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 argues that it contributed to the early transport revolution. First, it shows that the regulatory environment became more favorable for undertakers with their rights being better protected. Second it shows that investment in improving roads and rivers increased substantially in the mid-1690s shortly after the Glorious Revolution. Regression analysis and structural breaks tests confirm that there was a change in investment even after controlling for other determinants of investment. The results have implications for the debates on the role of political change in British economic growth.

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

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.[1] 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. A number of scholars express skepticism that the Revolutionary settlement made property rights more secure and fostered Britain's economic growth.[3] Some argue that the post-1689 regime might have even hampered financial development and international trade.[4]

Most studies on political change and economic development in Britain focus on government or private borrowing, taxation, and the stock market.[5] Infrastructure investment has received little discussion by comparison. Its omission from the literature is significant because infrastructure provides an excellent sector to test the effects of political risks. The literature on twentieth century infrastructure projects abounds with examples of political actors voiding investors' rights, lowering the maximum fees chargeable to users, or redistributing profits to interest groups. A recent study found that over a third of Latin American water and transport concession contracts in the 1990s and 2000s were renegotiated by governments.[6] Economic theory suggests that private infrastructure investors are especially prone to renegotiation because

[1] See Pincus, *1668: The First Modern Revolution*, for an argument that the Glorious Revolution led to fundamental changes in British society and political economic thought.
[2] North and Weingast, 'Constitutions and Commitment' and Ekelund and Tollison, *Politicized Economies*.
[3] Epstein, S.R., *Freedom and Growth*, pp. 22-37 and Clark, 'Political Foundations'.
[4] Temin and Voth, 'Private Borrowing,' and Zahedieh, 'Regulation, Rent-Seeking'.
[5] Sussman and Yafeh,' Institutional Reforms', Quinn, 'The Glorious Revolution', O'Brien, 'Fiscal Exceptionalism', Wells and Wills, 'Revolution and Restoration', Klerman and Mahoney, 'The Value of Judicial Independence'.
[6] Gausch, Laffont, and Straub, 'Concessions of Infrastructure', p. 1276.

once a project is begun it is irreversible. They are likely to forgo or delay projects if they expect that their rights will be weakly protected.[7]

This paper studies the effects of the Glorious Revolution on early efforts to improve roads and rivers. It examines the regulatory environment facing road and river undertakers from the start of the seventeenth century to the mid eighteenth century and investigates how politics affected investment. Improvements were proposed and undertaken by individuals and local governments acting through navigation companies and turnpike trusts. Acts of Parliament and patents established a legal monopoly over a project, set a maximum schedule of tolls, and set procedures for resolving disputes with users and landowners.

A key feature of the seventeenth century was the dual system of regulatory authority. The Crown and Parliament provided competing systems for obtaining and enforcing improvement rights. In the early 1600s, promoters turned to the Crown when it governed more independently and they turned to Parliament when King James and Charles reluctantly called it into session. Regulatory authority shifted to the House of Commons after the Civil War and for a brief period to Lord Protector Oliver Cromwell. Following the Restoration of the monarchy most rights were initiated through acts of Parliament, but King Charles II still exercised significant influence.

Political conflicts combined with the dual systems of authority contributed to an uncertain regulatory environment. Several undertakers had their rights purged following political changes like the Civil War and the Restoration. The Crown's procedure for resolving local disputes between undertakers, users, and landowners also lacked transparency and was at times

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

influenced by politics. Lastly, it was difficult to obtain new rights when it was unclear whether the Crown or Parliament controlled the supply of rights.

The Glorious Revolution changed the regulatory environment substantially. From the 1690s Parliament met annually and all improvement rights were initiated in the House of Commons. The Crown had little direct influence other than to approve bills for transport rights. The Revolution helped to provide a regular and increasingly effective forum for supplying improvement rights.

There were also significant changes in the protection of rights after the Glorious Revolution. Unlike earlier political changes there were few purges of undertakers who obtained rights from the Crown or Parliament in previous decades. Moreover, it was relatively uncommon for new river navigation authorities and turnpike trustees to have their rights voided or their maximum tolls revised downwards by Parliament after their original rights were established by an act.

The improved regulatory environment following the Glorious Revolution contributed to an increase in investment. The effects of political change are illustrated by a new data set on annual investment in roads and rivers. A preview of the findings is illustrated in Figure 1 which shows that the average level of investment increased substantially after the mid-1690s. The discontinuity shortly after the Glorious Revolution is robust to dropping years of exceptional investment and to controlling for other determinants of transport investment. Regression analysis and unknown structural breaks tests show that the mid-1690s marked an increase in the level of investment even after accounting for the effects of interest rates, coastal trade growth, population growth, real wages, harvest failures, and foreign wars. Thus the evidence strongly suggests that the Glorious Revolution contributed to early transport investment.

This paper contributes to several literatures. First, the findings 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 increased.[8] This paper extends their work in several ways. It identifies all cases of rights violations in Parliament using a new data set of all acts affecting road and river improvement from 1600 to 1749. It also adds new information on regulation from sources like the Calendar of State Papers and the Journals of the House of Commons and Lords.

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 because they capture differences in implementation and the amount of investment approved across acts, patents, and petitions. The data series also helps to resolve the issue of whether the Glorious Revolution or other economic factors stimulated investment. There is no current consensus on the role of politics in stimulating investments in the transport revolution.

Second, the findings add to the literature on parliamentary acts. In the eighteenth and early nineteenth century there were substantial numbers of 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 another contributing factor was the greater protection of rights, which effectively raised the demand for acts among individuals and local communities.

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

Lastly, this paper gives a new perspective on the economic effects of the Glorious Revolution. There are few works showing that economic indicators changed in the 1690s. For example, Clark shows that the rate of return on land was unaffected by political events in the 1690s.[11] The regression results presented here provide evidence that transport investment increased in the 1690s even after controlling for other factors that might have stimulated investment. Better roads and rivers substantially reduced transport costs and generated great benefits to property-owners and investors.[12] The paper thus provides the first time series evidence that the Glorious Revolution influenced a sector that was arguably necessary for Britain's economic development.

The paper is organized as follows. Section I provides more details on the nature and organization of transportation investment. Sections II, III, and IV examine the regulatory history of early transport improvements. Sections V and VI focus on the changes in investment.

I.

The British transportation sector was revolutionized in the eighteenth and nineteenth centuries. Increased investment in canals and railways played a key role along with technological changes like the invention of steam locomotives and steel hulls. In the seventeenth century, the vanguard investments of the transport revolution were extensions to river navigation through dredging, diverting, and making new cuts to tidal rivers as well as the widening and repairing of major roads into London and other emerging cities. Contemporaries noted the ingenuity underlying these investments. Daniel Defoe, for example, describes how parts of the river Trent were made navigable by the help of 'art.'

[11] Clark, 'Political Foundations'.
[12] See Willan, *River Navigation*, Albert, *Turnpike Road System*, Pawson, *Transport and Economy*, Gerhold, 'Productivity Change', Bogart, 'Turnpike Trusts and Property Income'.

> The Trent is navigable by ships of good burthen as high as Gainsborough….The barges without the help of locks or stops go as high as Nottingham, and farther by the help of art, to Burton upon Trent in Staffordshire. The stream is full, the channel deep and safe, and the tide flows up a great way between Gainsborough and Newark.[13]

Defoe goes on to emphasize the importance of the River Trent for inland trade:

> [The River Trent navigation]…is a great support to, and increase of the trade of those counties which border upon it; especially for the cheese trade from Cheshire and Warwickshire, which have otherwise no navigation but about from West Chester to London.

Most early transport investments were undertaken by individuals, partners, or local governments. The Crown and Parliament did little to foster publically financed infrastructure. Undertakers' aims were diverse, but often they sought direct personal gain. Richard Weston provides one example. Inspired by waterway works in the Low Countries, Weston sought to improve navigation on the river Wey in the 1630s. The project provided opportunity for substantial returns because it linked a rich agricultural region in Surrey with the river Thames and ultimately London. Weston supplied half of the initial capital for the navigation project. The remaining £3,000 came from three investors, James Pitson, Richard Scotcher and Richard Darnelly, who were members of the local business and political community.[14]

Local economic development was another motivating factor. Towns and communities often spearheaded road and river improvements with the explicit purpose of improving local transport links. However, even in these cases, it appears that prominent locals considered the private benefits they would receive in terms of higher property values or increased profits.[15]

In most cases it was necessary for undertakers to obtain improvement rights (a.k.a. rights of way). The need to purchase land and the specificity of projects created the potential for a 'hold-

[13] Defore, *A Tour*, Letter 8, Part 1: The Trent Valley
[14] See River Wey & Navigations : An historical background to the Wey Navigations.
[15] See Bogart, 'Turnpike Trusts and Property Income' for a discussion of trustee and investor motivations.

up' problem in which landowners charged undertakers excessive prices. Improvement rights gave formal authority to implement a project and outlined mechanisms for transferring land and resolving disputes. Disputes were common in river improvement, as flooding posed risks to lands and weirs had to be removed which dammed up rivers for power and fishing.

One way of obtaining improvement rights was to approach the Crown. In Common Law all highways and tidal rivers belonged to the Crown, so only the monarch could grant rights to alter royal infrastructure and charge tolls. If the Crown was favorable it could grant the undertaker a patent or similar type of royal privilege to undertake a specific project and collect tolls in perpetuity.[16] Patents also named a body of local commissioners who made recommendations concerning tolls and compensation for damages to landowners. In return, patentees often made annual financial payments to the Crown. The official payments for patents were often modest in their amount, but the unofficial payments could be more substantial.[17]

Parliament provided an alternative venue for obtaining improvement rights. Proposals were made through petitions to the House of Commons or House of Lords. Committees would review the petition and introduce a bill. If successful a bill was approved by both Houses and the Crown. To obtain an act, promoters also paid fees to officers in both Houses and possibly bribes to Members of Parliament (MPs) or Peers.

Acts of Parliament granted similar rights as patents. Acts named a group of individuals or a body of trustees and gave them authority to levy tolls and undertake specific projects. The rights

[16] From the sixteenth century the Crown sometimes created a Commission of Sewers with rights to compel landowners to cleanse the river and to levy a property tax to pay for maintenance. Commissions often lacked the authority to tax inhabitants other than those adjacent to the river, and so they were infrequently used for extensions of navigation after 1600. See Willan, *River Navigation,* p. 16.

[17] Most patentees paid between 5 and 10 pounds per annum for patents, see Willan *River Navigation,* p. 24. But in the course of the Civil War some patentees, like William Sandys provided substantial assistance to the Crown. This gives some indication that unofficial payments could be large.

vested in river navigation acts were typically permanent and passed to heirs or assignees, much like a patent. Acts to improve roads, known as turnpike acts, usually gave trustees authority to levy tolls for 21 years. Rights could be renewed through subsequent acts.[18] Acts also established a body of commissioners that would resolve disputes between undertakers and property owners regarding the purchase of land or damages suffered.

A key difference between acts and patents concerned the relative roles of the Crown and Parliament. In the case of patents, the Crown directly controlled the supply and enforcement of rights. Parliament was not involved and any interested party, including local landowners or rival claimants, could appeal to the Privy Council in the event of disputes.[19] For acts, Parliament took the lead in allocating rights and in making decisions concerning the alteration of rights once projects were underway. The Crown retained a veto over parliamentary bills and it could try to influence the legislative process, but it lacked the same extent of control as under patents.

II.

The pre-1689 regulatory history of transport improvement can be documented using information from the Calendar of State Papers, the Journals of the House of Commons and Lords, Acts of Parliament, and drafts of bills.[20] The works by Willan, Albert, and other transport historians also provide crucial source materials on the histories of projects. Tables 9 and 10 in

[18] The unique structure of turnpike trusts was linked to traditional system for road financing which it in part replaced. Traditionally road maintenance was the responsibility of parishes. They could claim labor and materials from their inhabitants, but they could not levy property taxes or tolls. Trusts were seen a temporary replacement but most continued to operate for a century or more. See Albert, *Turnpike Road System*, p. 16.

[19] 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.

[20] 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.

the appendix list all identified road and river projects proposed to Parliament and the Crown in each year from 1604 to 1688. The tables also indicate whether projects were completed.

Relations between James I and Parliament were stormy from the beginning of his reign in 1603. The King tried to increase his authority to tax without Parliament's consent and gain greater control over courts. The King called Parliament into session in several years from 1604 to 1610, but few transport bills were introduced and only one became an act.

In the 1610s James I tried to stifle Parliament by using a strategy that would become common in the following decades. The King called Parliament into session only once in 1614 and it was quickly dissolved because of disputes over taxation. Thus it was impossible to pass any transport bills in the 1610s. James I used this opportunity to increase his role in transport improvement. In 1617 the King awarded a patent to Jason Gason giving him powers over any river improvement in England. Gason transferred his rights to improve the Great Ouse to Arnold Spencer, which appears to be the only case that he exploited his broad patent.[21] In 1619 the King narrowed the focus of patents by granting the Mayor and Alderman of Bath rights to improve the river Avon.[22] The King also authorized payments and grants for improving specific highways, which served as an alternative to introducing road bills in Parliament.[23]

The need for additional tax revenues to fight continental wars forced James I to call Parliament into session in the early 1620s. Parliament used this opportunity to pass the famous Statute of Monopolies, which made it illegal for the Crown to issue patents except for inventions. At the same time Parliament tried to reassert its dual authority over transport rights. Six river

[21] See Woodcroft, *Titles of Patents of Inventions*, pp. 1-2, and Chrimes et. al., *Biographical Dictionary*, p. 647 for a description of Gason's patent.
[22] Willan, *River Navigation*, p. 25.
[23] 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.

improvement bills were introduced in Parliament from 1621 to 1624. In 1624 the first bill explicitly proposing to use tolls to improve the North road leading into London was also considered.[24]

An act from 1624 dealing with the Thames was significant because it dealt with a very important river for the London economy. It was also significant because it changed the rights vested in an earlier act. 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.[25] The 1624 Thames act vested sole authority in the commissioners from Oxford, and thus voided the authority of commissioners in Berkshire, Wiltshire, and Gloucestershire. It provides an early illustration of how rights could be renegotiated unfavorably for some groups, even in Parliament.

The early years of King Charles I's reign coincided with a slowing of parliamentary bills for transport improvement and an increase in royal patents. From the outset Charles I's relations with Parliament were hostile. Following several disputes over taxation Charles I dissolved Parliament in 1629 and did not call it into session throughout the 1630s—the so-called era of personal rule. Charles I avoided the restrictions in the Statute of Monopolies and issued numerous patents or other privileges to river undertakers. Some promoters received royal authority in the 1630s after there was an unsuccessful attempt to obtain a parliamentary bill for the same project. For example, an improvement bill for the river Lark failed in 1629, but in 1635

[24] Emmison, 'The Earliest Turnpike Bill', p. 108-132.
[25] See *Statutes of the Realm*, Public 3 James I, c. 20 for more details.

Henry Lambe successfully obtained a patent. Thus there was some overlap in projects proposed to the Crown in the 1630s and Parliament in the 1620s.

Several cases involving disputes between undertakers, landowners, and transport users came before Charles I and the Privy Council in the 1630s. In one case the patentee for the Great Ouse appealed to the President of the Privy Council to raise the maximum toll on goods from 1 to 1.5 pence per ton. Outraged users appealed to local Justices of the Peace 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.[26] In another case, Henry Lambe faced resistance from local mill-owners who claimed they were being adversely affected by the improvement of the river Lark.[27] A commission appointed by Charles I 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—both very generous for this region and time. [28] 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.

These two cases illustrate that during Charles I reign the protection of rights could be uncertain if local conflicts brought the case before the King and Privy Council. Local conflicts were arguably inevitable because of monopoly power and the externalities involved, but the opaque manner in which Crown resolved disputes must have given little confidence to promoters or the broader public. There is one documented case where Charles I acted arbitrarily toward an undertaker because of political considerations. The Earl of Bedford was given the right to drain

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

the Fens by a royal charter in 1637. After initiating the project, the Earl allied himself with the parliamentary opposition to the Crown. In response, Charles I seized upon locals complaints concerning a foreign contractor and decided to revoke the Earl's charter.[29]

During the Civil Wars of the 1640s, the security of patentees' rights became more uncertain. Patentees received rights from the Crown, but once the monarchy was abolished in 1649 it was unclear whether their rights would be maintained. The source materials suggest that only one patentee had completed their project by the start of the Civil War. Whether the Wars contributed to their lack of completion is difficult to say. William Sandys was the one patentee who successfully completed their project by investing more than £40,000 improving the river Avon in Warwickshire.[30] Sandys was elected to the Long Parliament in 1640 but was later expelled as a monopolist. Sandys went into exile and acted as a royalist supporter by raising funds for the Restoration of Charles II. While in exile, Sandys' rights in the Avon passed to William Say, who was his creditor but also president of the High Court of Justice, a strong supporter of Parliament, and a draftee of Charles I's death warrant.[31] As this example suggests, a political conflict like the Civil War could effectively result in the expropriation of an undertakers' rights, especially if they were allied with the losing side.

The shift in political power to the parliamentary side in 1649 also changed how new transport rights were supplied. The House of Commons was now in control. In 1650 and 1651 five river improvement bills and two road improvement bills were introduced in the Commons. Many dealt with important projects and some, like the Ouse in Yorkshire, had been proposed in the Commons unsuccessfully as early as the 1620s. One of these bills became the first act explicitly

[29] For more details see Wells, *The History of the Drainage*, pp. 105-127.
[30] Green, *Calendar of State Papers Domestic: Charles II, 1661-2*, pp. 610-632, Undated 1662.
[31] See Chrimes *et. al*., *Biographical Dictionary of Civil Engineers in Great Britain and Ireland*, p. 592, and Plant, 'Biography of William Say'.

authorizing the use of tolls to improve a river.[32] The 1651 act named James Pitson and several others as undertakers for the river Wey. Richard Weston, who originally developed the project, went into exile after the Civil War. It appears that Pitson was named as the official undertaker because he was a commissioner in Surrey and had links to the Commons.[33]

The Long Parliament which sat continuously from 1640 to 1653 was ultimately unsuccessful in producing transport improvement acts. Even when the Commons power was at its zenith in 1650 and 1651, only one in seven bills succeeded in becoming acts. The failure rates were high even though the Commons remained in session year-round. It is worth noting that all the failed bills in the 1650s would eventually be approved by Parliament and completed in the early 1700s.

In the mid 1650s power shifted from the Long Parliament to the Protectorate parliaments and England had its first written constitution. But the state resembled more of a military regime under the tutelage of Oliver Cromwell, the head of the New Model Army.[34] There was even a possible return to absolutism when the Crown was offered to Cromwell in 1657. Coincidental with these developments two proposals were made directly to Cromwell to improve rivers between 1654 and 1656.[35] In 1657, Cromwell even granted a 'charter' to undertake improvements on the Yorkshire Ouse.[36] Thus in the mid 1650s there was another shift in regulatory authority with Cromwell reasserting the prerogative of the executive.

The Restoration of Charles II in 1660-61 ushered in another series of regulatory changes. In the act establishing the Restoration settlement, there was a provision that all 'orders and

[32] See Firth and Rait, *Acts and Ordinances of the Interregnum, 1642-1660* , pp. 514-17.
[33] See River Wey & Navigations : An historical background to the Wey Navigations.
[34] Smith, Emergence of a Nation State, p. 331.
[35]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.
[36] *H. of C. Journals*, VII (1651-1660), pp. 575-578, 26 June 1657. Priestly, *Historical Account*, p. 491.

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'.[37] 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 James Pitson and the other original undertakers were unable to get their rights reinstated even though they invested £15,000 and made the river navigable. In 1662, Pitson tried to get a new act reinstating his rights but the bill failed in Parliament.[38] Recall that Pitson was a parliamentarian in the 1650s and thus he might have been considered as an enemy to the new King.[39] In 1664, Charles II named a new conservator, John Ratcliffe, who was to have rights over the Wey for 30 years. 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.[40] 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.[41] Numerous claims were submitted and how the original investors fared is unclear.[42]

[37] Quoted in Holmes, *the Making of a Great Power*, p. 28.
[38] Details on the petition are available in the Parliamentary Archives, HL/PO/JO/10/1/317 and HL/PO/JO/10/1/319.
[39] From the records 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.
[40] Green, *Calendar of State Papers Domestic: Charles II, 1668-9*, pp. 563-599, November 1669.
[41] Private Act, 22 & 23 Charles II, c. 26.
[42] Willan, *River Navigation*, p. 70.

The Restoration also brought retribution against William Say who held rights to the river Avon after William Sandys went into exile during the Civil War. All of 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.[43] 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."[44] Despite Sandys plea, Windsor was granted rights to the Avon by an act in 1662.[45]

In terms of the supply of new improvement rights, the Restoration initially introduced some uncertainty regarding the relative roles of the Crown and Parliament. In 1661, there were two attempts to obtain rights to improve rivers; one went through the Crown directly and the other went through Parliament.[46] Matters became more unclear in February of 1662 when the Lords passed a bill that would have effectively enhanced the authority of the Crown.[47] 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.[48] It was read twice but did not proceed further when the session ended in May 1662.[49]

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[43] Green, *Calendar of State Papers Domestic: Charles II, 1661-2,* pp. 610-632, Undated 1662.
[44] *Ibid*.
[45] 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.
[46] 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.
[47] A draft of the bill is in the Parliamentary Archives, HL/PO/JO/10/1/311.
[48] *H. of C. Journals,* VIII (1660-1667), pp. 400-401, 9 April 1662.
[49] The last mention in the Journals is April 28 1662. See *H. of C. Journals,* VIII (1660-1667), pp. 414-415.

There was more certainty by the mid-1660s when there was a reemergence of the 'Crown-in-Parliament' system of granting improvement rights. Several bills for the improvement of rivers and roads were introduced in the sessions from February 1663 to August 1665. The success rate for bills was low, but there was a concerted effort to introduce bills in Parliament. While no proposals were directly made to Charles II for patents, it appears that Charles II had significant influence over which undertakers received rights through acts. For example, Sir William Sandys, a long time supporter of Charles I and Charles II, was named as the undertaker for the Wye and Lugg. Another supporter of Charles II, Henry Hastings, was granted rights to make the Bristowe Causey navigable in 1664.[50]

In the 1670s and 80s political tensions increased once again in England. There were concerns about James, Duke of York's succession to the throne. Protestant members of Parliament believed that James was a Catholic. Charles II also increasingly used his authority to dissolve Parliament prematurely before many bills could be passed. The increasingly hostile political climate had several implications for transport rights. First, several promoters turned directly to Charles II for rights, especially at times when Parliament was not in session.[51] In 1684 Charles II also reinstated John Mallet's patent for the river Tone, making it the first awarded since the late 1630s.[52] Second, the frequent dissolution of Parliaments made it difficult to pass improvement bills. There was a noticeable decline in proposed bills starting in the 1670s when there were at least five dissolutions. Overall the conflicts of this period fostered uncertainty about the future of the Crown in Parliament system of regulation.

[50] Private Act, 16 & 17 Charles II, c. 6. See also Bennett, 'Hastings, Henry, Baron Loughborough'.
[51] 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.
[52] Green, *Calendar of State Papers Domestic: Charles II, 1684-5*, pp. 109-132, August 1684'.

In the 1670s and 80s there were also conflicts over the protection and enforcement of rights. There is one case where the rights vested in patents and acts came into conflict with disastrous implications for one promoter. 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. However, Bennet did nothing to improve the Ouse. In 1674 Samuel Jemmatt purchased rights to the river by paying £1200 to Arnold Spencer's creditors. Spencer originally held a patent for improving the river but control over the navigation passed to his creditors in the 1650s. The transaction had some legitimacy since the patent had not been nullified. However, a dispute arose when a rival undertaker, Henry Ashley Sr., lobbied the commissioners of the 1665 Act to name him as the undertaker. A provision in the legislation gave commissioners the authority to name a new undertaker if Bennet was unsuccessful in making the river navigable. In 1687, the commissioners granted Ashley formal rights to the river, ending Jemmatt's claim.[53]

A second case involved the only turnpike authority before 1689. The Great North Road trust was operated by Justices of the Peace in Hertfordshire, Cambridge, and Huntingdon. The toll gates were never put up in Cambridge and Huntingdon and they were pulled down by the Justices in Hertfordshire.[54] Around the same time Charles II removed many of his political opponents from positions as Justices on the County Commissions of the Peace and replaced them with political supporters. These politically motivated purges were significant because Justices were often named as undertakers for road improvement acts.[55]

The preceding analysis shows how the dual systems of regulatory authority—Crown versus Crown in Parliament—did not peacefully coexist during much of the seventeenth century. Under

[53] Summers, *The Great Ouse*, p. 53.
[54] Albert, *Turnpike Road System*, p. 20.
[55] See Glassey, *Politics and Appointment*, p. 262, for more details on the purges of JPs.

each system the procedures for allocating and enforcing rights were also less developed and sometimes opaque. As a consequence improvements rights were difficult to obtain and were not always protected. How did the regulatory environment change after 1689? The following section addresses this issue.

III.

In 1688 King James II's reign ended and a new monarchy was established in King William and Queen Mary. The Glorious Revolution would have lasting effects on Britain's political system, but from the vantage point of the 1690s and early 1700s it represented another regime change. Supporters of the new regime often emphasized the need to preserve the Revolutionary Settlement. Supporters of the old regime—known as Jacobites—pressed for opportunities to restore the Stuarts to the throne. Political tensions were also fostered by the vigorious competition between the Whigs and Tories. The two parties differed on fundamental issues like the prerogative of the monarch, religious tolerance, and foreign policy.

In the post-Glorious Revolution political environment it was not obvious that the rights of existing undertakers would be protected. Many river undertakers that received rights through acts in the 1660s and 1670s were closely allied with the Stuart monarchy. Supporters of the Revolution in Parliament might have tried to violate their rights in an effort to win support. Recall that earlier regime changes, like the Civil War and Restoration, resulted in some purges of rights.

The evidence suggests that in most cases Parliament did not violate pre-existing undertakers' rights and when they did it was linked with their failure to complete the navigation. Table 1 summarizes the outcomes for all undertakers who received their authority from patents or acts

before 1689. Table 13 in the appendix provides details on all acts affecting undertakers for these projects. In 13 of the 19 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.[56] 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 Medway, the Stower, and the Wye and Lugg) acts were passed naming new undertakers, but in all these instances undertakers did not complete the navigation.

The case of the Wye and Lugg is interesting because the undertakers were the Sandys family who were closely affiliated with the Stuarts. A 1695 act voided the Sandys family's rights to collect tolls on the Wye and Lugg. The opening passage states that the failure to complete the navigation was the official reason why their rights were revoked.[57] While politics could have played a role here, it does not seem to be a leading factor since the two MPs who introduced the Wye and Lugg bill came from opposite sides of the political spectrum. Thomas Coningsby was a court Whig and a strong supporter of King William. However, the other MP, Paul Foley, was a country Whig with allies in the Tory party. Foley was not the obvious MP to introduce the bill if the goal was to expropriate an old ally of the Stuarts.[58]

There are two cases where undertakers who received their authority before 1689 successfully defended their rights in Parliament in the 1690s and early 1700s. These cases yield more insights

[56] 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.
[57] 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.
[58] For more information on Foley and Coningsby see Cruickshanks et. al, *House of Commons*, pp. 671-90, 1057-1074 .

on the deliberations within Parliament concerning undertakers' rights. The first 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."[59] 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 under an act of Parliament, without their consent."[60] 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".[61] 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."[62] 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

[59] See *H. of C. Journals,* XIII (1693), 2 October.
[60] Details on the petition are available in the Parliamentary archives, HL/PO/JO/10/1/455/733.
[61] See *H. of C. Journals,* (1714), 12 March.
[62] See *H. of C. Journals,* (1714), 14 May.

and safe carriage of all goods and merchandizes."[63] The bill did not proceed any further after these counter-petitions were referred to the committee.

IV.

The Glorious Revolution marked the last major change in regulatory authority. As the Crown's power waned, its role in granting privileges was greatly reduced. Only one river improvement proposal was made directly to the Crown between 1689 and 1727 compared to more than one-hundred bills introduced in Parliament.[64] Parliament became the main forum for initiating and maintaining new transport rights for the rest of the eighteenth century.

The shift to parliamentary control after 1689 created a more favorable regulatory environment for undertakers. There were a number of innovations in parliamentary procedures which helped to lower the cost of obtaining transport bills. Parliament also met annually from 1689 and legislative sessions were longer allowing for more time to deal with local issues like transport bills. The declining failure rate for bills in the 1690s and early 1700s provides one indicator of improved legislative efficiency.[65] Another important development, which has received less attention in the literature, was the greater protection of undertakers' rights. Before 1689 several undertakers had their rights violated because of decisions made by the King and Parliament. These risks were lessened after the Glorious Revolution.

Tables 2 lists all identified instances where river undertakers receiving rights after 1689 had their rights violated by acts between 1689 and 1749. Table 11 in the appendix provides more

[63] See *H. of C. Journals*, (1714), 31 May-June 3.
[64] The only proposal to the Crown, see Hardy, *Calendar of State Papers Domestic: William and Mar*y, 1693, pp. 243-297, August 1693.
[65] See Hoppit, 'Patterns of Parliamentary Legislation' and Innes, 'The Local Acts' for more details on improvements in parliamentary procedures.

details on these acts. A violation is defined by any amending act of Parliament that voided undertaker's authority or lowered the maximum toll specified in their original act. Two undertakers experienced at least one violation, which represents only 6 percent of all undertakers who received rights between 1689 and 1749. Moreover, in the case of the Dee it is not even clear that a violation occurred since the company submitted its own petition stating that they "consented" to an act lowering their tolls.[66]

For comparison, table 3 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. These cases have already been discussed in section II. The figure at the bottom shows that 33 percent of undertakers experienced at least one violation before 1689. The implication is that political risks were higher before the Glorious Revolution than after.

A similar finding holds for turnpike trusts although there is only one observation before 1689 to make a comparison. Table 4 lists all cases where trusts established between 1689 and 1719 had their rights violated by acts between 1689 and 1749. Table 12 in the appendix provides details on these acts. The figure at the bottom shows that 18 percent of turnpike trusts established between 1689 and 1719 experienced at least one violation. The only turnpike authority before 1689 was along the Great North road and its gates were pulled down, providing some indication that rights to collect tolls on roads were not secure before the Revolution.

The greater protections offered to undertakers after 1689 were due to many factors. Perhaps the most important change was the lessening of conflict between the Crown and Parliament. William dissolved Parliament several times in the 1690s and resisted some bills expanding

[66] See *H. of C. Journals*, XXIV (1743), 31 January.

Parliament's authority, but he was far more conciliatory than James II and never threatened to disenfranchise Parliament. Under Queen Anne (1702-1713) and King George I (1714-1727) relations between the Crown and Parliament continued to be more favorable than at any time in the seventeenth century. The lessening of conflict meant that there was a lower chance that the Crown or Parliament would try to violate the rights granted by the other.

There are also the cases involving the Stour and Salwerpe and the river Itchen, which suggest 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.

V.

The improved regulatory environment after the Glorious Revolution should have provided a stimulus for infrastructure investment. In theory greater protections and greater ease in obtaining rights raises the expected return on transport investment.[67] This section examines the patterns of investment from 1604 to 1749 using new time series on 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.[68] 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

[67] See Pindyck, 'Irreversibility' for an analysis of investment under uncertainty.
[68] Road investments undertaken by parishes are omitted for two reasons. First, the regulation facing parishes was different. Local JPs could order parishes to levy rates for roads, while Parliament and the Crown were not closely involved. Second, parish road investment was very modest before 1750 in comparison to turnpikes. See Bogart, 'Did Turnpike Trusts'.

to estimate the value of proposed and completed investment. Table 14 in the appendix shows the investment data for a sample of river navigations. The appendix also provides more details on the procedure for estimating investment.

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 were willing to undertake and finance. Proposed investment provides one such metric because it is based on all proposed projects to the Crown or Parliament. However, 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 is based on all projects that were approved through patents or acts and completed. It does not double count projects like proposed investment because they are completed only once. Completed investment also captures the willingness of investors to provide crucial outside financing. Promoters might seek rights for certain projects in the hopes of obtaining financing, but investors may be reluctant because of the regulatory or economic environment. Completed investment thus incorporates the decisions of promoters and investors. The drawback of completed investment is that it omits proposed investments that were rejected by Parliament or the Crown because of politics or inefficiency in the proposal process.

Figure 1 shows that there was a sharp rise in completed investment starting in the mid-1690s and continuing through the decade of the 1700s. There was another surge in investment in the 1710s and 20s. These investments were associated with projects of great economic importance. Improved rivers and roads helped to fuel early industrialization in northern areas like Yorkshire.

Extensions to the Thames and the London road network helped to feed the growing metropolis. Investments in the transportation revolution had their roots in the 1690s.

The difference in completed investment before and after the Glorious Revolution is striking. Approximately the same amount was completed in the fifteen years from 1695 to 1709 as in the previous 85 years from 1604 to 1688. Over the period from 1689 to 1749, the mean annual investment was £18700. The average was £3200 for the period from 1604 to 1688 and £5000 from 1660 to 1688.

There were also large fluctuations in completed investment after 1689. The troughs for investment were in the late 1700s, the late 1730s, and the late 1740s and the peaks were the early 1700s, the late 1710s, and the mid 1720s. The peaks exaggerate the change in investment after the Glorious Revolution, but they do not change the overall conclusion. Figure 2 plots a 4-year moving average after replacing with a zero value the five years when completed investment was more than two standard deviations above the mean (1699, 1701, 1719, 1725, and 1726). The average level remained higher after 1689 even with the peak year investments eliminated. Using the adjusted series, average investment was £11600 from 1689 to 1749 which is more than double the average of £5000 from 1660 to 1688.

The large fluctuations after 1689 are common in transportation investment. As an illustration, figure 3 shows the number of acts for improving canals and roads from 1750 to 1830.[69] The number of acts provides an approximation of the cyclicality in completed investment. From the mid-eighteenth to the early nineteenth centuries there were boom and bust cycles, the most famous being the canal mania of the 1790s. In comparison to the later period the cyclicality in

[69] See Albert, *Turnpike*, Pawson, *Transport and Economy* and Ward, *the Finance of Canal Building*.

investment following 1689 was not an anomaly. Perhaps what is most striking is the absence of cyclicality before 1689.

Turning to proposed investment, the time series suggests there were similarities with completed investment but also some differences (see figure 4). Like completed investment, the mean level of proposed investment is higher after 1689 and there was a sharp increase in the mid-1690s. The difference lies in the substantial surge for proposed investment in the early 1660s. 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 in the 1650s.

The increase in proposed investment during the 1660s is partly explained by one project, a canal between the Severn and Thames. It was proposed three times between 1661 and 1664 and none were successful. Willan describes this project as a 'theoretical scheme'.[70] It was distinctive from most others because it was a canal and it would have required a substantial capital investment. The project was not completed until the late eighteenth century at the height of the canal boom. It appears to be a project ahead of its time in the mid-seventeenth century. If the Severn and Thames canal project is dropped from the series on account of its impracticality then proposed investment from 1660 to 1664 would fall by nearly 40 percent, making the early 1660s look less remarkable (see figure 5).

Even with the deletion of the Thames and Severn canal project, there was still a substantial increase in proposed investment in the 1660s. It suggests there was an interest in promoting transportation investment in the Restoration era. The reemergence of the Crown-in-Parliament system of allocating transport rights in the early 1660s might have appeared as a turning point for

[70] Willan, *River Navigation*, p. 10.

regulatory certainty. Ultimately, however, the regulatory environment of the 1660s did not continue and proposed investment declined during the 1670s and 80s. In the 1680s proposed investment contracted so much that it reached a level comparable to the Civil Wars of the 1640s.

The investment data support the hypothesis that the regulatory environment changed with the political settlement of the Glorious Revolution. Take for example, the surge in proposed and completed investment in the 1690s and early 1700s. In part it reflects pent-up demand from the 1670s and 80s when it was more difficult to obtain rights of way and the political system was unstable. But it is revealing that demand was fulfilled in the late 1690s rather than the early 1690s. Promoters had an incentive to delay projects in the early 1690s when the Revolutionary Settlement was new. By the mid-1690s there were more indications that the regime would persist, including the successful establishment of the Bank of England in 1694 and the conclusion of the Nine Years war in 1697. Promoters and investors responded as though they were more confident that their rights would be protected and Parliament would continue to be the main regulator in the future.

VI.

Changing economic conditions may have been another driving force behind the increase in transport investment. For example, lower interest rates might have made it easier for promoters to finance investment. Higher real wages might have increased purchasing power and raised the return on investment. A higher population growth rate or an increase in the growth of coastal trade might have increased the demand for infrastructure. 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. It is necessary to

test whether such factors can explain the rise in investment before concluding that the political changes following the Glorious Revolution made an additional contribution.

The role of the Glorious Revolution is assessed using the following regression model:

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

where y_t is completed or proposed investment in year *t*, α is a constant, ε_t is the error term, and x_t includes the real interest rate, the growth rate of coastal trade, the growth rate of population, an index for real wages, an indicator for years when there was a foreign war, and an indicator for years when there was a significant harvest failure.[71] The first set of specifications also includes a dummy variable that takes the value 1 for all years after 1689 and zero before. It tests whether there was an increase in the level of investment after the Glorious Revolution while controlling for other factors.

A key assumption is that there are no other events around the time of the Glorious Revolution that influenced investment outside of those capture by the control variables. Although this appears to be a strong assumption there are reasons to be reassured that omitted variables are not a significant problem. First there is little evidence in the available economic series that would suggest the economy changed substantially around 1689. Figure 6 shows indices for real interest rates, population growth, the growth of coastal trade, and real wages from 1660 to 1720. Values in year t are averaged over the five years (t-2, t-1, t, t+1, t+2) and are relative to 1689 which is 100. Population growth shows an increase from the 1680s to 1690s, but the other series show no obvious change around 1689. Thus there is little evidence for a strong correlation between economic determinants of investment and the Glorious Revolution. Second, most histories of the

[71] For descriptions of these variables and the sources see the appendix.

Glorious Revolution suggest that the immediate triggers for the Revolution were events on the Continent, rising religious tensions, and the birth of a Catholic heir—not a change in economic conditions that would raise transport investment.[72]

A few additional remarks are necessary before presenting the results. First, all variables in the regression are stationary (see table 5) and so a spurious relationship between the level of investment and economic conditions is not a concern. Second, all determinants of investment are lagged by one year, *t-1*, in the regression equation, to alleviate concerns about reverse causation. Third, a Tobit regression model is used to account for the left-hand truncation of investment at zero.

The coefficients for several specifications are listed in table 6. The dependent variable y_t is completed investment. In column (1) the coefficient on the post-1689 dummy is positive and significant. This finding indicates that the level of investment was higher after the Glorious Revolution even after controlling for several observable determinants of investment. Column (2) reports results using the completed investment series in figure 2 which replaces outliers years (i.e. years when investment was more than two standard deviations above the mean) with a zero value. The coefficient on the post-1689 dummy is still positive and significant indicating that years with exceptionally large investment do not change the results. The specification in column (3) performs a similar test after including a time trend. The coefficient on the post-1689 dummy remains positive and significant. This finding indicates that the years after 1689 are associated

[72] For a discussion of events leading up to the Revolution see Holmes, *The Making of a Great Power*, pp. 176-190. Pincus, *1688*, argues that political economic considerations helped to fuel the Revolution, specifically differences in the emphasis on land versus labor as the source of imperial wealth. This political debate was arguably independent of factors which led to a higher demand for transport investment.

with higher investment even after controlling for unobservable factors that incrementally changed with time.

The specification in column (4) addresses a different aspect of the post-1689 environment. It includes a time trend and an interaction term multiplying the post-1689 dummy and the time trend. The interaction term indicates whether the annual growth of investment was significantly higher after 1689. It is not clear that an improved political environment should necessarily lead to an increase in the growth of investment whereas there is a natural theoretical link between stable politics and a higher level of investment.[73] Nevertheless the interaction term between the post-1689 dummy and the time trend is positive and significant indicating that the growth in investment was also higher after the Glorious Revolution.

Most of the control variables have the expected sign, although only the dummy for foreign wars was significant in most specifications. The negative sign on foreign wars may suggest that war reduced investment by disrupting international trade, but more research is needed to investigate this link.

Table 7 summarizes the results for specifications using proposed investment as the dependent variable. The control variables like population growth, real interest rates, etc. are included in all specifications but the coefficients are not reported to save space. In column (1) the coefficient for the post-1689 dummy is positive and significant, indicating that the level of proposed investment was higher after 1689. Column (2) shows that the post-1689 dummy is significant after dropping the Thames and Severn canal from the proposed investment series. Column (3) shows that years

[73] The theoretical literature summarized by Newbury, *Privatization*, argues that investment opportunities will be forgone if the regulatory environment is uncertain. Thus less uncertainty leads to a higher level of investment or in other words a higher take-up rate for a given pool of projects. Growth implies an expanding set of projects and an expanding take-up rate. It is not clear that the Glorious Revolution affected the size of the pool and the take up rate.

following the Glorious Revolution and the Restoration were both associated with higher proposed investment. This finding is consistent with figure 4 which shows a surge in proposed investment in the 1660s and the 1690s. Lastly, in column (4), a time trend is included. Here the results show that the coefficient on the post-1689 dummy is not significant. Thus the Glorious Revolution did not have a robust impact on proposed investment after controlling for unobservable factors that incrementally changed with time. It is worth repeating however that completed investment was significantly higher after the Glorious Revolution. This is a significant finding because it was completed investment that ultimately affected the economy.

Unknown structural breaks tests provide further evidence that investment increased after the Glorious Revolution. The Quandt-Andrews unknown structural break test allows the data to identify whether there is any structural break in the constant term α 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 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.[74]

Figure 7 shows the Wald F statistics for every eligible break year in a specification that regresses completed investment on its one year lag and all the control variables. Note that no post-1689 dummy is included and for the moment there is no time trend. The largest F statistics in this model are clustered in the 1690s with the maximum in the year 1695. All F statistics in the 1690s exceed the 1% critical value. The single peak in the distribution suggests there is only one structural break and that it is most likely the year 1695. The significance of this finding is that

[74] See Quandt, 'Tests' and Andrews, 'Tests for Parameter', for details on the Quandt-Andrews test statistic.

the data indicate that the years shortly after the Glorious Revolution marked an increase in completed investment even without specifying this period in advance.

Table 8 provides a summary of unknown structural break tests across several specifications. All include the control variables and a one year lag of the dependent variable. None include the post-1689 dummy. Unless otherwise stated the trimming parameter is 15% and the maximum Wald F-statistic is used to identify the mostly likely break year. The results for the baseline model for completed investment were already discussed in figure 7. 1695 is identified as the structural break in the constant. The results are similar in the baseline model for proposed investment. 1692 is identified as the most likely break in the constant. In the case of completed investment there may be a concern that outlier years are distorting the estimates. If these years are replaced with an investment value of zero then the most likely break date is 1705. An increase in the break date is natural since two of the largest outlier years are 1699 and 1701. Assuming these years had zero investment diminishes the effect of the 1690s. Similarly the Thames and Severn Canal may be distorting the results for proposed investment. However, if this project is dropped then 1692 is still the most likely break date for proposed investment. For both proposed and completed investment, the most likely break dates for the constant are the same in the baseline model if the trimming parameter is 20% instead of 15%. The same results also hold if the trimming parameter is 10% although the results are not reported. Finally the most likely break date for completed investment is still 1695 even if a time trend is included. For proposed investment the inclusion of the time trend changes the results. Here the tests indicate there is no structural break in any year because the maximum F statistic is 4.6, well below the critical value. This result is consistent with the earlier regression which showed an insignificant coefficient on the post 1689 dummy when a time trend was included in the proposed investment regression.

It is also possible to test for a structural break in the coefficient on the time trend, which would indicate if there was a year in which the growth of investment was significantly higher or lower afterwards. The results for completed investment are reported at the bottom of table 8. They imply there is a structural break in the time trend coefficient and the most likely break year is 1695. This finding provides additional confirmation that the investment environment changed after the Glorious Revolution

Overall the results from the regression analysis and the unknown structural break tests are consistent. They suggest that the years after the Glorious Revolution marked an increase in completed investment even after accounting for a number of other determinants such as population growth and real interest rates. The results are similar for proposed investment in most specifications.

VII.

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 regulatory environment became more favorable for undertakers after the Glorious Revolution with their rights being better protected. It also shows that investment in improving roads and rivers increased substantially in the mid-1690s shortly after the Glorious Revolution.

The lessening of conflict between the Crown and Parliament and the firm establishment of Parliament as the main regulatory authority appear to be two key reasons for the greater security of improvement rights and the increase in investment. With less conflict undertakers could be confident that the Crown or Parliament would not usurp regulatory authority from the other and

purge rights. In Parliament, bills altering undertakers' rights had to pass through committees and be approved by both Houses. 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.[75] 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.

[75] Bogart, 'Turnpike Trusts and Property Income'.

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.[76] 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.[77] A report in the Parliamentary Papers provides information on the length of roads managed by each turnpike trust, including all those formed before 1750.[78] 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 of

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

miles of river that were made navigable through royal grants or acts, including Willan's description of all navigable rivers at benchmark dates (c. 1600, 1660, 1724) and Priestly and Shead's catalogue of river projects.[79] 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 9 and 10. 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: Acts altering Authority of Existing River Undertakers or Turnpike Trusts

Parliamentary renegotiation of undertakers rights are identified by studying all acts relating to road and river improvement in the *Statutes of the Realm* before 1714. The statutes do not contain private acts so these were obtained from the Parliamentary Archives. After 1714 road and turnpike acts are available at the Clark Library in Los Angeles. Table 11 lists all acts where rights of river undertakers established between 1689 and 1749 were diminished or voided. It provides a summary of the information to construct the estimates in table 2. Table 12 lists all acts where rights of turnpike trusts established between 1689 and 1719 were diminished or voided. It

[79] See Willan, *River Navigation*, pp. 146-152, Shead, 'Waterways Information', Priestly, *Historical Account*.

provides a summary of the information to construct the estimates in table 4. Table 13 lists all acts where the rights of river undertakers established between 1606 and 1688 were altered after 1689. It provides a summary of the information reported in table 1.

Appendix III: 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. Bogart reports expenditure per mile for a representative sample of 43 turnpike trusts during their first 10 years.[80] Turnpike expenditures were higher in their first 5 years because they widened and resurfaced the road. Evidence from new turnpike trusts in the 1820s implies that 62% of the expenditures in the first 5 years represented investments and the rest were maintenance or legal expenditures. The totals during the first five years imply an average investment per mile of £310 in 1819 prices or £160 per mile in 1750 prices.

Most river navigations made their investments during the first 10 to 20 years after they were established by an act. Table 14 shows the total investment and the average investment per mile for various river navigations from the 1630s to the 1740s. The sample consists of river navigations covering 187 miles or nearly 40% of the total made navigable by 1750. Dividing the total amount of investment by the number of miles gives an average of £1340 per mile in 1750 prices.

The average investment figures were multiplied by the number of miles proposed and completed in each project. Completed investments were assumed to have been completed

[80] Bogart, 'Did Turnpike Trusts', p. 464.

immediately, although they were implemented over several years. A moving average can be used to adjust for the completion time.

The determinants of investment include the average growth rate of coastal trade, the real return on land (i.e. the real interest rate), the growth rate of population, real wages, 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.[81] 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.[82] The real return on land comes from the Charity Commission records described by Clark.[83] 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.[84] The growth rate of population is taken from annual population figures provided by Wrigley and Schofield.[85] The real wages come from Clark.[86] 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),

[81] Ward, *the Financing of Canal Building*, p. 165.
[82] PRO E190 826-1827 and E190 819-827.
[83] Clark, 'Political Foundations', pp. 577-78.
[84] Inflation comes from the Cost of Living index in Clark, 'The Condition of the Working Class', pp. 1324-25.
[85] Wrigley and Schofield, *The Population History*.
[86] Clark, 'Condition of the Working Class'.

and the War of Jenkins Ear (1739-48).[87] Years when the wheat harvest was bad or deficient are taken from Smith and Holmes.[88] Table 15 lists all the variables including the investment series.

[87] Smith, *The Emergence*, pp. 307-308, Holmes, *Making of Great Power*, p. 439.
[88] Smith, *The Emergence*, pp. 436-437, Holmes, *Making of Great Power*, p. 446.

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Table 1: Summary of Protections after 1689 for River Undertakers with Rights from Patents and Acts before 1689

River	Original undertaker & year Granted	Completed	Rights changed by act after 1689?
Great Ouse, near Bedford	A. Spencer, 1627	No	No
Soar	T. Skipworth, 1634	No	No
Bristowe Causey	H. Hastings, 1664	No	No
Bradon and Waveney	Mayor, Yarmouth, 1670	No	No
Stour and Salwerpe	Sir T. Baldwyn, 1662	Yes	No
Wey	J. Pitson, 1651	Yes	No
Avon, Christchurch-Sarum	Lord Keeper, 1664	Yes	No
Avon, Warwickshire	W. Sandys, 1636	Yes	No
Witham	Mayor, Lincoln, 1670	Yes	No
Vale	C. Erebanion, 1678	Yes	No
Itchen, Great Ouse near Bedford, and Mole	Sir W. Bennet, 1665	Itchen only	No
Yorkshire Ouse	? 1657	No	1725 act names new undertakers, but old undertakers rights voided by Restoration
Great Ouse, St.Neots-Ives	J. Gason, 1617	Yes	Act in 1719 gives undertaker in 1687 more rights
Thames, near Oxford	Commissioners, 1623	Yes	1694, 1729 acts renew authority
Tone	J. Mallet, 1638	Yes	1698 act establishes new undertakers, who compensate patentees with rights from 168
Lark	H. Lambe, 1635	No	1698 act names new undertakers
Stower in Essex	A. Spencer, 1638	No	1705 act names new undertakers
Medway in Sussex	Lord McCoskery, 1665	No	1739 act names new undertakers
Wye and Lugg	W. Sandys, 1662	No	1695 act voids Sandy's rights

Sources: see text.

Table 2: 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
% of undertakers established between 1689 and 1749 that 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 3: 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
% of undertakers established between 1605 and 1688 that 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 4: Acts Violating the Rights of Turnpike Trusts 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
% of turnpike trustees established between 1689 and 1719 that 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 5: Augmented Dickey Fuller Tests for a 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
Dummy for Foreign War	-3.83	0.00
Dummy for Bad Harvest	-6.22	0.00
Real interest Rate	-8.18	0.00
Growth of Population	-6.89	0.00
Real Wages	-5.44	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 6: Coefficient Estimates for Completed Investment Equations

Variables	(1) Coeff. (stand. error)	(2) Coeff. (stand. error)	(3) Coeff. (stand. error)	(4) Coeff. (stand. error)
Completed Investment Lag	-0.0014 (.1588)	0.0299 (.1614)	-0.025 (0.157)	-0.024 (0.157)
Growth Coastal trade	1575 (1925)	612 (1471)	1476 (1890)	1504 (1903)
Growth Population	415470 (495623)	273631 (328605)	515324 (491052)	498648 (491081)
Real Wages	7510 (32756)	27372 (27372)	-14384 (45494)	-14008 (45457)
Bad harvest	7996 (10685)	-4772 (6886)	5857 (10594)	6038 (10592)
Foreign War	-25174 (8814)***	-6760 (4657)	-25198 (8768)***	-25136 (8761)***
Real Interest Rate	-792 (768)	-1392 (545)**	-727 (780)	-712 (778)
Constant	-28027.9 (28525)	-31456 (19538)	-263645 (295402)	-240918 (299425)
Post-1689 Dummy	47831 (11437)***	23021 (5912)***	39336 (15226)***	
Time Trend			154.2 (194)	140.1 (196)
(Trend)*(Post-1689 Dummy)				23.46 (9.03)***
Outlier years replaced with zero?	No	Yes	No	No
N	144	144	144	144
Log Likelihood	-768.9	-696.6	-768.6	-768.6

Notes: The dependent variable is completed investment. In column (2) outlier years are replaced with zero (see text). The estimates were produced using a tobit model with left truncation at zero. Robust standard errors are reported. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table 7: Coefficient Estimates for Proposed Investment Equations

Variables	(1) Coeff. (stand. error)	(2) Coeff. (stand. error)	(3) Coeff. (stand. error)	(4) Coeff. (stand. error)
Post-1689 Dummy	52651 (15385)***	54873 (15576)***	34575 (16627)**	31791 (22266)
Post Restoration Dummy			43047 (22498)*	
Time Trend				386 (315)
Other controls included?	Yes	Yes	Yes	Yes
Thames and Severn Project dropped?	No	Yes	No	No
N	144	144	144	144
Log Likelihood	-1232.9	-1220	-1229	-1231

Notes: The dependent variable is proposed investment. The estimates were produced using a tobit model with left truncation at zero. Robust standard errors are reported. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table 8: Quandt-Andrews test for an Unknown Structural Breaks

	Maximum Wald F-statistic	P-Value	Year when Wald-F-statistic is maximized
Completed Investment (break in constant)			
Baseline Model	15.66	0.00	1695
Outlier Years replaced with zero	15.77	0.00	1705
Trimming Parameter 20%	15.66	0.00	1695
Time Trend included	9.31	0.04	1695
Proposed Investment (break in constant)			
Baseline Model	8.44	0.05	1692
Thames and Severn Canal Dropped	10.97	0.02	1692
Trimming Parameter 20%	8.44	0.04	1692
Time Trend Included	4.6	0.29	1674
Completed Investment (break in trend)			
Time Trend Included	9.47	0.03	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'. Unless otherwise stated the trimming parameter is 15%.

Table 9: 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 10: 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 11: 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 12: 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 13: 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.
Stower, 4&5 Anne, c. 2	1705	Arnold Spencer was originally given a patent for the Stower. 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 13 George I, c. 34	1695 1726	Sandys family originally has rights by an act in 1662. 1695 act names new undertakers. A second act in 1726 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.
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.

Table 14: Investment in a Sample of River Navigations, 1600-1750

River	Time period	Amount Invested (£)	Miles	Investment per mile (£)
Avon	1640s	30000	42	714
Kennet	1720s	44603	20	2230
Weaver	1720s	18000	20	900
Douglas	1720s	6000	17.5	343
Wey	1650s	15000	19.75	759
Salwerpe	1660s	6000	5	1200
Beck	1720s	1400	1	1400
Dun	1730s	24750	18	1375
Aire and Calder	1720s	26700	25	1068
Dee	1740s	56461	8	7058
Exe	1690s	21000	4	5250
Great ouse	1630s	10000	14	714
Average		21660	16	1918
Investment Across Sample		259914	194	1340

Sources: For the Avon, Kennet, Weaver, Douglass, Beck, and Dun rivers see Willan, *River Navigation*, pp. 66-72. For the Wey see Parliamentary Archives, HL/PO/JO/10/1/317 and HL/PO/JO/10/1/319. For the Aire and Calder see Wilson, *Gentleman Merchants*, p. 138. For the Great Ouse see Summers, *The Great Ouse*, p. 50. For the Salwerpe see *H. of C. Journals,* X (1693), 2 October. For the Exe see *H. of C. Journals,* XII (1699) 15 February. For the Dee see *H. of C. Journals,* XXIV 3 May.

Table 15: Data Series

year	Completed invest.	Proposed invest.	Foreign wars	Bad harvests	Real inter. Rates	Coast trade growth in %	Real wage index	Pop. growth in %
1605	2400	2400	0	0	9.095748	0.021647	0.77305	0.011696
1606	0	42580	0	0	3.68936	0.327505	0.769797	0.009212
1607	0	0	0	0	2.987373	0.629514	0.766559	0.011688
1608	0	0	0	0	-0.81752	0.936697	0.763334	0.008331
1609	4000	4000	0	0	1.089283	0.936697	0.760123	0.008491
1610	960	2880	0	0	3.806405	0.936697	0.756925	0.002966
1611	0	0	0	0	5.492989	0.85291	0.75374	0.006133
1612	2080	2080	0	0	5.088207	0.769122	0.750569	0.00497
1613	0	0	0	0	6.372831	0.685335	0.747412	0.004496
1614	0	0	0	0	2.171027	0.685335	0.744267	0.000224
1615	0	0	0	0	1.697279	0.685335	0.741135	0.007819
1616	0	0	0	0	4.452281	-0.26841	0.744095	0.003332
1617	30820	30820	0	0	6.48893	-1.22216	0.747067	0.00133
1618	0	0	0	0	7.151204	-2.1759	0.750051	0.006623
1619	0	16080	0	0	8.901098	-2.1759	0.753046	0.009634
1620	0	0	0	0	10.94612	-2.1759	0.756054	0.009758
1621	0	71020	0	0	8.438579	-1.51011	0.759074	0.012439
1622	800	2720	0	0	4.478985	-0.84431	0.762105	0.013338
1623	0	0	0	0	2.7512	-0.17852	0.765149	0.003359
1624	20100	53600	0	0	2.963223	-0.17852	0.768205	-0.00336
1625	0	0	0	0	3.164732	-0.17852	0.771277	-0.00084
1626	800	47700	0	0	6.767884	1.194636	0.766162	-0.00676
1627	0	0	0	0	9.187108	2.567791	0.761082	0.004018
1628	0	29480	0	0	7.099481	3.940945	0.756035	0.011124
1629	0	18760	0	0	5.657073	3.940945	0.751022	0.008521
1630	0	0	0	0	3.22536	3.940945	0.746042	0.010704
1631	0	0	0	0	-2.15772	4.796374	0.741095	0.001637
1632	0	0	0	0	2.233751	5.651802	0.736181	0.002654
1633	0	80400	0	0	4.36229	6.507231	0.731299	0.010344
1634	3200	24640	0	0	5.351295	6.507231	0.72645	0.008239
1635	0	45560	0	0	7.034831	6.507231	0.721631	0.007576
1636	33500	142040	0	0	3.966901	4.521167	0.726948	0.004558
1637	0	0	0	0	2.503356	2.535103	0.732304	0.003355
1638	0	45560	0	0	3.090604	0.549039	0.7377	0.001575
1639	0	0	0	0	7.362581	0.549039	0.743135	-0.00632
1640	0	0	0	0	10.35354	0.549039	0.748611	0.000594

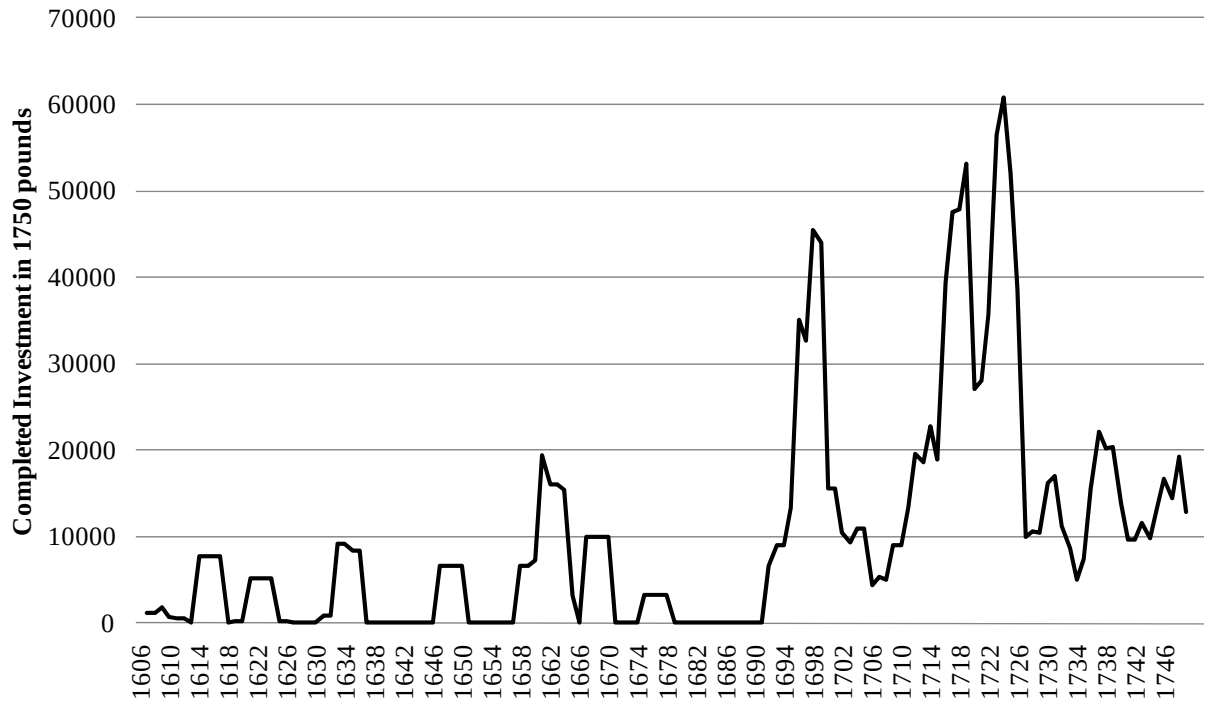
1641	0	44220	0	0	7.856761	-0.63742	0.754127	0.007294
1642	0	0	0	0	10.97377	-1.82387	0.759683	0.004116
1643	0	0	0	0	6.740494	-3.01033	0.76528	0.004879
1644	0	0	0	0	3.86991	-3.01033	0.770919	-0.00331
1645	0	0	0	0	8.100985	-3.01033	0.776596	0.001951
1646	0	0	0	1	6.166901	-1.20948	0.785036	0.008927
1647	0	0	0	1	-2.28966	0.591375	0.793568	0.007315
1648	0	0	0	1	-5.60065	2.392228	0.802192	0.002299
1649	0	0	0	1	-3.34187	2.392228	0.81091	0.000383
1650	26800	45000	0	1	-0.73365	2.392228	0.819723	-0.00153
1651	0	101840	0	0	8.38349	2.592959	0.828632	0.001531
1652	0	0	1	0	13.61813	2.79369	0.837638	0.002102
1653	0	0	1	0	13.13897	2.994421	0.846741	-0.00115
1654	0	16080	1	0	16.21133	2.994421	0.855943	-0.00287
1655	0	0	1	0	15.29006	2.994421	0.865248	0.005352
1656	0	26800	1	0	8.238592	3.191772	0.868216	0.00665
1657	0	73700	1	1	3.949728	3.389123	0.871194	0.000379
1658	0	16080	1	1	-3.38908	3.586474	0.874182	-0.01468
1659	0	0	1	1	-5.0447	3.586474	0.877181	-0.01354
1660	0	10720	1	1	2.660444	3.586474	0.880189	-0.00136
1661	26800	29200	0	1	2.098347	3.535464	0.883208	0.002142
1662	0	166160	0	0	4.697443	3.484453	0.886238	-0.00468
1663	2400	64820	0	0	6.414548	3.433442	0.889278	-0.00235
1664	48240	292480	0	0	5.762792	3.433442	0.892328	0.004886
1665	13400	96480	1	0	10.25602	3.433442	0.89539	-0.00391
1666	0	10720	1	0	12.47643	0.455628	0.900403	-0.00825
1667	0	67000	1	0	11.53898	-2.52219	0.905445	-0.00158
1668	0	0	0	0	10.52171	-5.5	0.910514	-0.00257
1669	0	21440	0	0	5.154119	-5.5	0.915612	-0.00198
1670	40200	108540	0	0	5.179299	-5.5	0.921274	-0.00298
1671	0	0	0	0	3.913481	-2.77475	0.957168	-0.0078
1672	0	0	1	0	3.694293	-0.0495	1.06212	-0.00181
1673	0	29480	1	0	5.966799	2.675749	0.875432	0.004014
1674	0	0	1	0	0.313979	2.675749	0.79153	0.003
1675	0	13400	0	0	1.580918	2.675749	0.973918	0
1676	0	0	0	0	6.79629	2.746589	1.020979	-0.001
1677	0	13400	0	0	4.641105	2.817429	0.915924	0.003591
1678	13400	13400	0	0	9.480069	2.888269	0.887975	0.006749
1679	0	0	0	0	6.709536	2.888269	0.953895	-0.00635
1680	0	0	0	0	4.837822	2.888269	0.961895	-0.00679
1681	0	0	0	0	5.191377	2.560829	0.930048	-0.0119
1682	0	10720	0	0	4.312597	2.233389	0.935897	-0.0061
1683	0	0	0	0	6.861108	1.905949	1.034413	-0.00286

1684	0	0	0	0	2.199721	1.905949	0.896432	0.000409
1685	0	26800	0	0	3.597351	1.905949	0.992051	-0.00369
1686	0	0	0	0	7.011234	1.6231	0.920704	-0.00103
1687	0	0	0	0	7.200397	1.34025	1.011595	0.002874
1688	0	0	0	0	10.05997	1.0574	1.201777	0.003682
1689	0	0	1	0	13.26345	1.0574	0.961538	0.004076
1690	0	26800	1	0	8.701033	1.0574	1.012775	-0.0002
1691	0	0	1	0	8.217158	-0.14387	0.893357	0.003047
1692	0	83080	1	1	1.480655	-1.34515	0.808028	0.000811
1693	0	15000	1	1	-4.19413	-2.54643	0.746255	0.005658
1694	0	0	1	0	-1.87388	-2.54643	0.9125	-0.00262
1695	26800	56280	1	1	-1.29672	-2.54643	0.7167	0.000202
1696	9600	76860	1	1	0.80674	-0.80655	0.731478	0.002219
1697	0	69980	1	1	4.396536	0.93333	0.681074	0.003219
1698	17040	33120	0	1	1.034164	2.673207	0.687885	0.00401
1699	113900	259880	0	0	0.192717	2.673207	0.755917	0.003396
1700	0	50920	0	0	7.142697	2.673207	0.884241	0.00239
1701	50920	60300	0	0	10.68682	1.868358	0.955395	0.006148
1702	11300	51500	1	0	13.48181	1.063508	1.037625	0.0067
1703	0	6720	1	0	14.13875	0.258658	0.917179	0.008214
1704	0	89780	1	0	7.912263	0.258658	0.978738	0.00447
1705	30820	115380	1	0	6.688393	0.258658	0.995264	0.001937
1706	6560	10080	1	0	6.061102	0.271844	1.058123	0.002899
1707	6400	22740	1	0	5.146872	0.28503	1.028846	0.003275
1708	0	26800	1	1	4.119835	0.298216	0.859659	0.003073
1709	4640	39920	1	1	-0.42917	0.298216	0.737019	0.001916
1710	10080	89140	1	1	-1.49914	0.298216	0.790672	0.002485
1711	5120	6880	1	1	0.131205	1.05381	0.780791	-0.00153
1712	16080	16080	1	0	3.970675	1.809403	0.8352	-0.0023
1713	5120	112520	1	1	7.582284	2.564997	0.783542	0.001341
1714	26820	42140	0	0	7.452309	2.564997	0.932819	0.003248
1715	30160	74380	0	0	7.014729	2.564997	0.897395	0.000763
1716	12320	25720	0	0	4.824047	2.043267	0.953895	0.005702
1717	21760	24640	0	0	5.101963	1.521537	0.969762	0.006424
1718	11500	11500	0	0	7.503877	0.999807	1.052885	0.006383
1719	111800	123860	0	0	5.461355	0.999807	0.938936	0.006342
1720	44840	44840	0	0	2.778613	0.999807	0.914347	-0.00373
1721	23320	29880	0	0	6.130456	0.993398	0.942308	-0.00149
1722	32900	57020	0	0	6.407456	0.986989	0.982692	0.000561
1723	7360	8480	0	0	6.157136	0.98058	1.038462	0.003357
1724	48680	51080	0	0	6.982885	0.98058	0.95129	0.00316
1725	53720	118120	0	1	5.139367	0.98058	0.811863	0.003335
1726	116240	118800	0	0	1.008204	0.942023	0.88851	0.008106

1727	24480	24480	0	1	1.670263	0.903466	0.803312	0.005489
1728	13760	13760	0	1	-0.16621	0.864909	0.785849	-0.01009
1729	0	10720	0	0	1.542348	0.864909	0.966284	-0.01654
1730	1600	25420	0	0	6.766092	0.864909	1.013889	-0.01264
1731	27320	62160	0	0	6.2448	0.428631	1.110505	-0.00114
1732	12960	61200	0	0	10.61575	-0.00765	1.137966	0.003982
1733	22780	22780	0	0	10.55979	-0.44392	1.103022	0.004908
1734	5280	35760	0	0	6.102034	-0.44392	1.038846	0.009932
1735	4320	159760	0	0	5.104049	-0.44392	0.993631	0.008541
1736	2680	122940	0	0	2.328932	-0.15056	1.043399	0.007551
1737	7680	46260	0	0	2.028563	0.142811	1.00414	0.005672
1738	14880	51060	0	0	3.648767	0.436178	1.103022	0.004188
1739	37240	41560	0	1	4.778905	0.436178	1.00024	0.005978
1740	28640	57840	1	1	1.520468	0.436178	0.843885	0.005044
1741	0	75020	1	0	0.662778	-0.52851	0.9089	0.001975
1742	15360	23040	1	0	3.059447	-1.4932	1.119008	-0.01082
1743	11520	33900	1	0	4.67396	-2.45789	1.203297	-0.00073
1744	11520	17120	1	0	9.673	-2.45789	1.155473	0.00651
1745	0	0	1	0	10.15365	-2.45789	1.043136	0.009865
1746	23040	71760	1	0	5.958459	-1.5326	1.023638	0.005695
1747	4960	4960	1	0	3.941745	-0.60732	1.047941	0.004073
1748	25600	29920	1	0	1.941579	0.317971	0.982692	0.001942
1749	12940	20300	1	0	1.389919	0.317971	1	0.00598

Sources: See Text.

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



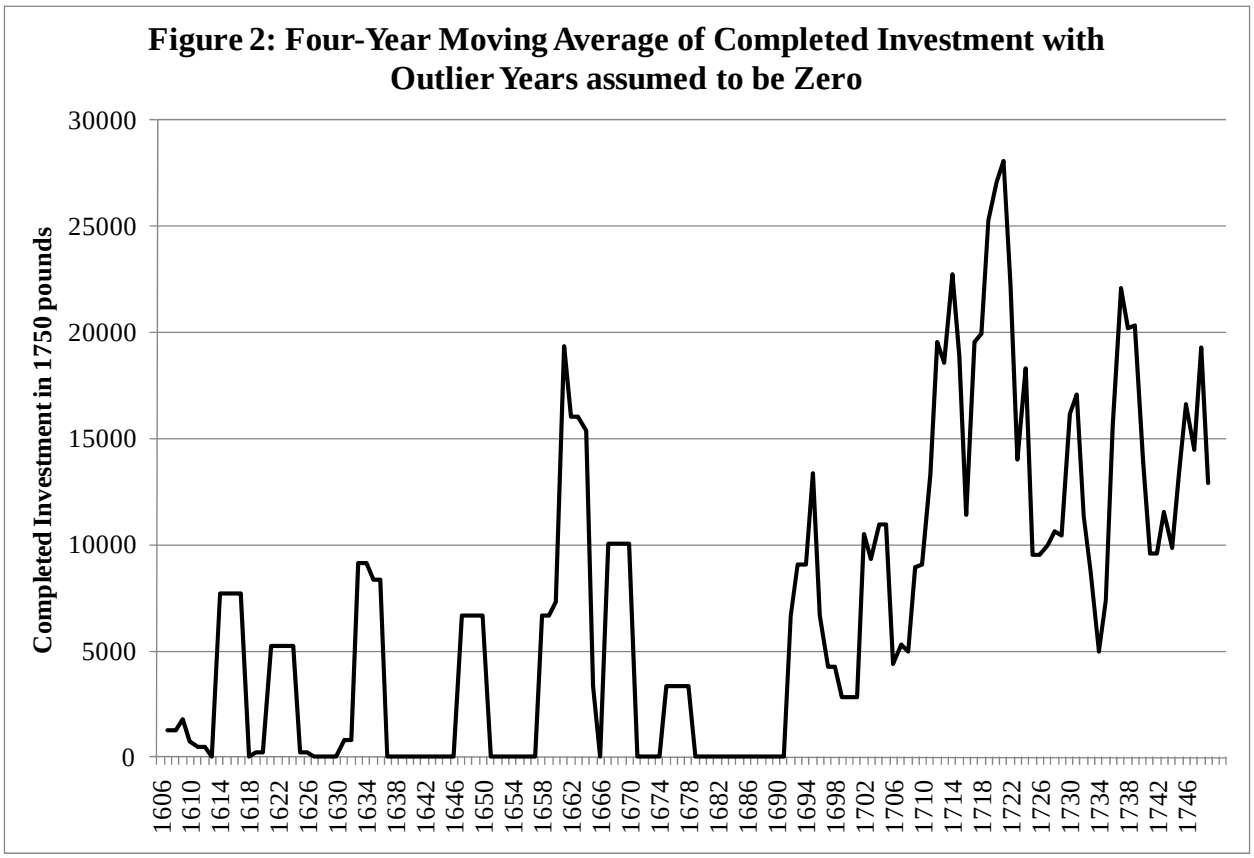


Figure 2: Four-Year Moving Average of Completed Investment with Outlier Years assumed to be Zero
Completed Investment in 1750 pounds
30000
25000
20000
15000
10000
5000
0
1606
1610
1614
1618
1622
1626
1630
1634
1638
1642
1646
1650
1654
1658
1662
1666
1670
1674
1678
1682
1686
1690
1694
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1702
1706
1710
1714
1718
1722
1726
1730
1734
1738
1742
1746

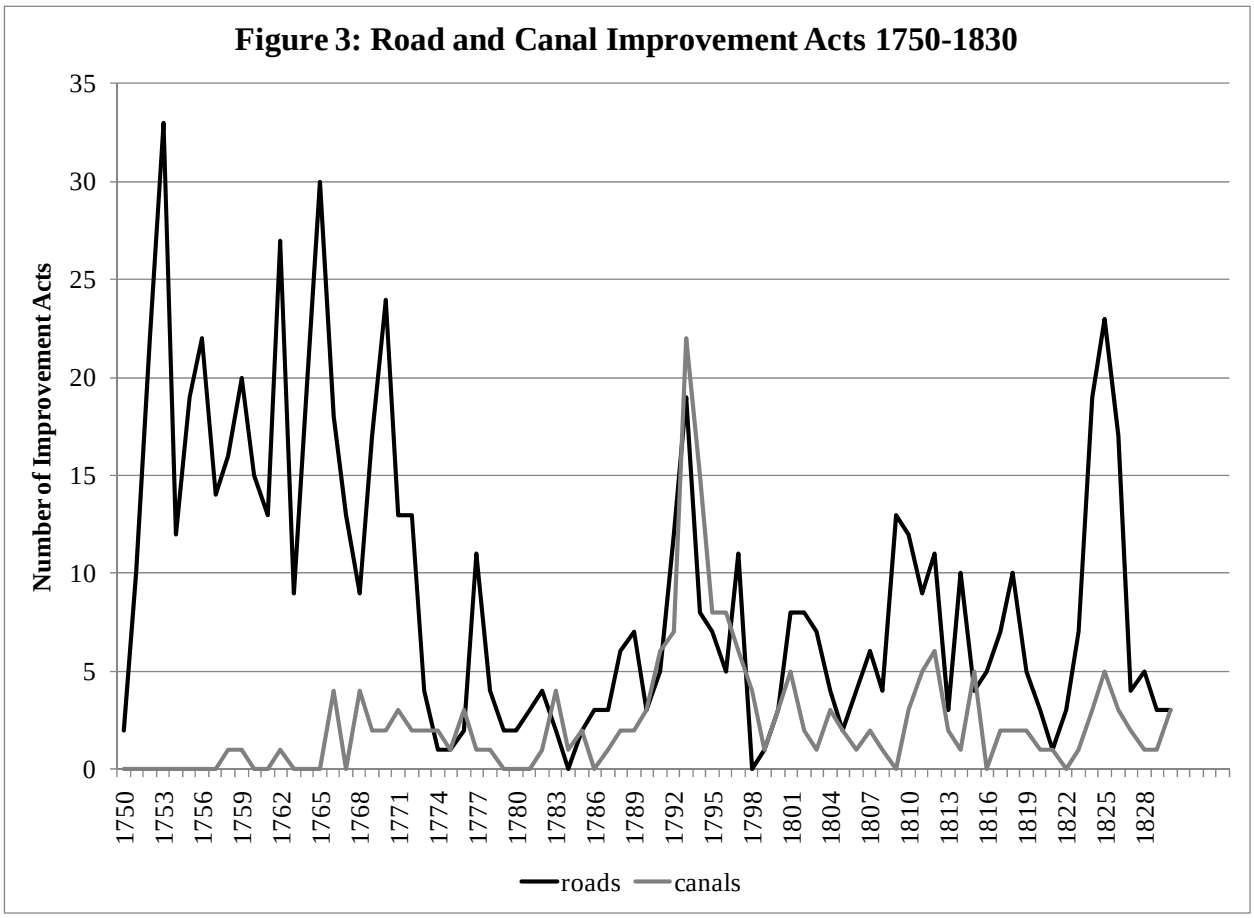


Figure 3: Road and Canal Improvement Acts 1750-1830
Number of Improvement Acts
35
30
25
20
15
10
5
0
1750
1753
1756
1759
1762
1765
1768
1771
1774
1777
1780
1783
1786
1789
1792
1795
1798
1801
1804
1807
1810
1813
1816
1819
1822
1825
1828
roads
canals

Figure 4: Four-year Moving Average of Proposed Investment in Road and River Improvements, 1607-1749

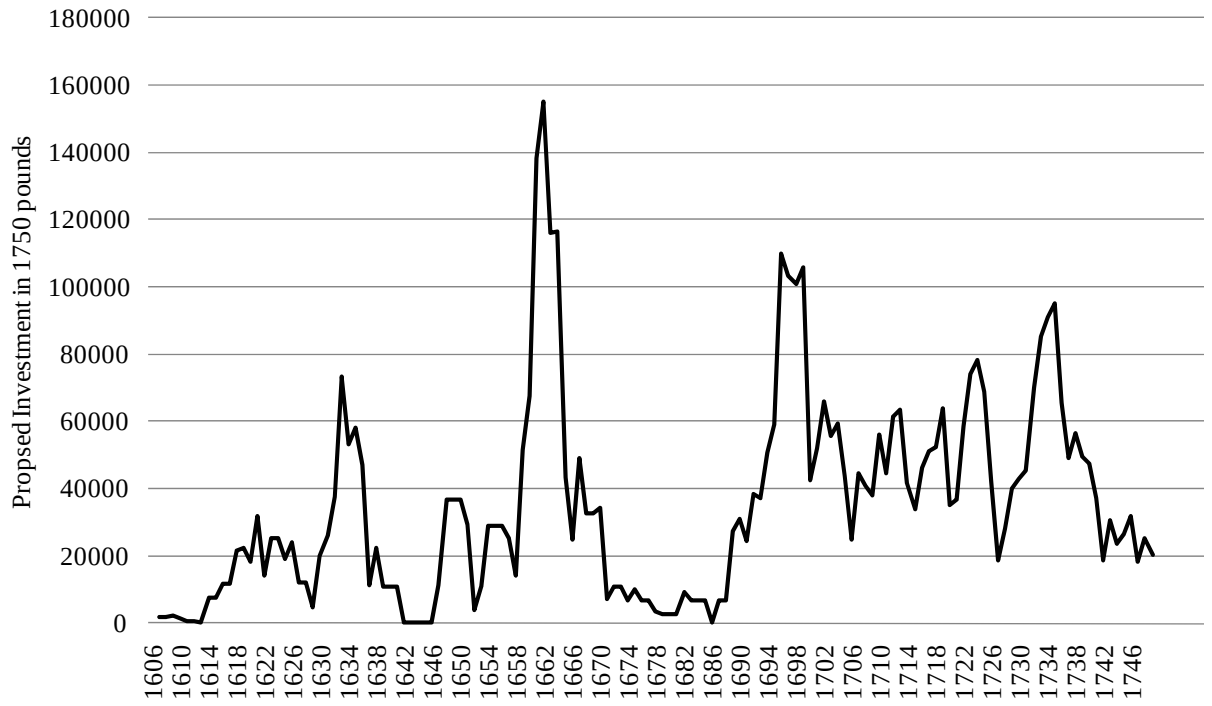


Figure 5: Proposed Investment with the Severn & Thames Canal Project Dropped

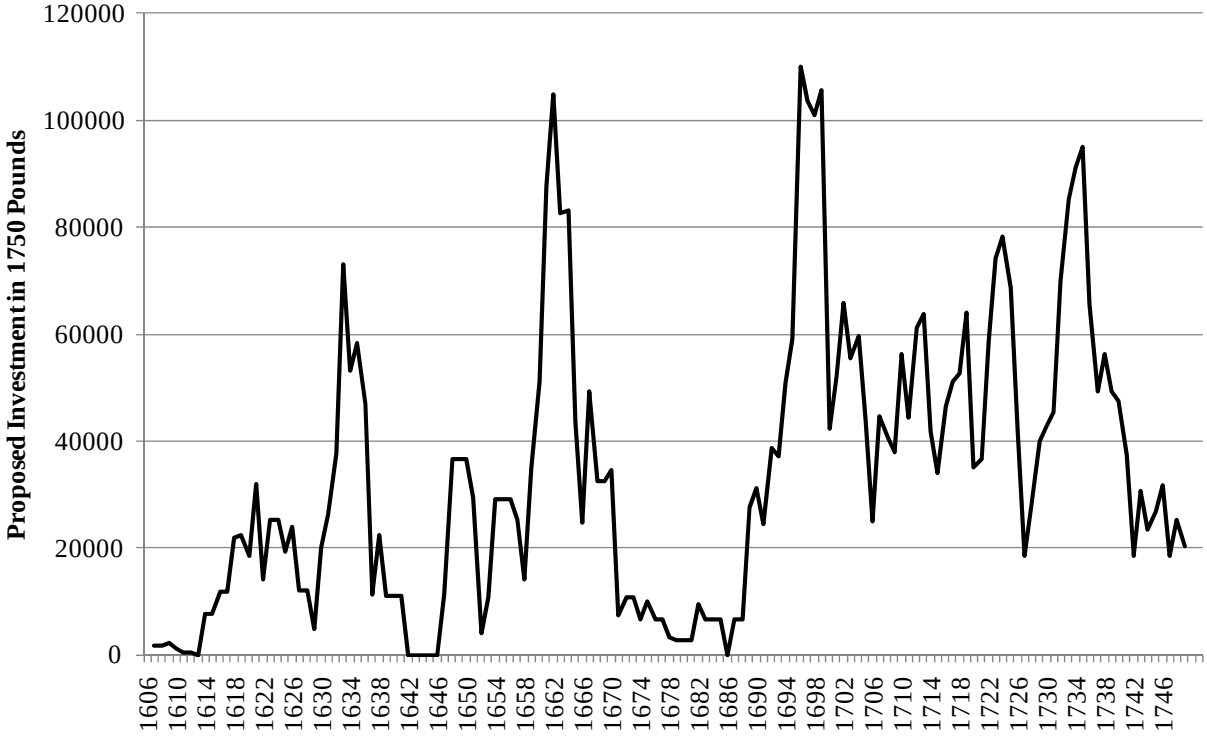
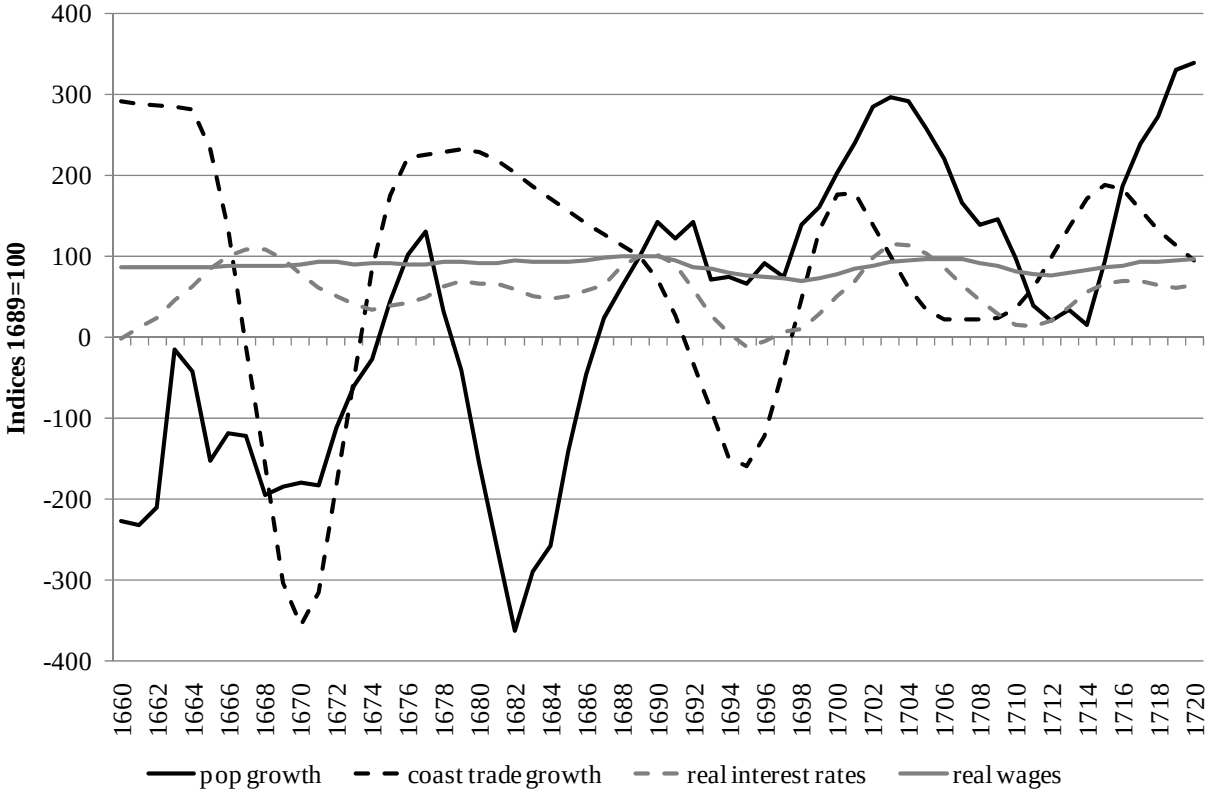


Figure 6: Economic Indices for Determinants of Investment,, 1660-1720



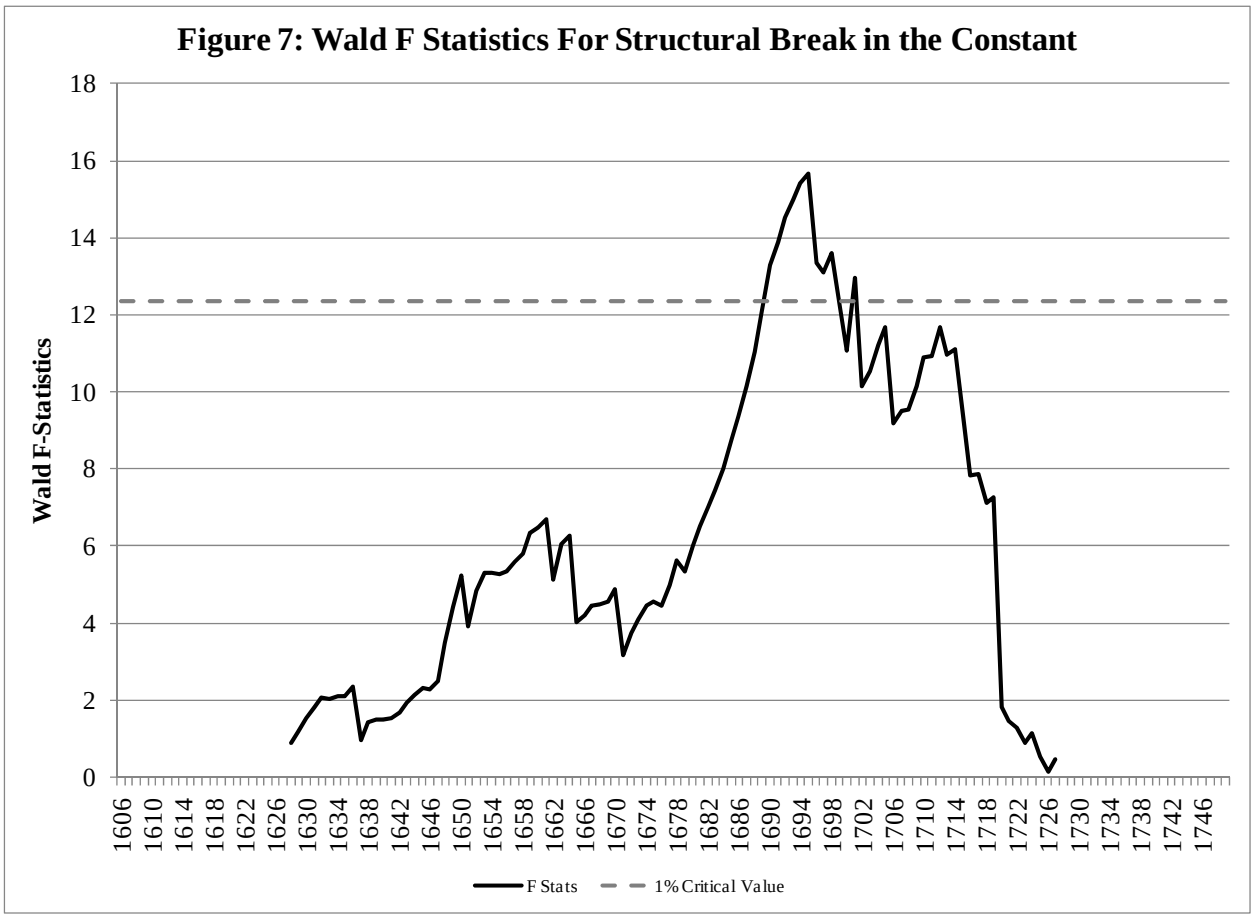


Figure 7: Wald F Statistics For Structural Break in the Constant
Wald F-Statistics
18
16
14
12
10
8
6
4
2
0
1606
1610
1614
1618
1622
1626
1630
1634
1638
1642
1646
1650
1654
1658
1662
1666
1670
1674
1678
1682
1686
1690
1694
1698
1702
1706
1710
1714
1718
1722
1726
1730
1734
1738
1742
1746
F Stats
1% Critical Value