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Coordination vs. Cooperation:

The Simple Analytics of Open Access with Illustrations from Railroads

By ***José A. Gómez-Ibáñez*** *(Harvard Kennedy School and Harvard Graduate School of Design)*

Introduction

Railroads, telecommunications, and electricity are examples of network industries because they all use physical infrastructure to connect customers with one another. In the last three decades, many countries have restructured their network industries to require that network providers grant independent companies access to their networks. Network industries are traditionally thought of as being monopolies, but in reality the monopoly often resides in the physical infrastructure network that connects the customers, but not in the services provided or carried over that network. In the case of railroads, for example, the track is thought to have the characteristics of a natural monopoly, while the trains that operate over them do not.

At a minimum, the reforms require the incumbent network provider to open access to its network. In some cases the incumbent network provider is allowed to continue to offer a full range of services in competition with the access seekers. For example, a railroad could continue to manage both tracks and trains, but would have to allow independent train companies to use its tracks. In other cases, the incumbent is forced to divest its monopoly network as a separate company or reorganize the network as a separate ring-fenced subsidiary.

From a policy perspective, open access—which is often referred to as vertical unbundling—can be seen as a tradeoff between the benefits of increased competition among those seeking access to the network and the costs of reduced coordination between those of the access users and the access provider. Quality services require the coordination of the operations and investments of the access users and the provider, if only to make sure their equipment is compatible and the capacity is available when and where needed. In the case of network industries, the fact that the access user and provider functions have traditionally been integrated in the same firm strongly suggests that coordination between these two functions is much easier when they are provided by one firm, reporting to the same CEO and stockholders, than if they are provided by two independent firms.

My paper on which this policy brief is based, "Coordination vs. Cooperation: The Simple Analytics of Open Access with Illustrations from Railroads," uses a simple analytic model of the competition-coordination

José A. Gómez-Ibáñez

José A. Gómez-Ibañez is the Derek C. Bok Professor of Urban Planning and Public Policy at Harvard University, where he holds a joint appointment at the Graduate School of Design and the Harvard Kennedy School of Government. He teaches courses in economics, infrastructure, and transportation policy in both schools.

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The Taubman Center and its affiliated institutes and programs are the Kennedy School of Government's focal point for activities that address urban policy, state and local governance and intergovernmental relations. Taubman Center Policy Briefs are short overviews of new and notable research on these issues by scholars affiliated with the Center. This brief is a shorter version of "Coordination vs. Cooperation: The Simple Analytics of Open Access with Illustrations from Railroads."

A. Alfred Taubman Center for State and Local Government
Harvard Kennedy School
79 JFK St., Cambridge, MA 02138

Telephone: *(617) 495-2199*
Email: *taubman@hks.harvard.edu*
www.hks.harvard.edu/taubmancenter

tradeoff and the experiences of railroads in Australia, Europe, and North America to argue that vertical unbundling should be applied with caution. The simple analytic model shows that it takes only a modest increase in coordination costs to offset the benefits of even fairly significant increases in competition. Additionally, railroad case studies suggest that coordination costs are likely to be high when (1) the interaction between the network provider and the access user is intimate and complex, (2) the network is operating close to capacity, (3) the access seekers differ in the network services they desire, (4) there is little reciprocity between access providers and seekers, and (5) the access grants are broad rather than selective.

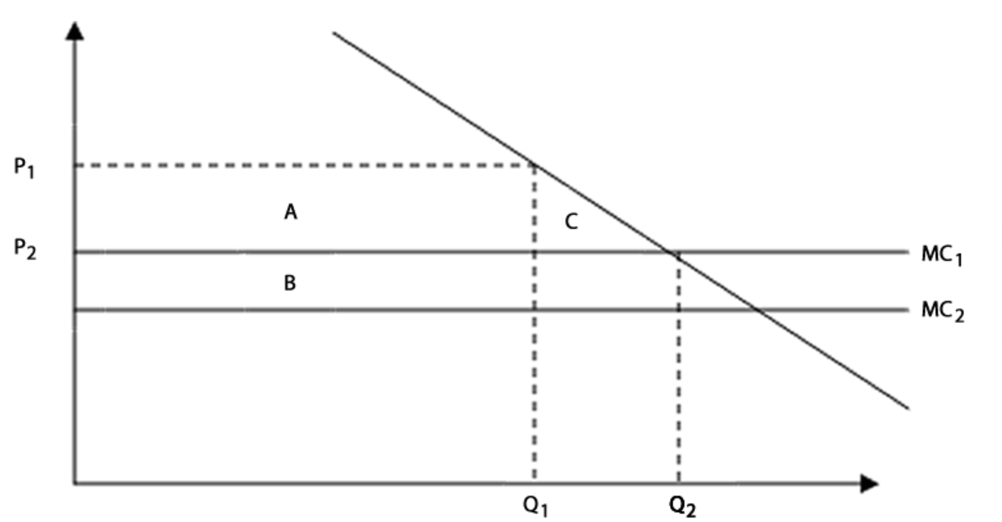
My paper suggests that open access is not very attractive for many types of railroad services. The competitive benefit from open access is probably small for most passenger and freight rail services, since they typically suffer from intense competition from highway and air transportation services already. Specialized “heavy-haul” rail services that carry minerals and grains are something of an exception, in that they typically face less competition from other modes of transportation. But heavy-haul railroads also often operate over networks that are near capacity and the interface between access providers and seekers is very complex, and thus any benefits from increased competition are likely to be offset by high costs in lost coordination.

The Simple Analytics of Open Access

The tradeoff between competition and coordination with open access is illustrated in the simple diagram in Figure 1 below, originally developed by Oliver Williamson (1968) in his famous article on the economics of mergers.

Williamson used the diagram to illustrate how the public policy analysis of a merger involves a tradeoff between the potential loss in competition from the consolidation of the two firms and the cost savings that the consolidation might bring. His diagram can just as easily be used to understand the tradeoffs in open access, however, since the unbundling achieved by open access is simply a merger in reverse. Instead of a loss in competition potentially

Figure 1: Benefits and Costs from Open Access



offsetting a gain from reduced costs of coordination in a merger, a gain in competition potentially offsets a loss from increased costs of coordination in an unbundling.

Without open access the incumbent integrated network provider charges its retail customers a price P_1 per unit of traffic and supplies Q_1 units of traffic. (Think of the units of traffic as being shipments in the case of railroads.) The incumbent does not face effective competition from other networks and therefore can charge a price (P_1) that is far above its marginal cost, MC_1. Under these assumptions the network provider with exclusive access earns profits equivalent to the rectangles labeled A and B (less any fixed costs).

The simple analytic model shows that it takes only a modest increase in coordination costs to offset the benefits of even fairly significant increases in competition.

If independent companies are given access, however, competition forces the integrated network provider and the access users to charge retail prices that are close to their marginal cost. However, that marginal cost increases to MC_2, because coordination between the network provider and the access users is less effective when the access users are independent firms. Opening access increases the retail customers' benefits in the amounts of the rectangle A (because they pay less for the traffic units they would have bought anyway) plus triangle C (because they buy more units at the new lower price P_2). But the network provider and access users collectively lose profits in the amounts of rectangle A (because prices fall on traffic units that would have been purchased anyway) and B (because costs increase).

Whether open access increases benefits for society as a whole depends on whether triangle C is larger than rectangle B. From this society-wide perspective rectangle A can be ignored because it is simply a transfer of profits from the network provider to retail customers in the form of lower prices. In reality, however, rectangle A is the source of much controversy since it can represent a substantial loss to the network providers.

Figure 1 implies that it takes only a small increase in coordination costs to offset even a fairly significant increase in competition, and that even a small increase in competition creates a substantial transfer from the network provider to the retail customer. If competition generated by open access reduces retail prices by 20 percent and the price elasticity of demand is -1, for example, then the welfare gain from the price reduction (triangle C) would be offset by only a 2 percent increase in coordination costs (rectangle B). The network providers would lose the equivalent of 22 percent of their revenues, although most of that (20 percent, in rectangle A) would simply be a transfer to the customers and not a net loss to society as a whole.

Published Empirical Estimates of the Benefits and Costs

There are only a handful of published empirical estimates of the retail price reductions from open access, and all are for freight railroads and cluster around 10 to 20 percent. Such modest price reductions are not surprising, since most railroads already face competition from so many other sources besides other railroads. Railroads compete not only with other modes of transportation, but with alternative locations and products. A coal-carrying railroad may have less to fear from trucks or barges, for example, than from coal mined at other locations or from other sources of energy.

Published empirical estimates of the coordination costs generated by open access are even fewer and less reliable. However, one can develop a qualitative sense of the scale of the coordination costs and the factors that influence them from the experiences with railroad unbundling in Great Britain, Australia and the United States.

The more intimate and complex the relationship between the performance of the network provider and that of the access user, the more difficult it will be to coordinate that interaction through arms-length contracts between independent firms.

Factors that Affect Coordination Costs

Australia: The Complexity of the Interface

Australia's experience with its mining railroads illustrates how much the costs of coordination depend on the complexity of the interface between the network provider and the access user. The more intimate and complex the relationship between the performance of the network provider and that of the access user, the more difficult it will be to coordinate that interaction through arms-length contracts between independent firms.

Australia has required open access in all network industries since 1995. Australia's railroads carry primarily freight rather than passengers and a company owned and subsidized by the national government, the Australian Rail Track Corporation (ARTC), manages the track in most states while independent private and state-owned companies operate the trains. The main exceptions to this pattern are in the coal-mining state of Queensland, where the state government still owns a vertically integrated railroad used to carry the export coal of several dozen mining companies to ports, and in the Pilbara in Western Australia, where the two leading multi-national mining companies have built five private iron-ore rail lines to connect their mines to ports.

The problems of coordination have been more obvious in the mining railroads of the Pilbara and Queensland than elsewhere, in part because ARTC is not expected to recover its full costs from train operators. Access to government subsidy reduces potential frictions between the access provider and the access seekers. In the Pilbara, the two multinational mining companies have been waging legal battles since 1998 to prevent independent mining companies from gaining the right to use their railroads, and in Queensland miners have been fighting a 2009 proposal by the state to establish a separate company to manage the track and sell it to private investors.

The intensity of the disputes in the Pilbara and Queensland reflects in part the practical importance of rectangle A in Figure 1. At their core, the access controversies are about who will capture the lion's share of the benefit from developing Australia's mineral resources: the investors who built the mines or the investors who built the railroads.

But the disputes are also fueled by genuine concern about the costs of lost coordination in such specialized and sophisticated railroads. So-called heavy-haul railways like those in Australia's mining regions have two basic characteristics that complicate coordination. The first is that they operate with axle loads of 30 to 40 tons, far exceeding the 20 to 25 tons on normal railroads and stretching the frontiers of the technology of steel wheels on steel rails. That wheel-rail interface is, of course, also one of the most obvious points of interaction between track and train operators. Faulty wheels can damage rails, and vice-versa, increasing the risk of damage or derailments of trains that are often hundreds of cars long.

The second important characteristic of heavy-haul railroads is that they are typically only one part of a complex and capital-intensive process for bringing minerals to market. The ore or coal must be mined and processed, then put in stockpile yards until a train arrives and it can be loaded with specialized equipment. On arrival at the port the ore may be loaded directly onto a ship, or put in stockpile yards and/or blended with ores from different mines to meet customer specifications. Each one of these steps has capacity limitations and is subject to unexpected breakdowns or delays, and the difficulties of coordinating the capacities and operations becomes even more difficult the more different companies are involved in the many steps.

Concerns about coordination in heavy-haul systems gained credence in 2006 and 2007 when the Goonyella Supply Chain, the infrastructure system used to export coal from the Bowen Basin in Central Queensland, became so congested that mine operators were unable to deliver their contract tonnages. The Goonyella chain included 12 mines operated by 10 different mining companies, one railroad infrastructure company, one train operating company, and two independent port terminals. An independent review of the Goonyella Supply Chain commissioned by the Queensland government concluded that the chain's underperformance had cost Australian producers AU$1.2 billion in lost sales in less than a year. Multi-user systems are typically run as scheduled operations, for example, so that if a mine is not ready to load at its appointed time it is difficult to redirect the train to a mine that is ready. Implementing changes is slow because of the need to build a consensus from the many participants and to secure approval from the regulator. The operational and commercial relationships between system participants are so complex that it is difficult for the contractual frameworks that underpin the system to capture them well.

Great Britain: Capacity and Diversity

Beginning in 1991 the European Commission (EC) issued a series of directives to require member states to open access to their railroad networks. The experience of continental Europe is not very instructive, however, both because all of the continental track companies remain publicly owned and subsidized and because the EC did not require open access for domestic passenger trains, which are the most important form of rail service in Europe. Great Britain provides some interesting lessons, however, because it went farther than the EC required.

Britain's experience suggests that the problems of coordination increase rapidly as the network approaches capacity and when the access users vary in their network requirements.

Between 1994 and 1997 Britain divided the state-owned and vertically integrated British Rail into more than 70 different private companies including an infrastructure provider called Railtrack. For the first several years the reforms seemed to be a success as services and patronage increased while government financial support was relatively steady. By 2001, however, Railtrack was in bankruptcy, the immediate causes of which were a series of three fatal accidents and a serious cost overrun on a project to upgrade speeds and capacity. Both the accidents and the cost overruns had their roots in the difficulty of aligning the incentives of the unbundled companies through contracts, especially as the system approached capacity.

Many of the coordination problems were related to the scheme of access charges and penalties that the government regulators established for the unbundled industry. Railtrack was to charge train operating customers for accessing its tracks, and these access charges were supplemented by a complex system of performance penalties and bonuses designed to encourage the punctuality and reliability of trains. If Railtrack did not make a path available on schedule it had to pay the delayed train operator a substantial penalty. If the path was not available because the track was blocked by another train company, however, then Railtrack could recover its penalty from the train company at fault.

The access charges in the initial schedule were too low, and thus encouraged an unexpectedly large increase in congestion on the network because it was relatively inexpensive for train operating companies to add trains to their schedule. And the increase in traffic on the network ate up most of Railtrack's excess capacity, making it more difficult for Railtrack to provide paths when promised or to schedule track maintenance without incurring penalties. In an attempt to correct this problem, Railtrack soon was encouraged to negotiate with train operators about capacity improvements and the ways to fund them. These negotiations between Railtrack and multiple operators proved extremely cumbersome.

The fatal accidents that precipitated Railtrack's bankruptcy occurred in part because of the penalties Railtrack was required to pay because of track closures or delays. In one case, cracked rails were later determined to be the cause of one of the accidents. Railtrack had known about the cracks, but was reluctant to close the track during the busy summer season (as increased traffic would increase the number of penalties Railtrack would pay) and had scheduled the repairs for November, a month after the accident. The other major contributor to Railtrack's bankruptcy, the cost overruns on a track expansion project, was caused by the difficulties of delivering network improvements in an unbundled railroad industry and coordinating upgrades between a number of companies with different incentives.

Britain's experience suggests that the problems of coordination increase rapidly as the network approaches capacity and when the access users vary in their network requirements. The closer the network is to capacity the greater the need for maintenance, the harder it is to schedule maintenance without disrupting service, and the more important it is to establish incentives for the provider to invest in added capacity. The more heterogeneous the access users the more difficult it is to reach a consensus about how the scarce remaining capacity should be allocated or the types of new investment needed.

Freight track rights in the United States and Canada appear to work reasonably smoothly in part because they are selective and reciprocal.

The United States and Canada: Selectivity and Reciprocity

The United States and Canada illustrate the importance of selectivity and reciprocity in access rights. The North American railroad system is dominated by seven enormous, privately owned and vertically integrated freight railroads, five in the United States and two in Canada. About one-fifth of the freight track network is governed by access agreements that allow a second "tenant" railroad to operate over a "landlord" railroad's track. Most of these exchanges of track rights are voluntary, for example to avoid the unnecessary duplication of track in urban areas or to allow directional running on parallel single-track main lines. But some of the rights have been required by U.S. government regulators to prevent the threatened loss of shipper access to a second railroad as a result of a merger. In addition, Canada allows shippers with access to only one railroad at either origin or destination to have their shipment transferred to another carrier if the origin or destination point is within 30 kilometers of an interchange point between the two railroads.

These freight track rights appear to work reasonably smoothly in part because they are selective and reciprocal. The rights are granted for the minimum section of track needed to accomplish the cost savings or other goals of access. And the fact that the railroads typically are tenants in some cases and landlords in others encourages them to behave more responsibly in the exercise of their rights.

The importance of reciprocity is illustrated by the difficulties encountered in its absence. The United States created Amtrak in 1970 to relieve the freight railroads of the responsibility for providing money-losing intercity passenger services. In return the freight railroads agreed to provide the passenger company access to their tracks on reasonable terms. As a result Amtrak is dependent on other railroads because

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it owns very little of its own track except in the very busy Northeast Corridor, but the freight railroads are not dependent on Amtrak because they operate almost exclusively over their own tracks. Not surprisingly, the percentage of Amtrak trains that experience delays and the percentage of delays attributed to interference from other railroads' trains (rather than signals or track) are much higher off the Corridor than on (Gómez-Ibáñez 2009). Slotting an Amtrak train into a busy freight corridor is presumably difficult, particularly if the train is already behind schedule. But it would not be surprising if the freight railroad dispatchers do not try as hard as they might, especially since they are not vulnerable to Amtrak's dispatching elsewhere.

Conclusions and Applications to Other Industries

In sum, the decision to open access involves a tradeoff between added competition and lost coordination. Focusing on lost coordination is important, however, since Williamson's simple analytic model shows that only a small increase in coordination costs can offset a fairly substantial price reduction from added competition. The experience with open access in Australian, British and North American railroads suggests that the costs of lost coordination can vary considerably. Coordination costs are lower if the interface between the network provider and the access user is simple and robust, if there is excess capacity in the network, if all the access seekers desire similar features in the network, if there is reciprocity in access rights that limits incentives to behave opportunistically, and if most of the competitive gain can be achieved by granting rights to only a small portion of the network.

The competition-coordination tradeoff also helps explain why open access is more common in some network industries than others. In the case of highways, for example, the potential competitive benefits of open access are large since autos and trucks dominate most transportation markets, and the coordination costs are low in part because the interface between the road and the rubber tire is more forgiving than the interface between rails and steel wheels. Open access has been relatively successful in the electricity industry as well in part because the coordination costs are relatively low. Coordination is critical because the power dispatched must match power consumed nearly instantaneously, and complicated by enormous system interdependencies because the flows on any one transmission line are affected by the flows on the other lines in the system. But high voltage transmission accounts for typically less than 10 percent of the electricity system costs, so having excess transmission capacity to deal with the fluctuating demands and flows is not terribly costly.

Finally, the insight from railroads in the United States – that a very limited grant of access can sometimes achieve a substantial competitive gain – appears to apply to at least some other network industries. For example, mobile telephone companies in India and Africa have voluntarily agreed to share towers. Sharing towers cuts the costs of entering new markets considerably without generating the more complicated technical coordination problems that might arise from sharing the equipment on the towers. And tower sharing has its precedent in the sharing of street poles by power, telephone and cable TV companies in developed countries, although often mandated by municipalities rather than done voluntary. In all these cases competition was significantly increased with a grant of access so limited that it posed little threat of increasing coordination costs.

Citations:

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