When do toll roads pay?

Local conditions and the financial returns to English turnpike roads, 1820

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Abstract

Experience shows that private or locally financed toll roads do not always reward their investors. This paper studies a case where investors in toll roads earned competitive returns on average but with wide variation in outcomes. The context is England and Wales during their early industrialization when private investors provided much of the capital to improve what were called turnpike trust roads. This paper draws on parliamentary reports which provide data on financial returns for over 1000 turnpike trusts in 1820. The returns data are aggregated and matched with county-level characteristics on population density, coal endowments, and policy variables like the Herfindahl Index of local market concentration. Regression results show that population density and coal endowments explain much of the county-level variation in financial returns, indicating that local economic conditions were especially important. Low market concentration also played a role, mainly in dampening returns.

JEL Codes: K23, N43, N73

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The financing of infrastructure is a major challenge for economies. Infrastructure projects require large upfront investments, often greater than the savings of any individual or small community. Infrastructure also yields services long into the future, making them less attractive to short-sighted investors. Even patient ones might be wary because future returns depend on the rate of economic growth and policy choices, which are difficult to predict. Central governments would seem the best candidates to finance infrastructure, but often they are fiscally constrained, and in some cases, they fund projects with more political than economic significance.

History shows that the challenges of infrastructure financing have been addressed in many ways. In reviewing the European experience from the Roman Age to the present, Cassis, De Luca, and Florio (2016) document great variety in the use of local taxes versus tolls, in the extent of central government transfers, in the reliance on debt, and the division between public and private organizations. Concerning the early modern age, they argue for a 'little divergence' in infrastructure financing with continental countries, like France and Spain, relying more on central government financing and management, and England relying more on tolls and local and private funding. The English system was indeed distinctive. Parliament granted trusts and joint stock companies the powers to construct or improve roads, canals, water supply, and dock works. Capital was raised through bonds or stocks. Most funding was provided by local individuals, often landowners, commercial interests, and urban savers. Financial guarantees from the central government in London were largely absent.

The returns to investing in English infrastructure projects have been studied from several perspectives. Many studies find that investors earned competitive returns on average, but there

was a wide variance across projects and sectors.[2] This paper reviews the financing of turnpike road trusts and studies how local economic and policy environments affected their financial performance in 1820. Turnpike trusts are interesting because they significantly improved roads by levying tolls and borrowing against toll revenues. Their success is evident in the amount of investment they undertook and the decline in transport costs from 1750 to 1830 (Bogart 2005). Trusts are also revealing to study because there is excellent data on their finances starting in 1820, including measures of financial performance. The data allow for the calculation of interest payments relative to debt at the individual, county, and aggregate levels. This paper focuses on county-levels, both to provide an overview and because they can be easily matched with county-level economic and policy data. The focus on 1820 is useful because England's economy had completed its early industrialization by this date. But steam railways were not yet invented, and thus the effects of competition with a far superior technology are absent.

A central hypothesis explored in this paper is that turnpike trusts generated higher financial returns in high population density areas and also where there was high employment in manufacturing. The main mechanism is through increased traffic levels which generate greater revenues. Another potentially relevant feature of a local economy was its growth rate in the early nineteenth century. While high growth brings traffic in the future, it is not always good for infrastructure investors in the short term. Trustees may have been more concerned with expanding capacity to meet future demands, which left less revenues to pay bondholders.

Another hypothesis focuses on coal. The English and Welsh economy was abundant in coal, and this inorganic source of energy helped to create a large mining and manufacturing industry

[2] See Albert (1972), Pawson (1977), Buchanan (1986), Webster (2015), and Bogart (2017a) who study turnpike trusts, Ward (1974) and Arnold and McCartney (2011) who study canals, Jackson (1983) who study docks, Casson (2009), Mitchell, Chambers, and Crafts (2011) and Arnold and McCartney (2005, 2011) who study railways, and Goldsmith and Carter (2016) who study water supply. For a general analysis see Trew (2010).

as early as 1700 (Wrigley 2010, Shaw Taylor and Wrigley 2014). The coal economy generated concentrated traffic flows and high revenues per mile which should increase returns to the infrastructure sector. One caveat is that coal was primarily shipped by canal and by sea, and so it is not clear that the transportation of coal alone could generate high returns for turnpike trusts. Coal traffic also contributed to more road damage and maintenance. Thus, the effect of local coal endowments on returns is ambiguous and could be positive or negative.

Lastly, this paper studies how policy choices concerning the industrial organization of trusts affected returns. Led by the House of Commons, parliament was fairly liberal in granting turnpike acts. By the early nineteenth century, turnpike trusts numbered around 1000, which meant that many were in close proximity to one another. Moreover, it was common for multiple trusts to manage the radial roads leading into a single town, creating an environment for competition over local traffic. These features suggest that low market concentration levels may have contributed to lower returns for investors in turnpike trusts.

I test these hypotheses using county-level data on turnpike returns and county-level differences in economic structure, coal endowments, and market structure. The results support the hypothesis that higher population density contributed to higher returns. They also show that coal negatively affected returns, suggesting that the revenue gain from moving coal to canals or nearby towns was overwhelmed by the higher maintenance costs. Lastly, there is some evidence that counties with more fragmented turnpike markets had lower returns, pointing to a role for competition.

The results speak to the sources of England's early success in infrastructure compared to most continental European countries. Current estimates suggest England had higher road

spending levels per capita and miles of paved road per square mile than France, its main military and economic rival.[3] The explanation is partly due to different levels of development. England could afford to build a larger network relying on user fees and limited government transfers because its economic density and manufacturing specialization generated more traffic. Other economies did not have this advantage, and thus local communities and central governments needed to contribute more. The significance of policy choices is also revealing. The liberal chartering regime in the English parliament meant that it was easy to create turnpike trusts. As a result, a competitive market often formed which served to limit monopoly profits. It should be noted that the English chartering system has been criticized for creating duplicative investments in railways (Casson 2009), and a similar argument was made for turnpike trusts by reformers in England during the 1820s and 30s. While duplication was an issue, it is notable that infrastructure returns were never pushed so low in England that default and bankruptcy became widespread.[4]

The paper is organized as follows. Section I provides background on turnpike trusts with an emphasis on their financing. Section II reviews the hypotheses relating local economic structure, endowments, and policy choices with turnpike returns. Section III presents the data. Section IV reports the results. Section V concludes.

I.

[3] According to Conchon and Sulzman (2016) the Pont et Chaussees spent 150 million livre on roads from 1760 to 1790. Converting to pounds at the exchange rate of 23.5:1 (see McCusker, Money and Exchange) implies an investment of £6.4 million. Around 1790 English and Welsh turnpike trusts had a debt of approximately £4 million. Given that France had a more than twice the population investment levels per capita were larger in England and Wales. Road stocks imply similar conclusions. France had around 40,000 km of primary roads and England had 18,000 miles of turnpike road by 1800.

[4] The United States and Canada for example many bankruptcies in transport, see Carlos and Lewis (1995) and White (2011) for railroads, Klein (1990) and Klein and Majewski (1992) for turnpikes.

At the end of the seventeenth century statutory law dictated that the parish or township 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 communities to request that tolls be levied on their highways. Tolls could not be levied without the approval of the government in Westminster. Highways technically belonged to the Crown, but Parliament insisted that tolls be granted through legislative procedures. The result was a 'turnpike act.'

Turnpike acts had several general features. They transferred authority to a body of trustees for 21 years, but it was typical for their authority to be renewed subsequently. Trustees had to meet property and income qualifications. Notably the requirements were often lighter on landowners. Trustees had the right to levy tolls and they were also authorized to issue bonds secured on the toll income. Parliament also forbade the creation of turnpike shares and collection of profits. 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.[5]

A brief review of turnpike trust finances in 1834 illustrates their income sources and spending patterns. Trust revenues came from tolls and statute labor contributions. The latter came as payments in lieu of performing labor. Some trusts also had other contributions or income yielding assets. Table 1 shows revenues for tolls, composition, and incidental receipts

[5] 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.

for all turnpike trusts in England and Wales in 1834. There is also an estimate of the value of statute labor performed. Toll revenues equaled £1.4 million or 89% of all monetary revenues. The value of statute labor performed was higher than composition payments, and together they account for 8.3% of all revenues.

Table 1: Categories of turnpike trust revenue in England and Wales in 1834

Category	value in pound sterling	% of monetary revenues	% of all revenues
Tolls	1,434,069	93.9	89.4
Parish composition in lieu of statute duty	58,077	3.8	3.6
Incidental receipts	35,494	2.3	2.2
Total monetary revenues	1,527,640		
Estimated value of statue labor performed	75,758		4.7
Total all revenues, including statute labor	1,603,398		

Sources: Data are drawn from British Parliamentary Papers 1840 (XXVII, p. 647).

Table 2 shows the expenditure categories for all trusts in England and Wales in 1834. The first five categories conservatively include road spending and total 64% of the all expenditure. Interest and debt payments are just over 25%. The remaining 10% goes to trust salaries, legal expenses, and incidentals. Thus, around two-thirds of turnpike expenditures were directly related to the maintenance or improvement of roads, and as much as 75% was at least indirectly related including trusts' managerial costs. Therefore, in total trusts spent around £1.2 million on roads in 1834.

Table 2: Categories of turnpike expenditure in England and Wales in 1834

Category	value in pound sterling	% of total expenditure
Labor (manual and team)	516,376	31.9
Materials for surface repairs	217,048	13.4
Improvements	217,152	13.4
Land purchased and damages to land	30,202	1.9
Tradesman's bills	67,098	4.1
Salaries to trust officers	92,954	5.7
legal	28,889	1.8
Interest	280,376	17.3
Debt Payments	107,810	6.7
Incidental expenses	59,045	3.7
Total	1,616,950	

Sources: Data are drawn from British Parliamentary Papers 1840 (XXVII, p. 647).

The central focus of this paper is on the trust borrowing and debts. Turnpike trusts relied on borrowing to finance road improvements. Total borrowing for 1834 was £153 thousand. This equaled 70% of spending on road improvements in the same year. The remaining monies for investment mainly from toll revenues and balances, which were trust savings.

There were two main types of turnpike debt. The first were bonds secured on the tolls (so-called mortgaged debt). The second were unsecured bonds (so-called called floating debt). The mortgage bonds had no set maturity date and the trustees could repay the principal in full at any time. All bonds for an individual trust were generally treated equal, and so there were no first or second claims on the revenues. The exception was that 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 overwhelming proportion of investors in turnpike bonds came from areas near the road. As an 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.[6] Webster's analysis of 41 mortgage ledgers provides more general evidence on investor identities. Webster found that 42 percent of investors can be classified as landowners, 31 percent as commercial interests, and 27 percent as savers. Banks or other financial institutions contributed little to none.[7]

By the 1830s the financial scale of turnpike trusts had become quite large. Debts across all trusts in England and Wales, including mortgage, floating debts, and balances due, were just above £7.4 million in 1834. To give some perspective on this figure, total British central government tax revenues in 1834 were about £50 million, making turnpike debt about 15% of central government revenues. What is perhaps most remarkable is that the returns were competitive in the aggregate. Interest payments in table 2 equaled about 4% of total mortgage debt, implying that trusts paid about 4% of their par value. Earning a 4% return is higher than the yield on government bonds in the 1830s. It is also revealing that foreclosures on the tolls were relatively rare, and were in process for only a handful of trusts in 1820

The story is more varied at the individual trust level. Approximately 15% of the trusts paid no interest, while the rest paid the full or partial interest. Thus, there was a varied financial return paid to turnpike investors. [8] Why was this so? This paper explores several types of hypotheses related to local economic conditions, endowments, and policy choices. It does not provide an exhaustive analysis. Rather it aims to focus on the principle factors, or those of historical interest. The following section discusses these hypotheses.

II.

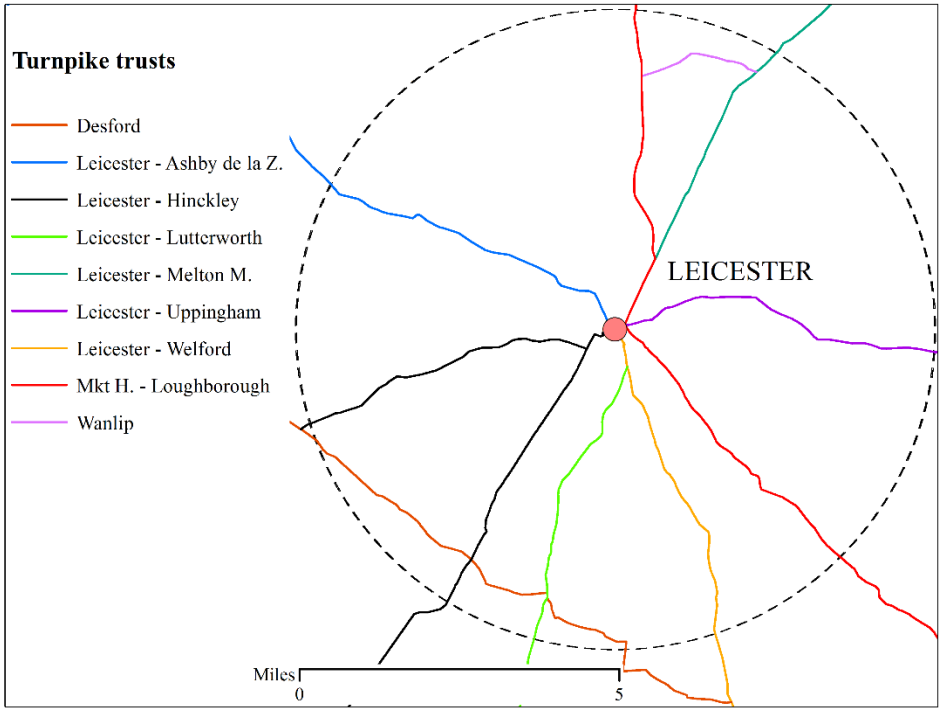
[6] Buchanan, "The evolution of the English turnpike trusts."
[7] Webster, *The Public Works Loan Board 1817-76.*
[8] See Bogart, "Investing in early public works,' for more details.

One set of hypotheses focuses on England's economic environment. Its high population density and high manufacturing employment would seem to contribute to higher returns by increasing road traffic and hence revenues. Its large endowments of coal may have also generated higher returns through greater traffic, but for the reasons discussed earlier, the effects of coal are subtle. Coal traffic might have created more road damage, and increased operating expenses while offsetting revenue gains. Coal might have also created an economy more dependent on shipping and canals, and less on roads.

The role of policy choices requires more background explanation. The English turnpike network is notable for being highly fragmented. Turnpike trusts spread widely through the network from the 1690s to the 1830s. Trusts managed all the major roads leading into London and between major cities and towns. They also managed the major roads between industrial towns and their hinterland, as well the market towns in rural areas. By the 1830s approximately 1000 trusts managed 20,000 miles, implying that the average managed only 20 miles of road.

The example of Leicester illustrates the level of fragmentation at a local level. The population of Leicester and its immediate surroundings was around 30,000 by the 1820s, so it was a medium town compared to the likes of Manchester with a population around 187,000 by the same time. As the map below shows, Leicester had 9 separate turnpike trusts managing its radial roads in 1820. The dashed circular line shows a radial distance of 5 miles from the center of Leicester. This case illustrates how close individual turnpike trusts were to their neighbors.

Figure 1: Turnpike Roads near Leicester around 1820.



Source: map produced by author with the help of Larry Bush.

The origins of market fragmentation were mainly political and legal.[9] Starting in the late 17th century the Monarchy and Parliament gave Justices of the Peace more powers to impose highway rates on parish rate payers, and ultimately landowners. The most heavily trafficked areas sought to avoid those taxes and shift the burden to road users through tolls. Concerns about the fairness of tolls were voiced in Parliament in the1690s, but ultimately leaders in Parliament acquiesced to local landed interests and authorized the creation of turnpike trusts. For several decades trusts were formed by local interests, many of whom behaved as though they were more interested in shifting the tax burden to road users and did not coordinate with other areas. Parliamentary debates suggest there was also a view that local management was better. It was

[9] See Albert (1972, pp. 14-29) for a discussion of the origins of trusts.

thought that a larger trust organization might misallocate funds or unduly expropriate property against the wishes of the local landowners.[10]

There are two notable exceptions to the norm of market fragmentation. Most Welsh counties had few turnpike trusts managing the roads, and in Breconshire there was a single trust managing the roads of whole county. The large size of Welsh turnpike trusts seems to have played some role in fostering the Rebecca Riots, which were a violent social protest against high tolls. The other exception was the merger of several turnpike roads north of London. The merger was prompted by concerns that small trusts devoted too much of their revenues to administration.[11] After several failed bills in the 1820s, an act was passed in 1826 merging 14 trusts into one, controlling around 130 miles. In the 1830s there were further bills to unite trusts into unions, similar to the New Poor Law, but they failed to be enacted. By the time railways came on the scene the English turnpike network remained largely fragmented.

III.

This section introduces the data sources used in the analysis below. I begin with data on financial returns to turnpike bondholders. The report from the 'Select Committee to consider the Acts now in Force Regarding Turnpike Roads and Highways,' published in the British Parliamentary Papers (BPP 1821 IV), was the first significant inquiry that reported financial conditions for turnpike trusts. 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,

[10] See Guldi (2016, p. 79-127) for a discussion of opposition to centralized control over roads.
[11] See Albert (1972, pp. 65-72) for a discussion of the merger of trusts north of London.

interest due, and the amount of debt in 1820. Aside from additional information on operations, the reports also include 'notes' sometimes describing how long interest was in arrears, the size of legal expenses, and road improvements. [12] The main issue is that interest payments are not reported separately from other expenditures. Fortunately, data on the value of debt, interest due, and notes due can be combined to estimate interest payments and rates of return measured as payments divided by debt. The details for the calculation are explained in another paper.[13]

For this paper, I aggregate trust rates of return to the county-level. This will enable matching with county-level data on population density and coal endowments. The county level rate of return is calculated by averaging trust-level returns weighted by miles or by debt. The county-level returns are reported in table 3 under the two weighting assumptions. The counties are ordered from lowest return to highest return in column (1). Sussex in the southeast has the lowest return and Essex, also in the southeast, has the highest return.

Table 3: Rate of Return to Bondholders Across Counties

County	(1) Weighted by Miles	(2) Weighted by Debt
Sussex	3.06	2.47
Caernarvonshire	3.79	2.89
Bedfordshire	3.27	2.98
Carmathenshire	3.67	3.08
Cambridgshire	3.59	3.14
Glamorganshire	4.3	3.16
Derbyshire	3.23	3.18
Northmaptonshire	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

[12] The full report is available in BPP (1821 IV). A summary of the 1821 report is in Marshall's (1835) Analysis and Compendium of all the Returns Made to Parliament.
[13] See Bogart, "Investing in early public works."

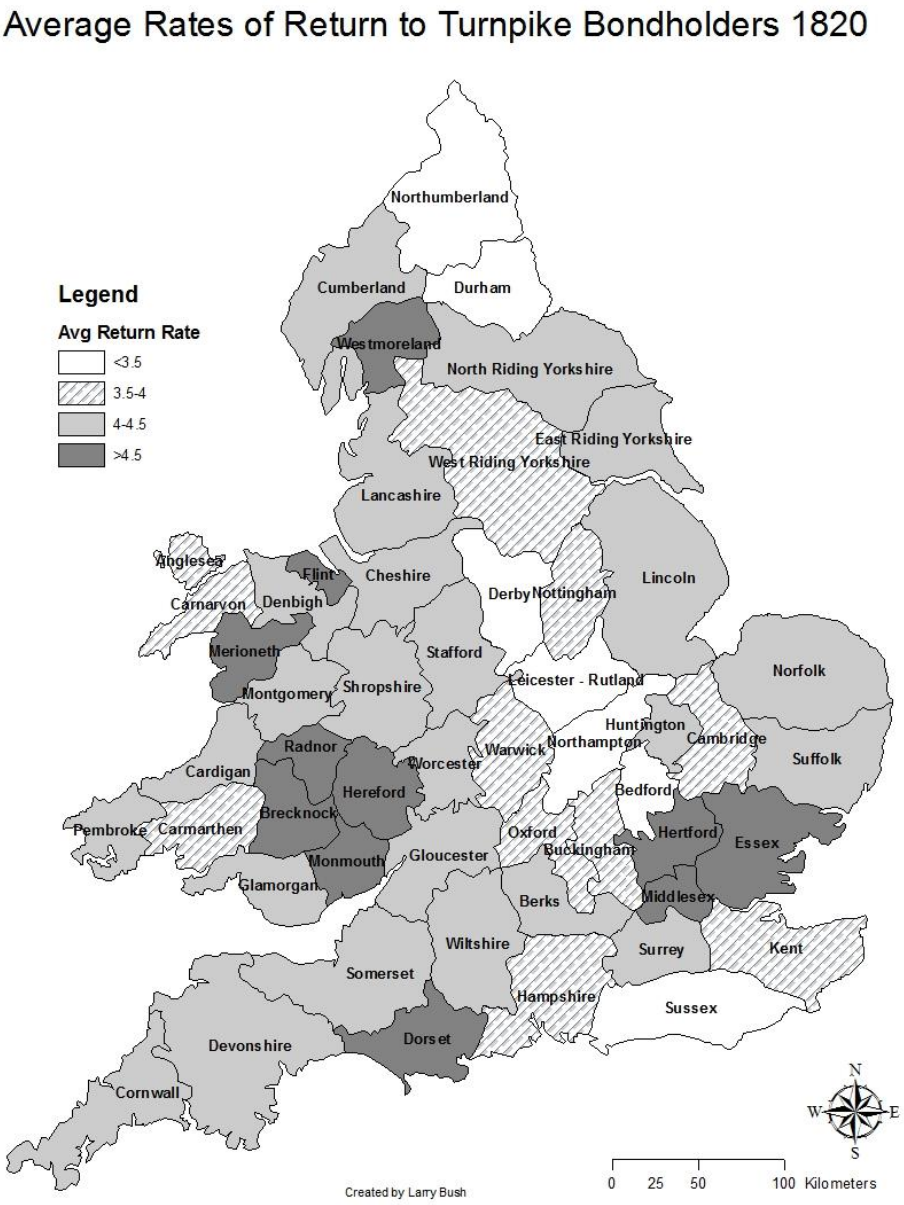
Denbighshire	4	3.65
anglesey	3.69	3.69
Pembrokeshire	4.02	3.69
Warwickshire	3.6	3.77
Wiltshire	4.05	3.83
Nottinghamshire	3.84	3.85
Suffolk	4.21	3.87
Surrey	4.07	3.91
Lincolnshire	4.07	3.93
Montgomeryshire	4.17	4
Cornwall	4.17	4.02
Berkshire	4.04	4.04
Gloucestershire	4.34	4.08
Lancashire	4.22	4.08
Yorkshire, 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
Radnershire	4.69	4.69
Middlesex	4.71	4.72
Essex	4.68	4.73
Correlation coefficient		0.84

Sources: same as 1820 table 2

The rates of returns across the 51 counties in England and Wales are shown graphically in figure 2 using the weighting by miles. Returns are the highest in the southeast near London and

in the coal mining region of south Wales. Returns are lowest in the east midlands and the far north where coal mining was prominent.

Figure 2



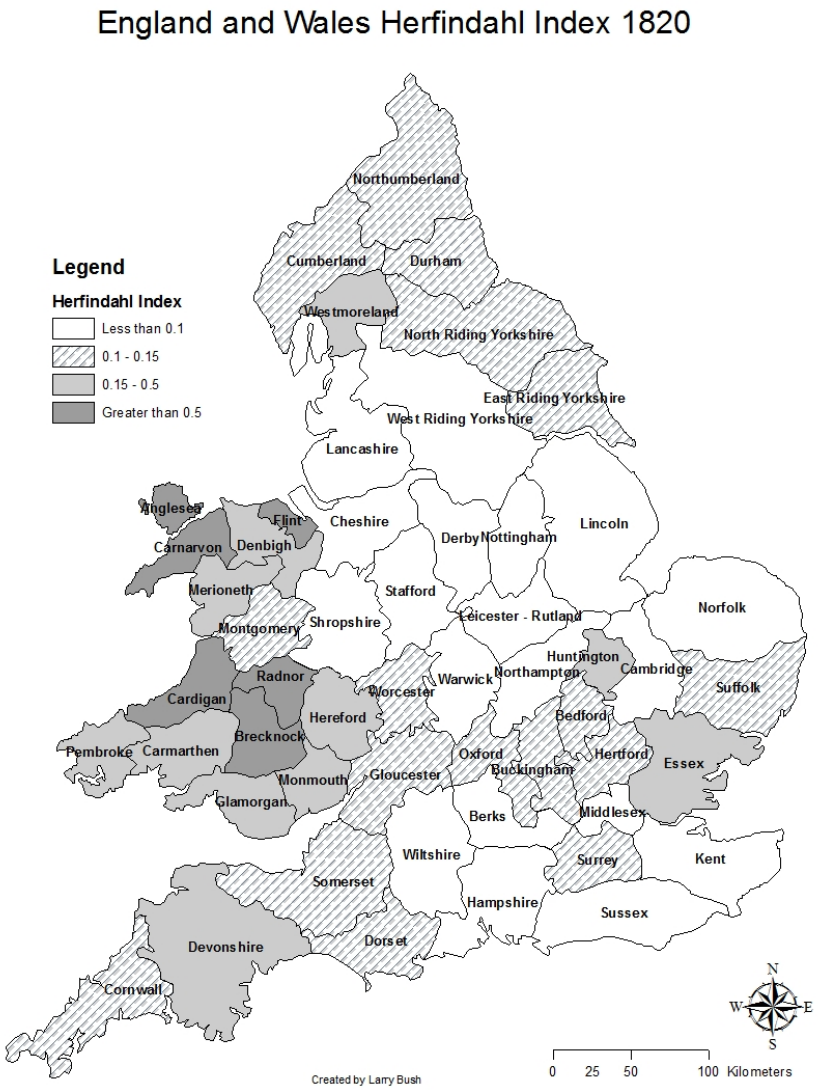
Sources: Data for 1820 come from author's calculations based on BPP (1821 IV).

The county level economic structure variables include population density in 1821 and county-level population growth from 1811 to 1821, both of which are derived from the census

and published in Marshall (1835). Flinn (1984, pp. 26-27) identifies the counties with coal mining before 1830. Marshall (1835) also reports the share of land in arable, pasture, and woodlands in each county around 1820 (p. 6). Higher shares of pasture and woodlands would indicate lower density agricultural production, and thus may be associated with lower returns.

One policy variable is the county's average length of miles managed by a turnpike trust in 1820. Average mileage is drawn from the 1821 report. A second policy variable is a county-level Herfindahl Index (HI). It is calculated as the sum of the squared share of revenues across all trusts in a county. The HI is between zero and one, with one corresponding to a single trust having all the revenues. The county-level HI of turnpike trusts is shown in figure 3. Most counties in the north Midlands and South had very low HI, while Wales stands out as a region with higher HI.

Figure 3



VII.

This section reviews the methodology and presents the results. The various hypotheses explaining turnpike trust returns are tested using regressions on county-level data.[14] The regression takes the following form:

[14] Counties are useful because there is published data on population and other economic characteristics by county. Also in parliamentary reports turnpikes trusts are reported by the primary county where their road resides, so

$$return_i = \beta_1 economic\ structure_i + \beta_2 coal_i + \beta_3 policy_i + \varepsilon_i$$

where the county level rate of return, $return_i$, is calculated by averaging trust-level returns weighted by miles or by debt. The economic structure variables include 1821 county population density in thousands per square mile and the log difference in population from 1811 to 1821. Other economic structure variables include the fraction of land in pasture and the fraction in woodland. The fraction in arable is omitted and serves as the comparison. Coal is dummy variable indicating whether the county had coal. The policy variables are the Herfindahl Index (HI) for each county and the average mileage per turnpike trust. The policy variables are highly correlated and so only one will be used in each regression. Finally, ε_i is the error term.

It should be stressed that the model does not yield causal effects concerning the economic structure and policy variables. Economic structure could be influenced by the profitability of turnpike bonds, and thus reverse causation is a concern. Also, the policy choices might be associated with other factors, like local politics, that might be driving outcomes. Therefore, the results below should be treated as correlational patterns. However, given such correlations have never been produced they are of interest in their own right.

Summary statistics of all the variables are displayed in table 4. The average return across counties is around 4 which is consistent with previous results. Readers should note that population density is skewed by Middlesex county containing London. All other counties have a population ranging between 50 and 600 persons per square mile. Middlesex has 4500 persons per square mile.

information on turnpike outcomes are easily summarized at the county level. The downside is that local economies vary within counties, and thus county-level variation may be too coarse to test some hypotheses.

Table 4: Summary statistics for regression

Variable	Mean	Standard dev.	Min	Max
average return weighted by debt	3.956	0.573	2.47	4.726
average return weighted by miles	4.072	0.479	2.869	4.713
population density 1821 in 000s	0.257	0.552	0.052	4.059
log diff pop. 1821 and 1811	0.117	0.033	0.026	0.207
fraction land pasture	0.447	0.168	0.136	0.875
fraction land woodland	0.247	0.161	0	0.672
has coal	0.294	0.46	0	1
turnpike Herfindahl index	0.181	0.215	0.028	1
average mileage per trust	32.028	40.741	8.197	250
Observations				51

Sources: see text.

The first regressions use the average county rate of return weighted by debt (see table 5). The results in column 1 focus on economic structure. Greater population density has a positive and significant correlation with returns to bondholders. This finding is consistent with the hypothesis that greater population density increased the revenues to trusts and raised investor returns. Another result is that greater population growth has a negative and significant correlation with turnpike returns. This may suggest that trusts were using their surpluses from present growth to reinvest and meet future demands. Hence, they paid their investors a lower return in the short-term. Greater pasture and woodlands are associated with lower returns, but their coefficients are not precisely estimated. The indicator for having coal has a weak relationship with turnpike returns. As noted earlier, coal was primarily shipped by canal and by sea. Thus a strong coal economy did not necessarily mean more revenues and higher returns for turnpikes. The northeast around Newcastle is a good example. It had extensive coal mining and its average return on turnpike bonds was low to moderate.

Table 5: Regression results explaining average returns to turnpike bondholders in a county in 1820

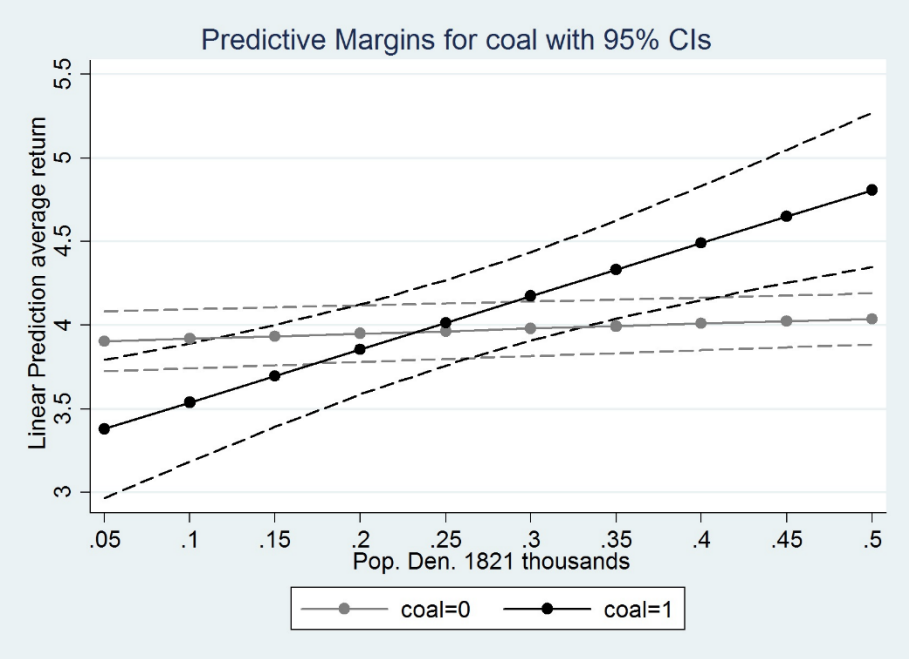
variable	(1) Coef. (Std. Err.)	(2) Coef. (Std. Err.)	(3) Coef. (Std. Err.)	(4) Coef. (Std. Err.)
Pop. den. 1821 in 000s	0.306	0.296	0.315	0.311
	(0.052)***	(0.039)***	(0.040)***	(0.040)***
Log diff. pop 1821 and 1811	-7.562	-9.806	-8.924	-8.824
	(2.113)***	(1.972)***	(2.084)***	(2.149)***
fraction land pasture	-0.64	-0.285	-0.445	-0.377
	(0.485)	(0.522)	(0.487)	(0.505)
fraction land woodland	-0.831	-0.516	-0.586	-0.553
	(0.528)	(0.503)	(0.482)	(0.494)
has coal	-0.035	-0.67	-0.605	-0.618
	(0.166)	(0.244)***	(0.244)**	(0.249)
has coal* pop. Density		2.882	2.745	2.727
		(0.774)***	(0.788)***	(0.821)**
Herfindahl index for trusts			0.537	
			(0.372)	
Average size of trust in miles				0.0022
				(0.0017)
Constant	5.265	5.295	5.168	5.148
	(0.368)***	(0.365)***	(0.366)***	(0.383)***
N	51	51	51	51
R-Square	0.277	0.357	0.393	0.379

Notes: The dependent variable is the average rate of return in the county weighted by the debt of trust. Robust standard errors are reported. *,**, and *** represent statistical significance at the 10%, 5%, and 1% levels respectively. Sources: see text.

Some coal counties had manufacturing and higher population densities. Lancashire and the West Riding of Yorkshire are good examples. Combining coal with manufacturing likely

generated greater traffic flows for turnpikes, and thus the effects of coal may have been different in these counties. To test this hypothesis, column (2) in table 3 adds an interaction between coal and population density in 1821.The interaction captures large manufacturing counties like Lancashire. The results show that returns were significantly higher in counties with coal and greater population density. The magnitude of the interaction effect is plotted in figure 4. Returns are significantly higher for counties with coal and with population densities above 400 persons per square mile which includes Lancashire. Returns are low for counties with coal and population density at or below 100 persons per square mile which includes Carmarthenshire and Northumberland.

Figure 4: Marginal effects of population density and coal on rates of return



Notes: The estimates are based on column (2) of table 2.

One general conclusion is that endowments and economic structure variables can explain much of the variation in returns to bondholders (the R-square in column 2 is close to 0.35). It appears that England's turnpike roads paid investors good returns relative to other historical cases in large part because of its greater population density and where population density was combined with an abundance of natural resources like coal.

How important were policy choices by comparison? Column (3) in table 2 adds the county-level Herfindahl index for toll road services. Its sign is positive, indicating that more concentration is associated with higher returns, but the coefficient is not precisely estimated. Column (4) replaces the Herfindahl index with average length of trusts in road mileage. Greater average mileage managed by trusts is positively correlated with returns but is statistically insignificant. Similar results are found for related variables like turnpike miles per square mile of land and the ratio of turnpike miles to all road miles in a county.

Another set of regressions were run which use the average county rate of return weighted by miles rather than by debt. The results are not reported to save space. They are generally similar except the coefficients for the Herfindahl Index and average road length of trusts are now positive and significantly correlated with turnpike returns. Thus, the policy variables have greater explanatory power in other specifications.

Yet another set of regressions were run which use the natural log of turnpike revenues per road mile as the dependent variable. Their results can be summarized as follows and are not shown to save space: (1) population density is significantly associated with higher revenues per mile, which provides additional confirmation that the channel to greater financial returns is through greater traffic. (2) Population growth from 1811 to 1821 is significantly associated with

higher revenues per mile, which confirms that population growth does indeed create new financing opportunities, even if it does not generate greater returns in the short-run. (3) Coal does not have a consistent relationship with revenues per mile, which suggests that having coal alone did not generate greater funding opportunities or financial returns. (4) Lastly, the policy variables, HI and average mileage per trust, are significantly associated with *lower* revenues per mile. These findings are surprising because more market concentration and larger trusts should limit competition and raise revenues per mile. The sign of the coefficient implies the opposite. This result could be explained by reverse causation in which markets were designed to be more concentrated in response to low traffic environments. Wales is a good example. It offered less in terms of revenues per mile and therefore trusts may have structured their market differently to limit competition. Future research needs to analyze how market structures formed in order to better understand their effects.

VIII.

Much of England's infrastructure was financed by local individuals during its early industrialization. Parliament gave turnpike trusts and other statutory authorities' rights to improve or construct roads, rivers, canals, bridges, and dock works. Along with these rights came the opportunity to profit from public works. But there was also a potential to suffer financial losses, as has been the case in many modern infrastructure settings.

This paper studies the variation in returns paid to turnpike bondholders at the county-level in 1820. It shows that population density and abundant coal were key factors in explaining the local returns in England's turnpike sector. There is suggestive evidence that policy choices relating to market structure also played a role, mainly in dampening returns.

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