete: Trade logistics in the global economy- The Logistics Performance Index and Its Indicators & Schwab, K. & Sala-i-Martin, X. (2009). The global competitiveness report 2009–2010, p. 4-5. World Economic Forum.

¹⁴ International Transport Forum. (2008). Transport outlook 2009: Globalisation, crisis and transport.

¹⁵ Tasianx, R. (2009). The future of International freight. A.T. Kearney.

drive consumption.¹⁶

In sum, it can be seen that the creation and maintenance of basic infrastructure is pivotal to sustain economic output. The Access Index, which addresses countries' competitiveness in the global market place, points to the empirical correlation between GDP growth and factors of physical and information access such as transportation, trade, and telecommunications. It is remarkable that the top ten nations, including Singapore, the Netherlands, Germany, the United Kingdom and France, in this index accomplished an average GDP per capita growth rate of 22.6 percent in the last 10 years compared to only 14.1 percent for the bottom ten scorers.¹⁷ Occupying rank 12, the United States is not part of the top ten countries.

Moreover, the business case also tells us that insufficient maintenance of infrastructure today can cause the need for a significantly more expensive replacement of run-down infrastructure in the future.¹⁸ Underinvestment will thereby increase transportation and logistics costs to be paid down the road (no pun intended). "High international transport costs put a "double squeeze on domestic incomes," in the words of Andreas Kopp of the OECD/ ECMT Transport Research Centre. They force exporters to reduce their product in order to offset the higher transport costs. Similarly, they make importers pay higher prices, which he likens to a

¹⁶ Kharas, H. (January, 2010). The emerging middle class in developing countries. OECD Development Centre. p. 10.

¹⁷ National Stone, Sand & Gravel Association. (2010). International transportation comparison.

¹⁸ Kopp, A. (September 8, 2006). The Political Economy of Transport Infrastructure Funds, p.1. OECD/ECMT Transport Research Centre.

“21% import tax.”¹⁹ An even worse consequence of underinvestment is the highly expensive and dramatic catastrophes due to decayed roads, bridges, rail tracks and the like as seen in recent years. Thinking back to the year 2007 when a major freeway bridge collapsed in Minneapolis into the Mississippi River illustrates the necessity of proper maintenance.²⁰ Overall, in the United States it is estimated that more than 26 percent of the country's bridges are either “structurally deficient or functionally obsolete”²¹. According to the American Association of Civil Engineers, especially in urban areas this percentage is expected to increase further. Maintaining physical infrastructure is a necessity and should be executed at least at a level that is able to satisfy currently forecasted growing demands.²² However, investment in infrastructure should not only be seen as a prerequisite but also as a source of competitive advantage for an economy.

National competitive advantage

Globalization has accelerated the velocity with which economic activity can shift from one place to another - probably to a span of a couple of years. The emerging economy of China is arguably the most illustrative example for the economic rise of a nation, with a compounded

¹⁹ National Stone, Sand & Gravel Association. (2010). International transportation comparison.

²⁰ CBC News. (August 01, 2007). Freeway bridge collapses into Mississippi.

²¹ American Society of Civil Engineering .(2009). American's infrastructure report card 2009 Grades.

²² The World Bank. (2007). Connecting to compete: Trade logistics in the global economy- The Logistics Performance Index and Its Indicators.

average growth rate of GDP of 17.4 percent in the years 2000 to 2008.²³ This fast development of China and other Asian countries is among other factors pushing demand for bigger and better physical infrastructure to support transportation and logistics.²⁴ Moreover, the increased level of competitiveness in the global market place requires countries to be on the leading edge if they want to succeed in the future. Reduced lead time and logistics costs can create an important source of competitive advantage.²⁵ Especially in emerging countries, but also in industrial nations, a well-developed infrastructure can attract foreign direct investment, business relocations or simply business partners that are interested in integrating new players into their global supply chain.²⁶ Moreover, with regards to potentially upcoming regulation on carbon emissions, countries should be well advised to invest in a transportation infrastructure causing a decreased carbon footprint. Today, transportation is still one of the major “bad boys” with regard to the percentage contribution to man-made greenhouse gas emissions.²⁷ Environmentalists often argue that the cost of transportation to the environment is not yet fully accounted for (an “externality”) and hence not reflected in our logistics cost today. Treating natural resources as capital which is depleted might increase the awareness of

²³ http://www.google.com/publicdata?ds=wb-wdi&met=ny_gdp_mktp_cd&idim=country:CHN&dl=en&hl=en&q=china+gdp, own calculations

²⁴ National Stone, Sand & Gravel Association. (2010). International transportation comparison.

²⁵ Source (2): APPENDIX. CALCULATING NATIONAL LOGISTICS COSTS, p. 81

²⁶ The World Bank. (2007). Connecting to compete: Trade logistics in the global economy- The Logistics Performance Index and Its Indicators.

²⁷ Cambridge Consultants. (2010). 2013: creating a better journey Transport Report 2008.

businesses to the environmental cost of “cheap” but polluting transportation modes. Hence, the upgrading of transportation infrastructure to support more eco-efficient moving of freight might become an economically reasonable and strategically intelligent investment to keep logistics cost low.²⁸ A reduction in pollution can be a direct result of less congested roads.

The current economic downturn has re-focused some countries attention to the importance of investment in infrastructure as part of their economic stimulus packages. Worldwide, overall infrastructure spending over the next 20 years is expected to total \$ 35 trillion, which constitutes the highest amount since World War II.²⁹ A study by CIBC World Markets shows that as part of their current economic stimulus packages North America will spend \$180 billion on infrastructure each year, Europe will dedicate \$205 billion, Asia will expense \$400 billion and Africa will invest \$10 billion annually.³⁰ According to the multiplier effect theory transportation infrastructure projects are supposed to have a major multiplier because of their high trickle-down effect throughout the economy.³¹ Hence, investment in infrastructure seems to be a very reasonable measure to stimulate an economy. The current infrastructure boom is able to create new powerhouses of economic growth if investments are made wisely. All in

²⁸ Link, H. (1999). Road infrastructure cost accounting in the EU-countries. German Institute for Economic Research.

²⁹ Gerritsen, E. (May 19, 2009). White Paper: The Global Infrastructure Boom of 2009-2015, p. 1. The Journal of Commerce.

³⁰ Simpkins, J. (February 5, 2009). Global infrastructure spending to reach \$35 trillion over the next 20 Years. Money Morning.

³¹ Engineering News-Record. (December 10, 2008). Economic Multiplier Effect Makes Transportation Tops.

all, investment in the maintenance and improvement of infrastructure is a key to economic growth and national competitive advantage.

Dissenting thoughts

Nonetheless, it needs to be acknowledged that not all researchers and experts share the argumentation that was provided above. In order to provide a comprehensive picture, some contradictory positions will be addresses that might potentially create ambiguity but will provide a balanced perspective on the discussion.

While investment in infrastructure is perceived by the majority to increase productivity, there are also some studies that conclude that “proximity to additional infrastructure capital” does not lead to greater output.³² Some experts argue that even though there might be a dependence of infrastructure and economic output, the question of causality is not proven sufficiently. The question that remains partially unanswered is whether transportation infrastructure causes economic development or whether growth in economic output increases demand for transportation infrastructure.³³

Moreover, it is increasingly questioned whether investments in transportation infrastructure should indeed keep pace with the growth in traffic. Recent evidence has shown that additional transportation infrastructure, in particular roads, simply stimulates demand for

³² Cohen, J. (November 3, 2008). The broader effects of transportation infrastructure: Spatial econometrics and productivity approaches.

³³ Banerjee, A., Duflo, E. & Qian, N. (March, 2009). On the road: Access to transportation infrastructure and economic growth in China.

even more transportation. Hence, the congestion problem is not solved but shifted from one area and point in time to another.³⁴ According to the Texas Transportation Institute the mobility problems due to congestion have worsened in the last two decades. In 2007, the congestion cost for additional time and fuel added up to a total of \$87.2 billion in the urban areas in the United States compared to only \$16.7 billion in 1982.³⁵

As elaborated upon in the beginning of this section, in the past there has been a correlation between investment in transportation infrastructure and economic output. In the days of the global economic crisis, trade is in the tank and the need for transportation capacity has decreased significantly. Even though the assumption of a medium term economic recovery with a consequent increase in trade seems likely, some researchers opine that the crisis has exemplified the world's limit to ever increasing economic growth.³⁶ If they are right, additional investment in new transportation capacity could turn out harmful for a nation by taking away purchasing power from the population for the sake of unnecessary capacity expansion. This is what some writers think happened in Japan in the 1990's where huge infrastructure investments were financed through high taxes and became a drain on the private economy, causing a "crowding-out" effect.

Additionally, it is not certain whether transportation infrastructure investments indeed help to

³⁴ Mayet, R. (August 20, 2001). Investment in transport infrastructure. European Environment Agency.

³⁵ Schrank, D. & Lomax, T. (July 2009). Urban Mobility Report 2009. Texas Transportation Institute.

³⁶ Jackson, T. (March 30, 2009). Prosperity without growth? Sustainable Development Commission.

reduce poverty by advancing the situation of the poor more than the one of the rich. Studies on poverty reduction in Nepal show that even though the poorer areas are able to capture an appreciated share of the positive benefits of investments in roads, rich areas also benefit significantly leaving a gap in income inequality despite the initial transportation infrastructure investment.³⁷ However, we tend to believe that a rising tide lifts all boats.

We would also like to point out other quality-of-life effects of having a well-functioning system of roads, railroads and airports. This alleviates inconveniences and hazards such as time lost to traffic congestion, traffic accidents, smog, as well as the higher expenses of repairing battered vehicles. An obvious beneficiary of a good system is a revenue generator like tourism, where smooth traffic and clean air should create happy and returning visitors.

This paper will elaborate further on the state of and investments in transportation infrastructure in the United States and its main trading partners in the context of the countries' commercial histories and economic maturity levels. The concern is that low quality infrastructure may "end up turning the clock back," as Doug Duncan, President of FedEx Freight, phrases it. "It is causing American businesses to become less competitive, and leading to smaller markets and smaller jobs."³⁸

³⁷ Ali, I. & Pernia, E. (January, 2003). Infrastructure and poverty reduction: What is the connection? Asian Development Bank.

³⁸ National Stone, Sand & Gravel Association. (2010). International transportation comparison.

How Does the United States Compare?

To get a feel for whether the United States is indeed under-investing in its logistical infrastructure, it is worth comparing this country to other nations, including our main trading partners. We compiled a huge list of almost 90 quantitative and qualitative factors, but as soon as we had the data realized that indiscriminate, wholesale comparisons would be akin to comparing apples to oranges. For example, most direct comparisons between the U.S. and a small country like Singapore would be meaningless unless they were put in context. As we gathered data, we also realized that there is a multitude of physical, socioeconomic, and historic dimensions coming into play.

First, we realized that it made sense to separate the sixteen countries into just a few groups, and we were inspired by a whitepaper by the accounting firm KPMG to separate them into the categories of “Large and Mature”, “Small and Mature”, and our own creation “BRICM”, which is the four BRIC countries Brazil, Russia, India and China, plus Mexico, which we felt really fit in with that group for our purposes.³⁹ We suspected the countries within these three groups would be similar enough to make meaningful comparisons and perhaps draw some tentative conclusions about their states of development and economic priorities. We use the word “tentative”, as we are acutely aware of the small sample sizes and the futility of trying to draw scientific conclusions or valid statistical inferences based on this study. Despite these

³⁹ KPMG Advisory: *Global Infrastructure: Trend Monitor*. European Transport Edition: Outlook 2008–2012

shortcomings, we will see that the data reveals some very interesting patterns, and that the differences in the observed data among the three categories can be quite illuminating.

The countries were divided into these three categories primarily based on their size, population, average Gross Domestic Product (PPP based)⁴⁰ and World Economic Forum Stage of Development⁴¹ (in parentheses behind each country's name):

| Large and Mature | Small and Mature | BRICM |
|----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|----------------------------------------------------------------------|
| USA (3) Canada (3) Japan (3) Germany (3) United Kingdom (3) France (3) Italy (3) | Netherlands (3) South Korea (3) Taiwan (3) Singapore (3) | Brazil (2) Russia (2.5) India (1) China (2) Mexico (2.5) |
| Average size = 3.1 million sq.km. | 44,500 sq.km | 8.1 million sq.km |
| Average population = 105 mill. | 23 mill. | 589 mill. |
| Average GDP = \$35,700 | \$36,800 | \$9,600 |

Table 1: Grouping of US and main trading partners

This table on the next page compares and summarizes typical characteristics of each group of countries, based on information distilled from the more than 90 data items that we gathered for each of the sixteen countries:

⁴⁰ From the CIA World Factbook

⁴¹ Schwab, K. & Sala-i-Martin, X. (2009). The global competitiveness report 2009–2010. World Economic Forum.

| Large and Mature | Small and Mature | BRICM |
|----------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| Highly variable population density (from 3.4 to 336.3 people per km ²) | Densely populated (from 402.4 to 6,682.3 people per km ²) | Highly variable population density (from 8.2 to 351.9 people per km ²) |
| Urbanized (76.7%) | Very urbanized (86.0%) | Less urbanized (61.6%) |
| Declining industrial but strong agricultural and raw materials base; Service based economies | Declining industrial and agricultural base; Service based economies | Growing industrial base and strong agricultural base; Still industrial, raw materials and agriculture based economies |
| Well established infrastructure, mostly in need of upgrades and maintenance | Well established infrastructure, mostly in need of upgrades and maintenance | Developing new infrastructure to accommodate modernization and growth |
| Generally not too dependent on international trade | Very dependent on international trade | Growing dependence on international trade |
| Overall, very competitive economies with stable, well functioning administrations | Highly competitive, niche oriented and nimble economies with relatively stable administrations | Not so competitive, with growing pains and governance and stability problems typical of poorer economies |
| Competitive advantages: Service sector, innovation, management quality, stability | Competitive advantages: Location, niche sectors, international trade, innovation | Competitive advantages: Cheap and abundant labor, agricultural products, raw materials |
| Highly rated and more efficient infrastructure | Highest rated infrastructure quality of the three groups | Fairly low rankings on infrastructure |
| Substantial stimulus funds directed towards infrastructure improvements (up to \$180 bill) | Fairly modest stimulus funds directed towards infrastructure improvements (up to \$17 bill) | Relatively huge sums committed to infrastructure improvements (up to \$470 bill) |

Table 2: Group characteristics

It is not a big stretch of imagination to realize that the infrastructure challenges of a flat, small and rich country like the Netherlands will be quite different from a sprawling and developing giant like Russia, or that Singapore's problems really are miniscule when compared to a mess like India. Singapore is working on tweaking and perfecting an already superb transportation infrastructure, while India is faced with mind boggling challenges on every front (political, budgetary, socio-economic, climatically, etc.) However, we could easily be carried away into

a less-than valuable qualitative discussion rooted in impressions, opinions and stereotypes, unless we anchored most of this report on verifiable facts that we can hang our hats on.

The “Master Database” for this report has been a huge spreadsheet with more than 2,000 entries. Some of the data was easy to find and verify, while for many of the crucial comparisons we were looking for it was exceedingly difficult to find good, consistent and comparable data. For example, some of the interesting data we were seeking – like infrastructure spending as a percentage of GDP – was not harvested or compiled in a manner so we could compare it. Depending on the source, estimates of U.S. spending on infrastructure ranged from less than 1% to more than 10% of GDP! The difficulty comes from how the various reporters define infrastructure, and in many cases they would not even reveal the exact definition, especially when the article had a more political purpose. The term Infrastructure, for example, is difficult to pinpoint. Does it involve both the public and private sectors? If just the public sector, are both Federal, statewide, county-wise and municipal (incl. port and airport) spending included? Does infrastructure include schools and libraries, water, power and sewage lines, broadband networks, and other public works in addition to investments in transportation and logistics installations? If everything was included, we suppose a figure of 10% of GDP could be justified, but if we are just talking road construction, the figure is probably less than 1% of GDP. With an annual GDP of 15 trillion dollars, even a meager 1% is as much as 150 billion dollars (or almost the entire GDP of

Singapore). We will get back to more detail on the infrastructure spending later in this report.

To handle all this data, we also had to divide the various measures into distinct categories. We

decided it would be practical to divide the data into five major groups:

| | |
|-----------------------------------------------|-----------------------------------------------------------------------|
| Geographic data | Size, population (incl. density and growth), Urbanization, Topography |
| Economy and Spending data | GDP, Sectors, Budgets, Investment |
| Infrastructure data | Spending, Various modes, Traffic data, Modal Split, Road Safety |
| International Trade data | Main Exports and Imports, Customers, Trade Dependence |
| Development & Competitiveness data | Various rankings and scores |

Table 3: Data qualification

We need to take a closer look at each of these groups.

Geographic Data

Quantitative Analysis: We compared the U.S. and China to the three main categories:

| Measure | USA | China | Large and Mature | Small and Mature | BRICM |
|---------------------------------------|-------------|---------------|------------------|------------------|-------------|
| Size (km ²) | 9,826,675 | 9,596,961 | 3,104,951 | 44,485 | 8,092,344 |
| Population | 307,212,000 | 1,338,613,000 | 104,772,138 | 23,214,215 | 589,100,600 |
| Density (people per km ²) | 31.3 | 139.5 | 164.0 | 2,052.0 | 116.0 |
| Population growth, p.a. | 0.98% | 0.66% | 0.33% | 0.48% | 0.78% |
| Urban population | 82% | 43% | 77% | 86% | 62% |
| Topography | Mixed | Mixed | Mixed | Flat or mixed | Mixed |
| Usable coast line (km) | 19,924 km | 14,500 km | 16,680 km | 1,156 km | 15,195 km |

Table 4: Geographic data

These numbers are undisputable (although there are various ways to measure coastline), and have relevance for a nation's logistical infrastructure for a variety of reasons. Large countries with a mixed (i.e. mixture of hilly, coastal and flat) topography will have to invest more in long-distance rail, road and canal networks than very small and flat countries like the Netherlands and Singapore. For a very large country like Russia with a very low population density (only 8 per square kilometer) it will be extremely costly per capita to build a national highway system. Russia can rely on rail and air transportation to haul freight and people,

which will probably be more efficient. Also, Russia (like Japan) has a declining population, and may not have the same urgent needs for expanding their road systems. China and India, on the other hand, are densely populated countries in immediate need of better and bigger transportation networks. Both countries can justify investing in this, to alleviate bottle necks to continued growth.

With relatively hefty immigration and birth rates, the high population growth rate for the U.S. is unusual for a Large and Mature country. Several other countries in this group have negative growth rates (Japan, Germany, Italy), which takes some pressure off making new transportation investments. If the population continues to grow at 1% per year, this will increase the need for greater freight and passenger capacity. The expected population growth in itself is a good argument for increased investments in infrastructure.

It is interesting to note that all of the sixteen countries studied have fairly extensive coast lines, meaning that the maritime trades have historically been a driver for their economies. Having shore access, and thereby a network of ports, creates a different modal mix and provides more viable options than for a mostly landlocked country. Needless to say, the ports can be used for both domestic and international transportation. In the U.S., several factors have limited domestic maritime transportation (except to and from the states of Hawaii and Alaska, as well as Puerto Rico), not the least the restrictions on vessel ownership and construction imposed by the Jones Act and Anti-Reflagging Act. Because ships operating in

the domestic trade have to be built in the U.S. and owned and crewed by American citizens - thus raising the cost and limiting competition - offshore transportation of bulk cargoes and shipping containers is minimal between the Lower 48 states.

Economic and Spending Data

| Measure | USA | China | Large and Mature | Small and Mature | BRICM |
|-------------------------------------------|----------------|---------------|------------------|------------------|---------------|
| GDP (nominal) | \$14,260 bill. | \$4,758 bill. | \$4,399 bill. | \$528 bill. | \$1,921 bill. |
| GDP per capita (PPP) | \$46,600 | \$6,500 | \$35,714 | \$36,800 | \$9,640 |
| Sectors: | | | | | |
| Agriculture | 1.2% | 10.9% | 1.6% | 1.7% | 8.8% |
| Industry | 21.9% | 48.6% | 24.0% | 28.4% | 33.2% |
| Service | 76.9% | 40.5% | 76.7% | 69.9% | 58.0% |
| Central Govt. Budget | \$3,615 bill. | \$1,137 bill. | \$1,621 bill. | \$177 bill. | \$509 bill. |
| - as % of GDP | 25.0% | 24.0% | 44.5% | 28.9% | 27.3% |
| Gross Fixed Investment as % of GDP | 12.5% | 42.6% | 18.3% | 24.2% | 26.8% |
| Most recent unemployment rate | 9.7% | 10.2% | 8.1% | 4.6% | 8.3% |

Table 5: Economic and spending data

This table reveals some interesting patterns. Although USA's Gross Domestic Product (in nominal terms, not PPP – or Purchasing Power Parity, as used for the per capita numbers) is still three times that of China, the central governments of each country have the same budget,

percentage wise (around 25%). However, China is spending a total of 42.6% of its GDP on fixed investments⁴², of which a big chunk is infrastructure investments. At 12.5%, the U.S. gross fixed investment (the value of additions to fixed assets purchased by business, government and households) is the lowest among the 16 countries, and should be a cause for concern. Even though the U.S. has evolved into a post-industrial service economy, it makes us wonder whether such a low level may be insufficient to preserve this country's infrastructure and remaining industrial base.

The fact that China and the other BRICM's still have large agricultural sectors (in India it is 17.5% of the economy) means that they have particular transportation needs. More low-value bulk cargoes will be moving around within these countries, which puts an inordinate strain on their road systems and increases air pollution if they predominantly rely on trucks to haul the commodities.

⁴² The CIA World Factbook defines Gross Fixed Investments as total business spending on fixed assets, such as factories, machinery, equipment, dwellings, and inventories of raw materials, which provide the basis for future production.

Infrastructure Data

| Measure | USA | China | Large and Mature | Small and Mature | BRICM |
|---------------------------------------------------------|--------------|--------------|------------------|-------------------|-------------------|
| Infrastructure spending as % of GDP | < 2% | Abt. 9% | Abt. 4% | Insufficient data | 2 – 9% |
| <u>Transportation modes:</u> | | | | | |
| Large airports | 190 | 63 | 37 | 4 | 31 |
| Railways (km) | 226,400 km | 77,800 km | 57,700 km | 2,600 km | 54,900 km |
| Paved roads | 4,210,000 km | 3,584,000 km | 1,151,000 km | 64,000 km | 965,000 km |
| Waterways | 41,000 km | 110,000 km | 9,300 km | 2,000 km | 56,000 km |
| Large seaports | 10 | 8 | 9 | 3 | 8 |
| Merchant marine vessels | 422 | 1,826 | 420 | 707 | 718 |
| Pipelines | 793,000 km | 58,000 km | 142,000 km | 1,900 km | 77,000 km |
| Container Port Traffic (TEU's) | 39.3 mill. | 115.1 mill. | 15.0 mill. | 18.0 mill. | 27.0 mill. |
| Motor Vehicles per 1,000 people | 765 | 128 | 569 | 293 | 139 |
| Motor vehicles per km paved roadway | 56 | 48 | 60 | 157 | 112 |
| Road traffic deaths per 100,000 people | 14 | 17 | 8 | 10 | 20 |
| Road traffic deaths per 1,000 km paved roads | 10 | 63 | 8 | 66 | 311 |
| Transportation & Logistics costs as % of GDP | 10.0% | 17.0% | 8.6% | 13.5% | 14.8% |
| Modal Split: | | | | | |
| Rail | 52% | 74% | 19% | Insufficient data | Insufficient data |
| Road | 39% | 26% | 65% | | |

Table 6: Infrastructure data

There is a lot of information under the Infrastructure heading, and we have to be cautious

how we interpret many of these numbers. Wholesale comparisons may neither be fair nor

possible. This section highlights many of the challenges and priorities of the various countries and their governments when it comes to infrastructure development.

It seems clear to us that the difference between what the U.S. and China spend on infrastructure is too large, particularly given the fact that most other developed countries – especially in Europe – spend around 3 to 4% of their GDP on this. We can understand why China is at a 9% pace, because they are very determined and financially able to invest as much as they can in their physical infrastructure, incl. transportation and port networks. The well-run countries in Europe are at a fairly steady and higher level than the U.S., and they are especially targeting investments in excellent public transportation systems. Investing in passenger transportation has everything to do with freight, as it will take private cars off the road and make it much easier for trucks and delivery vans to get around. We could of course be apologists for the U.S. and say that public transportation is not possible here because of suburban sprawl, but this is too short-sighted now that our population density is much higher and that the cost of constantly having to add more lanes to freeways is approaching ridiculous levels. Of the 16 countries we studied, only Mexico is spending around the level of the United States on infrastructure, or less than 2% per year. Consequently, Mexico has plenty of transportation problems on its own. India's level, by the way, is around 3.6%, which is also too low for their ambitious plans to compete with China as an industrial nation. Of course, all the countries we studied, with the exception of China and

Singapore, are democracies, meaning that it is difficult for their political leaderships to build consensus and focus their resources on a few targeted areas. Because of China's and Singapore's top-down political structures, decrees and plans from the central governments tend to be implemented quickly. Countries like the U.S. and India may be at the opposite specter of this, where a fragmented bureaucratic structure (federal, state, counties, cities, municipal corporations, etc.) and perhaps too much democratic micromanagement make it an exhaustive and time consuming process to get anything major done.

The various transportation modes shown in the table make for interesting reading, but it is hard to draw any conclusions based on this data. Of course, large countries are going to have more airports, more rail tracks, more roads and more inland waterways than small countries. What is quite telling, though, is the relatively sad state of the American merchant marine fleet. Because of the unfortunate long-term results of U.S. legislation, the fleet of American cargo vessels is surprisingly small for such a large nation. The U.S. is the largest importer in the world, as well as one of the top three merchandise exporters, but its fleet of cargo vessels is 23% of that of China's, and smaller than even all of the "Small and Mature" countries, with the exception of Taiwan. Singapore, for example, has 1,292 merchant marine vessels, compared to America's 422. Maritime legislation is one of those areas where there is a complete disconnect between American national politicians and the maritime industry. We don't know what the exact problem is, but it is probably a case of a downward spiral, where

the American maritime shipping industry has shrunk to such a small level that it is no longer noticed by the decision makers in Washington D.C. And have you heard of any American sea captains running for office lately? Neither Washington DC nor Wall Street seems interested in global transportation, which means the oceans are prowled by ships from Europe and Asia. This may also be related to the fact that the world's largest port operating companies are all foreign: 1) PSA International (Port of Singapore); 2) HPH (Hutchinson out of Hong Kong); 3) APM Terminals (a sister company of the Danish giant Maersk); 4) DP World (the Dubai company that was unfairly barred from the U.S.); 5) Cosco Pacific (a sister company of China Ocean Shipping Company); and 6) Eurogate (a German based operation). In seventh place is actually the local SSA Marine, which is a branch of Seattle-based Stevedoring Services of America. They have a 0.9% global market share.⁴³

While China and the U.S. have the highest container traffic through their ports (China at 115 million containers in 2008, and the U.S. at almost 40 million⁴⁴), it is impressive to see the large throughput of the Small and Mature countries. Several of these countries are transportation hubs for containerized cargoes, and derive substantial revenues from transshipping millions of containers every year. They have developed highly efficient and modern ports, around which there are clusters of other maritime and logistics related businesses. Of course, this is definitely a matter of location-location-location, as Singapore,

⁴³ UNCTAD. (2009). Review of maritime transport, Chapter 5, Table 39.

⁴⁴ Ibid, Table 37.

Taiwan and the Netherlands are all perfectly situated in the major trade lanes. So why not take advantage of it?

The data on road traffic and traffic deaths is a grim reminder that the developing world has a long way to go. The U.S., being such a car based society, is actually doing quite well in this area. Traffic deaths are an indicator that having good roads (and undoubtedly safe drivers and safe vehicles) is imperative for keeping the fatalities down. India is a frightening case of unsafe roads, with an average 941 annual traffic accident deaths per 1,000 km (600 miles) of paved roadway. This compares to only 5 in France and 10 in the U.S. Given the Western European data, with between 5 and 10 deaths per 1,000 km, the U.S. can definitely improve its safety record. Better and less congested roads may be a partial solution, while the people at MADD (Mothers Against Drunk Driving) are also correct in reminding us that close to half of the American deaths are caused by impaired drivers. Another reason why Americans run a higher risk of dying in a car crash is the fact that they spend so much more time in a car than Europeans do. The German dependence on the automobile may be the closest to the American, so perhaps the German average of 8 deaths per 1,000 km should be a natural medium term (5 year) goal for here, as well.

When we look at what these countries spend on transportation and logistics as a proportion of their national economies, it is not necessarily a good thing to show a high percentage in this area. A high proportion spent on this most likely means that the system is inefficient, and that

too much of society's resources are spent on moving things around. It would be interesting to study whether there is an optimal percentage, given any country's mixture of development, commercial and trade activity, and geographic conditions. For example, you would expect Singapore to be fairly efficient with respect to transportation and logistics costs (no mountain passes to cross and no hauling of bales of hay 3,000 miles), but surprisingly they are at a high 15% level. The explanation may be that this is sort of a "cost of goods sold" for them, as they have invested heavily in serving as a transit point for cargoes. The U.S. level of 10% of GDP is middle-of-the-road, with the smaller and more densely populated European countries at lower levels (6-10%) and most of the developing BRICM countries at substantially higher levels. The exception here is India, with only 8% spent on transportation and logistics.⁴⁵ The explanation we can think of for this is that the country is not developed enough yet to have an extensive, national transportation infrastructure. India is still very agrarian, and most of the agricultural and industrial output may be consumed locally, thus not requiring extensive transportation equipment or roadways. Given the European levels, it is reasonable to think that the U.S. should be able to become even more efficient and perhaps bring its costs down to the single digit territory. Modern logistics route planning and more fuel efficient vehicles, trains and planes may help to bring this number down a few percentage points over the next few years. Less congested roads will help, too.

⁴⁵ National Stone, Sand & Gravel Association. (2010). International transportation comparison. The numbers on this page come from a Boston Logistics Group report.

We have discussed some of the possible realities hiding behind the numbers, and lent our informed opinion about many of the findings, rather than scientific proofs. It seems clear to us that many factors come into play when judging a country's infrastructure development and spending. We have to be careful about drawing comparative conclusions, because each country has its own geographic, cultural, trade related and historical reasons for its particular state of affairs. Nevertheless, we should not be shy about looking for best practices and compare the United States to countries and economies that make comparative sense.

International Trade Data

| Measure | USA | China | Large and Mature | Small and Mature | BRICM |
|------------------------------------|-------------------|---------|-------------------|-------------------|-------------------|
| Trade as % of GDP | 17% | 44% | 37% | 141% | 38% |
| Proximity to main trading partners | Close and distant | Distant | Close and distant | Close and distant | Close and distant |

Table 7: International trade data

We also looked at each country's main export and import products, as well as whom their main trading partners were. For example, there is extensive trade within each trading bloc. The Europeans trade with themselves within the European Union, while the North American Free Trade Agreement (NAFTA) contributes to a lot of trade among Canada, the United States and Mexico. In Asia and South America there is also extensive regional trading

relationships (e.g. ASEAN⁴⁶ and Mercosur⁴⁷), although many of these economies are built around exporting merchandise to Europe and North America. So while export-dependent China needs efficient systems for getting the goods out of the country, the North American and European blocs need efficient systems both for handling the imports and the intra-regional flow of goods.

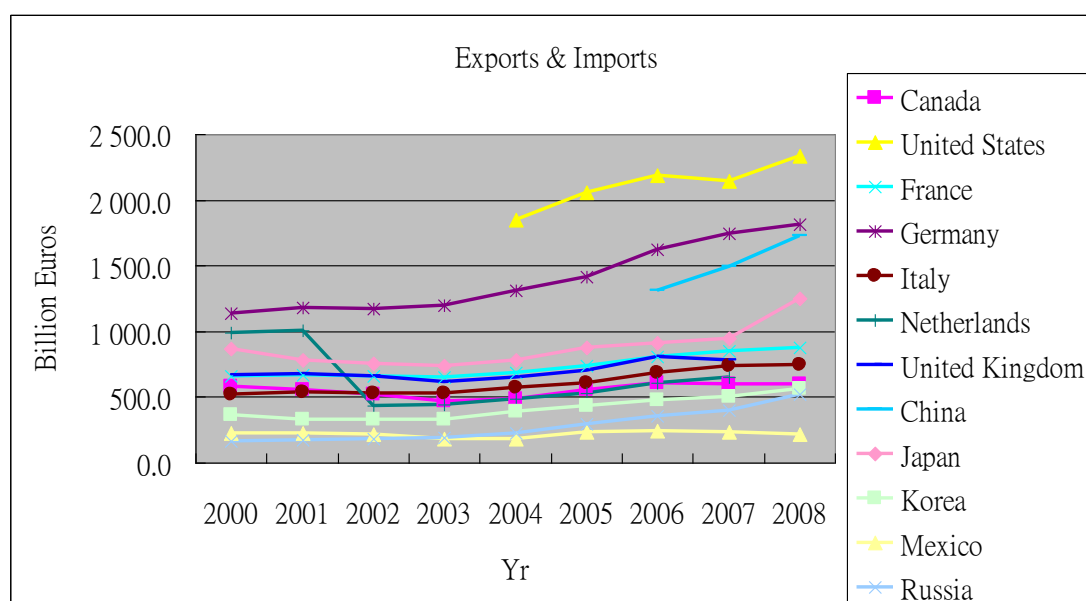


Table 8: Imports and exports

America's low trade percentage (exports and imports are only 17% of its national economy) shows that the domestic economy is really where most of the action is. This country needs to pay a lot of attention to creating and maintaining efficient and modern systems for handling its domestic cargoes, whether they'd be local or interstate. The two largest economies in the world, USA and Japan, also happen to have some of the lowest international trade

⁴⁶ The ASEAN countries are currently Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam.

⁴⁷ The Mercosur countries are currently Argentina, Brazil, Paraguay and Uruguay, with Bolivia, Chile, Colombia, Ecuador and Peru as associate members.

dependence, due to their large domestic sectors. Extremely trade intensive countries such as Germany and all the “Small and Mature” ones, are focusing more on making sure their infrastructure for foreign trade is in ship-shape condition. This means an emphasis on efficient ports, feeder systems to and from the ports, as well as airfreight terminals.

Who a country’s trading partners are also determines the transportation structure and needs. If you can reach most of your trading partners by road, rail, canals or pipelines (like Russia), the country doesn’t have to invest heavily in maritime ports and air cargo freight terminals. If you are far away from your trading partners (like Brazil), the country will need to make sure it has a well-functioning networks of ports and feeder systems. Island nations like the United Kingdom, Taiwan, Japan and Singapore are obvious examples of countries that need good maritime transportation systems if they are to reach their foreign suppliers and customers. The U.S. is a hybrid when it comes to this dimension: it has huge neighboring trading partners it can reach over land (Canada and Mexico), but it is also on a large island continent half way between its suppliers and customers in Europe, Asia and South America. This country needs to have great systems for handling both surface freight and seaborne freight.

Another dimension is the nature of what each country is buying and selling. Russia, for example, is a huge supplier of oil and natural gas to Europe, and most of it is transported by pipeline. The same goes for all the natural gas the U.S. gets from Canada. Singapore, on the other hand, has absolutely no natural resources or agricultural products, and virtually all of

their freight is containerized. China and the U.S. are large economies that buy and sell a variety of merchandise, including bulk commodities and finished goods that can be containerized. These large countries, with their diverse economies, also need diverse infrastructures to handle the variety of goods coming and going. For many reasons, the complexity of the logistics infrastructure for a large, diversified country is much higher than for a smaller, more niche oriented economy. Just because of this, a multi-dimensional economy like the U.S. should be prepared to pay more to build and maintain its infrastructure than the smaller and more specialized nations.

Development and Competitiveness

We used a variety of rankings from different institutions to assess national competitiveness in terms of logistical infrastructure, but also overall economic and human development.

The various ranking agencies are:

- U.N. United Nations Development Programme
- WEF World Economic Forum
- IMD The International Institute for Management Development, a Swiss
Business School
- W.B. The World Bank

| Measure | USA | China | Large and Mature | Small and Mature | BRICM |
|---------------------------------------------------|------|-------|------------------|------------------|-----------|
| U.N. Human Development Index (rank) | 13 | 92 | Avg. 13.7 | Avg. 19.8 | Avg. 85 |
| WEF Stage of development (scale of 3) | 3 | 2 | 3 | 3 | 2.0 |
| IMD Global Competitiveness rank | 1 | 20 | Avg. 19.7 | Avg. 15.8 | Avg. 37 |
| IMD infra-structure rank | 1 | NA | Avg. 11.1 | Avg. 14.7 | Avg. 37 |
| WEF infra-structure rank | 8 | 46 | Avg. 15.9 | Avg. 13.0 | Avg. 67.2 |
| <u>WEF rankings (scale to 7):</u> | | | | | |
| Quality of infras. | 5.9 | 4.0 | 5.7 | 6.0 | 3.5 |
| Quality of roads | 5.9 | 4.2 | 5.6 | 5.9 | 3.3 |
| RR infrastruct. | 4.8 | 4.1 | 5.3 | 5.7 | 3.3 |
| Port infrastruct. | 5.7 | 4.3 | 5.4 | 6.0 | 3.5 |
| Air transport inf | 6.0 | 4.3 | 5.7 | 6.2 | 4.4 |
| Global compete-tiveness | 5.59 | 4.74 | 5.2 | 5.3 | 4.3 |
| <u>W.B. logistics performance indexes (to 5):</u> | | | | | |
| General logistics | 3.84 | 3.30 | 3.90 | 3.90 | 2.90 |
| Log. Infrastruct. | 4.07 | 3.20 | 4.00 | 3.90 | 2.80 |
| Domestic logistics costs | 2.20 | 2.97 | 2.30 | 2.80 | 2.80 |
| Logistics timeliness | 4.11 | 3.68 | 4.20 | 4.20 | 3.30 |

Table 9: Development and competitiveness

These are all widely recognized ranking bodies for surveying, compiling and publishing annual comparisons on global competitiveness, development and infrastructure quality. The table above shows the latest data available. The three last columns contain our averages for

the three groups.

As we can see, the U.S. has little to be ashamed of in a relative sense. Overall, its ratings are very close to the averages for the Large and Mature countries, which it is natural to compare the U.S. to. Comparisons to China, the Small and Mature countries and the BRICM's may have some academic interest, but most of the differences have their explanations in the various developmental, resource and geographical conditions of the individual countries and groups. We could compare the U.S. to a developing steamroller like China, but at this point it probably makes more sense to make direct comparisons to economies more similar, like Canada, Japan and the larger European countries.

IMD is very happy with what it sees in the U.S., and ranks the country first in the world in global competitiveness and infrastructure. The WEF's three levels of development are 1: Factor driven; 2: Efficiency driven; and 3: Innovation driven. Of the 16 countries we studied, only India was given a 1, meaning that they are still fairly low on a pyramid we can compare to a Maslow's "Hierarchy of Needs".⁴⁸ China scores a 2, meaning that they are industrializing and aiming to improve overall efficiencies in their economy. All of the Large and Mature and Small and Mature countries scored 3's on this, as they are all at a stage in their development where the basic needs are taken care of. As predominantly service and information societies, they are striving for growth through innovation and human development.

⁴⁸ This is a well known pyramid, with five human needs ranked in order of necessity and development.

If you look more closely at the U.S. rankings compared to the average for the large and small, mature countries, it gets a low score on railroad infrastructure. The country receives excellent scores on all components of competitiveness; of which logistical infrastructure is only a portion of the overall assessment (they consider everything from tax regulations to labor laws to access to financing to crime and corruption, etc.). With a score of 2.2, the U.S. is also the lowest on domestic logistics costs (probably because the gas and diesel taxes are a lot lower than in Europe). Only one country had lower domestic logistics than the U.S., namely Japan, which obtained a score of 2.02. Japan is a lot more densely populated than the U.S., so it would be expected that greater route efficiencies could be achieved there.

The various rankings in the above table are primarily based on polls of business executives in the various countries. This means they are averages of subjective answers to questionnaires, and will most likely have variable margins of error. The UNDP's human development ranking is based on a composite of many measurable factors (longevity, infant mortality, pollution, literacy, average income, etc.) Regardless of how the data is derived, it is clear that the U.S. is ranked very highly in all of these surveys. We are probably looking at a situation where the country has more to lose than to gain if it doesn't take its infrastructure improvement and maintenance needs seriously. The Chinese steamroller is catching up fast, and ten years from now that country will probably have to be categorized as "Large and Mature", meaning that we can make meaningful comparisons between China and the U.S. At

least when it comes to logistical infrastructure, any such comparisons may not come out in America's favor at that point.

Trends in Infrastructure Investment

The statistics we gathered show trends and status of the transportation situations and investments in different countries. The relationship between the economic conditions and the transportation infrastructure development will be addressed based on these findings. We will discuss two different aspects of the trends. One is the global trends of transportation development and the other is the trend of transportation investment in our sixteen countries.

At the global level, due to the development of technology and in order to reduce shipping cost by economies of scale, the ship builders and aircraft manufacturers are building cargo vessels and aircraft with larger and larger capacity. The capacity of some container ships has increased from 8,000 twenty-foot equivalent units (TEU) to 15,000 TEU's. The world's largest container ship, the M/V Emma Mærsk, has a capacity of 15,200 TEU containers. STX Shipbuilding of South Korea reports it has completed the design of a 22,000 TEU containership.⁴⁹ Larger cargo airlines also tend to use new or recently built larger aircraft to carry their freight. Therefore, countries are investing in their transportation infrastructure in order not only to catch up with the trend of technology but also to maintain the competitive advantage and income from trade.

⁴⁹ Seatrade Asia Online. (2007). STX reveals design for world's largest containership.

At the country level, according to the International Transport Forum, the overall volume of transport infrastructure investment has grown since 2000.⁵⁰ The investments in transportation infrastructure had increased by 20% from 2000 to 2003 in Western Europe. However, the level of investment declined by over 5% from 2003 to 2007. Investment in transportation infrastructure as a percentage of Gross Domestic Product (GDP) has continuously declined to less than 0.8% by 2007 before the financial crisis started in 2008.

The volume of infrastructure investment in the U.S. grew by 3% from 2000 to 2003 but showed a falling trend. The GDP share of inland transportation investment has remained constant at 0.6 % to 0.7% over time in the U.S from 2003 to 2008.

The level of Russian infrastructure investment rose to a new peak in 2007. It shows a sharp growth from 2000 to 2006, at 1.8% of GDP, but declining to 1.4% by 2007 because of the stronger GDP growth.

The volume of infrastructure investment of other emerging countries also increased sharply from 2003 to 2008 because the increased GDP would greatly reduce poverty. Governments of those emerging countries use infrastructure investment as a means to grow their economies.

From the available export and import data statistics, those countries have the same trend of international trading from 2000 to 2008. The trading of the countries slightly decreased from 2000 to 2003, and kept increasing from 2003 to 2008. The growth of trading and increased

⁵⁰ International Transport Forum. (2008). Investment in transport infrastructure 1995-2007.

GDP (both nominal and Purchasing Power Parity based) means increasing demand for consumer goods and good economic conditions. Goods need to be transported more efficiently and lower transportation costs favorably contribute to the transport-intensity of production.⁵¹ Without the support of the transportation infrastructure, it is more difficult to increase the amount of goods distributed. Therefore, the investment on transportation infrastructure can help to meet the growing demand. Thus, investments in infrastructure during good economic conditions can not only support the increasing demand but also help grow the economy, creating a reinforcing feedback loop. On the other hand, the economy's growth would be hampered without a good infrastructure.

In addition, according to Building America's Future, the investment in infrastructure will result not only in better physical networks - safe roads and improved transit - but it will also have the added benefit of creating thousands of jobs.⁵² The unemployment rate will decrease and people earn their salaries from these jobs. Furthermore, it will help to grow the GDP of the country and the economy. With growth of the economy, investment in transportation infrastructure as a percentage share of GDP should continue to decline. From the most recent edition of the Economist magazine, we calculated the average unemployment rate of the three country groups as follows:

⁵¹ International Transport Forum. (2008). Transport outlook 2009: Globalisation, crisis and transport.

⁵² Building America's Future. (December 16, 2009). Building America's future praises infrastructure investments and accountability measures in U.S. House Jobs Bill.

| | Large and Mature | Small and Mature | BRICM |
|--------------------------|-------------------------|-------------------------|--------------|
| Unemployment rate | 8.1% | 4.6% | 8.3% |

Table 10: Unemployment rates

Even though the popular perception of the developing BRICM countries is that they have low unemployment, the reality is that it is currently higher than for the Large and Mature countries, and very much higher than the more successful Small and Mature countries. In several ways, the unemployment rate is a good barometer for the overall health of a national economy. The most recent figures for the U.S. show an unemployment rate of 9.7%, while China's rate was published as 10.2%.

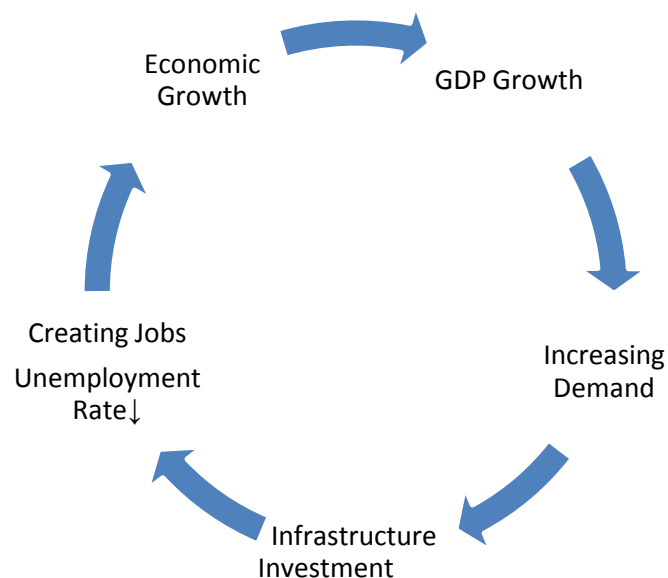


Table 11: Reinforcing cycle

In conclusion, there is a reinforcing growth cycle that incorporates the economy and the infrastructure. The economy affects the investment in infrastructure and the infrastructure affects the economy. Without the growth of a strong economy in a country, it has limited

ability to upgrade the infrastructure, although the investment in infrastructure can help to stimulate the economy. However, as the recent Japanese example shows, if the (economic and population) growth cycle is broken, overinvesting in infrastructure may indeed crowd funds away from the private sector and be damaging for the economy, at least in the short to medium term. Thus, the growth of the economy and the investment in transportation infrastructure are complementary to each other. Without both of them acting in unison, it is hard to achieve the goal of development for the country.

Future of Transportation Infrastructure Investment

Due to the global economic recession starting in 2008, the financial and economic crises caused severe impacts to the global trading and transportation systems for at least two years. The demand for consumer goods has decreased and the trade volume has also dropped. No one can accurately predict what the future will be after the recession. Four aspects of the future are discussed below.

First of all, due to the development of new technology, the capacity of the transportation equipment is getting bigger. All countries have to upgrade their transportation infrastructure to catch up the trend of extra-large shipments. Without transportation infrastructure investment, a country might lose its competitive advantage under the ongoing globalization, especially when neighboring countries have built newer transportation infrastructures.

For example, many shippers and carriers have tried to find new routes for the new mega

cargo vessels because of size limitations in the Panama Canal. As a result, the Panamanian government is investing in a major widening to accommodate the larger vessels and maintain tariff incomes to the country. Strategic countries such as Panama have to keep investing in their transportation infrastructures to offer highly performing transport services and maintain their competitive advantages in the global market.

Secondly, according to the World Economic Outlook of April 2009, world trade volumes were expected to decline by 11% in 2009 and increase by only 0.6% in 2010 (they grew by 7.2% in 2007 and by 3.3% in 2008).⁵³ It is hard to say when the global economy will recover from the recession and catch up to the growth levels seen before 2008.

According to the International Transportation Forum, there could be three scenarios for how the crisis will affect global growth patterns. These three scenarios, “Bounce Back”, “Retrenchment”, and “Adjustment”, are addressed below:⁵⁴

Bounce Back

The crisis is an accident, and once the financial system has been repaired, the economy will return to pre-crisis business-as-usual. The crisis reduced the growth of global GDP in 2009 and 2010. The rates will recover to the original pre-crisis scenario by 2013 with continued globalization.⁵⁵

⁵³ International Monetary Fund. (April, 2009). World Economic Outlook – Crisis and recovery.

⁵⁴ International Transport Forum. (2008). Transport outlook 2009: Globalisation, crisis and transport, p.6

⁵⁵ International Transport Forum. (2008). Transport outlook 2009: Globalisation, crisis and transport, p.8

Retrenchment

The crisis ends the pre-crisis globalization pattern and strongly reduces globalization. The crisis reduced the growth of global GDP in 2009 and 2010. The global GDP will be in a lower growth path than pre-crisis. The extreme trade imbalances and availability of cheap credit are not likely to be sustainable. It is far from the pre-crisis pattern of globalization.⁵⁶

Adjustment

The future global GDP growth will be weaker than pre-crisis pattern. It will adjust global trade imbalances and reduce financial leverage. A number of imbalances in the global economy need to be handled and that leads to more moderate growth. Although the effect of the slump is large, the effect won't show in the short term,⁵⁷ but the expected GDP levels will be delayed by up to 5 years in the long run.⁵⁸

In fact, the crisis has eased global trade imbalances and overall inflation was offset by the recession. The export volume of Asian countries decreased dramatically and the domestic commodity prices are now lower. However, the overcapacity in export terms was either absorbed by domestic demand or by reducing output.⁵⁹ Such adjustments might result in high logistics costs.⁶⁰ However, the question of how domestic transportation infrastructures can

⁵⁶ Ibid

⁵⁷ Ibid, page 10

⁵⁸ Ibid, page 8

⁵⁹ Roach, S., 2009, The right call on China

⁶⁰ <http://www.morganstanley.com/views/gef/archive/2006/20060511-Thu.html>

support such domestic demand still depends on whether the government is willing to invest more in infrastructure during the recession.

Thirdly, the oil price always plays an important role that affects the transport cost, especially for air cargo and truck transport. How to eliminate the dependence on fuel becomes a challenge to countries that depend heavily on trade to grow. Those countries now focus on developing fuel-efficient technology, such as solar and wind energy applications, which can not only improve their transportation infrastructure but also help them to reduce the transportation cost.

Moreover, the regulation of environmental protection and climate change force countries to build or upgrade their transportation facilities. The more intensively a country uses the transportation infrastructure to support the demand from a growing economy, the more carbon dioxide is emitted from this sector. The IMO projects that overall maritime tonne-miles will grow by 30 to 46% by 2020 and by 150 to 300% by 2050.⁶¹ Consequently, the CO₂-emissions must be taken into account in new investment and upgrading of transportation infrastructures. The improvement of fuel efficiency and upgraded infrastructure will help to reduce CO₂-emissions and air pollution.

Finally, the financial crisis affects funding of transportation infrastructure investments. Clearly the current economic downturn has interrupted the trend of infrastructure

⁶¹ International Transport Forum. (2008).Transport outlook 2009: Globalisation, crisis and transport, p.9.

investments.⁶² How to raise financing for infrastructure becomes more important to governments around the world. Without the financial support from both public and private investors, it will be hard to put infrastructure investment plans into practice. Smart governments find a way to finance investments in their transportation systems, and can use this as a way to jump start the economy, help grow international trade, and improve the country's overall competitiveness. In essence, they will be making strategic investments for the future.

The economic downturn from 2008 to this year has already reduced the growth in world trade, and it may take several years to regain the same volumes. Infrastructure investments will only have a limited effect on the recovery. Nevertheless, environmental and technological challenges remain, and countries have to constantly upgrade and invest in their transportation infrastructures to meet the domestic and trade related demands. How to utilize infrastructure investments to help economies recover and thrive will still be an important task for all countries.

Moreover, many transportation planners and engineers are focusing on the development of innovative technology to help solve the congestion and emissions problems. Fuel efficient engines consume less fuel than the early models. Information systems and high speed equipment are designed to ease traffic congestion. Various government agencies had to invest

⁶² International Transport Forum. (2008).Transport outlook 2009: Globalisation, crisis and transport, p.19.

in their transportation infrastructures to cope with the technology trend. We will address three types of technological development that affect transportation investment decisions:

Engineering improvements

Fuel price is a key factor that has always had a great effect upon the transportation sector.

Due to rising fuel prices, engineers have tried to develop fuel efficient engines to reduce fuel consumption and decrease the dependence on fuel. For example, new engines can operate on bio-diesel and green energy is applied to generate power to supply accessories. Thus, many governments support and subsidize the development of fuel efficient equipment for their transportation industries.

Moreover, since the environmental issue has been brought to the forefront, people pay more attention to reducing their environmental “footprint”. However, in the U.S. transportation generates most of the carbon dioxide. How to reduce CO₂ emissions becomes a challenge for the government. Governments try to invest in their transportation infrastructures and increasingly both encourage and legislate green technologies in order to reduce energy usage and the environmental impact. This helps to keep engineers and innovative companies busy with developing new technologies and applications.

Information systems

Information technology is the trend of the 21st century and the development of information systems accelerates the globalization. Radio-frequency identification (RFID) technology and

Enterprise Resource Planning (ERP) systems are frequently used to improve the efficiency in supply chain management today. Rising complexity is also a main factor behind the appearance of fourth party logistics providers (4PL's). Various advanced information systems have integrated the data and utilized transportation efficiency algorithms. Governments can monitor traffic congestion and obtain competitive advantages via investing in appropriate control systems. For example, Singapore's Changi Airport has nine airfreight terminals (AFTs) and these AFTs are equipped with state-of-the art material handling systems to ensure the efficient handling of cargo, 24/7.⁶³ The automatic handling system is applied to new terminals for freighter flight planning in order to strengthen Singapore's position as a premier air freight hub.

High speed equipment

The problem of traffic congestion occurs in virtually every country and this is an important challenge for every government. Some have invested in upgrading their facilities with high speed equipment, such as automatic guidance systems and high speed trains. Facilities with high speed equipment help cargoes move faster and more efficiently. In addition to speedier transportation, the usable lifetime of the infrastructure is extended. Importantly, large countries benefit from high speed equipment through improved efficiencies. For example, China is building a new express train connection for the 1,438 mile stretch from Beijing to

⁶³ Changi Airport Group. (2009).

Guangzhou, extending from northern to southern China. It will reduce the transit time from days to hours. While initially benefiting passenger transportation, the effect on freight transportation will be less congestion, improved transit times and fewer delays. Ultimately, the freight trains themselves should be able to move at higher average speeds, gaining transportation efficiencies and being gentler on the environment.

Can Generalizations and Conclusions Be Drawn?

We have been studying and comparing a considerable amount of data, but our sample size is too small to draw scientifically valid conclusions. Even so, there are patterns and discernable differences found when we separated the countries into three different groups. It was also instructive to consider the similarities and differences between the United States and China.

The relationship between the standard of a country's logistical infrastructure and its economic development and performance is not always easy to decipher. Any causality is muddled because of an abundance of other influences and variables. However, at some point in a country's development, the physical infrastructure can be a bottleneck and braking pad for further growth, and will compromise a country's potential. Having a good infrastructure is like having the proper tools for being able to compete and get the job done in a globally demanding market situation.

We would like to highlight seven elements that jumped out at us when preparing this report:

1) There is a reinforcing cycle of economic output and transportation infrastructure:

Economic output, of course, is a result of many factors coming together to pull a country in the right direction. Having a functional and efficient logistical infrastructure is an important factor in making a country more productive and able to move goods around expeditiously. The loop structure is so that the more income a country has, the more funding it should be able to direct towards infrastructure construction and improvements. The prime example is present day China, where export revenues are consciously applied towards improving its roads, railroads, ports and inland waterways. Other countries (not necessarily among the sixteen we studied) find themselves locked in a vicious circle where with poor finances they cannot afford to build infrastructure, further eroding their chances to improve their finances and be competitive.

2) No straight line comparisons are possible: It made sense for us to divide the sixteen countries into three distinct categories. Each category possesses certain shared characteristics, and the differences between the categories are often so dramatic that comparisons would be misleading and unfair. For example, Singapore is not the United States, and many direct comparisons would make little sense. The size of an American county and with a completely flat landscape, one airport, one port, one rail station and no need for freeways, comparing Singapore with the U.S. would be absurd. However, at a micro level, there is no doubt that the various governments and municipal authorities

could learn from each other by comparing best practices in terms of management and technological innovation.

3) More relevant for the U.S. to compare itself to other Large and Mature countries:

So if we are to make comparisons between countries, it would mostly have to be within the three distinct groups, where there are many commonalities and shared characteristics.

The U.S. is Large and Mature, and it needs to compare itself to other Large and Mature countries. In practice, comparisons to Canada, the UK, Germany and Japan make more sense, at least at the macroeconomic level.

4) The U.S. population growth is higher than Europe's and Japan's, necessitating

higher infrastructure investments. We observed a current population growth rate of 0.98%, which is surprisingly high for a mature country. Many European countries, plus Japan and Russia, are experiencing population declines, but immigration and high birth rates work to keep the U.S. growing by about 3 million people a year. The U.S. Census Bureau projects that the U.S. population will be 420 million in 2050, or a growth of more than 35% in 40 years. It is important for planners and politicians to realize that this will necessitate major boosts in the physical infrastructure capacities. From that standpoint, the U.S. is more under the gun than other, comparable countries in the Large and Mature category. The good news is that more people should mean greater economic growth, and

the cycle argument outlined in point 1) above will apply. In short, with more taxpayers, the country should be able to finance infrastructure improvements.

5) Developing countries (BRICM) have a different set of growth problems to deal with:

Countries that were poor and backwards only a few years ago have a lot of catching up to do. In many cases, they are still working on establishing a minimum level of transportation infrastructure to bring them up from an agrarian to an industrial and service based type economy. These countries are using their immense export revenues to finance physical improvements to their networks of roads, railways, seaports, airports and waterways. For these countries it is often a matter of building structures from scratch (“Greenfield” developments), while mature countries are usually looking at enhancements to existing structures (adding lanes, adding runways, going from single to double spur, widening canals, etc.)

6) Besides improving and maintaining the road system, increasing the public

transportation quality is also important to get cars off the road and improve the traffic flow for trucks: Throughout this report, we have been very conscious of the fact that freight transportation cannot be separated from passenger transportation, or in other words, improvements to one segment will benefit the other. This is particularly true for road, rail and airport improvements, because freight and people share the same infrastructure. Greater capacity will help both segments, and higher usage of public

transportation is a powerful means to help freeing up space on the roads for cargo transportation. The United States would be wise to rid itself of some of the “wild west” mentality, where people ride to and from work in millions of 2-ton pickup trucks and SUV’s every day. Good political leadership may mean forcing people to change their habits through restrictions, regulations and taxation. We are aware that this is the typical European (“social engineering”) method, but eventually the congestion and pollution will be so severe here than American politicians don’t have much choice.

7) The U.S. is still ranked very highly with respect to overall competitiveness and

quality of infrastructure: This is the good news, and shows that the U.S. is by no means a logistical basket case. Again, the frame of reference is important, and this country ranks highly even against agile and modern countries in Europe and Asia. Being competitive today, however, does not mean that the country will be on top ten years from now. Globalization has introduced fierce competition in many areas, and having an appropriate and functional transportation system is crucial for staying ahead. We cannot quite get the

American Society of Civil Engineers’ Report Card 2009 Grades out of our minds:

| | | | |
|-------------------------|----|--------------------------------------|----|
| Aviation | D | Public Parks & Recreation | C- |
| Bridges | C | Rail | C- |
| Dams | D | Roads | D- |
| Drinking Water | D- | School | D |
| Energy | D+ | Solid Waste | C+ |
| Hazardous Waste | D | Transit | D |
| Inland Waterways | D- | Wastewater | D- |
| Levees | D- | | |

Table 12: American Society of Civil Engineers’ Report Card

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The cover photo shows a high speed train in Taiwan

<http://worldmustbecrazy.blogspot.com/2008/12/worlds-fastest-train.html>)