How do Institutional Innovations Diffuse?
Evidence from Turnpike Trusts in Eighteenth-Century England

Dan Bogart
Department of Economics, UC Irvine
dbogart@uci.edu

Abstract

Turnpike trusts were private organizations that received statutory authority to build and operate toll roads in eighteenth century England. They were promoted by local landowners, merchants, and manufacturers who hoped to benefit from lower transport costs, higher property values, and increased profits. Despite the realization of these benefits, turnpike trusts diffused slowly between 1663 and 1750. Then during the 1750s and 1760s, trusts were rapidly adopted along most of the major highways. This paper shows that political instability and opposition from vested interests slowed the initial diffusion of turnpike trusts. It also shows that neighbor effects contributed to the rapid adoption of turnpike trusts after the mid eighteenth century. The results provide general insights on the diffusion of institutional innovations.

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1. Introduction

There is increasing consensus among scholars that institutions are linked with economic growth, but there are still many questions about the process of institutional change. One aspect of this larger question concerns the diffusion of institutional innovations, or new rules and organizations that promote economic efficiency. The literature on technology diffusion provides a useful starting point for such questions. Scholars have shown that technologies often diffuse slowly for some initial period, before reaching an inflection point, in which they are rapidly adopted. This pattern is often described as the S-curve. There are a variety of explanations for the S-curve. One emphasizes that benefits vary across firms and individuals, and that as demand for the technology increases, or its cost of implementation falls, early adopters give way to the majority of the population. Other explanations emphasize neighborhood effects. They suggest that firms and individuals are more likely to adopt technologies if their neighbors also adopt

(Geroski, 2000) The technology literature also suggests that politics and opposition from vested interests can impede the adoption of innovations. In particular, scholars have argued that if politicians or bureaucrats have veto power over the implementation of a technology, then they might block adoption to reward groups that lose from the innovation (Mokyr, 1990).

This paper draws on concepts from technology diffusion to explain the diffusion of an institutional innovation that greatly improved economic efficiency prior to the industrial revolution in England. It focuses on the emergence of turnpike trusts, which were private organizations that built and operated toll roads. Turnpike trusts were created by Acts of Parliament. The Acts named a body of trustees, and gave them authority over an individual roadway that was previously maintained by local governments. Trustees were given the right to
levy tolls on road-users and to issue bonds secured upon the income from the tolls. However, trustees had to keep the tolls below a maximum schedule, and they were required to devote all the revenues to road improvements, salaries, interest, and debt payments. This last restriction was the most significant, because it implied that trustees were not allowed to earn direct profits.

In spite of these limitations, turnpike trusts were widely adopted. They were promoted by local landowners, merchants, and manufacturers, who submitted petitions to Parliament. The petitions usually stated that communications and transport would be greatly improved if turnpike trusts could levy tolls and improve the road. Parliament had the choice of rejecting a turnpike petition or accepting it by passing an Act of Parliament. Before 1695, few turnpike petitions were introduced and only one was accepted, but afterwards, Parliament began to receive and accept greater numbers of petitions. Figure 1 plots the total number of turnpike trusts and their cumulative road mileage between 1663 and 1840. Aside from having the classic S-shape the diffusion process had two defining characteristics. One was the prolonged length of the initial adoption phase, lasting from 1663 to 1750. The second was the geographic clustering of adoption, especially during the 1750s and 1760s when turnpike trusts were established throughout much of the road network in England and Wales.

The widespread adoption of turnpike trusts had important effects on the economy. Several scholars have shown that turnpike trusts substantially increased road investment and lowered transport costs.\(^3\) I extend the previous literature here by analyzing the two defining characteristics of the turnpike diffusion process: (1) the prolonged length of the initial diffusion phase, and (2) the geographic clustering of adoption. First, I show that political instability and opposition from vested interests slowed the initial adoption of turnpike trusts by impeding the

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\(^2\) For the theoretical literature on the linkages between institutions and growth see North (1990). For an example of the empirical literature, see Acemoglu, Johnson, and Robinson (2001).
passage of turnpike Acts in Parliament. Second, I demonstrate that neighbor effects were the main factor contributing to the geographic clustering of turnpike adoption. In particular, I use panel and instrumental variables techniques to show that cities were more likely to have turnpike trusts adopted along their main road, if their neighboring cities also had turnpike trusts. I interpret this result as evidence of demonstration effects, network effects, or competition effects. Demonstration effects occurred when groups learned about the benefits of turnpike trusts through their neighbors. Network effects arose when a group’s benefits from turnpike trusts increased as connecting road segments were also improved by turnpike trusts. Lastly, competition effects reflect that groups tried to maintain their comparative advantage over neighbors by adopting turnpike trusts. More generally, the results show that a stable political system and the ability to overcome vested interests are necessary for the adoption of institutional innovations. The results also highlight that neighbor effects have significant influence on institutional diffusion.

The paper is organized as follows. Section 2 presents an overview of English history and the rise of turnpike trusts. Section 3 discusses the main hypotheses that explain turnpike diffusion. Section 4 shows that political instability and opposition from vested interests inhibited the passage of turnpike Acts. Section 5 shows that neighbor effects influenced the diffusion of turnpike trusts along the London road network. Section 7 concludes and discusses some general insights on institutional diffusion.

2. Overview

It is well known that the English economy experienced an Industrial Revolution beginning in the late eighteenth century. Recent research has shown, however, that the English

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See section 2 for a discussion of the literature on turnpike trusts.
economy began to develop long before in the seventeenth century (Allen, 2001; Clark, forthcoming). Along with increasing prosperity, the seventeenth century also witnessed intense political instability. In the 1610s and 1620s, there were disputes between King James I and Parliament over taxation and religion. Taxation was a particularly vexing issue because the Crown had to call Parliament and request taxes in order to finance military expenditures and its own consumption. King James I wanted to end this system by eliminating Parliament and developing independent sources of revenue. Parliament tried to check James I through a variety of actions. One of the most famous was the Statute of Monopolies in 1623, which outlawed the Crown’s authority to grant monopoly patents in return for revenue. The disputes between the Crown and Parliament continued under the reign of Charles I and culminated in the English Civil War of the 1640s, and the abolishment of the monarchy. Charles II was restored to the thrown in 1660. He and his son James II tried once again to create an absolutist regime in England. Their reign came to end with the Glorious Revolution of 1689, in which Parliament removed James II and gave the throne to William of Orange.

The Glorious Revolution marked the rise of Parliament as the supreme political authority. Almost immediately Parliament began passing numerous Acts which addressed economic issues. Turnpike Acts were one of the major components of this legislative movement (Bogart and Richardson, 2006). The Acts transferred authority from parishes to a body of trustees. Parishes were the smallest unit of local government in England, and typically spanned an area between 2 and 4 square miles. They were required to pay for road improvements in their jurisdiction by claiming labor services from their residents, and by levying taxes on property income, such as land. A particular road segment remained under the parish system until an Act of Parliament gave turnpike trusts authority over the road. The Acts were initiated by local groups, who
submitted a petition to the House of Commons. After receiving a petition, a committee examined witnesses representing the petitioners, as well as those who opposed the turnpike trust. If the committee agreed with the petitioners, then it wrote a bill naming a body of trustees and defining their privileges and restrictions. If the bill was approved by the House of Commons and the House of Lords, then the turnpike trust was formally established (Clifford, 1971).

The official rationale for a Turnpike Act was that the ordinary laws (i.e. the parish system) were ineffectual and needed to be amended in order to increase road maintenance and investment. Parishes had the ability to pay for substantial road improvements by levying property income taxes, but they rarely chose to do so prior to the late eighteenth century (Bogart, 2005). Parishes had little incentive to tax themselves when most of the benefits went to through-travelers. The through-traffic problem was especially relevant along the highways leading into London, where wagons and carriages often passed through dozens of parishes along their route. In such cases, parishes were forced to bear two costs. One, they had to pay for all the maintenance and investment costs. Second, their road expenditures served to increase through traffic, which lowered prices in their market and added to congestion. Borrowing constraints were another reason why the parish system was unsuccessful in financing road investment. Legal restrictions on issuing debt forced parishes to rely on current tax revenues, and as a result, they had little incentive to undertake road investments that yielded benefits over the long run.

Turnpike trusts resolved the borrowing constraint problem because they were able to issue debt at a low cost. They also resolved the through traffic problem by levying tolls on road-users. These two factors enabled turnpike trusts to increase road expenditures along individual roadways by between 10 and 20 times (Bogart, 2005). Greater road expenditure affected the economy by contributing to lower transport costs. Between 1750 and 1820, freight charges fell
by around 40%, while passenger travel times were reduced by 60%. The aggregate impact of lower freight charges and travel times was substantial and amounted to a social savings of between 1 and 2% of national income in 1800 for England and Wales. The social savings were due to a number of factors including road improvements from turnpike trusts, larger carriage firms, and better technologies, such as new coaches and stronger horses. The best estimates suggest that turnpike trusts contributed to around half of the reductions in freight charges, and made a similar contribution to lower travel times.¹

Turnpike trusts were an institutional innovation that promoted greater infrastructure investment, and like most innovations they were adopted slowly considering the magnitude of their benefits. The first turnpike Act was passed in 1663 and applied to a 15 mile-stretch along the Great North Road, connecting London with Newcastle. The next two turnpike trusts were created in 1695. One was similar to its predecessor in that it applied to a major highway from London to Essex. The other was created along a road leading into the provincial city of Norwich. Over the next 25 years, turnpike trusts were adopted along road segments near a handful of major cities such as Bath, Reading, Gloucester, Oxford, Northampton, Portsmouth, and Colchester. During the 1720s and 1740s, the diffusion process accelerated, as turnpike trusts were adopted along several routes leading into London, as well as other provincial cities in the far West and North. Turnpike trusts finally proliferated throughout the road network during the ‘turnpike boom’ of the 1750s and 1760s. This period witnessed the adoption of over 300 trusts along 10,000 miles of road (Pawson, 1977). The two final waves of adoption occurred during the 1790s and 1820s, when most trusts were established on secondary roads near major cities, like London, Leeds, Birmingham, and Manchester. The diffusion process ended in the 1830s.

¹ There is a large literature on the relationship between turnpike trusts and transport costs. See Jackman (1916), Albert (1972), Pawson (1977), Chartres and Turnbull (1983), Gerhold (1988, 1996), and Bogart (forthcoming).
after 1000 turnpike trusts were established on 20,000 miles, or 17% of the road network (Great Britain, 1840).

Geographic clustering was a common feature in each wave of adoption. The maps in figure 2 illustrate the clustering of adoption along the London road network. Using the late seventeenth century travel guide, *Britannia*, I have identified the roads that linked London with 67 major cities that had a population of 2500 or more in 1700 (see Bowen, 1970; Corfield, 1983). I then use the data from Albert (1972) and Pawson (1977) to establish when turnpike trusts were established on each segment of this network. The darker lines in panel A represent road segments with turnpike trusts in 1750, while the gray lines are segments that were still under the control of parishes. Panel A shows that in 1750 turnpike trusts controlled most of the mileage to cities like Manchester, Newcastle, Bristol, Hereford, Worcester, Shrewsbury, Chester, Canterbury, and Portsmouth, but little of the mileage to cities like Plymouth, Tiverton, Southampton, Lincoln, Norwich, King’s Lynn, Yarmouth and Carlisle. Along the routes where trusts were adopted, they were often established in only a handful of years. For instance, turnpikes were adopted on 74% of the 110 miles between London and Bristol between 1726 and 1728. Similarly, turnpikes were adopted on 32% of the 275 miles between London and Newcastle between 1741 and 1747. In the latter case, the adoption pattern resembled a cascade. Starting in 1741, a turnpike trust was established along the Doncaster to Boroughbridge segment. In 1745, a second turnpike was established along the Boroughbridge to Durham segment. Finally, in 1747, a third turnpike was adopted along the Durham to Newcastle segment, as well as a fourth turnpike trust along the branch from Durham to Sunderland.

Panel B of figure 2 shows that turnpike trusts were adopted along most of the remaining portions of the London road network between 1750 and 1770. As in the earlier period, trusts
were often established along routes in a short time period. As an example, turnpikes were established on 112 miles of the London-Plymouth road between 1753 and 1759. The segments between Shaftesbury and Sherborne, Sherborne and Crewkerne, Axminster and Exeter, as well as Exeter and Chudleigh all had turnpike trusts adopted in 1753. The segment between Chudleigh and South Brent had a turnpike in 1755, while the segment between South Brent and Plymouth had a turnpike in 1757. Finally, the segments between Chard and Axminster, as well as Crewkerne and Chard had turnpikes established in 1758 and 1759, respectively.

Geographic clustering was not unique to the London road network. In 1740, the West Riding of Yorkshire had one turnpike trust managing 13 miles of road. In 1741, the situation changed dramatically as 6 turnpike trusts were established along 239 miles throughout the region. A similar phenomenon occurred in Norfolk county where several turnpike trusts were established along 216 miles in 1769 and 1770 (Pawson, 1977).

This overview described the effects of turnpike trusts and the political system in which they were adopted. It also documents the prolonged length of the initial adoption phase and the geographic clustering of turnpike adoption. The following section draws on the technology diffusion literature to develop some hypotheses that explain the diffusion of turnpike trusts.

3. Explaining the Diffusion of Turnpike Trusts

The technology diffusion literature has developed a number of models that explain the S-shape diffusion curve. One of the most common is the known as the probit model (Geroski, 2000). It assumes that each individual earns a specific net benefit from a technology, and at any given time, some individuals will adopt because they earn positive net benefits, while others do not. Now imagine that the net benefits increase because the market expands, or because the cost
of the technology falls. Initially, adoption will be concentrated among individuals who earn the
highest benefits. Later, however, the early adopters will give way to the mass of the population,
which have a higher threshold level of benefits.

The probit model has been expanded to include a variety of neighbor effects, including
demonstration effects, network effects, and competition effects. Demonstration effects capture
the idea that neighbors learn from one another about the benefits of technologies. It can give rise
to an s-shape diffusion curve because one individual’s adoption increases the likelihood that
others will understand the potential benefits. Network effects imply that an individual’s benefits
from a technology increase whenever their neighbors also adopt. It can be caused by costs
savings associated with higher aggregate usage, as well as technological complementarities.
Like demonstration effects, network effects can lead to an S-shape diffusion curve because one
individual’s adoption increases the benefits for others. Competition effects are similar to
network effects, but they do not imply that individuals benefit in absolute terms. One example is
two competing firms who must choose whether to adopt a technology. Both firms might earn the
highest benefits if neither adopts, but if one adopts then it will be beneficial for the other to adopt
as well because it lowers their relative costs.

Competition effects are related to another idea that vested interests can block
technological adoption. Technological change usually creates both winners and losers. If the
losers are politically powerful then they may lobby for a ban on the technology (Mokyr, 1991).
Their success is likely to vary across political regimes. One possibility is that democratic
political systems better enable the winners to buy off the losers. Another possibility is that
political actors are less likely to seek support or be captured by vested interests when the political
system is stable (North, Wallis, and Weingast, 2005).
Several of the ideas in technology diffusion are related to hypotheses about turnpike diffusion. Before describing the specific hypotheses, I first develop a model of turnpike adoption, which illuminates the process. Suppose there are \( n \) groups in the economy and each of these groups can petition Parliament to establish a turnpike trust along their local road. In the first stage, all groups decide whether to petition for a turnpike trust. Their strategy is defined by \( a_i \), which equals 1 if they decide to petition and 0 otherwise. In the second stage, Parliament considers all turnpike petitions. With probability \( p_i \), Parliament rejects the petition for group \( i \) and with probability \( 1 - p_i \), Parliament accepts their petition. The outcome of Parliament’s decision is defined by \( d_i \), which equals 1 if they reject group \( i \)'s petition, and 0 otherwise.

Figure 3 illustrates the payoffs for different outcomes. If group \( i \) petitions in the first stage, and their petition is accepted by Parliament, then they receive the payoff \( b_i'(a_{-i}, d_{-i}) - c \). The parameter \( c \) is a lobbying cost and is constant across all groups. \( b_i' \) is group \( i \)'s monetary benefit when they have turnpike trusts along their local road. It is a function of \( a_{-i} \) and \( d_{-i} \), which are the vector of petition strategies and Parliament’s rejection decisions for groups other than \( i \). If group \( i \) petitions in the first stage, but their petition is rejected by Parliament, then they receive the payoff \( b_i^p(a_{-i}, d_{-i}) - c \). \( b_i^p \) is group \( i \)'s monetary benefit when they have parishes managing their local road, while \( a_{-i} \) and \( d_{-i} \) are defined as before. Finally, if group \( i \) does not petition in the first stage, then they receive \( b_i^p(a_{-i}, d_{-i}) \) and avoid the lobbying cost \( c \).

In stage 1, each group takes the petition strategies for other groups as given, and decides whether to petition for a turnpike trust along their road. If group \( i \) submits a petition, then their expected payoff is \( E_d[b_i'(a_{-i}, d_{-i}), b_i'(a_{-i}, d_{-i}) | a_i = 1] - c \), where \( E_d[., | a_i = 1] \) signifies their
expectation over Parliament’s rejection decisions if they petition. If group $i$ does not petition, then their expected payoff is $E_d[b_i^n(a_i, d_i)|a_i = 0]$, where $E_d[a_i = 0]$ is defined analogously.

Consider the two group case as an example. The expected payoff for group 1, when both groups submit a petition, is given by expression (1):

$$p_1p_2b_i^n(1) + p_i(1 - p_2)b_i^n(0) + (1 - p_1)p_2b_i^p(1) + (1 - p_1)(1 - p_2)b_i^p(0) - c . \quad (1)$$

$b_i^n(1)$ is group 1’s benefit under the parish system when Parliament rejects group 2’s petition, and $b_i^n(0)$ is group 1’s benefit under parishes when Parliament accepts group 2’s petition.

$b_i^p(1)$ and $b_i^p(0)$ are group 1’s benefit under turnpikes and are defined analogously. The expected payoff for group 1 when it does not petition, and group 2 does petition, is given by $p_2b_i^n(1) + (1 - p_2)b_i^n(0)$. Therefore, conditional on group 2’s decision to petition for a turnpike trust, group 1 will petition whenever inequality (2) holds:

$$[p_1p_2 - p_i]b_i^n(1) + [p_i(1 - p_2) - (1 - p_2)]b_i^n(0) + (1 - p_1)p_2b_i^p(1) + (1 - p_1)(1 - p_2)b_i^p(0) \geq c . \quad (2)$$

The model illustrates that a number factors influenced the diffusion of turnpike trusts. First, it shows that Parliament could inhibit the diffusion of turnpike trusts by rejecting petitions. In the two group case, if Parliament never rejects (i.e. $p_i = 0$ for all $i$), then conditional on group 2’s petition choice, group 1 will petition if $b_i^p > b_i^n + c$. That is, whenever the monetary benefits of turnpike trusts are greater than the benefits under parishes plus the lobbying cost. However, if groups expect that Parliament may reject their petition, then some turnpike trusts will not be proposed, because the expected net benefits may not exceed the lobbying cost $c$.

The model assumes that Parliament rejected turnpike petitions at random, but in reality, Parliament chose to reject petitions. I model Parliament’s decision-making process in this manner because there are some factors which affected failure, but were exogenous to the
characteristics of individual turnpike trusts. For instance, the political instability of the seventeenth century was not directly related to turnpike trusts, yet it may have caused Parliament to take a negative attitude towards petitions. Throughout the seventeenth century, the Crown was trying to bypass Parliament and develop new sources of taxation, often through the sale of monopolies. Parliament could have feared that turnpike trusts were similar to a monopoly grant, and would provide a new source of tax revenue for the Crown. Therefore, Parliament might have rejected more turnpike petitions when political tensions were heightened.

Another possibility is that Parliament rejected petitions because they sided with local groups who opposed turnpike trusts. Local road-users were concerned that excess toll revenues would be captured by trustees, toll collectors, or turnpike bondholders. Another fear was that turnpike trusts would divert trade away from established cities. Lastly, there was a concern that turnpike trusts would reduce rents for landowners near cities, because they increased agricultural imports from outlying areas. All of these concerns would have been pertinent to Parliament because they threatened the livelihood of powerful constituents. If these constituents could be bought off, then turnpike petitions would have a better chance of passing. If not, then Parliament might have rejected turnpike petitions in order to maintain the status quo.

The model also illustrates how demand and supply factors entered into the adoption process. Whenever the economy experienced growth, road traffic increased and the demand for road improvements rose. Because turnpike trusts could levy tolls, they were better equipped to meet this demand than parishes. Therefore, all else equal, an increase in economic growth would raise $b^t_i$ relative to $b^p_i$. Changes in interest rates also affected the relative benefits by altering the cost of improving roads. Turnpike trusts had the authority to issue bonds, whereas parishes could not. As a result, whenever interest rates declined, $b^t_i$ increased relative to $b^p_i$. 
The model also highlights how neighbor effects could lead to the clustering of adoption. For some groups the relative benefits of turnpike trusts increased when nearby groups also had turnpike trusts. One reason is that neighboring groups resided along roads that were connected to their road. This situation would give rise to a network effect, in which a group’s benefit from improving its own road increased when the connecting roads were also improved. Uncertainties about the benefits of turnpike trusts are another reason why neighboring adoption decisions mattered. Groups learned about the benefits of turnpike trusts by observing a ‘demonstration’ of its effects in the local area. Lastly, competition between groups may have led to a clustering of adoption. For instance, the adoption of a turnpike trust near a city could encourage firms to locate in this city. This might raise the returns to adoption for neighboring cities, because turnpike trusts could redress the competitive imbalance.

Many of the preceding hypotheses have been analyzed in the literature on turnpike trusts. William Albert (1972) and Eric Pawson (1977) emphasized the role of economic growth in stimulating the turnpike boom of the 1750s and 1760s. T.H. Ashton (1959) and William Albert (1972) debated whether lower interest rates contributed to the adoption of turnpike trusts. The role of political instability has not been analyzed, but Douglass North and Barry Weingast (1989) made a related argument when they suggested that the Glorious Revolution of 1689 increased the security of property rights by ending the constitutional struggle between Crown and Parliament. William Albert (1972, 1979) and Eric Pawson (1977) disagreed about whether opposition groups hindered the passage of turnpike petitions before 1750. Finally, William Albert (1972) claimed that early trusts provided a stimulus for further adoption because they demonstrated the benefits of using tolls, and because they created a competitive imbalance between cities.
In the following sections, I build on this existing literature and use new data to determine whether political instability and opposition from vested interests inhibited the adoption of turnpike trusts, and whether neighbor effects also influenced their diffusion. I test each of these hypotheses against the alternative view that the adoption process reflected changes in the demand for road transport services, or a decline in the cost of improving roads. The results reveal that political instability, opposition efforts, and neighbor effects all had an impact.

4. The Role of Politics and Vested Interests

The slow initial adoption of turnpike trusts is one of the defining features of the diffusion process. In this section, I show that the failure of turnpike petitions contributed to the slow initial adoption. I also provide evidence that the elimination of political instability and efforts to overcome opposition from vested interests removed an impediment to turnpike adoption.

Turnpike trusts were novel organizations in many respects, but the idea of using tolls to finance road improvements was well known by the early seventeenth century. As evidence, there was a petition submitted to Parliament in 1609, which requested the right to levy tolls along one of the major London highways. Little else is known about the petition, other than it failed in the legislative process. A similar petition was introduced in 1623 by the parishes of Biggleswade, Edworth, and Astwick in Bedfordshire. It proposed that the Lord Chancellor and the Lord Treasurer be authorized to levy tolls and supervise improvements along the major London highway leading through the three parishes. Like its predecessor, this petition did not become an Act (Emmison, 1934). The next turnpike petition was introduced in 1662. It proposed to levy tolls along the Dunstable-Hockliffe section of Watling Street, which was the main highway connecting London with Manchester, Chester, Derby, and Shrewsbury. Like the
previous two petitions, it was also unsuccessful in becoming an Act. The first successful turnpike petition was introduced in 1663. It applied to a short section of the Great North Road in Hertfordshire, Cambridgeshire and Huntingdonshire. The tenure of this trust proved to be limited, however, because the tolls were discontinued in the 1670s and 1680s (Albert, 1972).

There were no other turnpike petitions introduced for the rest of the 1660s, and throughout the 1670s, and 1680s. After 1690, this trend was reversed as fewer turnpike petitions failed and more were introduced. Table 1 illustrates this fact by combining Julian Hoppit’s (1997) database of failed legislative petitions with Albert and Pawson’s database of turnpike Acts. It lists the number of failed and successful petitions in each decade from 1690 to 1770, along with the failure rate. The total number of petitions increased dramatically from 8 in the 1690s to 53 by the 1720s and 184 by the 1750s. The failure rate for turnpike petitions also declined from 37% in the 1690s, to 13.2% in the 1720s and 7.6% in the 1750s.

The failure of a turnpike petition usually resulted in a delay, rather than an absence of adoption. Supporters could always reintroduce their petition at a later legislative session, and in over 90% of the cases their reapplication was successful in becoming an Act. In spite of the high success rate for reapplications, there were often long delays between the first failed petition and the successful petition. Among the 37 petitions that failed between 1690 and 1750, the average time lapse between the first year when a petition was introduced and the year when a later petition became an Act was 12.5 years. Before 1720, it often took longer for the second petition to be successful. For instance, among the 15 failed petitions between 1662 and 1720, it took an average of 17.7 years before a successful Act was passed. One example of a long delay involved the Dunstable-Hockliffe section of the Watling Street Highway, where a turnpike Act was passed in 1710, nearly 48 years after the first petition was introduced in 1662.

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5 The Dunstable-Hockliffe petition can be found in the *Journals of the House of Commons*, vol. 8, 24 April, 1662.
The preceding evidence suggests that the failure of petitions inhibited the adoption of turnpike trusts. It may have also discouraged some local groups from submitting turnpike petitions in the first place. These arguments can be further supported by a regression analysis which tests the relationship between the number of new turnpike Acts passed each year and the annual failure percentage for all legislative petitions, excluding turnpike petitions.\(^6\) The annual failure percentage for all legislative petitions, excluding turnpike petitions, measures the extent to which Members of Parliament agreed on other types of legislative proposals. It is also correlated with the annual failure rate for turnpike petitions between 1660 and 1800 (\(\rho = 0.8\)).

Figure 4 plots the legislative failure percentage, excluding turnpike petitions, as well as the number of new turnpike Acts passed each year between 1660 and 1800. The failure percentage for all legislative petitions was over 60% during the 1660s, 1670s, and 1680s. After 1690, it declined and fell below 40% during the 1710s and 30% during the 1720s. After a brief rise during the 1730s, the legislative failure percentage continued to decline and reached a low point of 20% during the 1750s and 1760s.\(^7\) An inspection of Figure 4 suggests that more turnpike Acts were passed when the failure percentage for all legislation, excluding turnpike petitions, was low. The regressions in Table 2 use annual data between 1700 and 1800 to test whether such a relationship exists. The first column presents estimates from a Poisson regression of the number of new turnpike trust Acts passed in year \(t\) on the failure percentage of all legislative petitions, excluding turnpike petitions, in year \(t\). The estimates reveal that there is indeed a negative correlation between the annual failure percentage of legislative petitions and the passage of new Turnpike Acts. The second column measures this same relationship after including the stock of turnpike trusts in year \(t\) and the square of the stock in year \(t\). This

\(^6\) See Albert (1972) for all Acts and Hoppit (1997) for the data on legislative failure percentages.

\(^7\) For an overview of the trends in failure rates and their causes see Hoppit and Innis (1997).
specification incorporates a variety of models that predict an S-shape diffusion curve. Not surprisingly, the estimates show that the time series pattern is indeed consistent with an S-shape diffusion process. More importantly, they show that the failure percentage for legislative petitions continues to be negatively correlated with new turnpike Acts. The estimates in the third column are based on a specification that also includes interest rates in year $t-1$, as well as the annual growth rate of industrial production in year $t-1$. Lagged interest rates should influence the decision to promote a turnpike trust in the current year because they changed borrowing costs. A higher lagged growth rate of industrial production should also affect the promotion decision in the current year because it increased economic activity, and hence traffic. As expected, the estimates show that the coefficient on the lagged growth rate is positive and significant, while the coefficient on lagged interest rates is also negative and significant. Even more notable, the results continue to show that the coefficient on the legislative failure percentage is negative and large in magnitude. A one standard deviation decrease in the failure percentage of 8.84 leads to a 1.48 increase in turnpike Acts, or 25% of the annual average.

Figure 5 provides another illustration of the impact of legislative failure percentages. It compares the actual diffusion curve for turnpike trusts between 1702 and 1800, with a predicted diffusion curve using the Poisson estimates from the third column in Table 2 and data on the failure percentages, lagged industrial growth rates, and lagged interest rates between 1702 and 1800. The predicted diffusion curve and the actual diffusion curve are very similar. Figure 5 also plots a predicted diffusion curve using the same Poisson estimates, but with one key difference. It assumes that the failure percentage for all legislative petitions remained constant at 20%, which was the average during the 1750s and 1760s. In this case, the predicted diffusion

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curve is strikingly different, showing that the adoption of turnpike trusts would have proceeded more quickly. The estimates imply that the 1800 adoption level would have been reached in 1774, had the failure percentage for legislative petitions been 20%, rather than its actual value.

The regression results show that high legislative failure rates in the early eighteenth century slowed the initial diffusion of turnpike trusts. Political instability was one of the key factors that led to high legislative failure rates. Between 1660 and 1689, King Charles II and King James II were in a dispute with Parliament. They had to request taxes from Parliament in order to finance military expenditures and their own consumption. Charles II wanted to end this system by eliminating Parliament and developing independent sources of revenue. Turnpike trusts provided a potential source of tax revenue because they were granted a monopoly right to levy tolls on road-users. The trends in Figure 4 suggest that during times of heightened political instability, Parliament may have rejected or discouraged turnpike petitions because they feared that trusts would become an ally of the King and would help to undermine their political power. The data also suggests that the Glorious Revolution of 1689 marked a turning point. Parliament agreed to grant the new king, William of Orange, sufficient tax revenues if he consented to Parliament’s authority over public finances. This agreement resulted in an immediate decline in legislative failure rates during the 1690s. Legislative failure rates continued to decline in the 1700s and 1710s as Parliament entered into similar agreements with Queen Anne and King George I. An unintended consequence of the new political regime was that turnpike trusts were less likely to become a revenue source for the Crown, and thus, they ceased to be a political threat to Parliament.

Opposition from vested interests was another factor that impeded the passage of Turnpike Acts in Parliament. One way of measuring opposition is through ‘counter-petitions’ submitted
against turnpike petitions. Counter-petitions offered a variety of reasons why turnpike petitions should be dismissed. One type of complaint was that the tolls were unnecessary and injurious to road-users. This concern was voiced in a counter-petition to a proposed turnpike trust along the road between Sevenoaks and Tunbridge in Kent. The anonymous author claimed that the parishes managing the Sevenoaks and Tunbridge road were wealthy and did not need the aid of the tolls. They also argued that the tolls would be especially burdensome to cattle breeders, who used this road to bring their livestock to London markets.9

Another complaint in counter-petitions was that turnpike trusts would be ‘prejudicial’ to the trading interests of a particular city. This was the argument put forth by the inhabitants of Buckingham, when they submitted a counter-petition against the Bicester and Aylesbury turnpike petition in 1712.10 Not coincidentally, the city of Buckingham was also promoting a turnpike petition along the road from Buckingham to Aylesbury during this same year. Both the Bicester to Aylesbury and the Buckingham to Aylesbury petitions were contentious because they applied to major thoroughfares between the West Midlands and London. Presumably, if Buckingham was able to prevent Bicester from getting a turnpike trust along its road to Aylesbury, then it could help this city become the leading trade center of the area. The city of Newcastle-under-Lyme offered a similar objection in 1763 to a proposed turnpike trust along the road between Lawton and Stoke-upon-Trent in Staffordshire. The main issue here was that the proposed turnpike road bypassed Newcastle-under-Lyme. The loss of through traffic was potentially prejudicial to Newcastle because it was a leading trade center on the London-Carlisle road. Moreover, many of the city leaders in Newcastle served as trustees for the turnpike

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9 The document stating the reasons against the Sevenoaks and Tunbridge turnpike can be found at the Hampshire Record Office, 44m69/G2/342.
10 The counter-petition of Buckingham can be found in the Journals of the House of Commons, 1712.
between Lawton and Tittensor, which passed through Newcastle and provided an alternative route for travelers to London (Thomas, 1934).

Counter-petitions confirm that there was opposition to turnpike trusts, but it remains unclear whether opposition inhibited the passage of many turnpike petitions. Eric Pawson (1977) found that only 15% of all turnpike petitions before 1750 were subject to a counter-petition, and that as little as 5% were subject to a counter-petition between 1750 and 1770.\(^\text{11}\) Pawson’s figures suggest that formal opposition was absent in most cases, but they do not imply that counter-petitions were ineffective. In three of the four examples discussed early, counter-petitions appear to have delayed turnpike adoption by at least 8 years. For instance, the Sevenoaks to Tunbridge turnpike petition failed in 1699 around the same time that a counter-petition claimed that it would place an undue burden on cattle breeders. Their opposition was overcome in 1709, when a turnpike Act was passed for the Sevenoaks to Tunbridge road. The Bicester to Aylesbury turnpike petition failed in 1712, during the same year that the city of Buckingham introduced a counter-petition claiming that it would prejudice its trading interests. Buckingham’s opposition was quite successful because a turnpike trust was not established along the Bicester to Aylesbury road until 1770, 58 years after the first petition was introduced. The Buckingham to Alyesbury turnpike petition also failed in 1712, perhaps because the city of Bicester felt that this turnpike trust would prejudice its trading interests as well. In this case, Buckingham eventually won out, and got its turnpike Act passed in 1720. The opposition of Newcastle-under-Lyme was not successful because the Lawton to Stoke-upon-Trent Turnpike Act was passed during the same year that their counter-petition was introduced. According to one historian, its successful passage was due in large part to the lobbying efforts of pottery manufacturers, like Josiah Wedgewood, whose factories were near the road (Thomas, 1934).
Overall, the evidence suggests that opposition existed, but that it was eventually overcome, especially by the mid-eighteenth century. It is beyond the scope of this paper to explain how opposition was neutralized, but one conjecture is that Parliament compensated the losers from turnpike trusts by granting exemptions through the maximum toll schedules defined in each Act. For instance, the Luton turnpike Act of 1744 included a provision that no tolls could be collected on grain shipped to St. Albans or Bedford on their market days. This provision was clearly designed to benefit local farmers and merchants, and may have been included to overcome their opposition. However Parliament managed to compensate the losers, its ability to assuage opposition groups was fairly unique, and may be one reason why England was a leader in technological and institutional innovations.

5. Neighbor Effects and the Diffusion of Turnpike Trusts

Aside from the slow initial adoption phase, the turnpike diffusion process was also notable for having periods of rapid adoption. The most famous was the turnpike boom of the 1750s and 1760s, in which 300 turnpike trusts were established along 10,000 miles of road. In this section, I show that neighbor effects contributed to rapid adoption in close geographic areas. I provide evidence that a city was more likely to have a turnpike trust adopted along its road to London, if neighboring cities also adopted. Using panel and instrumental variables methods, I interpret this result as evidence of demonstration effects, network effects, or competition effects.

I focus my analysis on the London road network because it was the main trade route between London and major provincial cities, as well as between cities and their hinterland. Using data on the London road network (see figure 2), I identify the first year when each major

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city with a population over 2500 in 1700 had a turnpike trust established along its portion of the London network. Figure 6 shows the ‘survival curve’ for the 67 major cities, where survival means that a city does not have a turnpike trust established along any portion of the London road network that directly connects with the city. The 1720s, 1740s, and 1750s stand out as the three main periods where turnpike trusts were most likely to be established near major cities. The key question is whether adoption was clustered during these decades because of shared characteristics among neighboring cities or because of neighbor effects. I test these hypotheses by estimating a random effects probit model, where the dependent variable is an indicator for whether city at year had a turnpike trust established along its portion of the London network. The explanatory variables include time-invariant city characteristics, dummy variables for each year , and the fraction of neighboring cities that have turnpike trusts along their London route in year . The city characteristics include its distance to London, a dummy variable equal to 1 if the city had water transport to London, a dummy variable equal to 1 if the city had a population above 5000 in 1700, and finally the number of weekly coach and wagon services between the city and London in 1705.

12 17 George II c.42
13 To given an example, the London-York-Scarborough route followed the Great North Road until Doncaster, at which point it went to Tadcaster, then to York, and then to Scarborough. In 1745, a turnpike trust was established between York and Tadcaster, while in 1752 a turnpike trust was established between York and Scarborough. In this case, York is coded as having a turnpike trust along its portion of the London network beginning in 1745, while Scarborough is coded as having its first turnpike in 1752. If the Tadcaster to York turnpike trust was created after 1752, then both cities would be coded as having their first turnpike in 1752, when the York to Scarborough turnpike was created.
14 The data on city characteristics are taken from a variety of sources. Distances to London are provided in the travel guide Britannia. Cities are defined as having water transport if they were located on the coast, or if they were located next to a navigable river which linked them to London (Stevens, n.d.). The population figures come from Corfield (1983). The number of weekly coach and wagon services are drawn from the London travel directory, the Traveller’s and Chapman’s Daily Instructor. Travel directories were designed for travelers and merchants, who wanted to know when coach and wagon services were available to particular cities. They have been used in a number of studies as a source for the volume of transport services between London and major cities (Chartres and Turnbull, 1983; Gerhold, 1988; Bogart, forthcoming).
The set of neighboring cities is defined as all major cities that lied on the same route to London. For example, Plymouth, Exeter, and Salisbury were neighboring cities because they all had a population above 2500 in 1700 and the travel guide Britannia identified all three cities as being on the same road to London. Plymouth was the furthest city from London and it had a turnpike on its portion of the London road beginning in 1757. Exeter was the second city on the route and it had a turnpike on its portion in 1753, while Salisbury had the same in 1755. In the case of Plymouth, the fraction of neighboring cities that adopted turnpike trusts would be 0 for all years up to 1752, 0.5 in 1753 and 1754, and 1.0 in 1755 and beyond. I also use two other variables as an alternative to the fraction of neighboring cities that adopted turnpike trusts in year \( t \). The first is the weighted fraction of neighboring cities that adopted turnpike trusts in year \( t \). This variable is calculated in the same way as before, except that it weighs the adoption of neighbors by their distance. The second alternative is the fraction of adjacent cities that adopted turnpike trusts in year \( t \). This variable focuses only on those neighbors that are next to a city. In this case of Plymouth, its adjacent city would be Exeter, and so the fraction of adjacent cities that adopted turnpike trusts is 0 for all years up to 1752, and 1 in 1753 and beyond. Exeter’s fraction of adjacent cities with turnpike trusts would be different because it had two adjacent cities, Plymouth and Salisbury.

Table 3 provides estimates for the three specifications using a random effects probit model. The estimates are similar across all three specifications. They show that distance to London and access to water transport are negatively correlated with city turnpike adoption, while

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15 The appendix provides a complete description of all 22 routes, along with references in Britannia.

16 For example, the distance between Plymouth and Exeter is 35 miles, while the distance between Plymouth and Salisbury is 103 miles. Therefore, for Plymouth, the weighted fraction of neighboring cities that adopted turnpike trusts would be 0 for all years up to 1752, 0.746 in 1753 and 1754, and 1.0 in 1755 and beyond. The higher value in 1753 and 1754 reflects the fact that Plymouth had turnpike trusts adopted near a close neighbor in 1753, and a far away neighbor in 1755.
the number of weekly coach services to London is positively correlated with city turnpike adoption. More significantly, the estimates reveal that neighboring city turnpike adoption was positively correlated with city turnpike adoption. To illustrate the magnitude of the coefficient, Figure 7 plots a 95% confidence interval for the increased probability of city turnpike adoption when half of all neighboring cities adopted during various years. The estimates are based on the coefficients from the second column in table 3 and use the average value for city characteristics. The figure shows that neighboring city adoption had little effect early and late in the eighteenth century because the likelihood of adopting turnpike trusts was very low in these periods. In between, however, neighboring turnpike adoption could have a significant impact. For example, in 1740 the probability of city turnpike adoption increases by 38% if half of its neighboring cities adopted turnpike trusts in 1740. A similar calculation shows that the probability of city turnpike adoption increases by 85% if all neighboring cities adopted turnpike trusts in 1740.

Panel data techniques provide one way to identify the effects of neighboring city adoption. An alternative approach is to use two-stage least squares, where the characteristics of neighboring cities are used as instruments for the adoption of turnpike trusts in neighboring cities. This methodology was originally proposed by Manski (1993), and has been applied in the network externalities literature (Gowriskankaran and Stavins, 2004). To develop the approach, I begin by positing a linear probability model of city turnpike adoption along the London road network. I define a variable that equals 1 if a major city had a turnpike trust adopted along its London route in any year between 1695 and 1750, and 0 otherwise. The dummy variable for city turnpike adoption is assumed to equal a linear function of the city characteristics used above and the fraction of neighboring cities that had turnpike trusts adopted along their London route between 1695 and 1750. It was necessary to analyze turnpike adoption between 1695 and some
end date because I do not have time-varying data on city characteristics. I chose 1750 because it marked the beginning of the turnpike boom.

The coefficient of main interest is the fraction of neighboring cities that had turnpike trusts adopted between 1695 and 1750. In principle, it measures the increased probability that a city will have a turnpike trust adopted along its London route when all of its neighbors also have turnpikes adopted. OLS may not yield consistent estimates of this coefficient, because neighboring city turnpike adoption is endogenous. In particular, it is possible that there are unobserved factors that are correlated with turnpike adoption across groups of cities. A solution is to find instruments that are correlated with the fraction of neighboring cities that had turnpike trusts adopted before 1750, but are unrelated with the unobserved factors affecting city turnpike adoption. I propose to use the average distance between neighboring cities and London, the fraction of neighboring cities that had water transport to London, the fraction of neighboring cities with a population above 5000 in 1700, and the average number of weekly coach and wagon services between neighboring cities and London. The average distance and the average number of neighboring cities with water transport to London are exogenous and should be unrelated with the unobserved factors affecting city turnpike adoption. The fraction of neighboring cities with a population above 5000 and the average number of weekly coach and wagon services between neighboring cities and London are not exogenous, but they likely to be unrelated to the unobserved factors. Consider the example of Plymouth and Exeter. If Exeter had a large number of weekly coach services to London, then there would have been a greater value in adopting turnpikes near Exeter’s London route. At the same time, the number of weekly coach services to Exeter is unlikely to be associated with any unobservable factors that would have affected the value of adopting turnpikes near Plymouth.
Table 4 lists OLS and IV estimates for various specifications. The first two columns use the fraction of neighboring cities that have turnpike trusts adopted before 1750. The third and fourth columns use the weighted fraction of neighboring cities that have turnpike trusts adopted before 1750. The fifth and sixth columns use the fraction of adjacent cities that have turnpike trusts adopted before 1750. The instruments for the weighted fraction of neighboring cities are also weighted by the distance to neighbor cities. Similarly, the instruments for the fraction of adjacent cities are restricted to the characteristics of adjacent cities. Across all specifications, the OLS estimates show that the adoption of turnpike trusts near neighboring cities significantly increased the likelihood of city turnpike adoption. In particular, if half of a city’s neighbors adopted turnpike trusts, then it would be 28% more likely to have a turnpike trust adopted along its portion of the London network. If half of its closest neighbors adopted, then it would be 30% more likely to adopt turnpike trusts. The OLS estimates also reveal that other factors mattered as well. For instance, if a city had a one standard deviation increase in weekly coach services then it would be approximately 12% more likely to have turnpike trusts adopted. If the city had water transport to London then it would be around 20% less likely to have turnpike trusts.

The IV estimates yield similar conclusions. They show that if half of a city’s neighbors adopted turnpike trusts, then it would be 23% more likely to have a turnpike trust adopted along its portion of the London network. Once again the impact would be even greater if close neighbors adopted turnpike trusts. The only case where IV changes the results is the coefficient for the fraction of adjacent cities that adopted turnpikes. The coefficient falls from 0.51 to 0.372, and is not statistically significant at the 90% level. Aside from this difference, the IV approach

17 Interpreting the magnitudes may be misleading because the estimates come from a linear probability model. That being said, the coefficients are very similar to marginal effects estimates from a standard probit model.
reinforces the earlier conclusion that the adoption of turnpike trusts near neighboring cities raised the probability of city turnpike adoption.

I interpret these results as support for the argument that demonstration effects, network effects, or competition effects influenced the diffusion of turnpike trusts. Demonstration effects capture the notion that local landowners and merchants learned about the benefits of turnpike trusts by observing their effects in neighboring locations. Network effects reflect the increased benefits from creating turnpike trusts along connecting segments of the transport network. Competition effects reflect the need to redress any losses in comparative advantage when turnpike trusts are adopted in neighboring areas. My empirical approach cannot distinguish between the three neighbor effects, and therefore, I can only conclude that at least one was present. It is also worth emphasizing that the regression results do not dismiss the importance of economic growth as a contributing factor to turnpike adoption. For instance, cities with more coach services to London had a higher probability of turnpike adoption before 1750. This finding implies that as the economy developed and coach traffic increased, more turnpike trusts would have been adopted. Therefore, the results support the view that a combination of neighborhood effects and economic growth influenced the diffusion process.

A final example further illustrates this last point. In 1740, the northern region, known as the West Riding of Yorkshire, had one turnpike trust managing 13 miles of road. In 1741, 6 turnpike trusts were established along 239 miles linking cities like Doncaster and Wakefield, Wakefield and Pontefract, Leeds and Elland, Doncaster and Boroughbridge, Doncaster and Saltersbrook, as well as Leeds and Selby (Pawson, 1977). The clustering of adoption in the West Riding was connected to the expansion of its main industry, woolen textile manufacturing. Between 1730 and 1735, the average annual growth rate for woolen textile production in the
West Riding was zero. It increased to 5.75% between 1735 and 1740, and was 4.04% between 1740 and 1745 (Mitchell, 1971). There is also evidence that the clustering of adoption was related to network effects, as several cities were linked with one another in 1741. Competition effects also played a role in the adoption of turnpike trusts near Leeds and Wakefield. These two cities were the main marketing centers for woolen textiles in the West Riding. They had an advantage in the region because they were located on the Aire and Calder rivers, which linked the region to the eastern coast (Wilson, 1971). In 1741, Leeds improved its transport links to the east by promoting the Leeds to Selby turnpike trust. Wakefield did the same in 1741 by promoting the Wakefield to Pontefract turnpike trust. Their simultaneous decision to promote parallel turnpike roads to the eastern coast suggests that each city wanted a turnpike trust in order to maintain their competitive advantage vis-à-vis the other.

6. Conclusion

The turnpike diffusion process had two defining characteristics. One was the prolonged length of the initial adoption phase, lasting from 1663 to 1750. The second was the geographic clustering of adoption, especially during the turnpike boom of the 1750s and 1760s. My results show that the failure of turnpike petitions in Parliament contributed to the slow initial adoption. I also provide evidence that the elimination of political instability after the Glorious Revolution and the ability to overcome opposition from vested interests removed an impediment to the adoption of turnpike trusts. My results also reveal that turnpike trusts were more likely to be adopted near cities, if turnpike trusts were also adopted near neighboring cities. I interpret this result as evidence of demonstration effects, in which groups learned about the benefits of turnpike trusts through their neighbors, as well as network effects, in which the benefits from
turnpike trusts increased when connecting road segments were also improved by turnpike trusts, or lastly competition effects, in which cities tried to maintain their comparative advantage by adopting turnpike trusts. Overall, the results reveal that turnpike trusts were not necessarily adopted when demand and supply factors warranted. Their adoption required a stable political system with an ability to implement controversial legislation. Moreover, turnpike adoption in particular areas was contingent upon the adoption decisions in neighboring locations.

The findings offer some general insights on the diffusion of institutional innovations. First, the results suggest that when the political system is unstable, institutional innovations may be blocked because of uncertainty about how new rules and organizations will influence the balance of power. In this case, turnpike trusts influenced power by providing potential tax revenue for Crown. More generally, organizations can offer support to an emerging political regime in return for some privilege. If opponents of the political regime expect that such a deal will be brokered, then they will try to prevent the emergence of the new organization, even though it may offer benefits to the larger society.

Second, the findings highlight the role of vested interests. Scholars have long recognized that vested interests can block technological innovations, but their role has received less attention in the case of institutional innovations. As with technologies, some societies are successful in overcoming opposition to new institutions because they compensate vested interests or because they use force against them. The political system of eighteenth century Britain was particularly adept in using both measures. It granted concessions to certain groups in return for their support, but it also used its military strength to put down riots against unpopular legislation (Albert, 1979). Future research may reveal why eighteenth century Britain was able
to overcome opposition from vested interests, and implement technological and institutional innovations, while other societies could not.

Third, the results show that demonstration effects, network effects, and competition effects influence institutional innovation in a similar manner as technological innovation. Groups learn about the benefits of new rules and organizations from their neighbors, just as individuals and firms learn about the benefits of new technologies from their neighbors. Groups are also likely to adopt a new rule or organization when others adopt the same institution. This is analogous to technologies where the propensity for firms to adopt grows when there are large numbers of aggregate users. Lastly, the findings suggest that groups may collude and delay their adoption of institutional innovations, because of tacit agreements to preserve the status quo.

Appendix: Data Sources for the London road network

Table 5 lists the 22 London routes, along with the major cities on each route. Each route can be identified in Figure 2. There are two types of routes. The first is a major highway that linked London to several major cities. For instance, route 9 connected London with Colchester, Ipswich, and Yarmouth. Another example of the first type is route 12, or the Great North Road, which linked London with Newcastle, Berwick, Durham, Sunderland, and South Shields. The second type was a branch highway that linked with a major highway. For instance, route 14 was a branch highway that connected Whitby, Scarborough, and York to the Great North road. It was classified as being separate from the Great North Road because of its length and the distance to other branches. Another example of a branch highway is route 18, which linked Whitehaven, Carlisle, Kendal, Lancaster, Liverpool, and Macclesfield with route 22, which was the major highway between Chester and London.
References


Stevens, Mike. Waterways of England and Wales: Their History in Maps, http://www.mikestevens.co.uk/maps/


<table>
<thead>
<tr>
<th>Decade</th>
<th>Total Petitions</th>
<th>Failed Turnpike Petitions</th>
<th>Successful Turnpike Petitions</th>
<th>Failure Rate for Turnpike Petitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1690-99</td>
<td>8</td>
<td>3</td>
<td>5</td>
<td>37.5%</td>
</tr>
<tr>
<td>1700-09</td>
<td>15</td>
<td>5</td>
<td>10</td>
<td>33.3%</td>
</tr>
<tr>
<td>1710-19</td>
<td>29</td>
<td>7</td>
<td>22</td>
<td>24.1%</td>
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<td>1720-29</td>
<td>53</td>
<td>7</td>
<td>46</td>
<td>13.2%</td>
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<td>19</td>
<td>170</td>
<td>10.0%</td>
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Notes: Successful turnpike petitions are petitions that became Acts in the same legislative session that they were introduced.
### Table 2: The Diffusion of Turnpike Trusts and the Failure Percentage of Legislative Petitions: Poisson Regression Estimates

<table>
<thead>
<tr>
<th>Variable</th>
<th>(Poisson) Coefficient</th>
<th>(Poisson) Coefficient</th>
<th>(Poisson) Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Stand. Error)</td>
<td>(Stand. Error)</td>
<td>(Stand. Error)</td>
</tr>
<tr>
<td>Failure Percentage for all Legislative Petitions, excluding turnpike petitions, year t</td>
<td>-.0882303 (.0051991)*</td>
<td>-0.0450755 (.007195)*</td>
<td>-.0443886 (.0072384)*</td>
</tr>
<tr>
<td>Stock of Turnpike Trusts, year t</td>
<td>—</td>
<td>0.0093941 (.001194)*</td>
<td>.0081075 (.001289)*</td>
</tr>
<tr>
<td>Square of the Stock of Turnpike Trusts, year t</td>
<td>—</td>
<td>-0.0000137 (1.73e-06)*</td>
<td>-.0000116 (1.89e-06)*</td>
</tr>
<tr>
<td>Growth rate of industrial Production, year t-1</td>
<td>—</td>
<td>—</td>
<td>2.286584 (1.106587)*</td>
</tr>
<tr>
<td>Interest rate, year t-1</td>
<td>—</td>
<td>—</td>
<td>-.1464849 (.0499369)*</td>
</tr>
<tr>
<td>Intercept</td>
<td>4.208526 (.1286985)*</td>
<td>2.125605 (.2991476)*</td>
<td>2.758799 (.3719648)*</td>
</tr>
<tr>
<td>N</td>
<td>99</td>
<td>99</td>
<td>99</td>
</tr>
<tr>
<td>Pseudo R²</td>
<td>0.3033</td>
<td>0.3700</td>
<td>0.3824</td>
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</table>

Table 3: The Effect of Neighboring City Turnpike Adoption on the Probability of City Turnpike Adoption along the London Road Network: Random Effects Probit Estimates

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1) Coefficient (Standard Error)</th>
<th>(2) Coefficient (Standard Error)</th>
<th>(3) Coefficient (Standard Error)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fraction of Neighboring Cities that Adopt Turnpikes in year t</td>
<td><strong>3.022527 (.1329596)</strong>*</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Weighted Fraction of Neighboring Cities that Adopt Turnpikes in year t</td>
<td>—</td>
<td><strong>2.941239 (.1288492)</strong>*</td>
<td>—</td>
</tr>
<tr>
<td>Fraction of Adjacent Cities that Adopt Turnpike in year t</td>
<td>—</td>
<td>—</td>
<td><strong>2.581809 (.1141836)</strong>*</td>
</tr>
<tr>
<td>Dummy for City Population Above 5000 in 1700</td>
<td>-0.03236 (.1200542)</td>
<td>-0.0970073 (.120453)</td>
<td>0.0509321 (.1234817)</td>
</tr>
<tr>
<td>Distance from City to London (in miles)</td>
<td>-0.0027526 (.0010192)*</td>
<td>-0.0016269 (.0010135)</td>
<td>-0.0019634 (.0010352)*</td>
</tr>
<tr>
<td>Number of Weekly Wagon Services to London, 1705</td>
<td>-0.0069697 (.0379263)</td>
<td>0.0259367 (.0385446)</td>
<td>0.0504688 (.0413712)</td>
</tr>
<tr>
<td>Number of Weekly Coach Services to London, 1705</td>
<td>0.3237542 (.0379918)*</td>
<td>0.3079018 (.0401274)*</td>
<td>0.2734409 (.0405641)*</td>
</tr>
<tr>
<td>Dummy for Water Transport to London</td>
<td>-0.3199711 (.1217489)*</td>
<td>-0.3302048 (.124631)*</td>
<td>-0.2468319 (.1204144)*</td>
</tr>
<tr>
<td>Intercept</td>
<td>-0.9680135 (.2343964)*</td>
<td>-1.056482 (.2371813)*</td>
<td>-0.8613771 (.2368929)*</td>
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<tr>
<td>City Random Effects</td>
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<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year Dummies</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>N</td>
<td>6732</td>
<td>6732</td>
<td>6732</td>
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<tr>
<td>Log Likelihood</td>
<td>-785.30334</td>
<td>-769.78699</td>
<td>-781.03326</td>
</tr>
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Notes and sources: The Dependent Variable is the probability that a major city adopted a turnpike trust along its London route in each year. The standard errors are adjusted by clustering among the 23 London routes. *Indicates statistical significance at the 90% level.
<table>
<thead>
<tr>
<th>Variable</th>
<th>(OLS) Coefficient (Stand. Error)</th>
<th>(IV) Coefficient (Stand. Error)</th>
<th>(OLS) Coefficient (Stand. Error)</th>
<th>(IV) Coefficient (Stand. Error)</th>
<th>(OLS) Coefficient (Stand. Error)</th>
<th>(IV) Coefficient (Stand. Error)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fraction of Neighbor Cities that Adopt Turnpikes</td>
<td>0.5617151 (.1506986)*</td>
<td>0.4585604 (.2619436)*</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Weighted Fraction of Neighbor Cities that Adopt Turnpikes</td>
<td></td>
<td>0.6108085 (.1336413)*</td>
<td>0.6305993 (.2027508)*</td>
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<td>Fraction of Adjacent Cities that Adopt Turnpikes</td>
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<td>0.5103051 (.1421471)*</td>
<td>0.3729125 (.2631748)</td>
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<tr>
<td>Dummy for City Population Above 5000 in 1700</td>
<td>0.1125816 (.1192651)</td>
<td>0.102564 (.1287578)</td>
<td>0.1105892 (.1173124)</td>
<td>0.1122935 (.1232035)</td>
<td>0.1361186 (.1223577)</td>
<td>0.1150838 (.1248001)</td>
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<tr>
<td>Distance from City to London (in miles)</td>
<td>0.0004006 (.0005997)</td>
<td>0.0004089 (.000628)</td>
<td>0.0004647 (.0005952)</td>
<td>0.0004653 (.0005986)</td>
<td>0.0003634 (.0006391)</td>
<td>0.0003856 (.0006288)</td>
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<tr>
<td>Number of Weekly Wagon Services to London, 1705</td>
<td>0.0109249 (.0268009)</td>
<td>0.0091884 (.0262677)</td>
<td>0.0169706 (.0260236)</td>
<td>0.0174728 (.0255168)</td>
<td>0.0119608 (.0289207)</td>
<td>0.0091361 (.0299376)</td>
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<tr>
<td>Number of Weekly Coach Services to London, 1705</td>
<td>.0512457 (.0299851)*</td>
<td>0.0558636 (.0348315)</td>
<td>0.0492686 (.0288373)*</td>
<td>0.0483989 (.0323921)</td>
<td>0.0522012 (.0290314)*</td>
<td>0.0587143 (.0321886)*</td>
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<tr>
<td>Dummy for Water Transport to London</td>
<td>-0.210129 (.1282516)</td>
<td>-0.21358 (.131276)</td>
<td>-0.1985173 (.119999)</td>
<td>-0.1975322 (.1235324)</td>
<td>-0.1824371 (.127537)</td>
<td>-0.1949523 (.1266028)</td>
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<tr>
<td>Intercept</td>
<td>0.1571721 (.1690744)</td>
<td>0.2150332 (.2086948)</td>
<td>0.0920783 (.1567674)</td>
<td>0.0797605 (.198991)</td>
<td>0.1477846 (.1742441)</td>
<td>0.2351414 (.2386141)</td>
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</table>

N: 66

R²: 0.3180 0.3121 0.3743 0.3741 0.3504 0.3355

Notes and Sources: The dependent variable is 1 if a major city had a turnpike trust adopted along its London route between 1695 and 1750. The standard errors are adjusted by clustering among the 23 London routes. *Indicates statistical significance at the 90% level.
<table>
<thead>
<tr>
<th>Route Number</th>
<th>City 1</th>
<th>City 2</th>
<th>City 3</th>
<th>City 4</th>
<th>City 5</th>
<th>City 6</th>
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</table>

Notes and Sources: The network was constructed using data from Albert (1972), Pawson (1977), and the Great Britain, 1840).
Figures

Figure 1: The Diffusion of Turnpike Trusts in England and Wales, 1670-1840

Sources: Data on Acts and mileage comes from Albert (1972) and Pawson (1977).
Figure 2 coming soon…
Figure 3: A Model of Turnpike Adoption

Notes: The parameter $c$ is a lobbying cost. $b'_i$ ($b'^p_i$) is group $i$’s monetary when they have turnpike trusts (parishes) along their local road. They are a function of $a_{-i}$ and $d_{-i}$, which are the vector of petition strategies and Parliament’s rejection decisions for groups other than $i$. 
Figure 4: Turnpike Acts Passed and the Failure Rate for all Parliamentary Petitions, 1660-1800

Sources: The Failure rate comes from data provided by Julian Hoppit. The number of new turnpike Acts passed comes from Albert (1972) and Pawson (1977).
Notes: The Failure rate for parliamentary petitions includes all legislative petitions, except turnpike petitions.
Figure 5: Predicted Diffusion of Turnpike Trusts, 1702-1800

Notes and Sources: Actual diffusion comes from the data in Figure 1. The estimated diffusion is drawn from the estimates in the last column of table 2.
Figure 6: Survival Curve for Major Cities along the London Network

Proportion of cities that have not adopted turnpike trusts along their portion of the London Road Network

Sources: see text.
Figure 7: The Increased Probability of City Turnpike Adoption when Half of all Neighboring Cities Adopt Turnpikes in the Same Year

Notes and sources: The increased probabilities are based on the estimates in column (2) of table 3. The bounds represent a 95% confidence interval.