BRIEFING

DECEMBER 2019

Barriers and opportunities for improving long-haul freight efficiency in China

INTRODUCTION

China has been the world's largest vehicle market since 2009 and is currently responsible for more than 10% of the world's transport-related CO_2 emissions.[1] Although heavy-duty vehicles (HDVs) make up only 5% of the total vehicle sales in China, the segment is responsible for nearly 50% of the on-road transport fuel used; this is because HDVs consume more fuel per kilometer and travel longer distances.[2] Among HDVs, long-haul rigid trucks and tractor-trailers are the biggest source of China's total vehicle fuel consumption and greenhouse gas (GHG) emissions.[3]

The Chinese government has made substantial efforts to improve the fuel efficiency of the HDV sector. Examples include the implementation of fuel consumption standards for new HDVs, the establishment of a nationwide green freight program, incentives for utilization of drop-and-hook transport, and improved enforcement of overloading limits.[4] Nevertheless, there are still significant inefficiencies.

The objective of this paper is to identify the key barriers and opportunities for improving long-haul trucking efficiency in China. The information was gathered via a literature

1 International Energy Agency, *CO_2 Emissions from Fuel Combustion*, (Paris: OECD/IEA, 2018).
2 International Energy Agency, *Energy Technology Perspectives 2017*, (Paris: OECD/IEA, 2017).
3 China Automotive Technology & Research Center (CATARC). (2013). *Development of fuel consumption standards for heavy-duty vehicles in China*. Presented at the International Workshop on Heavy-Duty Vehicle Fuel Efficiency Technology, Standards, and Policies. Tianjin, China. Retrieved from http://www.theicct.org/sites/default/files/CATARC%20PPT_EN_1.pdf
4 Drop and hook refers to the situation when a truck delivers and unloads a trailer at a certain location, where it picks up another trailer for its next delivery. Drop and hook reduces down time and empty kilometers and is only possible with interchangeable tractors and trailers.

Prepared by: Liuhanzi Yang, Oscar Delgado, Rachel Muncrief

review and interviews with Chinese stakeholders, including experts from industry associations, logistics companies, and research institutes.

This paper is organized as follows: The next section describes the key barriers to improved trucking efficiency. Following that, we outline the current policies and policy windows that present an opportunity to improve the efficiency of the freight system in China. The subsequent section summarizes additional measures that could help address these barriers and identifies key stakeholders that can lead on implementation.

KEY BARRIERS

Based on the literature review and interviews, we identified 11 barriers to improving long-haul freight efficiency and classified them in three broad categories: (1) institutional barriers, which refer to obstacles that are the result of government policies or business operations; (2) technological barriers, which refer to obstacles that limit the adoption of advanced and more efficient trucking technologies; and (3) financial barriers, which refer to factors that negatively affect access to capital and/or the operational cost structure of truck operators. Below we describe the barriers in detail.

INSTITUTIONAL BARRIERS

(1) THE INDUSTRY IS FRAGMENTED

China's road freight transportation industry is the largest in the world. In 2015, freight transport by road amounted to 5,796 billion tonne-kilometers, nearly twice the freight activity of the United States, which was 2,919 billion tonne-kilometers.[5] Although the overall road freight industry is large, the truck operators themselves are small. In the same year, 2015, the number of freight trucks on the road in China was 13.9 million and the number of carriers was 7.2 million. That is an average of around two trucks per carrier; 91.8% are owner-operators and 86.5% of the carrier enterprises own fewer than 10 trucks.[6]

There are a large number of owner-operators in China because the market entrance threshold is much lower than in other markets. The low cost of freight hauling trucks makes it relatively easy for a person to enter the market and start their own business. To complicate matters further, the education level of the average truck driver in China is significantly lower than the national average. These two factors combined lead to small scale, inefficient operations. In addition, the low entrance threshold leads to excessive competition in the marketplace. That competition, in turn, increases the likelihood of unfavorable practices such as overloading and operating with vehicles that do not comply with safety or environmental regulations.

(2) LACK OF ORGANIZED TRUCK-PAYLOAD MATCHING AND USE OF DROP AND HOOK

Truck utilization is usually lower in China than in other countries and regions. The lifetime-averaged annual vehicle kilometers traveled (VKT) for heavy trucks is 36,000 kilometers (km) in China. As a comparison, the numbers are 73,000 km in the European Union and 90,000 km in the United States (see Table 1). These lifetime averages also are lower than the typical VKT that long-haul trucks accrue in their first few years of

5 OECD (2019), Freight transport (indicator). doi: 10.1787/708eda32-en. The official data from the China Road Freight Development Report (2015–2016) is 6,470 billion tonne-kilometers. The difference could be the result of different methodologies.

6 China Federation of Logistics & Purchasing (CFLP), 2016. China Road Freight Development Report (2015–2016). An owner-operator is an individual who both owns and drives the truck.

operation, estimated at 96,000 km for China, 106,000 for the United States, and 216,000 for the European Union.

Table 1. An overview of the road freight industry in China, the United States, and the European Union

	China	United States	European Union
Lifetime VKT (km)	36,000[a]	90,000[a]	73,000[a]
Annual VKT in the first five years (km)	96,000[b]	106,000[b]	216,000[b]
Average speed (km/h)	38[c]	85[d]	60[e]
Total 2015 road freight (tonne-kilometers)	5,796 billion[f]	2,919 billion[f]	1,699 billion[f]
Number of total trucks	27.4 million[a]	19 million[a]	31 million[a]
Number of heavy trucks	6.2 million[a*]	2.3 million[a]	3.3 million[a]
Percentage of empty miles	15%–40% (estimation)	20%–25%[g]	15%–30%[h]
Number of staff employed	21 million[c]	7.8 million[i]	2.9 million[j]
Number of carriers	7,182,000[c]	892,078[i]	563,598[j]
Percentage of owner operators	91.8%[c]	39%[k]	n.d.

[a] International Energy Agency. *The Future of Trucks, implications for energy and the environment.* 2017. https://doi.org/10.1787/9789264279452-en.
[b] Dan Meszler, Oscar Delgado, and Liuhanzi Yang, *Heavy-duty vehicles in China: Cost-effectiveness of fuel-efficiency and CO2 reduction technologies for long-haul tractor-trailers in the 2025–2030 timeframe* (ICCT: Washington, DC, 2019), https://www.theicct.org/publications/heavy-duty-vehicles-china-cost-effectiveness-fuel-efficiency-and-co2-reduction
[c] China Federation of Logistics & Purchasing, 2016. China Road Freight Development Report (2015-2016)
[d] "Fact #671: April 18, 2011 Average Truck Speeds," Office of Energy Efficiency & Renewable Energy, https://www.energy.gov/eere/vehicles/fact-671-april-18-2011-average-truck-speeds
[e] European Parliament. Rail freight in the EU: Developing a tool for more sustainable transport. 2017. http://www.europarl.europa.eu/RegData/etudes/BRIE/2017/599425/EPRS_BRI(2017)599425_EN.pdf
[f] OECD (2019), Freight transport (indicator). doi: 10.1787/708eda32-en (Accessed on 06 May 2019)
[g] Joshua Agenbroad, Dave Mullaney, and Zhe Wang. *Improving Efficiency in Chinese Trucking and Logistics*. Rocky Mountain Institute, August 2016. https://rmi.org/wp-content/uploads/2017/03/China_Trucking_Charrette_Report_2016.pdf
[h] Eurostat. "Road freight transport by journey characteristics." 2017. https://ec.europa.eu/eurostat/statistics-explained/index.php/Road_freight_transport_by_journey_characteristics#Road_transport_by_type_of_operation
[i] American Trucking Associations. "Reports, Trends & Statistics." https://www.trucking.org/News_and_Information_Reports_Industry_Data.aspx
[j] Konrad Raczkowski, Friedrich Schneide, and Florent Laroche. *The Impact of Regulation of the Road Transport Sector on Entrepreneurship and Economic Growth in the European Union*. 2017. https://www.mobilelabour.eu/wp-content/uploads/2018/02/The-Impact-of-Regulation-of-the-Road-Transport-Sector-on-Entreperneurship-and-Economic-Growth.pdf
[k] OOIDA Foundation. "Owner-Operator and Professional Employee Driver Facts." https://www.ooida.com/OOIDA%20Foundation/RecentResearch/OOfacts.asp
*The official figure is 13.9 million from the China Road Freight Development Report (2015–2016).
Note: n.d. = no data

Figure 1 gives a detailed breakdown of the daily VKT and daily operation time for all freight trucks in China in 2015. About 56% of the trucks had VKT lower than 100 km per day, and 67% of the trucks were used less than four hours per day. The low daily VKT and utilization rate indicate that drivers are spending most of the day pursuing or waiting for payloads, which leads to lower logistics efficiency. This also may result in an increase in the rate of trucks running empty, although accurate data on the fraction of empty miles driven is not readily available. According to the literature, 40% is typically quoted as a rough estimation. However, based on our interviews with industry experts, the actual empty driving rate is likely less, as experts quoted anywhere between 15% and 40%. The reason for this is that truck drivers prefer to wait for loads rather than drive a return route with an empty truck. Therefore, it is the low utilization rate, rather than the high empty running rate, that negatively affects efficiency and increases logistics costs.

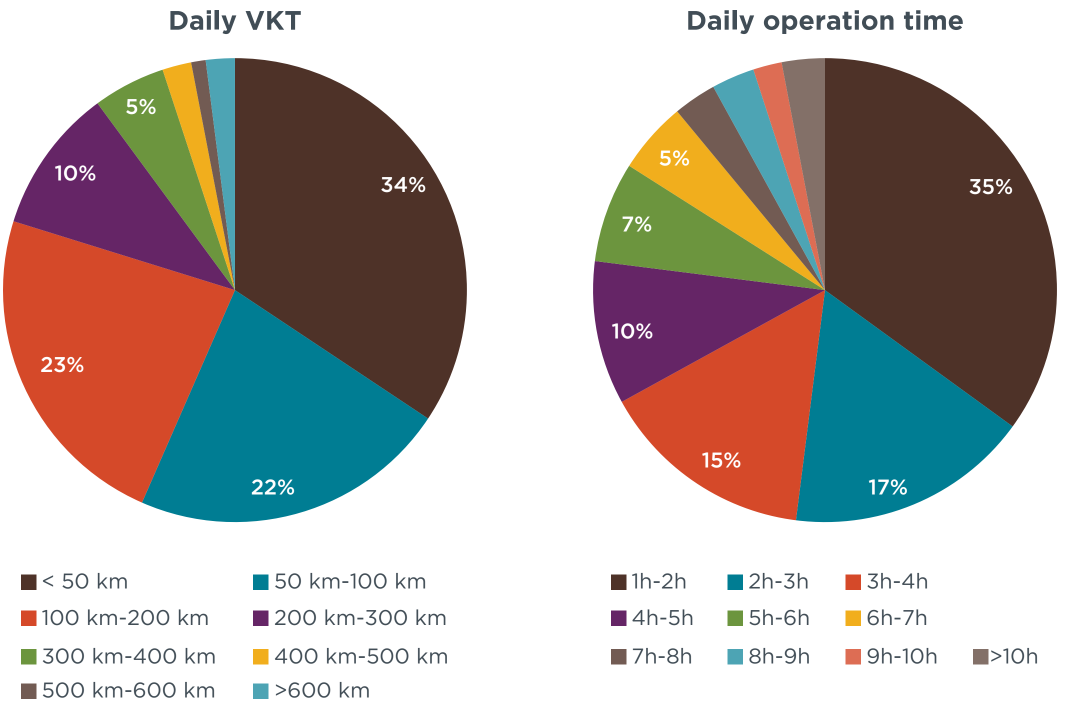

Figure 1. Breakdown of daily VKT and daily operation time of all freight trucks in China in 2015. Source: China Federation of Logistics & Purchasing, 2016. China Road Freight Development Report (2015–2016)

Drop-and-hook operations, in which the driver arrives with a loaded trailer, drops it off at the customer site or distribution center, and hooks up another loaded trailer, is a way of increasing asset utilization and efficiency by reducing dwell time at facilities. Drop and hook has been widely used for decades in the United States and the European Union. China has been promoting drop and hook since 2007 and initiated a pilot program in 2011 that provides funds for the construction or renovation of drop-and-hook stations and development of a drop-and-hook management information platform.[7] However, to date, the use of drop and hook is still not common in China. The ratio of registered tractors to trailers from 2007 to 2014 remained at about 1:1, indicating that most tractors and trailers remain coupled in operation.[8] By comparison, the tractor-to-trailer ratio in the United States is approximately 1:3. This allows trailers to be loaded and unloaded while others are simultaneously being transported. In addition, a large share of freight in China is being transported with straight trucks. China's 37% share of tractor-trailers in weight classes above 15 tonnes is lower than in the United States, where it is 75%, and the European Union, where it is 50%.[9]

The highly fragmented market is also a barrier for efficient drop and hook. Drop and hook requires collaboration among different shippers and carriers that make use of a shared trailer pool. For example, in the United States, trailers hauled by a given carrier can be owned by freight customers, leasing companies, third-party logistics companies, or even other carriers. The framework for sharing trailers does not yet exist in China and there are significant concerns, especially from small companies and owner-operators, about how trailer sharing can be implemented securely. Third-party logistics companies (3PLs) could facilitate sharing because they act as intermediaries between shippers and

7 Ministry of Transport (MOT), 2010. Implementation Plan for Pilot Transportation Project. http://zizhan.mot.gov.cn/zizhan/siju/daoluyunshusi/shuaiguayunshushidian/wenjiangonggao/201307/t20130711_1449285.html
8 Óscar Delgado and Hanyan "Ann" Li, *Market analysis and fuel efficiency technology potential of heavy-duty vehicles in China*, (ICCT: Washington, DC, 2017), https://theicct.org/publications/HDV-china-mkt-analysis-and-fuel-efficiency-tech-potential
9 Meszler et al., 2019.

carriers. But whereas 3PLs are common in the United States and the European Union, they are not yet common in China.

(3) LACK OF OPTIMIZED DISTRIBUTION BETWEEN TRUCK AND RAIL

For long distance freight movement over land, rail is typically more cost-effective than road freight transportation. In addition to lower cost, the benefits of rail include lower energy consumption and CO_2 emissions per tonne-kilometer. Trucks typically are required for transporting cargo to its final destination, but rail transport is optimal for longer legs of the journey. Rail-based freight transport is not currently common in China. Table 2 shows freight mode share in China, the United States, and the European Union. The rail-based freight transport share in China is similar to the United States and relatively low when compared to the European Union. Road transport accounted for 75.5% of total freight volume movement in China in 2015, and rail accounted for around 8%. Historically, the main reason for lack of rail utilization is lack of capacity.[10] Another barrier is the lack of data and the complexity of multi-agency management in China. For example, the Ministry of Ecology and Environment (MEE) and Ministry of Industry and Information Technology (MIIT) own data on individual mode efficiency, but do not have data on transportation activities, which are managed by the Ministry of Transport (MOT), while the Ministry of Commerce (MOC) manages international and domestic commodity data. Close collaboration and data sharing among different agencies is required to coordinate modal shift policies. According to China's Clean Diesel Action Plan, China plans to increase railroad freight transportation by 30% compared with the 2017 level.[11]

Table 2. Freight mode share in China, the United States, and the European Union

		China[a]	United States[b]	European Union[c]
Freight mode share (% of total freight volume)	**Road**	75.5%	66%	49%
	Rail	8%	9%	11.7%
	Water/air/pipeline/other	16.5%	25%	39.3%

[a] CFLP, 2016. China Road Freight Development Report (2015–2016).
[b] U.S. Department of Transportation, Federal Highway Administration (2016), "2016 Freight Quick Facts Report." https://ops.fhwa.dot.gov/publications/fhwahop16083/ch1.htm
[c] European Commission. *EU Transport in Figures – Statistical pocketbook 2016*. https://ec.europa.eu/transport/sites/transport/files/pocketbook2016.pdf

(4) CONFLICTING GOVERNMENT REGULATIONS AND STANDARDS

Numerous government agencies are involved in regulating the freight sector in China. Table 3 presents a summary of the major agencies and their relevant responsibilities. At times, these agencies have put in place conflicting or confusing regulations that disincentivized the adoption of efficient technologies and/or practices. As an example, the use of aerodynamic side skirts retrofitted on trailers is allowed by the MOT. However, annual inspection by the Ministry of Public Security (MPS) requires that the vehicles look exactly the same as when they were registered. Therefore, truck owners must either go through a burdensome administrative process with MPS to get approval for retrofitting their vehicles with a side skirt or remove the equipment for each annual check. Local regulations also add to confusion, as side skirts that are allowed in one province would cause the vehicle to be considered oversized in another, resulting in a monetary fine

10 CATARC, 2018. *China Freight Assessment* https://theicct.org/publications/china-freight-assessment
11 MEE, 2018. Action Plan for Battle Against Diesel Truck Pollution. http://203.187.160.134:9011/www.mee.gov.cn/c3pr90ntc0td/xxgk2018/xxgk/xxgk03/201901/W020190104656772362578.pdf

to the driver. Overall, this results in a very low market penetration of aerodynamic side skirts even though this technology is known to save enough fuel to pay for itself.[12]

Table 3. Major government agencies involved in freight transportation and relevant responsibilities in China

Government agency	Responsibility
Ministry of Transport (MOT)	Freight business operating permit, over-load/size regulations and enforcement*, freight vehicles fuel consumption standards and enforcement, and tolls
Ministry of Public Security (MPS)	Vehicle registration, traffic violation management, and over-load/size regulations and enforcement*
National Development and Reform Commission (NDRC)	Transportation development planning and infrastructure construction
Ministry of Industry and Information Technology (MIIT)	Vehicle manufacturer management and fuel consumption standards
Ministry of Commerce (MOC)	Commercial logistics development planning and vehicle compulsory scrappage regulation
Ministry of Ecology and Environment (MEE) (formerly the Ministry of Environmental Protection)	Vehicle emission standards and GHG emissions control
Ministry of Finance (MOF)	Logistics special funds management
State Administration of Taxation (SAT)	Business taxation policies and management
National Railway Administration (NRA)	Attached to MOT – railway planning and management
General Administration of Customs (GACC)	Export-import management
State Administration for Market Regulation (SAMR)	Vehicle product quality supervision and inspection, defect report and recall.
Standardization Administration of China (SAC)	Planning, development, revision, and management of standards
China Banking and Insurance Regulatory Commission (CBIRC)	Vehicle insurance regulation

*The MOT is in charge of detecting over-load/size activities and supervising the elimination of the illegal activities. The MPS is in charge of implementation of punishment for over-load/size activities.

(5) LACK OF PROPER ENFORCEMENT

Lack of proper enforcement is another major barrier to improving trucking efficiency in China. As previously mentioned, the market entrance threshold is low for owner-operators, and that leads to intense competition in the market. In the past, it was very common for owner-operators and small carrier companies to operate with overloaded and noncompliant vehicles in order to maximize profit. Additionally, China enforces its fuel consumption standards with administrative, rather than financial, penalties. For example, the MIIT can deny type-approval applications for new vehicles that fail to meet the fuel consumption limits, but it does not have clear authority to recall vehicles that

12 Felipe Rodriguez, Rachel Muncrief, Oscar Delgado, and Chelsea Baldino, *Market penetration of fuel-efficiency technologies for heavy-duty vehicles in the European Union, the United States, and China*, (ICCT: Washington, DC, 2017), https://theicct.org/sites/default/files/publications/HDV-market-penetration_ICCT_White-Paper_050917_vF_corrected.pdf; Dan Meszler, Oscar Delgado, and Liuhanzi Yang, *Heavy-duty vehicles in China: Cost-effectiveness of fuel-efficiency and CO_2 reduction technologies for long-haul tractor-trailers in the 2025–2030 timeframe*, (ICCT: Washington, DC, 2019), https://www.theicct.org/publications/heavy-duty-vehicles-china-cost-effectiveness-fuel-efficiency-and-co2-reduction

are not compliant with fuel-consumption standards.[13] Compared with the increasing regulatory actions taken against those not compliant with vehicle emission standards, for example the 170 million RMB penalty issued to Jianghuai Automobile Company over emissions fraud, regulatory actions for noncompliance with fuel-consumption standards is falling behind.[14]

TECHNOLOGICAL BARRIERS

(1) LACK OF TRUSTED INFORMATION ON THE BENEFITS OF FUEL-SAVING TECHNOLOGIES

Numerous existing technologies are capable of providing real-world, fuel-saving benefits for HDVs in China. Commercialized technologies are available to improve engine efficiency, reduce aerodynamic drag, reduce rolling resistance, and recapture braking energy. Cost-effectiveness studies have shown that the fuel savings derived from the range of available technologies significantly exceeds the purchase and maintenance costs.[15] However, many of these technologies are not currently widely adopted in China.[16]

One key reason for this is that awareness about the effectiveness and payback potential of efficiency technologies is low. This is especially true for owner-operators. Larger carriers and fleet managers are typically more aware, but still frequently lack access to relevant information. Even when carriers have heard about certain fuel-saving technologies, there is typically a low level of confidence in the claims made by the technology suppliers regarding the real-world performance and payback period.

An additional challenge is that international experience does not always translate to China. This is because, as mentioned above, trucks are generally operated quite differently in China as compared to the United States and European Union. For example, trucks in China typically operate at lower speeds, carry heavier payloads, and have lower annual mileage. So, until these characteristics change, data on benefits and payback generated from experience with the technology in the European Union or United States will not translate well to the China context. Additionally, real-world testing data on efficiency technologies from independent sources that are available in green freight programs in other countries (e.g., the U.S. Environmental Protection Agency's SmartWay) are lacking in China. Carriers are risk-averse, and they want certainty before investing. Technology verification is key to promote market adoption of efficiency technologies by increasing confidence in their potential and cost-effectiveness.

(2) LACK OF TECHNOLOGY STANDARDIZATION

Low standardization rates in logistics equipment is a major technical barrier to freight efficiency improvement. For example, for drop-and-hook tractor-trailers, there is no standardized coupling that all tractors and trailers use. MIIT issued a national recommended standard on mechanical coupling between tractors and semi-trailers in 2006 and a national recommended standard on specification for drop-and-hook vehicles in 2017.[17] These can help promote the standardization of drop and hook, but

---

13 Authority on denying type approval applications: Hongyang Cui, *China's New Energy Vehicle mandate policy (final rule)*, (ICCT: Washington, DC, 2018), https://theicct.org/publications/china-nev-mandate-final-policy-update-20180111. No clear authority to recall non-compliant vehicles: International Energy Agency (IEA), 2019. *Fuel Economy in Major Car Markets: Technology and Policy Drivers, 2005-2017*, https://theicct.org/publications/gfei-tech-policy-drivers-2005-2017

14 "China JAC Motors fined 24.7 mln USD for emission fraud." *Xinhua News*, July 8, 2019. http://www.xinhuanet.com/english/2019-07/08/c_138209479.htm

15 Meszler et al., 2019.

16 Rodríguez et al., 2017.

17 General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ), Standardization Administration of the People's Republic of China (SAC), 2006. GB/T 20070-2006 *Road vehicles - Mechanical coupling between tractors and semi-trailers – Interchangeability*; AQSIQ, SAC, 2017. GB/T 35782-2017 *Specification for swap trailer transport of road vehicles*.

currently there are still different designs of hooks on the market, and not all of them are compatible with each other. Standardized couplings for tractors and trailers have existed for many years in the United States. Fleet users and carrier associations forced standardization as interoperability is key to facilitating efficient logistics. The lack of standardization in China is a major barrier in moving toward drop-and-hook logistics. Another example is in multimodal (truck-to-rail) transportation, where containers are not designed to universally fit on both container chassis and railway cars. Lack of standardization even causes inefficiencies in the loading and unloading process, due to a range of different sizes and shapes of pallets that different shippers use.

(3) SURPLUS OF LOW-END TRUCKS AND TRUCK MANUFACTURERS

With more than 460 truck manufacturers, China's HDV market is highly fragmented and less consolidated than the U.S. and EU markets. Although all registered trucks in China are compliant with the current stage 2 fuel consumption standard, their fuel efficiency performance varies widely. Within the same weight bins, the type-approval fuel consumption can vary by as much as 14% for tractor-trailers.[18] This indicates that technology adoption levels and technology quality differ among different manufacturers. As the mindset of the smaller operators is more focused on purchase price than on total cost of ownership of truck assets, they usually buy the lowest-cost trucks, and these are equipped with less-advanced technologies and have higher fuel consumption. It is challenging to get consumers to purchase more advanced vehicles when there is an oversupply of low-end, inexpensive trucks readily available on the market.

FINANCIAL BARRIERS

(1) EXCESSIVE ROAD TOLL COSTS

Table 4 illustrates the average cost breakdown of long-haul trucking in China, the United States, and the European Union. Road tolls in China account for 36% of the total cost and are a higher portion of the total than fuel and labor costs. In contrast, tolls are 1% and 9% in the United States and the European Union, respectively.[19] Excessive toll charges incentivize truckers in China to drive very inefficiently on side roads instead of using motorways. A survey of 3,000 truck drivers found that 31% selected side roads instead of motorways whenever possible to save toll costs.[20] It should also be noted that while insurance costs are only 3% of total operational costs in China, as shown in Table 4, if a carrier owns a tractor-trailer as opposed to a straight truck, the insurance costs may effectively double, because the tractor and trailer must be insured separately.

18 Delgado and Li, 2017.
19 Torrey, W., and D. Murray, (2015). *An analysis of the operational costs of trucking: 2015 update*. Arlington, VA: American Transportation Research Institute. Retrieved from https://truckingresearch.org/wp-content/uploads/2015/09/ATRI-Operational-Costs-of-Trucking-2015-FINAL-09-2015.pdf; Federal Association of Road Freight Transport Logistics, 2013. Development of costs in road haulage. Retrieved from http://www.bgl-ev.de/web/der_bgl/informationen/branchenkostenentwicklung.htm&v=2-form
20 CFLP, 2016. China Road Freight Development Report (2015-2016)

Table 4. Breakdown of the total operational costs for a long-haul tractor-trailer in China, the United States, and Germany

		China[a]	United States[b]	Germany[c]
Breakdown of total operational costs for 49-tonne tractor	Fuel and diesel emission fluid	34%	39%	26%
	Tolls	36%	1%	9%
	Maintenance	3%	9%	6%
	Tires	3%	2%	2%
	Drivers	17%	34%	32%
	Insurance	3%	4%	3%
	Depreciation (China) Truck lease or purchase payments (US and Germany)	1%	10%	9%
	Other	3%	2%	12%

[a] China Cost Study (2018). Analysis of heavy-duty vehicle technology costs in China. Proprietary and confidential study performed by an independent Chinese consultant under contract to the International Council on Clean Transportation.
[b] Torrey, W., and D. Murray. (2015). An analysis of the operational costs of trucking: 2015 update. Arlington, VA: American Transportation Research Institute. https://truckingresearch.org/wp-content/uploads/2015/09/ATRI-Operational-Costs-of-Trucking-2015-FINAL-09-2015.pdf
[c] Federal Association of Road Freight Transport Logistics. (2013). Development of costs in road haulage. http://www.bgl-ev.de/web/der_bgl/informationen/branchenkostenentwicklung.htm&v=2 - form

(2) IMBALANCED COMPETITION IN THE FREIGHT MARKETPLACE

The glut of carrier availability in China, as previously discussed, leads to intense competition that puts individual private carriers in a weak negotiating position. Carriers, especially owner-operators, have little to no leverage, leaving them with no choice but to accept the (over)loading requirements from the cargo owners (shippers).[21] This leads to overloaded trucks and also lowers the incentive to ship by rail, because it drives down the cost of road transport so severely that it becomes cheaper than rail. According to the CFLP report, the freight rate charged by owner-operators is around one third of the rate charged by larger carrier companies, and the freight efficiency is 50% lower.[22] In addition, bulk cargo such as coal, which ideally would be moved by rail, is transported mostly by truck because on-road transport is much cheaper.

(3) CAPITAL COST CONSTRAINTS AND DISINCENTIVES

In China, the initial capital investment is a very important consideration for carriers when deciding which trucks to source. In most cases, carriers end up buying cheaper, less efficient trucks. The market for premium trucks is served mostly by imported vehicles from European original equipment manufacturers and it remains a niche market that accounts for a small share of total truck sales. In the EU and U.S. markets, carriers are more likely to focus on total cost of ownership; they are more likely to invest a larger sum up front to buy more reliable, more efficient trucks, with the knowledge that those investments eventually will pay for themselves.

For example, to properly use drop-and-hook systems, multiple trailers would need to be purchased for every tractor. A combination of one tractor with three trailers costs around 540,000 RMB, as opposed to 300,000 RMB for a single straight truck with lesser but similar capacity. This comparatively high upfront cost is one key reason why most truckers prefer to purchase straight trucks.

21 CATARC, 2018. China Green Freight Assessment. https://theicct.org/sites/default/files/China_Freight_Assessment_English_20181022.pdf
22 CFLP, 2016. China Road Freight Development Report (2015-2016)

In addition, the upfront cost of purchasing new trucks equipped with the latest efficiency technologies is also a major barrier for carriers, especially small ones. Even though the technologies may pay for themselves over time, carriers may not have access to the necessary additional capital required at the time of purchase.

Split incentives are another challenge. In some cases, it is the driver who pays the fuel cost instead of the carrier company.[23] When this is the case, the companies responsible for investments in equipment have little motivation to invest in efficient trucks or technologies.

CURRENT POLICIES AND POLICY WINDOWS

China seeks to build a safe, convenient, efficient, and green logistics system by 2020 and has crafted a series of policies, regulations, and programs to promote greener freight movement. This section outlines the current measures, opportunities, and recent developments related to this goal. See Table 5 for a summary.

NEW MINISTRY OF ECOLOGY AND ENVIRONMENT

The new Ministry of Ecology and Environment (MEE) was established in 2018.[24] It has responsibility for all duties previously handled by the Ministry of Environmental Protection and will take on additional responsibilities with respect to climate change that were formerly under the National Development and Reform Commission (NDRC). Moreover, it will handle issues regarding marine pollution control, underground water pollution regulation, and agricultural pollution control that were formerly under six other ministries. With its new management structure, the MEE is now the most powerful environmental regulatory body in the country. The New Clean Air Law, revised in 2015, gave the MEE clear authority to formulate and enforce ambient air quality standards and emission standards regarding air pollutants. If vehicles are found to be not compliant with the vehicle emission standards, the MEE has the authority to recall the vehicles and issue civil penalties. The new responsibilities on climate change and GHG emissions under MEE will bring opportunities to further improve efficiency and reduce CO_2 emissions from the freight sector.

CHINA GREEN FREIGHT INITIATIVE

The China Green Freight Initiative (CGFI) was launched in 2012. It aims to improve energy efficiency and reduce GHG and air pollutant emissions from road freight in China. This is a national, voluntary program and is a collaborative effort involving government, the private sector, development agencies, civil society, and other stakeholders. The China Road Transport Association, Clean Air Asia, and the Research Institute of Highways of the MOT are the leading organizations of the initiative.[25] The program has three components—green management, green technology, and green driving. Green management aims to improve fleet management through better loading and drop-and-hook practices. Green technologies aim to promote the adoption of fuel-saving technologies for trucks through the development of voluntary green truck standards and the issuance of a catalogue of green technologies and energy-saving products. For green driving, CGFI is seeking to promote eco-driving through the development of eco-

23 360che.com, 2011. Management methods for drivers of logistics companies. http://www.360che.com/driver/110811/16160.html
24 China State Council, 2018. China to establish ministry of ecological environment. http://english.www.gov.cn/state_council/ministries/2018/03/13/content_281476076462818.htm
25 Clean Air Asia, "China Green Freight Initiative (CGFI)," https://cleanairasia.org/node7314/

driving training programs and guidebooks.[26] CGFI has released two voluntary standards, the Green Freight Enterprise Standard and the Green Freight Vehicle Standard, which provide details on the "five-star" labeling program requirements for companies and trucks.[27] The CGFI is now in its fourth phase and is focused on engaging more shippers in the program, launching local pilot projects, and developing quantification tools and a communication platform.[28] With support from CGFI, Guangdong province launched a green freight demonstration project from 2011 to 2015. A total of 14 carrier companies and 1,500 trucks joined. Fuel-saving technologies such as low rolling-resistance tires, wind deflectors, and energy-saving driving systems were installed on most of the pilot trucks and significant fuel savings were demonstrated. Overall, the project produced a very positive demonstration effect. After it ended, carriers continued to purchase fuel-saving technologies on their own. According to one estimation, the project reduced CO_2 emissions by 64,000 tonnes per year.[29]

THREE-YEAR ACTION PLAN OF BLUE-SKY DEFENSE

In July 2018, China's State Council released a National Plan of Blue-Sky Defense.[30] The initiative, which first appeared in Premier Li's Government Work Report in March 2017, aims at reducing emissions of major air pollutants and GHGs and improving air quality by 2020. The Action Plan sets out the overall thinking, targets, key tasks, and timelines for accomplishing the objectives. It outlines tasks in six areas, including adjusting the transportation structure to advance green transportation. For example, the national volume of railway freight is targeted to be increased by 30% by 2020, compared to the 2017 level. The targeted increases vary by region. For example, freight volume by railway is expected to be increased by 40% in the Jing-Jin-Ji region, 10% in the Yangtze River Delta, and 25% in the Fenwei Plain. In some key ports, raw materials such as coal, ore, and coke are to be transported by rail or waterway, instead of truck, by 2020. For the steel, electrolytic aluminum, electricity, and coking industries, 50% of freight transport of raw materials is to be by rail in key regions by 2020. In September 2018, as a follow-up policy, China's State Council issued a 3-year action plan for promoting the adjustment of China's transport structure.[31] This action plan further sets out detailed tasks, quantitative indicators, and deadlines for accomplishing the goals. For example, 80% of new logistics parks and large industrial and mining enterprises with a total freight volume of more than 1.5 million tonnes will be connected to industrial railways by 2020. Main ports along the Yangtze River will be integrated into railway lines. In addition, the plan calls for strengthening enforcement on illegal overloading of trucks. By the end of 2020, weight detection will be at all entrances to highways nationwide, and the overloading rate is to be kept below 0.5%. The plan requests the promotion of multimodal transportation demonstration projects, container railway-waterway combined transportation, and urban green freight distribution demonstration projects. By 2020, around 100 urban green freight distribution demonstration projects will be implemented, and concentrated transportation modes such as drop and hook, joint distribution, centralized distribution, and night delivery are encouraged. Clean vehicles and electric vehicles are also encouraged in these urban green freight distribution demonstration projects.

26 Smart Freight Centre, *Green Freight Programs Worldwide*, 2015, http://www.nucms.nl/tpl/smart-freight-centre/upload/Green%20Freight%20Programs%20Worldwide%20-%20SFC%20May2015.pdf
27 China Road Transport Association (CRTA), 2015, *Green Freight Enterprise Standard*, http://www.cleanairasia.cn/uploads/soft/151119/1-151119131241.pdf; CRTA, 2015, *Green Freight Vehicle Standard*, http://www.cleanairasia.cn/uploads/soft/151119/1-151119131320.pdf
28 Clean Air Asia, "China Green Freight Initiative (CGFI)," http://cleanairasia.org/node7314/
29 Guangdong Green Freight Demonstration Project Office. World Bank Guangdong Green Freight Demonstration Project Shows Effectiveness. https://cleanairasia.org/node12753/
30 China State Council, 2018. Three-year Action Plan on Defending the Blue Sky. http://www.gov.cn/zhengce/content/2018-07/03/content_5303158.htm
31 China State Council, 2018. Three-year action plan for promoting the adjustment of China's transport structure. http://www.gov.cn/zhengce/content/2018-10/09/content_5328817.htm

Transportation agencies and local governments will provide financial support and policy support such as road access privileges to these demonstration projects.

DEVELOPMENT PLAN FOR THE LOGISTICS INDUSTRY (2014–2020)

In October 2014, the China State Council released a 6-year development plan for the logistics industry covering the period from 2014 to 2020.[32] The goal is to build a rationally laid out, technologically advanced, convenient, efficient, environmentally friendly, safe, orderly, and modern logistics industry by 2020. The development priorities include reducing logistics costs, promoting large-scale and advanced logistics companies, and enhancing logistics infrastructure construction. The plan lists 12 key types of projects: multimodal transport; logistics parks; logistics for agricultural products; supply chain management; logistics for resource-oriented products; logistics between urban and rural areas; e-commerce logistics; logistics standardization; information systems; development of advanced logistics technologies; recycling logistics; and emergency logistics. This development plan serves as high-level guidance for the logistics industry, and relevant ministries and many provinces and cities have issued follow-up plans. For example, the Ministry of Commerce issued the Business Logistics Standardization Special Action Plan.[33] Main tasks in that plan include the development of a pallet-sharing system and establishment of an integrated logistics information service platform. In 2018, the State Administration for Market Regulation (SAMR) published three national standards on logistics, including green logistics indicators and accounting methods, a performance indicator system for a logistics park, and the standardization of pallets.[34]

NEW VEHICLE FUEL CONSUMPTION STANDARDS

In China, the MIIT is in charge of fuel consumption standards and management. China is one of the six nations or regions worldwide that have implemented fuel consumption standards for new HDVs; the others are Japan, the United States, Canada, India, and the European Union. Three stages of standards have been issued so far. Stages 1 and 2 were implemented in 2012 and 2014. Stage 3 was finalized in February 2018 and went into effect on July 1, 2019 for new type approvals; it will go into effect for new HDVs sold in China on July 1, 2021. The Stage 3 standard will further reduce fuel consumption limits by around 15% for new HDVs. If the new standards are implemented effectively, new HDVs should achieve significant fuel consumption reductions over the next few years. In addition, studies have shown that there is still potential to further reduce the fuel consumption of HDVs in China through adoption of technologies that are currently commercially available in the United States.[35] Tractors and straight trucks are covered by the standards, but trailers are not covered, even though trailer technology is known to have an important impact on fuel consumption. According to the China Automotive Technology & Research Center (CATARC), 25% to 42% of HDVs registered

---

32 China State Council, 2014. Medium and long-term planning for the development of logistics industry (2014-2020), http://www.gov.cn/zhengce/content/2014-10/04/content_9120.htm

33 MOC, 2014. Business Logistics Standardization Special Action Plan, http://www.mofcom.gov.cn/article/fgsjk/201411/20141102649415.shtml

34 State Administration for Market Regulation (SAMR), 2018, Green logistics indicators and accounting methods, http://openstd.samr.gov.cn/bzgk/gb/newGbInfo?hcno=BB35259351DD2ABAFC1BC2460944EB5D;
SAMR, 2018, Performance indicator system of logistics park, http://openstd.samr.gov.cn/bzgk/gb/newGbInfo?hcno=5B8BB794C2A287A67649A62A2BB415F8
SAMR, 2018, Palletized unit load-based logistics system—Design criteria of pallets http://openstd.samr.gov.cn/bzgk/gb/newGbInfo?hcno=92A458FB5DD13305277F9916518EC36F

35 Delgado and Li, 2017.

after 2017 are still not compliant with the Stage 3 fuel consumption standard.[36] The next stage, Stage 4, is currently being discussed and will likely address some of these additional opportunities for further reductions. The Stage 4 standard is expected to be implemented for new type approval in July 2024, and for all new vehicle production in July 2026.[37]

PROMOTING THE DEVELOPMENT OF DROP AND HOOK

In 2009, five government agencies—the MOT, NDRC, MPS, the General Administration of Customs (GACC), and the China Banking and Insurance Regulatory Commission (CBIRC)—released a joint policy promoting drop-and-hook transport.[38] The document identified drop and hook as an advanced transport strategy that plays an important role in reducing logistics costs, reducing energy consumption and emissions, and improving overall economic development. The document lists eight institutional management policies that would facilitate the growth of drop and hook. They are: reduce the number of annual inspections of trailers; reduce insurance costs on trailers; improve the customs supervision policies for trailers; reduce tolls for trailers; promote the standardization of tractors and trailers; improve trailer license management; encourage freight companies to expand the logistics network; and promote collaboration between companies.[39] The document also encourages capital investment on infrastructure construction and conducting pilot programs for drop and hook. As a follow-up policy, the MOT and NDRC published an implementation plan on drop-and-hook pilot programs in 2010.[40] In 2012, the Ministry of Finance (MOF) and MOT released a special funds management regulation on drop-and-hook pilot programs.[41] The regulation specifies what projects and items can be funded, the subsidy allowance, and the application procedure. By the end of 2015, more than 209 demonstration projects had been implemented. The total fuel savings of the demonstration programs was 210,000 tonnes and the total logistics cost savings were nearly 30 billion RMB.[42]

PROMOTING THE DEVELOPMENT OF GREEN TRANSPORTATION

In November 2017, the MOT released a policy on promoting the development of green transportation.[43] On the freight side, several development goals were identified: to further increase the mode share of rail and water transport; to increase the freight volume by multimodal transport; and to reduce the energy consumption and emissions from freight transport. The five specific targets are: (1) the freight volume of multimodal transport in 2020 shall be 1.5 times of that in 2015; (2) the number of new energy and clean energy trucks on the road shall reach 600,000 in 2020; (3) at least 80% of on-road trucks shall be standardized with the ability to couple with any trailer or intermodal freight system by 2020; (4) energy consumption of on-road trucks shall drop by 6.8% between 2015 and 2020, based on a metric of fuel usage per tonne-kilometer; and (5) CO_2 emissions from the overall transportation sector shall decrease 7% by 2020. This policy sets specific

36 25% of straight trucks, 42% of dump trucks, 37% of coaches, and 35% of tractors are not compliant with stage 3 fuel consumption standard. CATARC, 2019. 20th meeting of the heavy duty commercial vehicles fuel consumption standard working group.

37 CATARC, 2019. 20th meeting of the heavy duty commercial vehicles fuel consumption standard working group.

38 MOT, 2009. Notice on promoting the development of transport. http://www.gov.cn/gzdt/2010-01/13/content_1509033.htm

39 Regarding the reduction of tolls, for regions that apply an annual fee system, the freight operators are subject to a toll based on the number of tractors. The trailers exceeding the number of tractors are not subject to a toll.

40 MOT, NDRC, 2010. Implementation plan on drop and hook pilot program. http://www.gov.cn/zwgk/2010-11/09/content_1741424.htm

41 MOF, MOT, 2012, Special funds management regulation on drop and hook pilot programs. http://www.gov.cn/zwgk/2012-05/21/content_2141661.htm

42 "China's drop-and-hook pilot program has saved logistics costs by nearly 30 billion RMB." Xinhua News, December 28, 2015. http://www.gov.cn/xinwen/2015-12/28/content_5028507.htm

43 MOT, 2017. Promoting the development of green transportation. http://xxgk.mot.gov.cn/jigou/zcyjs/201712/t20171206_2973177.html

targets for encouraging multimodal transport, promoting new energy and clean energy trucks, and improving logistics efficiency. Currently, several policies relevant to green transportation have been published or are ongoing, including transportation mode shift from road to rail, promotion of multimodal transport, promotion of drop and hook, and strengthening the fuel consumption and emission standards.

PROMOTING THE DEVELOPMENT OF MULTIMODAL TRANSPORT

Multimodal transport is performed under one contract but with at least two different means of transport, which is to say by some combination of road, rail, water, and air. Advantages of multimodal transport include shorter transport time, better logistics efficiency, and lower logistics costs. In December 2016, 18 agencies including the MOT, NDRC, MIIT, MOC, GACC, State Administration of Taxation (SAT), and China Railway released a joint policy for promoting multimodal transport.[44] The document lists 18 key targets, including goals related to optimizing market supervision, improving relevant regulations and enhancing enforcement, improving infrastructure construction, and strengthening the development of specialized intermodal transport equipment. The announcement of this policy indicated that China has upgraded the development of multimodal transport to a national-level institutional plan. Since 2016, three phases and a total of 70 multimodal transport demonstration projects have been funded and implemented.[45] By 2018, more than 1,000 carrier companies had participated in the demonstration projects.[46] Compared with traditional road freight, the logistics cost of multimodal transport demonstration projects was reduced by more than 8 billion RMB and the energy consumption was reduced by 1.08 million tonnes of standard coal.[47] In 2018, the freight volume of water-railway combined transport was 4.5 million 20-foot equivalent units, a 29.4% increase over 2017.

OVERLOAD ENFORCEMENT PROGRAM

In November 2017, the MOT and MPS released a joint enforcement action plan against illegal overloading of on road trucks.[48] The legal basis for the enforcement action is the unified standard on limits of dimensions, axle load, and masses for motor vehicles, trailers, and combination vehicles.[49] If a truck is found to be overloaded, the driver, the carrier company, and the freight station (loading company) will all be subject to a fine. The enforcement action plan is ongoing. According to the 3-year action plan for promoting the adjustment of China's transport structure, the overloading ratio of highway trucks should be below 0.5% by the end of 2020.[50]

---

44 MOT, 2017. Notice on further encouraging multimodal transport. http://www.gov.cn/xinwen/2017-01/04/content_5156520.htm#1

45 NDRC, 2018. Notice on the third phase of multimodal transport demonstration projects. http://www.ndrc.gov.cn/gzdt/201811/t20181121_920317.html

46 Economic Daily. 2018. Multimodal transport is speeding up. http://www.gov.cn/xinwen/2018-09/20/content_5323790.htm

47 China logistics network, 2018. The logistics cost of multimodal transport was reduced by more than 8 billion RMB. http://www.wl890.com/wuliujs/1542787818162.html?newsId=6505

48 MOT, MPS. 2017. Joint enforcement action plan against illegal over-loading of on road trucks, http://www.gov.cn/gongbao/content/2018/content_5277710.htm

49 AQSIQ and SAC, 2016. standard on limits of dimensions, axle load and masses for motor vehicles, trailers and combination vehicles, http://203.187.160.132:9011/www.miit.gov.cn/c3pr90ntc0td/n1146290/n1146402/n1146440/c5176849/part/5176853.pdf

50 China State Council, 2018. Three-year action plan for promoting the adjustment of China's transport structure, http://www.gov.cn/zhengce/content/2018-10/09/content_5328817.htm

Table 5 A summary of current measures, opportunities, and recent developments related to green freight movement in China.

Policy/Measure	Ministries	Dates	Description	Key Impacts to date
New Ministry of Ecology and Environment	MEE	Began March 2018	The responsibilities for climate change and GHG emissions control were shifted from NDRC to MEE	To be determined
China Green Freight Initiative	CRTA, Clean Air Asia, Research Institute of Highways	2012–present	Voluntary program to inform fleets how to operate more efficiently. Published two voluntary standards: Green Freight Enterprise Standard and Green Freight Vehicle Standard	14 carrier companies and 1,500 trucks have joined the Guangdong demonstration project. According to one estimate, the demonstration project has reduced CO_2 emissions by 64,000 tonnes per year.
Three-year Action Plan of Blue-Sky Defense	China State Council	2018–2020	The volume of railway freight is targeted to be increased by 30% by 2020 compared to 2017.	A follow-up detailed action plan on promoting the adjustment of China's transport structure was published.
Development plan of the logistics industry (2014–2020)	China State Council	2014–2020	To reduce logistics costs, to promote large-scale and advanced logistics companies, and to enhance logistics infrastructure construction.	Ministry of Commerce issued Business Logistics Standardization Special Action Plan. SAMR published three national standards on logistics.
New vehicle fuel consumption standards	MIIT	2012–present	New vehicles sold on the market shall be compliant with fuel consumption standards	Stage 3 standard further reduces fuel consumption limits by 15% compared with Stage 2. Stage 4 is being developed.
Promoting the development of drop and hook	MOT, NDRC, MPS, GACC, CBIRC	2009–present	To encourage development of drop and hook	By 2015, more than 209 demonstration projects have been implemented. The total fuel saved was 210,000 tonnes and the total logistics cost savings were nearly 30 billion RMB.
Promoting the development of green transportation	MOT	2017	To further increase the mode share of rail and water transport. To increase the freight volume by multimodal transport. To reduce the energy consumption and emissions from freight transport.	Ongoing policies: Adjustment of transportation structure, promotion of multimodal transport, strengthening the fuel consumption and emission standards.
Promoting the development of multimodal transport	MOR, NDRC, MIIT, MOC, and others	2016–present	To encourage the development of multimodal transport	By 2018, 70 multimodal transport demonstration projects had been funded and implemented. The total logistics cost savings were 8 billion RMB.
Overload enforcement program	MOT, MPS	2016–present	If a truck is found to be overloaded, the driver, the carrier company, and the freight station (loading company) will be subject to a fine	Ongoing

MEASURES TO ADDRESS BARRIERS TO FREIGHT EFFICIENCY

The barriers to improved freight efficiency that were discussed in previous sections do not exist in isolation. They are interconnected and can manifest in several ways. Figure 2 presents a summary of all the barriers previously discussed and the connections between these barriers. For example, the highly fragmented nature of the freight system leads to the overloading issue, which in turn leads to lower speeds and lower potential for use of certain technologies. The overloading issue also means that road freight is much cheaper than rail freight, and this leads to the underutilization of rail. Another example is that while aerodynamic side skirts retrofitted on trailers are allowed by the MOT, annual inspection by the MPS requires that the vehicles look exactly the same as when they were registered. As a result, carriers have little motivation to utilize this fuel-saving technology.

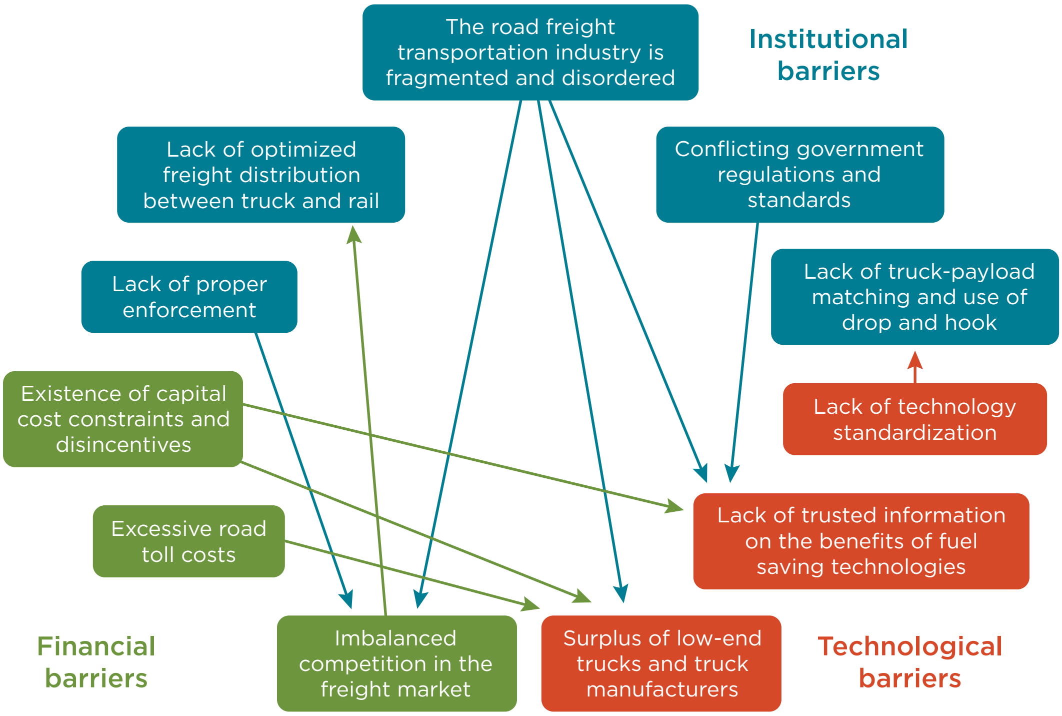

Figure 2. Barriers to improving long-haul trucking efficiency in China

As also previously detailed, China has implemented a series of measures to improve freight efficiency. However, not all of these measures have had the desired effect, and challenges still exist. Therefore, joint efforts from multiple stakeholders are required to accelerate and secure the desired improvements in freight efficiency. Table 6 provides an overview of barriers related policy recommendations and stakeholders that can ideally take additional actions.

A key policy measure to address the barrier of market fragmentation is to improve enforcement of regulations to ensure that only compliant trucks and qualified carriers can enter the market. Enforcement of fuel efficiency and emissions regulations will promote adoption of the best available technologies. Enforcement of weight limits and safety regulations will create a more even playing field for competing transport companies by helping to balance the supply/demand imbalance created by the current oversupply of suboptimal trucks and carriers. These efforts would also help remove barriers for use of rail.

Lack of truck-payload matching is also a barrier to improved trucking efficiency in China. Our interviews indicated that truck drivers are spending a lot of time waiting for payloads, which leads to low logistics efficiency. The government already has issued a series of policies on promoting the development of large organizational platforms, the growth of 3PLs, and the expansion of drop-and-hook transport. In order to increase scale and efficiency, follow-up actions and incentives are essential to implement these policies and further improve truck-payload matching.

As previously discussed, the barrier of underutilization of rail has been well recognized in China recently. A successful mode shift program would need joint efforts from the government, shippers, carriers, and rail companies. To be successful, the National Railway Administration (NRA) and railway companies need to provide cost-effective services that meet market requirements. In addition, the MOT ideally would implement incentives and develop a mechanism to guide the actions of market players. Large shippers ideally would take the lead in choosing railway freight whenever possible as part of corporate social responsibility.

A key solution to promote fuel saving-technologies and vehicles is to strengthen the mandatory standards for new vehicle fuel efficiency and GHG emissions. China has had fuel consumption standards for new HDVs since 2012. There is an opportunity to ensure that manufacturers apply advanced technologies to further improve fuel efficiency by implementing more stringent and comprehensive standards. Another barrier to the adoption of fuel-saving technologies is the low awareness of and confidence in both the technical and cost effectiveness of these technologies. Real-world testing and technology verification programs are inadequate in China. As these technologies have been widely used and have been shown to be cost-effective in other countries, it would be helpful if industry associations, international NGOs, and technology providers created a platform for sharing international best practices regarding fuel-economy technologies. In addition, real-world data collection and technology verification programs can help increase awareness of and confidence in these advanced technologies. Government, industry associations, and NGOs are encouraged to take the lead in developing such testing, verification, and driver training programs.

Fiscal policies and incentives are important measures that can help accelerate improved freight efficiency. Excessive toll charges are a major cause of inefficient driving on side roads. Tax and toll reform by the government can help incentivize drivers to operate more efficiently. In addition, financial subsidies for advanced technologies, efficient vehicles, and efficient logistics can help fleets overcome capital cost constraints and make investments in technologies that would otherwise be cost prohibitive.[51] To mitigate financial barriers for fleets, government agencies can develop incentive schemes to promote advanced fuel-saving technologies, advanced vehicles, and advanced transport modes. Technology suppliers can offer free trial options for carriers before they pay for fuel-saving technologies.

51 Ben Sharpe, *Barriers to the adoption of fuel-saving technologies in the trucking sector*. (ICCT: Washington, DC, 2017), https://www.theicct.org/publications/barriers-adoption-fuel-saving-technologies-trucking-sector

Table 6. Overview of barriers, related policy recommendations, and the stakeholders capable of taking action

Barriers		Measures	Stakeholders capable of taking action
Institutional barriers	**The road freight transportation industry is fragmented and disordered**	Improve enforcement. Ensure only qualified carrier can enter the market	MOT
		Promote the development of large-scale carrier companies	Government
	Lack of organized truck-payload matching and use of drop and hook	Create large logistics organization platforms	Government and industry
		Promote the development of 3PLs	MOT
		Promote drop and hook	MOT, NDRC, MPS
	Lack of optimized freight distribution between truck and rail	Improve the service level of rail transport	NRA, railway companies
		Promote the development of rail transport	MOT, NDRC, NRA
		Promote multimodal transport	MOT, NDRC, MIIT
		Choose railway freight whenever possible	Shippers
	Conflicting government regulations and standards	Unify the overlapping and conflicting standards and policies	Government
	Lack of proper enforcement	Strengthen enforcement	MOT, MPS, MIIT
Technological barriers	**Lack of trusted information on the benefits of fuel saving technologies**	Share international best practices	Government, industry associations, NGOs, technology providers
		Develop technology verification program and real-world testing	Government, industry associations, NGOs, technology providers
		Develop fleet manager and driver training programs	Government, industry associations, NGOs, carriers
	Lack of technology standardization	Standardize truck models, trailers, packages and loading/unloading equipment	MOT, MIIT
	Surplus of low-end trucks and truck manufacturers	Upgrade technology	Vehicle manufacturers
		Strengthen fuel consumption/ emission standards and enforcement	MIIT, MEE
Financial barriers	**Excessive road toll costs**	Reform tax and toll structures	NDRC, MOT, MPS, SAT
	Imbalanced competition in the freight marketplace	Strengthen enforcement	MOT, MPS
	Existence of capital cost constraints and disincentives	Offer financial incentives for advanced vehicles and technologies	MOT, NDRC, MOF
		Offer financial incentives to promote drop and hook	MOT, NDRC, MOF

CONCLUSIONS

Our review of literature, desktop research, and expert interviews with government and industry stakeholders in China found that the barriers for improving freight efficiency generally fall into three broad categories—institutional barriers, technological barriers, and financial barriers. These barriers are interrelated and jointly impact freight efficiency in China.

In order to develop a clean, efficient, and economically sound freight system, it is clear that overcoming the barriers identified in this paper would require coordinated and collaborative actions from all relevant stakeholders. Institutional barriers such as market fragmentation can be countered by strengthened enforcement and making sure only qualified carriers can enter the market. For technological barriers, mandatory fuel consumption regulations can play an important role in ensuring advanced efficiency technologies are deployed in trucks. Independent technology verification and real-world testing programs can help increase fleets' confidence in the technical applicability and cost effectiveness of these technologies. Concerning financial barriers, fiscal incentives and subsidies for green technologies from the government can support carriers that invest in fuel-saving technologies and mitigate the financial risk of making these investments.

As the landscape of the China freight system continues to rapidly evolve, there are a range of topics and questions that would be interesting to explore with further research. For example, the actual effectiveness of some of the policies reviewed in this paper—including, but not limited to, promoting the development of green transportation, the development of drop and hook, and enforcing overloading limits—is still uncertain; this is due to a lack of publicly available information about their impact, or because it is too early for such impacts to be assessed. Also, at this moment, it is unclear whether GHG emissions will be included in the next phase of vehicle emission standards and how the new energy vehicle trends might affect the freight system. We will continue tracking the development of these policies in future research.