Did the Glorious Revolution Contribute to the Transport Revolution?

Evidence from Investment in Roads and Rivers

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Abstract

The Glorious Revolution has been linked with Britain's economic development in the eighteenth century. This paper examines its impact on early transport improvements. First, it shows that several road and river undertakers in the 1600s had their rights violated because of political changes and actions taken by the Crown or Parliament. Second, it shows that the likelihood of rights violations was lower after 1689. Third, it uses structural breaks tests to demonstrate that the level of road and river investment was substantially higher after the mid-1690s. Together the evidence suggests that the institutional changes following the Glorious Revolution reduced political risk and uncertainty for infrastructure undertakers and that they responded by proposing and financing more projects.

Keywords: Property Rights, Investment under Uncertainty, Glorious Revolution, Transport Revolution

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I.

The Glorious Revolution of 1688 marked a key moment in British history. The overthrow of King James II by the invading army of William of Orange and the coronation of a new Protestant King represented a key change in ruling authority. According to some schools of thought the Glorious Revolution also contributed to broader economic and political change. One well-known view popularized by North and Weingast contends that the Glorious Revolution contributed to economic development by increasing the security of property rights and reducing rent-seeking.[2] The North and Weingast thesis has generated extensive discussion and debate in the literature. Most works focus on the security of government debt, the volume of private loans, and the stock market.[3] Infrastructure investment has received little discussion by comparison. This paper focuses on road and river improvements. It examines whether undertakers faced a lower risk of having their rights violated after 1688 and whether the level of road and river investment changed after the Glorious Revolution.

Investments in roads and rivers were a key driver of the early transport revolution. They substantially reduced transport costs and generated great benefits to property-owners and investors.[4] Improvements were proposed and undertaken by individuals and local governments acting through navigation companies and turnpike trusts. They received monopoly rights to undertake projects from acts of Parliament or patents issued by the Crown. Acts and patents also established a maximum schedule of tolls chargeable to users and procedures for resolving disputes between undertakers and local groups.

[2] See North and Weingast, 'Constitutions and Commitment' and Ekelund and Tollison, *Politicized Economies*.
[3] See Sussman and Yafeh,' Institutional Reforms', Quinn, 'The Glorious Revolution', Wells and Wills, 'Revolution and Restoration', and Klerman and Mahoney, 'The Value of Judicial Independence'.
[4] See Willan, *River Navigation*, Albert, *Turnpike Road System*, Pawson, *Transport and Economy*, Gerhold, 'Productivity Change', Bogart, 'Turnpike Trusts' and 'Were Statutory Authorities'.

Politics influenced whether the Crown or Parliament acted as the primary regulatory authority for road and river improvement. In the early 1600s the Crown and Parliament provided competing systems for obtaining improvement rights. Road and river promoters turned to James I and Charles I for patents nearly as often as they approached Parliament requesting acts. Regulatory authority shifted to the House of Commons after the Civil War. Following the Restoration most rights were initiated through acts of Parliament, but Charles II exercised significant influence and later revived the use of patents. Parliamentary control over regulation was solidified after the Glorious Revolution when it obtained greater political power.

The shifting political and regulatory environment of the 1600s had the potential to greatly influence transport investment by increasing risk and uncertainty for undertakers. They were in a precarious position because Parliament or the Crown could eliminate or diminish their rights through additional acts or rulings in the Privy Council. Undertakers might have been reluctant to invest in roads and rivers if they were uncertain whether Parliament or the Crown would protect or enforce their rights following a shift in power. Similarly, undertakers might have been reluctant to invest if they thought the Crown or Parliament might renege on privileges which each granted because of pressures from interest groups.

Political and regulatory risks are a general problem in infrastructure investment. The literature on twentieth century infrastructure projects abounds with examples of political or regulatory actors voiding investors' rights, lower the maximum fees chargeable to users, or redistributing profits to interest groups.[5] Infrastructure investors are especially prone to these types of violations because once a construction project is begun it is irreversible. A leading

[5] See Levy and Spiller, 'Institutional Foundations' and Newbury, *Privatization, Restructuring and Regulation*.

hypothesis in this literature is that infrastructure investors will forgo or delay making investments if there is a significant likelihood their income rights will not be protected.

This paper argues that the political changes following the Glorious Revolution reduced political risk and uncertainty for road and river undertakers and that they responded by initiating and investing in more projects. First, it provides evidence that some undertakers experienced violations of their rights in the 1600s. Second, it shows that the likelihood of rights violations was lower after 1689. Third, it uses structural breaks tests to demonstrate that the level of road and river investment was substantially higher after the mid-1690s.

The reasons *why* the Glorious Revolution reduced risks for undertakers and encouraged investment are more difficult to identify but the evidence points to several key changes.[6] A number of undertakers had their rights voided unexpectedly following major political changes like the Civil War and the Restoration. These political risks were lessened after 1688 as the conflicts between the Crown and Parliament diminished and undertakers had greater assurance that Parliament would remain as the main regulatory authority. This is not to say that all political conflict ended. The Jacobite Uprisings, for example, presented a risk that the Stuart monarchy would regain power, but on the whole Parliament's control over regulation was far more certain after the Glorious Revolution.

The evidence also points to differences in the way the Crown and Parliament resolved disputes between undertakers and interest groups. In the 1600s there were several cases where property-owners or transport-users appealed to the King and the Privy Council for compensation or lower fees. The cases suggest there was great potential for the King and Counselors to make

[6] There are several views in the literature on which factors contributed to the greater security of property rights after the Glorious Revolution. Some emphasize checks and balances, while others emphasize the structure of political parties and coalitions. See Stasavage, *Public Debt*, for discussion of these issues.

arbitrary rulings. After 1688 property-owners and transport-users made their appeals to Parliament through petitions for bills altering or diminishing undertakers' rights. The cases suggest that many of these petitions were unsuccessful because the multi-layered procedures for passing bills made it more difficult to violate rights through acts. Bills had to pass through a committee where witnesses and juries gave testimony on the merits or demerits. The House of Lords also had the ability to veto any bill passed by the Commons. The procedures for altering rights through rulings in the Privy Council had fewer layers and veto-points.

The findings in this paper build on the work of transport historians. Willan and Albert have documented cases where undertakers' rights were violated and they both emphasize the 1690s as a key period where the number of petitions and acts for improving roads and rivers surged.[7] This paper extends their work by identifying all known cases of rights violations and presenting an overall assessment of political risks facing undertakers. The paper also creates a new series on proposed and completed road and river investment from 1607 to 1749. The new series are better indicators for investment activity than counts of acts, patents, and petitions previously used in the literature.[8] Lastly, there is no consensus in the literature on whether the Glorious Revolution or other economic factors stimulated investment. This paper uses structural breaks tests to show that the 1690s marked an increase in the level of road and river investment even after accounting for factors like interest rates and the growth of coastal trade. The analysis thus provides stronger evidence that the Glorious Revolution contributed to higher transport investment.

The findings also add to the literature examining Parliament's role in encouraging economic development. In the eighteenth and early nineteenth century there were substantial numbers of

[7] Willan, *River Navigation*, pp. 24-30, Albert, *Turnpike Road System*, pp. 20-23

[8] Completed investment captures differences in implementation and the amount of investment approved across acts or patents. Proposed investment also has advantages because it captures differences in the amount of investment across petitions.

acts changing and establishing property rights, including acts to create river navigation authorities and turnpike trusts.[9] One driving force was the increased length, periodicity, and predictability of legislative sessions after 1689 as well as the introduction of procedural changes in Parliament.[10] The findings in this paper suggest that lower political risks may have also contributed to greater acts changing and establishing property rights. By making the rights vested in acts more secure against political manipulation, the Glorious Revolution effectively raised the demand for acts among individuals and local communities.

Lastly, this paper gives a new perspective on the North and Weingast thesis. There is much discussion in the literature as to whether property rights became more secure following the Glorious Revolution. Clark shows that the rate of return on land was unaffected by political events in the 1600s and argues that property rights in land were secure long before.[11] This paper differs because it provides evidence that rights to improve infrastructure became more secure after 1688. The results are similar to Wells and Wills who show that stock prices decreased in response to Jacobite threats against the post-1688 regime.[12] The results are also similar to Klerman and Mahoney who provide evidence that stock prices increased following the inclusion of a provision in the 1701 Act of Settlement increasing the degree of judicial independence.[13] Together the evidence from these papers suggests that political changes affected some rights more than others. Rights to incorporate and improve infrastructure may have been more affected because they were recently created by Parliament or the Crown in the 1600s.

II.

[9] See Langford, *Public Life,* Hoppit, 'Patterns of Parliamentary Legislation', Innes, 'The Local Acts', Bogart and Richardson, 'Parliament and Property Rights'.
[10] Hoppit and Innes,' Introduction'
[11] Clark, 'Political Foundations'.
[12] Wells and Wills, 'Revolution, Restoration, and Debt'.
[13] Klerman and Mahoney, 'The Value of Judicial Independence'.

Regulatory authority over river navigations and turnpike trusts changed numerous times in the seventeenth century. This section provides an overview from the early 1600s to the early 1700s. It supplements the work of Willan, Albert, and other transport historians with information from the Calendar of State Papers, the Journals of the House of Commons and Lords, Acts of Parliament, and drafts of bills.[14]

In 1600 most tidal rivers were under the authority of a Commission of Sewers. Commissions were appointed by the Lord Chancellor. They had rights to compel landowners to cleanse the river and to levy a property tax to pay for maintenance, but they had no authority to tax inhabitants other than those adjacent to the river, and they could not purchase land or divert the path of the river.[15] Road maintenance was the responsibility of parishes. These local governments could claim labor and materials from their inhabitants, but they could not levy property taxes or tolls and had no legal capacity to purchase land for new roads.[16]

Groups and individuals turned to Parliament to address these limitations. Proposals were made through bills introduced in the House of Commons or the House of Lords. The bills generally dealt with individual projects. Undertakers aimed to extend the navigation of tidal rivers through dredging, diverting, and making new cuts. They also proposed to repair and widen major roads. Bills were reviewed by committees and if successful they were approved by both Houses and the Crown.

[14] The paper uses the electronic version of the Calendar of State Papers available through British History Online. The Bankes Papers in the Bodleian Library were also consulted but they did not identify any patents or grants relating to rivers that were absent in the Calendar of Sate Papers. Barrat, 'The Bankes Papers', p. 315, also points out that many of the proposals for patents in the Bankes papers are discussed in the Calendar of State Papers.
[15] Willan, *River Navigation, p. 16.*
[16] Albert, *Turnpike Road System*, p. 16.

Transport improvement acts gave undertakers or trustees authority to levy tolls and undertake specific projects. They also established a body of commissioners that would resolve disputes between undertakers and property owners regarding the purchase of land or damages suffered. The rights vested in river navigation acts were typically permanent and passed to heirs or assignees. Turnpike acts usually gave trustees authority for 21 years, although most were renewed through subsequent acts.

The Crown also issued patents or grants of privilege to improve transport. The process had similarities with parliamentary acts. Individuals approached the king or his advisors in the Pricy Council and described a particular project.[17] The powers vested in patents gave undertakers authority to levy tolls and established commissioners to mediate disputes with property-owners. The main difference was that the Privy Council was the final court of appeal in disputes over river improvement patents.[18] In the case of acts, commissioners' decisions were enforceable in common law courts, but appeals could still be made to Parliament.

The relative authority of the Crown and Parliament over transport rights was closely connected with the broader political environment. King James I rarely called Parliament into session in the 1610s, making it impossible to pass transport bills. Instead James I authorized payments and grants for improving specific highways.[19] In 1617 James awarded a patent to Jason Gason giving him powers over any river improvement in England.[20] In 1619 the King narrowed

[17] For example, in 1633 someone made a proposal to the Privy Council to create a navigable river between the Thames and Severn. See Bruce, *Calendar of State Papers Domestic: Charles I, 1633-4*, pp. 41-61, May 1, 1633'.
[18] Macleod, *Inventing the Industrial Revolution*, p. 59, states that a quorum of six privy councilors could summarily rescind a patent if it was shown to be either harmful or in use.
[19] For example, James I ordered a payment of 20 pounds to John Hare for repairing the highways between Highgate and Barnet. See Green, *Calendar of State Papers Domestic: James I, 1603-1610*, pp. 590-605, April 27, 1610.
[20] See Woodcroft, *Titles of Patents of Inventions*, pp. 1-2, for a description of Gason's patent. Chrimes et. al., *Biographical Dictionary*, p. 647, states that Gason transferred his rights to improve the Great Ouse to Arnold Spencer. This appears to be the only case that Gason exploited his patent with respect to river improvements.

the scope of patents and gave the Mayor and Alderman of Bath rights to improve the river Avon.[21]

The growing use of patents aroused controversy in the 1620s. In 1623 Parliament passed the famous Statute of Monopolies, which made it illegal for the Crown to issue patents except for inventions. Around the same time Parliament tried to reassert its authority over transport rights. Panel A in Table 1 lists all river improvement bills from January 1621 to March 1629. Many dealt with important rivers like the Thames, the Medway, and the Yorkshire Ouse.[22] Parliament was unable to pass road and river improvement bills during the era of 'personal rule' from 1629 to 1640. King Charles I avoided the restrictions in the Statute of Monopolies and issued numerous patents or other privileges to river promoters in exchange for annual payments. Panel B in Table 1 shows all rivers that were proposed to be made navigable through royal grants in the 1630s. Notice that Parliamentary bills are absent during this decade.

Following the Civil War, regulatory authority changed once again. The House of Commons gained control over road and river improvement once the Monarchy and the House of Lords were both abolished. In the 1650s, several proposals for road and river improvement were submitted to the Commons. One of these proposals resulted in the first act explicitly authorizing the use of tolls to improve a river.[23] Richard Weston first proposed improving the River Wey in the 1630s. Weston, who was Roman Catholic, allied himself with James Pitson because he was a strong Parliamentarian.[24] The 1651 act named Pitson and several others as undertakers. Weston

[21] For discussion of the Avon patent see Willan, *River Navigation*, p. 25.
[22] In the 1620s there was also a bill to introduce tolls on a section of the North Road leading to London. See Emmison, 'The Earliest Turnpike Bill', p. 108-132.
[23] The act dealt with the Wey. See Firth and Rait, *Acts and Ordinances of the Interregnum, 1642-1660* , pp. 514-17.
[24] See River Wey & Navigations : An historical background to the Wey Navigations, http://weyriver.co.uk/theriver/nav_2_%20history.htm

appears to have been a hidden partner. The construction was financed through loans and shares with Weston and Pitson contributing a substantial portion.

There was a brief period in the mid-1650s when executive authority remerged. Between 1654 and 1656 two proposals were made to Oliver Cromwell to improve rivers.[25] In 1657, Cromwell granted a charter to undertake improvements on the Yorkshire Ouse.[26] The expansion of Cromwell's regulatory influence coincided with an enlargement of his political power. In 1653, Cromwell dissolved the Parliament that had sat since 1649 and established a new constitution in which government was by "a single person and a Parliament."[27]

There were another series of changes in regulatory authority following the Restoration of Charles II. In 1661, there were two attempts to obtain rights to improve rivers; one went through the Crown directly and the other went through Parliament.[28] Matters became more unclear in February of 1662 when the Lords passed a bill that would have effectively enhanced the authority of the Crown.[29] It allowed any municipal corporation, hundred, or county to improve a river in its area without authorization from Parliament. Furthermore, if any municipal corporation, hundred, or county did not improve the river, then any private person could get rights from the Lord Chancellor to improve the river. In April 1662 the Commons received the bill.[30] It was read twice but did not proceed further when the session ended in May 1662.[31]

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[25] See Green, *Calendar of State Papers Domestic: Interregnum, 1655-6*, pp. 88-154, January 1656. There is also evidence of a third proposal in 1655 although it is not recorded in the Calendar of State Papers. Jim Shead, 'Waterways Information,' states that Andrew Yarranton offered to seek letters patent from the Lord Protector to make the river Salwerpe navigable.

[26] *H. of C. Journals*, VII (1651-1660), pp. 575-578, 26 June 1657. Priestly, *Historical Account*, p. 491.

[27] Quoted in Seel and Smith, *Crown and Parliaments*, pp. 62-67.

[28] In November of 1660 a proposal was made to the Privy Council to improve the river Dee. See Green, *Calendar of State Papers Domestic: Charles II, 1660-1*, pp. 372-400, November 1660. In May of 1661 a bill was introduced in the Lords to improve the Stower and Salwerpe. See *H. of L. Journals*, XI (*1660-1666)*, pp. 249-251, 11 May 1661.

[29] A draft of the bill is in the Parliamentary Archives, HL/PO/JO/10/1/311.

[30] *H. of C. Journals*, VIII (1660-1667), pp. 400-401, 9 April 1662.

In the same session that the preceding bill failed, the Lords, Commons, and the King approved two bills authorizing improvements on the Stower and Salwerpe rivers and the Wye and Lugg rivers.[32] Several more bills were introduced for rivers and roads in the parliamentary sessions from February 1663 to August 1665, while no proposals were made to Charles II for patents or royal grants. Thus in this two-year period there was a reemergence of the 'Crown-in-Parliament' system of granting improvement rights. As one part of this arrangement it appears that Charles II had significant influence over which undertakers received rights. For example, Sir William Sandys was named as the undertaker for the Wye and Lugg. Sandys received a patent from Charles I in the 1630s and was a prominent royalist who helped raise funding for the Restoration.[33] In another example, Henry Hastings was granted rights to make the Bristowe Causey navigable in 1664.[34] Hastings was a supporter of Charles I during the Civil War and was appointed lord lieutenant of Leicestershire by Charles II.[35]

Charles II played a more direct role in river improvement after the mid-1660s. Panel A of table 2 shows the bills for river improvement introduced in Parliament between the session beginning in September 1665 and the session beginning in May 1685. Panel B in table 2 shows proposals for river improvement made to the Crown over the same period. More bills were introduced in Parliament, but some promoters were turning to Charles II, especially at times

[31] The last mention in the Journals is April 28 1662. See *H. of C. Journals*, VIII (1660-1667), pp. 414-415.
[32] See Private Act, 14 Charles II, c. 14 and Private Act, 14 Charles II, c. 15.
[33] Chrimes *et. al.*, *Biographical Dictionary*, p. 592.
[34] Private Act, 16 & 17 Charles II, c. 6.
[35] Bennett, 'Hastings, Henry, Baron Loughborough'.

when Parliament was not in session.[36] In 1684 Charles II also reinstated John Mallet's patent for the river Tone, making it the first awarded since the late 1630s.[37]

The Crown's role in granting privileges was greatly limited after the Glorious Revolution. Only one river improvement proposal was made directly to the Crown during the reigns of William and Mary, Anne, and George I, compared to more than one-hundred bills introduced in Parliament.[38] Parliament continued to be the only forum for initiating new transport rights after the 1720s.[39] The Glorious Revolution also marked a change in how local disputes relating to transport improvements were resolved. After 1689, acts continued to appoint commissioners to resolve disputes, but they also gave landowners or undertakers the right to request that a jury investigate the facts. Juries had the power to make recommendations to commissioners and were consulted by parliamentary committees considering bills to alter undertakers' rights.[40]

The Glorious Revolution marked the last of a series of major changes in regulatory authority. The key question here is whether undertakers rights were more secure after the Glorious Revolution and whether promoters and investors responded by initiating and financing more projects. The following section begins the analysis by giving several examples to illustrate the risks and uncertainty facing undertakers in the 1600s.

III.

[36] For instance, Parliament was not in session when the Earl of Bath and others proposed improvements on the Dee in April of 1669. See Green, *Calendar of State Papers, Domestic: Charles II, 1668-9*, pp. 258-305, April 1669.
[37] Green, *Calendar of State Papers Domestic: Charles II, 1684-5*, pp. 109-132, August 1684'.
[38] The only proposal to the Crown, see Hardy, *Calendar of State Papers Domestic: William and Mary*, 1693, pp. 243-297, August 1693.
[39] The Crown still retained the right to reject parliamentary bills, but it was uncommon. See Hoppit, *Failed Legislation*, p. 25, for details.
[40] The Journals of the House of Commons provide several examples where juries gave testimony or made petitions. For one example see *H. of C. Jocurnals*, XXIV (1743), 5 April.

There were a number of cases where undertakers had their rights voided following major political changes. In the act establishing the Restoration settlement, there was a provision that all 'orders and ordinances of both or either house of parliament….to which the royal assent was not expressly had or given…are and so shall be taken to be null and void'.[41] This provision was not designed to revoke the rights of river undertakers specifically, but it had the effect of voiding the rights of undertakers for the Yorkshire Ouse and the Wey because they received their authority from charters or acts in the 1650s.

The case of the river Wey is revealing because the undertakers were unable to get their rights reinstated even though they invested £15,000 and made the river navigable to the Thames. In 1662, James Pitson tried to get a new act reinstating the rights of undertakers named in the 1651 act but the bill failed in Parliament.[42] In 1664, Charles II named a new conservator, John Ratcliffe, who was to have rights over the Wey for 30 years.[43] In 1664, Ratcliffe attempted to get an act of Parliament to strengthen his claim, but the bill failed. In 1666 a law suit was filed in the Court of the Exchequer over the possession of the river, but the Lord Chief Baron did not rule on the case for several years.[44] The authority over the Wey was partially resolved by an act in 1670 which named Sir Adam Browne and others as trustees for the river. The act allowed shareholders to submit a claim to the Court of the Exchequer for part of the profits from the river.[45] Numerous claims were submitted and how the original investors fared is unclear.[46]

[41] Quoted in Holmes, *the Making of a Great Power*, p. 28.
[42] Details on the petition are available in the Parliamentary Archives, HL/PO/JO/10/1/317.
[43] The details of this case are reported in a petition in the Parliamentary archives, HL/PO/JO/10/1/319. It appears that Charles II ignored the interests of the earlier undertakers in part because they used materials from his father's confiscated estate during the Interregnum.
[44] Green, *Calendar of State Papers Domestic: Charles II, 1668-9*, pp. 563-599, November 1669.
[45] Private Act, 22 & 23 Charles II, c. 26.
[46] Willan, *River Navigation*, p. 70.

There is a second example in which undertakers' rights were voided following political changes. In 1636 William Sandys was awarded a patent for the River Avon and invested more than £40,000.[47] In 1641 Sandys was expelled from Parliament because he was a supporter of the Crown. Sandys' rights in the Avon passed to William Say, who was one of his creditors and a member of the House of Commons.[48] William Say's property was attained after the Restoration and his rights in the Avon passed to James Duke of York, the brother of Charles II.[49] Shortly afterwards Sandys petitioned to the Crown to restore his rights in the River. In his petition, Sandys argued that Say unlawfully took control of the river by "receiving thousands more than he paid." Sandys pleaded to Charles II to "prevail with the Duke of York not to be the only severe one and to suspend the delivery of any grant to Lord Windsor."[50] Despite Sandys plea, Lord Windsor was granted rights to the Avon by an act in 1662.[51]

Summers' work on the Great Ouse describes a case where the rights vested in patents and acts came into conflict.[52] In 1638 Arnold Spencer was granted a patent for the Great Ouse between Bedford and St. Neots. Spencer died in 1655 in the midst of financial difficulties and control over the navigation passed to his creditors. In 1665 an act of Parliament gave Sir Humphrey Bennet and others rights to collect tolls and improve several rivers including the Great Ouse near Bedford. In 1674 Samuel Jemmatt tried to purchase rights to the Great Ouse after Bennet failed to improve the River. Jemmatt paid £1200 to Arnold Spencer's creditors who held a claim over the patent. A dispute arose when the lessee of the Great Ouse navigation, Henry Ashley Sr., lobbied the commissioners of the 1665 Act to name him as the undertaker. A

[47] Green, *Calendar of State Papers Domestic: Charles II, 1661-2*, pp. 610-632, Undated 1662.
[48] Chrimes *et. al*., *Biographical Dictionary of Civil Engineers in Great Britain and Ireland*, p. 592.
[49] Green, *Calendar of State Papers Domestic: Charles II, 1661-2*, pp. 610-632, Undated 1662.
[50] *Ibid*.
[51] The re-establishment of formal rights can be found in the final provision of the 1662 act to improve the Stower and Salwerpe, 14 Charles II, c. 14.
[52] Summers, *The Great Ouse*, p. 53.

provision in the legislation gave commissioners the authority to name a new undertaker if Bennet and the others were unsuccessful in making their rivers navigable. In 1687, the commissioners granted Ashley formal rights to the river, ending Jemmatt's claim.

There are other examples illustrating that the King and the Privy Council could make arbitrary rulings in disputes involving undertakers. In the 1620s, Justices of the Peace set the maximum toll on goods shipped along a section of the Great Ouse at 1 pence per ton.[53] After an appeal by the patentee for the river, the President of the Privy Council raised the maximum toll to 1.5 pence per ton. In 1625 local users appealed to Justices who ironically raised the toll to 3 pence per ton. A final appeal was made to the Privy Council which then ruled that the toll be reduced to 2.5 pence per ton.

Willan describes another case where Henry Lambe faced resistance from local mill-owners who claimed they were being adversely affected by the improvement of the river Lark.[54] A commission appointed by the Crown recommended that Lambe should pay landowners £40 per acre for the purchase of meadow land and £2 per acre per annum as rent for tow paths. It also recommended that no tolls should be levied on the river between the town of Mildenhall and the river Ouse, which represented over half of the route granted to Lambe in the original patent. King Charles I agreed with their recommendation and decreed that the river should be toll free from Mildenhall to the Ouse. It is not known whether Charles I upheld the compensation to landowners, but if he did it would have been a very generous price for this region and time.[55]

[53] See Summers, *the Great Ouse*, pp. 48-49, for a discussion of this case.
[54] Willan, *River Navigation*, pp.27-28.
[55] In 'Land Rental Values,' Clark shows that rents per acre in the 1820s in Suffolk were £1.07 per acre. This implies that a rent per acre of £2 or a purchase price of £40 per acre was very generous for this area in the 1630s.

The preceding examples show that the rights of undertakers could be violated because of political changes or decrees and acts made by the Crown or Parliament. Similar problems arose in other economic activities like drainage.[56] The following section investigates whether the political risks facing river navigation undertakers and turnpike trustees decreased after the Glorious Revolution.

IV.

Undertakers or trustees who lost their authority to collect tolls and undertake improvements suffered the most serious violations of their rights. Those that had their maximum tolls reduced without their consent or were forced to pay subsidies to parishes also suffered serious violations. Cases where undertakers or trustees had their authority voided, their maximum tolls lowered, or were forced to pay subsidies can be identified by studying acts of Parliament relating to road and river improvements and royal decrees made through the Calendar of State Papers.[57] The analysis draws on these two primary sources as well as the secondary literature to estimate the likelihood of a violation for undertakers established before and after 1689. The analysis also considers how the rights of undertakers established between 1606 and 1688 were treated after 1689.

Estimating the likelihood of a violation is complicated because it is difficult to identify whether undertakers' rights were actually violated in some cases. Some undertakers may have lost their rights because they were negligent in carrying out their authority or—as in the case of most turnpike acts—there were provisions that Parliament would impose lower tolls on trustees

[56] For example, the Earl of Bedford was given the right to drain the Fens by a royal charter in 1637. The project was initiated when locals brought complaints before commissioners in 1639. The commissioners determined that the Earl had violated the provisions of the charter. To make matters more complicated, the Earl was becoming closely allied with the parliamentary opposition to the Crown. Charles I seized upon the findings of the commissioners and revoked the Earl's charter. For more details see Wells, *The History of the Drainage*, pp. 105-127.
[57] See the appendix for a discussion of the sources for public and private acts.

once their debts were paid off. This type of measurement error is only problematic if it creates a systematic bias in favor of lower risk after 1689.[58]

Tables 3 lists all identified instances where undertakers established between 1689 and 1749 had their rights violated by acts between 1689 and 1749. A table in the appendix describes these cases in detail. The likelihood at the bottom is estimated by the number of undertakers who had their rights violated by at least one act between 1689 and 1749 divided by the number of undertakers who received rights between 1689 and 1749. There was only a 6 percent likelihood that a river undertaker established after 1689 experienced at least one violation. The implication is that Parliament violated very few undertakers' rights after 1689. In particular, the maximum tolls were not reduced until long after undertakers recouped their investments.[59]

Table 4 lists all instances where undertakers established between 1606 and 1688 had their rights violated by political settlements, royal decrees, or acts between 1606 and 1688. Most of these cases have already been discussed in section III.[60] The main result at the bottom of the table shows there was a 33 percent likelihood that a river undertaker experienced at least one violation before 1689. By these indicators, the risks facing undertakers were much lower after the Glorious Revolution than before.

A similar finding holds for turnpike trusts although there is only one observation before 1689 to make a comparison. Table 5 lists all cases where trusts established between 1689 and 1719

[58] It should be noted that there is already likely to be a bias in favor of finding similar risks because it is endogenous which undertakers propose projects and get approval. If property rights were less secure before 1689 then those undertakers whose rights were relatively more secure should have been more likely to propose projects and get approval. As a result, the observed likelihood of a violation for undertakers before 1689 may give an under-estimate of the likelihood of a violation for the population of undertakers in this period.

[59] For example, the 1699 act establishing the Aire and Calder set the tolls at 10 shillings per ton in the summer and 16 shillings per ton in the winter for all goods. This maximum schedule lasted until a 1774 act set the maximum between 3 and 7 shillings per ton for most commodities. By this date investors had already earned substantial returns on their initial investment. See Wilson, *Gentlemen Merchants*, p. 140.

[60] The 1624 Thames act is described in the appendix.

had their rights violated by acts between 1689 and 1719. The results show there was a 18 percent likelihood that trusts established between 1689 and 1719 experienced at least one violation. The only turnpike authority before 1689 was along the Great North road. It was operated by Justices of the Peace in Hertfordshire, Cambridge, and Huntingdon. Albert notes that toll gates were never put up in Cambridge and Huntingdon and they were abruptly pulled down in 1680 in Hertfordshire. [61] This one example provides some indication that rights to collect tolls on highways were not as secure in the 1670s and 1680s.[62]

The conclusion that undertakers faced lower risks after 1689 is unlikely to be overturned because of biases in the estimates. The difference in the likelihood that river undertakers experienced a violation of their rights is quite large—33 vs. 6 percent. Moreover, an analysis of the cases also suggests there is no obvious bias in favor of greater security after 1689. It is clear that undertakers suffered a violation when they lost their rights to the rivers Avon, Great Ouse, and Wey following the Civil War and Restoration. Henry Lambe's rights also appear to have been violated by the rulings of Charles I. Thus if only these four cases are considered the likelihood of a violation before 1689 would still be significant. There are also cases of questionable violations after 1689. For example, an act in 1743 lowered the maximum tolls for the Company of Proprietors for the River Dee. The company submitted its own petition stating that they "consented" to an act lowering their tolls.[63] It was very rare for undertakers to give consent to lower their maximum tolls and therefore it is likely they were not aggrieved by the

[61] Albert, *Turnpike Road System*, p. 20.
[62] It is worth pointing out that in 1680, 1681, 1687, and 1688 Charles II and James II removed many of their political opponents from positions as Justices on the County Commissions of the Peace and replaced them with supporters. These politically motivated purges were significant because Justices were often named as undertakers for road improvement acts. See Glassey, *Politics and Appointment*, p. 262, for more details on the purges of JPs.
[63] See *H. of C. Journals*, XXIV (1743), 31 January.

act. If this case is dropped then the likelihood that river undertakers had their rights violated after 1689 would be close to zero.[64]

Undertakers who received their authority before 1689 did not necessarily enjoy the same protections after 1689. Recall that these undertakers received their rights from patents in the 1630s or acts in the 1660s and 1670s. Many of these undertakers failed in making their rivers navigable and starting in the 1690s groups began submitting petitions requesting that new undertakers be allowed to complete the navigation. Thus Parliament had to decide whether it would maintain the rights of old undertakers who did not complete the navigation. There were also political aspects. Several undertakers from the 1630s and 1660s were closely affiliated with the Stuart monarchy. How would Parliament deal with their rights given the political tensions of the 1690s?

The evidence suggests that in most cases Parliament did not violate these undertakers' rights and when they did it was linked with their failure to complete the navigation. Table 6 summarizes the outcomes for all undertakers who received their authority from patents or acts before 1689. In 14 of the 20 cases undertakers' rights were not altered by acts or they were renewed by acts. In one of the six remaining cases there was an act that eliminated a patentee's rights, but they received compensation from the new undertakers.[65] In another, involving the Yorkshire Ouse, new undertakers were named but the original undertakers had already lost their rights following the Restoration. In the four remaining cases (the Lark, the Soar, the Stower, and

[64] There are also cases of questionable violations against turnpike trustees after 1689. For example, an act in 1740 reduced the maximum tolls for the trustees of the Stokenchurch to Oxford road. The MPs from the committee reported that the debts issued by the trust had been paid off, and therefore it is unlikely that trustees were harmed by the act. In another case the trustees of the Fornhill to Stony Stratford road appear to have lost their rights because they misinformed creditors about the revenues from the tolls. If these two cases are dropped then the likelihood that trustees suffered a violation of their rights drops to 0.12.

[65] Haskell, 'River Tone', states that patentees for the Tone were paid £330 for their rights to the river after an act was passed in 1698.

the Wye and Lugg) acts were passed naming new undertakers, but in all these instances undertakers did not complete the navigation. For example, Henry Lambe was never successful in making the Lark navigable in the 1630s.[66] In another case the Sandys family lost their rights to collect tolls on the Wye and Lugg after they were not successful in making the rivers navigable. The opening passage of the 1695 Wye and Lugg Act confirms that the failure to complete the navigation was the official reason why their rights were revoked.[67]

There are two cases where undertakers who received their authority before 1689 successfully defended their rights in Parliament in the 1690s and early 1700s. They are described in detail because they illustrate that it was difficult for local interest groups to alter rights through acts after 1689. The first case involved the Baldwyn family who invested more than £6000 in making the river Salwerpe navigable after an act was passed for this purpose in 1662. In 1693 a bill was introduced in the Commons that would give the Earl of Shrewsbury and Lord Coventry sole rights to improve the river. Sir Timothy Baldwyn submitted a petition to the Commons opposing the bill on the grounds that his father had already invested in the river and that the proposed bill "tends to make void the said Act, and to take away all the works and materials done in pursuance thereof."[68] Despite Baldwyn's petition, the Commons passed the bill on March 9, 1693. In mid-March, the Lords began deliberations on the river Salwerpe bill. Baldwyn submitted a petition to the Lords stating that "it is of dangerous consequence to take away any persons right, purchased

[66] Willan, *River Navigation*, p. 151.
[67] The opening passage states that Sandys 'never did anything towards the making of the said River of Lugg navigable. And what they did towards the said Work upon the said River of Wye was performed so slightly that most of the Locks and Passages by them made did in a very few years fall utterly to decay and ruin'. See *Statutes of the Realm: volume 7: 1695-1701*, pp. 78-84.
[68] See *H. of C. Journals*, XIII (1693), 2 October.

under an act of Parliament, without their consent."[69] The Lords ultimately dropped the Salwerpe bill and the rights of the Baldwyn family were protected.

The second case involved the river Itchen, where an act in 1664 was used to make the river navigable. In 1714 property-owners near the river submitted a petition to the Commons requesting that provisions in an earlier act be modified because "it hath not been of effect to answer the ends for which it was made; but becomes a grievance to the petitioners".[70] The bill was referred to a parliamentary committee. Numerous counter-petitions were submitted and read. George Huxley, one of the undertakers, stated that "should it pass, it would not only defeat the petitioners of their right, but utterly destroy the said navigation."[71] Inhabitants in the towns of Andover, Stockbridge, Whitchurch, and Winchester asked that no bill be passed in prejudice of the navigation because the river was "of great advantage to [their] city and country, by the cheap and safe carriage of all goods and merchandizes."[72] The bill did not proceed any further after these counter-petitions were referred to the committee.

V.

The theoretical literature draws a strong connection between risk, uncertainty, and the willingness to undertake irreversible investments.[73] These models would suggest that investment should have been lower before 1689 when there was a higher chance that undertakers' rights would be violated. They also suggest that investment should have increased substantially once it

[69] Details on the petition are available in the Parliamentary archives, HL/PO/JO/10/1/455/733.
[70] See *H. of C. Journals*, (1714), 12 March.
[71] See *H. of C. Journals*, (1714), 14 May.
[72] See *H. of C. Journals*, (1714), 31 May-June 3.
[73] See Pindyck, 'Irreversibility' for an analysis of investment under uncertainty.

became clear that risks were lower following the Glorious Revolution.[74] This section examines these predictions using new time series on proposed and completed investment in roads and rivers. The series is based on all proposed projects between 1607 and 1749 identified by entries in the Journals of the Commons, the Journals of the Lords, and the Calendar of State Papers. Parliamentary records and other sources identify the miles of road or river affected by each proposed project and whether they resulted in improved river navigation or repaired roads. Lastly the investments per mile for a sample of river navigation authorities and turnpike trusts are used to estimate the value of proposed and completed investment. The appendix provides more details.

The separation of proposed and completed investment is a significant advantage of the data because they address different aspects. Ideally one would like to observe the amount of investment that individuals or groups were willing to undertake. Proposed investments would seem ideal because they signify attempts to obtain rights from the Crown or Parliament to initiate projects, but there is an element of 'double-counting' because proposed investments in a year might include failed proposed investments from earlier years. When Parliament or the Crown rejected promoters they often sought approval again or new promoters tried to initiate the project. Completed investment has an advantage in this respect because it only counts projects once.

Completed investment also captures the response of investors. Promoters might seek rights for certain projects even when property rights are less secure, but these projects are less likely to

[74] To see why consider a stylized example where in the current year the undertaker believes their rights will be protected with probability q and with probability 1-q their rights will be violated. Suppose also that next year they expect to learn whether q is one or zero because there has been a political change. It will be better for the investor to wait until next year to make the decision to invest. This 'option-value' can be considerable because the undertaker cannot reverse the investment once it has been initiated and they realize their income rights are not secure.

be completed because investors will be reluctant to provide financing. A completed investment signifies the willingness of investors to provide crucial outside financing.[75] The drawback of completed investment is that it omits proposed investments that were rejected by Parliament or the Crown because of inefficiency in the proposal process.

Figure 1 plots a four-year moving average of completed investment from 1607 to 1749 in constant 1750 prices. There was a sharp rise in completed investment starting in the mid-1690s and continuing through the decade of the 1700s. Approximately the same amount was completed in the fifteen years from 1695 to 1709 as in the previous 85 years from 1604 to 1688. After 1709 completed investment fluctuated substantially, but the mean level was clearly higher than before 1689.[76]

The low level of investment in the 1600s followed by a rise after 1689 is consistent with the view that promoters and investors responded to lower risk. The surge in the 1690s also suggests that when the Revolutionary Settlement was new promoters had an incentive to delay projects. By the mid-1690s there were more indications that the regime would persist, giving promoters and investors more certainty about rights granted by Parliament.[77]

The series on proposed investment also shows a sharp increase in the mid-1690s, but there was also a substantial surge in the early 1660s, following the Restoration (see figure 2). The estimates imply that around £750,000 in road and river investment was proposed in the 1660s, which is more than two times the £275,000 proposed in the 1650s.

[75] The earlier discussion of the river Wey illustrates the importance of financiers. Also see Willan, *River Navigation*, p. 66, and Albert, *Turnpike Road System*.
[76] The cyclicality of investment is not surprising. Similar investment cycles occurred after the mid-eighteenth century. There were a series of booms in turnpike investment in the 1750s, 1760s, 1790s, 1810s, and 1820s. The well known canal boom occurred in the 1790s and was followed by the railway boom in the 1840s. See Pawson, *Transport and Economy* and Ward, *the Finance of Canal Building*, for more details.
[77] The successful establishment of the Bank of England in 1695 provided one signal of the regimes persistence.

The difference between proposed and completed investment following the Restoration deserves further discussion. The Restoration brought a reemergence of the Crown-in-Parliament system, suggesting that Parliament and the Crown would cooperate in supplying secure transport rights. Therefore, it is possible that promoters responded to the political changes of the Restoration by initiating more projects. However, the Restoration did not mark a significant change in completed investment. Only £90,000 was completed in the 1660s out of the £750,000 proposed. The low completion rate was due to several factors. A number of promoters received approval from Parliament but did not complete their project. Henry Hastings, for example, did not make the Bristowe Causey navigable to the Thames after getting rights through an act.[78] Similarly the undertakers who received rights to improve the Medway in Kent and Sussex failed to make the river navigable.[79] A number of projects in the 1660s also failed to receive approval from Parliament and were proposed more than once after previous bills failed.[80] For instance there were three bills in the early 1660s proposing a canal between the Severn and Thames and none were successful. Willan describes this project as a 'theoretical scheme'.[81] It was distinctive from most others because it would have required a tremendous capital investment. If the three bills for the Severn and Thames canal are dropped from the series on account of their impracticality then proposed investment from 1660 to 1664 would fall by nearly 40 percent, making the years after the Restoration look less remarkable.

The Glorious Revolution was also different from the Restoration in that proposed investment did not decline as much in the late-1700s and 1710s as it did in the late-1670s and 1680s.

[78] Willan, *River Navigation*, p. 11.
[79] An investigation by a Parliamentary Committee in 1739 stated that "not any of the several powers given by the said Act, or any part thereof, had been carried into execution." See *H. of C. Journals*, XXIII (1739), 20 February.
[80] More than one parliamentary proposal was submitted for the Avon in Hampshire, for the canal connecting the Thames and Severn, and the Great Ouse in Bedfordshire. Two proposals were made to the Crown for improving the river Dee and one was made to Parliament. See the appendix, table 11, for more details.
[81] Willan, *River Navigation*, p. 10.

Approximately £740,000 was proposed from 1705 to 1719 compared with £80,000 from 1674 to 1688. Proposed Investment contracted so much in the 1680s that it reached a level comparable to the Civil Wars of the 1640s. This finding is significant because the conflicts between the Crown and Parliament intensified in the 1670s and 1680s. This period also marked a brief revival in the use of patents for river improvement.

The river and road investments completed in the 1690s, 1700s, and 1710s were associated with projects of great economic importance. Many, like the Aire and Calder rivers in the industrial areas of Yorkshire, had been proposed much earlier in the 1600s, but were never approved or completed. There were also several new projects, like the extensions of navigation on the Thames river system and numerous repaired highways near London.

VI.

Changing economic conditions may have been another driving force behind the increase in transport investment after the Glorious Revolution. For example, lower interest rates might have made it easier for promoters to finance investment. A higher growth rate of coastal trade might have increased the demand for infrastructure, particularly river improvements. A lower frequency of harvest failures could have changed domestic trade patterns altering the need for infrastructure in some regions. Foreign wars might have disrupted trade and lowered the return on investment. These alternative explanations can be evaluated using regression analysis and structural break tests. Suppose that investment in a given year depends on these economic conditions and investment in the previous year. The regression model is represented by (1):

$$y_t = \alpha + \beta_1 y_{t-1} + \beta_2 x_{t-1} + \varepsilon_t \qquad (1)$$

where y_t is either proposed or completed investment in year *t*, ε_t is the error term, and x_t includes the real interest rate in *t*, the growth rate of coastal trade in *t*, an indicator for years when there was a foreign war, and an indicator for years when there was a significant harvest failure.[82] The constant term α measures the annual level of investment independent of these other factors. If the Glorious Revolution had no impact on the level of investment after accounting for economic factors, then the parameter estimate for the constant term should be stable before and after 1689. However, if the Glorious Revolution did matter after accounting for these other factors, then the constant term should have been significantly different—and larger—after 1689.

Before conducting the tests it important to establish that the variables in the regression are stationary. Table 7 reports augmented Dickey-Fuller tests. The test statistics indicate that a unit root is rejected for all the variables, indicating they are stationary. Table 8 reports results from a Chow test for a structural break in the constant term in 1689.[83] The F-statistics indicate a strong rejection of the null hypothesis of no structural break in 1689 for proposed and completed investment. They also show that the constant term is significantly larger after 1689.

The significance of the Glorious Revolution is further supported by unknown structural break tests. The Quandt-Andrews unknown structural break test allows the data to identify whether there is any structural break in the constant and if there is a single break which year is most likely to mark the break. In this procedure the Wald F-statistic for a structural break in the constant term is calculated for every year excluding 15% of the years at the beginning or end of the sample. If any of the Wald F-statistics for the intervening years exceeds the critical values

[82] For descriptions of these variables and the sources see the appendix.
[83] A structural break in the constant exists if for some year the coefficient is different before and after. See Hansen, 'The New Econometrics' for a discussion of structural breaks tests.

then there is evidence that at least one structural break exists. The most likely break-date is the year in which the Wald F-statistic attains its maximum value.[84]

The results of the Quandt-Andrews tests are reported in table 9. The Maximum Wald F-statistics are highly significant, suggesting a rejection of the null hypothesis of no structural breaks in proposed and completed investment. They also identify 1692 as the mostly likely structural break in proposed investment and 1695 as the most likely structural break in completed investment. Therefore the data indicate that the years shortly after the Glorious Revolution marked a turning point in both proposed and completed investment even after accounting for changes in interest rates, the growth of coastal trade, or the frequency of war and shocks.

The conclusions are similar in other specifications summarized in table 10.[85] The majority of transport investment involved river improvements, especially before 1730. Column (1) shows that if only completed river investment is included in y_t then the most likely break is 1694. If only proposed river investment is included in y_t then the most likely break is 1662. However, the Wald F-statistics strongly suggest there are two structural breaks, one in 1662 and the other in 1692. This makes sense because the data show a large surge in proposed river investment following the Restoration and the Glorious Revolution. Column (2) examines the break dates after adding more control variables like the inflation rate based on the consumer price index, real wages for craftsman, and population.[86] The most likely break date for completed investment is 1695. The most likely break date for proposed investment is 1662, but once again there is strong evidence for two breaks, one in 1662 and the other in 1692.

[84] See Quandt, 'Tests' and Andrews, 'Tests for Parameter', for details on the Quandt-Andrews test statistic.
[85] The results are the same if Newey-West standard errors are used to correct for auto-correlation.
[86] See the appendix for more details on these variables.

The results are also similar if outliers are dropped. There were five years when completed investment was more than two standard deviations above the mean (1699, 1701, 1719, 1725, and 1726) and five years when proposed investment was more than two standard deviations above the mean (1636, 1662, 1664, 1699, and 1735). Column (3) in table 10 shows that if these years are assumed to have the mean level of investment, then the breaks for proposed and completed investment are still 1692 and 1695.[87] Column (4) shows that the years 1690 and 1695 are the most likely breaks if proposed and completed investments are spread over a four-year period rather than the year the project was initiated. These findings further confirm that years with exceptionally large investment do not change the results. Column (5) shows that if a time trend is included then the most likely break in the constant for completed investment is still 1695. This last finding indicates that the 1690s marked an increase in the level of completed investment even after accounting for the long-run trend in investment and economy-wide factors.[88]

The patterns in the data are consistent with the hypothesis that political changes following the Glorious Revolution lowered risks and that infrastructure promoters and investors responded by initiating and financing more projects. Still there may be questions about causation. One concern is that investment was causing risks to decrease rather than lower risks causing investment to increase. This is certainly possible, but it is not clear why Members of Parliament would want to protect undertakers' rights because more transport investment was occurring. Moreover there is little evidence of such considerations in the Journals of the House of Commons. On the other

[87] The constant for completed investment is 5 times larger after 1689 when outliers are adjusted and it is 5.4 times larger when the raw series is used.

[88] 1692 and 1695 also marked a structural break in the coefficient on the time trend, but there was no structural break in the constant and the time trend simultaneously. This finding indicates that the 1690s did not mark a change in both the level *and* the trend growth of investment. This is not a major concern as it is not clear that both should the level *and* the growth of investment should change at the same time when risks decreased.

hand, the testimony of undertakers for the Salwerpe and Itchen rivers in the 1690s and 1710s clearly indicates that undertakers considered the security of their improvement rights.

Another concern is that some unmeasured component of economic growth was responsible for the Glorious Revolution *and* the rise of transportation investment. The relatively strong economic performance of Britain in the seventeenth century may have provided an impetus for political change but what is most crucial is the timing because structural break tests identify the year when investment patterns change. There was a positive growth rate in coastal trade during the 1680s, but it was not an exceptionally prosperous decade as indicated by the modest deflation in farm prices.[89] General histories also suggest that the Glorious Revolution was triggered by events on the Continent, rising religious tensions, and the birth of a Catholic heir.[90]

An additional concern is that other features of the post-Glorious Revolution environment were responsible for the rise in investment instead of lower risks. While other changes—like Parliament's improved ability to pass legislation—were undoubtedly important, there is additional evidence suggesting that political risks affected investment. According to Wells and Wills Jacobite activity decreased share prices for most joint stock companies in the late 1690s and early 1700s because investors feared that the institutional structure of the economy was at risk.[91] By the same reasoning promoters should have been reluctant to initiate transport projects during the Jacobite Uprisings because a restored Stuart monarchy could have manipulated the rights of turnpike trusts and navigation companies. Once the risk of a Stuart restoration subsided promoters should have been willing to initiate transport projects again.

[89] See the appendix for the data sources on coastal trade and inflation.
[90] For a discussion of events leading up to the Revolution see Holmes, *The Making of a Great Power,* pp. 176-190.
[91] Wells and Wills, 'Revolution, Restoration, and Debt', p 434.

The 1715 Jacobite Uprising was one of the most serious threats to the post-1688 regime. It began in September 1715 and ended in early February 1716.[92] A parliamentary session began in March 1715 and lasted more than a year until June 1716. Five road and river improvement bills were introduced in the months preceding the uprising (March-August 1715).[93] No bills were introduced in the main period of the Uprising (September-January 1715). Only one road bill was introduced in the months immediately following the Uprising (Feburary-June 1716) and it renewed the authority of an existing trust and did not propose any new investment.[94] In the next legislative session—more than year after the Uprising ended—five road and river improvement bills were introduced.[95]

There is a similar pattern surrounding another serious Jacobite Uprising from July 1745 to April 1746.[96] There were eleven road and river improvement bills in the legislative session from November 1744 to May 1745 before the Uprising.[97] There were only three road improvement bills in the session from October 1745 to August 1746, spanning most of the period of the

[92] Holmes and Szechi in *The Age of Oligarchy*, p. 98, date the beginning of the Uprising with the Earl of Mar raising the Jacobite Standard in September 1715 and ending with the dispersal of the Jacobite army on 8 February 1716.
[93] The Kennet river bill was introduced 6 April 1715, the Weaver river bill was introduced on 27 May 1715, the Arundell river bill was introduced on 1 June 1715, the St. Albans road bill was introduced on 2 June 1715, and the Tyburn to Uxbridge road bill was introduced 25 August 1715. See *H. of C. Journals*, XVIII (1715)
[94] The Shoreditch to Enfield road bill was introduced on 17 February 1716. It is was designed to stop toll evasion for an existing turnpike trust. See *H. of C. Journals* ,XVIII (1716), 17 February.
[95] The Derwent river bill was introduced on the 28 February 1717, The Wear river bill was introduced on 9 March 1717, the Highgate and Hampstead road bill was introduced on 15 March 1717, the Kensington and Colnbrook road bill was introduced on 29 March 1717, and the Hockley and Stony Stratford road bill was introduced on 20 May 1717. See *H. of C. Journals*, XVIII (1717).
[96] For a description of the 1745 Uprising see Holmes and Szechi in *The Age of Oligarchy*, p. 99.
[97] The Birmingham-Meriden, Birmingham-Stone Bridge, Boroughbridge-Durham, Hedon roads, Huntingdon-Cambridge, Hull roads, Penreth roads, Shepherds Shord-Devizes, and Speenhamland-Marlborough road bills were introduced in January 1745. The Beverley Beck and Dun river bills were introduced in January 1745. See *H. of C. Journals*, XXIV (1745).

Uprising. Only one of these three bills proposed new investment.[98] In the next legislative session after the Uprising ended, there were fifteen road and river improvement bills.[99]

The decrease in improvement bills during the two main Jacobite Uprisings provides additional support that political risks were a factor influencing infrastructure promoters. Reduced risk may not have been the only novel feature of the post-Glorious Revolution environment, but the evidence suggests it was an important factor.

VI.

The transportation revolution gained speed in the eighteenth and early nineteenth century, but it had its roots in the seventeenth century with the promotion of road and river improvements. This paper argues that the political changes following the Glorious Revolution reduced risk and uncertainty for road and river undertakers and that they responded by initiating and investing in more projects. For most of the seventeenth century, promoters turned to the Crown for patents or to Parliament for acts. Some undertakers lost their rights following major shifts in power like the Civil War and the Restoration. Others were forced to lower their fees and pay damages to local landowners. After 1688 there was a lower likelihood that undertakers' rights would be violated. The low level of proposed and completed investment in the 1600s suggests that promoters were reluctant to invest because of these risks. The Glorious Revolution marked a turning point. Investment surged in the 1690s and remained high in the 1700s and 1710s compared to the

[98] The Gloucester-Stone, Harborough-Loughborough, and Liverpool-Prescot roads bills were introduced in January 1746. The first two proposed to extend the authority of an existing trust. The latter proposed to add and improve new roads. See *H. of C. Journals,* XXV (1746).

[99] The Catterick, Cirencester roads (two bills), Durham roads, Gloucester-Hereford, Newcastle-Buckton, Penrith roads, Reading-Puntfield, Shenfield, Stockton-Barnard, Warrington-Wigan, Wymondham-Attleborough, and York-Durham roads bills were introduced in December 1746, January, and February of 1747. The Salwerpe and Wear river bills were introduced in January, and February of 1747. See *H. of C. Journals,* XXV (1746).

1640s, 1650s, 1670s, and 1680s. The evidence suggests that investment increased in part because undertakers' rights were more secure from government expropriation or manipulation.

The evidence also provides some clues as to why the Glorious Revolution made rights more secure. Perhaps the most important change was the lessening of conflict between the Crown and Parliament. The Jacobite Uprisings presented a threat to the new regime, but on the whole undertakers could be confident that the Crown would not usurp regulatory authority from Parliament. There are also some cases indicating that it was difficult to violate undertakers' rights through acts. Bills altering undertakers' rights had to pass through committees and be approved by both Houses of Parliament. These multi-layered procedures made it costly for local property-owners to demand exorbitant compensation or for users to demand lower tolls after the road or river was improved.

A broader conclusion is that the Glorious Revolution contributed to the transportation Revolution. Acts creating river navigation authorities and turnpike trusts contributed to lower transport costs and generated social savings equaling several percentage points of G.D.P. in the early nineteenth century. Governments in the seventeenth and eighteenth century were ill-equipped to provide these investments. Empowering individuals and local groups through acts offered a second-best approach to implementing investment. The Glorious Revolution provided a political foundation supporting greater investment in transport infrastructure.

Appendix I: Road and River Projects

Projects proposed to Parliament are identified through road and river bills listed in the indices for the Journals of the House of Commons and the Journals of the House of Lords. A list of failed bills from 1660 to 1750 is also available from Hoppit, *Failed Legislation*. Some bills aimed to improve the navigation of a river or to better maintain and improve a road. Others proposed to amend the rights of an existing authority. Based on their description, bills that proposed to improve a road or river were separated from bills that amended existing rights. For rivers I identify whether the bill was for an improvement using the petitions and committee reports. For roads I only included bills that proposed a new turnpike trust.

Projects proposed to the Crown are identified in the Calendar of State Papers, Domestic series, for James I, Charles I, the Interregnum, Charles II, James II, William & Mary, Queen Anne, and George I. The Calendar of State Papers also documents most patents or royal grants of privilege. Priestley and Shead provide information on the length of rivers improved by acts or patents.[100] The data in these two sources were used to determine the number of miles of river that were proposed to be made navigable in each petition. Albert provides data on the length of London roads improved by turnpike acts.[101] A report in the Parliamentary Papers provides information on the length of roads managed by each turnpike trust, including all those formed before 1750.[102] These sources were matched with petitions to determine the number of miles of road that were proposed to be improved.

Some proposals failed to be approved by Parliament or the Crown, and among those that were approved some were not completed. Several sources were consulted to identify the number

[100] Priestley, *Historical Account;* Shead, 'Jim Shead's Waterways Information'.
[101] Albert, *Turnpike Road System*, pp. 224-229.
[102] *Appendix to the Report of the Select Committee on Turnpike Roads and Highways,* (P.P. 1821 IV).

of miles of river that were made navigable through royal grants or acts. These include Willan's description of all navigable rivers at benchmark dates (c. 1600, 1660, 1724) and Priestly and Shead's catalogue of river projects.[103] If an act was approved for a project and no information could be found, then it was assumed that the river project was completed.

The number of miles of road improved through acts was approximated using information in the Journals of the House of Commons. All turnpike acts had to be renewed every 21 years. The petitions for renewal acts usually indicate the progress of improvement. In cases where no renewal act was sought or when it is stated that little progress had been made, then the miles were not counted as being completed; otherwise the mileage approved by an act was counted as being successfully improved.

The details of every road or river improvement proposal before 1689 are summarized in tables 11 and 12. The projects proposed after 1689 are not listed, but they can be readily identified in the Journals of the House of Lords or Commons.

Appendix II: Estimating Road and River Investment and its Determinants

Annual proposed and completed investment is estimated using the average investment per mile for a sample of 12 river navigations and 43 turnpikes trusts.[104] These samples indicate that turnpike trusts invested £160 per mile on average in 1750 prices and river navigations invested £1340 per mile on average in 1750 prices. These figures were multiplied by the number of miles proposed and completed in each project. Completed investments were assumed to have been

[103] See Willan, *River Navigation*, pp. 146-152, Shead, 'Waterways Information', Priestly, *Historical Account*.
[104] Bogart, 'Did Turnpike Trusts', p. 464 and Bogart, 'Were Statutory Authorities', p. 36.

completed immediately, although they were implemented over several years. A moving average can be used to adjust for the completion time. The estimates are not reported here to save space but they are available from the author upon request.

The determinants of investment include the average growth rate of coastal trade, the real return on land, years when there was a foreign war, and years when the wheat harvest was bad or deficient. Ward provides a data series on the growth rate of coastal ships entering and leaving for a sample of 16 ports starting in 1675.[105] Ward also provides data on the number of coastal ships entering and leaving 4 ports (Hull, King's Lynn, Bridgwater, Minehead) before 1675. The annual growth rate of coastal trade up to 1670 was calculated based on Ward's sample and additional data from Southampton and Portsmouth collected in the Public Record Office.[106] The real return on land comes from the Charity Commission records described by Clark.[107] Clark's estimates for each plot were averaged to form the annual series on the rate of return. The inflation rate was then subtracted from the real return on land to get an estimate of the real interest rate.[108] Years when Britain was in a foreign war include the first Anglo-Dutch War (1652-1654), Spanish War (1655-1660), the second Anglo-Dutch War (1665-67), the third Anglo Dutch War (1672-4), the Nine years War (1689-97), the War of Spanish Succession (1702-13), and the War of Jenkins Ear (1739-48).[109] Years when the wheat harvest was bad or deficient are

[105] Ward, *the Financing of Canal Building*, p. 165.
[106] PRO E190 826-1827 and E190 819-827.
[107] Clark, 'Political Foundations', pp. 577-78.
[108] Inflation comes from the Cost of Living index in Clark, 'The Condition of the Working Class', pp. 1324-25.
[109] Smith, *The Emergence*, pp. 307-308, Holmes, *Making of Great Power*, p. 439.

taken from Smith and Holmes.[110] Additional variables include inflation, real wages for craftsman, and population.[111]

Appendix III: Acts altering the Authority of Existing River Undertakers or Turnpike Trusts

Table 13 lists all acts where rights of river undertakers established between 1689 and 1749 were diminished or voided. Table 14 lists all acts where rights of turnpike authorities established between 1689 and 1719 were diminished or voided. Table 15 lists all acts where the rights of river undertakers established between 1606 and 1688 were altered. They were identified by studying all acts relating to road and river improvements in the *Statutes of the Realm* before 1714. The statutes do not contain private acts so these were obtained from the Parliamentary Archives. The Statutes of the Realm also omit most river and turnpike acts after 1714. For these acts the Collection at the Clark Library in Los Angeles was used.

The 1624 act changing undertakers for the Thames near Oxford was coded as a case where undertakers' rights were violated. A 1606 act gave the Lord Chancellor the right to appoint 18 commissioners to oversee the improvement of the river between Oxford and London. One commissioner was to come from Oxford University, one from the city of Oxford, and four from each of the counties of Oxfordshire, Berkshire, Wiltshire, and Gloucestershire. The 1624 Thames act vested sole authority in the commissioners from Oxford, and thus voided the authority of commissioners in Berkshire, Wiltshire, and Gloucestershire.

[110] Smith, *The Emergence*, pp. 436-437, Holmes, *Making of Great Power*, p. 446.
[111] Real wages come from Clark, 'The Condition of the Working Class'. Population comes from Wrigley and Schofield, *A Population History of England*.

There is one act worth noting involving trustees for the rivers Wye and Lugg. An act in l695 named several trustees including the Lord Bishop of Hereford, the Mayor of the City of Hereford, and the Bailiff of Leominster. A second act in 1726 (Public 13 George I, c. 34) states that several trustees have died and no provisions were made for filling up new trustees. The act named a body of trustees including all of the same political or religious office holders as the original act. There are also trustees with the same family name in both acts. There is no clear violation of rights in this act.

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Appendix to the Report of the Select Committee on Turnpike Roads and Highways, (P.P 1821 IV).

Table 1: Proposals to Improver Rivers in the 1620s and 1630s

Panel A: Rivers Proposed to be improved through bills introduced in Parliament	
Yorkshire Ouse	1621
Thames	1621
Wey	1621
Thames	1624
Wey	1624
Colchester haven	1624
Aire and Calder	1626
Medway	1628
Lark	1629
Panel B: Rivers Proposed to be improved through grants by the Crown	
Great ouse, near Bedford	1626
Thames and Severn canal	1633
Soar	1634
Rother	1635
Lark	1635
Avon, in Warwickshire	1636
Teme	1636
Fossdyke	1636
Witham	1636
Tone, Bridgewater to Ham mills	1638
Stour, in Essex	1638

Notes: Bills in Parliament are taken from the sessions beginning in Jan. 1621 through the session beginning in January 1629.

Sources: see appendix table 11 for sources on proposals.

Table 2: Proposals to Improver Rivers 1665 to 1685

Panel A: Rivers Proposed to be improved through bills introduced in Parliament	
Bristol and London	1667
Dee	1669
Weaver	1670
Brandon and Waveney	1670
Witham	1670
Parret and Tone	1673
Derwent in Derby	1675
Derwent in Derby	1677
Vale in Cornwall	1678
Wye and Lugg	1685
Panel B: Rivers Proposed to be improved through grants by the Crown	
Cam	1665
Dee	1666
Dee	1669
Blyth in Northumberland	1682

Notes: Bills in Parliament are taken from the sessions beginning in September 1665 through the session beginning in May of 1685.

Source: see appendix table 11.

Table 3: Acts Violating Rights of River Undertakers established between 1689 and 1749

River Provision in Act	Year
Colne, near Colchester Maximum Tolls reduced by two acts	1718, 1739
Dee Maximum Tolls reduced by act	1743
# of Undertakers established by act between 1689 and 1749	33
Estimated Likelihood that undertakers established between 1689 and 1749 had their rights violated by at least one act after 1689	6%

Sources: see text.

Notes: the Undertakers established by acts between 1689 and 1749 controlled the following rivers and were established by the following public acts: the Wye and Lugg (est. 7 & 8 William III, c. 14), the Colne (est. 9 William III, c. 19), the Tone (est. 10 William III, c. 8), the Dee (est. 11 William III, c. 24), the Lark (est. 11 William III, c. 22), the Trent (est. 10 William III, c. 26), the Aire and Calder (est. 10 William III, c. 25), the Avon and Frome (est. 11 William III, c. 23), Yorkshire Derwent (est. 1 Anne, c. 14), the Cam (est. 1 Anne Statute 2, c. 11), the Stower in Essex (est. 4&5 Anne, c. 2), The Avon from Bath to Hanham Mills (est. 10 Anne, c. 2), the Nene (est. 13 Anne, c. 19), the Kennet (est. I Statute 2, c. 24), the Wear (est. 3 George I, c. 3), Darwent in Derby (est. 6 George I, c. 27), the Douglass (est. 6 George I, c. 28), the Idle (est. 6 George I, c. 30), the Weaver from Frodsham Bridge to Winsford Bridge (est. 7 George I Statute 1, c. 10), the Mercey and Irwell (est. 7 George I Statute 1, c. 15), the Dane (est. 7 George I Statute 1, c. 17), the Eden (est. 8 George I, c. 14), rivers near Great Yarmouth (9 George I, c. 10), The Don from Holmstile to Tinsley (est. 12 George I, c. 38), the Beck (est. 13 George I, c. 4), the Don from Holmstile to Barnby Dun (est. 13 George I, c. 20), Yorkshire Ouse (est. 13 George I, c. 33), Stroudwater (est. 3 George II, c. 13), new undertaker for the Dee (est. 14 George II, c. 8), the Weaver from Winsford Bridge to the Town of Namptwich (est. 7 George II, c. 28), Worsley Brook (est. 10 George II, c. 9), Rodon (est. 10 George II, c. 33), and the Lea from Hertford to Ware (est. 12 George II, c. 32).

Table 4: Political Settlements, Royal Decrees, and Acts Violating the Rights of River Undertakers established between 1605 and 1688

River Act or Decree	Year
Thames Commissioners from Several counties eliminated by new act	1624
Great Ouse (St. Neots to St. Ives) Maximum tolls reduced by decree from Privy Council	1626
Lark Route cut in half by decree from King	1638
Avon (Warwickshire) Patentees rights voided by Commons and later by an act.	1641, 1661
Ouse (Yorkshire) Undertakers rights voided by Restoration Settlement	1661
Wey Undertakers rights voided by Restoration Settlement	1661
Great Ouse (Bedford to St. Neots) Undertakers rights voided by act	1665
# of Undertakers established between 1605 and 1688	21
Estimated Likelihood that undertakers established between 1605 and 1688 had their rights violated by at least one settlement, decree, or act.	33%

Sources: see text.

Notes: the Undertakers established by act or patent between 1605 and 1688 controlled the following rivers and were established in the following acts or patents: the Thames near Oxford (est. Public 3 James I, c. 20), the Great Ouse from St. Ives to St. Neots (est. patent 1617), the Thames near Oxford (est. act 1623, second group of undertakers), the Colchester Haven (est. act 1624), the Soar (est. patent 1634), the Lark (est. patent 1635), the Avon in Warwickshire (est. patent 1636), the Tone (est. patent 1638), Stower (est. patent 1638), Wey (est. act of the Interregnum 1651), Yorkshire Ouse (est. charter Lord Protector, 1657), Stower and Salwerpe (est. private act 14 Charles II, c. 14), Wye and Lugg (est. private act 14 Charles II, c. 15), Bristowe Causey (est. private act 16 & 17 Charles II, c. 6), Avon from Christchurch to New Sarum (est. private 16 & 17 Charles II, c. 11), Medway in Kent and Sussex (est. private 16 & 17 Charles II, c. 12), Itchin, Great Ouse, and Mole (private 16 & 17 Charles II, c. 13), Witham (private 22 & 23 Charles II, c. 25), Wey (est. private 22 & 23 Charles II, c. 26, second set of undertakers), Branden and Waveney (est. private 22 Charles II, c. 16), and Vale (est. private 30 Charles II, c. 20).

Table 5: Acts Violating the Rights of Turnpike Trusts Established between 1689 and 1719

Road Provision in Act	Year
Northfleet to Rochester Trustees forced to pay a subsidy to surveyors on nearby road	1725
Cherrill to Studley Bridge Maximum Tolls Reduced by two acts	1726, 1744
Hockliffe to Woborne Maximum Tolls Reduced by act	1728
Shepards Shord to Horsley Trustees eliminated by act	1729
Stokenchurch to Oxford Maximum Tolls reduced by act	1740
Fornhill to Stony Stratford Road Trustees eliminated by act	1740
# of Turnpike Trusts created between 1689 and 1719	34
Estimated Likelihood that turnpike trustees established between 1689 and 1719 had their rights violated by at least one act	18%

Sources: see text.

Notes: Tusts established by acts between 1689 and 1719 controlled the following roads and were established by the following public acts: Wadesmill to Stilton (est. 4 WM, c. 9), Shenfield to Harwich (est. 7,8 WM c.9), Wymondham to Attelborough (est. 7,8 WM c.26), Reigate to Crawley (est. 8,9 WM c.15), Gloucester to Birdlip Hill (est. 9 WM c.18), Woodford to Thornwood (est. 1 A 2 c.10), Barnhill and Hutton Heath (est. 4,5 A c.26), Fornhill to Stoney Straford (est. 6 AN c.4), Hockliffe to Woburn (est. 6 AN c.13), Bath roads (est. 6 AN c.42), Cherill to Studley Bridge (est. 6 AN c.76), Stratford to Dunchurch (est. 6 AN c.77), Sevenoaks to Tunbridge Wells (est. 8 AN c. 20), Stoke Goldington to Northampton (est. 8 AN c. 9), Dunstable and Hockliffe (est. 9 AN c.34), Petersfield to Portsmouth (est. 9 AN c.33), Royston to Wandsford Bridge (est. 9 AN c.14), Ipswich to Cleydon (est. 10 AN), Highgate to Barnet (est. 10 AN c.4), Kilburn Bridge to Sparrow Herne (est. 10 AN c.3), Northfleet to Rochester (est. 10 AN c.16), St. Leonard to Chestnut (est. 12 AN c.19), Reading to Puntfield (est. 13 AN c.28), Shepherd Shord to Bagdon (est. 13 AN c.17), Tittensor to Butlane (est. 13 AN c.31), Worcester to Droitwich (est. 13 AN c.27), St. Albans to South Mimms (est. 1 GI c.12), Tyburn to Uxbridge (est. 1 GI 25), St. Giles to Hornsey, Islington to Highgate (est. 3 GI c.4), Kensington to Cranford Bridge (est. 3 GI c.14), Maidenhead Bridge to Henley (est. 4 GI c.6), Reading to Basingstoke (est. 4 GI c.7), Beaconsfield to Stokenchurch (est. 5 GI c.1), and Stokenchurch to Woodstock (est. 5 GI c.2).

Table 6: Summary of River Undertakers with Rights from Patents and Acts before 1689

River	Original undertaker	Year Granted	Completed	Rights changed by act, 1689-1749
Great Ouse, St. Neots to St. Ives	Jason Gason	1617	Yes	Act in 1719 gives undertaker in 1687 more rights.
Thames, near Oxford	Commissioners	1623	Yes	Acts in 1694 and 1729 renew authority
Colne, near Colchester		1623	No	Act in 1698 names undertakers
Great Ouse, near Bedford	Arnold Spencer	1627	No	None
Soar	Thomas Skipworth	1634	No	None
Lark	Henry Lambe	1635	No	Act in 1698 names new undertakers.
Avon, Warwickshire	William Sandys	1636	Yes	None
Tone	John Mallet	1638	Yes	Act in 1698 establishes new undertakers. Undertakers compensate patentees who renewed rights in 1684
Stour in Essex	Arnold Spencer	1638	No	Act in 1705 names new undertakers
Wey	James Pitson	1651	Yes	None
Yorkshire Ouse		1657	No	Act in 1725 names new undertakers, but old undertakers rights were already voided by Restoration.
Stower and Salwerpe	Sir Thomas Baldwyn	1662	Yes	None
Wye and Lugg	William Sandys	1662	No	Act in 1695 voids Sandy family rights
Bristowe Causey	Henry Hastings	1664	No	None
Avon, Christchurch to New Sarum	Lord Keeper of the Seal	1664	Yes	None
Medway in Sussex	Lord McCoskery and others	1665	No	Act in 1739 names new undertakers
Itchen, Great Ouse near Bedford, and Mole	Sir Humphrey Bennet and Others	1665	Itchen only	None
Witham	Mayor Lincolnshire	1670	Yes	None
Bradon and Waveney	Mayor of Yarmouth	1670	No	None
Vale	Charles Erebanion	1678	Yes	None

Sources: see text.

Table 7: Augmented Dickey Fuller Tests for Unit Root

Variable	Test Statistic	P-Value
Proposed Investment	-5.72	0.00
Completed Investment	-9.48	0.00
Growth of Coastal Trade	-3.49	0.01
Indicator for Foreign War	-3.83	0.00
Indicator for Bad Harvest	-6.22	0.00
Real interest Rate	-8.18	0.00

Notes: If the test statistic exceeds a critical value then the unit root hypothesis is rejected and the variable is said to be stationary. The unit root is rejected for all variables.

Table 8: Chow test for a Structural Break in Proposed and Completed Investment in 1689

Null Hypothesis: No Structural Break in the constant term in 1689	
Proposed investment	
F-statistic	11.37
Prob. F(1,137)	0.001
Period	Constant (standard error)
1605-1688	3676 (10,505)
1689-1749	49,057 (16,525)
Completed investment	
F-statistic	23.03
Prob. F(1,137)	0.000
Period	Constant (standard error)
1605-1688	3494 (2326)
1689-1749	21,532 (8629)

Notes: The Chow test is conducted for the constant term α in regression (1). The constant term for 1605 to 1688 is estimated using observations only from these years. The constant term for 1689 to 1749 is estimated using observations only from these years.

Table 9: Quandt-Andrews test for Unknown Structural break in the Constant

Proposed investment	
Maximum Wald F-statistic	13.93
Probability	0.004
Year when Wald-F-statistics is maximized	1692
Completed investment	
Maximum Wald F-statistic	31.99
Probability	0
Year when Wald-F-statistics is maximized	1695

Notes: The tests statistics are calculated using software in Eviews. The program calculates probabilities calculated using the method in Hansen, 'Approximate Asymptotic P-Values'.

Table 10: Alternative Specifications for the Quandt-Andrews test for an Unknown Structural Break in the Constant

	(1) river investment only	(2) more control variables added	(3) outlier years replaced with mean	(4) investment spread over four years	(5) time trend included
Proposed investment					
Maximum Wald F-statistic	8.92	10.61	28.42	7.93	4.7
Probability	0.043	0.02	0	0.068	0.28
Year when Wald-F-statistics is maximized	1662	1662	1692	1690	1692
Completed investment					
Maximum Wald F-statistic	19.15	23.11	35.01	15.36	10.59
Probability	0.003	0	0	0.002	0.02
Year when Wald-F-statistics is maximized	1694	1695	1695	1695	1695

Notes: The tests statistics are calculated using software in Eviews. The program calculates probabilities calculated using the method in Hansen, 'Approximate Asymptotic P-Values'.

Table 11: Proposals for River Improvement, 1606-1688

River	Year	Miles	completed	Source
Avon	1606	12	0	*JHC: volume 1: 1547-1629*, pp. 273, 24 February 1606.
Thames	1606	15	0	*JHC: volume 1: 1547-1629*, pp. 299, 16 April 1606.
Great ouse, St. Neots to St. Ives	1617	23	1	Summers, *Great Ouse*, p. 48.
Avon, bath to Bristol	1619	12	0	CSP, Domestic*: James I, 1619-23*, pp. 57-68, July 1619.
Yorkshire Ouse	1621	18	0	*JHC: volume 1: 1547-1629*, pp. 605-606, May 1621.
Thames	1621	15	0	*JHL: volume 3: 1620-1628*, pp. 37-38, 6 March 1621.
Wey	1621	20	0	*JHC: volume 1: 1547-1629*, pp. 560-561, 17 March 1621.
Thames	1624	15	1	*JHC: volume 1: 1547-1629*, 19 March 1624.
Wey	1624	20	0	*JHC: volume 1: 1547-1629*, pp. 704, 14 May 1624.
Colchester haven	1624	5	0	*JHC: volume 1: 1547-1629*, 04 May 1624.
Aire and Calder	1626	25	0	*JHC: volume 1: 1547-1629*, pp. 836-837, 15 March 1626.
Great ouse, near Bedford	1626	10	0	*CSP: Charles I, 1625-26*, pp. 299-311, April 1-15, 1626.
Medway, maidstone to penhurst	1628	22	0	*JHL: volume 3: 1620-1628*, pp. 781-782, 6 May 1628.
Lark, Bury to the Ouse	1629	14	0	*JHC: volume 1: 1547-1629*, pp. 931-932, 20 February 1629.
thames and severn canal	1633	60	0	*CSP: Charles I, 1633-4*, pp. 41-61, May 1-17, 1633.
Soar, leceicester and trent	1634	16	0	Willan, *River Navigation*, p. 26.
Rother, bodiham to rye	1635	20	0	*CSP: Charles I, 1635*, pp. 51-76, May 1-16, 1635.
Lark, Bury to the Ouse	1635	14	0	*CSP: Charles I, 1635*, pp. 519-559, December 1-13, 163.
Avon, in Warwickshire	1636	25	1	*CSP: Charles I, 1635-6*, pp. 521-549, June 1-9, 1636.
Teme towards Ludlow	1636	40	0	*CSP: Charles I, 1635-6*, pp. 264-292, March 1-12, 1636.
fossdyke, enlargement	1636	11	0	*CSP: Charles I, 1636-7*, pp. 254-268, Undated 1636.
Witham, boston to washingborough	1636	30	0	*CSP: Charles I, 1636-7*, pp. 254-268, Undated 1636.
Tone, Bridgewater to Ham mills	1638	11	0	Willan, *River Navigation*, p. 27.
Stour, in Essex	1638	23	0	*CSP: Charles I, 1637-8*, pp. 289-314, March 1-18, 1638.
Wye	1641	20	0	*JHC: volume 2: 1640-1643*, pp. 89, 19 February 1641.
Arrundel, to the Thames	1641	13	0	*JHL: volume 4: 1629-42* , pp. 167, 19 February 1641.
Welland, stamford to deeping	1650	10	0	*JHC: volume 6: 1648-1651*, pp. 507, 11 December 1650.
Wey	1650	20	1	*JHC: volume 6: 1648-1651*, pp. 515, 26 December 1650.
Wye and Lugg	1651	20	0	*JHC: volume 6: 1648-1651*, pp. 542, 26 February 1651.
Ouse in Yorkshire	1651	18	0	*JHC: volume 6: 1648-1651*, pp. 542, 26 February 1651.
Darwent in Yorkshire	1651	38	0	*JHC: volume 6: 1648-1651*, pp. 542, 26 February 1651.
avon, bath to Bristol	1654	12	0	*CSP: Interregnum, 1654*, pp. 194-232, June 1654.
Wye and Lugg	1656	20	0	*CSP: Interregnum, 1655-6*, pp. 88-154, January 1656.
Ouse in Yorkshire	1657	18	0	*JHC: volume 7: 1651-1660*, pp. 504-505, 16 March 1657.
Avon, bath to Bristol	1657	12	0	*JHC: volume 7: 1651-1660*, pp. 510-511, 24 March 1657.
Nyne	1657	25	0	*JHC: volume 7: 1651-1660*, pp. 536-537, 21 May 1657'.

Avon, bath to Bristol	1658	12	0	*JHC: volume 7: 1651-1660*, pp. 588, 26 January 1658.
Dee	1660	8	0	*CSP: Charles II*, 1660-1, pp. 372-400, November 1660.
Stower and Salwerp	1661	20	1	*JHL: volume 11: 1660-1666*, pp. 249-251, 11 May 1661.
London to Bristol	1662	50	0	*JHC: volume 8: 1660-1667*, pp. 369-370, 21 February 1662.
Avon, Salisbury to Christ Church	1662	36	0	*JHC: volume 8: 1660-1667*, pp. 369-370, 21 February 1662.
Yorkshire Ouse	1662	18	0	*JHC: volume 8: 1660-1667*, pp. 369-370, 21 February 1662.
Wye and Lugg	1662	20	0	*JHC: volume 8: 1660-1667*, pp. 389-390, 19 March 1662.
Great Ouse, near Bedford	1663	23	0	*JHC: volume 8: 1660-1667*, pp. 447-448, 10 March 1663.
Mersey and Weaver	1663	20	0	*JHC: volume 8: 1660-1667*, pp. 444, 5 March 1663.
Vale in Cornwall	1664	10	0	*JHC: volume 8: 1660-1667*, pp. 570, 1 December 1664.
Darwent	1664	10	0	*JHC: volume 8: 1660-1667*, pp. 575-576, 13 December 1664.
Bristol and London	1664	50	0	JHC*: volume 8: 1660-1667*, pp. 546, 19 April 1664.
Bristol and London	1664	50	0	*JHC: volume 8: 1660-1667*, pp. 570-571, 2 December 1664.
Avon, to Christ Church	1664	36	1	*JHC: volume 8: 1660-1667*, pp. 575-576, 13 December 1664.
Bristowe Causey into thames	1664	16	0	*JHL: volume 11: 1660-1666*, pp. 635, 9 December 1664.
Itchen	1664	10	1	*JHL: volume 11: 1660-1666*, pp. 638, 15 December 1664.
ouse, lewes to Newhaven	1664	10	0	*CSP*: Charles II, 1663-4, pp. 631-657, July 1664.
Medway	1665	22	0	*JHL: volume 11: 1660-1666*, pp. 644, 19 January 1665.
Great ouse, near Bedford	1665	23	0	Summers, *the Great Ouse*, p. 53
Mole	1665	20	0	*JHL: volume 11: 1660-1666*, pp. 638, 15 December 1664.
Cam	1665	7	0	*CSP: Charles II, 1665-6*, pp. 38-58, November 1-14, 1665.
Dee	1666	8	0	*CSP: Charles II*, 1665-6, pp. 424-441, June 1-14, 1666.
Bristol and London	1667	50	0	*JHC: volume 9: 1667-1687*, pp. 6, 22 October 1667.
Dee	1669	8	0	*CSP: Charles II, 1668-9*, pp. 258-305, April 1669.
Dee	1669	8	0	*JHC: volume 9: 1667-1687*, pp. 109, 19 November 1669.
Weaver	1670	20	0	*JHC: volume 9: 1667-1687*, pp. 186-187, 20 December 1670.
Brandon and Waveney	1670	23	0	*JHC: volume 9: 1667-1687*, pp. 130-131, 2 March 1670.
Witham, boston to trent	1670	30	1	*JHC: volume 9: 1667-1687*, pp. 159-160, 3 November 1670.
Parret and Thone, Bridgewater to Bradford Bridge	1673	22	0	*JHL: volume 12: 1666-1675*, pp. 539-541, 1 March 1673.
Derwent in Derby	1675	10	0	*JHC: volume 9: 1667-1687*, pp. 368-369, 6 November 1675.
Derwent in Derby	1677	10	0	*JHC: volume 9: 1667-1687*, pp. 393, 6 March 1677.
Vale in Cornwall	1678	10	1	*JHC: volume 9: 1667-1687*, pp. 453-454, 14 March 1678.
Blyth in Northumberland	1682	8	0	*CSP Domestic: Charles II, 1682*, pp. 279-321, July 1682.
Wye and Lugg	1685	20	0	*JHC: volume 9: 1667-1687* (1802), pp. 739-741, 18 June 1685.

Sources: see text.

Notes: JHC is the Journal of the House of Commons, JHL is the Journal of the House of Lords, and CSP is the Calendar of State Papers, Domestic Series.

Table 12: Proposals for road Improvement, 1606-1688

Road	Year	miles	completed	Source
Between London and watford	1605	15	1	*CSP: James I, 1603-1610*, pp. 265-277, Dec., 1605.
Between Nonsuch and Talworth	1606	40	0	*JHC: volume 1: 1547-1629*, pp. 288, 21 March 1606.
Between London, royston and newmarket	1609	25	1	*CSP: James I, 1603-1610*, pp. 524-540, July, August, 1609.
Between Highgate and Barnet	1610	6	1	*CSP: James I, 1603-1610*, pp. 590-605, March, April 1610.
Biggleswade	1610	12	0	*JHC: volume 1: 1547-1629* , pp. 403, 01 March 1610.
Between Puckeridge and Royston	1612	13	1	*CSP: James I, 1611-18*, pp. 109-117, January 1612'.
Hertfordshire Roads	1622	5	1	*CSP: James I, 1619-23*, pp. 401-418, June 1622.
Near Biggleswade Bedfordshire'	1622	12	0	Emmison, 'the First Turnpike Bill'.
Between chelsea and fulham	1626	5	1	*CSP: Charles I, 1625-26*, pp. 533-582, Appendix.
between Maidenhead and Reading and Maidenhead and Henley	1634	20	1	*CSP: Charles I, 1633-4*, pp. 537-559, April 1-19, 1634.
London and Middlesex roads	1650	25	0	JHC: volume 6: 1648-1651, pp. 442-443, 18 July 1650.
London, near East Smithfield and the tower	1650	5	0	*JHC: volume 6: 1648-1651* , pp. 486-487, 23 October 1650.
Near Standon Bedfordshire	1661	15	0	*JHC: volume 8: 1660-1667* , pp. 292-294, 6 July 1661.
Great North Road in Cambridge	1663	15	1	*JHC: volume 8: 1660-1667*, pp. 455, 21 March 1663.
Watlingstreet Road near Bedford	1663	15	0	*JHC: volume 8: 1660-1667*, pp. 438-439, 23 Feb. 1663.
Standon Road	1663	15	0	*JHC: volume 8: 1660-1667*, pp. 455, 21 March 1663.
London to Chester	1664	170	0	*JHC: volume 8: 1660-1667*, pp. 583-584, 17 January 1665.
Highways in Bedford, Bucks, Northampton, and Warwick	1664	50	0	*JHC: volume 8: 1660-1667*, pp. 570, 1 December 1664.

Sources: see text.

Notes: JHC is the Journal of the House of Commons, JHL is the Journal of the House of Lords, and CSP is the Calendar of State Papers, Domestic Series.

Table 13: Acts altering the rights of River Undertakers created between 1689 and 1749

River Public Act	year	Details
Channel from Colchester to Wivenhoe/ 5 George I, c. 31	1718	Extension initiated by a petition from Mayor, Aldermen, Assistants, and Common-Council of Colchester, who served as undertakers for the earlier act. They stated that they had an outstanding debt of 12,000 pounds and could not repay the debt without an extension of their authority. An act was passed extending their rights for another 21 years. The tolls were reduced on all commodities.
Channel from Colchester to Wivenhoe/ 13 George II, c. 30	1739	Extension initiated by the commissioners of the act and the city leaders of Colchester. They request that their powers be extended for another 21 years so they can maintain a lock. The act was passed extending their rights for another 21 years. Toll on coal was reduced further to 3 pence.
Dee/ 17 George II, c. 28	1743	Amendment initiated by mayor and citizens of Chester requesting that the tolls on the river be reduced to encourage trade. The Dee company also submitted a petition consenting to the reduction in tolls. The act was passed reducing the tolls on all types of vessels.

Sources: See text.

Table 14: Acts altering rights for Turnpike Trusts created between 1689 and 1719

Road Public Act	Year	Details
Hockliffe to Woborne, 1 GII 10	1728	Original act names Bedfordshire JPs as trustees. First renewal initiated in year that the original act was set to expire. J.P.'s state that roads still need repair. Act is passed extending the term for 21 years and transferring authority to a body of trustees. Tolls on wagons and coaches are reduced.
Fornhill to Stony Stratford, 13 GII 9	1740	Original act names 33 trustees. Creditors state that they borrowed 6400 pounds, but cannot be paid unless the term is extended and the tolls are increased. Act is passed extending the term of the original act to 30 years. It also requires that trustees borrow new funds and repay creditors; otherwise the creditors could take receivership of the tolls. Trustees were unable to borrow and creditors took over temporarily, before commissioners appointed a new body of trustees. Second Act is passed extending the term for 23 years. Authority is vested in the trustees for the first act and those who took over after receivership. The rights vested in third act expired in 1739. A new act was initiated by inhabitants of Buckinghamshire and Bedfordshire stating that the road was still out of repair. It named a new body of trustees.
Cherrill to Studley Bridge, 12 GI 7, 17 GII 24	1726, 1744	Original act names Wiltshire JPs as trustees. First renewal act initiated 2 years before original act was set to expire. J.P.'s state that term needs to be extended to repay the 5000 pounds in debts. Act is passed extending term for another 21 years. The tolls on cattle are reduced, all others remain unchanged. Second renewal is initiated 3 year before previous act expired. J.P.'s state that the term needs to be extended to pay off a debt of 700 pounds. The act is passed extended the term for another 21 years. The tolls are reduced on coaches.
Northfleet to Rochester, 11 GI 5	1725	Original act names JPs as trustees. First renewal is initiated one year before original act is set to expire. JP's petition that road cannot be further improved unless term is extended. JP's from eastern portion of Kent also petition that tolls should be used to pay for road from Chatham and Boughton under the Bleane. Act is passed extending the term. It also requires JP's to pay a subsidy to surveyors on road from Chatham and Boughton under the Bleane.
Shepards Shord to Horsley, 2 GII, c. 12	1729	Original act names JPs as trustees. The first amendment act is initiated six years before it was set to expire. Trustees petition that debts cannot repaid and road cannot be repaired if the term is not extended. After the second reading the committee reviewing the bill is instructed by someone in the House that "they have power to provide in the bill that the trusts, by the former act shall cease and determine, and that proper powers, for the effectual amending the highways, directed to be repaired by the former act, be vested in other trustees." Act is passed naming a new body of trustees.
Stokenchurch to Oxford, 13 GII 15	1740	Original act names trustees. First renewal act was initiated in the year the original act was set to expire. Trustees petition that the term needs to be extended to keep the road in repair. MP reported from the committee that the debts had been paid off. Act is passed extending the term. The tolls on coaches are reduced.

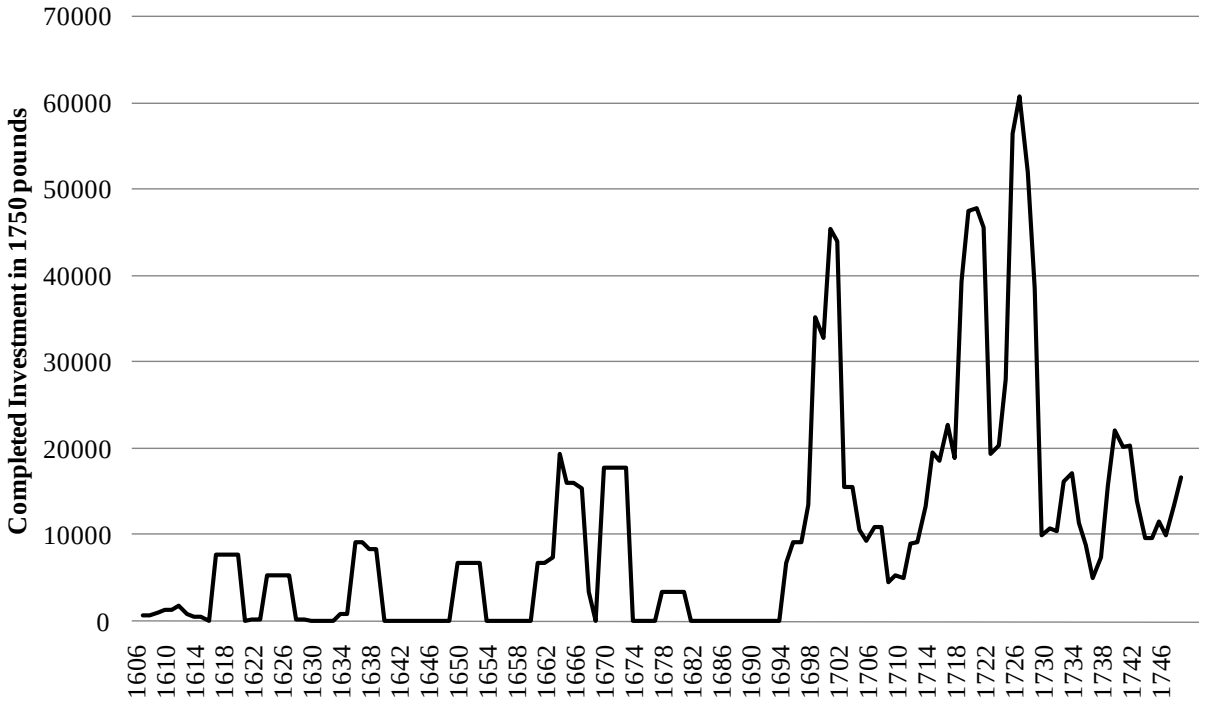
Sources: see text.

Table 15: Acts after 1689 altering rights for River Undertakers created between 1605 and 1688

River, Act	Year	Details
Great Ouse, St. Neots to St. Ives, 6 G I, c. 29	1719	Original undertaker Jason Gason had sold rights to Arnold Spencer. Spencer lost his rights to his creditors in 1650s. Samuel Jemmatt purchased the rights from Spencer's creditors. Henry Ashley purchased Jemmatt's rights in the 1680s, but it was disputed. Court case in 1687 split ownership between Jemmatt and Ashley. Ashley is given further powers to improve the river by the act in 1719.
Thames, near Oxford, 6&7 WM	1694, 1729	Original Commissioners in Oxford are named to oversee improvements by act in 1624. Act in 1694 allows Justices of the Peace the right to regulate water carriage rates on the Thames. The act does not change the authority of commissioners near oxford, but it does allow for appeals to the Justices of Assize for Oxfordshire. The 1729 act renews the provisions of the 1694 act.
Colne, near Colchester, 9 William III, c. 19	1698	Act in 1698 establishes the mayor's of Colchester's authority to improve the Colne. The original undertaker is not known.
Lark, 11 William III, c. 22	1698	Henry Lambe was originally given rights to improve the Lark. The 1698 act gave Henry Ashley authority as undertaker. There is no mention of Lambe's patent in the act or in the petitions to Parliament.
Tone, 10 William III, c. 8	1698	John Mallet originally had a patent for the Tone. The patent was renewed by Mallets heirs in 1684. The 1698 act named new undertakers. The act confirmed the conveyance of rights in the Tone from Mallet's heirs to the new undertakers.
Stour, 4&5 Anne, c. 2	1705	Arnold Spencer was originally given a patent for the Stour. Act in 1705 names new undertakers. Assignees of patent John Little and Benjamin Dodd lose authority.
Yorkshire, 13 George I, c. 33	1725	Undertakers received rights by charter from Cromwell. Their rights were voided by Restoration settlement. Act in 1725 names city leaders as undertakers
Wye and Lugg, 7 & 8 William III, c. 14	1695	Sandys family originally has rights by an act in 1662. 1695 act names new undertakers.
Medway, 13 George II, c. 26	1739	Lord McCoskory and others are original undertakers. Committee for 1739 act states they did not complete the navigation. 1739 act names new body of undertakers.

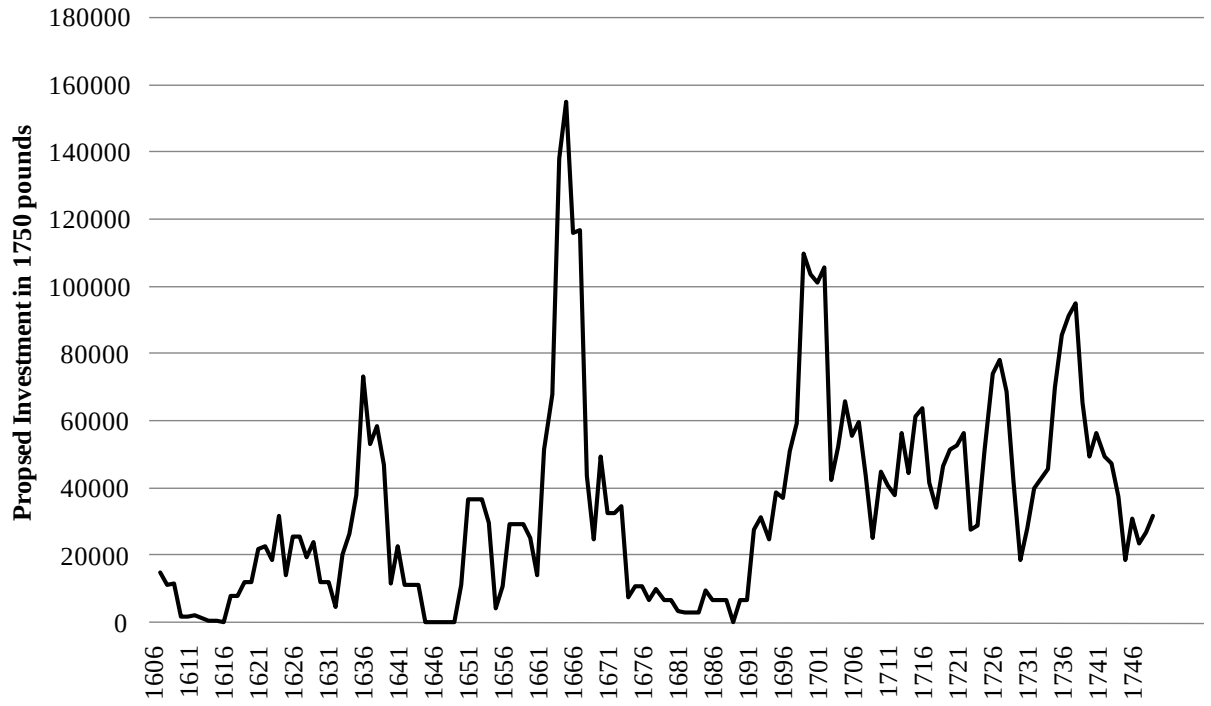
Sources: see text.

Figure 1: Four-Year Moving Average of Completed Investment in Road and River Improvements, 1607-1749



Sources: see appendix
Notes: The four-year moving average is equal to the average of completed investment in t-3, t-2, t-1, and t.

Figure 2: Four-year Moving Average of Proposed Investment in Road and River Improvements, 1607-1749



Sources: see appendix
Notes: The four-year moving average is equal to the average of proposed investment in t-3, t-2, t-1, and t.