

Research Articles

China and the Belt and Road Initiative's Role in Middle Eastern Affairs: A Consideration of Network Effects and Lock-In Dynamics

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This paper explores the question of whether China's Belt and Road Initiative (BRI), and China's growing global interconnectivity more generally, are generating network effects and lock-in dynamics. It considers evidence that the BRI as well as the increase in China's international interconnectivity has indeed created network effects and lock-in dynamics in several different ways, including transport infrastructure and the different components associated with the transportation of cargo such as railway gauges and types of railways. However, it also examines the ways that the BRI has not achieved network effects, due to the BRI harming relations with countries such as Pakistan and Sri Lanka.

Introduction

The exact meaning of the Belt and Road Initiative can be somewhat elusive and difficult to define. It is an initiative that was officially started by the president of the People's Republic of China, Xi Jinping, in 2013 while on a visit to Kazakhstan. It aims to connect the continents of Europe, Asia, and Africa via various infrastructure projects, such as the construction of railroads, roads, and ports. The name and the goal of the Belt and Road are reminiscent of the Silk Road, a network of trade routes that stretched across China to Europe established during the time of the Han dynasty. The overland portion is known as the Silk Road Economic Belt, and the sea portion is known as the Maritime Silk Road. The goal of the Belt and Road Initiative as stated by China is to generate economic growth for all participating nations by means of creating an easier, more convenient way to conduct international trade. There are five main objectives of the Belt and Road according to the People's Republic of China (The People's Republic of China, 2019) :

1. Policy Coordination
2. Infrastructure Connectivity
3. Unimpeded Trade
4. Financial Integration
5. Connecting People

As of December 2023, 151 countries have signed a Memorandum of Understanding with China to participate in the Belt and Road (Green Finance Development Center, 2023).

To understand if the Belt and Road is creating network effects and lock-in dynamics, it is first necessary to define these terms. Network effects exist where a product or service gains more value as the number of users grows. One such example is languages: English has become valuable because it is the most widely spoken language in the world. However, languages such as Chemehuevi, still spoken by

the Native Americans living in California even today, are not as valuable because such a low number of people speak that language, making it virtually unusable. As for lock-in dynamics, these occur when a product or service becomes so popular that other options become obsolete, and as a result one becomes locked into using a certain product or service. One such example of this would be Facebook versus Myspace. Facebook has nearly 3 billion users, whereas Myspace now has so few users that hardly anyone joins it anymore because users are not able to connect with as many people as one is able to on platforms like Facebook (more users is equivalent to being more beneficial).

In some instances, such as transportation infrastructure and bilateral trade agreements, the Belt and Road Initiative and China's growing global interconnectivity are creating network effects and lock-in dynamics, since BRI enables both China and participating countries to reap the benefits of infrastructure, trade, and closer relations. Thus, the increased number of participants allows the network to have more value. However, in some instances, network effects are not being created, as the infrastructure available in some countries is substandard, and there is potential for diplomatic relations to break down due to developing countries defaulting on Chinese loans.

Section 1: Transportation Infrastructure

The quality of the existing transportation infrastructure as well as transportation infrastructure yet to be constructed (ports, roads, and railroads) in the Belt and Road Initiative is already set to play a huge role in the Belt and Road Initiative for all countries involved. Specifically, in developing countries that have lower economic growth than others, such as many nations in Africa and in Southeast Asia, China has stated that the new roads, ports and railroads are slated to improve economic growth for partic-

ipating nations and therefore their position in the world economy and their trade relationships with other countries (Freeman & Tugendhat, 2023). In return, China reaps the benefits of increased Chinese exports through export credits given by the China Development Bank and the Export Import Bank of China (EXIM) as well as deeper strategic relationships with other nations (Freeman & Tugendhat, 2023).

1A. Hub and Spoke Model for Transport Infrastructure

One of the proposed transport infrastructures is the hub and spoke logistics network with regards to transporting goods from the sea to various locations on land. In the BRI, there are plenty of planned ports in seaside cities across Africa, Asia, and Europe. But the question arises as to how to transport goods efficiently and effectively from the ports where the ships dock to the cities where the markets are while avoiding high transportation costs. In addition, the logistics resources will not be used as efficiently as they could be, resulting in misallocation of these resources and a waste of time and money.

The seaports are connected to hub dry ports located away from the water. From there, the hub dry ports are connected to feeder dry ports which can connect to all the other dots, representing other cities. The hub and spoke model are regarded as a more systematic, efficient way of connecting the sea to various locations on the land. Regarding the larger Belt and Road, China is meant to be the hub, and other countries will be the spokes emanating from the hub (Freeman, 2019). This hub and spoke model is already being used by China in the Western Balkans (collectively, the countries of Albania, Bosnia and Herzegovina, Montenegro, Kosovo, North Macedonia and Serbia) (Conley et al., 2020).

It is important to mention that this region, though seen as profitable, has experienced its fair share of problems which previously impacted its ability to gain foreign direct investment. One of these issues is the sheer amount of corruption in the nation as seen in the table below due to the weak rule of law and lack of enforcement thereof, which has resulted in relatively low productivity and worse economic conditions than other nations (Conley et al., 2020).

Countries in the West Balkans have experienced high levels of corruption and relatively low levels of democracy scores (Conley et al., 2020). Corruption can create many issues, such as mismanagement of resources that hurt prospects for economic growth. Despite the issues presented above, this region is of great strategic importance for trade because it enables ships to pass through the Mediterranean into the center of Europe, therefore the potential trade profits are huge because it opens to a market of hundreds of millions of people. Both the European Union and the United States have seen the geopolitical advantages a nation could possess with influence over this region and therefore have invested money into the area.

China has invested \$1 billion annually into the Western Balkans since 2011 (Foreign Affairs Committee, 2022). Terms of the loans often stipulate those Chinese state-

owned enterprises, such as China Railway International (CRI) and China Communications Construction Company (CCCC) must complete at least some of the work (Foreign Affairs Committee, 2022). The terms of the loans are purposefully ambiguous, thus creating concerns about the amount of debt that the Balkans are taking on. For example, Montenegro (notably, a NATO member) owes 40% of its external debt to China, and a \$1 billion loan from EXIM to finance the Bar-Boljare highway project increased Montenegro's debt to GDP ratio to a whopping 80% in 2019 (Foreign Affairs Committee, 2022). Questions about the financial sustainability of the debt have been raised, as well as questions of China's intentions should the Balkan nations default on their loans.

Serbia is the largest of the Western Balkan nations and borders every country in the Western Balkans except for Albania. In addition, since it is not part of the European Union, it does not have the stringent rules and regulations that govern trade (low barriers to entry). Therefore, it serves as the hub in the hub and spoke model. Serbia recognizes China's claims to the sovereign nation of Taiwan. Furthermore, China has invested more than \$1 billion into Serbia for infrastructure projects and energy projects since signing a strategic agreement in 2009 (Sekularac, 2016). Serbia has been serving as China's hub for other Balkan nations, who then serve as the spokes. Serbia has also been serving as the hub for Belt and Road railways going to central, western, and eastern Europe.

The hub and spokes logistics model adopted by China in Serbia shows the probable generation of network effects. The hub and spoke model allow for many countries, despite issues such as corruption, to participate in the Belt and Road by making transportation from the sea to various points on land easier and less costly. This increases the value of the Belt and Road and creates a way to ensure money is saved to later reinvest in maintaining or updating the system. Large hubs with strategic importance and large populations serve as bridges to connect to other nations through transportation infrastructure. These lower barriers to entry benefit countries by connecting them to trade routes despite issues such as corruption. Countries joining the Belt and Road often view the project as a new chance to be more integrated into a less regulated and standardized network of international trade.

Foreign direct investment (FDI) in developing countries as seen in the Belt and Road Initiative has technology spillover effects, which can be seen as an indirect network effect of the Belt and Road. Spillover effects are defined as effects, economic growth in this case, that can occur or "spill over" due to the impact of another event which could be related or unrelated. In this case, FDI allows for the transportation of the Belt and Road to be constructed and much needed infrastructure to develop. As a result of this initial investment, the market for international trade can experience positive economic growth and allow for a greater capacity for more exports, allowing more money to flow into the country. Moreover, FDI can lead to more job creation in the host nation. As China invests in more nations, economic growth has the potential to become more

widespread, indicating network effects are growing (more nations participating, then receiving aid, resulting in positive economic growth in the form of job creation and other ways). FDI often leads to economic growth, but this is not always the case.

It must be acknowledged however, that not all foreign direct investment associated with the Belt and Road has generated the extent of the indirect network effects mentioned above. An example of this concept is illustrated in the China Pakistan Economic Corridor. The president of Gwadar's Rural Community Development Council (a port town in southwest Pakistan), Nasir Sohrabi, said in an interview with Financial Times, "China only procures sand and gravel locally for construction projects. All other raw materials are imported from China, leaving very little for local industry" (Aamir, 2021). Though Pakistan may reap many of the ultimate spillover effects (indirect network effects of the foreign direct investment), such as more developed infrastructure, they will suffer since there is no employment growth for local Pakistanis.

Pakistan has been importing machinery, chemicals, and manufactured goods from China as opposed to using products and services from the local industry. As such, the local industry does not even have the chance to compete with China, which could eliminate the local industry altogether. As a result, although Pakistan and some other nations obtain infrastructure, which could generate network effects in the form of economic growth in the long term, another long-term effect is the potential destruction of the local industry in many of the participating nations.

In the eyes of developing nations, the Belt and Road allows developing countries to have a role in international trade. Of course, China profits from the participation of these developing nations by allowing China to reach European markets. Developing nations also want to reap the benefits of indirect network effects, such as improved relationships with more powerful countries, as other nations could be more willing to work with them and engage in diplomatic relations due to their strategic location on the Belt and Road. As more and more nations become involved in the Belt and Road, there could be increased profit from trading partners, meaning network effects are working. However, as seen in the case of Pakistan, the Belt and Road may not generate network effects if the local population is left unemployed and dissatisfied, and if the local industries must compete with China, who has more financial resources at their disposal.

1B. Railroads and Rail Links

Another crucial part of the overland Belt and Road Initiative is the railroad system and rail links (which connect two main railways). In the Belt and Road, some of these railroads and rail links are as follows: the Zhezkazgan-Beineu rail link (located in Kazakhstan), the Angren-Pap rail link (located in Uzbekistan), the North-South and East-West link (located in Kyrgyz Republic), and Nairobi-Mombasa (located in Kenya) (Wang et al., 2020). A study by Wang et al found that in the Southeast Asia and Central and Eastern Europe portions of the railroad, "the increase of the

level of transport infrastructure has a significantly positive impact on economic growth" (Wang et al., 2020). The railway infrastructure and the road infrastructure associated with the Belt and Road has created some benefits to participating nations, as barriers to trade have been lowered and transportation costs are cheaper. These are indirect network effects as a result of the Belt and Road—each nation that chooses to participate in the construction of the railroads strengthens the network by connecting more people and more markets and therefore increases the value of the Belt and Road by facilitating international trade and a connected transportation system.

It must be acknowledged that there were some cases where the roads did not generate the network effects mentioned above. For example, in South Asia, where there are many poor-quality roads that are not conducive to international trade, creating more roads did not help to generate more economic growth (Wang et al., 2020). This effect is known as the law of diminishing returns in economics. The benefits of investing X units of money or time, roads in this case, decrease as more money or more time is put into it (Celes, 2020). Rather, perhaps creating an entirely new system of higher quality roads would have produced the indirect network effects of positive economic growth, as seen in the roads built in Central and Western Europe.

Railways are a cornerstone of the Belt and Road Initiative, as trains are one of the most effective and low-cost ways of transporting goods long distances. They also have the potential to create network effects, as a study by Landex found that "The network effects occur because the train routes (often) are quite long and that the railway system has a high degree of interdependencies as trains cannot cross/overtake each other everywhere in the network" (Landex, 2012).

As the Belt and Road railways are supposed to span three continents and roughly 100 countries, the railroads need to be properly integrated. To effectively create transportation infrastructure across several continents in the form of railways, the components of the railroads, mainly the gauges, must be the same or very similar.

1C. The Importance of Railway Gauges

Railroad gauges are the gaps between the two sides of the railroad, which are measured in millimeters. There are several different kinds of gauges used internationally, which can present a problem for trains which are constructed for only one type of gauge. The railways proposed for the Asian section of the Belt and Road all have different gauge lengths ranging from 1000mm to 1676mm. The three most common ones are broad gauges, narrow gauges, and standard gauges.

The first variety is the largest of the gauges, known as broad gauges, which are 1,676 mm in length. These gauges are used in India, Pakistan, Bangladesh, and several other countries as seen on the map. There are numerous beneficial aspects of using this type of gauge. Since the track is wider, it offers more stability for the train and can accommodate trains that both carry more cargo and run at higher speeds (De Charmoy, 2019). This comes from a con-

cept in structural engineering— an object with a wider base is harder to push over than an object with a narrower base. Another advantage is that these tracks can work even on rougher terrain, such as the more mountainous regions of China. However, they can be more costly than the other types of gauges.

The other extreme, a narrow gauge, is between 610 mm and 762 mm (Goyal, 2022). They are typically the cheapest to build and are found in nations such as Nepal and Myanmar. There are pros and cons to this type of gauge. The advantages are that a narrower distance between the tracks allows the train to accommodate tighter turns in railway routes (Shedd et al., 2020). However, this often means the trains are smaller and cannot accommodate a larger cargo volume, which limits the transportation capacity of the Belt and Road.

Besides the broad and narrow gauges, there is also the standard gauge which is 1435 mm in length. This is used by approximately 60% of the nations in the world such as Albania, France, Denmark, Austria, Bosnia and Herzegovina, and more (Charts, 2020). This means that if a train is originating in Tuticorin, India, and set to arrive in Bosnia and Herzegovina, it must change gauges two times. This means changing the structure of trains due to the railways or transferring tons of cargo from a broad-gauge train to a standard gauge train which would be intensely time consuming, creating a massive logistical headache. The advantage of the standard gauge is the fact that there are many nations that use it, meaning they are more connected for convenient international trade. Standard gauges are the middle ground between the broad gauge and the narrow gauge.

In the main intercontinental route stretching from Kunming, China to Kapikule, Turkey, there are 1,130 kilometers of meter gauges (gauges that are just a meter in length), 4,560 kilometers of standard gauges, and 4100 kilometers of broad gauges (United Nations, 1999). This could lead to potential lock in dynamics. Since 60% of the world uses standard gauges, the rest of the world could be locked into using standard gauges to properly conduct trade with most of the world. Otherwise, they will not be able to reap the benefits of the network, such as economic growth and more competitiveness with regards to trade. Having a railroad that is not compatible with the trains of other nations could mean isolation in terms of trade if they do not change to the most widely used gauge.

Thus, solutions will be needed to unlock the full network effect potential and reap the benefits of more cohesion and harmonization of the railways. One such solution is gauge changing trains, which are already in use in Spain and Japan. However, there are questions about the feasibility of implementing this type of train for the Belt and Road since it could be quite expensive.

Because the types of gauges are markedly different and enable the trains to have different resulting features, the trains are not all able to go at the same speed. “The speed of a train is a function of the diameter of the wheel, which in turn is limited by the gauge” (Goyal, 2022). A larger gauge width means that the rail can withstand greater speeds,

probably due to the train being more wide than tall and therefore having a lower center of gravity. The standard speed for the trains on the Trans-Asian Railway is 70 kilometers per hour, which is the speed used for Chinese trains. However, in Burma, the speeds of the trains are not able to achieve 70 kilometers per hour due to the gauges and poor infrastructure, making their maximum speed around 30 to 40 kilometers per hour on most railways in the nation (United Nations, 1999). However, these speeds can become even slower south of the Thanlwin River, reaching speeds of only 24 kilometers per hour (United Nations, 1999). Because the infrastructure is poor in this region of the world, this means the trains can also be limited in load weight in addition to speed. This can present issues, as the Belt and Road aims to increase global connectivity with the purpose of developing international trade via infrastructure and increasing economic growth for all participating nations. If one part of the railroad is not effective, operations are slowed down and this creates issues with logistics, meaning that network effects in the form of increased economic growth are not occurring.

Harmonization of the railways in the Belt and Road Initiative can be seen as a network effect because it encourages more nations to become involved in the international economy by linking every participating nation in a cohesive network. Many of these nations would not have had the chance to participate otherwise, because they lacked adequate funding to develop infrastructure on this level. For example, Laos is a nation that has traditionally not been able to participate in the global economy because of their poor financial situation. With loans from China, they now have built a 642-mile-long railroad worth \$5.9 billion US dollars (McDonald et al., 2021). This harmonization not only allows them to participate in the global economy, it also allows them to potentially generate a stream of income. By linking themselves to markets as far away as Europe, Laos believes this is the opportunity to revitalize their economy. Many nations are in the same situation as Laos, and they believe the Belt and Road is a chance for them to generate money for domestic markets, creating job growth and raising the standards of living. However, as with the Balkans, there are concerns about the level of debt that Laos has acquired to participate in the Belt and Road. Laos and China have created a joint venture called the Laos-China Railway Joint Venture Company to finance the railway. Chinese state-owned enterprises have a 70% stake in this project, while Laos has only 30% and their debt to GDP ratio may now be as high as 35% (Koskova, 2023).

1D. Types of Tracks

The main intercontinental route from China to Turkey also includes different kinds of tracks (United Nations, 1999). These include electrified tracks, non-electrified tracks, multiple tracks, and single tracks (United Nations, 1999). Electrified train tracks are tracks that have an active electric current coursing through them that help to power the locomotive. Non-electrified tracks do not have this current.

Multiple tracks are multiple lines of track that run parallel to each other, so that the rail system can operate with multiple trains. Single tracks are simply tracks that can only accommodate one train and not multiple.

Nonelectrified, single-track railroad systems are 63% of the route length on the main intercontinental route (United Nations, 1999). Electrified, single track are 10.6% of the route, non-electrified, multiple track are 6.6% of the route, and electrified multiple track are 19.8% of the route (United Nations, 1999). These concepts are mutually exclusive— if a train is not meant to run on an electrified track, it must run on the non-electrified track instead (one or the other must be selected).

With such different percentages of the type of track along the route length, it is possible that network effects could not occur, since as the number of users are increasing, the variety of track types increase as well, so no benefit comes of this because there are too many differences to create a cohesive system. It is also possible that lock-in dynamics could take over instead. Since non electrified, single-track systems are much of the route, other nations may be "locked into " using this type of track, since it is the most widely used and therefore would promote better interconnectivity amongst all nations in the Belt and Road.

One such solution to solving the issue of the electrification of the tracks is an electro diesel locomotive, which can run on both electrified and non-electrified tracks. This solution would help to create the network effects associated with the Belt and Road, such as greater economic growth and more connection between nations.

1E. Regulations with Regards to Transportation Infrastructure

Because the regulations with regards to the different types of gauges and types of tracks are so different from nation to nation, the varied railway infrastructure has led to the development of several operational requirements to create a more unified means of controlling the train tracks in the Trans Asian Railway as outlined by the United Nations. This is one network effect of the variances of the railways of the Belt and Road- as the number of users increase, more differences are realized, as a result, regulations are enacted to create a more united form of infrastructure so the cargo will be able to get to where it needs to go. Therefore, these rules and regulations create more value for the Belt and Road. Without rules and regulations, the Belt and Road would simply be a hodgepodge of different gauges, train speeds, train loads, and more. Organizational value is added when rules and regulations are in place.

1E) a. First Rule of Transportation Infrastructure (Railroads)

There are four main rules regarding the compatibility of the components of the Trans Asian Railway. The first is compatibility with regards to the variety and design of rolling stock. Rolling stock is defined as the railway cars that carry people or cargo on board. These can be electric

cars, steam cars, diesel cars, hopper cars, and more. As expected, these vary from nation to nation.

Focusing on the southern corridor alone (China, India, Bangladesh, Iran, Pakistan, Sri Lanka, Thailand, and Turkey) there are a variety of different characteristics of the rolling stock such as width between wheels, height, type of braking system, design speed, and weight (United Nations, 1999). According to the above report from the United Nations, in the southern corridor, the largest difference in rolling stock from neighboring nation to neighboring nation is the type of brake used by the trains (United Nations, 1999). The type of brakes the train is equipped with impacts the cargo: "Vacuum brakes are not nearly as efficient as air brakes and impose quite stringent speed restrictions on rolling stock" (United Nations, 1999). Vacuum brakes are the older form of brakes, used on trains since the 1800s. Air brakes use friction to stop trains.

The Belt and Road aims to create a more united infrastructure system by altering rolling stock to fit the most efficient design (reaching fast passenger train speeds while also carrying immense loads of cargo).

1E) b. Second Rule of Transportation Infrastructure (Railroads)

The second regulation is with regards to the compatibility of the building of the trains and the load scheduling practices of the trains. Load scheduling practices are determined by the intersection of demand for cargo and trains with supply (which can be impacted by rolling stock, number of employees available, etc). These are then used to determine timetables that can meet the demand at a cost feasible for the rail company (Watson, 2001). If these are not compatible, as with every other issue presented in this section, logistical headaches will be created. Because the trains must have different loads from nation to nation due to the differences in gauges, differences in demand and supply, and more, the optimal load must be found so that train cargo does not need to be adjusted every time a train crosses a new country's border (Watson, 2001). The optimal time needs to be found as well, to not create delays. Additionally, there needs to be uniformity in the way the trains are operated, meaning the way staff are trained and the way trains are maintained and serviced (Watson, 2001). The Belt and Road would introduce regulations for these differences as well to make the rules more united.

It must be acknowledged as well that some countries choose their rolling stock and their gauge width according to the topography of the nation. Nations that have a more mountainous or hilly topography may select a narrower gauge to handle sharper turns, for example. Therefore, exact uniformity may be unattainable in some cases as topography varies from nation to nation. Though many nations are participating in the Belt and Road railroad building and therefore users are increasing, the network effects (economic growth) of having the exact same railcar design, railroad design, et cetera may not be realized because these natural aspects of nations cannot be easily altered. In these cases, it may be more difficult to conduct international trade via railroads.

1E) c. Third Rule of Transportation Infrastructure (Railroads) and Capacity Discussion

The third criteria for regulations of the railroads of the Belt and Road initiative is possessing an adequate route capacity for cargo being transported on trains. Route capacity is defined as a “measure of the ability to move a specific amount of traffic over a defined rail line with a given set of resources under a specific service plan” (Krueger, 1999). A high capacity is essential for the sort of transportation and trade volume that is to be expected of the Belt and Road Initiative. Route capacity is often measured by practical capacity, because “it relates the ability of a specific combination of infrastructure, traffic, and operations to move the most volume within an expected service level” (Abril et al., 2008). This means, it considers all of the factors that can impact a train's capacity in real life. When examining a highly interconnected infrastructure project like the Belt and Road, it must be noted that these factors have the potential to vary from nation to nation, which in turn can impact capacity, so sometimes adjustments or workarounds are needed to address problems and create solutions that work for every nation involved.

Theoretical capacity may be high, but real capacity lowers as reliability increases (Abril et al., 2008). This means that for railroads to be the most reliable, it is not possible for trains to be carrying cargo at the highest possible capacity. At the highest capacity, profits tend to be at their maximum, however issues can occur with spreading the railroads too thin, such that transportation is not sustainable (Abril et al., 2008).

Practical capacity is defined as the most output a factory or supplier can create in the long term in a realistic sense and accounting for any obstacles involved. It is related to desirable reliability in this graph, meaning the level of reliability that is wanted by the operators of the railroad.

Capacity is never the same from location to location due to many factors such as train timetables, expectations of the quality of service, and the arrangement of the track (Krueger, 1999). There are three main factors that influence capacity, along with several subfactors. These main factors include infrastructure parameters, traffic parameters, and operating parameters (Abril et al., 2008). Because the amount of capacity can be so varied from nation to nation due to the track structure and many other differences, it is quite possible that network effects are not being created in this instance, as it may be impossible to account for all of the differences in infrastructure that occur in all of the participating nations and then attempt to create a harmonized system.

Infrastructure parameters that impact capacity include several subfactors.

Section 2: Parameters

2A) Infrastructure Parameters: Block and Signaling Systems

The first is block and signaling systems, which are vital to the safe operation of railways. Block and signaling sys-

tems control the start and stop of trains to keep them from crashing, since the signals keep them a safe distance from each other (Abril et al., 2008). Included in these signals are fixed and moving block signaling. With regards to the fixed signaling, “separation between trains is maintained by imposing the restriction that each block section be occupied by at most one train at a time” (Abril et al., 2008). However, with moving block signaling, the locations of the trains are known at virtually all times (Abril et al., 2008). This is a more modern form of keeping track of where the trains are due to the enhanced and instantaneous methods of communications of the 21st century. Single and double tracks also play a role in the capacity of a rail line (double tracks have capacity for two trains vs single tracks which can have just one train). However, issues can be created because there may be too much cargo to process in the given period of time (known as bottleneck issues in the realm of supply chain management). This parameter in the railways of the Belt and Road can create network effects. As the number of users (participants in the Belt and Road) increase, the benefits of creating parameters to know the locations of trains increases. Since so many nations are involved in the Belt and Road, organization in the form of this signaling will enable the railways to function at optimal levels. A downside of this is the fact that more users mean there is more to lose. If trains crash and create issues with the railways, infrastructure will be damaged, and cargo could be lost. The entire train timetable could be thrown off as well, creating financial loss and delays.

Infrastructure Parameters: Track Structure and Speed Limits

Another infrastructure parameter subfactor is track structure and speed limits. As stated above, the track structure and how the track is built determines whether the loads on the train can be heavier or lighter or operate at fast or slow speeds (Abril et al., 2008). In turn, capacity may be impacted—whether the train can carry a lot of cargo or must reduce the load to compensate for the structure of the track.

Traffic Parameters: Traffic Peaking Factors

The second of the three main parameters are traffic parameters, with traffic peaking factors being a subfactor impacting capacity. Traffic peaking factors are defined as a “measure of concentration of traffic within a short time frame” and help to analyze the amount of traffic currently being experienced by the railway system (Krueger, 1999). The traffic peaking factor has an immense effect on railway capacity since it can result in higher train traffic than normal, which can be unfeasible for the railway system to deal with.

Traffic Parameters: Train Mix

The train mix is the description of the speeds of the trains since this impacts traffic and therefore capacity. The best-case scenario is when the trains all have similar speeds

or the same speed, since traffic can occur if trains are going different speeds (Abril et al., 2008).

Traffic Parameters: Priority Probability

Trains can either be priority or nonpriority. Priority trains are given preference over lower priority trains, which can lead to decreased capacity since delays along the rail system can occur. The priority versus nonpriority system means that the railroad must create 2 dispatching systems whereby lower priority trains delay each other to get out of the way of the priority train. The main rule that governs this factor is: the larger the number of priority trains, the less the capacity of the railroad.

Clearly, all these traffic parameters can vary from nation to nation because of topography, railway structure, natural events resulting from weather, and much more. Therefore, it can be concluded that in this facet of transportation infrastructure, no network effects are created. Even though the number of participants is going up in the Belt and Road Initiative, it might be impossible to harmonize the railroads due to the sheer number of differences in the rail systems. Train speeds vary due to the gauges, there could be a different train mix and priority probability, and so on, making network effects hard to come by in this aspect of the Belt and Road Initiative.

Operating Parameters: Track Outages

Operating parameters are the last sort of factor impacting capacity, with several sub factors including track outages. Track outages are when tracks are taken out of service for maintenance, damage, failure, or other reasons. This directly impacts the capacity of the rail system because it can cause delays as the trains cannot pass over tracks that are taken out of the railway. Delays in turn can result in logistical issues as well as financial loss.

Operating Parameters: Maximum Trip Time Threshold

The maximum trip time threshold is the maximum period a train will take to get from point A to point B, inclusive of stops and delays and traffic. This impacts capacity by limiting the number of stops.

Operating parameters can be affected depending on the nation that the system is in as well, which can halt the creation of network effects.

Section 3: Different Route Capacities in Different Nations

As discussed above, the three main parameters that impact the capacity of railroads on the Belt and Road are infrastructure parameters, operating parameters, and traffic parameters. Along with their subfactors, these parameters can greatly impact whether a train can carry a light load or a heavy load or go at fast speeds or slow speeds. Because these parameters differ from nation to nation, it is to be ex-

pected that therefore the railroad capacity will also differ from nation to nation.

If the route capacity is not enough on any of the rail systems, operational barriers will occur, as the Belt and Road is expected to have a high capacity for international shipping on the Trans Asian Railway. However, these capacity shortages, though worrying, may be able to be solved through having alternate routes for trains in case of traffic, as well as investing in removing or altering routes that often experience bottleneck issues (United Nations, 1999).

In the United Nations' Economic and Social Commission for Asia and the Pacific's report on the Trans Asian Railway, several countries participating in the Belt and Road's railway construction were surveyed on the capacity of the existing rail lines in their respective nations. The following nations were surveyed, as they play large roles in this section of the railway: Bangladesh, India, Iran, Burma, Pakistan, Sri Lanka, Thailand, and Turkey. The following section of the paper will focus on the first five of those nations. It must be mentioned that these infrastructure projects in each of these nations are created by bilateral agreements, which are agreements created between two countries (China and the other country). In this way, bilateral agreements are network effects because they follow a hub and spoke model. As users increase, the number of signed agreements increases as well. This benefits all participants in the Belt and Road, since these agreements mean a greater global interconnectivity for everyone. However, China is quickly learning that there must be geopolitical and international relation considerations involved, which could decrease network effects if relations between nations are poor.

Bangladesh

The Bangladesh part of the Trans Asian Railway is riddled with problems. There are three sections of their current track which are experiencing maximum levels of capacity, known as saturation capacity. This is due to the poor track conditions, poor service, and lack of proper management of assets as well as corruption (Rasal, 2018). Additionally, the locomotives are only diesel, which may be unsustainable given the high expectations of capacity for the Belt and Road and the fluctuating prices of oil and natural gas.

To add onto these above issues, the Bangladesh Railway is facing issues with the gauges, as there are 2 types of gauges used in the country which can create operational issues (one gauge is best for the country in terms of creating a seamless railroad where no alterations are needed) (Rasal, 2018). There are problems with the quality of the railroads as well, since the tracks and locomotives in addition to the roads are all in poor condition and would not be able to handle the capacity that the Belt and Road would require (Rasal, 2018). As a result, Bangladesh believes foreign direct investment from China in the Belt and Road Initiative has the potential to greatly improve their crumbling infrastructure. In fact, Shafqat Munir of the Bangladesh Institute of Peace and Security Studies has stated, "We have significant infrastructural needs - if we don't take a high-way from China, who else will provide it?" (Mardell, 2020).

Bangladesh, like many underdeveloped nations participating in the Belt and Road, are relying on the initiative to kickstart their economic growth and create greater integration into the world economy.

Bangladesh has already signed several infrastructure financing agreements with China, worth billions of US dollars. The Padma Bridge Rail link (\$3.3 billion), digital connectivity (\$1 billion), and a power plant in Payra (\$1.9 billion) were included in these projects (Khatun & Saadat, 2020). These projects all are aimed at developing Bangladesh as a potential manufacturing power in a strategic location (surrounded by India and located in one of the most river dense parts of the world, enabling lower cost transport via waterways).

This may be one network effect of the Belt and Road— as participants increase, developing nations such as Bangladesh believe that the Belt and Road offers more opportunities to improve their infrastructure via foreign direct investment from China. Bangladesh believes Chinese FDI may allow them to become a bigger power on the world stage, allowing greater integration into the world economy. Additionally, this allows for increased global interconnectivity, since a lot of underdeveloped nations are in strategic areas but simply have not had the opportunity to participate in the economy due to a lack of quality infrastructure.

India

In India, three of the largest routes planned to be in the Trans Asian Railway already have the potential for high capacity. This is due to the structure of their railways— when there is a high traffic concentration, they can use alternative routes to get trains to where they need to go (United Nations, 1999). However, there have been reports of some areas on the train tracks having issues with poor quality. A couple of sections on the track have encountered capacity issues as well. Additionally, there is a bottleneck section over the Ganges River which has the potential to create some logistical issues (United Nations, 1999).

However, India has been critical of the Belt and Road operations in their territory, as the China Pakistan Economic Corridor passes through Kashmir, a region that has been claimed by both India and Pakistan. New Delhi has stated that they cannot participate in a project that is undermining their concerns regarding the territory, and as a result, they have boycotted several of the Belt and Road forums (Economic Times, 2019). This means that the Belt and Road may not create network effects, since the number of participants would be decreasing, and India is a growing economy that surely China would like to engage in business relations with. Thus, poor international relations between nations could be a barrier to the network effects of the Belt and Road. Poor international relations could lead to isolation of certain nations resulting in decreased projected profits of the Belt and Road, as well as a decrease in economic growth for the isolated nation. China, as the founder of the Belt and Road and the nation facilitating participants, must learn to walk the line between angering nations and increasing potential profits and global connectivity.

Iran

The nation of Iran did not send enough data for analysts to make a judgment about their potential contributions to the railways of the Belt and Road. However, recently the Iranian Railway fell prey to a cyber-attack which disrupted operations (Bergman, 2021). This could be a potential issue for the Belt and Road if cyber-attacks continue to become the norm. However, these cyber-attacks have the potential to create network effects. As more cyber-attacks occur, software engineers become aware of the types of issues within the software and can fix errors in the coding that allow hackers to take control. Therefore, within the network, as the number of nations participating goes up, the software and computer engineers working on the Belt and Road cybersecurity are more accustomed to dealing with the issues that hackers can present, and they can help make the entire Belt and Road safer. This also helps to avoid disruptions with operations on the railways.

Additionally, China and Iran have already strengthened their relationship diplomatically amid the COVID pandemic, with China giving away COVID vaccines to the hard-hit nation of Iran. Following Iran's decades long financial support of the terrorist organizations such as Hezbollah, Hamas, and the Palestinian Islamic Jihad, several nations, such as the United States, Canada, Australia, and all of the nations in the European Union, have imposed economic sanctions on Iran. These sanctions have ranged from bans on the buying of Iranian oil products (gas, petroleum, etc.) to even bans on the Iranian Space Agency. Despite this, China has proved itself to be one of Iran's indispensable allies, as 30% of total Iranian foreign trade has been conducted with China (Shariatinia, 2019).

The sanctions mentioned above have impacted Iran negatively in their economic sector, especially with regards to their oil sector, as their oil exports have decreased by millions of barrels per day (Cohen, 2021).

Given this background, Iran has been desperate for some sort of financial support to help them out of their economic rut. Enter China with the Belt and Road Initiative, with the promise of generating millions of US dollars of annual revenue for Iran. The two nations signed a \$400 billion US dollar agreement to construct roads, railways, and ports to fully integrate Iran into the Belt and Road initiative (Cohen, 2021). This can be seen as a network effect of the Belt and Road, as Iran possesses a strategic geographical location— it borders Turkey, Iraq, and Pakistan, with Saudi Arabia just across the Persian Gulf. Therefore, Iran joining the Belt and Road would aid in creating more value for each nation, as Iran's location would allow a more cohesive passage to more Middle Eastern and Western markets. Even though this may be a network effect, some may say that the financial support from China will allow money to be funneled into terrorist organizations (Cohen, 2021). This is due to the fact that since the 1980s, Iran has supplied their proxy terror groups such as Hamas, Hezbollah, the Palestinian Islamic Jihad, and others with rockets, missiles, training, and hundreds of millions of dollars to attack nations linked with the United States and has even attacked, killed, or detained

American, British, French, Canadian, and other citizens or various foreign nations (Cohen, 2021). As a result, this may decrease network effects of the Belt and Road by further isolating allies of the United States by including sponsors of terrorism such as Iran. Again, balancing between isolating or angering nations and creating a profit is crucial for participating nations in the Belt and Road.

Myanmar

Myanmar's railways could present logistical issues to the Belt and Road, as the capacity is already limited due to speed limits of the tracks (United Nations, 1999). This deficiency is due to poor quality of the bridges and railroads, which simply could not handle high speeds with heavy loads of cargo. With the Belt and Road, China has given Myanmar \$21 billion US dollars of direct foreign investment for use on infrastructure projects (Myers, 2020). However, Myanmar has been wary of China's huge loans, as they must ultimately be repaid with interest (Myers, 2020). These interest rates are typically high, coming in at roughly 4%, whereas typical interest rates for the Organization of Economic Cooperation and Development (OECD) are 1% (Garver, 2021). They have canceled several large Belt and Road projects, such as the Myitsone hydroelectric dam, worth \$3.6 billion dollars, instead choosing to focus on smaller infrastructure projects (Myers, 2020). In addition, only 9 out of 40 proposed projects have been started as of 2019, whereas 51 similar projects have already gotten underway in Pakistan (Mark, 2020). Additionally, local groups in Myanmar have been concerned with sustainability issues, as the infrastructure projects could have negative impacts on the environment. Other individuals at both the local level and the national level are concerned with collaborating with China on the Belt and Road, as they have supported rebel groups within Myanmar.

The international community has not been supportive of the government of Myanmar, as the government weaponized the military against civilians, 100 of whom perished in a military coup in February 2021 (Blinken, 2022). By participating in the Belt and Road, Western nations may not want to join to not encourage nations with a poor human rights record, such as Myanmar. In this way, network effects could be diminished, as value is subtracted when fewer nations join, as the Belt and Road can lose connectivity when nations do not participate.

However, network effects could be created if Myanmar's worries are eased. Their location is beneficial to the Belt and Road, as they border Thailand, Laos, India, Bangladesh, and China. Therefore, if they decide to join, economic growth for this region could increase, since trade in Southeast Asia would be more cohesive and therefore costs would be lowered. As Belt and Road participants increase in Southeast Asia, value is added to the Belt and Road, and infrastructure quality increases, therefore increasing capacity and connectivity.

Pakistan

In Pakistan, several routes of the railway system are experiencing capacity shortages as well. There are speed limitations on some tracks, and the rolling stock could also be improved to increase functionality.

China is directly investing \$62 billion US dollars into Pakistan to create coal mines, wind power, hydroelectric power, ports (both dry and sea) and more (Sacks, 2021). These new infrastructure projects are meant to aid Pakistan with their energy shortage.

However, Pakistanis have recently criticized China as reports came out that Pakistan was overcharged by China by \$3 billion dollars (Sacks, 2021). The International Monetary Fund has also warned that the China Pakistan Economic Corridor has been putting Pakistan into unsustainable debt, with an increasing current account deficit and needed a bailout of \$3.6 billion dollars from the IMF (International Monetary Fund, 2017). As a result, Pakistan may not fully integrate into the Belt and Road because they cannot afford to take on large amounts of debt by participating in the Belt and Road and accepting billions of dollars' worth of Chinese loans. This will not result in network effects, as the participants would be decreasing, and therefore the entire network will be less connected.

Section 4: Examination of Sri Lankan Port

Sri Lanka is an island country to the south of India. As such, China wanted to connect Sri Lanka to the Belt and Road through a deep-water port located in Hambantota, a strategic location, as Sri Lankan ports allowed shipping routes to connect to a multitude of other nations. Relations between the two nations had always been warm, with China becoming Sri Lanka's "biggest provider of development assistance in 2012" and later their biggest trading partner in 2016 with \$4.4 billion worth of trade between the two countries (Rithmire & Li, 2022). To construct the port, Sri Lanka accepted Chinese loans. One loan was a \$307 million dollar loan with a 6.3% interest rate over 15 years (Rithmire & Li, 2022). Another loan was a \$757 million dollar loan with a 2% interest rate (Rithmire & Li, 2022). In 2017, the Sri Lanka Ports Authority and China Merchants (an international state-owned enterprise) agreed to lease the port out for 99 years to China Merchants for an 85% equity stake (Rithmire & Li, 2022). In this case, network effects may have been created by connecting Sri Lanka to the rest of the Belt and Road by creating a deep-water port in a strategic location, theoretically fostering more trade, however it soured relations between Sri Lanka and China in the process, and sowed distrust between them. This arguably could result in less network effects in the future, as Sri Lanka will be less willing to participate in projects related to the Belt and Road Initiative.

Conclusion

As evident from the data from participating nations, there have been conflicting effects of the Belt and Road initiative. The Belt and Road has generated network effects

in the form of infrastructure growth and economic growth in some nations. These nations, among them Serbia, Bangladesh, and others, view China's investments as a chance to integrate into international trade. However, network effects have not been created in several nations because of their inability to participate financially, or their poor relations with other participant nations or potential participant nations, such as Sri Lanka, whose port was reclaimed by China due to their failure to pay back loans to China. The Belt and Road has the potential to create economic growth, however this may come at the cost of local

industries, or even at the cost of diplomatic relations with nations who suffered due to the Belt and Road. As the Belt and Road projects continue, China will need to learn the delicate balance of learning how to walk the line between maintaining relations between all participating nations and making a profit.

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