Investing in Early Public Works:

Financial risks and returns in English and Welsh turnpikes 1820-1882

Forthcoming in Economic History Review

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Current Draft: December 2017

Abstract

Private and local investors provided much of the capital to improve England’s infrastructure during its industrialization. In this article, I investigate the financial returns to investors in turnpike road trusts. I draw on parliamentary reports which provide comprehensive data on finances, including payments to bondholders. One key finding is that turnpike trusts paid their bondholders a return above the yield on government bonds before 1850. Afterwards turnpike interest payments declined, yet they still yielded competitive returns. Another key finding is that the risks were modest. Returns to holding individual turnpike bonds varied with most paying 4 to 5 percent and some paying zero. The latter were not the majority and in many cases interest payments resumed within a few years. Diversified portfolios of turnpike bonds enjoyed lower risks, and outperformed portfolios with railway and canal securities traded on the London exchange before 1850. Overall, the results contribute to a better understanding of the risks and returns associated with investing in early public works.

JEL Codes: K23, N43, N73
Key Words: Turnpike Roads, Infrastructure, Finance, British Industrial Revolution

1 I thank two anonymous referees for their helpful comments. I also thank Gary Richardson, Jean Laurent Rosenthal, Alejandro Komai, Anne Conchon, Arnaud Passalaqua and participants in seminars at UC Irvine, Northwestern, Stanford, and University of Paris 1 on an earlier version of this paper, Profiting from Public Works. Also special thanks goes to Alan Rosevear, Max Satchell, Ivy Bogart, and Marco Antonio Martinez Del Angel for help in creating turnpike datasets and for ongoing collaboration. I also thank John Turner and Qing Ye for provided data on railway and canal securities. All mistakes are my own.
All well-made plans can go awry. This famous maxim applies especially to infrastructure financing. Large capital expenditures are required for infrastructure projects and they are based on demand projections far into the future. Of course, projections can be wrong. Technology changes and economies evolve in unpredictable ways. There may be little surplus down the line to pay investors who risked their capital.

The challenges of infrastructure financing raise several interesting historical questions. First, there are foundational questions like who were the investors? Were they public or private? Were they local, metropolitan, or foreign? Next what did investors earn in financial terms? What risks did they face? Were they rational and well informed? Broader questions also emerge, like whether infrastructure investments contributed to wealth and income inequality? I provide here new answers to several such questions for the case of turnpike road trusts in nineteenth century England and Wales. The analysis complements a wider literature on the financing of infrastructure in Britain, Europe, and North America.²

By the early nineteenth century, approximately 1000 turnpike trusts were established to maintain and improve nearly 20,000 miles of road in England and Wales. They complemented similar authorities developing canals, rivers, and dock works. Turnpike trusts financed their projects almost entirely through tolls and by issuing bonds backed by toll revenues. These bonds were largely purchased by local individuals with governments in Westminster providing no guarantees and limited subsidies. Turnpike trusts had their greatest impact on transport in the

1830s and 1840s, which is often regarded as the ‘golden age’ of coaching. After 1850 turnpike trusts faced tough competition from railways and steamships, and were phased out over the next 30 years.3

I begin the analysis by measuring the financial returns earned by turnpike bondholders as a group. The existing literature largely paints a negative picture of overall returns. Albert finds that 60 per cent of trusts had at least three years of interest in arrears.4 Webster studies the repayment of turnpike debts after 1850 and finds that after defaults investors lost 39 per cent of what they were entitled to receive.5 This view is also consistent with contemporary claims that turnpike administration had many defects.6

I take a different approach by focusing on what investors received rather than what they missed or lost. I report the ratio of turnpike trust interest payments relative to debt from the 1820s through the 1880s (see section II). The ratio is a good metric for investor returns because few earned a capital gain or loss by selling turnpike bonds. Thus, interest payments relative to the value of the debt largely captures investors’ rate of return. I find that turnpike trusts paid competitive returns overall. Interest payments for all turnpike trusts as a percentage of debt were just over 4 per cent for most years between 1820 and 1850. For comparison, the yield on Consols, a long-term government bond, were under 3.5 per cent for most of the early nineteenth century. It is also notable that interest payments remained competitive during the early diffusion of railways in the 1830s and 40s.

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3 The impacts of turnpikes are discussed by Albert, Turnpike road system; Pawson, Transport and economy; Gerhold, ‘Productivity change’; ‘The development of stage coaching’; Bogart, ‘Did turnpike trusts’; ‘Turnpike trusts and the transport revolution’; ‘Turnpike trusts and property Income’.
4 Albert, Turnpike road system, p. 89.
5 Webster, ‘The public works loan board 1817-76’, p. 75.
6 Albert, Turnpike road system, p. 64.
However, I also find that financial returns for turnpikes deteriorated following the widespread adoption of railways. From 1850 to 1882, turnpike interest payments declined reaching less than 2 per cent. The debts of many trusts were repaid but some were cancelled or reduced, implying losses for investors. Despite their inglorious end, trusts still paid over the long-run. The rate of return to a hypothetical investor holding all turnpike debt from 1837 to 1882 equaled 3.41 per cent.

In section III, I turn to an analysis of the risks involved in holding individual turnpike bonds. Distributions of interest payments across trusts are constructed using newly digitized financial data for each turnpike trust in 1823, 1834 to 1838, and 1850. It is the first dataset providing comprehensive snapshots of financial performance for all turnpike trusts. Moreover, trusts are linked across years allowing for comparisons of individual performance over time. The results show that most trusts paid between 4 and 5.5 per cent on their bonds and at most thirteen per cent of trusts paid zero interest in any year. Data across time reveals that many trusts resumed paying interest after they had paid zero interest. Trusts generally recovered from negative shocks and poor performance was not permanent.

The evidence on risks and returns suggests investors in turnpike bonds were paid a risk premium or a higher expected return over Consols. However, in section IV, I show there is no evidence that riskier trusts, with a higher standard deviation in their interest payments or a history of paying zero interest, paid a premium on their contracted interest rate. Thus, a risk premium is evident only when considering turnpike bonds as a broad class of financial assets.

In section V, I examine the risks and returns to four types of investors in turnpike bonds. The generic investor held the bonds of a single turnpike trust. They were often landowners or savers from the area. I estimate their average mean return was 4.19 per cent with a standard
deviation of 1.69. The large landed investor was different in holding two or more bonds in their county. I show most two-trust county portfolios had a significantly lower standard deviation in returns than one-trust portfolios. Thus, there is evidence that large landowners experienced less risk through diversification. Charities were another significant investor. Like the generic investor, they often held one turnpike bond. Charity portfolios are found to have a similar average return to the generic investor, but with lower a standard deviation. Finally, the Public Works Loan Board (PWLB) was a government-funded body making loans to several turnpike trusts in the 1820s. I find its portfolio performed the worst in terms of yielding lower returns with greater variance.

Turnpike trusts paid competitive returns relative to government debt, but what about other risky assets like farmland or canal and railway securities? In section VI, I calculate the returns per unit of risk (i.e. the Sharpe Ratio) for a portfolio of each asset type. The Sharpe Ratio for the generic turnpike portfolio is higher than the farmland portfolio, suggesting landowners who diversified into turnpikes gained financially. Perhaps surprisingly, the evidence is mixed with respect to canals and railways. The latter two had a higher Sharpe ratio based on accounting profits relative to capital employed. However, based on total returns from the London stock exchange canals and railways had lower Sharpe Ratios than turnpikes. Canal and railway securities were subject to speculation which led to high variance in their capital gains. Turnpike bonds did not require market timing because there was little financial speculation.

Overall my findings point to a more positive assessment of turnpike trusts’ financial performance, especially compared to the more negative assessments in the literature. Unlike previous works, I analyze financial performance using data drawn from the parliamentary papers over several years. The newly assembled data shows that turnpike bonds paid good financial
returns and with modest risks, at least up to 1850. Their rate of return was also larger than the growth rate of the British economy, which averaged 2 per cent per year between 1820 and 1850.\(^7\)

In terms of distributional effects, my results also show that turnpikes were a source of landowner wealth in the early nineteenth century. Landowners were the largest investors in turnpike bonds. The healthy interest payments were an addition to increased land values from being near turnpikes.\(^8\) Their success was controversial at times. The famous Rebecca riots in South Wales are a good example and were motivated by the high tolls paid by users. Future research may definitively show whether turnpike trusts and related infrastructure bred more inequality.

My findings also add to a growing literature on early nineteenth century investors. Other works find that early investors had various motives and faced several constraints.\(^9\) Broadly, I find similar patterns in the case of turnpike investors. The comparison between landowners and charities is one illustration. The former could take risks knowing that turnpikes would likely raise their land rents. Charities could not take the same risks given their fiduciary responsibilities, nor could they benefit as greatly. In accordance with their different aims and constraints, charities invested differently. The PWLB is another illustration. One view is that the PWLB made loans to more speculative projects to stimulate economic activity.\(^10\) Its portfolio of turnpike bonds suggests the PWLB did in fact lend to more risky trusts.

Last, it should be noted that turnpike trusts’ performance is exceptional in infrastructure more generally. There is a literature studying financial returns and risks in the infrastructure sector during late 20\(^{th}\) century. The consensus is that they are often unprofitable and risk sharing

\(^7\) GDP growth is from Broadberry et. al., *British economic growth*.
\(^8\) Bogart, ‘Turnpike trusts and property income’.
\(^10\) Webster, ‘The Public Works Loan Board’ analyzes the aims of the PWLB.
schemes between the public and private sectors are necessary. Why turnpike bonds offered less risk than modern infrastructure securities is an open question. In the conclusion, I provide some potential explanations as to why English and Welsh turnpike trusts were different.

I.

In this section, a brief background on turnpike trusts and their debts is provided. Parliamentary legislation determined how infrastructure was financed and organized in England and Wales. So-called ‘turnpike acts’ transferred authority over a road to a body of trustees for 21 years and it was typically longer through renewal acts. Trustees had to meet property and income qualifications. Notably requirements were often lighter on landowners making them the most common group. Trustees had rights to levy tolls and rights to the labor of the residents in parishes near the road, known as statute labor. Turnpike trusts could also issue bonds secured on the toll income. Most turnpike acts forbade the creation of tradeable shares and collection of profits. The revenues were to be devoted to manual labor, materials, officers’ salaries, interest, and repayment of the principal on the debt. Surplus balances were held by the treasurer and applied to future expenses.

Turnpike trusts spread widely through England and Wales forming a network. The 1750s and 1760s saw the largest numbers formed. Turnpike trusts managed all the major roads leading into London and between major towns. They also managed the major roads between industrial towns and their hinterland, as well the market towns in rural areas. By the 1830s around 1000 trusts managed 20,000 miles or 20 per cent of the total network. A map of the turnpike road

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11 For analysis of infrastructure concessions during the 1990s and 2000s see Sirtaine et. al., ‘How profitable are private’; Estache and Pinglo, ‘Are returns to private’; Rothballer and Kaserer, ‘The risk profile’. 
network in England and Wales, the coalfields, and the largest towns in 1830 is shown in figure 1. The extraordinarily dense network is evident.

Figure 1: A map of the English and Welsh turnpike network in 1830

Sources: Map produced by Max Satchell and the transport, urbanization, and economic development in Britain, 1670-1911 project. See http://www.campop.geog.cam.ac.uk/research/projects/transport/

12 I thank Max Satchell for producing this map. See https://www.campop.geog.cam.ac.uk/research/projects/transport/data/ for more details on maps of infrastructure.
Trust revenues mainly came from tolls and statute labor contributions. The tolls were levied on all types of traffic including coaches, wagons, and horses. Statute labor was a requirement that local inhabitants provide up to 6 days a year to work on the roads. Turnpikes trusts were granted a portion of this labor by their regulating acts. While statute labor was much discussed by contemporaries, the tolls were the most important. As an example, toll revenues equaled £1.45 million and statute labor contributions were valued at £0.13 million in 1834.\(^\text{13}\)

Turnpike trusts mostly spent their revenues on roads. In 1834, around two-thirds of expenditures were directly related to maintenance or improvement, and 75 per cent was at least indirectly related including trusts’ managerial costs.

The focus of this article is on turnpike interest payments. There were two types of turnpike debt.\(^\text{14}\) The first were bonds secured on the tolls (so-called mortgage debt). The second were unsecured bonds and did not always pay interest (so-called floating debt). The mortgage bonds were by far the largest. They were often denominated in units of £50 or £100. They had no set maturity date and the trustees could repay the principal in full at any time.

The contracted interest rates on the mortgage debt could not exceed 5 per cent because of usury laws, and most ranged between 4 and 5 per cent. Importantly, for this study each bond for a trust was treated equal, without first or second claims on the revenues. If any bondholder did not receive their scheduled interest within six months they could foreclose on the tolls and become the first claimant on the revenues.

There were two periods of greater turnpike borrowing. The first was in the 1750s and 60s when most trusts were established. The second was in the 1820s and 30s when total turnpike

\(^{13}\) See for details on 1834 see Turnpike trusts. An abstract of the general statements (PP 1836, XLVII). For general information on turnpike finances see Bogart, ‘The Turnpike Roads of England and Wales’. To give some further perspective, total British central government tax revenues in 1834 were about £50 million making turnpike revenues about 3.2 percent of central government revenues. See Mitchell, British Historical Statistics, pp. 570.

\(^{14}\) See Albert, Turnpike road system, pp. 93-97 for a discussion of turnpike debts.
debt in England and Wales increased from £4.4 million to £7.3 million.\(^{15}\) In the 1820s, it appears that trusts were responding to new methods of road making developed by engineers like John Macadam and Thomas Telford.\(^ {16}\) They were also spurred by the growth of the coaching trade.

There are four stylized facts about turnpike bondholders. I review these before turning to my analysis. First, the overwhelming proportion of investors came from areas near the road. As one illustration, Buchanan’s detailed study of the Bath turnpike trust shows that many investors were resident in Bath with a minority having neighboring Bristol or London addresses.\(^ {17}\)

A second stylized fact is that turnpike investors came from all types of elites. Webster’s analysis of 41 mortgage ledgers provides the best evidence on investor background. Webster classified 42 per cent as landowners, 31 per cent as commercial interests, and 27 per cent as savers.\(^ {18}\) Charities were a prominent type of saver. According to a parliamentary report they held £62,959 in turnpike bonds which represented approximately 10 per cent of the debt in the 1830s.\(^ {19}\) Another prominent investor was the Public Works Loan Board (PWLB). Its official aim was to make loans to mines, for public works, and for the employment of the poor. Local authorities, like turnpike trusts, could apply for a loan, and if accepted the PWLB usually demanded a 5 per cent interest rate. The PWLB lent £401,000 to 107 trusts in England and Wales between 1817 and 1832.

A third stylized fact is that most investors did not diversify their holdings of turnpike bonds. Albert discusses many prominent investors in turnpike bonds.\(^ {20}\) The most any individual lent to is three trusts and they were always in the same county. Most investors to multiple trusts

\(^{15}\) See Appendix to the report of the commissioners, (PP 1840, XXVII).
\(^{16}\) According to Guldi, Road to Power, pp. 29-72, engineers were partly successful because of earlier experiences with military roads in Scotland, and the building of the London Holyhead road in the late 1810s.
\(^{17}\) Buchanan, ‘The evolution of the English turnpike’, p. 236.
\(^{18}\) Webster, The public works loan board 1817-76, p. 67.
\(^{19}\) See Appendix to the report of the commissioners, (PP 1840, XXVII), p. 9.
\(^{20}\) Albert, Turnpike road system, pp. 100-108.
were nobleman. Examples include the Duke of Norfolk, the Duke of Devonshire, the Marquis of Hertford, and the Earl of Guildford.\textsuperscript{21} The Charity Returns contain more insights. A review of the Returns for Somersetshire suggests that most charities invested in zero or one turnpike trust.\textsuperscript{22}

Fourth, most investors purchased their bonds directly from turnpike trusts and held them for the longer-term. The secondary market for turnpike bonds was thin. Mortgage registers for urban trusts show turnpike bonds sometimes changed hands.\textsuperscript{23} But there is no evidence for widespread trading in central markets like London.

While much is known about turnpike debt and bondholders, the financial risks and returns on turnpike bonds are not well documented or well understood. Most of the literature has focused on what investors did not get, including unpaid interest and defaults. Concerning the interest payments of turnpike trusts, only limited evidence has been provided. Albert lists interest rates for a sample of 100 trusts between 1730 and 1830 and finds the average interest rate was 4.66 per cent.\textsuperscript{24} Data from charities, collected by Clark, reveals that the average rate of return for 114 turnpike bonds between 1752 and 1844 was 4.74 per cent.\textsuperscript{25} Based on this evidence, turnpike trusts seemingly made competitive interest payments. There are two problems in drawing this conclusion. First, it is not clear the interest rates reported in Albert and the Charity records are contracted rates, or effective rates paid to investors. The two may differ if trusts missed interest payments. Second, the two samples may not be representative of all trusts. If they are biased, then the effective rate of interest across the population might be less.

\textsuperscript{21} In South Yorkshire many landowners invested in at most two or three turnpike trusts. See Nunn, ‘The Management’.
\textsuperscript{22} Report of the commissioners appointed in pursuance of two several acts (PP 1821, IV).
\textsuperscript{23} Buchanan, ‘The evolution of the English turnpike’, p. 239, documents active trading in the Bath turnpike trust.
\textsuperscript{24} Albert Turnpike road system, pp. 247-261.
\textsuperscript{25} I thank Clark for sharing this data. A description is given in Clark, ‘The Charity Commissioners’.
In the next section, I provide a new analysis of turnpike financial returns starting with the aggregate picture. I show that turnpike bonds paid at least as much as the yield on Consols.

II.

The finances of turnpike trusts can be characterized in great detail thanks to a series of parliamentary reports and accounts. A summary for all trusts is first provided for the year 1829 and annually from 1834.26 These summaries provide debts, interest payments, unpaid interest, and net borrowing for all trusts in England and Wales.

Panel A of table 1 shows the mortgage debts, floating debts, and interest payments in selected years before 1850. Note the interest payments do not include repayments of principal and apply only to mortgage debt. Floating debt did not always pay interest. The main item in the table is the interest paid as a percentage of mortgage debt. It varies from 3.6 to 4.15 per cent. The average is 4.0 per cent. This is large considering the average yield on Consols between 1820 and 1850 was 3.44 per cent.27

There was a large and growing stock of unpaid interest however. Unpaid interest represented 18.4 per cent of the mortgage debt in 1842 (see panel B in table 1). The main reason is that most trusts contracted to pay 5 per cent to their bondholders, but in practice some trusts paid less. When interest went unpaid it was rarely written off trusts’ accounts. Thus, the growing stock of unpaid interest represents an accumulation of past interest payments that fell short of the contracted levels.

<table>
<thead>
<tr>
<th>Table 1. Debt and Interest Payments to Turnpike Bondholders, 1829-1842</th>
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<td>Panel A: Debt and interest payments all turnpike trusts</td>
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<th>1829</th>
<th>1834</th>
<th>1838</th>
<th>1842</th>
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26 A summary of the reports up to 1838 is given in Appendix to the report of the commissioners, (PP 1840, XXVII).
27 Consol yields are available in Neal, The Rise of Financial Capitalism.
Panel A: Debt and interest on turnpike trusts

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<th>1829</th>
<th>1834</th>
<th>1838</th>
<th>1842</th>
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</thead>
<tbody>
<tr>
<td>Total Mortgage debt in £</td>
<td>6,578,815</td>
<td>7,068,275</td>
<td>7,260,903</td>
<td>7,238,704</td>
</tr>
<tr>
<td>Total Floating debt in £</td>
<td>303,541</td>
<td>273,937</td>
<td>202,034</td>
<td>161,367</td>
</tr>
<tr>
<td>Interest paid in £</td>
<td>236,619</td>
<td>289,376</td>
<td>301,462</td>
<td>295,934</td>
</tr>
<tr>
<td>Interest paid as percent of mortgage debt</td>
<td>3.60</td>
<td>4.09</td>
<td>4.15</td>
<td>4.09</td>
</tr>
</tbody>
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Panel B: Unpaid interest all turnpike trusts

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<th>1829</th>
<th>1834</th>
<th>1838</th>
<th>1842</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accumulated unpaid interest in £</td>
<td>821,386</td>
<td>1,002,255</td>
<td>1,123,623</td>
<td>1,333,486</td>
</tr>
<tr>
<td>Unpaid interest as share of mortgage debt</td>
<td>12.49</td>
<td>14.18</td>
<td>15.47</td>
<td>18.42</td>
</tr>
</tbody>
</table>

Sources: Data for 1829, 1834, and 1838 are from Appendix to the report of the commissioners (PP 1840 XXVII, p. 647). Data for 1842 are from Turnpike trusts. An abstract of the general statements of the income and expenditure of the several turnpike trusts in England and Wales (PP 1844 XLII).

I now turn to the long-term perspective. It is generally thought that trusts finances deteriorated because of railways. If so, one would think the railway mania of the mid-1840s marked the beginning of the decline for turnpikes. Figure 2 shows the interest payment as a percentage of mortgage debt over the long-run from 1829 to 1882.\(^{28}\) Interest payments remain above 4 per cent until 1850 and then begin a long decline reaching a low of 1.55 per cent in 1879. The timing suggests that it was the widespread adoption of railways that made turnpike finances perilous.

\(^{28}\) With the exception of 1829, the figures all come from the Abstract of General Statements of Income and Expenditure of Turnpike Trusts in England and Wales, published annually in the parliamentary papers.
Consistent with this interpretation, turnpike trusts began exiting the market after 1860. On average 52 trusts exited per year between 1865 and 1882. In the latter year there were only 40 turnpike trusts remaining.\textsuperscript{29} As trusts exited some repaid their bonds and others cancelled debts. The relative magnitudes of each are not known with certainty, but they can be inferred from trends in net borrowing (borrowing minus repayment) and changes in outstanding debt. Figure 3 shows that after 1842 trusts repaid more bonds than they borrowed resulting in negative net

\textsuperscript{29} These figures are taken from the Fourteenth annual report of the Local Government Board. 1884-85 (BPP 1884-85 XXXII.1, p. 66).
borrowing. The greater repayments continued for the next 42 years and totaled £5.03 million by 1882. The annual change in outstanding debts were also generally negative after 1842, and totaled £7.09 million by 1882. Notice that approximately £2 million in debt was eliminated without a corresponding repayment. This amount was likely cancelled.

Figure 3: Net borrowing and change in debt for all turnpike trusts in England and Wales

Sources: Authors calculations based on the Abstract of General Statements of Income and Expenditure of Turnpike Trusts in England and Wales, PP, various years.

Trends in unpaid interest are also illuminating. Unpaid interest as a share of the debt rose from 0.15 in 1829 to 0.27 in 1849. The share then declined sharply in the early 1850s and

\[^{30}\text{Unpaid interest and debts are taken from the Abstracts of General Statements. Figures on the share of unpaid interest are not shown to save space.}\]
1860s and went below 0.04 by 1877. It seems likely that much of this unpaid interest was cancelled. Unpaid interest fell at the same time changes in outstanding debts were larger in absolute terms than changes in net borrowing.

Do the trends after 1850 imply that trusts yielded poor financial returns in the long-run? To address this question, consider a hypothetical investor who held all £7,260,903 in turnpike mortgage debt in 1838. Suppose they received all interest payments and repayments of principal measured by net borrowing during the 44 years from 1838 to 1882 and that any remaining principal after 1882 was cancelled. The internal rate of return on this investment, $r$, is obtained by solving the following expression which equates the value of debt in 1838 with the discounted value of the future stream of interest payments and principal repayments:

$$
£7,260,903 = \sum_{t=0}^{44} \frac{\text{interest payment}_t}{(1 + r)^t} + \frac{\text{principal payment}_t}{(1 + r)^t}
$$

The solution to this equation is $r=0.0341$, which implies an internal rate of return equal to 3.41 per cent. Thus, the investor who held all turnpike debt in 1838 would have received a similar return over the next 44 years as an investor in Consols.

III.

The degree of risk is a crucial factor in determining the value of a security to investors. This section characterizes the risks by studying the distribution of interest payments at the individual trust level. The central question is how many trusts paid zero or a lower interest rate versus 4 to 5 per cent. I use newly digitized data on payments for all trusts in eight years: 1823, 1834 to 1838, and 1850. The 1823 data come from a parliamentary report in 1824 publishing
detailed financial returns made to county clerks. The 1824 report is especially valuable because it providers the first comprehensive source on trust level interest payments. However, it is incomplete in that 72 trusts provided no returns and 20 trusts provided incomplete information. In total interest payments are observed for 820 trusts in 1823. The trust-level data for 1834 to 1838 and 1850 are from the annual edition of the ‘Abstract of General Statements of Income and Expenditure of Turnpike Trusts in England and Wales.’ They report finances for each trust and are largely complete. For example, in 1836 interest payments are reported for 1130 trusts and in 1850 for 1117 trusts.

Figure 4 shows the distribution of interest payments in 1823, 1836, and 1850. In all years, the distribution is bimodal, with most trusts paying between 4.5 and 5.5 per cent and another group paying zero per cent. For example, in 1823, 38.5 per cent of trusts paid between 4.5 to 5.5 per cent and 13 per cent of trusts paid zero interest. The 38.5 per cent of trusts accounted for 32.8 per cent of the total debt. The 13 per cent accounted for 12 per cent of the debt. The proportions paying different levels of interest are similar in 1836 and 1850, except more trusts pay 4.5 to 5.5 per cent and fewer paid zero interest.

A natural next question is how many trusts paid zero interest regularly. To investigate this issue, I match individual trusts reported in 1823, 1834 to 1838, and 1850 to a ‘master’ list of all trusts ever formed. The matches are based on trust name and location information from their regulating acts. The match rates in each year are very high, over 98%. But the matched sample is unbalanced over time as some trusts exited, entered, merged with other trusts, or reported districts separately or together. 1114 trusts have interest rate observations in at least two of the eight years 1823, 1834 to 1838, and 1850. 607 have observations in all eight years.

31 See Turnpike Trusts. Copies of the Several Accounts BPP (1824 XX).
32 I thank Alan Rosevear for creating the master list of turnpike trusts ever formed.
Figure 4: Distribution for interest payments across turnpike trusts in 1823, 1836, and 1850

Sources: Authors calculations based on Turnpike Trusts. Copies of the Several Accounts (PP 1824 XX) and Turnpike trusts. An abstract of the general statements of the income and expenditure of the several turnpike trusts in England and Wales (PP 1837-38 XLVI, 1852-53 XCVII).

The matched samples show a partial recovery in financial performance for trusts paying zero interest. Figure 5 shows the distribution of interest payments in 1836 separately for trusts paying zero interest in 1823 and those paying some interest. Notably, many zero interest trusts later resumed paying interest. For example, 54 per cent of trusts paying zero interest in 1823 were paying 4 per cent or more in 1836. Thus, the losses incurred by some bondholders were not permanent. Also notable is that more trusts paying zero interest in 1823 were paying the highest
levels of interest in 1836. These trusts must have been repaying some of their unpaid interest accumulated from the past.

Figure 5: Distribution for interest payments across trusts in 1836 depending on whether zero interest was paid in 1823

Sources: Authors calculations based on Turnpike Trusts. Copies of the Several Accounts (PP 1824 XX) and Turnpike trusts. An abstract of the general statements of the income and expenditure of the several turnpike trusts in England and Wales (PP 1837-38 XLVI).

The rate at which zero interest paying trusts returned to paying interest is also revealing because it speaks to whether the finances of trusts experienced short-term or medium-term shocks. I focus on the trusts paying zero interest in 1834 and analyze their interest payments in the next four years 1835, 1836, 1837, and 1838. Those calculations can be summarized as
follows: 66 per cent of trusts paying zero interest in 1834 were still paying zero interest in 1835. By 1836 this share falls to around 60 per cent and is similar until 1838. Thus within 1 year there was a 34 per cent chance of paying some interest following zero and within 2 years there was a 40 per cent chance of paying some interest following zero. It appears that just over one-third of trusts experienced short term shocks, which temporarily forced them to pay zero interest.

IV.

The evidence from the previous section shows that holding turnpike bonds carried some risk and that on average investors were paid an interest rate above the yield on Consols. These findings raise the question of whether a risk premium applied across turnpike trusts. In other words, were expected returns for individual turnpike bonds higher if they were associated with more risk? To test for a risk premium, one could compare the average interest payment between 1823 and 1850 with the standard deviation over the same period. However, this is not an ideal test because average interest payments partly capture the behavior of trustees and creditors, rather than expectations. A better approach studies the relationship between the contracted rate of interest agreed to by the lender and the standard deviation in interest payments. If trusts associated with the higher contracted rate also had higher volatility that would be consistent with a risk premium.

This test is conducted using the sample of 986 trusts with interest rate observations in all 5 years between 1834 and 1838 and using data on the contracted rate of interest reported in 1838.\(^{33}\) The vast majority of trusts had one of three contracted rates: 4 per cent (12.2 per cent of trusts), 4.5 per cent (12.5 per cent of trusts), or 5 per cent (75 per cent). We don’t know when the contracted rates were set, however, it is likely that most predated 1834 and were not renegotiated.

\(^{33}\) Contracted rates in 1838 come from Appendix to the report of the commissioners (PP 1840 XXVII, p. 647).
annually. The average standard deviation of interest payments in the trusts with 4, 4.5, and 5 per cent contracted rates were 1.24, 1.38, and 1.30 respectively. The differences between the three groups are not statistically significant in any case. A similar analysis shows no significant relationship between the probability of a trust ever paying zero interest between 1834 and 1838 and contracted rate categories in 1838 (4, 4.5, or 5 per cent).

Thus, the evidence does not support a risk premium operating through the contracted rate of individual trusts. One explanation is that investors could not easily evaluate the risks of one trust versus another. It was easier to evaluate the risks of all turnpike trusts compared to Consols.

V.

Turnpike investors differed in their portfolios due to wealth, risk tolerance, social standing, and fiduciary responsibilities. In this section, the financial risks and returns for four types of investors are characterized. Their experiences are of broader interest as I discuss below.

The first is the so-called generic investor, who held a single turnpike bond. Often, they were local landowners or merchants. Their interest in owning a turnpike bond was partly economic. Nearby lands or trading businesses could increase in value if they lent to the trust and roads were improved. Outcomes for the generic investor are examined using the matched sample of 1114 trusts with observations in at least two years in 1823, 1834 to 1838, and 1850. For each of these trusts, I calculate the mean interest payment and standard deviation from 1823, 1834 to 1838, and 1850. One can think of the generic investor as randomly drawing from this distribution of trusts and getting its mean and standard deviation interest payment as a percentage of debt. Panel A of figure 6 shows a three-dimensional histogram of the mean and standard deviation of

34 The t-statistic comparing the mean standard deviation for trusts with contracted rates of 4 and 4.5 per cent is 0.63, comparing trusts with 4 and 5 per cent the t-statistic is -0.33, and comparing 4.5 and 5 per cent it is 0.42.
interest payments for each trust. On average, the generic investor got a mean return of 4.2 per cent and a standard deviation of 1.69. Many realized close to the average outcome. 47.6 per cent had a mean return between 4 and 6 per cent and a standard deviation between 0 and 2. There was a small chance, 6 per cent, of getting a mean return below 1 per cent and a standard deviation below 1 per cent. These were the trusts consistently paying zero interest. Thus, the generic investor faced a small risk of a very bad outcome and moderate risk of getting a return just below 5 per cent.

Figure 6: Distribution for mean and standard deviation of interest payments for different turnpike investor-portfolios

Panel A: Generic turnpike investor

Panel B: large landowners

Panel C: Charities

Panel D: Public Works Loan Board
Next consider the large landowning investor. They were similar to the generic investor in holding the bonds of turnpike trusts in their area. However, they were wealthy enough to hold bonds from two or three turnpike trusts, and perhaps they faced less risk because they were more diversified. The returns to large landholders are studied using the matched sample of trusts with observations in all reports from 1823, 1834 to 1838, and 1850. It is necessary to simulate their portfolios because we don’t know exactly which trusts they lent to. The method is as follows: For each county, 100 portfolios are simulated based on a random selection of two turnpike trusts. The resulting portfolios are equally weighted between the two turnpike bonds drawn at random. The mean is simply the average return between the two turnpike bonds. The standard deviation is given by the following formula:

\[
Standard\ deviation\ two\ trust\ portfolio = \sqrt{0.25 \times Var(trust\ 1) + 0.25 \times Var(trust\ 2) + 0.5 \times Covar(trust\ 1, trust\ 2)}
\]

The large landowner realizes a lower standard deviation by spreading the risk across two trusts. The standard deviation is reduced even more if the two trusts have negative covariance. In the simulations, a negative covariance was observed in 42 per cent of the two trust portfolios.

A 3D histogram of the mean and standard deviation for simulated large landowner portfolios is shown in panel B of figure 6. The average mean return is 4.46 per cent and the average standard deviation is 1.36. A high percentage realized close to the average outcome. 58.1

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35 A large landowner presumably had an incentive to invest in the turnpikes near where they had significant land. If their landholdings were scattered randomly in a county then their holdings of turnpike bonds would be random in a county as well.

36 Note some counties had one trust with complete observations and so they are not relevant in this analysis. I examine 39 counties in England and Wales.
per cent had a mean return between 4 and 6 per cent and a standard deviation between 0 and 2. Less than 1 per cent had a mean and standard deviation less than 1. Large landowners with two or more trusts rarely received zero interest continuously. The ability to diversify had a significant impact in reducing the risk of holding turnpike bonds even if the diversification occurred within a county.

Charities held just under 10 per cent of turnpike debt by the 1830s. They were different investors because of their mission to fund local schools or churches. To study charities I use Clark’s digitization of the Charity records. There are 114 turnpike bonds listed as assets held by charities in Clark’s data. I was able to match 88 of these turnpike trusts to the master list. Among these 88 some of the bonds refer to the same turnpike trust which leaves 58 unique trusts that I can confirm had at least one charity investor at some point.

Panel C in Figure 6 plots the 3D histogram for 58 trusts in the charity portfolio. The average mean interest payment for charity investors was 4.72 and the standard deviation was 1.18. Note the mean charity return is higher than the mean for the generic investor and the standard deviation is lower. Moreover, 67.7 per cent had mean interest payments between 4 and 6 per cent and a standard deviation below 2. None paid zero interest regularly. Given their mission, charities likely selected less risky turnpike trusts or they were gifted less risky trusts.

The final investor of interest is the Public Works Loan Board or PWLB. Recall it was a government funded body whose official aim was to provide financing for public works and to encourage employment. One interesting question is whether the PWLB made loans to trusts that were financially distressed and had difficulties getting loans from regular investors. This issue

37 For comparison, I also analyze 100 portfolios based on random draws of one turnpike trust for each county. The average mean return in the portfolios with one trust is 4.46 per cent and the average standard deviation is higher at 1.7. This further suggest that large landowners realized lower risk.

38 I thank Clark for sharing this data. A description is given in Clark, ‘The Charity Commissioners’. 24
can be investigated by comparing the financial returns of trusts they lent to versus all turnpike trusts. The turnpike trusts indebted to the PWLB are listed in the appendix to a report by a House of Lords committee published in 1833.\textsuperscript{39} I matched 101 of the turnpike trusts listed as receiving PWLB loans to the master list of all turnpike trusts. The 3D histogram for these 101 trusts is shown in panel D of figure 6. The average mean return is 4.02 per cent and the average standard deviation is 1.68. Their returns were also more widely dispersed: only 36.7 per cent had mean interest payments between 4 and 6 per cent and a standard deviation below 2. It appears the PWLB earned lower returns on average and experienced more risk, consistent with the PWLB lending to more financially distressed trusts.\textsuperscript{40}

VI.

The financial returns on turnpike bonds are now compared with a broader range of securities available to the early nineteenth century investor, including farmland, canals, and railways. I calculate the Sharpe ratio for a portfolio of each type of asset. The Sharpe ratio is the average return in the portfolio \( r_{portfolio} \) minus the risk free return \( r_{risk\ free} \) divided by the standard deviation of the portfolio \( \sigma \), or \( Sharpe\ Ratio = \frac{r_{portfolio} - r_{risk\ free}}{\sigma} \). A higher Sharpe Ratio generally implies a superior portfolio because it offers more return per unit of risk.\textsuperscript{41} In all cases below, the risk-free asset is the Consol with a return of 3.44 per cent.

The portfolio of turnpike bonds includes all trusts with at least two observed interest payments in 1823, 1834 to 1838, and 1850. It is equivalent to the portfolio available to the

\textsuperscript{39} See the Second Report from the Select Committee of the House of Lords Appointed to Examine the Turnpike Returns.

\textsuperscript{40} There could be other interpretations. The PWLB insisted on being the first creditor repaid at 5 per cent. It is possible this ordering of its credit made it hard to raise other capital and hence weakened borrowing trust’s overall performance. Further research is needed to sort this out.

\textsuperscript{41} Sharpe, ‘The Sharpe Ratio’.
generic investor shown in panel A of figure 6. I use the average unweighted mean and standard deviation across 1114 trusts.

The comparison land portfolio is based on rates of return on properties held by charities reported by Clark.\textsuperscript{42} The Charity records contain the price paid and the rental value of 53 farmlands between 1823 and 1850. While not perfect, the charity records contain the best available information on the return to investing in land. They also appear to be randomly distributed across counties in England.

Returns to railways and canals can be estimated in two ways. First, one can look at accounting profits, specifically the rates of return on capital employed (ROCE) which is net earnings or revenues minus operating expenses divided by paid in capital plus debt. Arnold and McCartney use surviving accounting statements to measure ROCE for the top 5 railway companies from 1838.\textsuperscript{43} I use their unweighted average and standard deviation over the years 1838 to 1850. Unfortunately, there is no estimate for the ROCE on canals across the entire population. But Arnold and McCartney estimate the rate of return on equity (ROE), which is net earnings deducting interest payments divided by paid in capital plus retained earnings. The sources are limited and they can only calculate ROE for five important canals.\textsuperscript{44} I use the unweighted average ROE and standard deviation across the five canals for the years 1821 to 1850.

The second approach is to use the total return for canal and railway securities traded on the London stock exchange. The total returns (capital gain or loss plus the dividend yield) are volatile mainly because of the capital gain or loss. Nevertheless, the total return is relevant in evaluating how investors benefitted from railways and canals because these securities were

\textsuperscript{42} Clark, ‘The Charity Commissioners’.
\textsuperscript{43} Arnold and McCartney, ‘Rate of return’, p. 53.
\textsuperscript{44} Arnold and McCartney, Veritable gold mines’, p. 228.
actively traded. The data on total returns come from Acheson, Hickson, Turner, and Ye, who analyze the London stock market from 1825 to 1875.\textsuperscript{45} I use their unweighted mean total return and dividend yield for all canal and railway securities from 1825 to 1850.

Table 2 summaries the mean and standard deviation for each portfolio, the method of calculating returns, and the Sharpe ratio. The turnpike portfolio had a higher Sharpe ratio than the farmland portfolio. Thus, landowners who diversified into turnpikes earned a higher return per unit of risk. The largest landowners would have experienced even lower risk because they were more diversified.

Compared with canals the relative performance of turnpike bonds depends on whether one considers accounting profits, the dividend yield, or the total return. Turnpikes had a lower Sharpe ratio than canals based on the ROE for the five canals. The same is true for the dividend yield, which reflects all canal securities traded on the London exchange. However, the total return for canals implies that turnpike bonds generated a higher Sharpe ratio. In fact, canal securities between 1825 and 1850 generated an average total return less than the risk-free Consol, which implies a negative Sharpe ratio. Thus, from an accounting point of view, canals were a better investment, but canal investors generally overpaid for their securities, and as a result, earned a much lower total return. This suggests the lack of speculation in turnpike bonds provided an unexpected advantage to its investors.

\textsuperscript{45} Acheson, Hickson, Turner, Ye, ‘Rule Britannia!’.
Table 2. A comparison of investment portfolios in the early nineteenth century

<table>
<thead>
<tr>
<th>Asset type</th>
<th>Portfolio or return component, years</th>
<th>Mean return in % (unweighted)</th>
<th>Standard Dev.</th>
<th>Sharpe ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turnpike portfolios</td>
<td>turnpike bonds, interest payments as percent of debt, 1823-1850</td>
<td>4.20</td>
<td>1.69</td>
<td>0.450</td>
</tr>
<tr>
<td>Farmland portfolios</td>
<td>farmland held by charities, rate of return, 1823-50</td>
<td>3.69</td>
<td>1.49</td>
<td>0.168</td>
</tr>
<tr>
<td>Canal portfolios</td>
<td>five canal companies, return on equity, 1825-1850</td>
<td>10</td>
<td>8.12</td>
<td>0.808</td>
</tr>
<tr>
<td></td>
<td>canal securities, dividend yield, 1825-1850</td>
<td>4.94</td>
<td>1.41</td>
<td>1.064</td>
</tr>
<tr>
<td></td>
<td>canal securities, total return, 1825-1850</td>
<td>3.21</td>
<td>5.21</td>
<td>-0.044</td>
</tr>
<tr>
<td>Railway portfolios</td>
<td>top five railway companies, return on capital employed, 1838-1850</td>
<td>5.77</td>
<td>2.1</td>
<td>1.110</td>
</tr>
<tr>
<td></td>
<td>railway securities, dividend yield, 1825-1850</td>
<td>3.11</td>
<td>4.03</td>
<td>-0.082</td>
</tr>
<tr>
<td></td>
<td>railway securities, total return, 1825-1850</td>
<td>4.01</td>
<td>16.08</td>
<td>0.035</td>
</tr>
</tbody>
</table>

Sources: For turnpike portfolio see generic investor portfolio discussed in text. The farmland portfolio is taken from charity records described in Clark, ‘The Charity Commissioners’; the return on equity for canals is taken from Arnold and McCartney, ‘Veritable gold mines’, p. 228; the return on capital for railways is taken from Arnold and McCartney, ‘Rate of return’, p. 53; canal and railway securities returns are based on data described in Acheson, Hickson, Turner, Ye, ‘Rule Britannia’.

The story is similar for railways. The Sharpe ratio using the ROCE of the top five railways is much higher than for turnpikes. However, the total return and dividend yield for all listed railways shows they generated lower returns and were associated with more risk than turnpike bonds. This conclusion comes with caveats because railways were a new industry in the 1830s and 40s and there was tremendous speculation in shares prices associated with the railway mania.

VII.
Turnpike road trusts in nineteenth century England and Wales provide an interesting context to examine the financial returns to investing in early public works. In this article, I calculate the size of interest payments made by all turnpike trusts relative to their mortgage debts. The results show that turnpike trusts paid competitive returns in the aggregate. Interest payments as a percentage of debt equaled approximately 4 per cent up to 1850. This can be considered a broadly competitive return considering the yield on Consols was just over 3.4 per cent for most of the nineteenth century.

Matters changed after 1850 when competition from railways increased. Nevertheless, investing in turnpike bonds still yielded a reasonable return over the long-run. The internal rate of return to a hypothetical investor holding all turnpike debt from 1838 to 1882 equaled 3.41 per cent.

I also examine the risks involved in holding individual turnpike bonds. Risk is first measured by plotting the distribution of interest payments across trusts and over time. The distributions are calculated using newly digitized interest payments for all turnpike trusts in 1823, 1834 to 1838, and 1850. In each year studied, interest payments varied and at the lower end some trusts paid zero interest. The financial losers were not numerous however. Many trusts recovered from negative shocks and poor performance in one year was not permanent.

Risks and returns are also measured for different types of turnpike investors. The generic investor earned a mean return of 4.19 per cent with a standard deviation of 1.69. Large landowners got similar returns but with less variance. Charities earned slightly higher returns and experienced the lowest variance. Lastly, the Public Works Loan Board earned the lowest returns and experienced the most variance.
Overall turnpike bonds had a place in the financial market of the early nineteenth century. They offered a better return than land which was the dominant investment before the industrial age. They offered lower returns than canals and railways based on net earnings and the value of capital, but they were not subject to speculation and so investors rarely overpaid for turnpike bonds.

Turnpike trusts are exceptional when one views infrastructure finances more generally. Most late 20th century infrastructure projects are considered unprofitable to investors. How was it that turnpikes generated competitive returns for so long, while infrastructure investments since have often failed? Definitive answers cannot be provided at this point, but I can offer some conjectures. It is likely that England’s high population density and emerging steam economy allowed it to adequately finance a large network of toll roads. It is one illustration of how increasing returns and endowments propelled infrastructure investment and economic growth during the industrial revolution. Another argument is that the government provided a favorable legal environment for private investment in infrastructure. Reforms dating to the Glorious Revolution of 1688 made rights enshrined in acts of parliament very secure. This included rights to levy tolls and pay turnpike investors. Lastly, local and national governments provided some subsidies, like statute labor, which could have also aided turnpike finances. Future research is needed to identify why turnpikes were exceptional.
**Official publications**

Report from the Select Committee appointed to consider the acts now in force regarding turnpike roads and highways in England and Wales, British Parliamentary Papers (PP 1821 IV, p. 343).

Report of the commissioners appointed in pursuance of two several acts of Parliament; the one made and passed in the 58th year of His Present Majesty, cap. 91, intituled,"an act for appointing commissioners to inquire concerning charities in England, for the education of the poor;" and the other, made and passed in the 59th year of His Present Majesty, cap. 81, intituled,"an act to amend an act of the last session of Parliament, for appointing commissioners to inquire concerning charities in England, for the education of the poor, and to extend the powers thereof to other charities in England and Wales." (PP 1821 IV, p. 1).

Turnpike Trusts. Copies of the Several Accounts Transmitted to the Clerks of the Peace of the Different Counties of England and Wales; from the Clerks of the Trustees of the Several Turnpike Trusts in Each County (PP 1824 XX, p. 1).

Appendix to the report of the commissioners for inquiring into the state of the roads in England and Wales (PP 1840 XXVII, p. 15).

Turnpike trusts. An abstract of the general statements of the income and expenditure of the several turnpike trusts in England and Wales (PP. All years, 1836-1883)

Second Report from the Select Committee of the House of Lords Appointed to Examine the Turnpike Returns Now Upon the Table and the Abstract Thereof, and to Consider, Whether Any Alterations Can be Made in the Law Relative to Turnpike Trusts: With the Minutes of Evidence Taken Before the Committee and an Index and Appendix. House of Lord Papers, 1833.

Fourteenth annual report of the Local Government Board. 1884-85 (PP 1884-85 XXXII.1, p. 66).

**Footnote References**


