THE NEW STEEL AGE?

ECONOMIC DEVELOPMENT AND THE AFRICAN RAILWAY RENAISSANCE

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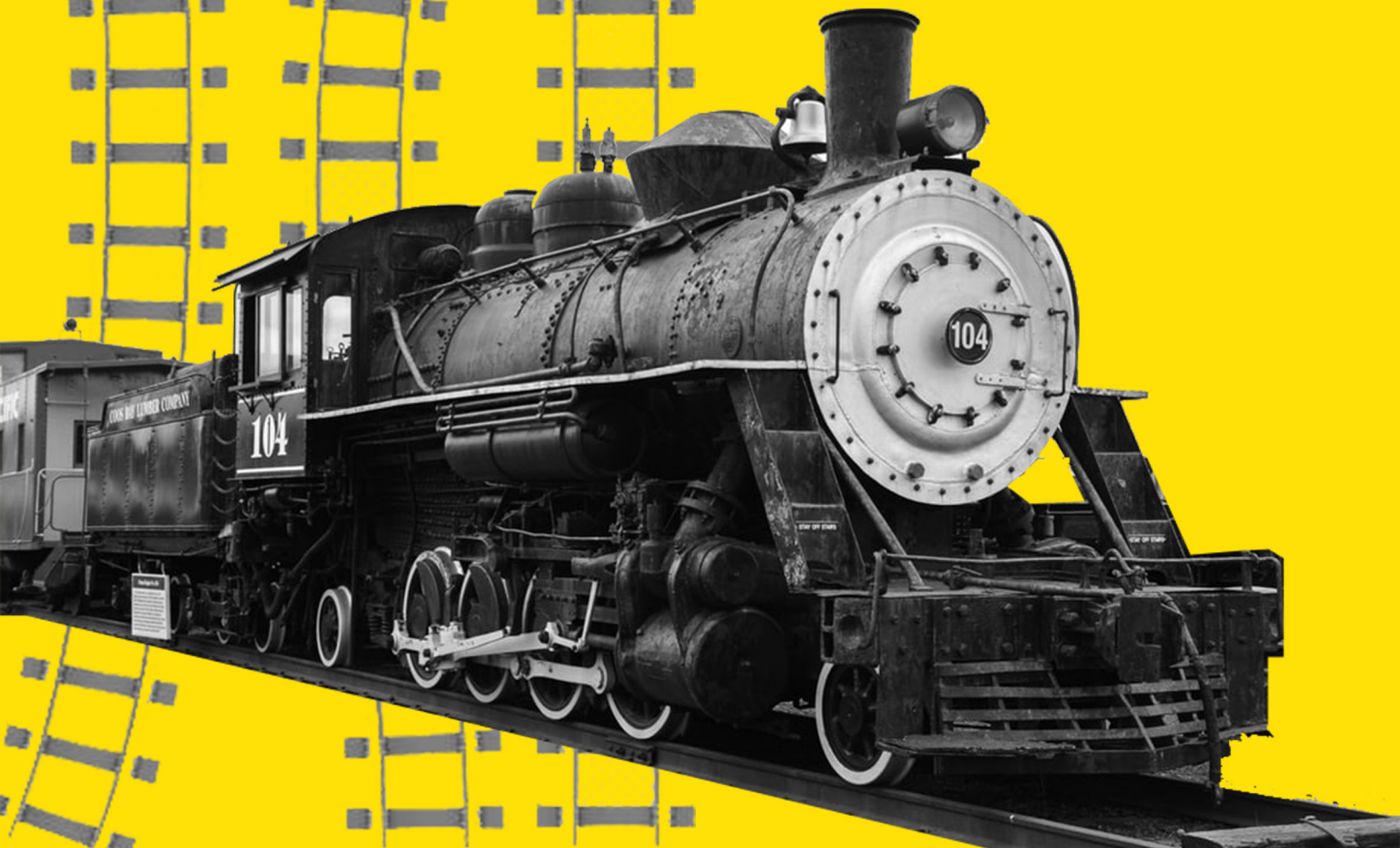

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Contents

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1. Introduction

The twentieth century saw a global decline in railway transport. Today, in 2022, there is a global renaissance in railway building that spans developed and developing countries. The UK Parliament approved the High Speed 2 (HS2) railway in July 2017 at a projected cost of nearly $60 billion. Construction on the first phase linking London and Birmingham, started soon after. A second phase to then connect Birmingham via two links to Leeds and to Manchester is planned for completion by 2033. In 2022, the UK completed the $23 billion London Crossrail project, which ran $4 billion over budget and almost four years late. The resulting Elizabeth Line opened in 2022 to enormous acclaim. The mayor of London described it as a 'roaring success' and more than two million trips were made on the line in the first five days of its operation (BBC, 2022). In the US, new railway construction and upgrades were included as part of the economic stimulus package in response to both the 2008 Global Financial Crisis and also the 2020 Covid-19 pandemic. One of the most prominent US projects is the Gateway Program, a $24 billion investment to redevelop the New York to New Jersey line (Boss, 2018). Australia is building the $8.6 billion Melbourne Metro Tunnel to expand the city's railway and metro system and is due for completion in 2025 (VAGO, 2022). In the 2000s Spain, Japan, Germany, France, Belgium, Italy, Netherlands, Korea, Taiwan, and Turkey were all constructing High Speed Railways (HSR) (Qin, 2014).

Leading the global renaissance has been China. In China, annual investment in railways increased from $10 billion in 2003 to $120 billion in 2010. Much of this new investment was in HSR, with China leading the world with 6,000km in operation by 2007, growing to 40,000km by 2021. By the end of 2030, the HSR network is expected to connect around 230 Chinese cities across every province (Dong et al, 2020). One of the busiest international borders is that between Singapore and Malaysia where 350,000 commute daily for work. The two countries have long discussed a HSR between Kuala Lumpur and Singapore, intended to reduce a 10 hour trip to 90 minutes (Boss, 2018). The HSR project was cancelled in January 2021 but was soon afterwards back under discussion (Business Times, 2022). Saudi Arabia is planning a 2,400km line to connect its capital Riyadh with Al Haditha, near the border with Jordan (Boss, 2018).

Historically Africa has always been central to global rail-visions, but has never lived up to those (externally driven) expectations. In the nineteenth century Britain dreamed of creating the Cairo to Cape Town railway. The effort faltered as the French, Germans and Belgians colonised chunks of Africa that prevented Britain having clear sovereign access from North to South. In the 1970s China built the TAZARA Railway to connect Zambia to the Tanzanian coast in the north. The railway faded from geo-political importance as political problems in Zimbabwe (1980s) and South Africa (1990s) eased and global sanctions on those countries were lifted. Freight carried on the line declined after 1986 as Zambia's economy was increasingly re-oriented to the south. By 2014 the TAZARA was running at an estimated 2% of capacity.

There is a renewed global recognition about the need for better transport infrastructure in Africa. Today much of the impetus for this drive comes *from* Africa. The African Development Bank (AfDB) have recognized an infrastructure need, estimating an annual infrastructure financing gap of around $100 billion per year (Phiri and Mungomba, 2019; Graff, 2019:2). The African Union (AU) vision for 2063, '*The Africa We Want*'. aims, among other things to achieve the 'free movement of people', the 'establishment of continental institutions' and 'full economic integration'. To this end the AU envisages a "Pan-African High Speed Train Network will connect all the major cities of the continent" (African Union, 2015:5). The HSR project was endorsed by the AU Heads of State at a summit in 2013. The planned network promises to connect the 16 landlocked countries in Africa to major seaports and neighbouring countries and create a single gauge railway system to link Africa, East to West and North to South (AUDA-NEPAD, 2022).

The African vision is rooted in the practical realities of available funding. The 2005 G8 summit in Gleneagles, Scotland established the Infrastructure Consortium for Africa (ICA) to support public and private investment in infrastructure. The Africa50 Infrastructure Fund was launched by the AfDB in 2013 to mobilize infrastructure funding. In 2014 the World Bank launched the Global Infrastructure Fund as a platform for identifying, preparing and financing large, complex infrastructure project (Wethal, 2019). These initiatives are backed up with resources. The overall financing of infrastructure in SSA more than tripled between 2004 and 2012 (Wethal 2019). The situation changed dramatically in 2013 with the launch of China's Belt and Road Initiative (BRI). The BRI is planned as a vast network of road and rail connections, seaports, energy, manufacturing investment across Eurasia (Asia, Europe, Central Asia and the Middle East) and Africa. During the rapid growth years of the 1990s and 2000s China invested massive amounts in infrastructure, reaching 14% of GDP in 2006 (Wethal, 2019), focusing on roads (Baum-Snow et al, 2020), ports (Brautigam, 2019) and railways (Qin, 2014). For China this is a personal lesson about development, in which the country is seeking toexport what works. Since 2013, BRI has become an integral aspect of Chinese foreign policy and working towards its success was made a constitutional obligation (Boyce, 2017). The BRI is scheduled to cost between $1 and $8 trillion, depending on the source of estimates (Dawn, 2018). Much of the infrastructure financing is done by Chinese lenders, in particular China Exim Bank (Wethal, 2019). Currently 138 countries have signed up to the BRI, including at least 38 African countries (Phiri and Mungomba, 2019).

The African vision and global funding together brought the global railway renaissance to Africa in the 2010s. Kenya signed a $3.8 billion contract with the Chinese Road and Bridge Corporation in 2014 to build the 480km Standard Gauge Railway (SGR). 90% of the project funding came from China's Exim Bank. The railway was opened in 2017 (Carrai, 2021). The railway was part of the Kenya Vision 2030 which envisages connecting Kenya, Uganda, Rwanda and South Sudan, at a total cost of more than $13 billion (Future Rail, 2016). The 752km Addis Ababa to Djibouti railway was built by the China Railway Engineer Corporation (CREC) and inaugurated in 2017, the $4.5 billion project was largely financed by China Exim Bank (Carrai, 2021). Morocco inaugurated its first HSR in November 2018 and unveiled Africa's first bullet train, the Al Boraq, with a top speed of up to 320km per hour, connecting Tangier Rabat and Casablanca. Within four years the government claimed that three million passengers had enjoyed journey times reduced from three to less than one hour (Africa Report, 2022). In September 2021 Egypt signed an $8.7 billion deal with the German company Siemens to build a 1,800 km electric railway between the Red Sea and the Mediterranean where trains would link 60 cities and reach a top speed of 250km per hour (CNBC, 2022). Senegal launched the Regional Express Train network in December 2021 to combat traffic chaos in the capital Dakar. In Tanzania, South Korean company Hyundai Rotem is developing a 546km HSR line. Nigeria has purchased two high-speed

trains, capable of some 330km per hour for its Red Line metro project, a 37km intra-city railway system. In Tunisia, trains imported from France began operations in December 2012 on a 471km stretch, at a maximum speed of 120km per hour (Africa Report, 2022). In 2020 the South African Director General of Transport said that a framework for a new HSR had been implemented. In 2022 China's ambassador to South Africa reported that his government was considering investing in an HSR line between Johannesburg and the port of Durban, a distance of around 570km (Global Construction Review, 2022).

What economic impact will the railway renaissance have in Africa?

There is excited hyperbole,

"*Africa shall be a continent where the free movement of people, capital, goods and services will result in significant increases in trade and investments amongst African countries rising to unprecedented levels, and in strengthening of Africa's place in global trade.*" (African Union, 2015:5).

The hyperbole *is* rooted in an on-going research agenda that has highlighted the economic problems of geography for SSA. Empirical evidence shows that being a landlocked county and the share of population further than 100km of the coast both have a negative impact on economic growth (Bloom et al, 1998; Gallup and Sachs, 1999). In SSA 25% of the population are in landlocked countries (Gallup and Sachs, 1999). Controlling for distance, income levels, and language non-European landlocked countries trade 40% less with the rest of the world while landlocked Africa trades 60% less (Coulibaly and Fontagne, 2005). In SSA only 19% of the continental population are within 100km of the coast. In the US 38% of the population are within 100km of the coast which rises to 67% once we include ocean-navigable river systems (Gallup and Sachs 1999). SSA also experiences a cost to distance. Half of the world's trade takes place among countries located within 3,000km radius of each other. In 1990 the average distance of SSA countries from their trading partners was over 7,800km (Gallup and Sachs, 1999). The burden of distance is reflected in high transport costs (other factors are also important, see the conclusion). In 2007, average transport costs (in US cents per ton-km) ranged from 2 in Pakistan, 3.54 in Brazil, 5.5 in the US and 6 in China, to 6 in Durban–Lusaka, 8 Lomé–Ouagadougou, 10 Mombasa–Kampala and 12 Douala–N'Djaména (Teravaninthorn and Raballand, 2009:14). Comparing recent price data on goods at port or source location to prices at their destination shows that the cost of transporting goods in Ethiopia is an estimated 3.5 times and in Nigeria estimated 5.3 times higher than in the US (Atkin and Donaldson, 2015). Evidence points to striking price differentials over geographic distance. In the years between 2002 and 2008 the price of oil in SSA increases from $25 to $97 if a city is 500 km farther away from the main city (Storeygard, 2016:1264). African countries are generally small suppliers of agricultural products whose prices are fixed on world markets. Differences in transport costs in this situation will be borne by the (African) exporter. In those economic sectors where production involves importing machinery and components for assembly and re-exporting them (textiles and electronics) even relatively small transport costs can have a substantial impact on final costs. The very sectors characteristic of successful export-led growth stories in Asia are those most hindered by transport costs (Woods 2004).

Can railways relieve the burdens of distance, population misplacement, landlocked status and high transport costs?

There is a lack of rigorous economic analysis estimating what economic impact railways will have in SSA. This is not surprising. The impact of big infrastructure can take decades for its full effects to impact the economy. A five year old railway renaissance does not give SSA cases study time enough to conduct 'before and after' economic studies of railways. Other efforts, such as the Computable General Equilibrium (CGE) (discussed in section 3.3.) only engage with a limited fraction of the impact of railways (such as reduced time of travel) and don't consider their wider economic impacts on spillovers, technology, urbanization, and institutions (as discussed in sections 4 and 5). This paper proposes a new methodology, to learn from the historical experience of global railway building and think about lessons for contemporary SSA.

The paper is organized as follows, section 2 outlines the methodology, section 3 examines the historical economic impact and draws lessons for contemporary SSA, section 4 examines the historical evidence for the indirect impact of railways on economic growth and section 5 concludes.

2. Methodology

What economic impact will railway construction have in SSA?

To answer this question, this paper turns to historical and contemporary studies of railway construction and seeks to draw lessons for contemporary SSA. The case studies used in this paper broadly follow the global history of railway building, from the early experiments with steam trains in Britain to the HSR of contemporary China. Did historical and contemporary railway construction boost economic growth, improve institutions, promote industrialization, and encourage the adoption of new technology?

2.1. The Case Studies

The global history of railway building has given us a huge number of well-studied cases to draw upon. The earliest recorded image of a railway is from a stained glass window in the church-minister of Freiburg im Breisgau in Germany. These animal or human drawn vehicles ran on tracks centuries before the invention of the powered locomotive (Hylton, 2016:9). In 1804 Richard Trevithick constructed a steam-locomotive which drew wagons on a line in Wales (Fremdling, 2003:210). These engines were systematically improved by George Stephenson (1781-1841) in the UK from 1814 onwards. The 50-km line between Liverpool and Manchester opened in 1830 and heralded the beginning of the railway age. Technology improved rapidly and within a few years the maximum speed jumped from 15 to 60 mph (Hylton, 2016:11). The technology spread rapidly, radiating outwards from the UK, first into northern Europe. In 1835 Germany opened its first 4 miles of track and by 1860 there were over 11,000 km of lines (Fremdling, 1977). At further distance the Austrian Empire saw a boom in railway construction in the 1840s whilst the adjacent Ottoman Empire was largely unaffected until the 1860s. By c1900 the Balkan network included some 17,400km of railway line (Stanev, 2017). Russia built 14km of railway line in 1837 to connect St Petersburg and Tsarskoye Selo, the Tsars' summer palace. The first economic line, between Moscow and St Petersburg, was opened in 1851, followed by the St Petersburg-Vienna (via Warsaw) line in 1862. This heralded the railway boom in Russia which continued from the 1860s until 1913 when more than 34,000 miles were built (Metzer, 1974).

In the 1850s the US experienced its first railway boom when approximately 22,000 miles of track were laid (Haines and Margo, 2006). By 1860 railways had conquered the entire eastern seaboard of the US (Wolmar, 2012). On May 10th, 1869 at Utah desert Promontory Summit the Transcontinental Railway was completed, which linked the 1,032 miles built by the Union Pacific from Omaha to Ogden to the 881 miles built by the Central Pacific from Ogden to Sacremento (White, 2011). Not all of the Americas lagged Europe. The first railway line in the region was opened in Cuba in 1837, only seven years after the first British railway. There was a lag until the 1850s when railway construction started elsewhere and by 1912 railway mileage exceeded 32,000km in Argentina, 23,000km in Brazil and 20,000km in Mexico (Herranz-Loncan, 2011:3). Railway construction was a slow-burner (1869)

in Uruguay compared to other Latin American economies, but by 1913 the 2,577km of railway in Uruguay was more than twice the European per capita average (Herranz-Loncan, 2011b).

Railways diffused more slowly eastwards from Europe, though once initiated they were adopted rapidly. In Japan from 1872 to 1907 the domestic rail network expanded from 29 to 7,152km and annual passengers carried from 495,000 to 101 million (Tang, 2014). The first passenger line in India totaling 20 miles was opened in 1853 and track length reached 67,247km in 1920, representing the fourth longest railway line in the world (Bogart and Chaudhary, 2012). In 1900 the railway system had more than 350,000 employees to transport over 180 million passengers (Kerr, 2014). The contemporary global renaissance in railway building (especially among HSRs) was pioneered outside the developed world, particularly in China after 2003 (Qin, 2014).

2.2. **The Rationale and the Merits of Case Studies**

This method may raise a quizzical eyebrow. How can we learn about contemporary Ethiopia by studying railway building in nineteenth century Sweden? One rationale is that the historical circumstances under which the earlier generations of railways were constructed are similar to those of SSA today. In 2020 average GDP per capita in SSA was about $1,500. This is broadly equivalent to the country case studies used in this paper when they initiated their railway building programs. GDP per capita in the UK in 1857 was $2,757, India in 1870 $533, Belgium 1820 $1,319, France 1820 $1,135, Spain 1820 $1,008 (Maddison 2007), Latin America 1913 $1,481, Japan 1913 $1,387 and the Western offshoots (US, Canada Australia and New Zealand) in 1870 $2,419 (Maddison, 2003). Railways were built in countries overwhelmingly dependent on agriculture for employment, production and exports that were experiencing or aspiring to promote industrialization (as in SSA today). Many of those historical railways were externally financed, usually by an foreign Great Power (for Britain and France in the nineteenth century see China and the BRI today) which raised questions about power asymmetries and the link between investment and colonialism. The historical railways were about crossing and linking up continents and opening up new landmass to trade and migration, notably the Trans-Siberian in Russia, the Chinese HSR or the Transcontinental Railway in the US. The plans of the AU to connect up the vast interior of landlocked Africa to capital and other cities and to ports explicitly draw on the same images.

Section 3 notes that given the relatively recent construction of new railways in SSA and the long lag between big infrastructure construction and economic changes it is difficult to gauge the full economic impact of railway construction. Studies of completed railway projects allows us to focus on before-and-after questions. One study, for example, looks at railway construction in Sweden between 1855 and 1870 and traces its impact on urbanization up to the year 2000 (Berger and Enflo, 2017). There is a significant methodological problem at the heart of before-and-after studies that has be-deviled economic studies of railway construction. There is abundant evidence that economic growth, industrialization or growth of international trade (in the nineteenth century US for example) occurred at the same time as railway expansion. This co-revolution does not establish a causal relationship between these phenomena (Fogel, 1962). Did railways drive economic growth or did economic growth create a demand for railways and the savings and government tax revenue to fund their construction? This paper draws from the vast number of economic-historical studies, the new datasets they have created and the impressive array of econometric-statistical methods they have used to deal with the problem of causality.

Donaldson (2010), for example, created a new dataset with almost seven million observations on district-level prices, output, rainfall and inter-regional and international trade in colonial India. Rainfall data came from the all-India network of 3,614 meteorological stations that recorded the amount of rainfall at each station on every day of the year. This data was supplemented with a digital map of India's railroad network in which each 20km segment was coded with its year of opening. The dataset allowed Donaldson to isolate the impact of weather on agricultural output and to then track the evolution of income levels (agricultural output) at district level before, during and after the expansion of the railroad network. Scholars have sought to measure the impact of contemporary railway construction on GDP by using night-time lights as measured by weather satellites. These satellites circle the Earth 14 times each day and take pictures between 2030 and 2200 hours at night. They use algorithms to filter out other sources of natural light using information about the lunar cycles, sunset times, the northern lights and other occurrences like forest fires and cloud cover. Given the lack of reliable sub-regional level GDP data in many developing countries, this is a useful proxy measure of overall economic activity. Lights data is calculated at approximately every one square km. One study combines satellite images of lights at night from 1992 to 2009 with digitised national rail maps from 1962, 1990, 1999, 2005, and 2010 to measure the economic impact of railway construction in China (Baum-Snow et al, 2012).

3. The Economic Impact of Railways in SSA – from Lessons to Direct Evidence

The following three sections utilize lessons from the historical case studies to think about the likely economic impact of railway construction in SSA. Section 3 reviews studies that use the methodology of 'social savings' from freight and passenger traffic by railways. The lessons from these studies suggest that there is a significant economic potential of the railway renaissance in SSA. Section 3 concludes by looking at the impact of railways on economic growth and offers a note of SSA-optimism. Sections 4 and 5 look at more indirect evidence from the historical cases studies linking railways to economic growth and the crucial role of the state respectively. Here the SSA-optimism becomes more cautious.

3.1. **Social Savings - Freight**

The first generation of railway studies focused on 'social saving', where social saving is defined as "the difference between the actual cost of shipping goods in that year and the alternative cost of shipping exactly the same goods between exactly the same points without railroads" (Fogel, 1966:34). Social saving is based on estimating the cost-saving (equivalent to the gain in national income) of the new technology compared to the next best alternative (Fogel, 1979; Crafts, 2004).

The key in the US story is the efficiency and low cost of water transport. Water transportation, first available on natural waterways, and later on canals, made possible the geographic redistribution of population and economic activity after 1800 (Fogel, 1966). As the first railways were being built in the 1840s, 40% of the nation's populace already lived west of New York, Pennsylvania and the coastal states of the South, and Ohio had emerged as the main wheat growing region of the country. The westward movement of cotton was virtually completed by 1850 and in 1860 about 90% of all cotton shipped to New Orleans arrived by boat (Fogel, 1966). The great US cities for trade and distribution such as Chicago, St Louis, and Cincinnati were on rivers or the Great Lakes. Of the 43 most important secondary markets, 32 were located on navigable waters still in use in 1890 (Fogel, 1962). The data on shipping costs and volumes produce a measure of the social savings from railways of only 2.7% of GDP (Fogel, 1964). A new generation of research has utilized digitized maps of Fogel's waterways and county-level data on agricultural land values (as opposed to state-level aggregates). This effort generates results almost identical to those of Fogel (Donaldson and Hornbeck, 2016). The case of Uruguay is similar and low estimates of social savings stems from the fact that two-thirds of the population lived in regions with a port or with easy access to river navigation (Herranz-Loncan, 2011b).

The implications of new Chinese-built railways for SSA can be better teased out from those studies of social saving that were significantly higher than in the US and Uruguay. One such example is that of Mexico in the late nineteenth century which saw the construction of railways in a country with no suitable or river transport system able to link natural resources and population centers. Without a viable alternative estimates of social savings in freight range between 24.6% and 38.5% of GDP (Coatsworth, 1979). In Russia, long distances and freezing winters prevented rivers and canals from being used for most of the year. Social savings were higher than the US, at 4.6% of GDP in 1907 (Crafts 2007). In India there was a decent river system along the Ganges and the Indus in the north but it was often impassable during the rainy season (Studer 2008:422). A 20-day journey from Calcutta to Allahabad downstream could take two or three months to return, rowing against the current (Derbyshire, 1987). In South India there were few, and in western India no navigable rivers. For most of India railways replaced slow-moving bullock carts, pack animals or headload workers. The railways were able to travel 600km a day and offered superior speed, predictable timetables, and travel all months of the year. Railroad freight rates were also much cheaper than road, river and coastal travel respectively (Donaldson, 2010). Social savings from freight have been estimated at 9% of GDP in 1900 (Crafts, 2004).

The lesson for SSA is that social savings in freight from new railway construction could be high. Ocean-navigable rivers, which provide cheap transport to the interior of most other regions, are virtually non-existent (Storeygard, 2016:1263). The Zambezi or Congo are famed for wildlife and white-water rafting, not for facilitating long-distance trade and transport. The alternative to railways are the poor quality existing road and rail systems. SSA has only 31 total paved road km per 100 square km of land, compared to 134 in other low-income countries. In rural areas, more than two thirds of the population live further than two km away from any all-season road (Graff, 2019:2). In 1994 the implicit tax on domestic sales arising from the poor quality railway line connecting Kampala, Uganda to the coast at Mombasa, Kenya was 48% on average and exceeded 100% in a number of sectors (Milner, 2000). In general, poor transport conditions are estimated to increase intra-African trading costs by 30-40% (Phiri and Mungomba, 2019). Good railways can transform transport options. The 784km railway line connecting Addis Ababa in Ethiopia to Djibouti was opened in 2016 and replaced a service that by 2000 had inferior tracks, slow train services and high tariff rates (an average of $55 per tonne in rail compared to $30 per tonne by road in 2004). The journey took 12 days by rail or 3 days by poor quality roads. The journey today takes only 12 hours (Mohapatra, 2016). We return to this point in the conclusion and discuss how simultaneous construction of a continental highway system in SSA may impact these conclusions.

3.2. **Social Saving – Passenger**

We need to add social savings for passengers to the previous estimates of social savings for freight. This requires estimating savings in transport times, where time is valued at the railway passenger's average hourly wage. In the US this has a significant impact on overall social savings. In 1890 passengers travelled 12.1 billion railway miles. The decline in travel by stagecoach, canal and steamboat cannot be explained by passenger fares as train travel was more expensive. The principal gain was in the speed of travel. An estimate for railroad passenger services produced an additional economic benefit of 2.6% of 1890 GNP. Combining this estimate with Fogel's freight measure raises the overall social saving to more than 5% of 1890 GNP. Now the estimate is reasonably large and it is "difficult to think of any other single innovation that rendered economic

gains of a similar magnitude." (Boyd and Walton, 1971:251). Elsewhere passenger social savings make little difference to overall social savings. In Mexico for example, in 1910 the railways carried 15.8 million passengers a total of more than 1 billion passenger km (Coatsworth, 1979). Despite these numbers, estimates of passenger social savings are only 0.6% of GDP (Crafts, 2004). Unit savings on passenger travel were small despite the greater speed and accessibility of railroads because low wages made passenger time less valuable (Coatsworth, 1979).

There are significant potential gains for passengers in SSA in the form of unlocked mobility benefits. 81% of the population of SSA are located more than 100km from the coast (Gallup and Sachs, 1999). A recent study of the entire BRI transport infrastructure estimates that BRI will reduce travel times for economies along transport corridors by up to 12% (World Bank, 2019). More specific case studies show that railway construction has offered significant time saving. Travel times on the Addis Ababa to Djibouti rail line, for example, were reduced from 12 days to 12 hours after upgrades were made by China(Mohapatra, 2016). The SGR in Kenya, opened in 2017, cut the journey time from Nairobi to Mombasa from 15 to 4.5 hours (Carrai, 2021). The limitations of the social saving approach lie in the valuation of people's time by their existing average wages. One benefit of railways not considered in the social saving methodology is to stimulate urbanisation-industrialisation and so help transfer low wage (agricultural) workers to higher wage (industrial) occupations. It is to other methods we must turn to gain a fuller picture of the lessons for SSA.

3.3. **Economic Growth**

More recent empirical work has extended the social savings approach of estimating the impact of railways on the level of income at a point in time and sought to estimate the impact of railways on economic growth over time. The effort has been aided by the ability of modern computing power to handle large data sets. The results generally support the pattern of findings from the earlier generation of studies. One study of railways in the US uses county-level information from maps to compare outcomes in a treated group (counties that gain rail access in the 1850s) with a control group (no rail access in the 1850s) before and after treatment (rail access). The results show that rail access led to higher land prices and facilitated a shift from agriculture to industry, but the effects were small (Haines and Margo, 2006). Similarly, in river-rich Uruguay the railways accounted for only 14% of total GDP growth. In high social-savings Latin America, Argentina, Brazil and Mexico railways made a sizeable impact on economic growth. In Brazil railway technology accounted for up to 90% of all GDP per capita growth between 1854 and 1914 (Herranz-Loncan, 2011). In India railways contributed 0.29 percentage points to annual income per-capita growth from the mid nineteenth century, larger than Uruguay (0.11%), similar to Brazil (0.31%), but less than Argentina (0.65%) and Mexico (0.53%) (Bogart et al, 2015). The aggregate impact of railways in India were smaller because output growth in the dominant agricultural sector was stagnant. Food availability per capita showed no increase during the 1870s and 1890s, then declined until the early 1920s (Habib, 2006). In more recent years studies have shown a consistently positive impact of railways on economic growth. In China between 1990 and 2013 the impact of railway construction on economic growth was positive and that impact increased over time (Shi et al, 2017).

For SSA the railway renaissance is too recent to have had chance to generate economic changes. There are some impressionistic (and pessimistic) studies of completed new SSA railways which amount to efforts at before-after studies. A scholarly visit to the newly opened Addis-Djibouti railway in January 2018, about a year after opening, revealed a litany of concerns. Few local people were aware of its existence, it took 90 minutes to reach from the centre of Addis despite light traffic, no connecting trunk lines to industrial zones or depots had been built to improve the connectivity of the railway, the timetable was unpredictable and freight transport was running well below capacity (Tarrosy and Voros, 2018b). By 2019 the Addis-Djibouti line had earned $40 million in revenue against operating costs of $70 million (Carmody et al, 2021). A visit to the Addis Ababa light railway system in 2018 also revealed problems. The capacity of the light railway (110,000 daily passengers) was not enough to make any significant dent in traffic in a city of 6-7 million people. Many trains were only running with a single carriage as the system was constrained by a limited power supply (Tarrosy and Voros, 2018a). In Kenya the SCR was opened in 2017 and was unable to compete with traffic freight on the Mombasa to Nairobi route where costs to transport a container by road ($800) were less than the rate charged by the SGR ($1,100) (Carmody et al, 2021).

A second methodology is through the construction and use of Computable General Equilibrium (CGE) models. BRI researchers have built large CGE models that capture the trade, investment, income, expenditure and taxation interactions between government, households and firms domestically and between countries. These models are then 'shocked' with changes (estimates of reduced time and costs) induced by new transport infrastructure. All the domestic, regional and global interactions of these changes can then be accounted for. One CGE study estimates that BRI transport infrastructure will reduce travel times by 12% in the 70 countries along the BRI corridor and by 3% in the rest of the world (World Bank, 2019). This time saving is estimated to increase trade in SSA (5.59%) but by less so than Central Asia (21.2%), East Asia and the Pacific (10.98%), and South Asia (6.3%). Intra-African trade is projected to increase while SSA trade with Europe (-2.68%) and the Middle East and North Africa (MENA) (-2.06%) will decline (World Bank 2019:54). Another more limited study generates similar results. The study 'shocks' the CGE set-up by assuming that BRI will lead to a 10% decline in trade margin cost on imports and exports. The model is applied to Kenya, Ethiopia, Rwanda, Tanzania and Uganda. All these countries are projected to benefit from BRI, with welfare gains of between +0.4 and 1.2% of GDP (Mold, 2018:17). As with the World Bank (2019) study exports to the rest of the world are forecast to decline and intra-regional exports to increase (Mold, 2018:22). CGE modeling is adept at estimatingthe impact of economic changes (such as reduced costs of transport) when the structure of the economy remains otherwise fixed. As we discuss later in this paper CGE modeling is less adept at capturing the profound structural change that history reveals railways have unleashed, to patterns of industrialization and urbanizaion, the behavior of firms, and the adoption of new technology.

4. The Economic Impact of Railways – from Lessons to Indirect Evidence

Section 3 concluded that the circumstances of SSA (current lack of alternative transport routes and population distribution) offer the possibility for new railways to have a transformative economic impact. The section concluded that without big railway construction SSA lacks concrete evidence linking big railways to economic growth. This section looks at more disaggregated economic lessons from the railway story to add more suggestive evidence to the discussion. The results are positive, railways are likely to contribute to economic growth in SSA but only marginally so. There is little indication railways can have sufficient economic impact to justify the billions of dollars it will cost to build them.

4.1. Spillovers from railway construction and operation

Investment in infrastructure may generate spillovers and so wider economic benefits. The traditional empirical measure of spillovers is the proportion of total output that goes to other industries rather than final demand and also the proportion of inputs sourced from other industries (Hirschman, 1958). Other sources of spillovers include firms learning from the production methods, managerial or organisations methods of other firms (imitation); when employees learn skills in one firm and transfer them to other firms (skill transfer); and when firms learn from each other about new technology (competition effect) (section 4.2) (Gorg and Greenaway, 2004).

Before the railway era both the US and Germany lacked domestic industrial capacity and the construction of railways in both countries necessitated industrial imports from Britain. The US and Germany both imposed tariffs on the imports of pig iron, the key raw material then used to build railways (Fremdling, 1977). In both countries the tariff re-channelled demand to local producers and stimulated domestic industrialization. Government efforts in Germany to promote domestic industry were more comprehensive. These efforts also encompassed state investment, public-private cooperation, scholarships to promising innovators, subsidies to competent entrepreneurs, and directly facilitated the organisation of new machinery and industrial processes (Chang, 2002). The state also promoted universal elementary and higher education to ensure that skilled workers were available to industry (Bowen, 1950). Even by 1871 in the US imports still represented one-third of railway purchases (Fogel, 1966) while Germany was largely self-sufficient and even exporting railway inputs and technology (Fremdling, 1977). In Russia the government both provided tariff protection and subsidised domestic rail manufacture. By the late 1890s 80% of

technologically complex locomotives were being produced domestically (Blanchard, 2000). The railways promoted the growth of the Donbas coalfield, the metallurgical complex of the Ukraine and the giant industrial works such as Hughes, Briansk, the Aleksandrovsk, and Putilov works in St Petersburg (White, 1976; Blanchard, 2000).

In Mexico railways were constructed and operated with rails, locomotives, rolling stock, spare parts, iron bridges and supervisory engineering personnel imported from abroad. On occasion even fuel (coal and wood), ties for laying tracks and unskilled labor were imported. Imported inputs as a percentage of total operating costs fluctuated between 30 and 40%, with no downward trend during the late nineteenth century (Coatsworth, 1979:955). Mexican politics was dominated by landlords who used railways to help "land-grabbing on a scale unknown since the Spanish conquest." (Coatsworth, 1979:958). The railways were used for the benefit of landlords, to export agricultural produce and import cheap manufactured goods. On the Mexican Central Railway (the country's longest) minerals and fibers accounted 1.3% of total freight tonnage in 1885 and 58.2% in 1908. In India the situation was even more striking. The railways were promoted not to benefit a domestic agricultural class but rather a foreign (colonial) British manufacturing class. British manufactures saw railways as a means to open up India for British exports and to facilitate their access to raw materials, especially cotton (Thorner, 1955). The British government was receptive. The 1873 British Parliament had 132 MPs and 54 Lords who were directors of railway companies (Hylton, 2016:179). Except for ballast for railway tracks and coal everything needed for railways down to sleepers was obligated to come from Britain (Habib, 2016). Between 1854 (the first railway opening) and 1884 and the volume of British cotton manufactured exports to India increased five-fold (Connell, 1885). By 1880/81 British manufacturers were supplying more than half of India's cotton cloth consumption (Habib, 2006:94). Foodgrains and raw cotton constituted 36% of rising Indian exports by 1869-70 (Habib, 2006). Between 1850 and 1910, 94% of Indian broad gauge locomotives were built in Britain and only 2.5% in India (Sinha, 2017). Even despite these policy strictures some spillovers leaked out into the domestic Indian economy. By 1899 the railways repair workshop at Jamalpur was employing 10,000 people, mostly Indians, and by that date had even manufactured a locomotive (Sinha, 2017).

Between 1960 and 1975 workers in Africa who left agriculture were employed in higher productivity manufacturing (De Vries et al, 2013). After the mid-1970s Africa stopped industrializing. The manufacturing share of employment declined, from 8.9% in 1990 to 8.3% in 2010 (De Vries 2013). Workers exiting agriculture tended to enter a low-productivity and often informal service sector (Badiane et al 2012). The contribution of structural change to growth turned negative for Africa during the 1980s, early 1990s, and into the 2000s (Badiane et al, 2013; McMillan et al, 2014). Africa needs railway-induced spillovers to boost domestic industrialization. Such spillovers may occur at the stage of railway-construction or operation.

Railway Construction: The railway (and other infrastructure) renaissance in SSA is reflected in a construction boom. In 2013 Chinese FDI into Africa totaled $3.1 billion and COPs (Chinese overseas contracted projects) reached $40.6 billion (Wolf, 2016). The share of SSA firms winning construction tenders declined in the 2000s relative to the 1990s (Zhang and Gutman, 2015). This limits learning by local firms. Local firms can also supply materials used by foreign or domestic construction firms. In Angola Chinese construction was initially supplied with imported cement. Angola then gradually developed domestic production. By 2014, Angola emerged as the third largest producer of cement in

SSA (Wolf, 2016). The construction of the SGR in Kenya reportedly sourced around 40% of materials from local sources and the construction of the Addis-Ababa railway reportedly sourced 25-30% of material from local sources (Carrai, 2021).

Railway Operation: BRI-built railways are too few and too recent to draw definitive conclusions as to their contribution to industrialization in SSA. We can use a number of related literatures to draw out several ideas. The *first* is the criticism that Chinse transport infrastructure is targeted towards exploiting natural resources rather than promoting domestic industrialization (Taylor and Zajontz, 2020). By 2015 less than 14% of Chinese private FDI stocks in Africa were in manufacturing and most of the rest was in mining (Wolf, 2016). One study forecasts that Kenya, Ethiopia, Rwanda, Tanzania and Uganda will experience declining outputs of manufactured goods such as textiles, light manufacturing and heavy manufacturing and increased output of grains and crops and marginal increase in extractive industries (Mold, 2018:20). Another study of the BRI shows that SSA trade is projected to increase in agriculture (2.59%) and some raw materials such as coal (13.32%), wood products (3.63%), and petroleum and coal products (5.62%). The study also confirms that trade will decline in some manufacturing sectors such as processed foods (-0.95%), paper products and publishing (-6.63%), chemicals, rubber and plastic (-4.33%), and metal products (-1.52%) but will increase in others such as energy intensive manufacturing (4.47%), electronics (6.44%), machinery and equipment (10.36%), and transport equipment (21.25%) (World Bank 2019:56).

The emphasis of these studies on the trade cost impact of BRI is only one part of the story. Official Chinese government policy has shifted to promoting manufacturing in SSA. In 2006 China's Ministry of Commerce (MOFCOM) launched a program to support the construction of overseas economic cooperation zones and five were eventually constructed in Africa (Egypt, Ethiopia, Mauritius, Nigeria and Zambia). The zones have attracted manufacturing investment, mainly from China (Tang, 2015). More generally private Chinese enterprises have invested in manufacturing motivated by expected improvements in infrastructure, expected government policy coordination and political cooperation (Du and Zhang, 2018). Manufacturing investment from China has been on the increase and in 2013 constituted 31% of annual Chinese private FDI (Wolf, 2016). In 2016 and 2017 a team from McKinsey Africa and China conducted a large-scale survey of 1,073 Chinese businesses across eight African countries (Cote D'Ivoire, Angola, Ethiopia, Kenya, Nigeria, South Africa, Tanzania and Zambia). Chinese firms were estimated to have a 12% share of manufacturing production ($60billion of output) in Africa (Sun et al, 2017:30). Chinese firms displayed a distinct Afro-manufacturing optimism. 74% of Chinese firm managers said they were optimistic about the future and such confidence was uniformly high across all sectors and countries. Many of the firms said they had plans for expansion, particularly into new products and industries. Many Chinese firms have made investments that reflect a long-term commitment to Africa. 44% said they had made capital-intensive investments, for example building factories or purchasing manufacturing equipment (Sun et al, 2017:36).

The *second* is the criticism that Chinese manufacturing firms, once drawn by a participation in BRI, don't then generate backward spillovers for locally owned firms. Here there is more enduring critical substance. Some Chinese firms do source simple, largely non-processed inputs such as leather, wood, and minerals from local companies. Even here a large number of Chinese manufacturers import almost all of their most basic raw materials from China (Tang, 2015). Several African countries have rules for foreign companies to sub-contract a part of their work to local firms. In Nigeria furniture imports were banned and foreign firms are obliged to source 35% of value

added from local sources to be able to sell products produced in a Free Trade Zone (FTZ) to the rest of Nigeria. The large size of the domestic market has lured foreign investors and boosted spillovers. Even in Nigeria, furniture remains the exception and Chinese firms still import the majority of their raw materials from China (Chen et al, 2016:16). In some cases Chinese firms have established long-term partnerships with local sub-contractors and may provide technological and financial assistance to them. More often Chinese firms complain about the difficulty of sourcing inputs from local suppliers and try to bypass the regulations. Few Chinese firms purchase processed or industrial inputs from local firms (Tang 2015). Chinese manufacturing do generate forward linkages and tend to use local wholesalers and distributors to market their goods on the local market, such as in Nigeria (Chen, 2021).

Spillovers can also occur in manufacturing through the acquisition of skills. Survey evidence shows that Chinese investment has created large numbers of jobs in their host countries, chiefly for African workers. A survey in Angola and Ethiopia found that Chinese firms contributed up to 60% of new manufacturing jobs between 2013 and 2018 (Oya and Shaefer, 2019). A survey in Kenya found that 78% of workers in Chinese owned firms were local (Rounds and Huang, 2019). The 2017 McKinsey survey of 1,000+ Chinese enterprises across eight African countries found that 89% of employees were African, adding up to more than 300,000 jobs for African workers (Sun et al 2017:40). The poor quality of existing skills among African labor is a recurrent theme of the BRI-Africa literature. One Chinese construction company surveyed was even reported to say that graduates from African vocational schools were worse to hire than un-qualified labor, as they had imbibed ideas from an obsolete curriculum (Sun et al, 2017:40). Chinese owned firms make an effort to improve African workers' productivity through labor training. In the McKinsey survey nearly two-thirds of the 1,000+ Chinese firms surveyed said that they provided some sort of skills training (Sun et al, 2017). Most companies reported learning-by-doing or on-site training, rather than formal training activities. Formalized training programs were more often offered by large Chinese companies, especially in manufacturing and telecoms (Calabrese and Tang, 2020). In Ethiopia, due to lack of skilled personnel, the railways were contracted under a build-operate-transfer method, with final transfer to Ethiopian operators in 2023. In the agreement Chinese contractors pledged to send Ethiopian Railway Company (ERC) employees to technical universities in Beijing, Tianjin and Chengdu for training in railway maintenance and operation (Carrai, 2021). The Chinese firm AVIC has set up a technical and vocational training program in six African countries to develop the skills needed for its own subsidiaries (Sun et al, 2017). AVIC invested in four major skills development projects in Kenya that was enthusiastically evaluated by participants but didn't lead to much eventual job creation (Sun and Lin, 2017). The pro-active developmental state in Rwanda required the Chinese firm C&H Garments to implement a skills transfer programme to local employees when it opened a large factory in 2017. In return the government of Rwanda invested heavily in new skills training programmes (Eom, 2018).

Evidence from contemporary and more distant history highlights the importance of using an industrial policy to ensure that the potential spillovers from infrastructure investment create pro-industrialization spillovers. An industrial policy encompasses "policies that stimulate specific economic activities and promote structural change." (Rodrik, 2008:3). In nineteenth century Germany industrial policy worked to promote local industrialization and in India to promote industry in distant Britain. The government of Ethiopia has utilized a clear industrial policy, Ethiopia's vision has been expressed in a series of developmental plans, including The Plan for Accelerated and Sustained Development to End Poverty (2005-2010) and the Growth and Transformation Plan (2010-2015) (Nicolas, 2017). Ehiopia's development plans promoted engagement with China to alleviate

infrastructure bottlenecks in roads, railways, and energy supply, attract Chinese and other foreign investment in manufacturing and promote the growth of locally owned firms (Sun et al, 2017). There is some limited evidence these efforts have resulted in local firms benefiting from spillovers associated with Chinese investment in manufacturing (Seyoum, 2015), Dutch investment in flower growing (Melese and Helmsing, 2010) and Chinese imports of footwear (GebreEgziabher, 2006). There is little evidence of other SSA governments utilizing an industrial policy to promote spillovers. In Zambia, for example, there has been no effort to promote backward spillovers by tackling skills shortages, capital market imperfections, high transport costs or implementing rules to ensure Chinese firms source inputs from local suppliers (Fessehaie 2012; Fessehaie and Morris, 2013).

4.2. **Induced Technological Change**

Railway construction stimulated a wider process of technological upgrading. In the case of Russia, the railways facilitated the rapid export of grain in the 1860s and 1870s which in turn provided the foreign exchange that permitted the import of foreign technology and machinery needed for domestic industrialization (White, 1976). In Germany iron production expanded rapidly in the 1830s and 1840s to build locomotives, wagons, rail, and bridges (see Section 4.1.). This entailed not just an expansion of output but also the adoption in the 1850s of modern coke-using blast furnaces. Foreign technology was transferred through leading German manufacturers traveling and studying in France and Britain, though employment of foreign engineers and skilled workers (Fremdling, 1977). A rigorous study of railway-induced technological change comes from the case study of Japan. The study combines geographical data of the railway expansion that identifies the opening year of each section. The measure of technology comes from cross-sectional factory data which contains the physical location of the factory and information on its power sources. The results show that railroad access growth accounted for 67% of factories use of new steam power technology (Yamasaki, 2017). Railways can also promote the spillover of knowledge. In 2016 there were 803 universities in China. Eight mega cities (out of 287 prefecture-level cities) hosted 64% of the first-tier universities with excellent facilities that attract the best scholars and students. Almost 100 cities have no universities. Between 2006 and 2016 more than half of peer-reviewed international journal papers were produced by scholars at the first-tier universities. Using a data set of academic publications shows that researchers working in second tier cities enjoyed a productivity boost after their city was connected by HSR with the mega cities. Both the quality (impact factor of the journal of publication) and quantity (number of papers written per year) of published papers increased. HSR facilitates inter-city travels and face-to-face communication, and leads to better matching and interactions, through mechanisms such as academic conferences (Dong et al, 2020).

Aggregate measures of the technological sophistication of SSA production and exports remains well below other developing countries. Africa's rate of progress in technological upgrading even slowed after the 1970s (Badiane et al (2012). Section 4.1 showed that BRI has stimulated investment in Africa by Chinese firms. There are many examples of Chinese firms introducing new technology to Africa. The McKinsey survey of 1,000+ Chinese firms across eight African countries showed that Chinese firms engage in technology transfer in Africa. Nearly half of Chinese firms in Africa have introduced a new product or service to the local market, and more than one-third introduced a new technology. In some cases Chinese firms have lowered prices for products and services by up to 40% through improved technology and scale efficiency. The Chinese firm Tecno developed a smartphone for Africa which retails for less than $50 and offers a camera specially designed to take clear pictures

of darker skin. Tecno was the first to introduce a keyboard in Amharic, in Ethiopia. Safaricom launched the mobile payment initiative M-pesa in Kenya in 2007. In 2015 M-pesa migrated all 12.8 million of its Kenyan subscribers to Huawei's platform in a single day which greatly increased the ease of making payments. In Tanzania, China StarTimes broadcasting invested $120 million over six years and reduced the local price of pay-television by 80-90% (Sun et al, 2017:44). There are also examples of technology being transferred from Chinese to locally owned firms. One study uses data from 1,033 manufacturing firms operating in Ethiopia in 2011. The study finds that foreign-owned firms are significantly more productive than their local counterparts suggesting that there are domestic opportunities for technology learning-imitation. The results show that the productivity level of Ethiopian firms is positively related to the share of foreign firms in the sector (Seyoum et al, 2015). Fieldwork surveys in Nigeria in 2014 and 2015 found that local manufacturing firms procured Chinese machinery. This machinery was set up and serviced by locally based Chinese equipment suppliers and tended to be much cheaper that European alternatives (Chen et al, 2016:13).

Studies are consistent in their assessment that technology transfer is relatively low and not enough to ensure SSA closes its growing technology gap with the rest of the world. The most effective mechanism to transfer technology to local firms is often argued to be joint ventures, of which there are few examples in SSA (Chen et al, 2016:14). Some explain the reason for technology-lagging to be the lack of local-SSA capabilities, in particular lack of labor and management skills, and the tendency of Chinese firms to invest in the most technologically simple, labour-intensive aspects of manufacturing in SSA. Huawei for example by 2020 had opened eight training centres across Africa but limited technology transfer to relatively simple tasks such as installing systems. There was no indication that local employees would be sent to China to participate in more basic aspects of R&D (Tugendhat, 2020:24).

4.3. **Impact on Urbanization**

Across human history urbanization has a very strong correlation with levels of GDP per capita. As countries develop people move from rural agricultural activities into urban centers and high(er) productivity manufacturing and service activities. Many researchers have used urbanization as a proxy measure for income (Gollin et al, 2015). Railways made a three-fold contribution to urbanization driven economic growth.

Railways *firstly* stimulated urbanization indirectly by permitting mass migration. The first major railway line from London was constructed in 1837. Railways facilitated rapid urbanization thereafter and the population of London grew from 2.8 to 7million people in the fifty years after 1861 (Wolmar, 2012b). The US railways were key in facilitating mass international migration into the US interior. Before the Transcontinental Railway was completed, it cost less ($65) to travel from Liverpool to the US than to cross the Great Plains (Ambrose, 2005:280). The Transcontinental Railway reduced the coast to coast journey from six months to a few days (Ambrose, 2005). Land agents were afterwards ready in Liverpool to persuade settlers to head for Iowa or Nebraska (Wolmar, 2012:182). In Russia the Trans-Siberian railway transformed Siberia from a place for criminals in exile to a place for migrants to work in industry and agriculture. Three million people migrated to Siberia between 1906 and 1914 and between 1896 and 1921 the population of Siberia doubled (Wolmar, 2014:155).

Secondly, railways stimulated urbanization more directly. The railways created stopping points with hotels, water tanks, repair facilities, and unloading equipment and from these grew farms, villages and cities (Ambrose, 2005:167). The village of North Platte grew from nothing to 5,000 inhabitants after the track stopped there in 1866-7 (Ambrose, 2005:217). It may be instinctive to think of the railway construction labor force as only a temporary entity. In the UK the navvies who travelled from site to site to build the railways became famous for laboring and drinking. In the Southern US, slave labor was used before and convict labor used after emancipation (Wolmar, 2012). This image is partly a myth. The Baltimore and Ohio (B&O) was the largest US railway by the late 1850s. The initial construction work on laying rails was the prelude to ongoing work to maintain and repair bridges and track over cycles that continued for many years. Early timber tunnels were revisited in a secondary building with brickwork and masonry. Those parts of the rail route that were most heavily used were subsequently expanded through double-tracking (Healey et al, 2013:18). On major lines such as the B&O, it was possible to secure quite steady work over long periods with prospects for job progression. Payroll evidence from the B&O shows that about 25% of the 1842 workforce was still in the company's employment 15 years later (Healey et al, 2013:22). Many skilled workers, such as machinists, blacksmiths and shop-men moved to the 'machine shop' towns, such as Martinsburg and Piedmont (Healey et al 2013:30).

The first competed railway line connecting Chicago was the 1848 Galena and Chicago Union Railroad. By 1852 Chicago was connected to the eastern seaboard via the Michigan Central (Wolmar, 2012). This rail link stimulated urbanization in Chicago as a hub for trade of meat, timber and grain from farms in the Midwest to urban areas on the east coast. One study shows that more than half of Midwestern urbanization in the 1850s can be attributed to the causal impact of railroad diffusion (Atack et al, 2010). Elsewhere, between 1815 and 1871 the urban population of Prussia (the core of modern Germany) grew from 2.8 to 6.7 million people. Analysis of an extensive dataset for 978 Prussian cities shows that access to railways had a significant impact on city growth rates between in the mid-nineteenth century (Hornung, 2014). In Russia the Trans-Siberian railway fueled extensive urbanization in the region. The population of Novosibirsk grew from 764 in 1893 to 100,000 by 1917 and the populations of Omsk, Chita, Krasnoyarsk and Irkutsk doubled in size (Wolmar, 2014:155). In India the railway era after 1860 coincided with urban growth. Important railway stations such as Madhupr, Mughalsarai, Allahabad, Behrampur, Cawnpore, Etawah, Tundla, Ghaziabad, Delhi, and Jamalpur transformed into railway towns (Sahoo, 2020).

Thirdly, this process of urbanization was boosted further when land grants to railways gave constructors an incentive to develop that land. Railway companies would then benefit directly from real estate profits and also indirectly by encouraging the migration of people and business to new locations and so generating more passenger-traffic for the railway. The Metropolitan Line of the London underground had a (unusual) right to land along the line of rail. Along the line as it snaked 50 miles into the countryside to the North-west of London the company built and marketed housing on its own estates such as Kingsbury, Neasdon and Wembley Park. The most prestigious development was the 1925 Chiltern Court over Baker St. which included 500,000 square feet of shopping and luxury flats. For an outlay of £500,000 pounds the company received an annual rental income of £40,000 (Wolmar 2012b:248). Other lines created incentive that other constructors took advantage of. The District Line on the London Underground was carrying 51 million passengers a year by 1904 through a dense network of lines that accelerated the expansion of London suburbs such as Fulham, Richmond, and Ealing (Wolmar, 2012b:108).

In SSA there is a long history of railway construction stimulating urbanization. In colonial era Ghana, the British government built two lines to link the coast to mining areas. These lines passed through low-populated tropical forests and helped turn them into cocoa plantations, of which Ghana became the world's leading exporter. This in turn attracted European settler and the resulting economic development of those areas determined the location of Ghana's main cities at independence. Ghana's urbanization rate increased from about 20% in 1901 to 40% in 1931 and to 70% in 2000 (Jedwab and Moradi, 2016:272). While newly constructed BRI railways may contribute to boosting urbanization across SSA the implications for economic development are today less clear. History has shown a consistently tight link between urbanization and increasing income per capita. This link has broken down across much of contemporary Africa. For example Gabon, Libya, Algeria, Angola, Zambia and Nigeria have high rates of urbanization with little industrialization. The breakdown in this relationship occurs because many countries have urbanized without significantly increasing the share of output from manufacturing and/ or tradeable services in GDP. SSA is urbanizing without increasing average incomes (Gollin et al, 2015).

5. Railways and the State

This section looks at how we can learn from the historical and contemporary history of railway construction more about the important role of the state. BRI is very much a statist, China to SSA, project. This is not surprising and is not only a manifestation of China's statist development model but reflects the economic reality of railway construction. This section explores the role of the state in relation to coordination and market failures, distributional implications, institutions and organization and financing.

5.1. Railways, Coordination and Market Failures

There is a big market failure in the construction of transport links such as railways. For a landlocked country in SSA there are crucial external benefits from investment in transport infrastructure by countries lying between them and the coast. Improving the railway line in Uganda, for example, would have little effect unless there was similar improvement in the line as it passes through Kenya on the way to the port in Mombasa. Why should Kenya take into consideration those external benefits to its investment for Uganda? When looking at existing levels of economic activity, patterns of road-carrier trade, and existing local (national) demand there is little obvious reason to invest in transcontinental railways. The World Bank for example proposed 100,000km trans-Africa road network to link 83 major African cities. The (direct) cost of $32billion over 15 years looks vast relative to existing patterns of limited intra-African trade. The external effects of improved transport integration are enormous. The (indirect) benefits of increased trade were estimated at over $250billion (Naude 2007).

The historical record of railways is littered with warnings about the costs associated with a lack of state-led coordination in construction. The privately built British railway system was highly fragmented. By 1880, 12 of the 15 largest towns in UK had competing routes to London and railway stations in the same town were often not connected to each other (Hylton, 2016:42). The construction of the London underground was long undermined by destructive competition between the Metropolitan and District lines. They ran parallel tracks and had debilitating arguments over payments for shared tracks. This failure to cooperate led to long delays to the completion of the Circle Line (Wolmar, 2012b). Though the US had more than 31,000 miles of railways in 1860, the system was likewise fragmented. There was no single national gauge and the 4 feet 8.5 inches standard accounted for only 50% of the total mileage. There was a 5 feet standard gauge in the south (White, 2011). There were 11 different gauges in the North and a similar number in the South (Wolmar, 2012:72). Railway lines were poorly connected to each other and railway companies often did not share terminals. Freight offloaded in Philadelphia, for example, had to be carted across the city to continue the journey (White, 2011). Virginia had five railway lines all leading to a different depot, none of them were connected and only three used the standard gauge (Wolmar, 2012). The construction of the Transcontinental railways led to much greater US government efforts to

coordinate the system. In 1864, Lincoln approved 4 feet 8.5 inch as the standard gauge (Ambrose, 2005). After the Civil War, the decision was enforced on the South, which converted 13,000 miles of track, 1,800 locomotives and 40,000 coaches (Wolmar, 2012:214). In India, by c1900 the privately built railway system was complicated and incoherent with a wide variety of gauges and types of ownership structure (Wolmar, 2017). Each company operated an independent 'empire', some charging high rates on any part of their system that linked up with other railways (Thorner, 1955). In contrast to the Anglo-American tradition, in continental Europe the much closer involvement of the state in economic affairs was more widely accepted. In Belgium the state financed the basic infrastructure, and private companies operated the railways and financed complementary infrastructure such as the rolling stock. The railway system was planned as a radial network of trunk lines with Paris as its center (Fremdling, 2003:211).

The construction of the Balkan railways shows how the identity of the governing authority led to different principles of integration. Between 1850 and 1918 the Austro-Hungarian and Ottoman empires dominated the region. The railway networks were mainly shaped to link the imperial capitals, Vienna, Budapest and Istanbul with the other cities of their empires. A second motivation was that of the external financiers, France, Britain and Germany, who sought to connect Europe to their colonial possessions in the Middle East. After the end of WWI in 1918 and the emergence of numerous new nation states in the Balkans, the railway systems fragmented. The national railway networks were mainly used to reinforce the internal sovereignty of states by connecting up domestic urban locations. The density of these networks increased but cross-border connections were relatively neglected. The USSR dominated the region after WWII and promoted trade across the region which again required better regional transport connections (Stanev et al, 2017). In China, the unified, central governing authority the Chinese Communist Party (CCP) launched the Western Development Strategy in 1999 to accelerate economic development in the more backward regions, and generate local employment (Lu and Deng, 2011). The effort included huge infrastructure investments in energy, mining and of course HSR (Strafor, 2013). An over-riding political aim of the project was to promote national integration and nation-building by more closely binding a region - that contained numerous minority groups and was suffering from political conflict – to the rest of China (Goodman, 2004).

The principle that construction of railways under the BRI follows could be various. China is most interested in utilizing SSA as a source of raw materials and as a market for Chinese manufacturing and construction firms. China has an incentive to build railways that link up the principle urban areas to facilitate the growth of a national market and to connect up urban and mining areas to ports to facilitate international trade. In 2002 the African Union (AU) emerged from the 1963 Organization of African Unity (OAU) (Phiri and Mungomba, 2019). In 2018, 44 countries signed the African Continental Free Trade Area (AfCFTA) committing themselves to end cross-border tariffs and 27 signed a protocol for the free(er) movement of people (Van Staden et al, 2018). If the AU dominates the railway agenda then construction will emphasize connecting up urban areas across borders. The AU participated in FOCAC 2012 in Beijing as a full member. China established a permanent mission to the AU in 2015. The AU has been able to successfully engage with China and promote its intra-Africa vision (Van Staden et al, 2018). The AU though remains weak relative to African nation states and is unable to impose its agenda on its member countries (Van Staden et al, 2018). SSA has a poor record in promoting intra-African infrastructural coordination. In the early 2000s there were four different rail gauges in use in Africa making inter-country links harder (Naude, 2007).

5.2. **Distributional Impact of Railways**

The Chinese government frequently repeats the mantra that BRI infrastructure construction will represent a win-win intervention. Modern economic theory makes it clear that infrastructure construction will, to the contrary, generate both winners and losers. The distributional impact of railways will hinge on the interplay between reduced transport costs and economic agglomeration externalities (Marshall, 1920). Agglomeration externalities occur when firms and workers derive benefits from being in close geographical proximity. In Ethiopia, for example, it makes sense for those with skills in leather footwear to live near a factory cluster. In turn this means new leather footwear factories are more likely to open near the growing pooled of skilled labour. Agglomeration externalities also operate at the level of knowledge. A close location makes it easier to exchange ideas about production and technology between firms in similar industries so raises the productivity of firms and workers. The extra mobility created by improved BRI-inspired transport links could create a snowball effect. Better transport connections will help firms and workers re-locate from other regions or countries to take advantage of large markets in cities like Addis Ababa and Nairobi (Puga, 2008; Ottaviano, 2008). The optimists note that BRI-induced railway development will likely reduce transport costs (section 3.2). These reduced costs will help spread economic growth to new areas by making it cheaper for those areas to produce, benefit from agglomeration externalities and then transport goods to customers. Pessimists sometimes forget that railways run in two directions. In impoverished southern Italy during the 1950s new transport infrastructure facilitated imports of goods from the rich north of Italy and the migration of people away from the South, so perpetuated relative poverty (Faini, 1983).

The historical and contemporary records confirm the insights of modern macro-economic theory. Railways create new wealth and destroy existing wealth. Railways are a win-lose, not a win-win technology. In Britain, 40 coach services that ran through Northampton daily all closed within six months of a local railway opening. The Manchester and Leeds Railway caused the value of Rochdale Canal shares to fall from £150 to €40 in two years (Hylton, 2016:23). During construction of the London underground Metropolitan Line, affluent landlords north of the river had significant influence over the conditions under which railways got access to their land. The line from South Kensington to Westminster cost £3million, five times as much as Metropolitan paid for longer line from Paddington to Farringdon, as big landowners used political leverage to extract substantial compensation (District Line) (Wolmar, 2012b:72). It was dense working class housing that was cleared with little effort at compensation. The Metropolitan line from Paddington to Farringdon St is estimated to have displaced 12,000 residents. Some of those re-housed as compensation were evicted two years later and their houses turned into profitable warehouses (Wolmar, 2012b:29). Railway companies paid slum landlords to evict tenants before a construction application to reduce compensation payments (Hylton, 2016:44). In the US the politics of land acquisition were even more egregious, though affected far fewer people. The 1851 Treaty of Laramie recognized that the Cheyenne and Arapaho held vast territory between the Rockies and western Kansas. The Transcontinental railway was built through this land in violation of the treaty (Wolmar, 2012:141). Native Americans found near the railway were killed and villages in close proximity were burned (Wolmar, 2012:162). The first wave of railway construction in Sweden between 1855 and 1870 generated large population increases in connected towns. This growth came at the expense

of non-connected towns more than 90km from the network which lost population (Berger and Enflo, 2017:125). This distributional impact was long-lasting as towns that gained access to the network during this first wave continued to grow experience faster economic growth throughout the nineteenth and twentieth centuries (Berger and Enflo, 2017:125). The construction of the railway in nineteenth century Japan led to manufacturing activity re-locating from small to larger towns (Tang, 2014). In India between 1861 and 1930, Donaldson (2010) found that when a district was connected to the railway its own income rose by 18% but income in neighboring districts declined by 4%. In China, to maintain speeds of 200km+ per hour, HSR trains only stop at populous urban areas and not small cities and rural areas. Around 3,000 from 6,100 passenger train stops in China were abandoned in the ten years of HSR construction after 2004 (Qin, 2014:3). Being located on an HSR line decreased total GDP and GDP per capita, by 4-6% on average (Qin, 2014). Another study combines satellite images of night lights from 1992 to 2009 with digitized national road and rail maps from 1962 to 2010 for China. The results show that each additional radial railroad line caused a displacement of about 17% of central city GDP and 26% of central city industrial sector GDP to surrounding regions (Baum-Snow et al, 2012).

The image, often inspired by the anti-monopoly protests in the US, of rapacious railway companies gauging out large profits to the detriment of railway users was not in general true. Where poor residents lost, poor travelers gained. In Britain between 1859 and 1874, the proportion of national ticket sales accounted for by third class increased from 50% to 77% (Hylton, 2016:29). On the London underground Metropolitan Line, 70% of tickets sold in the early years were for third class mass transport and only 10% for first class (Wolmar, 2012b:54). The Metropolitan Line ran special cheap (2 pence for 20 miles) working men trains that enabled poorer professionals to commute from outside London. This was a legislative condition on the underground company to compensate poorer people for the clearing of working class housing when building Liverpool St terminus (Wolmar, 2012b). On the Russian Trans-Siberian railway the vast majority of passengers travelled in third class so were most likely peasants (Wolmar, 2014).The private rate of return to railways in Britain averaged around 5%, there were no super-normal profits being earned (section 5.4. discusses measures of the wider social benefits of railways). A major reason for this was competition. Most major inter-city routes were served by competing railway companies and as late as 1910 almost 60% of domestic freight ton-miles in Britain were by sea (Crafts, 2004). In Mexico, Argentina, Brazil, Chile, and Uruguay across the late nineteenth and early twentieth century's railways earned minimal profits or made losses (Herranz-Loncan, 2011:12).

Well organised urban groups in Africa such as formal sector unionised workers, government employees and rent-receiving politicians have benefited from trade protection and import-substitution, while rural workers and farmers have lost out. Estimates have tended to show that the redistributionary effects are large relative to the overall efficiency gains of trade liberalisation (Rodrik, 1995; Yang and Gupta, 2005). There is no doubt in either theory or evidence that opening up Africa to freer intra-African trade and facilitating this with a continental wide network of transport will have distributional impacts. The fear of distributional impacts has hindered trade reform in Africa over decades. This paper has shown that railways may stimulate economic growth (section 3) but that big infrastructure always has distributional impacts at more disaggregated levels (above).

5.3. **Institutions, Organizations and Railways**

In the US the railway booms were associated with organizational innovation. The financing of railroad construction promoted the growth of the stock exchange. In 1873, railways held 80% of total stock market capitalization. Other railway-inspired financial developments included investment banking, security brokerage, and legal firms specializing in corporate law (Jenks, 1944). The railways were also associated with institutional degradation that undermined those new organizations through corruption and malpractice. The railways attracted individuals who became notorious for their financial speculation-manipulation. In Britain, George Hudson the Railway King paid investors unrealistically high dividends using money raised for the next round of construction. By 1848 Hudson had control of 1,450 miles of the 5,007 mile national system. The railway boom came to an end soon after as Hudson's financial shenanigans came to light and he fled the country with his investors losing £80million (Hylton, 2016:70). The US financier Charles Tyson Yerkes (jailed in the US for embezzlement in 1871) gained control of large part of the London underground in the late nineteenth century through a wide array of dubious financial practices (Wolmar, 2012b). In the US, Jay Gould manipulated stock prices to gain control of railway companies. Gould aimed to form exploitative monopolies over natural regions of commerce. For example he took control of the Erie railway which gave him leverage over coal, iron and oil in the territory west of New York (Morris, 2005). In the US railways helped create a corrupt system of corporate lobbying (White, 2011). The Central Pacific hired former Union Army General Richard H Franchot as the first paid lobbyist, on the then enormous salary of $20,000 per year (Ambrose, 2005:193). One estimate puts the total railway bribes paid to Washington at $13 million (Wolmar, 2012).

In 1864 the directors of the Union Pacific railway purchased the unknown company Pennsylvania Fiscal Agency. It was renamed Credit Mobilier (CM) and turned into a construction company owned by the directors of Union Pacific and other insiders. CM received inflated construction contracts from Union Pacific. Union Pacific struggled financially while CM (and its owners) made huge profits (Ambrose, 2005). By the late 1860s CM was granting dividends to its stockholders of 50-100% per year (Wolmar, 2012). In December 1869 as Union Pacific was $10 million in debt and owned $700,000 in wages that were eight months in arrears, CM paid a huge dividend to stockholders (Ambrose, 2005:318).

Will big infrastructure investment channeled through the BRI promote or degrade institutions in SSA?

Resources (whether aid or loans for infrastructure) channelled to governments can contribute to improving the quality of the civil service, strengthen policy and planning capacity, and establish strong institutions. South Korea and Taiwan in the 1960s and 1970s were good examples of this. Botswana shows that the same processes can also work in SSA (Brautigam and Knack, 2004). It is a proud point of principle that China offers loans without any such conditionalities. Chinese investment to SSA is not going to countries conditional on them having or making efforts to improve good governance or reduce corruption. The top ten destinations for Chinese investment to Africa in 2003-17 were Egypt, Nigeria, Algeria, South Africa, Mozambique, Ethiopia, Angola, Niger, Zambia and Morocco. Nine of the ten (except South Africa) are in the middle or bottom of the global Corruption Perceptions Index (CPI). Among the top ten recipients of Chinese FDI in Africa 7 were outside the World Bank

top 100 easiest places to do business in 2018. Mozambique and Zimbabwe experienced sharply declining measures of governance between 2012 and 2016 yet China continued investing. China also continued to invest in high-risk, conflict prone countries such as DRC, Sudan and Angola (Ado, 2020). High levels of foreign resource flows can reduce incentives for bargaining over revenues and taxation which may be critical for the development of accountability and transparency and may provide a soft budget constraint that undermines budget planning and controls. Foreign resource flows can motivate governments to undertake riskier investments knowing that (Chinese) financiers will bail them out. The empirical evidence confirms that higher foreign resource flows are associated with declines in the quality of governance (as measured by the International Country Risk Guide (ICRG)) (Brautigam and Knack, 2004). A related view is that Chinese companies have long experience in negotiating and lobbying via informal institutions and political connections (known as guanxi in China) and so have an advantage over western firms in thriving amidst the weak institutions prevalent in SSA (Ado, 2020). The optimist may note that this permits long-term infrastructure and industrial investment in the poorest SSA countries. The pessimist may conclude this could lock in a politics of poor institutions to the enduring benefit of Chinese investors and SSA elites.

The optimist may extend that argument and suggest that Chinese-funded infrastructure may promote economic growth in SSA and that economic growth in turn improves institutions. Recent economic history gives us good examples of initially poor countries that managed to ignite economic growth and then gradually improve institutions over the last fifty years. These countries include China, Indonesia, Malaysia, Singapore, South Korea, Taiwan, Thailand, Vietnam, Tunisia and Dominican Republic. The data shows that measures of institutions are broadly equivalent in SSA today as in Indonesia and Thailand in the early 1960s or in Vietnam and China c1980 (Johnson et al, 2007). As people become richer they demand better institutions, better public services, more security, law and order and greater political participation. This dynamic was captured by the Lipset (1959) hypothesis that showed how democratisation follows incomes growth. These escapes from weak institutions generally involved export-led growth, especially of manufactured exports (Johnson et al, 2007). Manufacturers in turn started demanding better institutions, such as legally enforced protection of property rights to protect their investments. Governments obliged over time as manufactured exports generated politically important employment and wealth. If BRI infrastructure can promote spillovers and boost domestic manufacturing (section 4) and promote the transfer of technology (section 4.2.), then perhaps it could help promote a virtuous economic growth-better institutions cycle over time.

Railway construction in SSA is too recent to test this dynamic perspective in a rigorous manner, but ad hoc case studies offer some suggestive evidence. Two recent big China-SSA infrastructure projects financed by China Exim Bank and constructed by Chinese state-owned construction companies give us a mixed bag of evidence. The ADR links Ethiopia's landlocked capital to a station near the deep-water Djibouti Port. There was little transparency about the deal which was negotiated by high-level bureaucrats without any external oversight. These negotiations received some criticism and there was some sign of institutional quality changing in response. In 2018 the government of Ethiopia added a rule that its attorney general must approve all large loan agreements (Carrai, 2021). The SGR connects the Kenyan capital Nairobi to a port in Mombasa. Construction occurred in the run-up to a national election. The President's office utilized the project for electoral purposes, speeding up construction, overriding government regulations, neglecting protection for (politically inconsequential) landowners, and rejecting legal petitions from activists challenging the financial agreement and procurement procedure (Carrai, 2021:6). Despite China's reputation-promise of

non-interference, pressure to maintain or improve institutions did come from China. China's Exim bank focused on pushing Kenya to strengthen budget planning to help ensure the loans could be repaid. In Kenya, unlike Ethiopia, Chinese investment was subject to scrutiny by a free and independent media (recall the US media exposing the corporate malfeasance of the railways in the nineteenth century). Partly as a consequence the Chinese government through its Nairobi embassy also sought to ensure compliance with local environmental and social regulations and international guidelines. CCCC released a Corporate Social Responsibility (CSR) report in 2016, a first for a Chinese firm operating abroad. (Carrai, 2021). More rigorous evidence is available, though at a very aggregate level for both countries, not over a long time span and not specifically tied to the two railway projects. The evidence is ambiguous. Comparing before (2008) and after (2018) railway construction in Kenya and Ethiopia (as measured by the World Governance Indicators) Regulatory Quality improved in Kenya and worsened in Ethiopia, Rule of Law worsened in both countries, control of corruption improved in both countries, and government effectiveness improved in both countries (Carrai, 2021:4).

5.4. **Financing Railways**

Early railway construction in the UK was profitable for both landowners and shareholders. The Act of Parliament that forced landowners to cede their land for railway construction was resented but allowed landowners to utilize political influence to obtain high purchase prices (Wolmar, 2012:39). Across two railway building booms (1834-37 and 1844-47) Britain privately financed more than 10,000km of railway line construction (Fremdling, 2003:210). In densely populated Britain, railways connected existing cities which came with a ready market. The Liverpool-Manchester railway line, for example, paid its shareholders a regular dividend of 9.5%. London's established status as the global financial capital allowed railways to easily conjure up investors. The canal boom of 1790 to 1797 raised £7.8 million to fund 53 canal schemes. By 1850 the paid up share capital of railways in Britain came to £187 million (Hylton, 2016). Without these propitious advantages railways often failed elsewhere.

In the US railways were often built ahead of demand, hoping that farmer-settlers would migrate to a region to generate a demand for railway services. In Canada, although railway construction peaked in the final decades of the nineteenth century, significant gains in wheat production and rail traffic did not occur until the second decade of the twentieth century. Settlement was contingent on unknowns such as soil fertility and the reliability of rainfall (Eichengreen, 1995). In the US, without established financers, the early New England railway lines were financed by relying on family friends and other personal contacts. This local finance constrained railways to a modest scale, often textile producers linking their mills or Boston merchants wanting a railway link to the Great Lakes. The construction of the St Lawrence and Atlantic Railway in 1840s Canada was financed with bond sales and many of the farmers that bought bonds paid their subscriptions in the form of pork and eggs to feed the construction gangs (Eichengreen, 1995). In September 1862 the Union Pacific launched a flotation aiming to sell 100,000 shares and raise $100 million, but only sold 45 shares to 11 men. Another attempt in 1863 sold 2,000 shares, raising $2million for a scheduled cost of $100-200 million (Ambro zse, 2005:86). In 1837 the Mexican government issued its first concession for railroad construction to a private contractor who proposed to build a single track from port city of Veracruz over the mountains to Mexico City. The first railway line was not inaugurated until 1873. Investors had been deterred by civil and international war. Another effort to issue railway concessions, to connect Mexico City to the northern border in the 1880s were stymied as Spain, Britain and France suspended diplomatic

relations when Mexico defaulted on its international debt. In face of these loud investor-deterrents the Mexican government had to provide substantial subsidies to ignite the country's first railway boom in the 1890s (Coatsworth, 1979). It was generally, and reasonably expected that the railways would generate large social benefits but not private profits without some sort of government subsidy (Mercer, 1969).

One means of financing railways was through direct government support. In the 1830s the government of Massachusetts took a one-third partnership in the Western Railroad which it financed by issuing debt in London (Eichengreen, 1995). The Central and Union Pacific Railways were granted $16,000 of government bonds per mile on flat land, $32,000 for foothills, and $48,000 for mountainous terrain (White, 2011). An 1864 Act lent the two transcontinental companies $50 million worth of government bonds for thirty years and allowed the railways to hold off interest payments until the 30 year bonds were due (White, 2011). A *second*, more indirect means was by offering a financial guarantee to investors. Railway projects in Canada in the early-nineteenth century received government guarantees of 6% on large (£75m+ projects) provided that half the lines were already built. The guarantee stimulated large-scale foreign investment into Canadian railway construction (Eichengreen, 1995). In India if a railway company did not attain a 5% minimum rate of return, the government made up the difference. As with Canada, Indian railways than attracted large-scale private foreign investment (Bogart and Chaudhary, 2012). Given that the return on the London money market in 1849 was only 3.2%, this guarantee has been widely condemned as 'excessive' and held to reflect the political influence of railway interests in Britain (Habib, 2006). A more general criticism of guaranteed returns was that the system could encourage construction of railway lines where there was no hope of generating sufficient traffic and also give constructors little incentive to economize on costs (Eichengreen, 1995:88). A *third* means was to give land grants to railway companies. Approximately 150 million acres of land were granted to US railways between 1850 and 1870. In the US land grants were attractive for various reasons. Prairies in the US were lightly settled and most of the land was already formally owned by the government. Land grants generated less political resistance (the inhabitants were politically inconsequential, see section 5.2.) than payment of financial subsidies which required debt or taxation. As the railway was built the land would rise in value and its sale or lease would generate a financial return for the railway company (Section 4.3) (Mercer, 1969). The Transcontinental railways were given grants of 10 square miles per mile of track in strips alternating either side of the track (Wolmar, 2012). Some writers have suggested that the land grants were overly generous and generated excessive returns for the railway companies (Mercer, 1969).

Such government aid-subsidies could be justified if the social rate of return on investment exceeded the private rate of return. The rate of return on the private investment should also exceed the normal/market rate of return in the economy which represents the opportunity cost of capital used in railway construction (Mercer, 1969). Estimates show that the social return to construction of the Central Pacific railways was very high (28.5%) and more than double the private rate of return including the land grant (14.1%) (Mercer, 1969:1420). These estimates of social rates of return are much higher than the returns available in other investment opportunities, farm mortgages for example earned between 7 and 9% (David, 1969). In Brazil government assistance to the railways included dividend guarantees, low-cost loans land grants, and construction outright by the government. There was a similar subsidy-rationale as the social rate of return on railways was very high (up to 27.5%) and much higher than the rate of return on alternative investments (up to 8.2%).

In India many contemporaries were skeptical about the system of guaranteed returns because there was "no incentive for the railways to keep costs down" which allowed companies to "exploit their position" and get "generous rewards without taking any risks." (Wolmar, 2017:63). This should have been less of concern as the railways were closely supervised by the government. Each company had a government appointed director who was able to veto any decisions that ran counter to government policy. The government approved or specified the routes, construction standards, passenger and freight tariffs, train services, expenditures and the accounts (Wolmar, 2017). In practice the government lacked the capacity and expertise to exert effective control over railways. Most of the shareholders and boards of directors were resident in the UK and it was difficult for them to control company officials based in India (Bogart and Chaudhary, 2012).

The early Indian lines were unprofitable for decades because traffic developed slowly and revenues were modest. The government was forced to pay substantial sums to raise the return to 5% (Bogart and Chaudhary, 2012). There is good evidence that costs were inflated by the railways. Once railways were nationalized in India in the late nineteenth century, the state found it relatively easy to cut costs sharply without impacting the quality of service or safety standards for workers (Bogart and Chaudhary, 2012). It is possible to accept this evidence but still argue that the low returns were principally a product of the intrinsic difficulties of constructing and running railways in India and inadequate local capital markets to finance them. Without the subsidy railways would never have been built in India (Bogart and Chaudhary, 2012).

In the US there is an enduring myth that those railways being paid by the mile extended construction length to raise more money from the government (Ambrose, 2005:132; Wolmar, 2012). There is little evidence for this. In the 130 years after the construction of the Transcontinental railway, only a few miles have been shaved off its length and this was mainly due to geological changes in the level of the Great Salk Lake which allowed for a shorter distance (Ambrose, 2005:375). In Spain there was clear evidence of extensive cost over-runs on railway construction. Charges for construction exceeded the costs of construction by more than 50% of total construction costs for those railways that received government subsidies. Nineteenth century Spain was risky for foreign investors, the country was subject to extreme political instability, the government faced chronic fiscal stress and resorted to frequent default on its international debt. The laws on railway construction, subsidization and degree of state ownership were unclear and frequently revised. The financial return to operating Spanish railways was in general negative and below the return on alternative investments. Charging high construction prices to the Spanish state was the only practical means of inducing private firms to build railways in Spain (Keefer, 1996).

In the end, the financial problem of railways was not that they were earning excessive returns as profits were low (section 5.2.) and returns were well below estimates of social benefits. The problem lay in the fact that the returns railways made did not facilitate corporate financial stability. The railways were in constant need of both subsidy and rescue. In 1842 the Erie Railway defaulted on interest payments and the government of New York canceled its $3 million debt to ensure construction work could continue. The Erie railway eventually suffered five bankruptcies (Wolmar, 2012). The Union Pacific faced recurrent financial crises as funds were siphoned off to enrich its company directors (noted above). As railways became ever more central to the US economy their financial fragility drove

national economic instability. By 1873 railways counted for 80% of all total stock market capitalization (Morris, 2005:100). During 1873 and 1874, nearly 100 railway companies defaulted on more than $400 million of debt and by 1878 railway stock had fallen by 60% (White, 2011:84). The collapse drove a national recession. In 1890 defaults on Argentinian railway bonds caused financial flows from Europe to dry up. Railway investors globally found themselves unable to fund debt. In the US 89 from 364 railroads representing 40,000 miles or 25% of the national total went bankrupt, including the Union Pacific Railway (Wolmar, 2012:265). This led to then the deepest depression in US history (White, 2011). Throughout these cycles of financial instability the political influence of railways ensured that the creative destruction of capitalism was gentle to the rich (White, 2011). Bankruptcy did not lead to demise of debt-riddled railway companies which were instead repeatedly rescued by the state and legal courts (White, 2011:223). Without any market discipline the railways "created a world where private success often came from luck, fortunate timing, and state intervention." (White, 2011:509).

The historical financial fragility of railway companies has echoes in SSA. The SGR in Kenya was financed by a $3.6 billion loan from China, was inaugurated in 2017 and by May 2020 had accumulated operating losses of $200 million (Carmody et al, 2021:9). The light railway system in Addis Ababa was operated by the Chinese Shenzhen Metro Group on a three year contract after construction was completed in 2014. The contract included the operation and maintenance of the lines and the income from ticket purchases. It wasn't clear how the government Ethiopia could start repaying the loan without any income from the project (Tarrosy and Voros, 2018a). The Addis Ababa to Djibouti railway was constructed between 2011 and 2016 and financed by the government of Ethiopia and a $4.5 billion loan from China's Exim Bank. The Ethiopian Railway Corporation (ERC) accumulated debts of around $3.7 billion by the end of 2016 (Tarrosy and Voros, 2018b). In 2019 the Addis-Djibouti line earned $40 million in revenue against operating costs of $70 million (Carmody et al, 2021:12). In Kenya between opening in 2017 and May 2020 the SGR ran up operating losses of $200 million. By 2020 Nairobi Railways was effectively bankrupt and unable to pay outstanding dues on accumulated debt of $350 million (Carmody et al, 2021).

6. Conclusion and Discussion

In conclusion, our historical digression and contemporary thinking have together taught us a lot about railways in SSA. There is an essential kernel of optimism. Railways can and do promote economic growth. There is a lot we need to be wary about, from financial fragility, to undermining institutions, to the political consequences of railway-induced distributional effects. If we have learned a lot about railways, there remain much we need to guess about. Can railways put the 'united' into SSA?

6.1. What we learned about railways

Our historical and contemporary survey of railways and social savings in freight and passengers and time-wise impact showed that railways can have a positive impact on economic growth in SSA. Railways offer a significant upgrade on poor quality roads and the (non-existent) river to ocean transit network in SSA. This may change as Africa also now has plans to construct a continent-wide system of highways. As the studies of social savings show (Section 3.1) the economic benefits of railways drop sharply when there is a competitive-alternative mode of transport. More recent evidence from China however shows that HSR are fundamentally different from nineteenth-century railway technology. The speed and reliability of HSRs offers economic benefits over and above those generated by even the efficient Chinese highway system. This is only potential. Railways can generate spillovers that promote domestic industrialisation, there are signs of this in SSA, but so far mainly benefiting Chinese owned firms. There are some signs of technology transfer to SSA from infrastructure construction but much is needed to support rapid economic growth. Railway construction is likely to promote urbanization, but whether of the historically economically progressive or of the more recent dysfunctional SSA variety only time will tell. Railways (especially when combined with the efforts to promote Africa-wide free trade) will likely have significant distributional impacts that may create a politics opposed to the possible efficiency gains of easier and cheaper transport access. Other concerns about realising the potential benefits of railway construction lie in the interface between the SSA state, railway construction and Chinese investors. Whether SSA states will manage to coordinate their infrastructure investment and overcome market failures will hinge on whether supra-African organizations (the Chinese government and the AU) can negotiate and promote or themselves implement a continental-wide infrastructure vision. There is much evidence that large inflows of foreign resources, whether aid or infrastructure, can undermine domestic institutions, will this effect predominate over the more indirect route whereby infrastructure promotes economic growth and economic growth leads to better institutions?

6.2. **There is more to this that just building railways**

The BRI infrastructure project tends to forget SSA history. When we combine a historical glance at infrastructure building with the historical railway record of financial fragility and persistent bankruptcies, we raise real concerns for contemporary SSA.

Newly independent SSA states invested heavily in infrastructure. In Ghana, during the 1960s, for example, 80% of expenditure was directed to infrastructure and social services. Those countries benefiting (as today) from natural resource export booms such as Algeria, Congo Brazzaville, Congo, DRC, and Nigeria spent most of their post-independence revenues on large-scale infrastructure projects. The World Bank was designed explicitly to leverage finance for large infrastructure projects. By 1973 more than 60% of foreign aid to SSA went into infrastructure (Wethal, 2019). Many SSA countries experienced positive growth initially but projects proved unsustainable. Infrastructure was not adapted to local markets, existing infrastructure or available management and maintenance capacities (Wethal, 2019). In Kenya by the 1970s the track and rolling stock of the railways were in poor physical condition, due to the lack of reinvestment and maintenance. The Kenya Railways Corporation (KRC) was overstaffed, having doubled employment after 1957 with no increase in railway traffic (Jedwab et al, 2014, Jedwab and Moradi, 2016). Some heavy industrial projects were abandoned without ever starting production. White elephants littered SSA and became symbols of a failed development strategy. Infrastructure borrowing increased SSA debt from $7 billion in 1970 (11% of GDP) to $176 billion in 1990 (58% of GDP). With the advent of structural adjustment in 1980s resources allocated to infrastructure by African governments and international donors was drastically reduced (Wethal, 2019). Structural adjustment was a loud acknowledgement that infrastructure couldn't work without the support of good economic policy. Can BRI infrastructure work without lending conditionalities to support a supporting framework of good policy making?

Existing poor policy prevents the efficient and cost-effective use of transport infrastructure. Recent estimates show that on average it took 116 days to move an export container from a factory in Bangui, CAR to the nearest port and fulfil all the customs, administration and port requirements to load the container onto a ship (Donaldson et al, 2017). Police or military checkpoints are common. In 2000, for example, on the 992 km highway from Lagos Nigeria to Abidjan, Cote D'Ivoire there were 69 checkpoints or 7 per 100km. From Niamey, Niger to Ouagadougou, Burkina Faso (529km) there were 20 checkpoints (Yang and Gupta, 2005:13). SSA has long suffered a widespread problem of an over-valued exchange rate that undermines the competitiveness of manufactured exports. In recent years exchange rate over-valuation has often been related to the commodity price booms or aid surges that drive many SSA economies (Johnson et al, 2007). In 2014 the collapse of the Nigerian Naira (caused by falling world oil prices) increased the cost of imported inputs for Chinese firms and dramatically reduced their profit margins (Chen, 2020:23). In the early 2000s the trucking industry in West and Central Africa was characterised by low truck utilization rates and aging vehicle fleets. The non-competitive cartels running the industry prevented new entrants into the sector and so could maintain a combination of low service quality and high prices (Teravaninthorn and Raballand, 2009). This paper has demonstrated the consistently positive impacts from railways to economic growth. Section 3.3 discussed various studies that showed how BRI transport projects are forecast to boost trade and real income, more so in the 'corridor economies'. Policy remains crucial and complementary policy reforms can increase these gains dramatically. One study finds that

complementing BRI physical infrastructure with trade reforms such as deepening trade agreements or better market access would magnify the gain by between two and four-fold (Baniya et al, 2018).

Just as there were significant externalities in building continental transport infrastructure there are also externalities in policy reform. Why should Kenya reform its border crossings to the benefit of Ugandan exporters? Continent-spanning railway infrastructure needs to be supplemented by continent-wide coordinated policy reform. The African Continental Free Trade Agreement (AfCFTA) was launched in 2012 as the flagship of the AU long term vision (The Agenda 2063: The Africa We Want). AfCFTA seeks to create an Africa based on free movement of people, good and services (Phiri and Mungomba, 2019). Efforts at regional integration have a long and unsuccessful history in SSA. By the early 2000s Africa was home to some 30 regional trade agreements, many of which are part of deeper regional integration schemes (Yang and Gupta, 2005). By the early 2000s each country in SSA was a member on average of four. There is little evidence these agreements increased intra-African trade (Naude 2007). The West African Monetary Union (WAEMU) launched an effort during the 1990s to deepen economic integration. WAEMU's eight country-members signed two multilateral conventions to regulate and facilitate transport and transit across borders. The effort had no discernible impact on intra-WAEMU trade (Coulibaly and Fontagne, 2005). Will AfCFTA be different? Perhaps this time it will, through the combined efforts of the AU and China?

6.3. **Putting the 'United' into Sub-Saharan Africa**

Continental railways contributed to nation-building. The railways put the 'United' into the 'States of America' by first binding the US together north and south, and then in 1869 with the completion of the Transcontinental Railway west and east (Ambrose, 2005). The railways simulated nation-building in clocks, letters, and politics. Clocks were chaos before the railways. In the US before the railways there were 27 local times in Michigan and 38 in Wisconsin alone (Wolmar, 2012:233). By 1883 railways had promoted and enforced standard national times to coordinate their schedules (White, 2011:150). By 1847 the need in the UK to plan a national timetable encouraged railways to abandon a plethora of local times and switch to Greenwich Mean Time (Hylton, 2016:137). The exchange of news or romantic missives was arduous before the railways. The 1838 parliamentary Act in the UK gave the General Post Office (GPO) wide ranging powers to put mail on any train, to demand special trains if needed and stop railway companies changing train times. This created the conditions whereby the introduction in 1840 of the penny post led to a huge increase in letter writing, (Hylton, 2016:132). In India the national postal system started in the 1850s. The number of letters and packets carried (mainly by the railway) increased from 85 million in 1869 to 1,043 million in 1914 (Habib, 2006). Before railways, politics was a comfortable localised affair, usually presided over by slumbering local land owners. The Chancellor of Oxford University argued that railways would allow undesirables to travel and acquire subversive ideas and used his considerable influence (he was the Duke of Wellington) to ensure that railways came no closer to the University than 10 miles away at Steventon. The railways did exactly as backward looking conservatism feared. Railways allowed books, magazines and newspapers and ultimately 'ideas' and 'opinions' to travel. The cost of books and magazines dropped from dollars to pennies in the US (Ambrose, 2005). The railways contributed more directly to political mobilization. In 1838 , the UK Anti-Corn Law League used the railways to transport its speakers around the country who were followed by journalists reporting on their activities for the national press (Hylton, 2016). In India the newly formed Indian National Congress which later morphed in the broad-based nationalist movement led by Gandhi, was formed

in 1885 and achieved its all-India status because delegates could travel to its meetings by train (Habib, 2006). The railways put the 'National' into the Indian Congress and the movement led the successful struggle for Indian independence.

There are evident parallels here with the AU vision that seeks to bind Africa together, east and west, north and south. But these transformative virtues of the railway have a distinctive nineteenth century feel about them. What need railways to deliver letters when email or WhatsApp do it more effectively? But don't forget the research from China which showed that the quantity and quality of academic research increased when cities were connected by HSR. There still seems to be a resonance between railways and ideas.

The history of transport in SSA is more a story of parochial political concerns rather than visionary efforts at building nations or integrating the African continent. Expanding the provision of transport infrastructure is not enough. Railways may not be built to connect the right areas to reduce transport costs and boost trade. One study uses data from satellites and online routing services to simulate trade flows through more than 70,000 links spanning all of Africa. The study models the optimal transport system given the underlying economic fundamentals (patterns of urbanization, location of natural resources etc) for every African country (Graff, 2019:2). South Africa and Tunisia have well designed road systems while there are significant economic costs of the road network in South Sudan, Somalia, and Chad among others (Graff, 2019:20). One reason for the economic-misallocation of roads is the role of politics. Political leaders may have built transport links or provide other public policies to benefit a politically preferred region or city. One study uses satellite data on light intensity across 126 countries and 38,427 sub-regions between 1992 and 2009 to compare the birth region of the current political leader with other regions. In countries with weak political institutions (as measured by Polity2) being the 'leader region' is associated with increased nighttime intensity and regional GDP by around 30% and 9% respectively (Hodler and Raschky, 2014). In Kenya the total length of paved and improved roads increased threefold between 1964 and 2002. Road building was driven by politics and the various presidents of the country disproportionately targeted their ethnic homelands (Jedwab et al, 2014:21). There is no guarantee having a 'neutral' umpire like the Chinese-BRI to help alleviate the imbalances in Africa's transport networks. One study disaggregates the total value of aid disbursements from 10,786 World Bank projects and 1,420 Chinese projects down to the level of 10,158 geographic grid cells across Africa (21% of them received an average of $30 million of assistance). The estimates show that areas with too few existing roads, receive more World Bank funding while areas with too many roads receive even more Chinese funding (Graff, 2019:44).

Using infrastructure to unify nations and continents requires building (expensive) transportation systems ahead of the (anticipated) increases passengers, trade and urbanization that can ultimately justify the investment. In 1870s Kansas, empty trains ran over 2,400 km of track across deserted prairie to vacant towns (White, 2011:211). The same is happening in contemporary SSA where trains in Kenya and Ethiopia are taking time to generate traffic and profits and running large losses in the interim. The history of railways and the emerging evidence of SSA-railway finances shows that the railways are financially fragile. Is Chinese capital patient enough to endure all the bankruptcies, re-scheduling of financial terms and long-term loss making that will inevitably feature in the African railway renaissance?

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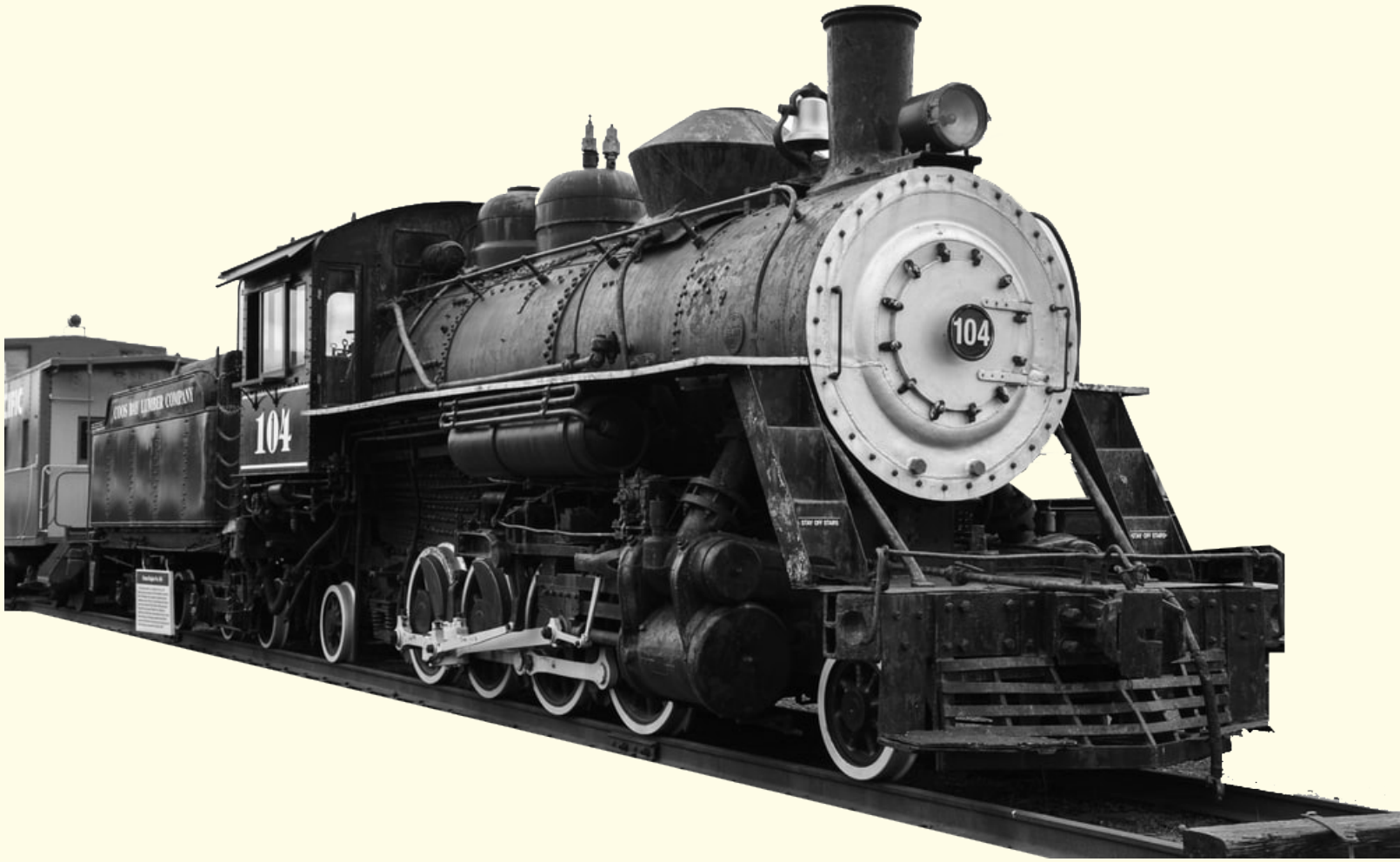

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