

Profiting from Public Works:

Financial Returns to Infrastructure and Investment Strategies during Britain's Industrial Revolution

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Abstract

The infrastructure sector has the potential to generate wide differences in profits and economic outcomes. This paper examines financial returns and investment strategies for Britain's turnpike roads in the early nineteenth century. There are three main findings. First, rates of return on capital invested and returns to bondholders were similar to competitive sectors. Second, there was significant variation in returns across trusts. Third, there is evidence that turnpike investors were driven by financial motives, although economic motives appear to be important in some cases. The findings have implications regarding the connection between infrastructure and Britain's industrialization.

JEL Codes: K23, N43, N73

Key Words: Monopoly, Regulation, Turnpike roads, Infrastructure, Britain, Industrial Revolution

¹ Helpful comments were provided by participants in seminars at UC Irvine, Northwestern University, and Stanford University on an earlier version of this paper. Special thanks go to Jean Laurent Rosenthal. All mistakes are my own.

I. Introduction

Infrastructure markets are often a source of contention among consumers and firms. In some settings, only one firm or government agency serves the market with the predictable result that prices and profits are high. In other cases, entry can be substantial resulting in excessive competition and ultimately bankruptcy due to large fixed investments. Failure in the infrastructure market can also affect efficiency. Monopoly pricing limits the use of infrastructure and stunts its developmental effects. Bankruptcy can result in disruption of services, volatile pricing, and stifle further investment. The more efficient markets are ones in which infrastructure investors earn a similar return as competitive industries.²

History is replete with examples of monopoly and bankruptcy in the infrastructure sector. The Danish Sound tolls are one of the most famous examples of monopoly. The Danish king collected tolls on all ships passing through the straight between Sweden and Denmark. The toll income provided a large share of the King's revenues and was a constant source of contention among the trading nations of the north Atlantic (Smith Homans 1858). The turnpike roads in the early United States are a well-known example of a bankrupt infrastructure sector. The openness of entry and the low population density of the economy made the payment of any dividends exceptional (Klein 1990, Klein and Majewski 1992, Bogart and Majewski 2011).

This paper examines the financial returns to Britain's turnpike roads during its industrializing era. Following the Bubble Act of 1721, corporations were rare in Britain for more than a century. The exception is in infrastructure where Parliament granted trusts and joint stock companies' powers to construct or improve roads, rivers, canals, ports, and railways. Turnpike

² There is a large literature on monopoly and regulatory challenges in the infrastructure sector. See Laffont (2005) and Gómez-Ibáñez (2003) for overviews.

trusts and related infrastructure authorities financed significant investment from the late 1600s through the late-1800s and are often seen as a precursor to the modern corporation in Britain (Harris 2000).

The financial performance of Britain's infrastructure sector has several implications. Some scholars have suggested that Britain's well developed transport system was partly responsible for the high level of market integration at the start of the Industrial Revolution (Shiue and Keller 2007, Jacks 2011). That being said, infrastructure authorities generally relied on tolls to pay for investment. It is possible that trusts and companies exploited their monopoly power and charged more than was necessary to earn a competitive return. Financial returns in infrastructure are also linked with theories about what made Britain a leading economy c.1800. There is an argument that British landowners and businessmen invested in infrastructure with the goal of developing their local economy even if there was little hope of earning high dividends or healthy interest payments. Far from being altruistic, landowners and businessmen aimed to benefit indirectly through higher rents and profits. Whether such 'economic' motives for investing were as important as 'financial' motives is still a matter of debate.

There are a number of studies on the financial returns in Britain's infrastructure sector. Drawing on comprehensive sources, Mitchell, Chambers, and Crafts (2011) and Arnold and McCartney (2005), have demonstrated that rates of return for railways were modest, ranging between 4 and 5 percent. Outside of railways there is less conclusive evidence. A key problem is that scholars have used samples of companies which are either small or selected on characteristics linked with profitability. For example, the best evidence on interest rates paid to turnpike bondholders is drawn from a sample of trusts paying interest (Albert 1972). However,

many trusts did not pay interest and thus the average observed interest rate yields a biased estimate of population returns.

This paper estimates rates of return for the turnpike road sector in the early 19th century. The main data sources are financial surveys of *all* turnpike road trusts in England and Wales in 1820, 1829, and every year after 1834. The surveys were conducted by parliamentary committees and provide a rare snapshot into the revenues, expenses, assets, and liabilities for a population of infrastructure providers. The rich data sources are used to construct the first estimates of capital invested in the turnpike sector and the rate of return on capital. I also study the financial returns for individual turnpikes trusts in 1820 using the first financial survey. The data are also studied at the county level in 1820 and 1829 to examine the motives of investors.

There are three main findings. First, the data show that in the aggregate turnpikes did not generate super-normal profits from the tolls. The sum of net revenues for all turnpikes trusts in England and Wales as a percentage of the total capital invested averaged around 4.5 percent in the 1820s, 1830s, and 1840s. The sum of all interest payments as a percentage of total debt was around 4 percent over the same period. Similar returns were earned on land, housing, and long-term government bonds during the eighteenth and early nineteenth century.

Second, the data from 1820 show there was considerable variation across turnpike trusts in terms of the interest payment as a percentage of debt. Between 10 and 20 percent of turnpike trusts paid no interest, yielding a zero percent return to bondholders. At the other end of the spectrum 60 to 70 percent of turnpike trusts paid a return between 4.5 and 5 percent. The risks of holding an individual turnpike bond could be minimized with a balanced portfolio of turnpike bonds, but as most investors were local the possibilities were somewhat limited.

The third finding is that investors in turnpike bonds behaved as though they were motivated by a mixture of financial and economic goals. I show that turnpike debt grew significantly between 1820 and 1829 in counties with higher rates of return to bondholders in 1820. Debt also grew the most in northern England where industrialization was occurring. The results suggest that investors were lending more to trusts in counties where financial returns had recently been good or were most promising in the future. On the other hand, a curious fact is that few investors fully exploited their legal rights with respect to debts. The bonds were secured on the income from the tolls, but few investors in 1820 foreclosed when interest payments were missed. Along the same lines there is evidence that the majority of investors did not convert their claims on unpaid interest into debts during the 1820s and 1830s even though some trusts began to resume interest payments. It appears some investors were interested in preserving the turnpike trust and ensuring sufficient revenues for road maintenance. Foreclosure and conversion came at the cost of reducing the indirect benefits like higher land values.

The evidence on financial returns to turnpike trusts is broadly similar for other infrastructure sectors like canals and railways (Mitchell, Chambers, and Crafts 2011, Arnold and McCartney 2005, 2011). Rates of return were generally around 4 to 5 percent as I outline below. The findings thus point to a potential role for regulation in striking a reasonable balance between the need to adequately compensate infrastructure investors and the goal of keeping tolls low for users. This view runs counter to some works more critical of Britain's regulatory policy. Casson (2009), for example, argues that Members of Parliament did not want to deny requests from local communities seeking a railway in their area. Something like a 'tragedy of the commons' resulted with too many railways being built to sustain profitability. While there was some evidence of

duplication, it is important to note that infrastructure profits were never pushed so low in Britain that the industry tumbled into bankruptcy as occurred in U.S. railroads in 1893 (White 2011).

The findings also illustrate how infrastructure, economic policy, and industrialization were connected. Even before the massive investment in railways, Britain's infrastructure capital grew substantially. The establishment of turnpike trusts played a crucial role from 1750 to 1820 accounting for several percentage points of GDP through better roads (Albert 1972, Pawson, 1977, Freeman 1977, 1979, Bogart 2009). Britain's economy not only mobilized investment, it was able to limit the costs of monopoly. If it had been otherwise, the tolls would have likely been larger and the use of transport services diminished.

Lastly, the results speak to the investment strategies of Britain's elite during the Industrial Revolution. Channeling savings to sectors requiring large scale investment was a key challenge for all economies c.1800 as capital markets were under-developed (Trew 2010). In the infrastructure sector, British investors put their capital into projects with reasonable prospects of yielding large dividends or healthy interest payments, but they were also open to projects where the direct private returns fell short of the social returns. The broader motivations of Britain's investing elite are possibly a key factor in Britain's economic success during industrialization. Similar conclusions have been made for the United States during the nineteenth century and point to a role for culture in promoting economic development.³

II. Background on Britain's Infrastructure Development, 1700-1830

In 1700 Britain was already undergoing the early stages of economic development, but there were bottlenecks. One of the most important was the poor quality of the transport network

³ See Mokyr (2009) for a related discussion of Britain's Industrial Enlightenment. See Bogart and Majewski (2011) for a comparison of Britain and the US with respect to the chartering of transport authorities.

and the weak institutional framework for implementing investment.⁴ Problems with the road network provide a good illustration. Local governments, known as parishes, were required by law to pay for road maintenance and improvements in their jurisdiction. Parishes were given the authority to claim labor services from their residents, or levy taxes on property income, but they could not levy tolls on road-users or issue bonds. Parishes were generally ineffective in providing road maintenance and investment. The main problem was that parishes were small, and therefore, most of the benefits went to through-travelers.

The poor quality of the road network led to calls for a new system of financing. The impetus for reform did not come from government ministers or Members of Parliament (MPs), but rather from local groups. By the early 1700s it became increasingly common for communities to request ‘turnpikes’ so that tolls could be levied on their highways. Tolls could not be levied without the approval of the central government. Highways technically belonged to the Crown and Parliament insisted that tolls be granted through legislative procedures. A ‘turnpike act’ transferred authority to a body of trustees for 21 years, but it was typical for their authority to then be renewed subsequently. Trustees had to meet property and income qualifications. Most were landowners, merchants, and manufacturers drawn from the local area. Trustees had the right to levy tolls and issue bonds secured on the toll income. Importantly, as we shall see later, trustees were not allowed to directly benefit from operating the trust. All the capital was raised through bonds, and all revenues were to be devoted to interest payments and road improvement.

⁴ See Willan (1964), Albert (1972), Ward (1974), Pawson (1977), and Ville (2004) for comprehensive works on Britain’s infrastructure and transportation problems.

Turnpike trusts spread widely through the network. The first trusts were created in the late 1600s but their take-up was limited until 1750. In the 1750s and 1760s hundreds of trusts were established and a well-developed network was formed owing to their significant investment (Bogart 2005). The finances of turnpikes were stressed during the Napoleonic wars of the early 1800s when rampant inflation and volatility hit the British economy. Turnpike tolls were capped in nominal terms by parliamentary acts and did not keep up with inflation for many trusts. Their financial condition was weak by the 1820s leading to several parliamentary inquiries and calls for major reform. Nevertheless the turnpike system continued for several more decades. By the 1830s trusts managed approximately 20,000 miles or 20 percent of the total network. Their penetration is remarkable considering that toll roads rarely exceed 10 percent of a network.

River navigation went through a similar development. Britain was well endowed with rivers, but many internal areas remained more than 15 miles from a navigable waterway (Willan 1964). Custom dictated that inhabitants near a river should be responsible for its maintenance, but many failed to remove debris and other impediments to navigation. Locals could petition to form a Commission of Sewers, which had rights to compel landowners to cleanse the river, and if necessary, levy a property tax to pay for maintenance expenses. Most Sewer Commissions suffered from the same problems as parishes. They had no authority to tax inhabitants other than those adjacent to the river, and they could not purchase land or divert the path of the river.

As with roads, improvements to river navigation were undertaken by authorities sanctioned through parliamentary acts. River navigation acts gave a single undertaker, company, or municipal corporation the authority to improve navigation. They authorized the use of tolls, specified mechanisms for raising capital, and the associated governance structures. The greatest

growth in river navigation occurred from 1690 to 1750 when miles of navigable river increased from 898 to 1351 (Willan 1964).

Dock works, canals, and railways were the final infrastructure developments of the industrial revolution period. They often receive more discussion from historians because the investments were larger than roads and rivers and their economic impact was likely greater in an absolute sense.⁵ That said, the recent literature stresses the long roots of the industrial revolution (Allen 2009). The impact of early investments should not be under-estimated. The organizational structure of docks, canals, and railways also followed the earlier model. They were initiated by local interests and were undertaken by companies sanctioned through Parliament. This procedure was forged by roads and rivers in the early eighteenth century.

III. Infrastructure Rates of Return: A review of the Literature

Rates of return have been estimated for various infrastructure sectors. Studies of railways generally use the *Railway Returns* because they provide comprehensive data for all companies. Arnold and McCartney (2005) use this source to measure rates of return on capital invested from 1830 to 1912. They find modest returns for the sector as a whole ranging between 3.5 and 4.5 percent. Mitchell, Chambers, and Crafts (2011) revise the estimates for a sample of railways from 1870 to 1913 and argue for average returns around 4.5 to 5.5 percent. Although there is some disagreement between the two studies, both point to the conclusion that railway investors did not earn super-normal returns.

Outside of railways much of the evidence is based on non-random samples of company or trust records. There are documented instances of super-normal profits and abuse, but their

⁵ The literature on dock works, canals, and railways is too voluminous to review. To see how rivers and highways compare with dock works and canals see Aldcroft and Freeman (1983).

representativeness is unclear. For example, the evidence on rates of return for river navigation companies is thin and largely anecdotal. In one study, it is shown that dividends on the Aire and Calder navigation ranged between 10 and 28 percent from 1720 to 1775 (Wilson 1971, p. 140). It is no surprise that the undertakers of the Aire and Calder were known locally as the ‘fourth estate of the realm (p. 140).’ Despite its financial success, there are reasons to suspect that the Aire and Calder was an exceptional case. Its revenues grew by an average annual rate of 3.5 percent from 1700 to 1772 and 2.1 percent from 1775 to 1826 (Wilson 1971). By comparison, revenues for the Great Ouse navigation near Bedford grew by an average annual rate of 1.1 percent between 1750 and 1800 (Summers 1973). On the River Cam near Cambridge revenues grew at an average rate of 1.6 percent between 1752 and 1813 (Summers 1973). It appears that Aire and Calder navigation was at the upper end of the distribution in terms of revenue growth and therefore dividends. Location is the most likely explanation. The Leeds region, near the Aire and Calder, was undergoing industrialization, while Bedford and Cambridge were not.

There is better information on rates of return for canals, but again there are data problems which limit the conclusions. There is a well-known survey of the dividends and share capital for all canal companies covering the year 1822.⁶ The survey of dividends is particularly useful because it covers most canal companies. It reports the total share capital and total dividends paid for five groupings of canals. The total dividend divided by the total share capital in each group provides the dividend rate for each group. A weighted average of dividend rates based on the total capital of each group gives the sector-level estimate.⁷ The resulting dividend rate for all canals in 1822 is 5.9 percent.

⁶ The author is anonymous. The title is called ‘the Present State of England,’ in the Quarterly Review.

⁷ The first grouping had £3.73 million in capital and dividend rate of zero. The second group had a £4.07 million in capital and a dividend rate of 2.2 percent. The third group had a £2.19 million in capital and a dividend rate of 7.3

Based on the 1822 survey, it would appear that canals were quite profitable in the early 1820s. The problem is that dividend rates (i.e. dividends divided by share capital) do not provide a good estimate of rates of return. In a very detailed study, Arnold and McCartney (2011) estimate various measures of financial performance for five canal companies from 1770 to 1850. They show that the rate of return on capital and rate of return on equity is lower than the dividend rate especially for profitable companies. Arnold and McCartney estimate a rate of return on capital (net earnings divided by debt plus equity) of 10.2 percent for their sample of canals in the early 1820s. The dividend rate for their sample was 23.9 percent in the same years. There is a large difference because canals used a mixture of debt and equity and they had significant retained earnings (Arnold and McCartney 2011, p. 228). The key implication here is that the rate of return on capital in the canal sector during the 1820s was definitely lower than the reported dividend rate of 5.9 percent.

It is possible to give a new estimate of the rate of return on capital for all canals by reworking the dividend rate calculation from 1822. We cannot use Arnold and McCartney's return on capital for the entire sector because their sample of canals was clearly at the upper end of the returns distribution, but we can use their estimate for canals in the top earnings group. Recall the 1822 survey gives dividend rates for five groups. Replacing the dividend rate for the top group of canals with an 11 percent rate of return implies a sector-level estimated return of 4.5 percent.⁸ This latter figure is probably not far off for the sector as a whole because Arnold and McCartney argue that the divergence between dividend rates and rates of return on capital are highest for the most profitable canals (p. 231).

percent. The fourth group had a £2.07 million in capital and a dividend rate of 10.4 percent. The fifth group had a £1.12 million in capital and a dividend rate of 27.5 percent.

⁸ Originally the fifth group had a £1.12 million in capital and a dividend rate of 27.5 percent. I replaced the 27.5 dividend rate with 11 percent and re-calculated the rate of return with all other groupings kept the same as before.

There are a similar set of issues is estimating returns for turnpike trusts. Turnpike trusts were different from canals because all the capital was raised through bonds, with the majority secured on the income of the tolls.⁹ If the bondholders did not receive their scheduled interest payment within six months they could foreclose on the tolls and become the first claimant on the revenues. The mortgage bonds had no set maturity date and the trustees could repay the principle in full at any time.¹⁰ All bonds for an individual trust were treated equal, and so there were no first or second claims on the revenues. Interest rates could not exceed 5 percent because of usury laws which limited interest rates on all classes of private debt.

The typical investors in turnpike bonds had some connection with the road. Albert (1972) provides numerous examples where prominent investors had land or mines near the road (pp. 102-105). Buchanan (1985) conducted a detailed study of the Bath turnpike trust and showed that many urban investors were resident in Bath with a minority having Bristol or London addresses. In terms of the occupation of investors, there is more doubt about the general pattern. Albert (1972, p. 103) argues that most of the capital came from the landed classes (farmers, gentry, and landowners) and gives examples to support this view. On other hand, Buchanan conducted a detailed study of the Bath turnpike and found significant investment coming from merchants, tradesman, and women especially by the 1800s (p 235). Buchanan notes the importance of the 'small urban saver' in the Bath trust, which is quite different from the role of the Dukes of Devonshire and Norfolk who lent more than half of the total debt to the Sheffield Glossop turnpike in 1818 (Albert 1972, p. 105).

⁹ See Albert (1972) for a detailed description of the organization and financing of turnpike trusts.

¹⁰ There is a caveat here. The bonds would expire when the trust was distinguished. The expiration date would have been a problem as most trusts operated under a temporary 21-year authority, but Parliament regularly renewed turnpike charters in order not to create defaults.

Another key organization feature relates to profits. Trustees were legally forbidden from profiting through the tolls. All turnpike acts stated that the revenues were to be devoted to manual labor, materials, officers' salaries, interest, and repayment of the principal on the debt. Surplus balances were to be held by the treasurer and applied to future expenses. It appears that legal principles were behind the non-profit structure of trusts. All highways belonged to the Crown and it was not clear in the 1700s how to privatize such a large asset.

In spite of legal provisions against profits, various forms of appropriation were still possible. Trustees, for example, might accept payments in exchange for road repair contracts. There were also concerns that treasurers would use balances as a source of deposits (Albert p. 76). Interest payments provided another channel for appropriation. As one illustration, a farmer in northern England commented on a turnpike in his area stating that "the [toll] would continue indefinitely. This is because those who have loaned money for the repair of the road are not keen to be repaid as long as they enjoy 5 percent interest, an unusually high figure for this area..."¹¹ The suggestion from this case is that the original bondholders were given an interest rate that was larger than the local market rate, most likely 4 percent. If the interest payments were regularly met then the original bondholders would indeed earn a rent, which they could collect annually or capitalize upon by selling the bond on the market above par.

Did turnpike officers and investors profit from the tolls despite legal attempts to limit their returns? There is not systematic evidence on the malfeasance of trustees and treasurers, but arguably what is crucial is whether the trust earned a high rate of return on capital invested. There is less possibility for appropriation if the returns on capital are low. Below I will investigate this issue more thoroughly. In the case of bondholder returns, there is evidence on

¹¹ Quoted in Berg and Berg (2001) p. 240.

the interest rates paid. Albert (1972 pp. 247-261) lists interest rates for a sample of 100 trusts between 1730 and 1830. Figure 1 plots the average interest rate in Albert's sample along with the yield on long-term government bonds known as '3 percent Consols.' The average interest rate for turnpike bonds is 4.66 percent from 1730 to 1830. By comparison the average yield on government bonds is 3.9 percent. Interest rates are not necessarily the same as yields, but even if one incorporates the available data on prices of turnpike bonds it would appear that turnpike investors were paid a premium.¹²

The main problem with the preceding conclusion is that Albert's sample of interest rates is not representative of the population. By definition the observations are for trusts that were paying interest. However, many trusts did not consistently pay interest. Albert (1972) recognized this point when he showed that many trusts had significant amounts of interest due to creditors in the 1820s. To determine whether bondholders earned a premium we need data from a random sample or preferably the population of turnpike trusts. The following section discusses the data sources which I use to estimate returns for all turnpike trusts in the 1820s, 30s and 40s.

IV. Data on Financial Returns to Turnpikes

Parliament began making in-depth inquiries into the finances of turnpike trusts in the early nineteenth century. There was a perception that trusts were being mismanaged and that many could default on their bonds because of financial distress. The report from the 'Select Committee to consider the Acts now in Force Regarding Turnpike Roads and Highways,' published in the

¹² Some information on turnpike bond prices can be gleaned from the portfolios of charities (see Clark 1998 for details on charities). In the Charity data 58 percent of the turnpike bonds were purchased at prices exactly divisible by 25. This suggests that these bonds traded at par because most turnpike bonds were issued in units no smaller than 25 pounds. Moreover, prices rarely deviated from what is likely to have been the par value. The prices of bonds in the Charity sample were divided by the nearest number exactly divisible by 25. The average ratio between the price and nearest number exactly divisible by 25 is 1.009, which is statistically indistinguishable from 1.

British Parliamentary Papers in 1821, was the first significant inquiry. The committee writing the ‘1821 Report’ required the officers of each turnpike trust to provide a financial summary and information on operations. In total 1020 trusts from England and Wales submitted returns on annual revenues and expenses averaged over the years 1818, 1819, and 1820. They also reported the balance held by treasurer, interest due, and the amount of debt in 1820. In terms of operations, officers reported the length of the trust in miles, the number of trustees, the dates of their first authorizing act of Parliament and the most recent act, and whether trustees earned their income from land or personal property. Lastly, the reports include notes with additional information such as how long interest was in arrears, the size of legal expenses, and road improvements.¹³

More detailed financial reports were made for trusts in 1829 and annually from 1834.¹⁴ In the post-1821 reports, separate tabulations are made for interest payments, principal payments, purchases of land, and general improvements. The upshot is that from 1829 onwards revenues minus operational costs can be precisely calculated for all trusts. Revenues are defined as total receipts minus borrowing. Operating costs are defined as total expenses minus interest payments, debt repaid, and expenditures on improvements. For the 1818-20 data some assumptions are needed to calculate net revenues. The main issue is that interest payments are not reported separately from other expenditures. Fortunately data on the value of debt and interest due can be combined to estimate interest payments. The details for the calculation are given in section VI.

All the financial reports suffer from one major limitation: no estimate is given for the value of road capital either before the trust was formed or after due to its investments. There are

¹³ A summary of the 1821 report is in Marshall’s (1835) *Analysis and Compendium of all the Returns Made to Parliament*. The full report is available in BPP (1821 IV).

¹⁴ A summary of the reports up to 1838 is given in BPP (1840 XXVII).

some estimates in the literature. Harris (2000) values all turnpike capital for England in 1810 which is derived from Ginarlis and Pollard's (1985) estimate of quasi-investment from 1750 to 1820. The problem is that the Ginarlis and Pollard series does not adequately distinguish between investment and maintenance expenditures. As such it over-states investment and capital. Below I provide a new estimate for the value of capital invested in turnpike roads by 1820 using an estimate of average capital investment per mile drawing from a sample of trusts. Beyond 1820 additions to the capital stock through investment are estimated from annual expenditures on 'improvements' in the 1829 and 1834-45 surveys.

V. Did Turnpike Trusts Earn Super-normal Returns?

Table 1 summarizes revenues, expenses, and capital for the turnpike sector. Capital is the most complex and so it is discussed in some detail. Turnpike capital in 1820 is equal to average investment per mile multiplied by total turnpike mileage in 1820. The investment data come from Bogart (2005) which reports average expenditure per-mile for a sample 38 trusts covering the years from 1700 to 1820. Figure 2 shows the average expenditure per mile during the first 40 years of a turnpike trust's existence. Expenditure includes all items: investment, maintenance, interest payments, etc. The ages varied by the act of Parliament and each trust's first year is standardized to 1. By 1820 the average age of trusts was around 1764 so the typical expenditure profile displayed is from 1764 to 1803. Lastly, all the expenditures are converted in 1819 prices using wages of unskilled labor, which is one of the main inputs into road repair.

It is clear from Figure 2 that significant road spending occurred in the first two years of a trust's existence, less in year's three to five, and then beyond year five expenditure per mile stabilizes and grows mildly. The figures are consistent with a model in which trusts improved

their road and then maintained it afterwards so that depreciation was essentially zero. This model seems to work well for the pre-1820 period as many trusts did not significantly alter the road after making their initial improvement. For the purposes of estimating investment per mile, I assume that all spending by the turnpike trust in the first two years was investment in road capital, the difference between the average spending in years 3, 4, and 5 compared to years 6 to 20 was investment, and none of the spending beyond year five was investment. These assumptions yield an investment per mile of £502 in 1819 prices. Multiplied by total turnpike mileage implies a value of turnpike capital around £10.5 million in 1819 prices.

The estimates of turnpike capital here are lower than Harris (2000) who puts it at £15.9 million for England in 1810. Harris' figure appears to be too high given that total turnpike debt in England and Wales was £4.4 million in 1820. If the capital stock was £15.9 million and debt was £4.4 million then there must have been significant investment from retained earnings and/or significant repayment of debt, both of which seem unlikely based on the histories of trusts discussed in Albert (1972). The debt in 1820 provides another check on the estimates of capital. Suppose that none of the trusts' original debts were repaid by 1820 and that most were incurred in the 1750s and 1760s when the vast majority of trusts were formed. Nominal wages in 1760 were around half their level in 1819. Thus if one assumes all debts were investments and convert them to 1819 prices they would amount to around £8.8 million which is similar to my 1820 capital estimate of £10.5 million.

From 1820 the estimated value of turnpike capital increases because of sizeable investment (see the notes to table 1). The effects of investment are partly offset by deflation. The current price of total capital is reported in subsequent years as it will be compared with net revenues in

current prices. Prices were generally falling from 1820 and so the capital value in 1829 and later years is diminished by deflation.

The main items in Table 1 are the rates of return, calculated as the percentage of net revenues in capital value. The rate of return on capital invested in turnpikes ranges between 3.6 and 5.6 percent. The 1830s had the highest returns on capital and the lowest return was in 1842. Over the six observations in the 1820s, 1830s, and 1840s the average return on capital in the turnpike sector is 4.6 percent. How does this compare with the rest of the economy? Clark (2009) uses returns on land and housing to calculate the rate of return on low risk capital investments. He finds that from 1820 to 1850 the average rate of return was 4.42 percent. Therefore, the average return on turnpike capital was approximately equal to the return on land and housing.

It is worth pausing to consider the implications of the previous finding. First, turnpike trusts look to be similar to other British infrastructure sectors in that rates of return on capital were modest. Thus despite the potential for monopoly power, the turnpike, canal, and railway sectors as a whole did not generate monopoly profits. On the other hand, profits do not appear to be too low so as to stifle investment. It appears that a balance was struck between users' desire for cheap infrastructure and investors' desire to earn large profits from infrastructure.

The second implication is more specific to turnpike trusts. As the rate of return on capital was similar to the competitive rate of return, it is likely that attempts to 'tunnel' the resources of the trust were not fruitful. A theoretical model illustrates the argument. Suppose that a trust had an annual surplus of S after covering their cost of capital. Suppose also that trustees or some other actor with control desired to appropriate the surplus illegally or through their privileged position. As the trust is not a firm, a controlling actors, say a trustee, can appropriate only if they

incur a cost. Let $C()$ be an increasing, convex, and differentiable function in A , the level of appropriation. $C()$ can be interpreted as the cost of tunneling or avoiding authorities. The controlling actor will choose an optimal appropriation, A^* , such that the marginal cost $C'(A^*)$ equals 1 unless the available surplus S is less than A^* and in that case the entire surplus is appropriated. Figure 3 illustrates a case where the controlling actor is unconstrained in their appropriation because they have a large surplus. Figure 4 illustrates a case where the controlling actor is constrained from appropriating because of a limited surplus. If the surplus was pushed down to zero then the level of appropriation is also zero. The key point is that trustees, officers, or bondholders as a *whole* could not appropriate significant sums from turnpike trusts because their net revenues were only sufficient to cover the cost of capital.

In practice, surplus revenues were divided between various actors and trustees or bondholders might have fared better. To explore this issue, I now estimate the rate of return to bondholders. Table 2 shows the total debt and interest paid in the turnpike sector in the 1820s, 1830s, and 1840s. In most years, the interest paid equaled around 4 percent of total debt. The only year where bondholders earned significantly less is 1829 when the return was 3.4 percent. Averaging across all six years yields an average interest paid of 3.9 percent. For comparison, the average yield on long-term government bonds between 1730 and 1830 is 3.9 percent. Thus an investor who had a diversified portfolio of turnpike bonds purchased at face value would have received exactly the same return as government bondholders over the long-run. In other words, there is no evidence that turnpike bondholders as a whole were paid an above market return.

The data also show a relatively large amount of missed interest payments in the aggregate. Interest due is reported in table 2 and equaled between 12 and 20 percent of the total debt. How did missing interest payments reduce bondholder returns? Unfortunately, the sources don't

indicate when interest payments went into arrears, but the amount of interest that was missed in each year can be estimated. The estimate for 1820 assumes that the total interest due was accumulated evenly in all years since 1799. The British economy experienced substantial inflation from 1800 to 1820 and many turnpike trusts faced financial difficulties because their toll caps were not adequately adjusted for inflation. Therefore, it is likely that the initial stock of unpaid interest was largely accumulated in the twenty years from 1800 to 1820. After 1820 the yearly changes in unpaid interest are observed and so the timing is clearer. I assume that the difference in unpaid interest between two years (say 1820 and 1829) represented the total unpaid interest in the intervening period. I then assume it was accumulated evenly in every intervening year. The bottom of the table 2 shows the estimates of interest in each year that went unpaid. They imply that around 0.4 to 0.7 percent of the debt went unpaid each year. If instead trusts were able to make these payments then the hypothetical return would have been around 4.5 or 4.75 percent (see the bottom of table 2). In the end, bondholders did not make an above market return because not all interest payments were made.

Bondholders were not the only group that could claim the surpluses of the trust. Trustees and their officers could capture some of the residual net revenues after payments to bondholders were made. In a privately-owned firm, the owner can claim the residual net revenue as a return on their equity, or the value of the firm minus the debt obligations. If we suppose that turnpike trusts were a firm, how large was the return on equity? Table 3 shows the net revenues, interest payments, and the net revenues minus interest payments for all turnpike trusts in various years. Equity is estimated as the value of capital invested in turnpike roads plus cash balances minus the value of all debt. The estimated equity is fairly large relative to total debt because inflation increased the value of capital relative to debt. Cash balances play a relatively small role.

At the bottom of table 3 the estimated rate of return on equity is reported. It varies significantly from year-to-year as one might expect. The average across all years is 5.3 percent. The return on equity as constructed here is larger than the return on capital invested, but it is not especially large compared to business profits in the private economy. Generally entrepreneurs earn 5 to 10 percent returns on their equity, but they also face substantial risk and are often personally liable for debts. Turnpike trustees and their officers faced some risks, although not to the same extent. If trustees or the treasurer were thought to be negligent in performing various duties they could be sued. Such cases were occasionally brought to courts (Wellbeloved 1829). Trustees' compensation appears to be broadly consistent with their risk level.

The analysis thus far focuses on the turnpike sector as a whole. At the trust-level the outcomes were sometimes different. Some turnpike trusts paid the full interest to bondholders yielding returns between 4.5 and 5 percent. Others paid little in the way of interest. This raises several additional questions. How did individual investors fare and were their portfolios well diversified? I now turn to these issues by examining the distribution of returns to bondholders in the 1820 data.

VI. The Distribution of Returns to Individual Bondholders in 1820

The rate of return calculations in tables 1-3 can be done at the trust-level using the various parliamentary reports. It is not a trivial task as each report gives financial information on more than 1000 trusts. I have coded financial information for all trusts in the 1821 Report in order to gain insights on the micro outcomes. The report covers the years 1818 to 1820 and is the first population-wide survey of turnpike trusts in England and Wales. For simplicity I label financial returns as applying to the year 1820.

It is useful to review the assumptions made in the underlying calculations. As noted above, the 1821 Report gives the value of debt and missing interest payments. I combine these two to estimate interest payments which are not reported. If there is no interest due from the trust, then the return on turnpike bonds is assumed to be the coupon rate. In Albert's sample of interest rates between 1816 and 1825 most ranged between 4 and 5 percent with an average very close to 4.75 percent. I use 4.75 as the return on turnpike bonds for trusts with zero interest due. If there is interest due from the trust, then it is likely that interest payment in 1820 were less than the amount specified by the coupon rate. For these trusts I estimate returns using the amount of interest due. Figure 5 shows the distribution of interest payments due as a percentage of debt across 962 trusts with information reported. 615 of the 962 trusts had some interest in arrears. Most had interest due equal to less than 10 percent of the value of their debt, but a few were in severe financial distress with interest due equal to more than 50 percent of their debt. In 119 of 615 trusts with interest due the 1821 Report specifies that interest payments were not made in the three previous years, 1818 to 1820. Here I assume the interest payment in 1820 is zero. For the remaining 496 trusts with interest due, I estimate the interest missing in 1820 using two scenarios. First, the total interest due was accumulated evenly in every year since 1809. Second, the total interest due was accumulated evenly in every year since 1799. Essentially in scenario 1 missed interest is the total interest due divided by 11 since interest could have been missed in any of the eleven years from 1809 to 1820. As it turns out these assumptions don't matter a lot. In terms of the raw data, a trust usually had a 0 percent return if it had significant interest due and a trust had a 4.75 percent return if it had no interest due.

The average return is reported for the two scenarios in table 4. Under scenario 1 the un-weighted average return is 3.48 percent and under scenario 2 the un-weighted average return is

3.70 percent. The averages are similar if returns are weighted by mileage (see scenario 2 in table 2). The modest return to individual turnpike bonds in 1820 is consistent with the aggregate figure in table 2. What is new in table 4 is the estimate of the standard deviation in returns across turnpike trusts. Under scenarios 1 and 2 the standard deviation in bondholder returns is 1.83 and 1.71. It appears there was a wide variance across trusts. Figure 4 shows the distribution of bondholder returns under the two scenarios. In 1820 most trusts yielded returns at the two extremes: 0 and 4.75 percent. The most striking are the 144 trusts making no interest payments under scenario 2.

It is clear there were risks associated with holding an individual turnpike bond. One implication is that investors would have experienced a volatile stream of payments if they were unable to diversify their holdings across the entire turnpike sector. One might argue their utility would have been higher if they had invested in government bonds which had a similar average return but with less volatility. A natural next question is whether bondholders diversified their portfolio of turnpike bonds. The evidence suggests there were a number of constraints on diversification. The high unit-value of turnpike bonds was one limitation for investors with limited savings. Bonds were dominated in units of £25, 50, or 100. For comparison, the nominal annual income for white collar workers was around £130 in 1820 (Lindert and Williamson 1983). Thus it is likely that many white collar workers could not afford more than a few turnpike bonds.

Geography was another constraint on diversification. Most of the evidence suggests investors were primarily local, and may have even resided a short distance from the turnpike road (Albert 1972). The locality of investors suggests they were not well diversified, but it is possible that investors were able to reduce some variance in returns by holding a balance

portfolio of turnpikes in their area. To investigate this issue I constructed the return on turnpike bonds in each county in England and Wales using the weighted average of returns for each trust in a county. The weights correspond to the mileage of each trust in the first estimate and to the debt of each trust in the second estimate.

Table 5 shows the returns to bondholders by county, with the lowest return counties at the top and the highest return counties at the bottom. The two weighting methods produce similar results. The correlation coefficient in the two series is 0.84. The main finding is that some counties still had returns well below 3.9 percent, which is the average yield on government bonds. In the series weighted by debt, 21 out of 53 counties had an average return below 3.9. In the series weighted by mileage, 12 out of 53 counties had an average return below 3.9. Diversification at the county level helped but it did not guarantee a more certain return on turnpike bonds.

At the regional level the possibilities for diversification were better but still imperfect. Map 1 shows a map of the average returns to turnpike bondholders by county. There is some clustering of returns at the regional level, but there is not a clear distinction between the north and the south where industrialization was proceeding at different rates. Within regions some counties had varying returns implying some possibility to diversify. To take a few examples, investors in low return Bedfordshire could have diversified into neighboring Hertfordshire which had higher returns. However, investors in Sussex had few options as returns were not as large in neighboring Hampshire, Surrey, and Kent.

Overall the evidence suggests that investing in turnpike bonds was risky. If investors held a balanced portfolio across all turnpike trusts then the risks were low and the returns were similar

to government bonds, but it is likely that many investors could not fully diversify. At this point, it is reasonable to wonder why an investor would hold a small portfolio of turnpike bonds. One possibility is that mistakes were made. Investors may have thought the turnpike sector would generate higher net revenues, but they turned out to be wrong, at least in 1820. If so, then we would expect little new investment in turnpike bonds moving forward from the 1820s, especially in counties with lower returns. There is another theory that investors expected to suffer some losses on turnpike bonds, but they still willingly invested because they hoped to reap the benefits of economic development arising from investment in infrastructure. In this case, investment might have continued in the 1820s even though bonds had proven to be risky. The following section discusses the motivations of investors and analyzes investor choices in the 1820s.

VII. The Motivation of Infrastructure Investors Revisited

There are two general views on why British investors held infrastructure securities. Ward (1974, p. 126) describes them as ‘financial’ motives and ‘economic’ motives. According to their ‘financial’ motives, investors desired to hold a portfolio that maximized rates of returns while balancing risks. In this light, it is instructive to review how Mitchell, Chambers, and Crafts (2011) model the financial motives of British railway investors in the late nineteenth century. Investors first identify the portfolios with the lowest risk for a given level of return. Next they chose a portfolio that maximizes the Sharpe ratio, defined as the difference between the expected return on the portfolio minus the return on government bonds divided by the portfolio’s standard deviation. In the financial motives model, an investor would hold a turnpike bond if its expected return was higher than the expected yield on government bonds and if the likelihood of missing interest payments was not too large. If this was the only criterion for holding turnpike bonds, it

would appear that many investors would opt out as the expected returns were similar to 3.9 percent and there were risks as we have seen.

Some historians and economists have argued that economic motives can also explain why turnpike or other infrastructure securities were held (Albert 1972). Their idea is that infrastructure projects raised property values or business profits in their vicinity—the so-called indirect benefits. If a project was likely to be unprofitable and therefore would not receive external funding then local businessmen and landowners might be willing to provide the financing. They would consider their indirect benefits plus the financial return in terms of dividends or interest payments. As long as the indirect benefits were sufficiently large then local landowners and businessmen would consider investing even if the financial returns are low. Of course, there is an additional complexity in that some would be willing to free-ride on the investments of others. Various theories have been developed to explain how the free-rider problem could be overcome, including boosterism and kinship ties (see Klein 1990).

There is general agreement in the literature that financial motives were present in British infrastructure financing, but there are mixed views on the extent of economic motives.¹⁵ It is well established that local landowners and businessmen invested but it is not obvious they stood to benefit indirectly. Buchanan (1986) argues that many local investors in the Bath turnpike trust would not have obviously gained in terms of higher property values or business profits. As one example, women were sometimes large investors even though they did not control land and did not operate many businesses. On the other hand, there is evidence that local property owners

¹⁵ Ward (1974) gives evidence for financial motives. Bogart and Richardson (2011) also give evidence that infrastructure improvement acts increased in number following years when the real return on consols was low.

indeed gained from turnpike roads. The estimates suggest that parishes increased their property income by 10 to 20 as a result of getting turnpikes in their jurisdiction (Bogart 2009).

To shed more light on this complex issue, I examine financial and economic motives in the context of turnpike debt during the 1820s. As shown earlier average rates of return on turnpike bonds were similar to government bonds in 1820 but they were much more variable. Nevertheless, total turnpike debt in England and Wales increased by 46 percent from 1820 to 1829. The large growth in debt in itself does not invalidate the financial motives hypothesis. It could be that investors were overly optimistic when turnpikes were built in the previous decades and they did not anticipate the shocks of the Napoleonic Wars. By 1820 investors were aware of the risks and the counties where returns to turnpike bonds were disappointing. Moving forward they could have lent to turnpike trusts in counties where rates of return were high in 1820 and where observable information suggested that rates of return would increase.

I examine whether financial motives influenced lending using county-level data on the growth rate of turnpike debt between 1820 and 1829. The debt figures in each year include mortgage and floating debt only. The average growth of debt was 26.5% across 51 counties in England and Wales. Debt growth in each county is regressed on the average rate of return on turnpike debt in each county in 1820, the population density in 1821 in each county, and the growth of population in the county between 1811 and 1821.¹⁶ Under the financial motives hypothesis, turnpike debt growth should be higher in counties with higher rates of return to bondholders in 1820. The financial motives theory would also predict debt growth to be higher in counties with more population density or more population growth because rates of return were likely to increase in the future. I also include indicator variables for regions. There are five

¹⁶ Marshall (1835) gives population figures for each county in 1811 and 1821.

regions: the North, the Midlands, the Southwest, Wales, and the Southeast. I include dummies for the first four regions making the Southeast the omitted region.

The results are reported in table 6. The coefficient for the mileage-weighted average rate of return is positive and significant as predicted. The interpretation is that investors lent more in counties that had a higher rate of return in 1820. However, when the average rate of return is weighted by debt the coefficient is smaller and not statistically significant. The weights are used to calculate the average because presumably investors took ‘size’ into account when they judged the financial performance of individual turnpike trusts in a county. It is unclear however whether they used a clearly visible measure like road mileage or something more nuanced like debt. If we think investors were less informed about debts, then weighting by mileage would seem more appropriate. Under that assumption the financial motives hypothesis is supported.

There is no clear evidence investors lent to turnpike trusts based on county population density in 1821 or population growth in the previous decade. Neither variable was statistically significant. Either these measures were not what most investors considered to be useful in terms of predicting returns or they did not have financial motivations in mind. The interpretation is unclear. The regional variables suggest another interesting pattern. The dummy variable for Northern counties is positive and significant, indicating that turnpike debt grew more in northern counties even after controlling for other factors. The result is intuitive: the North was industrializing and thus offered investors a greater potential rate of return. It also fits with the financial motives hypothesis because bonds in northern counties were likely to have higher returns in the future. At the same time one could also argue that the North had a tradition of investing for economic motives, whereas other regions had less. Ward (pp. 138-140) draws a contrast between the ports cities of Liverpool and Bristol. Liverpool’s merchants were thought

to be more interested in developing local commerce and Bristol's merchants sought the highest direct return on their savings which typically included government debt.

VII.1 Foreclosures and Conversions

There are other investor choices which speak to financial and economic motives. One curious fact is that in 1820 few bondholders foreclosed on the tolls even though many trusts were not making their bond payments. In the 1821 Report there are only two documented cases where creditors seized the tolls: the Aldermaston and Basingstoke Second District trust in Hampshire and Stockport and Marple trust in Cheshire. Recall that 144 trusts in 1820 paid no interest at all and so it is puzzling why there were so few foreclosures.¹⁷

There are various theories as to why foreclosures were rare. One emphasizes economic motives. Foreclosure meant that creditors had the first claim on toll revenues. Grabbing revenues to paying current and past interest obligations may have left little revenues for road maintenance. A poor road might have been worse for investors if the indirect benefits were sufficiently important. Another theory emphasizes financial motives. Investors may have believed that by not foreclosing and devoting more revenues to maintenance in the short-term, toll revenues would increase more in the future and they would ultimately collect more interest payments in the long-term. Such a belief could be justified if there was increasing returns in which road investments today lead to higher revenue growth in the future.¹⁸ A related theory is that the costs of foreclosing were too high. Investors needed to expend resources getting the legal authority to foreclosure and as a result they may have seen little point (Albert 1972, p. 97).

¹⁷ The evidence on foreclosures comes from the 'observations' column in the 1821 report. Although it is possible that some foreclosures were not noted in the observations, it is unlikely that it was prevalent.

¹⁸ One can simulate a model where revenues grow faster if maintenance is continued in the initial periods rather than devoted revenues to interest payments, say through a foreclosure.

Was there a financial motive not to foreclose? While it is difficult to give a precise answer, one can evaluate whether interest payments eventually resumed for trusts not paying interest in 1820. I investigate this issue using interest payments for trusts in 1840. I focus on the sample of trusts not paying any interest in 1820 because they were the group where foreclosure was an option. I was able to match 117 of the 144 trusts in both the 1821 and the 1840 Reports, but only 112 had information on interest payments. Figure 7 shows the distribution of interest payments as a percentage of debt in 1838. Twenty-eight trusts or 25 percent of the sample was still paying zero interest. On the other hand, 66 or just over 50 percent of the sample was paying 4 percent or more. It is difficult to say what contributed to these trusts' financial recovery, but one possibility is that investors helped to improve their finances by not foreclosing.

More insights can be gain by examining other strategies besides foreclosure. Investors could seek to convert their claims to unpaid interest into new turnpike bonds. For example, suppose the total debts of the trust were £3000 and the interest due was £1000. Investors could convert the interest due into principal making the total debt £4000. Such a strategy might make sense from a financial point of view if there was a sufficiently high probability the trust's revenues would increase in the future. As an illustration suppose that an investor did not foreclose in order to give the trust the ability to finance maintenance. If revenues increased then the investor could convert unpaid interest and start collecting payments on a larger principal. Following the above logic, one would expect that some investors in trusts with interest due would eventually convert their claims into new debt. They would have been especially likely to do so if the trust's finances had improved and it was now able to meet its current interest payments. I investigate the propensity to convert using the 1840 Report which asked every trust

how much of their debt consisted of unpaid interest converted into principal by 1838. I again focus on the sample of trusts that were not paying interest in 1820.

The findings on conversion are summarized in table 7. I find that 26.7 percent of trusts converted some of their interest due into debt and the rest did not convert any. The average percent of debt that was converted was 27.3 percent.¹⁹ The propensity to convert was only slightly higher for trusts whose financial condition had improved by 1838. 73 of the 117 trusts in the sample were paying at least 2.5 percent on their current debt in 1838. One might expect conversion to be more likely in the group of better performing trusts, but it was not. Just 24.6 percent of the trusts whose interest payment in 1838 were at least 2.5 percent of their debt converted any interest due between 1820 and 1838. The amount of conversion was also similar, representing 23.7 percent of their debt.²⁰

Based on these figures it appears that many investors did not choose to convert their unpaid interest into debt. The clerk for the Basingstoke, Alton, and Preston Candover trust made an interesting side comment in noting that no conversion had occurred in that case. He stated that ‘interest, it is believed, for twenty years was *liberally* given up by the bondholders, owing to the inadequacy of the tolls to meet the demands in respect of the trust (p. 156 italics added). Why did bondholders behave liberally as the clerk describes? Economic motivations provide one explanation. If bondholders’ main motivation was to ensure the adequate maintenance of the

¹⁹ As noted above there was some attrition in the sample. 27 trusts not paying interest in 1820 could not be identified in the 1840 report. One reason is that trust’s names could change making matching difficult. Name changes are likely to be random and so the conclusion’s reached earlier would not change much if they were identified. The other explanation for attrition is that some trusts were dissolved between 1820 and 1838. There must have been some dissolution of trusts because the number of turnpike miles in England and Wales decreased from 20,875 to 19,800 between 1820 and 1838. It is not exactly clear what happened to the debts of dissolved trusts, but the most likely outcome is that the debts were cancelled. With cancellation conversion of interest due to debt would have been even less likely. Therefore the estimates of the propensity to convert in table 7 are probably over-stated, making it a less common outcome.

²⁰ An unreported regression of the probability of converting on the interest paid as a percent of debt also showed now significant relationship.

road, then they might be willing to forgo the option of converting in order to save revenues for repairs. There were clearly limits to such strategies and some investors would not have perceived any indirect benefits from a well-maintained road. In these cases they presumably negotiated with trusts to convert unpaid interest into debt.

VIII. Conclusion

Britain pursued a unique infrastructure policy during its industrializing era by granting monopoly rights to improve or construct roads, rivers, canals, bridges, and ports. This paper uses data on the entire turnpike road sector to investigate whether trusts exploited their monopoly power and earned excessive rates of return. The evidence shows that the sector as a whole yielded financial returns similar to more competitive sectors. Net revenues as a percentage of the capital invested was 4 to 5 percent and returns to bondholders were even less. One implication is that there was little surplus for insiders, like trustees, to appropriate. Turnpike trusts did not create a ‘fourth estate’ of the realm, earning excessive profits from public work. A second implication concerns the efficiency of the infrastructure sector. There is great potential for market failure in the infrastructure sector. Monopoly pricing and profits limits the benefits of infrastructure, but bankruptcy creates problems as well through disruption of services, volatile pricing, and by discouraging new investment. The evidence on rates of return throughout the literature suggests that Britain’s infrastructure sector did not suffer from these problems to the same degree as in other countries and time periods.

This paper also shows that some investments in individual turnpike trusts did not pay. Around 15 percent of trusts were not making any interest payments by 1820. The implication is that bondholders were adequately compensated only if they held a diversified portfolio which

was not always possible given the propensity for investors to be local. As the nineteenth century capital market eventually centered on London the opportunities for diversification increased substantially. Investors were more willing to fund larger projects like railways by the mid-1800s.

The last finding of this paper concerns the motivations of investors. There is evidence that investors pursued financial objectives by directing their lending to turnpike trusts in areas with better financial performance or that had better financial prospects. That said there are some curious patterns, in which investors did not foreclose on the tolls when interest was due, nor did they convert unpaid interest into the principle. Economic motives, whereby investors hoped to benefit indirectly from the improvement and maintenance of the road, provide an explanation for such behavior. Britain's landowners and businessmen had a broad approach to investing during the Industrial Revolution. In some cases, they were willing to invest in a project with little prospect of paying dividends or interest payments, but for which they and the broader public could expect to benefit. It is remarkable that elites in Britain pursued such an investment strategy and is an indicator of why Britain's economy was so successful in the early nineteenth century.

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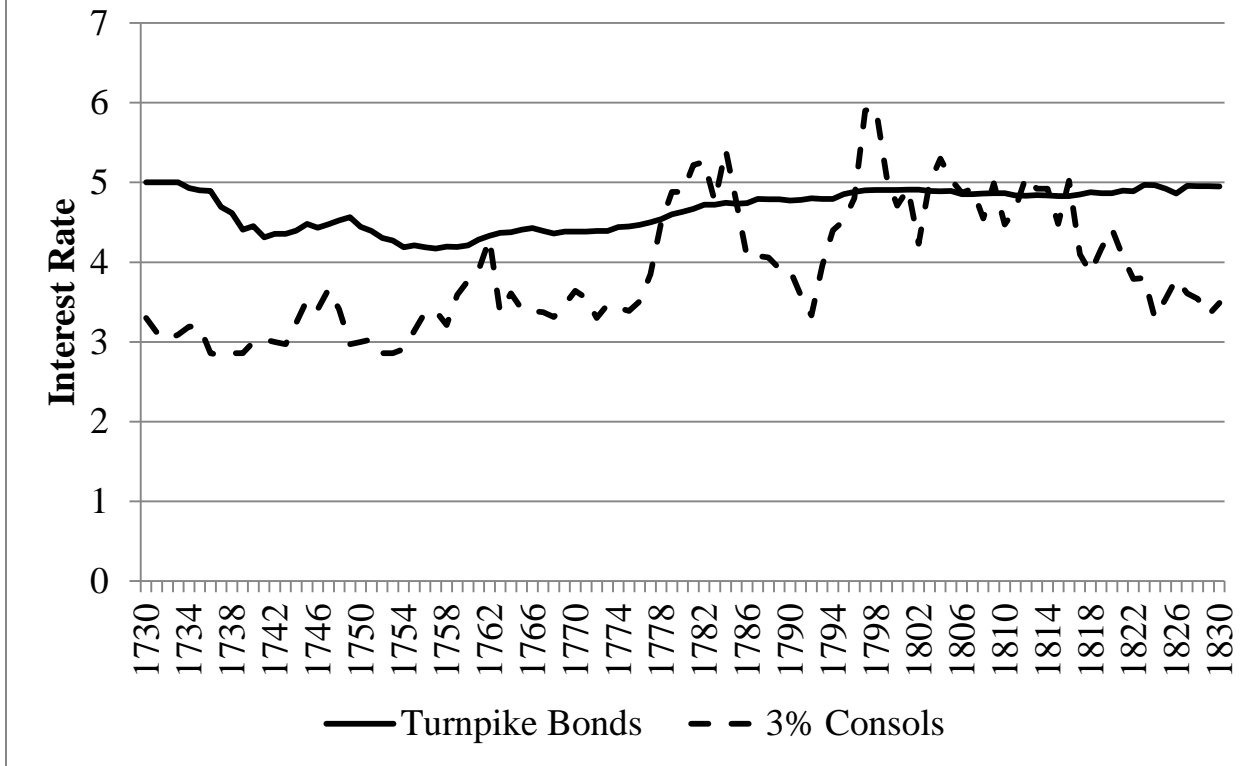
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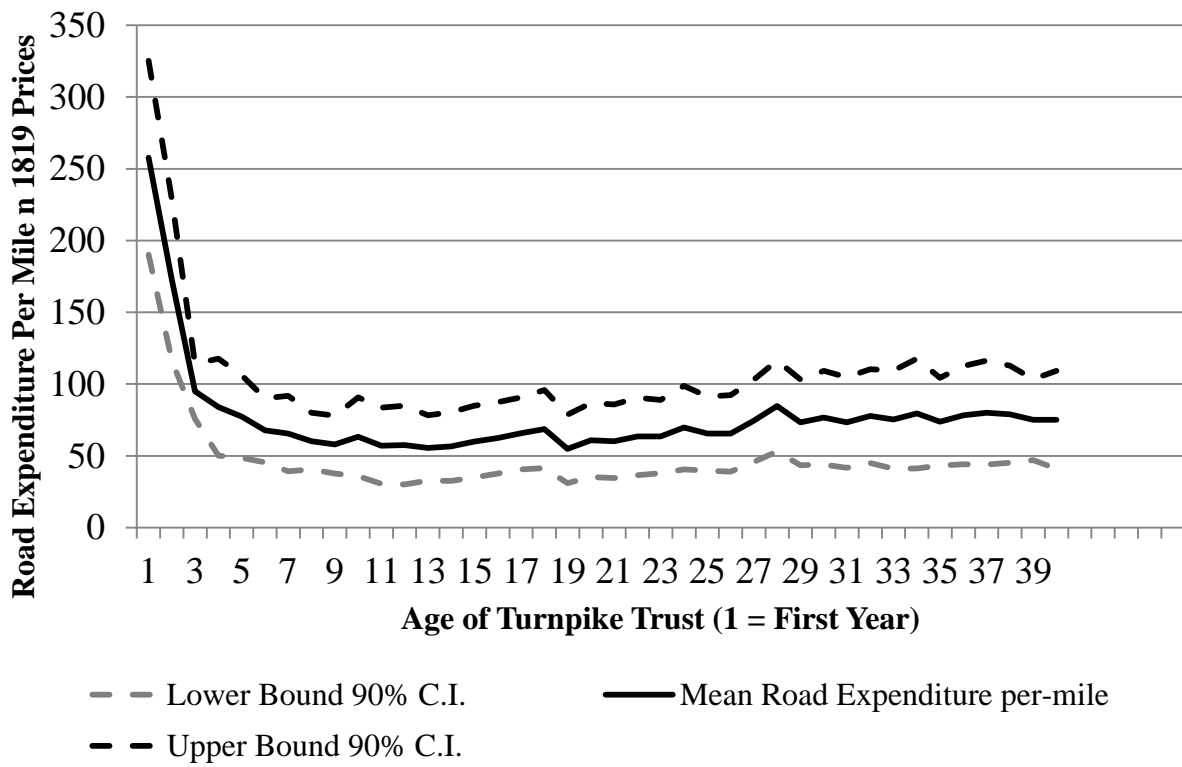
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Figure 1: Interest Rates on Turnpike Bonds and Yields on 3% Consols, 1730-1830



Sources: Albert (1972), p. 247-261.

Figure 2: Average Road Expenditure Per Mile and the Age of Turnpike Trusts before 1820



Sources: The data on road expenditure come from Bogart (2005).

Figure 3: Surplus Appropriation by Trustees when unconstrained by Total Surplus

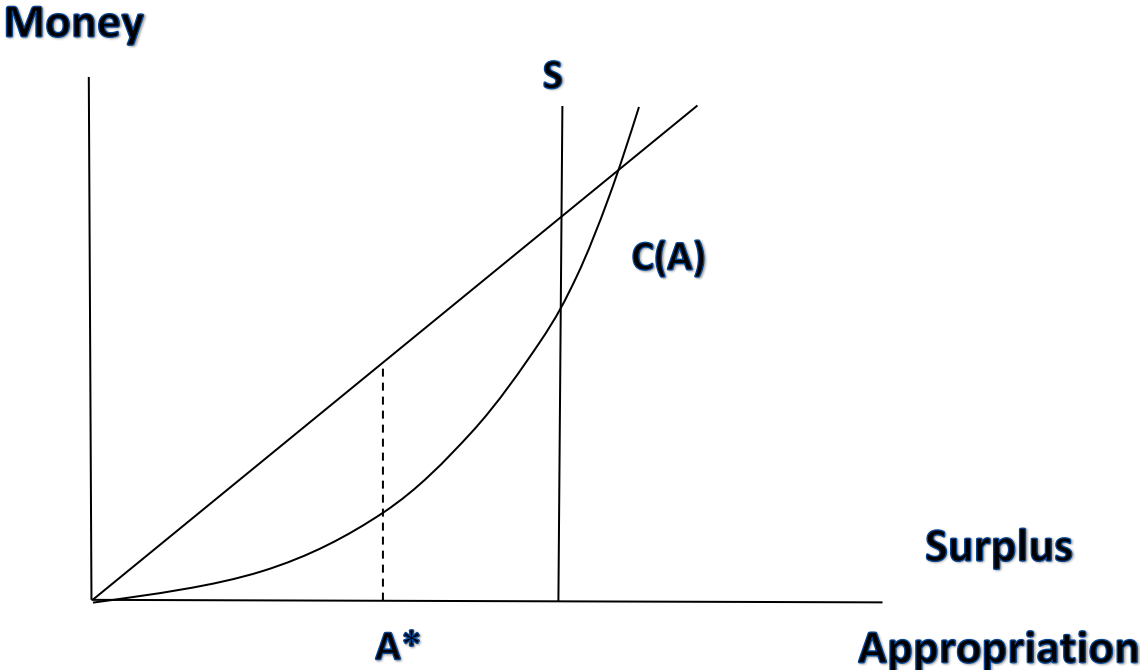


Figure 4: Surplus Appropriation by Trustees when constrained by Total Surplus

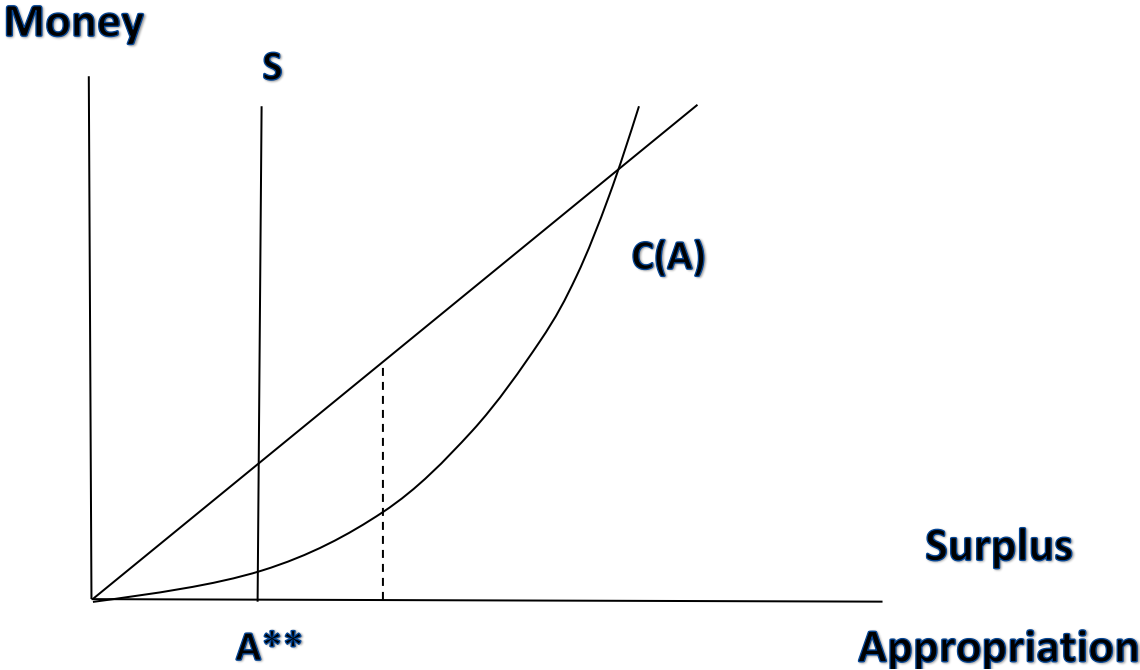
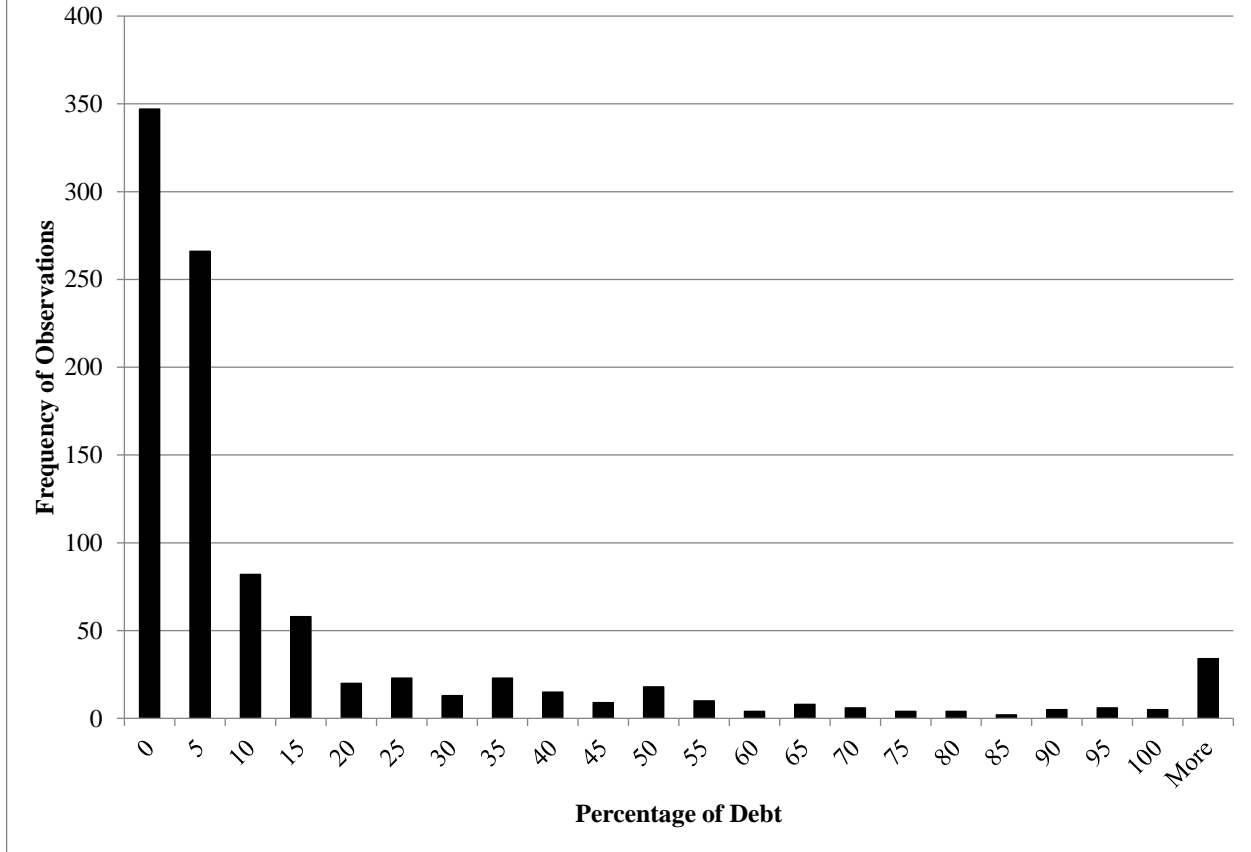
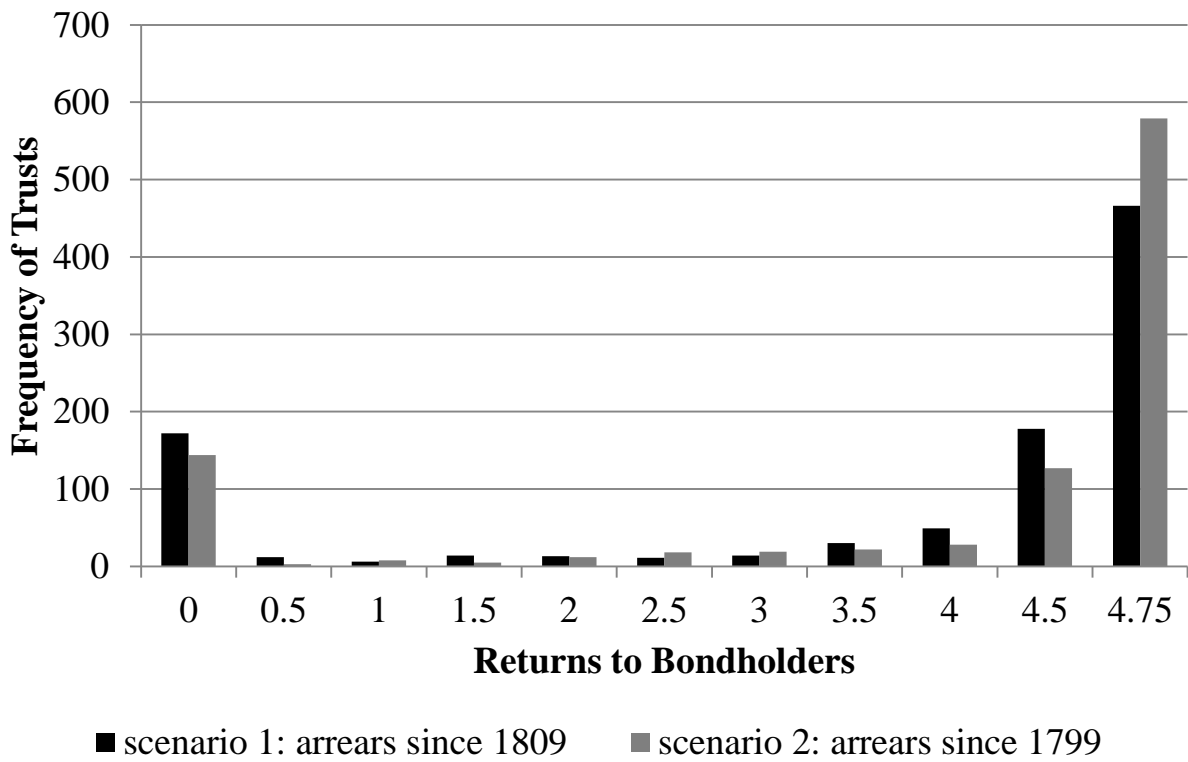


Figure 5: The Distribution of Interest Due as a Percentage of Turnpike Debt, 1820



Sources: see text.

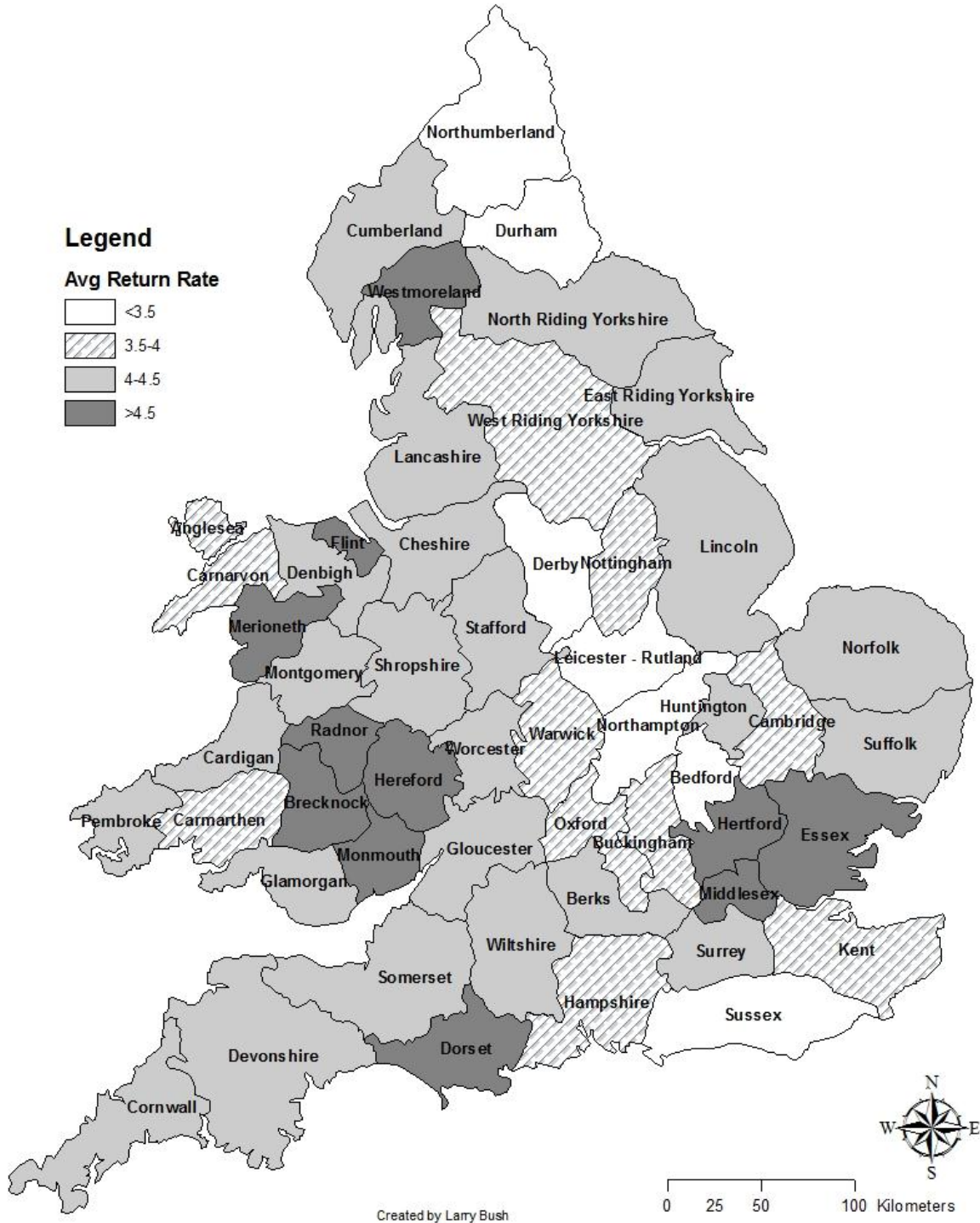
Figure 6: The Distribution of Returns to Turnpike Bondholders in 1820



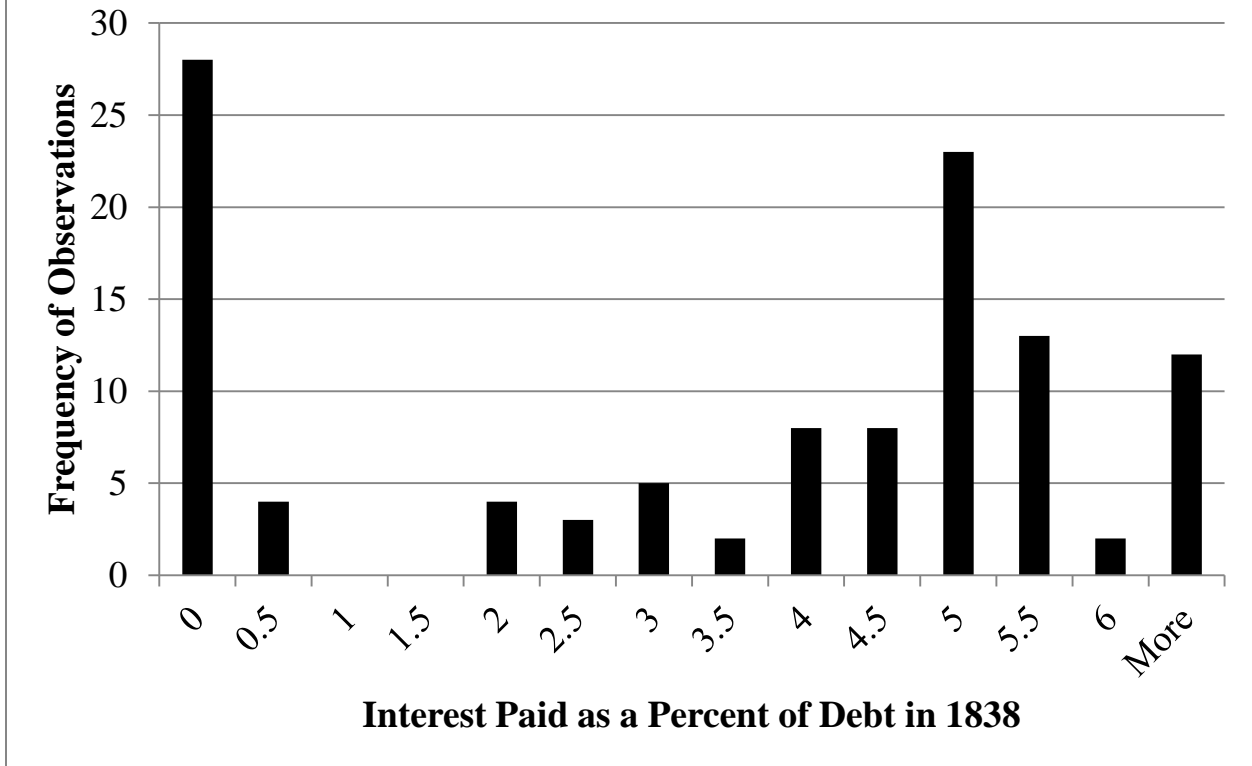
Sources: see text.

Map 1

Average Rates of Return to Turnpike Bondholders 1820



**Figure 7: Distribution of Interest Payments in 1838
for Trusts paying no interest in 1820**



Sources: see text.

Table 1: Rate of Return on Turnpike Capital

	1845	1842	1838	1834	1829	1820
Total revenues	1,393,898	1,446,214	1,781,488	1,753,542	1,455,293	1,088,767
Total expenditures	1,372,149	1,528,259	1,670,180	1,701,798	1,678,032	1,034,124
Operating Expenses	870,937	1,006,876	1,082,397	1,085,370	927,368	660,464
Net Revenues (current price)	522,961	439,338	699,091	668,172	527,925	428,303
Estimate of turnpike capital (current price)	11,987,503	12,252,339	12,489,196	12,082,366	11,698,518	10,479,250
Net revenues as % of capital	4.36	3.59	5.60	5.53	4.51	4.09

Sources: Data for 1820 come from Marshall (1835, p. 85) and from BPP (1821 IV). Data for 1829, 1834, and 1838 are from BPP 1840 (XXVII, p. 647.). Data for 1842 are from BPP (1844 XLII). Data for 1845 are from BPP (1847-48 LI)

Notes: Total revenues exclude money borrowed. Total expenditures include all spending on repairs, interest, debts repaid, and investment. Operating expenses include spending on repairs and salaries relating to management for 1834 to 1845. For 1829 operating expenses equal total expenses minus debt payments, interest payments, and investments. Investments in 1829 are estimated to be 270,300 which is the average annual increase in mortgage debt from 1820 to 1829. For 1820 operating expenses equal total expenses minus estimated debt interest payments (see table 2) and investments. There is no information on investment in 1820. I estimate it at 200,000 which is less than 1829 but similar to the 1830s. Net revenues are total revenues minus operating expenses. Turnpike capital is equal to total turnpike miles 20,875 multiplied by 502 the average investment per mile for trusts expressed in 1820 prices. Turnpike capital in 1829 is the 1820 capital deflated to 1829 prices plus total investment between 1820 and 1829 which is estimated to be 2,162,400 which is the increase in mortgage debt from 1820 to 1829. Turnpike capital in 1834, 1838, 1842, and 1845 is the previous observation of capital deflated to current prices plus investment which is estimated by spending on improvements.

Table 2: Return to Turnpike Bondholders

	1845	1842	1838	1834	1829	1820
Total Mortgage and Floating Debt	6,964,960	7,238,705	7,463,027	7,342,210	6,882,356	4,402,466
Interest paid	282,439	295,934	301,462	289,376	236,619	173,660
Interest paid as percent of debt	4.06	4.09	4.04	3.94	3.44	3.94
Interest Due	1,409,805	1,333,488	1,123,623	1,002,255	821,586	605,688
Interest Due as a percent of debt	20.24	18.42	15.06	13.65	11.94	13.76
Estimate of missing interest in current year	25,439	52,466	30,342	36,134	23,989	32,542
Estimate of interest missed in current year as percent of debt	0.37	0.72	0.41	0.49	0.35	0.74
Hypothetical percent return if no interest was missed	4.42	4.81	4.45	4.43	3.79	4.68

Sources: same as table 1

Notes: Debt, interest paid, and unpaid interest is taken from the reports in each year except 1820 where is estimated using trust-level data drawn from BPP (1821 IV). The estimate of missing interest in current year for 1820 assumes that unpaid interest was accrued evenly in every year since 1799 and thus the unpaid interest is divided by 21 to get the missing interest in the current year. For subsequent years, the addition to total unpaid interest over the previous observation is assumed to have accrued evenly in every year.

Table 3: Residual Net Revenues and the Rate of Return on Equity

	1845	1842	1838	1834	1829	1820
Net Revenues (current price)	522,961	439,338	699,091	668,172	527,925	428,303
Interest paid	282,439	295,934	301,462	289,376	236,619	173,660
Net Revenues minus interest	240,522	143,404	397,629	378,796	291,306	254,643
Estimate of turnpike capital (current price)	11,987,503	12,252,339	12,489,196	12,082,366	11,698,518	10,479,250
Balances Held by Trust	362,362	286,071	303,837	313,882	361,836	281,160
Total Mortgage and Floating Debt	6,964,960	7,238,705	7,463,027	7,342,210	6,882,356	4,402,466
Hypothetical Equity	5,384,905	5,299,705	5,330,006	5,054,038	5,177,998	6,357,944
Hypothetical Return on Equity	4.47	2.71	7.46	7.49	5.63	4.01

Sources: same as table 1

Notes: net revenues, interest paid, turnpike capital, and debt are taken from tables 1 and 2. Balances held by the trust are taken from various reports. Hypothetical equity is total capital minus debt plus balances held by the trust

Table 4: Summary of Rates of Return on Individual Turnpike Bonds, 1820

Method	observations	Mean	Standard Deviation
scenario 1, un-weighted	965	3.48%	1.83%
scenario 2, un-weighted	965	3.70%	1.71%
scenario 2, mile-weighted	965	3.76%	

Sources: same as 1820 table 2

Table 5: Rate of Return to Turnpike Bondholders Across Counties

county	Weighted by Miles	Weighted by Debt
Sussex	3.06	2.47
Caernarvonshire	3.79	2.89
Bedfordshire	3.27	2.98
Carmathenshire	3.67	3.08
Cambridgeshire	3.59	3.14
Glamorganshire	4.3	3.16
Derbyshire	3.23	3.18
Northamptonshire	2.92	3.18
Hampshire	3.86	3.34
Leicestershire	3.35	3.35
Durhamshire	3.45	3.36
Northumberlandshire	2.87	3.36
Buckinghamshire	3.96	3.42
Yorkshire, West Riding	3.95	3.63
Denbighshire	4	3.65
Anglesey	3.69	3.69
Pembrokeshire	4.02	3.69
Warwickshire	3.6	3.77
Wiltshire	4.05	3.83
Nottinghamshire	3.84	3.85
Suffolk	4.21	3.87
Surrey	4.07	3.91
Lincolnshire	4.07	3.93
Montgomeryshire	4.17	4
Cornwall	4.17	4.02
Berkshire	4.04	4.04
Gloucestershire	4.34	4.08
Lancashire	4.22	4.08
Yorkshire, North Riding	4.42	4.1
Norfolk	4.25	4.11
Cheshire	4.07	4.12
Kent	3.82	4.14
Cardiganshire	4.2	4.14
Devonshire	4.29	4.23
Oxfordshire	3.73	4.27
Worcestershire	4.01	4.29
Staffordshire	4.35	4.31
Shropshire	4.38	4.33
Yorkshire, East Riding	4.14	4.38
Merionethshire	4.59	4.41
Cumberlandshire	4.22	4.45
Dorsetshire	4.58	4.49
Huntingdonshire	4.42	4.51
Monmouthshire	4.52	4.62
Westmoreland	4.54	4.63
Herefordshire	4.65	4.64
Sommersetshire	4.46	4.64

Breconshire	4.64	4.64
Flintshire	4.69	4.66
Hertfordshire	4.7	4.67
Radneshire	4.69	4.69
Middlesex	4.71	4.72
Essex	4.68	4.73

Sources: same as 1820 table 2

Table 6: Determinants of Turnpike Debt Growth from 1820 to 1829, Regression Coefficients

Variable	Coefficient (Robust Standard error)	Coefficient (Robust Standard error)
Average Rate of Return (mileage weighted)	31.79 (18.15)*	
Average Rate of Return (debt weighted)		14.79 (15.4)
Population density 1821	-0.009 (0.006)	-0.006 (0.007)
Population Growth 1811 to 1821	-1.04 (1.66)	-1.33 (1.99)
Northern County Dummy	46.26 (20.05)**	40.93 (22.07)*
Southwest County Dummy	-0.581 (21.47)	1.55 (22.23)
Midlands County Dummy	2.488 (20.88)	-5.82 (19.79)
Wales County Dummy	-10.03 (23.87)	-5.4 (24.88)
Constant	-92.23 (76.85)	-17.49 (71.64)
N	51	51
R-square	0.22	0.175

Sources: see text.

Notes: *, **, and *** represent statistical significance at the 10%, 5%, and 1% level respectively.

Table 7: Summary of Trust's Conversion of Unpaid Interest into Debt

Number of Trusts that did not pay interest in 1820	144
Number of Trusts identified in 1838 that did not pay interest in 1820	117
Match rate for sample of non-interest paying trusts in 1838	81.3
Percentage in sample that converted any interest due into principal by 1838	26.7
Average converted interest due as a percentage of debt	27.3
Number of Trusts in sample that paid more than 2.5% on debt in 1838	73
Percentage in sample paying more than 2.5% on debt in 1838 that converted	24.6
Average converted interest as a % of debt in sample paying more than 2.5% on debt	23.7

Sources: Data on conversion comes from BPP (1840 XXVII). Trusts with interest due are drawn from BPP (1821 IV).