Turnpike Trusts and the Transportation Revolution in 18th Century England

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Abstract

There is a long debate in economic history about the causes of the transportation revolution and its economic impact. This study examines the effects of the Turnpike Trust System in 18th century England. Turnpike trusts were organizations that financed road improvements by levying tolls. They replaced the authority of parishes, which financed road improvements using local taxes. This study shows that turnpike trusts contributed to lower freight charges and improved the quality of services. It also shows that all road transport innovations, including turnpike trusts, generated a social savings of more than 1% of national income in 1800 and 1820.

1. Introduction

The transportation revolution of the 18th and 19th centuries embodied dramatic reductions in transport costs and improvements in the quality of services. These changes had a profound effect on economic development by contributing to globalization and industrialization.[1] In spite of its historical implications, there are still many questions about what caused the transportation revolution. Some scholars argue that technological change was the most important factor, whereas others suggest that organizational change was equally important.[2] This study investigates the impact of a specific organizational change by examining the effects of turnpike trusts in 18th century England.

A turnpike trust was an organization that financed road improvements by levying tolls and issuing mortgage debt. They were created by Acts of Parliament, which named a body of trustees and gave them authority over a particular roadway, which was previously managed by individual parishes located along the road. Unlike turnpike trusts, parishes did not have access to external sources of funding, such as tolls or bonds. Instead, they financed road improvements by levying local property taxes and by claiming up to six days of labor per year from their residents. Parishes were also different because they were part of the traditional hierarchy of local government, whereas turnpike trusts were statutory authorities that were promoted and managed by local property owners.

The diffusion of turnpike trusts spanned the 17th, 18th, and early 19th centuries. The most significant period of adoption occurred during the 1750s and 1760s, when over 300 trusts were created along 10,000 miles of road (see Figure 1). By the 1830s, the turnpike network expanded further to include 1000 trusts managing around 20,000 miles, or 17% of the entire road network in England and Wales.[3]

Aside from controlling a substantial portion of the road network, turnpike trusts also managed the most heavily traveled routes. As early as 1770, they were responsible for all of the major highways leading into London, as well as a dense network of roads in the industrial regions of the West Midlands and the North (Pawson, 1977).

The transition from parishes to turnpike trusts was important because it resulted in a substantial increase in road investment. Turnpike trusts spent between 10 and 20 times

[1] See Williamson and O'Rourke (1999), Estevadeordal, Frantz, and Taylor (2003), and Ville (1990).

[2] See North (1968), Shepherd and Walton (1972); Harley (1988), Menard (1991), Kaukiainen (2001), Mohammed and Williamson (2004).

[3] For information of the length of the road network in England and Wales, see the Parliamentary Papers, *Appendix to the Report of Commissioners appointed to inquire into the State of the Roads.*

more than the parishes they replaced. They were also the driving force behind a four-fold increase in aggregate road expenditure between 1730 and 1800 (Bogart, 2004).

There are a number of reasons why turnpike trusts invested more than parishes. One factor was that parishes were forced to rely on local taxes, and therefore they were less likely to undertake road improvements that largely benefited road-users passing through their jurisdiction. Turnpike trusts addressed this problem by levying tolls and thereby forcing road-users to contribute to the costs of investment. Turnpike trusts also resolved a number of other problems in the parish system. For example, they improved coordination by replacing a multitude of parishes with a single body of trustees who could direct investment over an entire roadway or a network of roads. Turnpike trusts also resolved borrowing constraints faced by parishes because they could issue debt at a low cost. Finally, turnpike trusts resolved intra-parish bargaining problems by transferring authority to local property owners, who had a common interest in carrying out road improvements.

The expansion of turnpike trusts and greater road investment coincided with a number of revolutionary changes in the road transport sector. The most important were a dramatic decline in freight charges and passenger travel times, along with a substantial growth in freight and passenger services.

The coincidence between turnpike trusts and the transportation revolution has spurred a substantial literature investigating the relationship between the two. A number of scholars, such as W. T. Jackman (1916), William Albert (1972), Phillip Bagwell (1974), and Eric Pawson (1977), have argued that turnpike trusts contributed to lower freight charges and faster travel speeds by smoothing road surfaces and reducing inclines. However, these views have been challenged by Dorian Gerhold (1996), who argued that other innovations were more important than turnpike trusts. For instance, Gerhold suggested that improvements in horse breeding and increases in the size of carriage firms contributed to over half of the total reduction in freight charges during this period.

Gerhold's findings raise a more general concern that turnpike trusts were induced by a variety of innovations that were responsible for the reductions in transport costs. For example, it is possible that technological changes initially caused transport costs to fall and that turnpike trusts were adopted once traffic volumes increased. If this was the case, then turnpike trusts may have made a smaller contribution to the transportation revolution than previously thought.

There is also the question of whether turnpike trusts raised fares and freight charges by

introducing tolls. The tolls may have offset the benefits of better roads simply because the investment and maintenance costs were large. Alternatively, the tolls may have been too high because trustees exploited their monopoly power. Parliament tried to eliminate such abuses by setting a maximum schedule of tolls and by forbidding trustees from earning profits. Parliament also tried to give trustees an incentive to keep the tolls low by requiring that they own property, which could potentially earn higher income from lower transport costs. However, monopoly abuses may still have persisted if the maximum schedules were not designed properly and if trustees could earn greater returns by supplying materials and lending to the trust.

This study addresses these questions and reassesses the impact of turnpike trusts on the transportation revolution and economic development in 18th Century England. It begins by reviewing the major changes in the road transport sector during this period, including a 40% reduction in real freight charges and a 60% reduction in passenger travel times. Next, this study demonstrates that turnpike trusts lowered freight charges by an average of 20% and that they had an even larger impact along the heavily-traveled London routes. Finally, this study evaluates the broader significance of the road transportation revolution and shows that it generated a social savings of more than 1% of national income in 1800 and 1820.

In order to develop these conclusions, this study combines new information with a number of data sets in the literature. The first data set is a collection of land carriage rates from 130 city-pairs covering the period from 1695 to 1825. Land carriage rates were regulated freight charges set by local magistrates. They represented the maximum price that a carrier could charge for the shipment of goods between two cities. A number of scholars, such as William Albert (1972) and Dorian Gerhold (1996), have used land carriage rates to measure the impact of turnpike trusts on freight charges. They are a popular source because they track freight charges for individual city-pairs over a long time period. However, none of the earlier studies have analyzed land carriage rates across a large number of city-pairs, nor have they tested whether rates were lower for city-pairs after turnpike trusts were established along their route.

This study uses a new data set of over 5000 land carriage rates from 130 city-pairs to estimate whether turnpike trusts lowered freight charges. After controlling for a number of factors, the analysis shows that land carriage rates were stable before turnpike trusts. It also shows land carriage rates declined by around 20% after trusts were established. These findings are important because they show that turnpike trusts did not raise freight charges

and that they were not induced by other innovations. The results also suggest that turnpike trusts contributed to approximately half of the total reduction in freight charges between 1750 and 1820.

This paper also provides two additional pieces of evidence that turnpike trusts lowered freight charges. First, it shows that the tolls on wagons declined by more than 20% in real terms between 1730 and 1800. This finding is important because it indicates that the burden of the tolls diminished at the same time that freight charges declined. Second, this study analyzes the differences between winter and summer land carriage rates and shows that winter rates converged to summer rates between 1750 and 1800. This second finding is also significant because it cannot be explained by contemporaneous factors, such as increases in firm-size or changes in technology. However, it is consistent with the argument that turnpike trusts lowered freight charges by making the roads more durable in the rainy season.

Aside from measuring the effect of turnpike trusts along the average route, this study also examines whether trusts had a greater impact on freight and passenger services to London. The London transportation market deserves special attention because it was the largest and most important in the British economy. It is also possible that turnpike trusts had a larger effect along the London routes because they were able to finance greater investment and spread the costs across larger numbers of road-users.

This study uses the data on land carriage rates to show that turnpike trusts lowered freight charges by an additional 10% along the London routes. It also draws upon information from travel directories to measure changes in the number and types of transport services leaving from London. The evidence indicates that the number of freight and passenger services grew substantially between 1760 and 1800, after most turnpike trusts were established. It also shows that turnpike trusts preceded the diffusion of fly-machine services, which were high-speed passenger services between London and major provincial cities.

The analysis concludes with an assessment of the impact of road transport innovations on economic development in England and Wales. The major finding is that the social savings from all innovations, including turnpike trusts, equaled 1.2% of national income in 1800 and 2.1% in 1820. These estimates suggest that the effects of road transport innovations were comparable with canals, which are often considered to be the most important transport improvements before railroads (Hawke and Higgins, 1983). The estimates also suggest that the road transport revolution made an important contribution to the early Industrial

Revolution.[4]

More generally, the results of this study address the larger debate on the relative importance of technological and organizational change in the transportation revolution. This debate has been most pronounced in ocean shipping, where Douglass North, Gary Walton, and James Shepherd (1968, 1972) have argued that the decline of piracy and changes in loading and packaging procedures contributed to lower freight rates during the 18th and 19th centuries. However, many of their claims have been challenged by Knick Harley (1988), who argued that the introduction of steam power and metal hulls was more important.

The case of 18th century road transport offers an interesting comparison with ocean shipping because there were no technological changes that can compare with the introduction of steam power or metal hulls. However, the English road transport sector clearly experienced a number of organizational changes, which played an important role in lowering transport costs. Turnpike trusts represent one of the most interesting organizational changes because they required a broader set of institutions. For example, the turnpike system required a political system that allowed new trusts to be established whenever local demand for road improvements increased. In addition, the turnpike system depended on formal and informal rules to ensure that the tolls would be enforced and that they would be directed towards road improvements. As a result, the turnpike system provides one of the best illustrations of how institutions affected economic development during the 18th and 19th Centuries.

2. The Road Transportation Revolution

There is a common perception that road transport was inefficient during the 18th century and that canals and later railroads were the vanguard of the transportation revolution. This negative view of road transport may be applicable to the early 18th century, but it is not accurate for the second half of the 18th century. During this later period, there are a number of indications that the road transport sector increased both its efficiency and its capacity. These developments included increases in travel speeds, reductions in freight charges, and a substantial growth in road traffic.

One of the most important changes in the road transport sector was a rise in passenger travel speeds. To illustrate the trends, Figure 2 combines the data from W.T. Jackman

[4]For an elaboration of the hypothesis that road transport improvements played an important role in the Industrial Revolution see Szostak (1991) and Ville (1990).

(1916) and Eric Pawson (1977) and plots the average journey miles per hour across a sample of 225 city-pairs between 1750 and 1829.[5] Over the whole period, average journey miles per-hour increased from 2.6 to 8.0, with the most dramatic changes occurring between 1750 and 1780. In a few cases, it is also possible to measure the decline in travel times for individual city-pairs over the entire 18th century. For instance, the travel time between London and Manchester decreased from around 90 hours in 1700 to 60 hours in 1760, 24 hours in 1787, and 19 hours in 1821 (Pawson, 1977).

The rise in travel speeds represented a substantial increase in the quality of passenger services, and therefore it could have coincided with an increase in passenger fares. To estimate the trends in passenger fares, this study combines the data of Jackman (1916) and Gerhold (1996) with new information on a large number of passenger fares in 1760 and 1770.[6] Figure 3 uses the new data to plot an index of real passenger fares between 1750 and 1830. It is equal to an index of average passenger fares divided by Greg Clark's consumer price index (2001a). The series shows that real passenger fares fluctuated; however they were lower by an average of 7.5% between 1790 and 1809. As a result, it is clear that passengers were paying a lower fare in the early 19th century, while enjoying a much faster service.

Another important development in the road transport sector was the decline in freight charges. The best source of information on freight charges during this period are land carriage rates, which represent the maximum price that a carrier could charge for the shipment of a certain weight of goods between two particular cities. Land carriage rates were introduced by legislation passed in the 1690s. The legislation gave local magistrates the authority to set maximum freight charges in order to prevent carriers from colluding and raising their prices. It also gave magistrates discretion over which markets to regulate. In most cases, magistrates set the rates on goods shipped from London, but in other cases they also set rates on goods shipped from other cities.

A number of scholars have investigated whether land carriage rates are a useful measure of actual freight charges.[7] Most of the available evidence suggests that actual freight charges were very similar to land carriage rates. For example, Michael Freeman (1977) has shown that between London and Portsmouth both advertised and actual freight charges were very

[5] Journey miles per hour are defined as the total journey distance divided by the total journey time. For information on the data see Table 10 in the appendix.

[6] The new data come from the London directory, *The New and Complete Guide to all Persons who have any Trade or Concern with the City of London.* For more information see Table 11 in the appendix.

[7] For example, see Willan (1962), Albert (1972), Freeman (1977), Turnbull (1985), and Gerhold (1996).

close to land carriage rates between 1775 and 1800. Gerard Turnbull (1985) has also shown that carriers in the North of England often charged freight rates that were identical to land carriage rates. Turnbull has also documented that magistrates in the West Riding of Yorkshire raised land carriage rates in 1800 because rising feed prices were forcing carriers to suspend services at the previous price ceiling. Therefore, the evidence suggests that land carriage rates represented a binding constraint on carriers and that they were adjusted when underlying costs changed.

This study builds on this earlier literature and uses a new data set of over 5000 land carriage rates from 130 city-pairs between 1695 and 1827.[8] The data set is particularly useful because it tracks the trends in freight charges over the entire 18th century. Figure 4 plots an index of real land carriage rates between 1700 and 1819 and compares it with Dorian Gerhold's productivity index for London to Leeds.[9] The two series have similar trends, except that average freight charges fell by about 40% between 1750 and 1800, while the rates between London and Leeds fell by 50%. The decline in freight charges between London and Leeds was not exceptional among freight services to London. For example, land carriages rates between London and Newcastle also fell by 50% between 1750 and 1800. However, the changes were often less dramatic for freight services between provincial cities such as Leeds and York, where land carriage rates fell by around 25% during this period.

Unlike the passenger sector, the freight sector did not experience a substantial reduction in travel times. The only cases where travel times did decrease were along routes where 'fly-wagon' services were introduced. Fly-wagon services were distinctive because they traveled at a greater speed than standard freight services. However, they were not very common along most routes before 1800.

Aside from the changes in freight charges and travel times, the road transport sector also witnessed a dramatic increase in road traffic, especially between London and the provinces. John Chartres and Gerard Turnbull (1977, 1983) provided the first estimates of traffic growth by comparing the number of weekly freight and passenger services listed in London travel directories. For example, if directories indicate that between Birmingham and London the number of weekly passenger services increased from 2 to 3 between 1750 and 1760, then Chartres and Turnbull inferred that the number of services between these cities grew by 50% over this period. Using this methodology for a sample of major cities, they estimated

[8] The data set and the manuscript references are described in the appendix.

[9] The real land carriage index is equal to an index of average land carriage rates divided by Clark's consumer price index (2001a). See Table 8 in the appendix for more information.

that the number of freight and passenger services grew at an average annual rate of 1.2% and 2.9% respectively between 1715 and 1796.[10]

Chartres and Turnbull's estimates have been challenged by Dorian Gerhold (1988), who argues that their methodology overstates the number of actual services, because most directories did not distinguish between services to a single city versus multiple cities.[11] To deal with this problem, Gerhold proposed an alternative approach which combines all services to a particular county that departed from the same inn, on the same day. Using this method, Gerhold estimated that the number of freight services grew at an average annual rate of 0.2% between 1705 and 1798, which is far below Chartres and Turnbull's estimate of 1.2%.

Dorian Gerhold's findings are rather surprising because they suggest that the number of freight services grew very slowly, at the same time that freight charges fell by around 40%. Therefore, to assess whether the number of freight and passenger services increased when transport costs fell, this study examines a collection of London travel directories for the years 1715, 1740, 1749, 1760, 1770, 1779, 1783, 1790, and 1800.[12] Columns (1) and (2) in Table 1 present the raw data on the total number of weekly services at each of these dates. The estimates suggest that the number of services grew dramatically, especially in the passenger sector. Across the entire period, the average annual growth rate was 2.7% for freight and 3.6% for passenger services. More importantly, the figures suggest that the growth in services increased between 1760 and 1800, when transport costs fell substantially.

To check whether the previous series overstate the actual growth in services, Table 1 also includes data on the number of weekly services between London and 45 major cities with a population above 2500 in 1700.[13] Among others, the major cities include Birmingham, Leeds, Manchester, Liverpool, and Bristol. Presumably, these cities should have been large enough to support their own wagon and coach services, and therefore they would be less likely to have over-lapping services with other major cities. The figures in columns (3) and (4) show that freight and passenger services to major cities displayed similar patterns as in the larger sample. In particular, between 1715 and 1800 the average annual growth rate was 2.3% for freight and 3.1% for passenger services, which is slightly lower than the growth rate

[10] In 1715, Chartres and Turnbull estimate that there were 158 weekly passenger services and 108 freight services between London and a sample of major cities. By 1796, they estimate that the number of passenger and freight services grew to 1596 and 294, respectively.

[11] For example, suppose a single wagon service traveled to two cities, but was listed under each separately. In this case, the number of listed services would be two, while in reality there was only a single service.

[12] See the appendix for more information on the sample of directories.

[13] The list of major cities is drawn from Corfield (1982).

in services across all cities. This finding suggests that there is some bias from over-lapping services, but not enough to overturn the conclusion that road traffic grew substantially, especially after 1760.

The estimates of service growth are important because they provide evidence that road traffic grew and that the number of ton-miles and passenger-miles increased during this period. In principle, output could grow because load sizes increased or because more wagons and coaches were traveling greater distances. As the data in Table 1 suggests, a substantial portion of the growth in the passenger sector came from greater numbers of coaches along the road. In part, this followed from limitations on the number of passengers that could travel in a single coach, but it was also due to traveler's preferences for less crowding.

By contrast, carriers did not have to accommodate passengers' demands for comfort, and therefore they could enlarge output by increasing load-sizes as well as adding more wagons. Both of these effects are apparent in Table 1, which shows that the number of services grew substantially between 1749 and 1770, when Parliament limited the maximum load size of a wagon to 3 tons. However, between 1770 and 1783, the number of freight services grew more slowly, when Parliament raised the maximum load size to 6 tons in 1765 (Jackman 1916).

Considering all the evidence, it is clear that the road transport sector was expanding and becoming much more efficient over the 18th century. It is worth noting that the decline in road transport costs was similar to the decline in transport costs in ocean shipping during the 19th century. For example, freight rates declined by around 40% in real terms between 1870 and 1914 (Mohammed and Williamson, 2004). In that case, technological change is often cited as the most significant factor in driving down freight charges. Was it also the most important factor in 18th century road transport, or were organizational changes, such as the adoption of turnpike trusts, more important?

3. Turnpike Trusts and the Road Transport Revolution

Turnpike trusts are often identified as an influential factor in the road transport revolution in 18th Century England. For example, scholars such as Jackman (1916), Albert (1972), and Pawson (1977), have all argued that turnpike trusts contributed to lower transport costs by improving road quality. However, these conclusions may be premature because turnpike trusts could have raised transport costs by introducing tolls. In addition, turnpike trusts may have been induced by other innovations that were ultimately responsible for improvements

in efficiency.

The idea that turnpike trusts lowered transport costs is based on the argument that they widened and improved the road surfaces by increasing maintenance and investment. Wider roads were important because they decreased congestion and they enabled wagons to replace packhorses along roads that were previously too narrow (Pawson, 1977). Better road surfaces were also crucial because they lessened the wear on wagons and allowed horses to haul larger loads and to carry passengers at a greater speed (Gerhold, 1996).

The benefits of better roads were well-known during the early 18th Century, when parishes managed most of the major roadways in England.[14] One reason why turnpike trusts ultimately financed greater investment is that they were able to levy tolls and issue debt, while parishes had to rely on local labor and property taxes. Debt financing was important because it allowed trusts to finance projects with high fixed costs. The ability to levy tolls was also important because it forced road-users to contribute to the costs of investment. In particular, the tolls shifted the cost of improving major highways to road-users, who benefited more than the residents of parishes.

Aside from resolving fiscal constraints, turnpike trusts were also more effective because they resolved coordination problems. Coordination was important because parishes collectively managed the road network. Therefore, it was possible that individual parishes did not invest in their own road segment because they expected that other parishes would not make similar investments. Turnpike trusts addressed this issue by centralizing decision making authority over an entire roadway, and by forming inter-locking bodies of trustees, which helped to coordinate investments across trusts.[15]

Turnpike trusts were also successful in financing road investment because they resolved bargaining problems within parishes. For example, there may have been disputes between laborers and landowners concerning the level of investment and the relative tax burden paid by each group. Turnpike trusts resolved this problem because they transferred control rights to local property owners, who had a common interest in financing investment.

In general, the turnpike system had a number of attributes which allowed it to finance greater road investment. However, it also introduced the potential for rent-seeking because turnpike trusts were granted a monopoly right over the provision of a particular road service. Parliament was aware of the potential abuses from monopoly power, and therefore

[14] For example, see Daniel Defoe, *A Tour Through the Great Britain*, volume II, pp. 439-40.

[15] For examples of inter-locking bodies of trustees, see Albert (1972).

they imposed a maximum schedule of tolls and forbade trustees from earning direct profits. Parliament also pursed more indirect strategies by allowing competing trusts to enter the market and by requiring that trustees own property. The latter policy was particularly important because it provided trustees with an incentive to keep the tolls as low as possible, so that they could maximize the value of their property holdings, including land, houses, mines, and factories.

Although these measures were intended to reduce rent-seeking, it is not clear that they were effective. There was great suspicion among contemporaries that trustees were earning profits through construction contracts and by lending to the trust. For example, in *The Wealth of Nations*, Adam Smith suggested that abuses by trustees made the tolls twice as large as was necessary to properly maintain the road network.[16] Smith's views were shared by the pamphleteer Robert Phillips, who complained that travelers "pay a great deal of money to the Turnpikes; and then they find the roads daily grow worse."[17] While these views may not be representative, they clearly raise the possibility that trustees were interested in maximizing toll revenues, rather than keeping the tolls as low as possible. The behavior of trustees has important implications for the changes in transport costs, because higher tolls may have offset the benefits from road improvements.

Another important issue is whether technological or organizational changes influenced the adoption of turnpike trusts by lowering transport costs and increasing traffic volumes. In some cases, it is clear that turnpike trusts preceded certain innovations, and therefore they were unlikely to affect their adoption. For instance, most of the major improvements in wagon and carriage design occurred after 1800, when most turnpike trusts were already established (Strauss, 1912; Stratton, 1972). Similarly, most of the major innovations in road building techniques came after 1800, when James Macadam and Thomas Telford introduced the idea of building roads with convex surfaces and layers of gravel of different sizes.

However, there are also cases where innovations occurred during the same time period or along the same roads where turnpike trusts were created. For example, the size and strength of shire horses increased during the second half of the 18th Century, when domestic breeds were combined with breeds from Holland. In addition, larger carriage firms emerged after 1750 and tended to be most common in London transportation services.

The potential link between turnpike trusts and stronger horses is significant because the

[16] See p. 1726 for Smith's views on this issue.
[17] Quoted in Pawson (1977), p. 265.

new breeds may have played an important role in raising load sizes and increased travel speeds. Similarly, larger firms may have contributed to lower costs by making better use of capacity and by saving on inputs such as labor and horse feed (Gerhold, 1996). Therefore, it is also possible that turnpike trusts were simply a consequence of these alternative factors, and that they did not make an important contribution to the transport revolution.

4. Did Turnpike Trusts Lower Transport Costs?

One of the important questions in the literature on turnpike trusts is whether they contributed to lower freight charges. Previous scholars, such as William Albert (1972), have noted that freight charges declined during the 1750s and 1760s, when many turnpike trusts were established. However, Albert did not examine whether turnpike trusts were induced by other innovations or whether turnpike trusts may have raised freight charges by levying tolls. In order to revaluate the impact of turnpike trusts on freight charges, this study draws on a new data set of land carriage rates. Recall that land carriage rates represent the maximum price paid by the road-user, and they include the effects of the tolls as well as road improvements. Therefore, if the tolls offset the benefits of road improvements, then we would expect that land carriage rates would stay the same or rise after turnpike trusts were established. Also, if trusts were induced by other innovations, then we would expect that land carriage rates should decline before trusts were established.

One of the challenges in evaluating the effects of turnpike trusts is that they were not established instantly along the routes connecting city-pairs. For example, along the 275 mile route between Newcastle and London, 17 separate turnpike trusts were established at various times between 1710 and 1776. Therefore, this study measures the adoption of turnpike trusts by the fraction of route mileage managed by turnpike trusts in each year.[18] For instance, in the Newcastle to London case, the fraction of turnpike mileage was 0.51 in 1740, 0.87 in 1745, and 0.92 in 1750. If turnpike trusts lowered freight charges in this particular case, then land carriage rates should have declined after 1740 as turnpike trusts became more common along the route between London and Newcastle.

[18] To link turnpike trusts with city-pairs, I first identified when and where turnpike trusts were established using the comprehensive studies of Albert (1972) and Pawson (1977). Next, I matched turnpike trusts with city-pairs using the travel guide, *Britannia Depicta* (Bowen 1970) and *Paterson's Roads* (Mogg 1826). In a few cases, a route could not be identified for a city-pair, in which case I used the maps from the *Phillimore Atlas* (Humphrey-Smith, 1984).

As a first step, we can test whether freight charges declined after turnpike trusts were established by estimating the following equation:

$$\ln(\text{real land carriage rate}_{ijt}) = \beta(\text{fraction turnpike}_{it}) + \delta_1 \ln(\text{real wage}_{jt}) + \delta_2 \ln(\text{real feed price}_{jt}) + \gamma + \alpha_i + \varepsilon_{ijt} \quad (1)$$

where i represents each city-pair, j represents one of four regions (Southeast, Southwest, North, and Midlands), and t represents each year ($t = 1695, 1696, ..1827$). The variable $\ln(\text{real land carriage rate}_{ijt})$ is the natural log of the real land carriage rate for city-pair i in region j in year t; fraction turnpike is the fraction of city-pair $i's$ route mileage managed by turnpike trusts in year t; $\ln(\text{real wage})_{jt}$ is the log of the real wage in region j in year t; $\ln(\text{real feed price})_{jt}$ is the log of the price of horse feed in region j in year t; γ is a constant; α_i is a city-pair dummy, and ε_{ijt} is the error term.[19]

The regression includes the real wage and the real feed price because it was an important determinate of real freight charges (Gerhold, 1993). In addition, the regression includes a city-pair dummy variable, which captures all time-invariant, unobservable characteristics associated with each city-pair. For example, it controls for the distance between city-pairs as well as geographic factors. However, the inclusion of the city-pair dummy also implies that the effect of turnpike trusts is measured by changes in land carriage rates within city-pairs, rather than differences across city-pairs. As a result, the coefficient on the variable, fraction turnpike$_{it}$, can be interpreted as the percentage change in real land carriage rates after turnpike trusts were established along 100% of the route mileage for a city-pair.

The results are presented in column (1) of Table 2. The estimates suggest that real land carriage rates declined by 50% after turnpike trusts were established. This finding casts substantial doubt on the hypothesis that turnpike raised freight charges by levying tolls. At the same time, it probably over-states the impact of turnpike trusts, because it does not account for other factors that affected land carriage rates. For example, it does not account for the possibility that a new breed of horse was introduced in a particular year and caused land carriage rates to fall for many city-pairs. Also, it does not incorporate the long-run effects from such innovations.

To control for some of these unobservable changes, we estimate a second regression:

[19] For more information on the variables see the appendix.

$$\ln(\text{real land carriage rate}_{ijt}) = \beta_1(\text{fraction turnpike}_{it}) + \lambda_t + \theta(\text{year}_t) + \beta_2(\text{fraction turnpike}_{it})(\text{year}_t) + \delta_1 \ln(\text{real wage}_{jt}) + \delta_2 \ln(\text{real feed price}_{jt}) + \gamma + \alpha_i + \varepsilon_{ijt} \quad (2)$$

where λ_t is a year dummy variable and year_t is the actual year (i.e. $t = 1695, 1696, ..1827$). The year dummies will capture short-run effects, such as a brief rise in the price level or the introduction of a new breed of horse in a particular year. The year variable will measure the trend reduction in real land carriage rates across all city-pairs and will capture the long run-effects from innovations that were not exclusive to city-pairs with turnpike trusts.

Regression equation (2) also includes an interaction between the fraction of route mileage managed by turnpike trusts and the year. This variable tests whether the trend in land carriage rates changed after trusts were established. It is important to include this variable in the regression because the introduction of the year dummy variables implies that the coefficient on the fraction of turnpike mileage will only capture the impact of turnpike trusts during the year that they were established. However, trusts were unlikely to have such an immediate effect, because it often took several years to remake the road.[20]

The results from the second regression are reported in column (2) of Table 2. In this case, the effect of turnpike trusts can only be measured at a particular date. For instance, by 1800, the estimates indicate that city-pairs with turnpike trusts had 16.8% lower land carriages rates than city-pairs without turnpike trusts; and by 1820, this difference increased to 23.5%.[21] Another way of measuring the effect of turnpike trusts is calculate their share of the total reduction in real land carriage rates. For instance, if a city-pair had no turnpike trusts along its route, then the estimates imply that real land carriage rates would decline by a total of 14.2% between 1750 and 1800. By contrast, if a city-pair had a turnpike trust established along its route, then real land carriage rates would have declined by a total of 31% between 1750 and 1800.[22] Therefore, the estimates suggest that turnpike trusts accounted for approximately half of the total decline in real land carriage rates.

[20] For instance, Bogart (2004) shows that turnpike trusts made road investments over their first two years.

[21] The 16.8% figure comes from the following calculation, 5.9131-1800×0.0033784. Similarly, the 23.5% figure comes from the calculation 5.9131-1820×0.0033784.

[22] The 14.2% figure comes from the calculation, $(-0.0028437) \times (1800 - 1750)$. The 31% figure is equal to 14.2% + 16.8%.

The coefficients from regression (2) are both economically and statistically significant. However, the standard errors may be biased if the error terms ε_{ijt} are correlated over time. To test for autocorrelation, this study uses the Baltagi-Wu test statistic (1999), which applies to unbalanced panels, such as the land carriage rate data set. The Baltagi-Wu test indicates that we cannot reject the hypothesis of first-order autocorrelation in the error terms. As a result, it is important to check if the estimates are still significant, after assuming that the errors follow an AR(1) process.[23] The estimates from this alternative regression are reported in column (3) in Table 2. They indicate that the coefficients on the turnpike variables are similar to previous specifications and remain significant. In particular, they imply that city-pairs with turnpike trusts had 22.1% lower real land carriage rates by 1820.[24]

To provide a few examples of the effect of turnpike trusts on freight charges, Figure 5 plots the evolution of land carriage rates per-mile against the fraction of turnpike mileage in four cases: Leeds to London, York to London, Richmond to London, and Newcastle to London. As the Figure illustrates, land carriage rates declined once turnpike trusts were established along the majority of the route mileage used by the four city-pairs. The most dramatic change occurred between Richmond and London, where per-mile land carriages rates declined from 0.12 pence per stone (or 14 pounds) in 1700 to 0.064 pence in 1758.

The York to London case is also interesting because land carriage rates rose temporarily between 1741 and 1745, before falling substantially during the early 1750s. The rise in land carriage rates between 1741 and 1745 was probably associated with the introduction of several turnpike trusts along this route between 1739 and 1745. Therefore, in some cases it appears that the tolls initially raised freight charges, before being offset by the effects of road improvements and other innovations.

4.1 Are Turnpike Trusts Capturing the Effect of Other Innovations?

The preceding analysis controlled for a number of unobservable factors by including city-pair dummies, year dummies, and a general time trend. However, there is still a concern that the turnpike variables are measuring the influence of other innovations. For example, it is possible that increases in firm-size caused freight charges to fall during the 1750s, and that this led to greater traffic and eventually the adoption of turnpike trusts. If so, then turnpike trusts may have been a consequence, rather than a cause of the transport revolution.

[23] For more information on this estimation procedure see Baltagi and Wu (1999).

[24] The 22.1% figure comes from the calculation, 7.3835-1820×0.0041781.

One way to evaluate whether turnpike trusts are confounding these other factors is to test whether land carriage rates fell during the 5-year period before turnpike trusts were established.[25] To perform this test, a variable was constructed that measures the fraction of turnpike mileage that will be created within the next five years. For instance, suppose that a city-pair had a turnpike trust established on half of its route in 1745, and along the other half in 1755. In this case, the new variable will take the value 0.5 from 1740 to 1744, 0 from 1745 to 1749, 0.5 from 1750 to 1754, and 0 for every year after 1755. Therefore, if turnpike trusts were induced by other innovations, then land carriage rates should decline during the years 1740 to 1744 and 1750 to 1754, just before turnpike mileage increased.

Following this approach, Table 3 reports the estimates from three different specifications, all of which include the variable measuring the fraction of turnpike mileage that will be created within the next five years. Across all the specifications, the estimates show that land carriage rates did not fall before trusts were established. For example, in column (1), the estimates indicate that land carriages were not any lower during the 5-year period preceding turnpike trusts. In columns (2) and (3), the estimates also indicate that the trend in land carriage rates did not change just before trusts were established.[26] As a result, there is no direct evidence that turnpike trusts were induced by other innovations that caused transport costs to fall.

The effect of turnpike trusts can also be measured by changes in the tolls over time. Early in the 18th Century, it was expected that the tolls would be temporary, and that once the road was improved they would be eliminated (Albert, 1972; Pawson, 1977). In practice, the tolls were not eliminated because very few turnpike trusts were dissolved before the mid-19th century. Nevertheless, the price of accessing roads may still have declined over time, if the tolls fell in real terms.

The only available information on the changes in tolls comes from the maximum schedules published in the Acts of Parliament. The maximum schedules were first introduced in the initial Act establishing the trust and were subsequently updated by renewal Acts, at least every 21 years. The maximum schedules did not necessarily equal the tolls paid by road-users because trustees had the option to levy lower tolls. However, trustees were less likely to levy lower tolls after their initial Act was passed because there was less traffic and the expenses of the trust were higher. Trustees were also likely to charge the maximum toll

[25] In other words, we can test whether the adoption of turnpike trusts in any of the years $t+1$, $t+2$, $t+3$, $t+4$, or $t+5$, implied lower land carriage rates for a city-pair at date t.

[26] The results are similar if we measure the changes in rates 10 years before trusts are established.

during the early 19th century, when there was substantial price inflation. Therefore, this study examines the changes in maximum schedules across a sample of 70 Acts between 1730 and 1744, which includes 43 initial Acts and 27 renewal Acts. It also examines another sample of 58 Acts between 1800 and 1801, which is largely comprised of renewal Acts.[27] Among all 70 Acts between 1730 and 1744, the average toll for a wagon drawn by four horses was 0.91 shillings and among the initial Acts, the average toll was 0.98 shillings. In the 1800 to 1801 period, the average toll on a wagon drawn by four horses increased to 1.80 shillings. However, the toll on wagons declined in real terms by more than 20% because the price level increased by around 150% between 1730 to 1744 and 1800 to 1801.[28] This finding is important because it indicates that the burden of the tolls diminished over the same time period that freight charges were falling. Also, it may suggest that trustees were willing to set lower tolls by 1800, because they were earning indirect benefits from lower transport costs.

Additional evidence on the effect of turnpike trusts comes from the seasonal variation in land carriage rates over the 18th Century. Seasonality is relevant because travelers often remarked on the poor condition of the roads in winter, when the rains increased. Therefore, if turnpike trusts lowered freight charges by improving the road, then it should be the case that winter freight charges declined relative to summer charges.

The effects of seasonality can be measured by the difference between winter and summer land carriage rates. During the 1730s and 1740s, winter land carriage rates were on average 35% higher than summer land carriages rates; however by the 1750s and 1760s, they were only 20% higher and by 1800 they were essentially equal to summer rates.[29] The decline in winter versus summer land carriage rates is important because it cannot be explained by contemporaneous factors, such as improvements in horse breeding and increases in firm size, because each of these factors should affect freight charges similarly throughout the year. By contrast, this evidence is consistent with the argument that turnpike trusts lowered freight charges by improving road quality.

The land carriage rates between Leeds and Selby, in the West Riding of Yorkshire, provide

[27] See the appendix for a description of the sources.

[28] The figures on inflation come from Clark (2001a). The difference in average tolls between 1730 to 1744 and 1800 to 1801 is statistically significant (t-statistic, 4.69).

[29] For information on average land carriage rates in winter and summer see table 9 in the appendix. The relative decline in winter land carriage rates after 1750 is statistically significant within the sample of city-pairs where seasonal rates were set. For example, in a regression of the ratio of winter to summer rates on a set of decade dummy variables, all decade dummies are negative and significant beginning in the 1750s.

an excellent example of the effect of turnpike trusts on winter freight charges. Beginning in the 1690s, the summer rate between Leeds and Selby was 6.5 shillings per four horseback (896 pounds), while the winter rate was 15.5 shillings. These rates continued until 1744, when the summer rate was reduced to 6 shillings and the winter rate was reduced to 10.5 shillings. The greater decline in winter rates (32% versus 8%) is significant because it came shortly after the adoption of the Leeds and Selby Turnpike Trust in 1741. The timing of these changes is unlikely to be coincidental, because the parishes which preceded the Leeds and Selby trust did not make any major road investments prior to 1741.[30]

4.2 Did Trusts Have a Greater Impact in the London Market?

The impact of turnpike trusts on London freight and passenger services deserves special attention because it was the largest and most important transportation market in the British economy. It is possible that turnpike trusts had a greater impact on the London roads because trustees could capitalize on greater traffic volumes by financing more road investment, and by lowering the tolls on individual road-users. Also, turnpike trusts may have had a greater impact along the London routes, either because Parliament had different regulatory policies or because there was greater competition between trusts. Finally, London carrier and passenger firms may have been more likely to adopt new technologies and services that were complementary with the road improvements of turnpike trusts.

One way of evaluating the effects of turnpike trusts in the London market is to test whether land carriage rates declined by a greater amount after trusts were established along the London routes. Table 4 presents estimates from regression equation (2), after including an interaction between the fraction of turnpike mileage and a dummy variable that equals 1 if London is included in the city-pair. In column (1), the results indicate that London city-pairs experienced an additional 30.7% reduction in land carriage rates after trusts were established. While this estimate provides suggestive evidence that turnpike trusts had a larger impact on the London routes, it probably overstates the effect because it does not include year dummies and a time trend. However, after these controls are included (column 2), the estimates still suggest that trusts had a larger effect along the London routes. In particular, they indicate that London city-pairs with turnpike trusts experienced an additional reduction in land carriage rates of 9.3% by 1800 and 12.2% by 1820.[31]

[30] For more information on the investment behavior of parishes before turnpike trusts see Bogart (2004).

[31] The 9.3% estimate comes from the calculation, 2.5556-1800×(0.0014714) and 12.2% comes from the

Besides lowering freight charges, turnpike trusts may have also contributed to greater travel speeds between London and the provinces. One of the best indicators of increasing speed is the diffusion of 'fly-machine' services. These services were unique because they traveled continuously at a speed of around 8 miles an hour. According to London directories, fly-machine services were relatively rare before 1750, and were only available along a handful of London routes. However, by 1770 they comprised around 20% of all London passenger services and were available to most major cities.[32]

The information on fly-machine services is useful because it provides an indicator of when travel speeds increased between London and most provincial cities. Therefore, we can evaluate the contribution of turnpike trusts to greater travel speeds by investigating whether they preceded the adoption of fly-machine services. Table 5 lists all cities where fly-machine services to London were first identified in the 1770 London directory, as well as the first year when trusts were established on at least 80% of their route mileage. The table shows that in 64 out of the 71 cities, turnpike trusts preceded the adoption of fly-machines. This evidence suggests that turnpike trusts were not a consequence of fly-machine services and that they may have contributed to their adoption.

Last but not least, turnpike trusts made an additional contribution to London transportation services by increasing road capacity. The evidence on service growth in Table 1 shows that road traffic between London and the provinces increased substantially after most turnpike trusts were established in the 1740s, 1750s, and 1760s. Trusts enabled the growth in traffic by widening roads and adding more routes to London. As a result, they lessened the effects of congestion, which might have severely limited the reductions in freight charges and passenger travel times between 1750 and 1800.

5. The Transportation Revolution and Economic Growth in England and Wales

Aside from turnpike trusts, the road transport sector experienced a number of innovations, including developments in wagon and carriage design, changes in the technique of road

calculation, 2.5556-1820×(0.0014714). However, these results are not significant after assuming first order autocorrelation in the errors (see column (3) of Table 4). Therefore, the hypothesis that turnpike trusts had a larger impact along the London routes is only partially supported by the evidence.

[32]It is important to note that fly-wagon services comprised less than 1% of all freight services in 1770. They became much more common by 1800, when they made up nearly 6% of all services.

building, improvements in horse breeding, and increases in firm-size. The cumulative effect of all these innovations was a 40% reduction in freight charges, a 7.5% reduction in passenger fares, and a 60% reduction in passenger travel times. Given the large magnitude of these effects, it is natural to ask whether they made a significant contribution to economic growth in England and Wales. The traditional way in which economic historians evaluate the effects of transport innovations is to calculate their social savings, or the fraction of national income that would be lost had the transport innovations not been developed (see Fogel 1965; Fishlow, 1965; O'Brien 1983).

A social savings calculation requires information on ton miles and passenger miles as well as the change in freight charges, fares, and travel times. In our case, there is reasonably good information on the changes in transport costs, but no direct information on the total volume of services. Therefore, to measure the social savings from road transport this study provides new estimates of total passenger miles and ton miles in 1800 and 1820.[33] The new volume estimates are based on figures for the total cost of freight and passenger services. According to Theo Barker and Dorian Gerhold (1995), the tolls equaled between 10 and 15% of total costs for a sample of freight and passenger firms in the 1820s. If these figures are representative, then total toll revenues divided by either 0.1 or 0.15 would yield an estimate of the total cost of services. In 1800, total toll revenues in England and Wales were around £0.76 million, which would imply that the total cost of transport services using turnpike roads was between £5.09 million and £7.64 million. A similar calculation suggests that the total cost was between £7.43 million and £1.11 million in 1820.[34]

The previous estimates only apply to services on turnpike roads where tolls were levied. Therefore, to estimate the total cost of parish traffic, this study multiplies the total cost on turnpike roads by the ratio of parish road expenditure to turnpike road expenditure. A substantial portion of road expenditure in the early 19th Century was devoted to maintenance (Bogart, 2004). As a result, the relative amount of parish spending should represent a decent approximation of the relative cost of parish traffic. In 1800, total parish expenditure was around 53% of total turnpike expenditure, which would imply that the total cost of parish road services was at least £2.68 million in 1800. By 1820, parish road expenditure increased and was approximately 70% of turnpike expenditure, which would imply a total cost of at

[33] R. Dudley Baxter (1866) has provided estimates of passenger miles and ton miles in 1834. However, these figures are too late to properly evaluate the impact of road transport innovations because canals had claimed a large portion of freight traffic by 1834.

[34] The figures on turnpike revenues and expenditure come from Bogart (2004).

least £5.20 million.

The relative accuracy of the total cost figures can be substantiated by their proportion in national income or GDP. According to Greg Clark's estimates, GDP in England and Wales was £229 million in 1800 and £322 million in 1820 (2001b). If we choose the lower bound estimate for total costs, this would imply that road transport accounted for approximately 3.4% of GDP in 1800 and 3.9% in 1820. Both of these estimates are reasonable given that the total cost of canal services was around £4.4 million or 2% of national income in 1800.[35]

Table 6 summarizes the social savings estimates from all road transport innovations. Columns (1) to (4) provide the figures for the total cost of road services using the lower bound estimates in 1800 and 1820. Columns (5) to (7) list the estimates of total ton miles and passenger miles for turnpike roads and parish roads. The volume estimates are equal to the total cost of services divided by either the average freight charge per-mile or the average passenger fare per-mile in each year.[36]

There are two key assumptions in the volume calculations. First, total costs are assumed to be equal to the total value of services. This assumption will lead to a downward bias in ton-miles and passenger-miles because the total value of services includes profits as well as costs. Second, the volume estimates assume that freight represented half of the value of all services using turnpike roads and the entire value of services using parish roads. In the case of parish roads, freight was likely to dominate because most of these roads served local traffic between farmers and their markets. By contrast, most inter-city freight and passenger services used the major roadways, which were all managed by turnpike trusts.

Columns (8) to (11) list the social savings estimates for freight and their proportion in GDP. For 1800, the social savings are based on a 31% reduction in freight charges along turnpike roads and a 14.2% reduction in freight charges along parish roads. For 1820, the savings are based on a 43.4% reduction in freight charges on turnpike roads and a 19.9% reduction along parish roads. All of these figures come from the regression estimates in Table 2, which identify the trends for city-pairs with and without turnpike trusts.[37] The

[35] According to Hawke and Higgins (1983), the total number of ton miles on canals in 1800 was 442 million, assuming a average lead of 50 miles. If canal rates were half of road freight charges, then the total value of canal services would be £4.42 million.

[36] The average freight rate per ton-mile was £0.085 in 1800 and £0.082 in 1820. The average passenger fare per-mile was taken to be £0.020 in 1800 and £0.0165 in 1820. These figures come from the land carriage rate and passenger fare data sets. See the appendix for more information.

[37] In particular, it is assumed that along turnpike roads freight charges would be £0.124 in 1800 without the 31% reduction in freight charges between 1750 and 1800. Similarly, they would be £0.145 in 1820 without the 43.4% reduction in freight charges between 1750 and 1820.

estimates indicate that in the freight sector, road transport innovations generated a social savings of around 0.7% of GDP in 1800 and 1.3% in 1820.

Columns (12) to (15) summarize the social savings in the passenger sector, which totaled around 0.5% of GDP in 1800 and 0.8% in 1820. In this case, most of the benefits came from lower travel times, rather than reductions in fares. The social savings on passenger fares are based on a 7.5% reduction in fares, while the time savings are based on an increase in journey miles per hour from 2.6 in 1750 to 6.2 in 1800 and 7.4 by 1820.[38] The benefits from greater speed were assumed to be equal to the total number of hours saved while traveling, multiplied by the hourly income for white collar workers.[39] Laborers were excluded because most travelers were either landowners or skilled professionals.

Overall, the estimates suggest that road transport innovations generated a social savings of around £2.6 million or 1.2% of GDP in 1800 and £6.6 million or 2.1% of GDP in 1820. The rising level of social savings between 1800 and 1820 is consistent with the view that road transport made an increasing contribution to economic development during the early stages of the Industrial Revolution. When the effects of road transport are combined with canals, it is clear that both transport improvements made an even larger contribution to growth. According to Gary Hawke and Jim Higgins (1983), canals generated a social savings of around 4.7 million in 1800. This implies that the combined social savings from canals and road transport was approximately £7.3 million or 3.2% of GDP in 1800. To put these figures into perspective, Pol Antras and Hans Joachim Voth (2003) estimate that total factor productivity growth averaged 0.3% per annum in the British economy between 1770 and 1800. This would imply that canals and road transport accounted for roughly a third of all productivity growth between 1770 and 1800.[40]

How much did turnpike trusts contribute to the social savings? While it is difficult to

[38] The 7.5% reduction in passenger fares represents an average of the 11% and 4% reduction in real passenger fares in 1790-99 and 1800-09 respectively. The social savings calculation assumes that without any innovations fares would be £0.022 in 1800 and £0.018 in 1820.

[39] According to the passenger mile estimates, faster speeds implied a savings of 28 million hours in 1800 and 56 million hours in 1820. The nominal annual income for white collar workers was assumed to be £100 in 1800 and £130 in 1820. Peter Lindert and Jeffrey Williamson (1983) show that there is substantial variation across white collar occupations. Therefore this study uses a figure which is 2/3 of the average income across white collar occupations in 1805 and 1819. To arrive at an estimate of the hourly wage, these figures were divided by Hans Joachim Voth's (2001) estimates of the average annual number of hours for professionals in 1800.

[40] A T.F.P. growth rate of 0.3% would generate a social savings of 9.4% between 1770 and 1800. Therefore, roads and canals would account for approximately a third of the social savings from all innovations in the British economy.

make precise statements about the passenger sector, it is possible to provide some answers in the case of freight. According to the regression estimates in Table 2, turnpike trusts lowered freight charges by 16.8% as of 1800 and 23.5% by 1820. This would imply that they accounted for around 30% of the total social savings in freight for 1800 and 1820. However, these estimates are likely to understate the effect of turnpike trusts because they do not incorporate the greater impact of turnpike trusts along the more heavily traveled London routes. The social savings also understates the effect of turnpike trusts because it does not account for the impact of additions to road capacity. Without these investments, it is likely that growing traffic volumes would have led to greater congestion and severely limited the observed reductions in passenger travel times and freight charges.

More generally, the social savings calculation does not incorporate changes in technology, organization, and the location of economic activity resulting from lower transport costs. For example, Rick Szostak (1991) argues that lower road transport costs contributed to increased regional specialization, greater product standardization, and the rise of factories. Road transport innovations may have also encouraged greater integration of agricultural markets as well as changes in farming practice. Therefore, after including these broader effects, turnpike trusts and all other road transport innovations probably made an even larger contribution to economic development.

6. Conclusion

The rise of turnpike trusts transformed the organization and financing of road infrastructure in 18th Century England. In total, nearly 1000 turnpike trusts were established along 20,000 miles of road, resulting in one of the most expansive toll road networks in history. At the same time, the road transport sector experienced a number of revolutionary changes, including a 40% reduction in freight charges and a 60% reduction in passenger travel times.

This study examines the relationship between turnpike trusts and the transportation revolution using a number of new data sets. The analysis shows that turnpike trusts did not raise freight charges by levying tolls, and that trusts were not induced by other innovations that lowered transport costs. Instead, the evidence suggests that turnpike trusts contributed to approximately half of the 40% reduction in freight charges during this period. In addition, this study provides evidence that turnpike trusts had their greatest impact on London transport services, which were the largest and most important in the

British economy. Finally, this study provides evidence that all road transport innovations contributed to a social savings of more than 1% of national income in 1800 and 1820.

This study also has a number of implications for the debate over the relative importance of organizational and technological changes in the transportation revolution. The key conclusion is that turnpike trusts represent an important example of an organizational change that contributed to lower transport costs and improvements in the quality of services. However, it is also important to recognize that turnpike trusts had a greater impact because of other organizational and technological changes. For example, turnpike trusts were more effective because carriage and passenger firms increased their scale and efficiency. In addition, turnpike trusts benefited from improvements in horse breeding and the development of new road construction techniques during the early 19th Century.

The turnpike trust system also illustrates how institutional changes were linked with the process of economic development during the 18th and 19th Centuries. Ever since the work of Douglass North (1991), economic historians have debated whether institutions cause economic development or whether they are simply a consequence of it. The turnpike trust system represents one of the best of examples of an institution that was both a cause and a consequence of growth. Turnpike trusts clearly responded to the expanding economy by satisfying existing or potential demand for road transport services. However, they also created demand for such services by lowering freight charges and travel times. As a result, they made an independent contribution to the process of development.

Appendix: Data Sources

Information on land carriage rates are drawn from Quarter Session Order Books and the Returns Submitted to the Clerks of the Peace in Middlesex. The Returns are held at the London Metropolitan Archives (MR/WC/1-970). Quarter Sessions Order Books are available on microfilm in the Family History Library in Salt Lake City. The references are York (#2045901-5, #2045938-9), West Riding of Yorkshire (#1657872-4, #1657913-5), North Riding of Yorkshire (#469697–99, #547724-27), Newcastle (#1886204-05), Hull (#1894997-98), Leicestershire (#1470041-42), and Cheshire (# 1502213-28). Additional information was drawn from the Order Books in the Northamptonshire and Shropshire Record offices as well as Michael Freeman (1977) and William Albert (1972). Table 7 lists all city-pairs. Table 8 lists average land carriage in shillings per ton-mile, along with the standard deviation

and the number of unique observations. I averaged over unique observations in order to avoid biases from city-pairs with more observations. Finally, Table 9 lists the average ratio of winter and summer land carriage rates across city-pairs that set seasonal rates.

For the regressions, the wage data come from Greg Clark's farm laborer wage series (2001). Horse feed prices come from Quarter sessions records for Hull and from secondary sources, such as Thirsk (1985), Hill (1966), and Rogers (1963). Feed prices are assumed to be equal to an average of oat prices and bean prices. The general procedure was to match city-pairs with wage and feed prices from one of four regions: the Southeast, the Southwest, the Midlands, and the North. All city-pairs that included London were matched with the input price series from the Southeast, regardless of the final destination.

The information on average passenger travel times and fares comes from Jackman (1916), Pawson (1977), and Gerhold (1996). Additional information on fares comes from the 1760 and 1770 London travel directory, *A New and Complete Guide to all persons who have any trade or Concern with the City of London.* Tables 10 and 11 provide summary statistics.

The information on freight and passenger services comes from a series of London directories including, *The Merchant and Trader's Necessary Companion* (1715), *The New and Complete Guide* (1740, 1749, 1760, 1770, 1783), and *The Shopkeeper's and Tradesman's Assistant* (1779, 1790, and 1800). All of these directories are available in the microfilm series, *the Eighteenth Century.*

The information on toll schedules comes from the series, *Acts of Parliament* and *Local and Personal Acts. Acts of Parliament* are available in the Clark Library in Los Angeles and *Local and Personal Acts* are available in the University of Minnesota, Law Library.

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Tables

Table 1: The Growth of Passenger and Freight Services Leaving from London, 1715-1800

Year	(1) Number of Listed Weekly Freight Services, All Cities	(2) Number of Listed Weekly Passenger Services, All Cities	(3) Number of Listed Weekly Freight Services, Major Cities	(4) Number of Listed Weekly Passenger Services, Major Cities
1715	840	620	140	150
1740	1570	780	220	110
1749	1610	760	230	140
1760	1950	940	340	210
1770	2960	1960	390	410
1779	3100	3190	340	820
1783	3360	3820	370	860
1790	4590	8010	520	1590
1800	7790	12,210	970	1960
	Average Annual Growth Rate	Average Annual Growth Rate	Average Annual Growth Rate	Average Annual Growth Rate
1715-1800	2.7%	3.6%	2.3%	3.1%
1760-1800	3.5%	6.6%	2.7%	5.7%

Sources: The figures for 1715 come from *the Merchant and Traders Necessary Companion*. The figures for 1740, 1749, 1760, 1770, and 1783 come from *the New and Complete Guide to all Persons who have any Trade or Concern with the City of London*. Lastly, the figures for 1779, 1790, and 1800 come from *the Shopkeepers and Tradesman's Assistant*.
Notes: Figures are rounded to the nearest ten and all years exclude services to cities in Middlesex County. Major cities are defined as cities with a population greater than 2500 in 1700, see Corfield (1982).

Table 2: The Effect of Turnpike trusts on Land Carriage Rates: Baseline Specifications

Variable	(1) Coefficient (Standard Error)	(2) Coefficient (Standard Error)	(3) Coefficient (Standard Error)
Fraction Turnpike	-0.500 (0.125)*	5.9131 (0.7710)*	7.3835 (1.3354)*
(Fraction Turnpike)*(year)		-0.0033784 (0.0004)*	-0.0041781 (.0007)*
Year		-0.0028437 (0.0009)*	
ln(real wage)	0.557 (0.021)*	0.1943 (0.0374)*	0.4862 (0.0241)*
ln(real feed price)	-0.269 (0.024)*	0.0609 (0.0400)	0.1198 (0.0140)*
Constant	1.198 (0.082)*	5.7925 (1.6202)*	-0.0142 (0.0026)*
City-pair dummies	Yes	Yes	Yes
Year dummies	No	Yes	Yes
AR(1) disturbances	No	No	Yes
Baltagi-Wu LBI statistic			0.822
R^2	0.319	0.801	0.786
City-Pairs	130	130	120
Total observations	5071	5071	4941

Notes: Dependent variable is the natural log of the real land carriage rate for city-pair i in year t.
* indicates statistical significance at the 95% level.

Table 3: Did Land Carriage Rates Fall before Turnpike Trusts Were Adopted?

Variable	(1) Coefficient (Standard Error)	(2) Coefficient (Standard Error)	(3) Coefficient (Standard Error)
Fraction Turnpike	-0.4896 (0.0142)*	5.8779 (0.7761)*	7.408616 (1.3354)*
Fraction Turnpike within the next 5 years	0.0407 (0.0276)		
(Fraction Turnpike)*(year)		-0.0033564 (0.0004)*	-0.0041802 (.00076)*
(Fraction Turnpike within the next 5 years)*(year)		0.0000042 (0.00001)	0.0000128 (0.0000088)
Year		-0.002876 (0.0009)*	
ln(real wage)	0.5521 (0.0210)*	0.1935 (0.0374)*	0.4822 (0.0243)*
ln(real feed price)	-0.2724 (0.0238)*	0.0605 (0.0400)	0.1191 (0.0140)*
Constant	1.2093 (0.0823)*	5.8497 (1.6268)*	-0.0148 (0.0027)*
City-pair dummies	Yes	Yes	Yes
Year dummies	No	Yes	Yes
AR(1) disturbances	No	No	Yes
Baltagi-Wu LBI statistic			0.822
R^2	0.319	0.801	0.786
City-Pairs	130	130	120
Total observations	5071	5071	4941

Notes: Dependent variable is the natural log of the real land carriage rate for city-pair i in year t.
* indicates statistical significance at the 95% level.

Table 4: Did Turnpike Trusts Have a Larger Effect along the Roads Leading into London?

Variable	(1) Coefficient (Standard Error)	(2) Coefficient (Standard Error)	(3) Coefficient (Standard Error)
Fraction Turnpike	-0.4579 (0.0133)*	4.4440 (0.0793)*	6.5232 (1.3865)*
(Fraction Turnpike)*London dummy	-0.3076 (0.0276)*	2.5556 (0.4324)*	2.1804 (1.3757)
(Fraction Turnpike)*(year)		-0.0025512 (0.0004)*	-0.0037085 (.00078)*
(Fraction Turnpike)*(London dummy)*(year)		-0.0014714 (0.0002)*	-0.0010766 (0.000781)
Year		-0.0017917 (0.0009)*	
ln(real wage)	0.5521 (0.0210)*	0.0873 (0.0400)*	0.4587 (0.0243)*
ln(real feed price)	-0.2582 (0.0235)*	0.0575 (0.0398)	0.1182 (0.0139)*
Constant	1.2227 (0.0814)*	4.19079 (1.6291)*	0.0341 (0.0027)*
City-pair dummies	Yes	Yes	Yes
Year dummies	No	Yes	Yes
AR(1) disturbances	No	No	Yes
Baltagi-Wu LBI statistic			0.814
R^2	0.329	0.812	0.789
City-Pairs	130	130	120
Total observations	5071	5071	4941

Notes: Dependent variable is the natural log of the real land carriage rate for city-pair i in year t.
* indicates statistical significance at the 95% level.

Table 5: Turnpike Trusts and the Diffusion of Fly-Machine Services

Cities with fly-machine Services to London beginning in 1770	First year when trusts were established on at least 80% of the route mileage	Cities with fly-machine Services to London beginning in 1770	First year when trusts were established on at least 80% of the route mileage
Maidenhead	1727	Peterborough	1754
Oakingham	1759	Newport Pagnell	1728
Reading	1736	Nottingham	1738
Windsor	1759	Oxford	1719
Sunninghill	1759	Burford	1751
Swaffam	1725	Ipswich	1785
Chester	1744	Falkenham	1785
Stockport	1738	Shrewsbury	1748
Blandford	1766	Ludlow	1751
Derby	1738	Bath	1727
Buxton	1738	Taunton	1753
Chelmsford	1725	Wells	1753
Harlow	1725	Wolverhampton	1727
Stifford	1808	Walsall	1766
Cheltenham	1751	Brighton	1770
Tewkesbury	1756	Chichester	1749
Portsmouth	1749	Horsham	1756
Southampton	1758	Epsom	1755
Winchester	1762	Godalming	1757
Romsey	1764	Guildford	1749
Ware	1725	Kingston	1718
Deal	1802	Weybridge	1767
Maidstone	1752	Witney	1751
Margate	1802	Birmingham	1724
Sittingbourne	1738	Marlborough	1728
Asfhord	1793	Salisbury	1753
Manchester	1738	Trowbridge	1728
Warrington	1753	Devizes	1728
Lincoln	1756	Hull	1765
Sleaford	1756	Leeds	1739
Stamford	1749	Wakefield	1739
Barton Humber	1765	Sheffield	1765
Bourne	1756	Tadcaster	1739
Norwich	1769	Chestnut	1725
Yarmouth	1769	Worcester	1731
Northampton	1728		
Total Number of Cities			71
Number of Cites Where Turnpike Trusts Preceded Fly Machine Services			64

Source: Information on fly-machine services comes from the London Directory, *The New and Complete Guide*.

Table 6: Social Savings Estimates from all Road Transport Innovations: 1800 and 1820

Year	(1) Total Cost of Road Services, Turnpike Roads	(2) Total Cost of Road Services, Parish Roads	(3) Total Cost of Road Services, All Roads	(4) Total Cost of Road Services as % of GDP
1800	£5,093,000	£2,680,000	£7,773,000	3.4%
1820	£7,427,000	£5,199,000	£12,625,000	3.9%
	(5) Number of Ton miles, Turnpike Roads	(6) Number of Ton miles, Parish Roads	(7) Number of Passenger Miles, Turnpike Roads	
1800	29,786,000	31,345,000	126,385,000	
1800	45,285,000	63,398,000	225,051,000	
	(8) Social savings on Freight, turnpike Roads	(9) % of G.D.P.	(10) Social Savings on Freight, Parish Roads	(11) % of GDP
1800	£1,143,000	0.5%	£445,000	0.2%
1820	£2,848,000	0.9%	£1,289000	0.4%
	(12) Social Savings on Passenger fares, Turnpike Roads	(13) % of G.D.P.	(14) Social Savings on Passenger Travel Times, Turnpike Roads	(15) % of GDP
1800	£206,000	0.1%	£844,000	0.4%
182	£301,000	0.1%	£2,169,000	0.7%
	(16) Total Social Savings, All Roads	(17) % of G.D.P.		
1800	£2,638,000	1.2%		
1820	£6,607,000	2.1%		

Notes: For details on the calculations see the text. The G.D.P. figures come from Clark (2001b).

Table 7: The Land Carriage Rate Data Set

City One	City Two	First Year	Last Year	City One	City Two	First Year	Last Year
Askrigg	York	1719	1825	Manchester	Newcastle	1800	1821
Beverley	York	1697	1825	Berwick	Newcastle	1802	1821
Barnsley	York	1814	1825	Alnwick	Newcastle	1802	1821
Bradford	York	1697	1825	Morpeth	Newcastle	1802	1821
Bedale	York	1697	1825	Durham	Newcastle	1802	1821
Bridlington	York	1730	1825	Darlington	Newcastle	1802	1821
Carlisle	York	1814	1815	Barnard	Newcastle	1821	1821
Coln	York	1757	1825	London	Richmond	1695	1820
Driffield	York	1814	1825	London	Leeds	1695	1821
Durham	York	1719	1825	London	Boroughbridge	1695	1820
Doncaster	York	1719	1825	London	Settle	1731	1805
Darlington	York	1810	1825	York	Wakefield	1695	1820
Easingwold	York	1814	1825	Newcastle	Pontefract	1763	1820
Gainsbrough	York	1757	1825	Sheffield	Wakefield	1763	1820
Halifax	York	1697	1825	Skipton	Leeds	1773	1820
Hull	York	1697	1825	Skipton	Tadcaster	1773	1820
Huddersfield	York	1757	1825	Leeds	Sheffield	1773	1820
Howden	York	1757	1825	Sheffield	Pontefract	1773	1820
Helmsley	York	1757	1825	Leeds	Selby	1695	1799
Kendal	York	1757	1825	Selby	Leeds	1695	1799
Keighley	York	1814	1825	Wakefield	Tunbridge	1695	1799
Knaresborough	York	1757	1825	Tunbridge	Wakefield	1695	1799
Lancaster	York	1814	1825	York	Hull	1707	1795
London	York	1697	1825	Scarborough	Hull	1717	1795
Leeds	York	1697	1825	Leeds	Hull	1725	1795
Middleham	York	1697	1825	Wakefield	Hull	1725	1795
Masham	York	1757	1825	London	Hull	1749	1795
Nottingham	York	1765	1825	Lincoln	Hull	1749	1795
Newcastle	York	1705	1825	Beverley	Hull	1795	1795
North Allerton	York	1810	1825	Brigg	Hull	1795	1795
Otley	York	1757	1825	Bridlington	Hull	1795	1795
Pontefract	York	1785	1825	North Cave	Hull	1795	1795
Pocklington	York	1814	1825	Hedon	Hull	1795	1795
Pickerington	York	1814	1825	Hornsea	Hull	1795	1795
Rochdale	York	1814	1825	Louth	Hull	1795	1795
Rotherham	York	1815	1825	Patrington	Hull	1795	1795
Ripon	York	1697	1825	Weighton	Hull	1795	1795
Richmond	York	1697	1825	Welton	Hull	1795	1795
Snaith	York	1814	1825	London	Boston	1749	1780
Selby	York	1815	1825	London	Horncastle	1752	1823
Sheffield	York	1787	1825	London	Lincoln	1764	1825
Stockton	York	1814	1825	London	Louth	1751	1827
Skipton	York	1697	1825	London	Spalding	1749	1826
Scarborough	York	1719	1825	Boston	Spilsby	1752	1821
Stamford	York	1795	1813	Barton	Lincoln	1765	1821
Stokesley	York	1757	1825	Horncastle	Spilsby	1795	1821
Tadcaster	York	1814	1825	Boston	Alford	1751	1821
Thorne	York	1814	1825	Horncastle	Alford	1795	1821
Thirsk	York	1757	1825	Boston	Louth	1763	1821
Wakefield	York	1697	1825	Lincoln	Horncastle	1752	1821
Weighton	York	1803	1825	Chester	London	1695	1814
Wetherby	York	1814	1825	Shrewsbury	London	1695	1794
Whitby	York	1719	1825	Leicester	London	1695	1824
Yarm	York	1719	1825	Harborough	London	1695	1824
London	Newcastle	1744	1826	Lutterworth	London	1695	1824
Doncaster	Newcastle	1766	1821	Hinckley	London	1695	1824
York	Newcastle	1755	1821	Ashby	London	1695	1824
Pontefract	Newcastle	1768	1821	Melton	London	1695	1824
Leeds	Newcastle	1758	1821	Northampton	London	1710	1781
Ripon	Newcastle	1774	1821	Wellingborough	London	1754	1781
Hexham	Newcastle	1772	1821	Daventry	London	1754	1781
Carlisle	Newcastle	1772	1821	Tiverton	London	1758	1782
Dorchester	London	1750	1786	Bridgport	London	1758	1786
				Portsmouth	London	1718	1786

Table 8: Average Land Carriage Rates per-mile, 1700-1825

Decade	Average Land Carriage Rates in shillings per-ton per mile (current prices	Standard Deviation	Number of observations	Consumer Price Index, 1700-09 = 1, from Clark (2001)	Real Land Carriage Rate Index (1700-09=1)
1700-09	1.22	0.37	52	1	1
1710-19	1.23	0.32	32	1.04	0.97
1720-29	1.23	0.31	34	1.04	0.97
1730-39	1.25	0.25	45	0.95	1.08
1740-49	1.26	0.30	58	0.95	1.09
1750-59	1.24	0.31	97	1.06	0.96
1760-69	1.16	0.27	92	1.13	0.84
1770-79	1.13	0.25	97	1.30	0.71
1780-89	1.14	0.25	95	1.30	0.72
1790-99	1.20	0.28	121	1.53	0.64
1800-09	1.46	0.34	157	2.08	0.58
1810-19	1.66	0.40	206	2.26	0.60
1820-27	1.74	0.45	109	1.69	0.84

Notes: The average is un-weighted across city-pairs. It also includes only one observation for each city-pair per decade, unless land carriage rates changed, in which each unique observation is included.

Table 9: Average Ratio of Winter to Summer Land Carriage Rates, 1730 – 1809

Decade	Average Ratio of Winter to Summer Land Carriage Rates	Standard Deviation from Average	Number of observations
1730-39	1.52	0.46	60
1740-49	1.35	0.33	91
1750-59	1.21	0.23	141
1760-69	1.17	0.23	149
1770-79	1.12	0.15	129
1780-89	1.17	0.22	126
1790-99	1.19	0.25	107
1800-09	1.04	0.06	40

Notes: The table only includes city-pairs where seasonal rates were set.

Table 10: Average Journey Miles Per-Hour in the Passenger Sector, 1750-1830

Decade	Average Journey Miles Per-Hour (journey distance/total journey time)	Standard Deviation	Number of observations
1750-59	2.61	1.12	20
1760-69	3.06	1.01	20
1770-79	4.69	1.19	41
1780-89	5.36	1.66	51
1790-99	6.26	1.96	28
1800-09	5.05	0.56	3
1810-19	6.85	2.42	21
1820-29	7.96	1.55	41

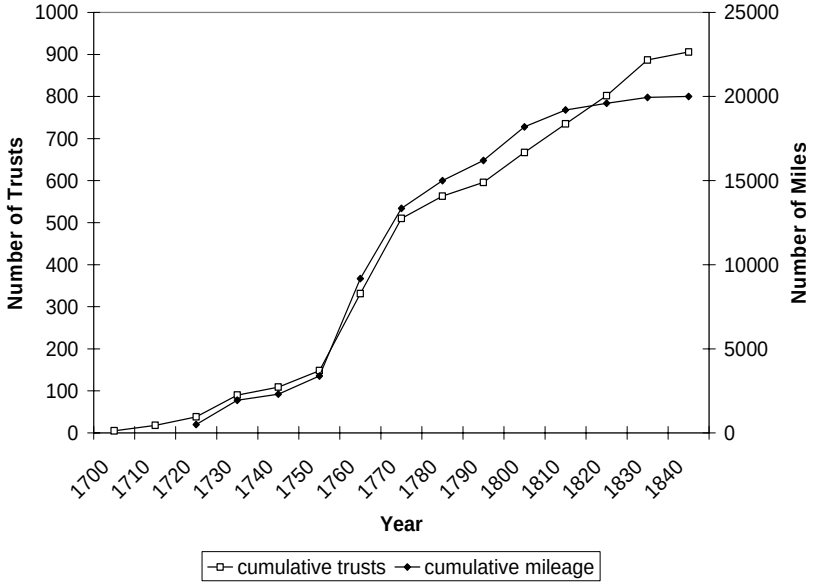
Sources: Jackman (1916) and Pawson (1977).
Notes: Average journey miles per-hour are equal to the total distance traveled divided by the total journey time.

Table 11: Average Passenger Fares per-mile, 1750-1799

Decade	Average passenger fare per-mile in shillings	Standard Deviation	Number of Observations	Consumer Price Index, 1750-59=1, from Clark (2001)	Real Passenger Fare Index (1750-59=1)
1750-59	0.216	0.06	14	1.00	1.00
1760-69	0.216	0.06	215	1.06	0.94
1770-79	0.223	0.08	418	1.22	0.85
1780-89	0.265	0.08	140	1.22	1.00
1790-99	0.278	0.11	37	1.44	0.89
1800-09	0.403	0.11	13	1.95	0.96
1810-19	0.327	0.09	15	2.21	0.71
1820-30	0.337	0.06	8	1.59	0.98

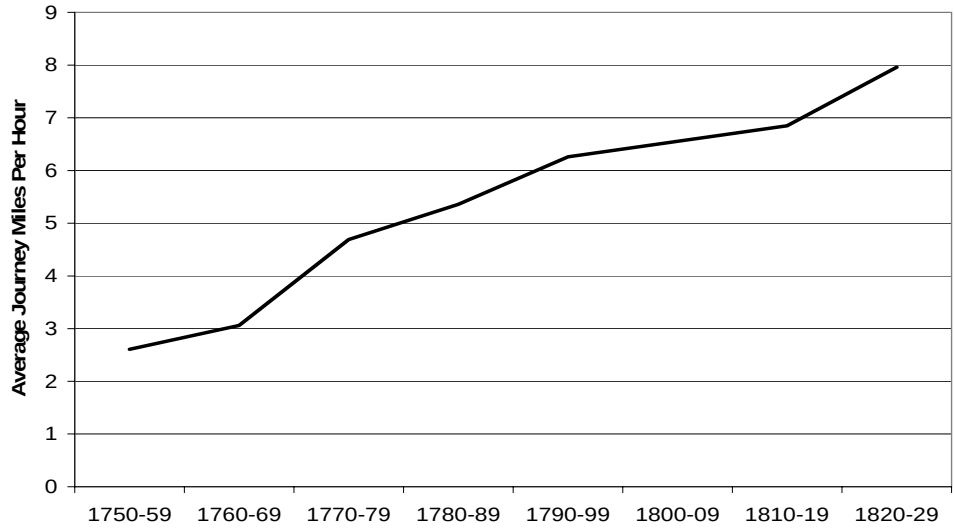
Sources: Most of the observations for the 1760s and 1770s come from the London directory, *the New and Complete Guide to all persons who have any trade or Concern with the City of London*, (1760) and (1770). All other observations come from Jackman (1916) and Gerhold (1996). The consumer price index comes from Clark (2001).
Notes: The averages are un-weighted across city-pairs.

Figure 1: The Diffusion of Turnpike Trusts in England and Wales, 1700-1840



Sources: Albert (1972) and Pawson (1977).

Figure 2: Average Journey Miles Per-Hour, 1750-1829

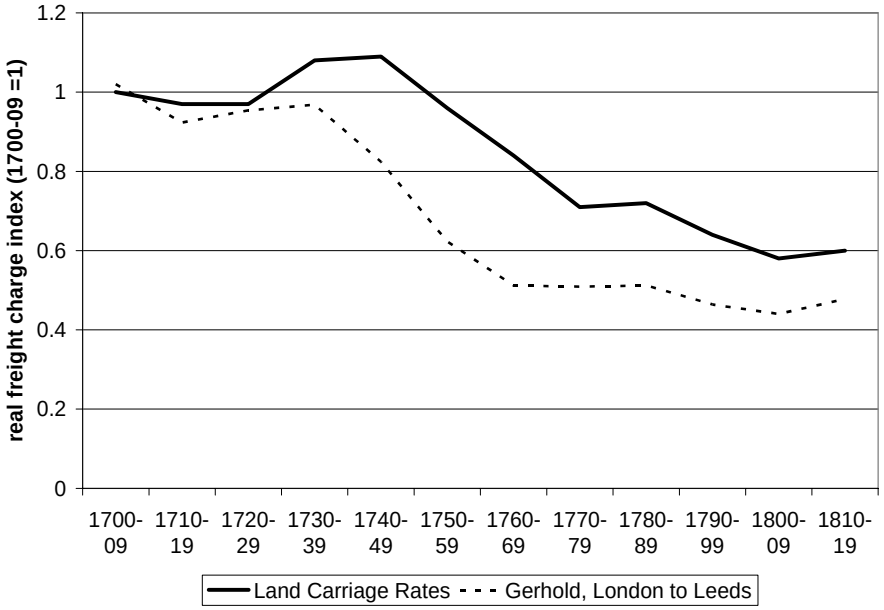


Sources: Jackman (1916) and Pawson (1977).
Notes: Average journey miles per-hour is equal to the total journey distance in miles divided by the total journey time.

Figure 3: An Index of Real Passenger Fares, 1750-1830

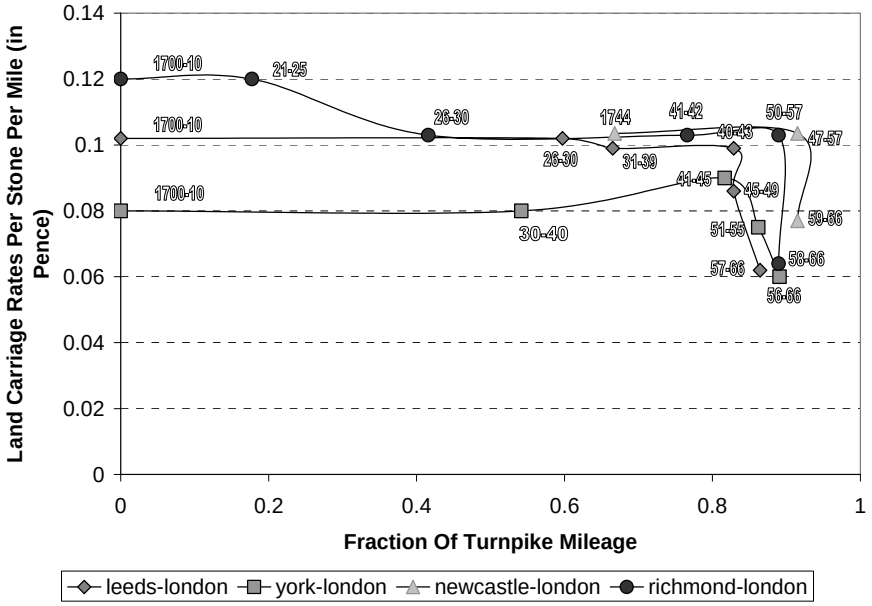
Sources: see the appendix.

Figure 4: An Index of Real Freight Charges, 1700-1819



Source: For details on Land Carriage Rate data see the appendix. The London to Leeds index comes from Gerhold (1996).

Figure 5: Turnpike Trusts and the Evolution of Land Carriage Rates Between 1700 and 1766: Some Examples



Sources: see text.