

Profiting from Public Works:

Financial Returns and Investor Motives in Britain's Infrastructure Sector during Industrialization

Dan Bogart¹

Department of Economics, UC Irvine

dbogart@uci.edu

Abstract

Investors in turnpike trusts and canal companies provided much of the capital to improve roads and waterways in Britain during its early industrialization. This paper estimates rates of return for the turnpike road sector in the early 19th century and provides new evidence on whether economic or financial motives drove investor behavior. The analysis shows that the turnpike sector yielded competitive returns to investors in the aggregate, but at the individual trust-level financial returns varied significantly. Second, turnpike investors behaved as though they sought financial returns like interest payments and dividends, but their behavior also suggests that some were willing to sacrifice financial returns for higher returns on property. The findings have implications regarding the efficacy of Britain's infrastructure sector and the culture of investing.

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I.

Britain made substantial investments in its transport infrastructure as it industrialized. Railways were the largest in absolute terms and as a percentage of fixed capital formation, but there were also significant investments from 1760 to 1830 during the era of canals and turnpikes.² Private financing was prominent in Britain's transport investment from an early stage. Parliament granted turnpike trusts, river navigation companies, canal companies, and dock companies powers to construct or improve transport infrastructure. These statutory authorities were a precursor to the modern corporation in Britain and were exceptional cases of corporate financing prior to the repeal of the Bubble Act.³ As private capital continued to flow into the transport sector throughout the period from 1700 to 1900 one might presume that investors earned significant financial returns. The potential for monopoly power in infrastructure also suggests that rates of return could have exceeded the competitive rate of return.⁴ However, episodes like the canal mania in the 1790s suggest that investors may have made mistakes and were too optimistic about financial returns in infrastructure. In the end, how much did investors earn in Britain's infrastructure sector?

A number of works in the literature estimate financial rates of return, but outside of railways the findings are not conclusive.⁵ A key problem is that scholars have relied on samples of company records 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

² Feinstein (1988, p. 444) gives estimates of gross capital formation in railways and other transport and communications by decade. Railways accounted for 28% of all gross capital formation in the 1840s. In the 1790s other transport and communications accounted for 20% of all gross capital formation.

³ Harris (2000) details the progress of corporations in transport and their contribution to business organization.

⁴ There is a large literature on monopoly and regulatory challenges in the infrastructure sector. See Laffont (2005) and Gómez-Ibáñez (2003) for overviews.

⁵ See Mitchell, Chambers, and Crafts (2011) and Arnold and McCartney (2005).

Albert's (1972) sample of trusts paying interest. However, many trusts did not pay interest and therefore the observed interest rate in the sample yields a biased estimate of investor returns in the population of turnpike trusts.

There is another related debate on the motives of infrastructure investors. According to one view British landowners and businessmen invested in infrastructure even if there was little hope of earning high dividends or interest payments. Far from being altruistic, they aimed to benefit indirectly through higher rents and profits.⁶ The 'economic' motive for investing has been challenged as being second order in importance compared to 'financial' motives. The claim is that many investors could not have gained enough in property income or profits and therefore they must have sought direct rewards.⁷ The debate over the extent of economic versus financial motives is unresolved in part because the literature has not provided empirical tests of investor behavior and because the extent of financial returns is still unclear.

This paper makes two contributions to the literature: First, it estimates rates of return for the turnpike road sector in the early 19th century and provides an assessment of rates of return in the entire infrastructure sector. Second, it provides new evidence on whether economic or financial motives were present in turnpike financing. The main 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 analyze the level and distribution of financial returns to

⁶ Albert (1972) is perhaps the strongest proponent of the view that turnpike trustees had developmental motives.

⁷ See Ward (1974) and Buchanan (1986).

bondholders of individual turnpike trusts using the first financial survey in 1820. My calculations show that the turnpike sector yielded competitive returns to investors in the aggregate. The sum of net revenues for all turnpike trusts in England and Wales as a percentage of the total turnpike 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 in England and Wales was around 4 percent over the same period. At the trust level the picture is more nuanced. Between 10 and 20 percent of trusts paid no interest in 1820, yielding a zero percent return to bondholders. At the other end of the spectrum between 60 and 70 percent of turnpike trusts paid a return between 4.5 and 5 percent. The general picture is that investors in turnpike bonds earned a similar return as investors in land, housing, and government bonds as long as they held a balanced portfolio, but it is likely that many investors were not sufficiently diversified as most were local and returns were not equalized across counties.

In the second part of the paper, I propose three behavioral tests that could potentially falsify financial or economic motives. First, I study the growth of turnpike debt across counties from 1820 to 1829 and test whether turnpike bond rates of return at the county-level in 1820 can explain some of the growth in debt. The growth of debt is found to be higher in counties where the average return was higher in 1820 as one would expect if investors were allocating their savings to counties that recently proved to have the highest financial returns. In a second test, I examine the set of trusts with substantial interest due in 1820 (i.e. the poor performers). Investors in these trusts had the legal right to foreclose on the tolls, but the data show that very few investors in 1820 foreclosed when interest payments were missed. The rarity of foreclosure is more consistent with economic motives, but it can also be rationalized by a strategy where investors let trusts improve their financial position without the costs of foreclosure in the

expectation that later the trust would resume interest payments. The data show that such a strategy is plausible as over 50 percent of trusts not paying interest in 1820 eventually resumed making interest payments by 1838. Third, I study whether investors in poorly performing trusts converted unpaid interest into the principal debt owed. The data show that conversions were more common than foreclosure but not the norm. Also trusts managed by landowners were less likely to convert unpaid interest into debt. Landowners were arguably the group whose property income was most sensitive to the road maintenance and investment provided by trusts. Therefore economic motives would predict that landowner-managed trusts should be the least likely to convert debt as it left less revenues for road improvement. Overall, the tests do not call for a firm rejection of either the economic or the financial motives hypotheses. Instead the patterns of behavior are consistent with investors having a mixture of financial and economic motives.

The findings have several implications. First, the evidence on financial returns to turnpike trusts is similar to other infrastructure sectors like canals and railways where rates of return were around 4 to 5 percent.⁸ 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 were not 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. This view runs counter to some works more critical of Britain's regulatory policy. Casson (2009), for example, argues that too many railways were built to sustain profitability. While there is some evidence of

⁸ The evidence on rates of return in railways and canals will be discussed in the next section and come from Mitchell, Chambers, and Crafts (2011) and Arnold and McCartney (2005, 2011).

duplication, it is important to note that infrastructure profits were never pushed so low in Britain that the industry tumbled into bankruptcy as often occurred in other countries.⁹

The findings also 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.¹⁰ In the infrastructure sector, British investors put their capital into projects with reasonable prospects of yielding large dividends or healthy interest payments, but in some cases 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 one 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 'investor culture' in promoting economic development.¹¹

I.

In 1700, Britain's system for financing infrastructure was ill-suited for its emerging economy. Investment came only with key reforms involving financing.¹² The road network provides 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 and levy taxes on property income, but they could not levy tolls on road-users or issue bonds. On account of their small size and inability to finance, parishes were generally ineffective. By the early 1700s it became increasingly common for

⁹ The United States for example many bankruptcies in transport, see White (2011) for railroads, Klein (1990) and Klein and Majewski (1992) for turnpikes.

¹⁰ See Trew (2010) for a model of transaction costs in infrastructure financing.

¹¹ 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.

¹² See Willan (1964), Albert (1972), Ward (1974), Pawson (1977), and Bogart (2005) for more on Britain's financing problems and reforms in transportation.

communities to request ‘turnpikes’ so that tolls could be levied on their highways. Tolls could not be levied without the approval of the government in Westminster. 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 and most were landowners, merchants, and manufacturers drawn from the local area. Trustees had the right to levy tolls and they were also authorized to issue bonds secured on the toll income. Parliament forbade the creation of turnpike shares, and therefore all the capital for road improvements was raised through bonds.

The typical investors in turnpike bonds lived near or had property near the road. As an illustration, Buchanan (1985) conducted a detailed study of the Bath turnpike trust and showed that many investors were resident in Bath with a minority having Bristol or London addresses. There was more variety in the occupation of investors. In some cases they were landowners as in the case of the Sheffield Glossop turnpike where the Dukes of Devonshire and Norfolk lent more than half of the total debt.¹³ But as Buchanan showed for Bath many investors were merchants, tradesman, and women or who could be described as ‘small urban savers’ (p. 235).

Turnpike trusts spread widely through the network in the 1750s and 1760s. Their financial condition appears to have been satisfactory until the Napoleonic wars when inflation and volatility hit the British economy. Turnpike tolls were capped in nominal terms by parliamentary acts and often did not keep up with inflation. Nevertheless most turnpike trusts continued to operate for several more decades. By the 1830s trusts managed approximately 20,000 miles or 20 percent of the total network.

¹³ Albert (1972 p. 105).

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.¹⁴ 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 limited tax authority and could not finance investment. 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.

Dock works, canals, and railways were the other 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.¹⁵ That being said, 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 turnpike roads and rivers in the early eighteenth century.

II.

¹⁴ Willan (1964) provides an excellent overview of river navigation projects.

¹⁵ See Aldcroft and Freeman (1983, 1988) for an overview of the literature on dock works, canals, and railways.

Rates of return have been estimated for various infrastructure sectors, but the conclusions are often clouded by sample selection problems. Railways are an exception because the *Railway Returns* 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 returns well above more competitive sectors.

The evidence on rates of return for river navigation companies is thin. In one study, Wilson showed that dividends on the Aire and Calder navigation ranged between 10 and 28 percent from 1720 to 1775. In a colorful side comment, Wilson noted that the undertakers of the Aire and Calder were known locally as the ‘fourth estate of the realm’.¹⁶ Despite its financial success, there are reasons to believe that the Aire and Calder navigation was at the upper end of the distribution in terms of dividends. Its revenues grew by an average annual rate of 3.5 percent from 1700 to 1772 and 2.1 percent from 1775 to 1826. By comparison, revenues for the Great Ouse navigation near Bedford grew by an average annual rate of 1.1 percent between 1750 and 1800. On the River Cam near Cambridge revenues grew at an average rate of 1.6 percent between 1752 and 1813.¹⁷ Location is the most likely explanation for the differences. The Leeds region, near the Aire and Calder, was undergoing industrialization, while Bedford and Cambridge were not.

¹⁶ Wilson (1971, p. 140) discusses the Aire and Calder.

¹⁷ For evidence on the income of the Great Ouse and Cam see Summers (1973).

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 1822.¹⁸ 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.¹⁹ The resulting dividend rate for all canals in 1822 is 5.9 percent.

It would appear that canals were quite profitable in the early 1820s. The problem is that dividend rates do not provide a good estimate of rates of return. In a 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. Arnold and McCartney estimate a rate of return on capital (net earnings divided by debt plus equity) of 10.2 percent and a dividend rate of 23.9 percent for their sample of canals in the early 1820s (p. 228). The key implication 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.

For a comparison with turnpikes later, I provide a new estimate of the rate of return on capital for all canals by reworking the dividend rate calculation from 1822. Recall the 1822 survey gives dividend rates for five groups. The problem is the top group where Arnold and

¹⁸ The author is anonymous. The title is called 'the Present State of England,' in the Quarterly Review.

¹⁹ 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 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.

McCartney argue there is a greater divergence between dividend rates and rates of return on capital (p. 231). Replacing the dividend rate for the top group of canals with Arnold and McCartney's sample estimate implies a sector-level estimated return of 4.5 percent.²⁰ Like railways, canals did not generate rates of return far above more competitive sectors.

There are a similar set of issues in estimating financial returns for turnpike trusts. They were different from canal companies because all the capital was raised through bonds, with the majority secured on the income of the tolls. If any individual bondholder 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 principal in full at any time.²¹ 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.

Another key difference from canals relates to profits. Turnpike 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.²² In spite of legal provisions against equity and 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 income (Albert p. 76).

²⁰ 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.

²¹ 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.

²² 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.

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...”²³ 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 on by selling the bond on the market above par.

Did turnpike officers and investors in fact profit from the tolls despite legal attempts to limit their returns? There is not systematic evidence on the malfeasance of trustees, but arguably what is crucial is whether the rate of return on capital was above the competitive rate in which case there were surpluses for trustees to appropriate. Below I estimate the rate of return on capital to address this issue. In the case of bondholder returns, there is evidence on 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 consols.²⁴ 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.²⁵

²³ Quoted in Berg and Berg (2001) p. 240.

²⁴ Yields are taken from Global Financial Data which draws on Neal (1990).

²⁵ 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

The main problem with the preceding conclusion is that Albert's sample of interest rates is only representative of trusts that were paying interest and 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. Data from a random sample or preferably the population of turnpike trusts is needed to determine whether bondholders earned a premium. The following section discusses the data sources which I use to estimate returns for all turnpike trusts in the 1820s, 30s and 40s.

III.

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 investors were suffering as a result.²⁶ The report from the 'Select Committee to consider the Acts now in Force Regarding Turnpike Roads and Highways,' published in the 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 balances held by the 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

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.

²⁶ See Albert (1972) for a discussion of Parliament's investigations of turnpike trusts in the early 1800s.

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.²⁷

More detailed financial reports were made for trusts in 1829 and annually from 1834.²⁸ 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 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 1810. One potential problem is that the Ginarlis and Pollard series includes some maintenance expenditures with investment. As Harris estimates capital through cumulative quasi-investment in each year without accounting for depreciation it is likely that the value of capital is overstated. Below I provide a new estimate for the value of turnpike road capital in 1820 which accounts for depreciation.

IV.

²⁷ 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).

²⁸ A summary of the reports up to 1838 is given in BPP (1840 XXVII).

Table 1 summarizes revenues, expenses, and capital for the turnpike sector. Capital is the most complex so it is discussed in more detail. Turnpike capital in 1820 is equal to average investment per mile net of depreciation multiplied by total turnpike mileage in 1820. The investment data come from another study which reports average expenditure per-mile for a sample of 38 trusts covering the years from 1700 to 1820.²⁹ 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. Based on the average age of trusts, the typical expenditure profile displayed is from 1764 to 1803. Lastly, all the expenditures are converted to 1819 prices using wages of unskilled labor, which is one of the main inputs into road repair.³⁰

It is clear from Figure 2 that significant road spending occurred in the first two years of a trust's existence, less in years three to five, and then beyond year five expenditure per mile stabilizes and remains roughly constant. The figures are consistent with a model in which trusts improved their road and then maintained it afterwards so that net depreciation was 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 in 1820 implies a value of turnpike capital around £10.5 million in 1819 prices. After

²⁹ See Bogart (2005).

³⁰ Wages for unskilled labor come from Clark (2009).

1820 the estimated value of turnpike capital increases. There were sizeable investments of around £270 thousand annually from 1820 to 1829. The value of capital peaks in 1838 at just under £12.5 million in current prices. Prices were generally falling from 1820 and so the capital value in 1829 and later years is partly diminished by deflation.

The 1820 estimate of turnpike capital is the most crucial because it is the base for all others. It is worth pointing out that Harris estimates turnpike capital to be £15.9 million for England in 1810 in current prices. As discussed above, Harris' figure is likely to be too high because it is based on a quasi-investment series which includes maintenance spending. One might even be concerned that £10.5 million is too high an estimate given total turnpike debt in England and Wales stood at £4.4 million in 1820. That concern is lessened because debt should be lower than nominal capital due to the inflation that occurred from 1760 to 1815. For argument's sake suppose that all turnpike borrowing went to finance investment. Also assume that all debt in 1820 was incurred in the 1750s and 1760s when the vast majority of trusts were formed. In this plausible situation, £4.4 million in debt would amount to a capital of £8.8 million in current prices because unskilled wages in 1760 were around half their level in 1819. £8.8 million is similar to my 1820 capital estimate of £10.5 million and would make sense if one incorporates some retirement of debt and investment from retained earnings between 1760 and 1820.

Drawing on the new estimates of turnpike capital, the rate of return can now be estimated by taking the ratio of net revenues and total capital. The rate of return ranges between 3.6 and 5.6 percent. The 1830s had the highest rates of return on capital and the lowest was in 1842. Over the six year observations, the average rate of return on capital is 4.6 percent. Thus, returns in the turnpike sector are surprisingly close to the estimate for canals in the mid-1820s and for railways

later. How do turnpike returns compare with the rest of the economy? Clark (2009) uses land and housing to calculate the rate of return on low risk capital investments. He finds that between 1820 and 1850 the average rate of return was 4.42 percent, which is similar to Britain's infrastructure sector.

The rate of return on capital provides an overall measure but it does not distinguish different types of capital. In practice, the surplus revenues of a turnpike trust were divided between various actors. Bondholders generally had the first claim on revenues and their financial returns need to be examined. As there is no data on the yields of turnpike bonds across the population, I focus on interest payments divided by debt. Table 2 shows the totals for 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.

Returns to turnpike bondholders would have been higher if there were not such a large amount of unpaid interest. The total interest due is reported in table 2 and equaled between 12 and 20 percent of the total debt. Unfortunately, the sources don't indicate when interest payments went into arrears, but the amount missed in each year can be estimated with some assumptions. 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. After 1820 the yearly changes in unpaid interest can be estimated more precisely. I assume that the difference in unpaid interest between two years (say 1820 and 1829) represented the total unpaid interest in the intervening period and was accumulated evenly in every intervening year. The resulting estimates at the bottom of table 2 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.

Turnpike trustees are another group that might have appropriated the surpluses from tolls. Their financial return can be estimated if we suppose turnpike trusts were a privately owned firm and that trustees earned a hypothetical return on equity. Table 3 shows the net revenues minus interest payments for all turnpike trusts in various years. It also reports ‘hypothetical equity’ estimated as the value of capital invested in turnpike roads plus cash balances minus the value of all debt.³¹ The average return on equity across all years is 5.3 percent. It is larger than the return on capital invested, but not especially large compared to entrepreneurs in the private economy. Generally entrepreneurs earn 5 to 10 percent returns on their equity, while also facing substantial risk and personal liability. Turnpike trustees and their officers generally operated with few personal risks and liability.³² Therefore an estimated average return on equity around 5.3 percent is consistent with a sector where entrepreneurs face low risk.

The general picture is that financial returns in the turnpike sector were similar to other sectors in the British economy. This outcome is notable because there was a potential for monopoly power or substantial over-investment. Returns could have been much higher or lower as in other historical episodes involving infrastructure investment. Turning now to the

³¹ 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.

³² Wellbeloved (1829) discusses the laws relating to turnpike roads in the early nineteenth century and gives an example of a case where a trustee was held liable. It does not appear that suits were widespread however.

perspective of an individual investor, it is not clear that holding turnpike bonds was the best use of their savings even though returns were competitive in the aggregate. If returns varied across trusts and investors could not diversify they may not have been compensated for the risks. I now examine this issue by studying the distribution of returns across turnpike trusts.

V.

To gain insights on trust-level outcomes, I estimate returns to bondholders for 962 trusts detailed in the 1821 Report. Financial data is averaged over the years 1818 to 1820 and for simplicity returns are labeled with 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 in estimating 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 contracted rate. In Albert's sample described above, the average contracted interest rate is very close to 4.75 percent between 1816 and 1825. 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 payments in 1820 were less than the amount specified by the contracted rate. For these trusts I estimate returns using the amount of interest due. Figure 3 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. 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.

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 standard deviation in returns across turnpike trusts equal to at least 1.7. The distribution is shown in figure 4. Most trusts yielded returns at the two extremes: 0 and 4.75 percent. The most striking is that at least 144 of 962 trusts were making no interest payments.

The variance in returns was problematic for turnpike investors because there were a number of constraints on diversification. Bonds were denominated in units of £25, 50, or 100, while annual income for white collar workers was around £130 in 1820.³³ Thus only a few individuals and families could afford to hold bonds from several turnpike trusts. Geography was another constraint on diversification. Most histories show that investors were primarily local, and sometimes resided a short distance from the turnpike road.³⁴ It is possible that investors were able to reduce some variance in returns by holding a balanced portfolio of turnpike bonds in their county, but as it turned out returns were not equalized across counties. Table 5 shows mileage

³³ Lindert and Williamson (1983) give estimates of annual income for various types of workers.

³⁴ See Albert (1972) and Buchanan (1986).

and debt weighted average returns to turnpike bondholders by county. Many had average 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.

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. Aside from displaying the variation across space, the key point is that returns varied within regions implying some possibility to diversify in nearby counties. For example, investors in low return Bedfordshire could have diversified into neighboring Hertfordshire which had higher returns. However, in other areas diversification into a neighboring county was not possible. In Sussex, for example, investors had few options as returns were not as large in neighboring Hampshire, Surrey, and Kent.

More broadly, the evidence shows that some turnpike investors bore high risks given they could only earn an interest rate of 4.5 or 5 percent. It is puzzling therefore why an investor would hold a small portfolio of turnpike bonds as some did. 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. 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. The following section discusses the motivations of investors and analyzes investor choices in the 1820s.

VI.

There are two general views on why British investors held infrastructure securities. Ward (1974, p. 126) describes them as ‘financial’ motives and ‘economic’ motives. Narrowly conceived financial motives imply that investors chose a portfolio that maximizes the difference between the expected return minus the risk free rate divided by the portfolio’s standard deviation.³⁵ More broadly financial motives imply that investors make decisions to maximize their discounted stream of financial payments including foreclosures and legal actions. The premise underlying economic motives is that infrastructure projects raised property values or business profits in their vicinity—the so-called indirect benefits. Local businessmen and landowners considered the indirect benefits of a project plus the financial returns 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 expected financial returns were low. In this scenario investors also had to solve the free-rider or collective action problem. Each individual landowner or businessman would want others to suffer the financial losses and enjoy the benefits of better roads, but if all behaved this way then no investment would occur in the first place.³⁶

There is some evidence in the literature that financial motives were present in British infrastructure financing. For example, infrastructure improvement acts have been shown to increase in number following years when the real return on consols was low.³⁷ One interpretation is that the promoters of acts behaved as though the financial return on an alternative outlet for savings (the consol) would affect the returns to getting legislative approval for infrastructure

³⁵ For example, Mitchell, Chambers, and Crafts (2011) assume that railway investors in the nineteenth century chose a portfolio that maximizes the Sharpe ratio.

³⁶ Various theories have been developed to explain how the free-rider problem could be overcome, including boosterism and kinship ties (see Klein 1990). Here I do not examine how the free rider problem was solved but rather whether it was solved and more specifically whether investors acted on economic motives.

³⁷ Bogart and Richardson (2011).

projects. With respect to economic motives, there is a prima facie evidence based on findings that turnpike trusts increased local property income.³⁸ But there is no quantitative evidence which strongly demonstrates the presence of economic motives. Most studies have focused on the identity of investors and draw inferences about their motives.³⁹ The conclusions are mixed as Ward observed when studying the motives of the Duke of Bridgewater's famous investment in the Worsley canal. Ward argues that the Dukes' investment in the Worsley could be justified by his increased sales of coal in Manchester, but with respect to the Duke's second undertaking, the Manchester-Runcorn navigation, increased sales of coal "could not in themselves have provided a sufficient return on the expenditure of a quarter of a million pounds."⁴⁰

To shed more light on this complex issue, I propose a series of behavioral tests. The goal is to identify any patterns of behavior that cannot be explained by financial motives and might be explained by economic motives. One surprising fact is that total turnpike debt in England and Wales increased by 46 percent from 1820 to 1829. It is surprising because average rates of return on turnpike bonds were modest and variable in 1820 as we have seen. 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 were aware of 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.

I test the preceding hypothesis by regressing debt growth in each county between 1820 and 1829 on the mileage or debt weighted average rate of return on turnpike debt in each county

³⁸ Bogart (2009).

³⁹ See Ward (1974), Albert (1972), Buchanan (1986), and Bogart (2009).

⁴⁰ See Ward (1974), p. 127.

in 1820.⁴¹ I also include dummy variables for regions as controls. Counties are assigned to five regions: the North, the Midlands, the Southwest, Wales, and the Southeast. The dummy for counties in the Southeast region is omitted. The results are reported in table 6. Even after accounting for regional effects, the coefficient for the mileage-weighted average rate of return in 1820 is positive and significant. Consistent with the financial motives hypothesis, 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 all turnpike trusts in a county. It is unclear 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.

The other interesting finding in table 6 concerns regions. The dummy variable for northern counties is positive and significant. The result arguably fits with the financial motives hypothesis: the North was industrializing and thus this region offered investors a greater potential rate of return. Contrary to this view one could also argue that the North had a tradition of investing for economic motives, whereas other regions had less.⁴² However, as I show later such an interpretation is not consistent with other behavioral tests.

A second test of investor behavior comes from foreclosure actions. One curious fact is that in 1820 few bondholders foreclosed on the tolls even though many trusts were not making

⁴¹ 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. The dependent variable is the log difference in debt between 1820 and 1829.

⁴² For example, Ward (pp. 138-140) draws a contrast between the ports cities of Liverpool and Bristol. There is a claim that Liverpool’s merchants were more interested in developing local commerce and Bristol’s merchants sought the highest direct return on their savings which typically included government debt.

their interest 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.⁴³ The rarity of foreclosures would seem to fit the economic motives model, because investors were not exploiting their legal rights to seize the tolls. On the other hand, foregoing foreclosure could be rationalized by financial motives. Foreclosure involved legal costs which were possibly prohibitive.⁴⁴ Moreover, investors may have believed that by not foreclosing and allowing the trust to devote more revenues to road maintenance in the short-term, toll revenues would increase in the future and they would ultimately collect more interest payments in the long-term. Such a belief could be justified if road investments today led to higher toll revenue growth in the future, say by drawing economic activity to the area near the road.

If interest payments eventually resumed for trusts not paying interest in 1820, then the beliefs just described would be consistent with what happened. I investigate this issue focusing on the sample of 144 trusts not paying any interest in 1820 because they were the group where foreclosure was an option. I was able to match 112 of the 144 trusts in the 1840 Report, which provides the interest payments for all trusts in 1838.⁴⁵ As just noted, there is some attrition in the sample. Five of the 144 trusts did not report interest payments in the 1840 Report and thus they could not be included. The remaining 27 trusts not paying interest in 1820 could not be identified in the 1840 Report.⁴⁶ Their absence could affect the conclusions if attrition is correlated with

⁴³ 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.

⁴⁴ See Albert (1972, p. 97) for a brief discussion of foreclosure costs.

⁴⁵ See BPP 1840 (XXVII) for the 1840 Report.

⁴⁶ It is not entirely clear why these trusts are missing. One possibility is that trust names changed making matching difficult. 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.

characteristics that affect resumption of interest payments. I investigate this possibility by testing whether the amount of interest due as a percent of the debt in 1820 was different for trusts that are identified in 1840 compared to those that are not. The results show that the mean interest due is nearly identical in the two sub-samples, suggesting that attrition is not likely to be correlated with characteristics that affect resumption of interest payments.

Turning now to the results, figure 6 shows the distribution of interest payments as a percentage of debt in 1838 for the sample of 112 trusts not paying interest in 1820. While twenty-eight trusts or 25 percent of the sample were still paying zero interest, 66 trusts or just over 50 percent of the sample were paying 4 percent or more. Based on the large number of trusts that recovered financially it might have been rational for investors to forego foreclosure and wait for interest payments to resume. Once again financial motives cannot be easily rejected

The last behavior test concerns debt conversion. Investors could convert their unpaid interest into new turnpike bonds through an agreement with trustees. 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. One might 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 then 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 112 trusts that were not paying interest in 1820 that are successfully matched in the 1840 Report.

The findings on conversion are summarized in table 7. The data show 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. The propensity to convert was only slightly higher for trusts whose financial condition had improved by 1838. Just 24.6 percent of the trusts whose interest payments in 1838 were at least 2.5 percent of their debt converted any interest due between 1820 and 1838. The amount of debt converted was also similar for trusts paying at least 2.5 percent in 1838. Thus there is an unexpected behavior here. If investors had financial motives then conversion should be more likely in the group of trusts whose financial condition improved. It was not.

Perhaps there was an ‘economic’ rationale underlining the decision not to convert. 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 by 1838. 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 (BPP 1840, p. 156 italics added). Why did bondholders behave liberally as the clerk describes? To probe deeper, I analyze the characteristics of trusts in 1820 that were correlated with debt conversion. One characteristic of potential importance is whether the majority of trustees were landowners as opposed to holders of personal property like moveable or financial assets.⁴⁷ Trusts managed by landowners were arguably different because landowners benefitted more from the road maintenance provided by turnpike trusts than other business groups in the economy whose assets were more mobile.

⁴⁷ The 1821 Report gives a brief description stating whether trustees’ income came from ‘Land’ or from ‘General’ sources. In other cases, the number of trustees with landed income and the number with personal income (i.e. financial or moveable property) are given. To ensure a strict measure of landowner control, a trust is coded as a landed trust if more than two-thirds of trustees are landowners or simply ‘Land’ was reported.

Landowner trusts should be less likely to convert if there was an economic motive to foregoing debt conversion.

A logit regression in table 8 tests whether trusts managed by a super-majority of landowners were less likely to convert after controlling for other trust characteristics. The sample of trusts is a subset of the 112 trusts without missing information on whether trusts were managed by landowners and other key characteristics like the level of interest due in 1820, the date of establishment, and the length of road. The results show that the dummy variable for trusts managed by landowners is negative and significant. In other words, landowner managed trusts were less likely to have their unpaid interest converted into debt by 1838. This last finding is important because it is consistent with economic motives. Another notable finding in table 8 is that trusts in northern counties were more likely to have some debt converted compared to trusts in southeastern counties. Earlier we saw that debt growth between 1820 and 1829 was higher in northern counties even after controlling for the rate of return in 1820. It was unclear whether economic motives could explain this finding. Based on the result that trusts in northern counties were more likely to convert unpaid interest it would appear that investors in northern counties did not place greater weight on economic motives.

To summarize, the series of behavioral tests analyzed here do not point to a firm rejection of either economic or financial motives in Britain's infrastructure financing. Consistent with financial motives, investors lent to turnpike trusts in areas where recent financial performance was better and many trusts that missed interest payments and were not foreclosed upon eventually resumed making interest payments. Consistent with economic motives, many investors did not convert unpaid interest into debt and landowner managed trusts were less likely to convert than trusts managed by a broader set of groups who likely gained less from road

improvements and more from interest payments. Overall the patterns of behavior are consistent with investors having a mixture of financial and economic motives.

VII.

Much of Britain's infrastructure was privately financed during its early industrialization. Parliament gave turnpike trusts and other statutory authorities' monopoly rights to improve or construct roads, rivers, canals, bridges, and dock works. This paper estimates financial returns in the turnpike sector and compares it with canals, railways, and other sectors in the British economy. The evidence shows that the turnpike sector yielded financial returns similar to more competitive sectors. The net revenue as a percentage of the capital invested was 4 to 5 percent and the return to turnpike bondholders was just under 4 percent. 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 for turnpike trusts, canals, and railways 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 at the trust-level returns to bondholders varied. Around 15 percent of trusts were not making any interest payments by 1820 and therefore individual bondholders earned a competitive return only if they held a diversified portfolio. However, diversification was difficult as turnpike bonds came in relatively large denominations and as most investors

were local. As the nineteenth century capital market eventually centered on London, investors found greater opportunities for diversification. It is not surprising they were more willing to fund large projects like railways by the mid-1800s.

The last finding of this paper concerns the motivations of investors. Financial returns are the typical motivation for investors and indeed we see its influence in Britain's infrastructure sector during the Industrial Revolution. But the data also suggest that British landowners and businessmen were willing to invest in some projects 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 perhaps it is an indicator of why the British economy was generally successful in the early nineteenth century.

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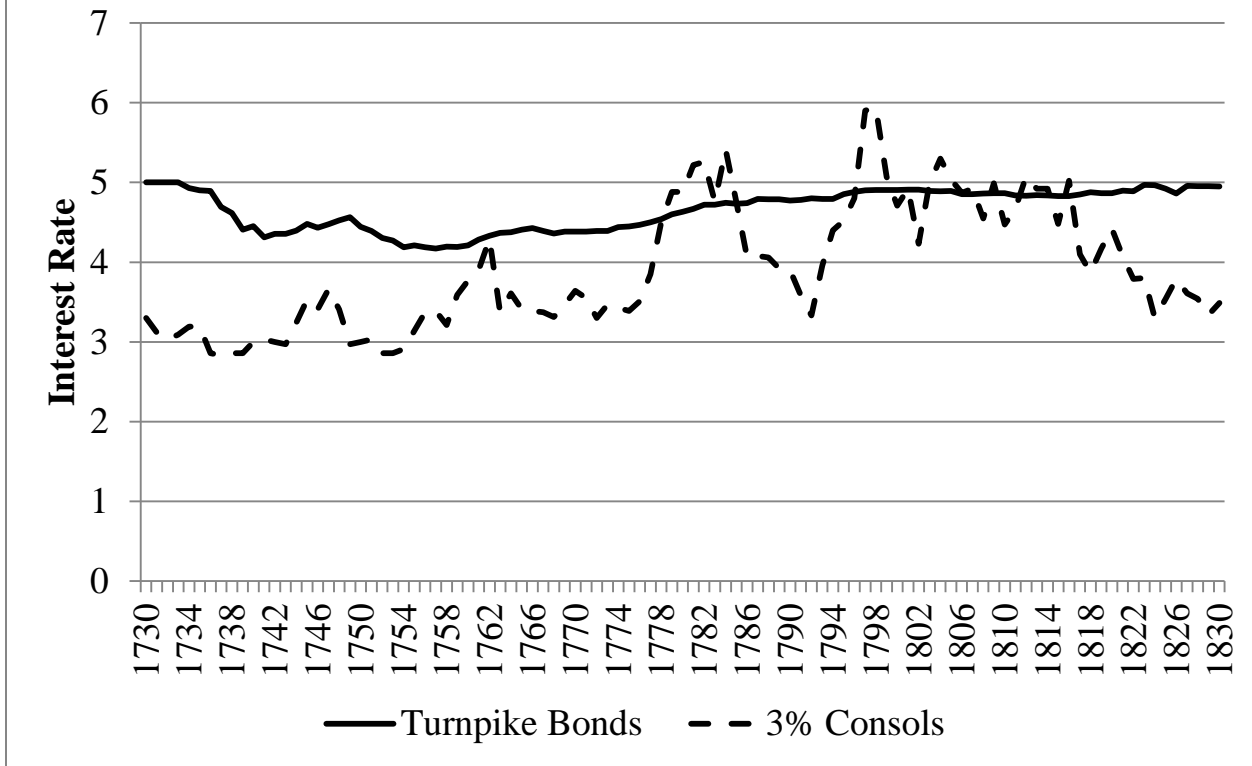
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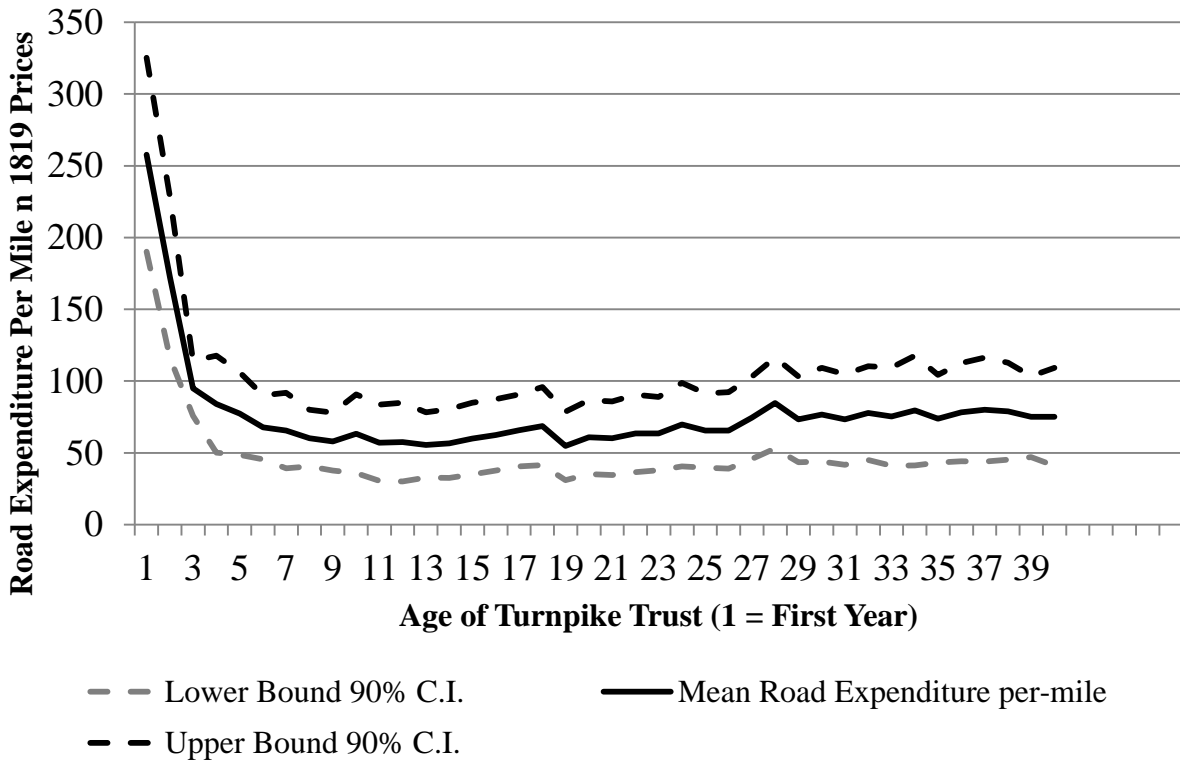
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Figure 1: Interest Rates on Turnpike Bonds and Yields on 3% Consols, 1730-1830

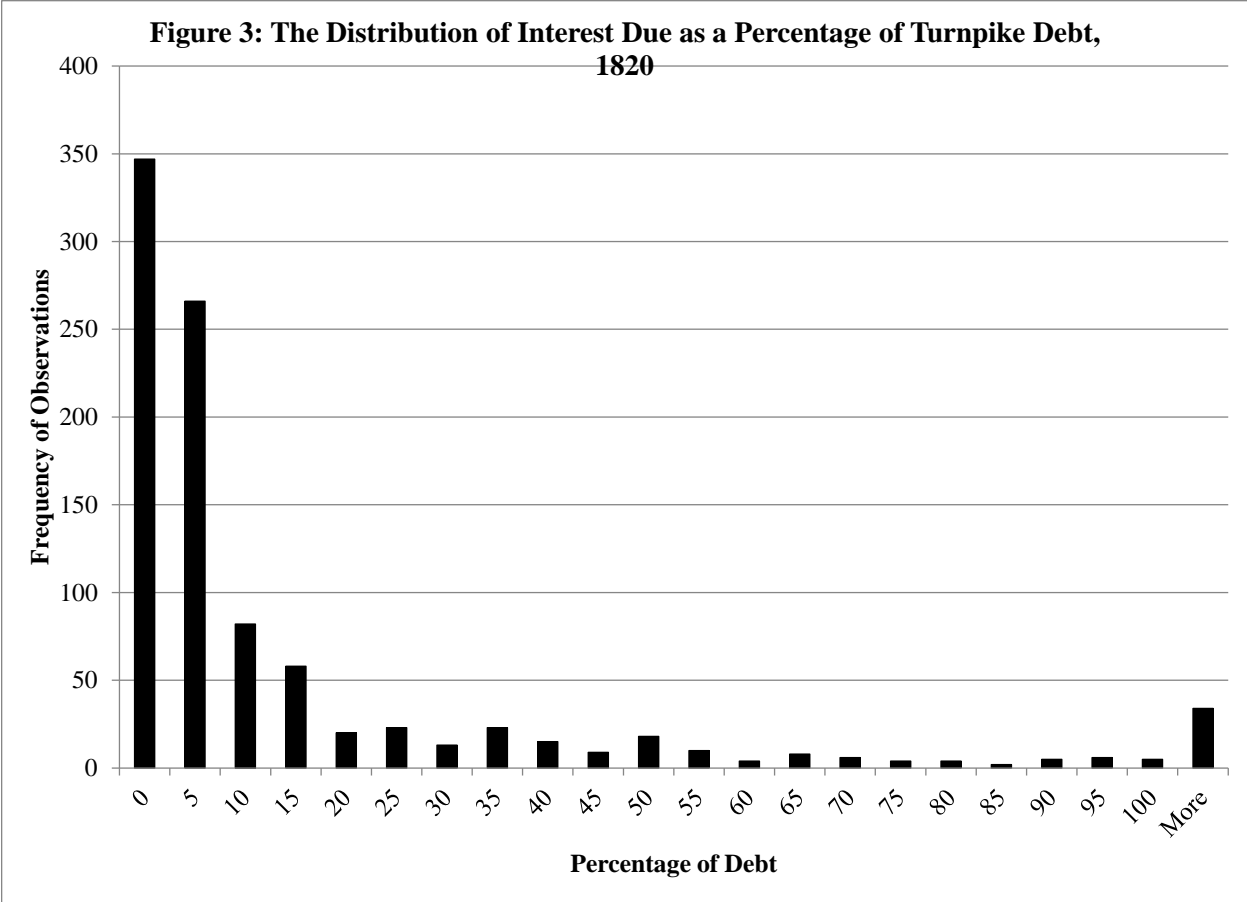


Sources: Albert (1972), p. 247-261.

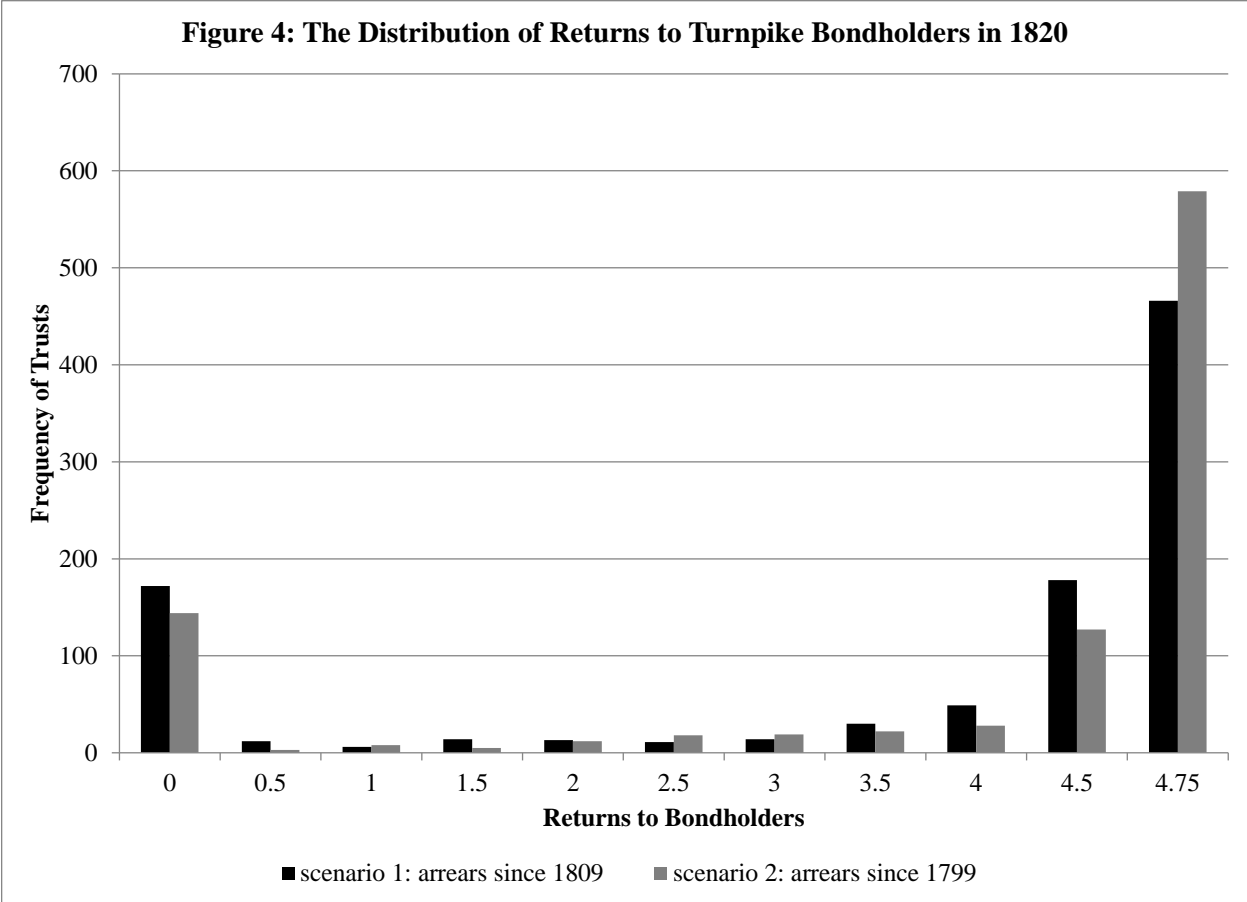
Figure 2: Average Road Expenditure Per Mile and the Age of Turnpike Trusts before 1820



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

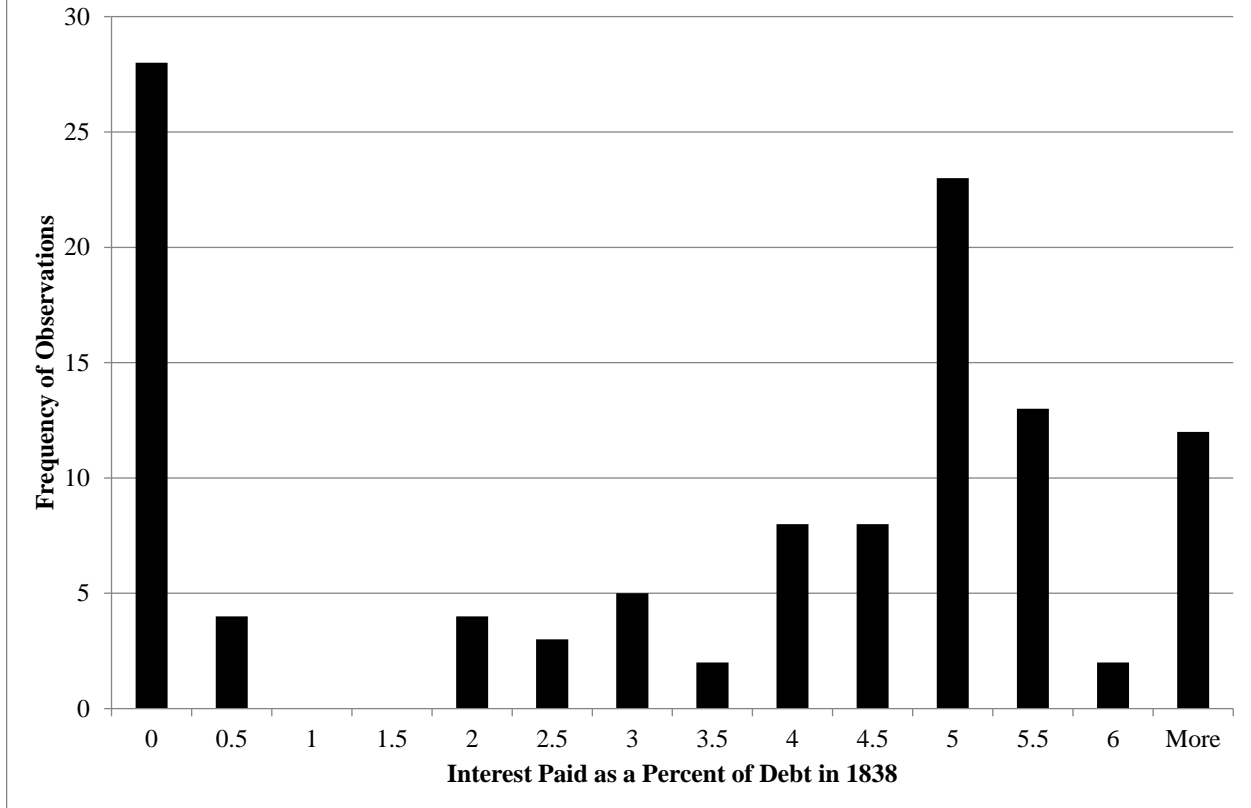


Sources: see text.



Sources: see text.

Figure 6: 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 minus interest payments	240,522	143,404	397,629	378,796	291,306	254,643
Balances Held by Trust	362,362	286,071	303,837	313,882	361,836	281,160
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 in 1820

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
Radnorshire	4.69	4.69
Middlesex	4.71	4.72
Essex	4.68	4.73

Sources: see text.

Table 6: Rates of Return in 1820 and Debt Growth Across Counties from 1820 to 1829

Dependent Variable: log difference in county
turnpike debt between 1820 and 1829

variable	Coefficient (Robust Standard error)	Coefficient (Robust Standard error)
Average Rate of Return in 1820 (mileage weighted)	0.311 (0.174)*	
Average Rate of Return in 1820 (debt weighted)		0.16 (0.136)
Northern County Dummy	0.499 (0.188)**	0.436 (0.2)*
Southwest County Dummy	0.067 (0.192)	0.08 (0.197)
Midlands County Dummy	0.078 (0.2)	-0.006 (0.185)
Wales County Dummy	-0.037 (0.219)	-0.0001 (0.227)
Constant	-1.09 (0.716)	-0.441 (0.541)
N	51	51
R-square	0.2	0.16

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 identified in 1838 that did not pay interest in 1820	112
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 that converted in subsample paying more than 2.5% on debt	24.6
Average converted interest due as a percentage of debt in subsample	23.7

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

Table 8: Trust Characteristics and the Probability of Debt Conversion between 1820 and 1838

Dependent Variable: 1 if any debt was converted for trust, 0 otherwise

variable	Logit coefficient. (Robust Standard error)
Dummy for Landowner Managed Trust	-1.46 (0.63)**
Length of road in Miles	-0.05 (0.03)*
Interest due as percent of debt in 1820	-0.016 (0.005)**
Year trust founded	-0.016 (0.013)
Northern County Dummy	2.48 (1.21)**
Southwest County Dummy	0.39 (1.36)
Midlands County Dummy	2.74 (1.11)*
Wales County Dummy	3.08 (1.51)*
Constant	28.22 (24.8)
N	88
Pseudo R-square	0.23

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