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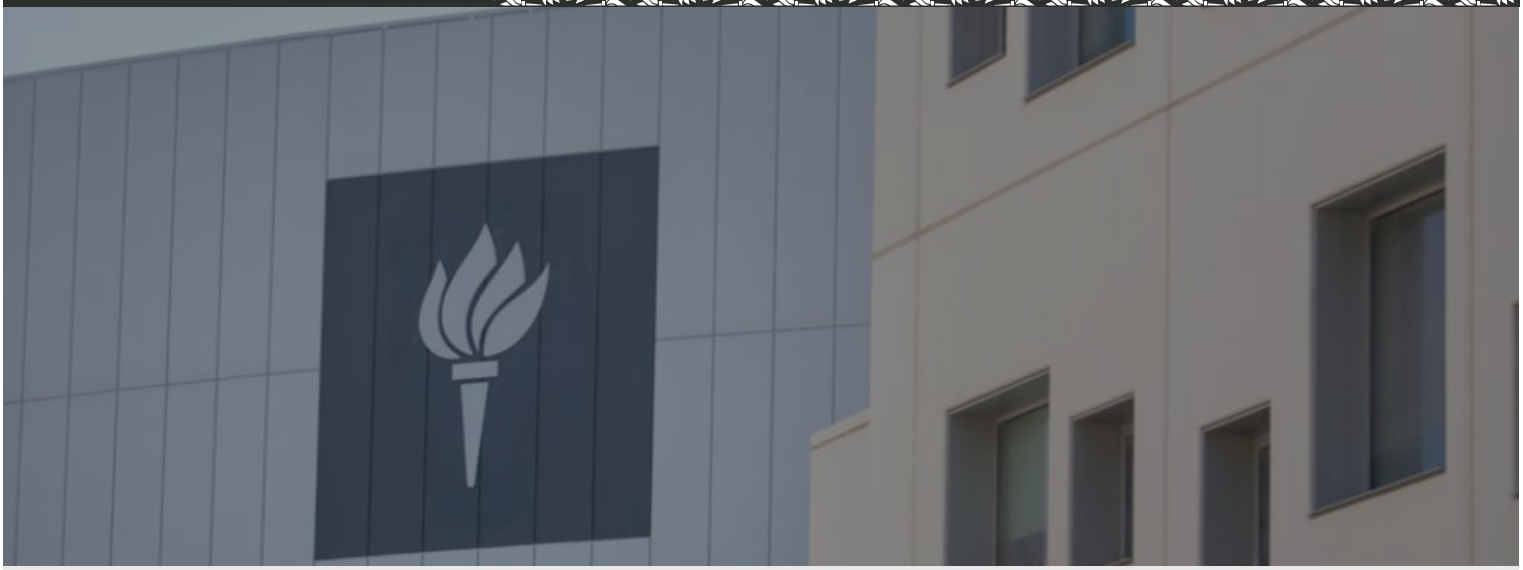

Financing sanitation infrastructure in nineteenth-century England and Wales

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Jonathan Chapman†

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Abstract

This paper investigates the role of high borrowing costs in deterring sanitation investment in late nineteenth-century Britain. Many councils were not providing public goods such as water supply and sewer systems even at the end of the century, despite having had access to government loans since the 1860s. Using an annual dataset of the financial accounts of almost seven hundred town councils, the paper identifies significant variation in the interest rates that towns had to pay when borrowing to fund investment. Panel regressions show that higher interest rates were associated with significantly lower levels of sanitation investment, with the relationship robust to controlling for town tax base, non-tax revenue sources, demographic characteristics, and town fixed effects. The regression estimates imply that providing loans at the government's cost of borrowing would have increased the stock of sanitation infrastructure in 1903 by around 25%, and so potentially hastened Britain's mortality decline.

Keywords: public investment, sanitation, Britain, urban infrastructure.

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1 Introduction

Improved sanitation was a major contributor to mortality decline during the nineteenth and early twentieth centuries.[1] Yet many towns were reluctant to invest in the infrastructure needed to provide clean water supply or effective sewerage, with considerable variation in the timing and extent of spending on these critical public goods.[2] Several studies have identified the importance of local political failures, particularly taxpayer opposition, in delaying infrastructure development.[3] In contrast, the barriers that towns faced in raising the funds for investment—capital market failures—have received relatively little attention. Building infrastructure necessitated borrowing on an unprecedented scale, and so the need for towns to access cheap loans was a central part of contemporary debate.[4] Yet there has been little quantitative assessment of the role of financing costs in determining the extent of sanitation investment.

In this paper I investigate the importance of high borrowing costs in deterring sanitation investment in England and Wales at the end of the nineteenth century—the period when many towns first began providing sanitary public goods. I use an annual dataset of the financial accounts of almost 700 British town councils to identify town-level infrastructure investment, and to estimate the interest rates paid by town councils between 1887 and 1903. All of these councils were able to borrow—from either the government or from private lenders—but faced very different costs of doing so. I then test the relationship between interest rates and the level of

[1] See, for example, Szreter *Health and wealth*, Chapman 'Urban infrastructure', Alsan and Goldin 'Watersheds', Ferrie and Troesken 'Chicago's mortality transition'. Harris and Helgertz 'Urban sanitation'.
[2] Cain and Rotella 'Death and spending'; Cutler and Miller 'Public health improvements'; Chapman 'Urban infrastructure'.
[3] For example, (in Britain) Hennock, 'Finance and Politics', and *Fit and Proper Persons*; Wohl, *Endangered Lives*; Millward, 'Political economy'; Aidt et al. 'Retrenchment hypothesis'; Chapman 'Democratic reform', and 'Extension of the franchise'; (in the United States) Troesken 'Race, disease, and water', and (in Germany) Brown 'Coping with crisis'.
[4] Bellamy *Administering central-local relations*, Chapter 3. Troesken *Pox of liberty.*

investment in sanitation public goods (water supply, sewers, and street improvements), controlling for the size of each town's tax base and their non-tax revenue sources, as well as demographic and occupational characteristics, and town fixed effects.

The results show that higher interest rates had a large deterrent effect on sanitation investment, and so likely slowed improvements in public health. A one standard deviation increase in the interest rate was associated with a decrease in annual capital investment of between 0.2 and 0.3 standard deviations—a much larger effect than associated with a higher tax base. These estimates imply that had the government been willing to lend to town councils at their own cost of borrowing (the consol rate), then the stock of infrastructure investment in 1903 would have been around 25% higher than in reality. Given the importance of sanitation infrastructure to improved public health, this greater investment could have significantly expedited Britain's mortality decline.

A simple comparison of trends in town interest rates and sanitation investment provides powerful suggestive evidence that changes in the cost of borrowing had a powerful influence on infrastructure development. In the mid-1880s many British towns were spending little on public goods provision, despite Parliament mandating them to do so in the early 1870s—and providing them with subsidized loans for just that purpose.[5] After 1890 however, sanitation investment grew rapidly, with the aggregate value of loans outstanding growing by more between 1890 and 1900 than in the fifteen years following the 1875 Public Health Act. At the same time the average interest rate paid by town councils decreased from 4.0% to 3.3%. However, this general trend masks considerable inequalities across towns: it was only in 1899 that the interest rate paid by the town at the 75th percentile was as low as that paid by those in the 25th percentile in 1887. Thus changes

[5] Webster 'Public Works Loans Board'.

in borrowing costs offer a potential explanation both for towns delaying investment after 1875, and starting (or growing investment) in the 1890s.

The differences in towns' borrowing costs are likely to be explained by differences in access to private capital markets. While all towns had access to borrowing from the central government (through the Public Works Loans Board), towns varied in their ability to raise funds from private sources. Towns that had the resources to obtain Local Acts of Parliament were able to raise funds through stock issues, a financial instrument that was attractive to investors due to being easily tradable, and that could be used to repay loans from other sources—and hence allowed towns to take advantage of declining market interest rates. Consistent with this hypothesis, I find that larger and wealthier towns—the group that historians have identified as being able to obtain such Local Acts—paid lower rates of interest throughout the period.

The comprehensive dataset also allows me to provide a broad overview of the development of sanitation in Britain from the landmark 1848 Public Health Act onward. While previous studies have analyzed only a small number of towns, I am able to identify both the financial and demographic characteristics associated with sanitation investment across nearly all towns in England and Wales.[6] The 1848 Public Health Act successfully induced most towns to gain authority over sanitation expenditure—but they often chose not to do so until the 1870s. Sanitation investment increased rapidly after the 1872 Public Health Act, reflecting both increase in town obligations, and also, possibly, the availability of cheap loans from the Public Works Loans Board. In addition to declining interest rates, the regressions demonstrate the importance of a growing tax base and sources of non-tax revenue in funding sanitation. Finally, I demonstrate the growing

[6] For instance Millward and Sheard 'Urban fiscal problem' use a sample of 25 towns.

importance of transfers from county councils to fund improvements to Britain's road infrastructure—a source of funding largely overlooked in the historical literature.[7] Together, these results provide a broad set of facts that can inform and stimulate future research into the history of British urban development.

The paper concludes by discussing avenues for future research into the ways capital market access influenced historical infrastructure investment. Although this paper suggests that restricting access to private markets inhibited investments, however some limitations may be required reassure nervous investors and hence decrease borrowing costs. Given the importance of sanitation infrastructure to mortality decline, better understanding of how, where, and why towns were able to finance those investments is sorely needed.

[7] Although see Waller *Town, city and nation*, pp251-253.

2 Data

The paper draws extensively on a dataset constructed from the annual accounts of urban councils in England and Wales, reported in the *Local Taxation Returns* in the Parliamentary Papers collection.[8] A panel dataset was constructed by hand-matching towns between years to account for variations in place names over time. The annual accounts provide a detailed disaggregation of the sources of revenue and types of expenditure for each town council in England and Wales, as well as the amount of loans outstanding, and the value of the tax base. I transform the nominal reported values into real terms using the Rousseaux Price Index, and construct per capita figures using census population data.[9] I then supplement the financial data using individual Parliamentary Papers on specific topics—these are referenced at appropriate points in the text.

The organization of these accounts improved significantly after 1884 and as a result most of the analysis begins after that date. Prior to 1884, the reports do not distinguish between current and capital expenditure, leading to large "spikes" in the spending series due to infrastructure investments. From 1884 onwards, in contrast, the reports separate expenditure "not out of loans" and "out of loans"—allowing me to separate ongoing and investment expenditure. Further, from 1887 the reports distinguish between loan interest payments and principal repayments, allowing me to estimate the interest rate paid by each town (see Section 4). From 1904 these spending categories were again combined—and as such 1903 is the final year of analysis.

I focus on towns that existed as sanitary authorities throughout the period 1875 to 1911—avoiding any issues due to changes in the composition of the sample. The resulting sample of 690

[8] A full list of the papers is available upon request.
[9] In doing so I follow Millward and Sheard 'Urban fiscal problem', and use data from Mitchell *British historical statistics*, pp723—24. The appendix contains details of the census data and full variable definitions.

towns contains a high proportion of the non-metropolitan urban population of England and Wales: 79% in the 1881 census, and 77% in 1891.[10] It is important to note, however, that the category of "urban" was extremely heterogeneous—incorporating both the largest cities (except London) and towns with population of less 500. The demand for infrastructure thus likely varied considerably across towns—a point returned to in the empirical analysis.

The paper focuses on investment in sanitation infrastructure, defined as expenditure out of loans on water supply, sewers, and street improvements, for three reasons. First, these public goods are of critical importance in improving public health, contributing significantly to Britain's mortality decline. Clean water supply and sewer systems both directly halt the spread of waterborne disease, while street improvements also had a sanitary impact since paving affects the ease of cleaning streets, and because they were sometimes associated with slum clearance.[11] Second, all the towns in the sample had the ability to spend on these public goods by virtue of being an urban sanitary authority, whereas the authority (or requirement) to invest in other infrastructure could vary between municipal boroughs and other towns. Finally, sanitation was the major component of urban investment in this period, accounting for 68% of the outstanding loan stock—a contemporary measure of sanitary progress—between 1887 and 1903.

I estimate towns' cost of borrowing using the average interest rate paid over each year. That is, I divide the expenditure on interest in each year by the estimated average value of loans outstanding during the year. Although this measure is noisy, the overall estimates seem plausible

[10] Restricting the sample excludes towns that became sanitary authorities after 1875—particularly newer industrial towns in the North-West—and those that stopped being sanitary authorities during the period (for instance, when large towns subsumed urban areas in their suburbs). London is also excluded as it was governed under a different system and hence accounts were reported separately.

[11] Baird 'Sanitation'; Millward and Sheard, 'Urban Fiscal Problem'.

when compared both to the consol rate and to the rates of interest charged by the Public Works Loans Board (see Figure 2 and surrounding discussion). Further, the results are robust to excluding outliers on this measure (see Section 6).

3 Trends in Infrastructure Investment

Investment in sanitation infrastructure grew impressively in the second half of the nineteenth century, but even in 1900—half a century after the landmark 1848 Public Health Act—there was considerable variation across the country in the provision of these critical public goods. Under the system introduced by the 1848 Act, responsibility for maintaining urban environments was passed to town councils, who were given the authority to invest in sanitation infrastructure. Faced with the high cost of investment, many town councils chose not to do, forcing Parliament to make provision obligatory through further Public Health Acts in 1872 and 1875—with some, albeit limited, success. However, these legislative changes have limited power to explain the variation in sanitation expenditure across towns or the rapid growth in investment that occurred late in the nineteenth century. In the following section I turn to changes in interest rates as a potential alternative explanation.

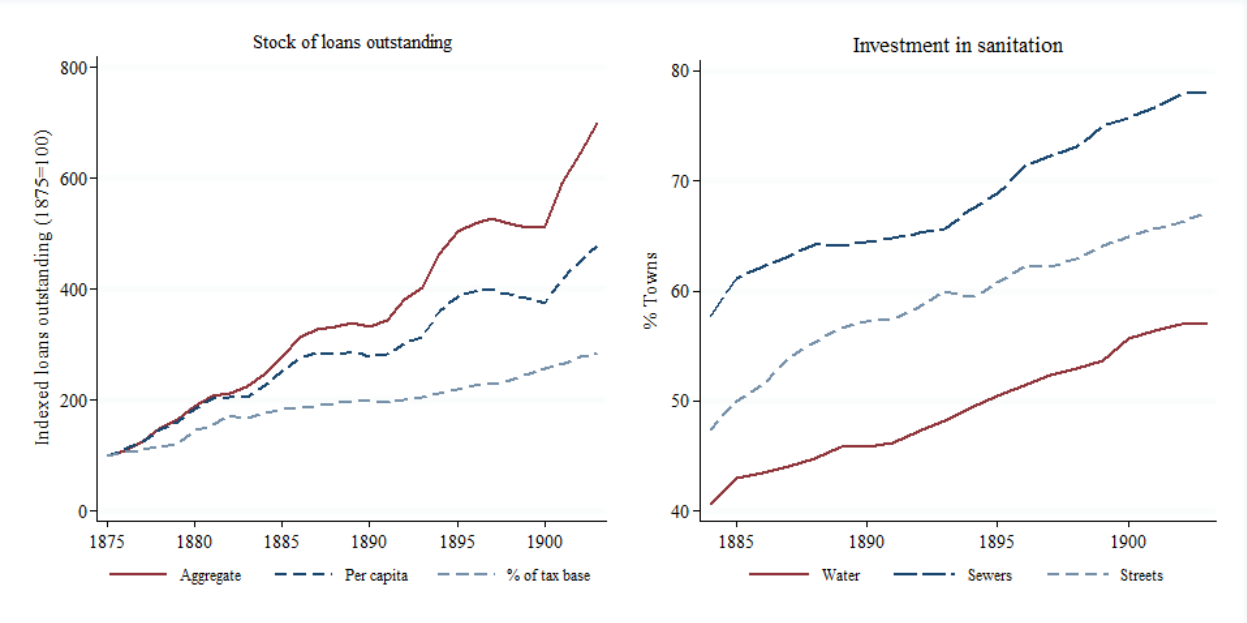
Figure 1 shows that the imposition of the 1870s Public Health Acts, combined with the provision of subsidized loans, were followed by a spate of infrastructure investment. Loans were required to fund investment and, as a result, local authority borrowing has been used as a measure of sanitary progress by both contemporaries and modern researchers.[12] As we can see in the left hand panel, the stock of loans outstanding increased rapidly after the 1875 Public Health Act: between 1875 and 1885 the average value of loans across the sample increased almost threefold (and 2.5 times in per capita terms). Much of this investment was funded by the Public Works Loans Board (PWLB), which provided loans for sanitary purposes to urban councils from the 1860s onward.[13] More than half of spending by local boards of health on water and sewers was financed

[12] Wohl *Endangered lives,* pp112-115. On this basis Szreter *Health and wealth,* Chapman 'Urban infrastructure', and Harris and Hinde 'Sanitary investment' use local authority loans to investigate the effect of sanitation infrastructure on Britain's mortality decline.

[13] The discussion of the PWLB in this paragraph is based on Webster 'Public Works Loan Board', particularly pp903—906.

by the PWLB between 1872 and 1876, potentially reflecting both the difficulty in raising funds elsewhere, and the fact that interest rates offered by the PWLB were relatively low during this period.

Figure 1: Sanitation spending increased gradually between 1872 and 1903.



Note: Lines in left hand panel relate to averages across towns. "Aggregate" relates to the value of the loans in the year. The right hand panel displays the proportion of towns invested in each public good, where investment is defined as having outstanding loans relating to that public good *Source: See Section 2.*

However, the legislative changes in the 1870s cannot explain the fact that much infrastructure investment did not occur until after 1890. As we can see in the right hand panel of Figure 1, by 1885 less than half of towns had invested—in the sense of having loans outstanding—in water supply and only 60% had invested in sewers. The level of investment continued to grow however, with the growth in investment even greater between 1890 and 1903 than between 1875 and 1890. To understand these changes we must look more carefully at the factors affecting towns' investment decisions.

Growing town wealth can explain some, but by no means all, of the growth in investment. Throughout the nineteenth century town councils were expected to fund their own expenditure, largely through local taxes, meaning that towns varied significantly in their ability to invest. Some towns simply had much greater financial resources—the per capita tax base of the median town was approximately half that of the town at the 95th percentile throughout the period—and this translated into more spending.[14] Yet, as we can see in Figure 1, increases in the tax base cannot account for the rapid acceleration in spending: the average tax base grew only by around 40% between 1887 and 1903—a period when, as we have seen above, investment increased several fold.

Local politics may explain some of the cross-sectional variation in expenditure, but does not appear to explain the rapid increase in expenditure after 1890. Several authors have argued that local taxpayer resistance to higher spending can explain delays in sanitation investment after 1870. In particular, the second half of the nineteenth century saw a number of institutional reforms that changed the composition of the electorate, with consequences for the support for public goods.[15] However, by 1885 most extensions to voting rights had occurred, and the major exception—democratic reforms as part of the 1894 Local Government Act—appears to have hindered public goods spending.[16] Politics clearly mattered, but we must look elsewhere to understand the rapid growth in investment that occurred after 1890.

This study focuses primarily on the role of cheap finance in promoting sanitary investment

[14] See Millward and Sheard 'Urban fiscal problem', and results in Table 1. The ways in which towns could fund investment are discussed in detail in Section 5.
[15] Aidt et al. 'Retrenchment hypothesis', Chapman 'Extension of the franchise'.
[16] See Chapman 'Democratic reform'. In particular, some elections before 1894 did not use a secret ballot and allowed the wealthy several votes.

after 1887. Nineteenth-century sanitary reformers certainly saw the need to access cheap finance as important, while modern historians have pointed out the coincidence between falling interest rates in the 1890s and the rapid rise of municipal borrowing.[17] The novelty of this paper is to be able to use town-level data on the cost of borrowing, and hence provide both rigorous tests of that hypothesis and estimate the relative importance of finance costs in determining infrastructure investment.

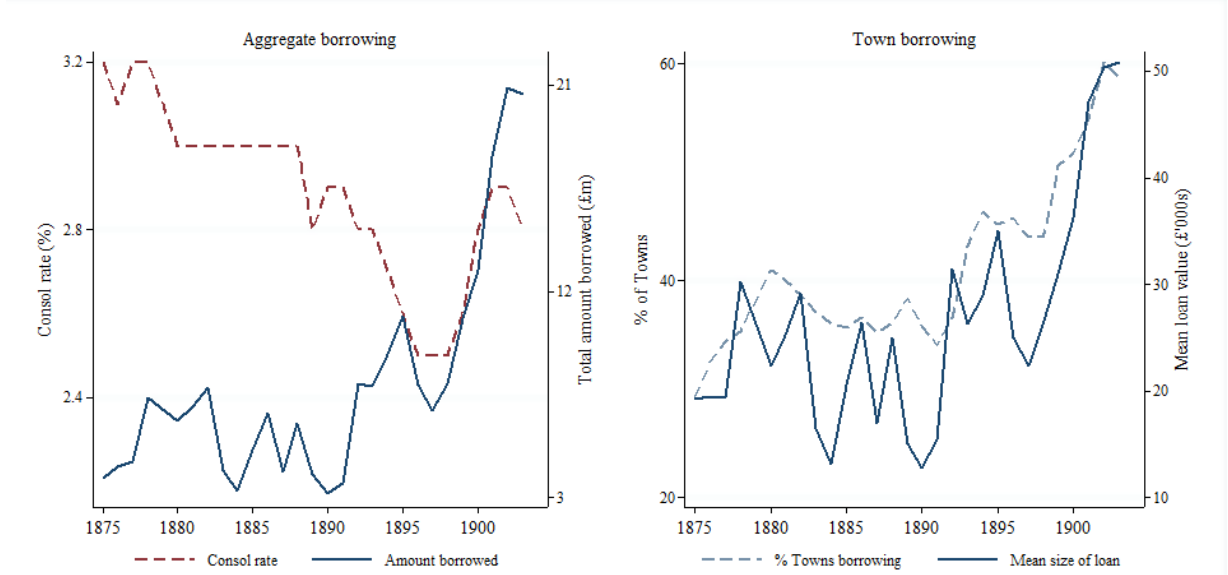
[17] Wilson 'Finance', Bellamy *Administering central-local relations,* p94.

4 Financing Infrastructure Investment

National interest rates plummeted at exactly the time as sanitation investment increased in the 1890s, providing *prima facie* evidence that changing borrowing costs can explain the surge in investment at the end of the nineteenth century. In this section I use the financial dataset to provide the first quantitative evidence that this fall in interest rates was passed onto town councils—indicating that they were able to access capital markets. Further, there was widespread variation in borrowing costs, suggesting that differences in interest rates may also explain the differing speeds of investment in sanitation infrastructure. Larger towns paid lower rates of interest, supporting claims in the historical literature that the ability to issue stock provided a key source of comparative advantage in raising funds. Smaller towns, who tended to rely on funds from the Public Works Loans, paid higher interest rates, suggesting that the government failed to significantly subsidize loans after 1887.

There was a clear negative correlation between the long term interest rate and town borrowing, as we can see in Figure 2. After 1890 the cost of money plunged, with the consol rate falling from 3% to 2.5% in 1896. At the same time the value of loans to town councils surged—increasing from £4 million to £12 million between 1887 and 1903. This growth reflected both more towns taking out loans and higher average loan value (see right hand panel)—in 1903 around 60% of the towns took out loans, compared to 37% in 1887. Prior to 1887, in contrast there is no clear trend in borrowing, with growth in the late 1870s followed by an 1880s slump.

Figure 2: Negative correlation between town borrowing activity and national interest rates



Note: Left hand panel displays the total value of loan received in each year. The right hand panel shows the mean size of the loans received and the percentage of towns receiving a loan in each year. *Source: See Section 2 and for the consol rate Mitchell* British historical statistics*, p678.*

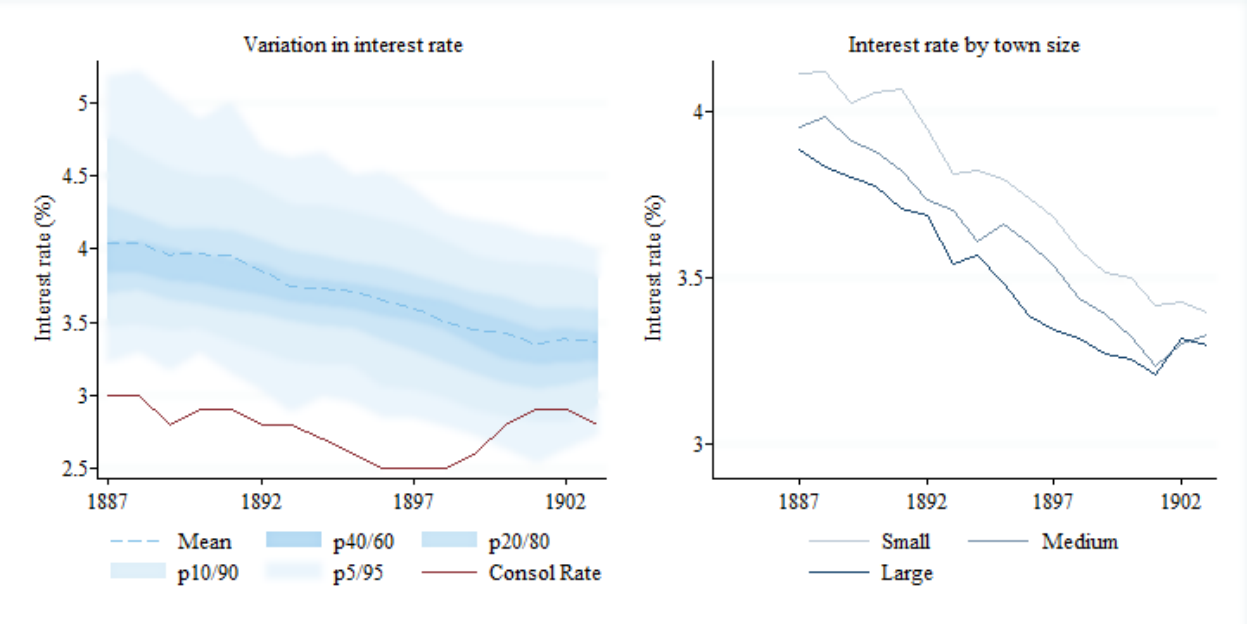
Figure 2 demonstrates that town councils were able to benefit from the cheap money after 1890, providing further evidence that falling borrowing costs contributed to surging investment. The fall in the price of capital reflected a reduction in capital exports following the Barings crisis, and the consequent high demand for secure domestic assets.[18] An opportunity for towns to borrow cheaply thus appeared. However, *a priori* it is by no means certain that they would have been able to take advantage of that opportunity as they faced important legal restrictions in obtaining private loans—a point discussed in detail below. The financial dataset indicates that, in fact, they were able to borrow more cheaply: the estimated interest rates paid by towns fell this period, with the mean interest rate across towns declining from 4% to 3.4% between 1887 and 1903.

Figure 2 also indicates a striking variation in the interest rate across towns, suggesting that

[18] Wilson 'Finance' p48.

these differences in borrowing costs may also explain cross-sectional variation in investment. The towns at the tenth percentile of the interest rate in 1887 were paying 3.5%, compared to approaching 4% for the median town, and 4.8% for a town in the 90th percentile. This range narrowed through the period but remained significant (the figures for 1903 are 2.9%, 3.3% and 3.8%). Some towns thus had a significant disadvantage in borrowing that could explain the delays in investment—it was only in 1899, for instance, that the rate paid by the town at the 75th percentile was as low as that paid by those in the 25th percentile in 1887.

Figure 3: The cost of borrowing varied considerably across towns.



Note: Town size is defined based on 1891 population: Small: <10000 population, Medium: 10-25,000, and Large: above 25,000.
Source: See Section 2 and (for consol rate) Mitchell British Historical Statistics*, p678.*

The cross-sectional variation in the interest rate is likely to reflect differences in the types of instruments towns could use to raise funds. National legislation provided for all councils to be able to borrow against the security of the rates, conditional on the approval of a central government

department.[19] However, the form of borrowing that could councils could undertake under that legislation was tightly prescribed, with limitations on the length and the form of repayment, as well as the maximum size of loan (relative to the tax base). In addition, loans had to be approved by a central government department. As a consequence, many towns instead turned to Local Acts of Parliament to gain more flexibility—but doing so was expensive and so was an option only open to relatively large and wealthy towns.[20]

One key benefit of Local Acts was that they allowed towns to raise funds through stock issues, which were which were particularly attractive to private investors because they were tradeable on the open market. The mortgage debt that towns could issue under national legislation could not, in contrast, be bought and sold on an organized market. Nor could it be issued to repay earlier debts—and hence take advantage of falling interest rates—whereas stock could. The ability to raise stock thus gave town councils access to lower cost borrowing.

Large towns in particular were better able to bear the cost of obtaining Local Acts, and so we would expect them to have paid lower interest rates—and they did, as shown in the right hand panel of Figure 2. In 1887, large towns (those with population above 25,000) were paying a rate of 3.88% on average, compared to 4.11% in small towns (population below 10,000). As explained by an 1884 Royal Commission "several of the large corporations have been able to issue consolidated stock, the result of which is that those towns can borrow almost as cheaply as the State can lend to them".[21] Simple regressions (reported in Online Appendix C) show that towns

[19] The discussion of the legal restrictions on town borrowing is based on Page *Local authority borrowing*, Chapters 8-9 (in particular the discussion of the 1875 Public Health Act on pp134-140), and Wilson 'Finance' pp34-40.
[20] Harris and Hinde 'Sanitary investment' discuss the types of borrowing approved under Local Acts.
[21] *Royal Commission on the Housing of the Working Classes* (PP 1884-85 [C.4402 C.4402-I C.4402-II] XXX. 87, 819), p37.

with a higher tax base also paid lower interest rates, offering further evidence that the towns most able to access Local Acts of Parliament obtained cheaper finance.

Some towns may have faced particularly high interest rates because they could not borrow from private sources at all. Smaller towns were particularly reliant on loans from the PWLB, meaning that they may have been forced to pay relatively high interest rates.[22] Interest rates payable on PWLB loans were set by the Treasury, and changed only at irregular intervals, meaning that they lagged falls in the market rate of borrowing. In the 1890s, for instance, the falling cost of borrowing led to councils repaying PWLB loans with funds from private markets. Only in 1897—when the consol rate was once again increasing—did the Treasury cut interest rates in response.[23]

There is little historical evidence as to why some towns relied more on PWLB loans than others, but it seems at least feasible that smaller towns simply did not have the option to borrow at lower rates elsewhere. Some towns may have struggled to raise finance privately due to the small size of the amounts issued, or because they were seen as a high credit risk—meaning that the PWLB was the lowest cost option. Alternatively, it could be that the added flexibility on loan terms offered by the private markets was more attractive to larger towns with more complex projects.[24] The very largest towns may have been deterred by the borrowing limit of £100,000 imposed between 1879 and 1897, although loans of this size were rare (only 103 instances between 1887 and 1897).[25] Regardless of the reason, however, if towns were limited to borrowing from the

[22] Wilson 'Finance' p.35.
[23] Bellamy *Administering central-local relations*, p94. In 1879, the PWLB rate was set as ranging between 3.5% and 4.25%, depending on the length of repayment. In 1885 the range was changed to 3.5-4% (*Ibid* Chapter 3, fn 71), and then the rate was reduced further to 2.75% in 1897 (p94, it is not clear which length of loan the latter refers to).
[24] In 1879 the PWLB also imposed a limit of £100,000 on the annual amount a town could receive from the PWLB. Only the large towns would have been affected by this limit, however—there are only 14 instances of small or medium size towns borrowing more than this amount in a year.
[25] See Bellamy *Administering central-local relations* p91 for implementation of the cap, and p94 for the removal.

PWLB they are likely to have paid higher interest rates—providing a further explanation for the variation in the sample.[26]

After 1890 it became easier for all councils to finance investment by issuing stock, possibly explaining part of the downward trend in interest rates. The 1890 Public Health Act allowed any urban authority to issue stock with the sanction of the Local Government Board.[27] At the same time, model clauses for the issuance of stock were agreed in 1889, which would reduce the cost of incorporating such powers in any Local Act.[28] Together, this would have given smaller towns greater flexibility in raising finance—and may explain why the difference between the average interest rate paid by large and small towns narrowed over the 1890s: in 1887 large towns paid 0.25 percentage points less than small towns; by 1903 the gap was only 0.1 percentage points.[29]

These patterns provide suggestive evidence that changes in borrowing costs could have explained the rapid increases in investment seen in the 1890s, but there are possible confounding factors to consider. In particular, towns with more financial resources would be both less likely to default (leading to lower interest rates) and also have higher demand for public goods.[30] Differences in the towns' financial constraints could thus confound the regression analysis; an issue I discuss in depth in the following section, after introducing the empirical specification..

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[26] Webster 'Public Works Loans Board' argues that the PWLB loans in the 1870s were below the market rate. That claim does not necessarily contradict the hypothesis here for two reasons. First, after the 1870s there was increasing debate over whether offering cheap loans was justifiable, partially explaining the sluggish response to declining market rates (see Bellamy *Administering central-local relations* Chapter 3). Second, prior to 1875 local authority loans were particularly unattractive to private borrowers due to a lack of regulation on local accounting practices (*ibid,* p81), meaning that the market rate of interest may have been particularly high during that period.

[27] Page *Local authority borrowing* p155.

[28] Bellamy *Administering central-local relations* p87.

[29] The change in the difference between the two groups is statistically significant at the 10% level.

[30] Although towns rarely defaulted on repayments, suggesting that this may not have been a major concern (Bellamy *Administering central-local relations* p92). However, lenders may not have recognized the low default risk at the time given the unprecedented degree of town borrowing.

5 Empirical Specification and Identification

I now turn to examining the relationship between borrowing costs and investment in sanitation—the combination of water supply, sewer systems, and streets. I start by introducing the empirical specification, before addressing the identification strategy in detail. The third subsection then discusses the variables used to control for heterogeneity in the demand for infrastructure.

5.1 Specification

I estimate regressions of the following form:

$$y_{i,t} = \alpha + \beta interestRate_{i,t} + X_{i,t}\gamma + \delta_t + [\lambda_i] + \varepsilon_{i,t} \quad (1)$$

where *i* indexes a town, *t* indexes a year (between 1887 and 1903), and *y* represents sanitation investment. *interestRate* is the average interest paid in the year, as discussed in the previous section. *X* is a vector of control variables that could plausibly be associated with the demand for public goods expenditure (discussed in detail in subsection 3). I include year fixed effects (δ_t) to account for trend growth in the town over time and, in some specifications, town fixed effects λ_i.

I use both the stock and flow of sanitation investment as dependent variables ($y_{i,t}$). To proxy for the stock of sanitation infrastructure I use the per capita sanitation loans outstanding in the town. This measure captures the outcome of most interest—the level of sanitation infrastructure provided—however, it suffers from the drawback that annual fluctuations in the interest rate can only have a limited impact since much investment would occur in previous years. As such, as a second dependent variable I use the per capita expenditure out of loans on sanitation—that is, capital expenditure. This measure directly captures the amount invested on sanitary public goods in each year, which we would anticipate being more responsive to interest rates.

Our main focus is on the coefficient relating to the average interest rate, β. Conceptually, we

can consider a town as operating within a market for loans, in which the interest rate they pay is determined by their demand for infrastructure and the supply of funds in the market. The changes in the interest rate then capture the supply of loans shifting to the right, and towns consequently moving down their demand curve and increased borrowing. Identification is then based on the assumption that differences in the supply curve are not reflecting heterogeneity in demand—an assumption I discuss in detail in the next section.

There are two possible channels through which higher cost of borrowing could affect investment in public goods, although the average interest rate measure does not, unfortunately, allow me to distinguish the two. First higher interest rates reduce the net return on any new investment—and hence make that investment less attractive. Here the assumption is that the average interest rate (calculated off "old" loans) also reflects the interest rate on the "marginal loans"—which is justified if interest rates are falling and towns could refinance old loans.[31] Second, higher interest payments for existing loans may reduce the funds available for additional investments or other public spending.

The lumpy nature of infrastructure investment could, in principle, skew the regression results in a number of ways, and so I run a number of robustness tests to check the validity of the results. First, I implement a Tobit specification to account for the fact that most towns did not invest in sanitation in every year, meaning that there is a large mass (around 50%) of values at 0 for spending out of loans. Second, there were some extremely large investments which could skew the results—so I check the robustness to excluding these values, and to logging the dependent variable (necessitating restricting the sample to observations with strictly positive spending only). Third,

[31] Some towns at least refinanced loans in this way in the 1890s (Bellamy *Administering central-local relations* p94). As discussed in Section III however this could be difficult if towns were not able to issue stock.

investment in one year can substitute for that in later years, so that towns may not invest—even when faced with a low interest rate—because they have already done so. In our case this seems unlikely to be a concern because investment continued to grow rapidly throughout the period (there is no evidence of satiation), but as an additional check I control for the lagged loan stock.

4.2 Identification

The identification strategy relies on the assumption that, after inclusion of the control variables, changes in the interest rate are uncorrelated with other factors affecting town borrowing. This assumption could be violated if factors affecting the demand for infrastructure also affect firms' access to loans—leading to a spurious correlation. It would also be violated if high demand induced firms to seek private capital, and hence lower interest rates—in that case, reverse causality would be a concern. In this subsection, I discuss my approach to dealing with each of these concerns.

To account for heterogeneity in demand for public goods, I include a number of time-varying controls, as well as town and year fixed effects. Larger, wealthier towns are likely to have had greater demand for public goods, and also been lower default risks, and consequently been able to obtain lower borrowing costs. I thus include a number of time-varying covariates to capture the sources of this heterogeneity—these are discussed in detail in the following subsection. Town fixed effects account for any time-invariant factors affecting demand, such as geographical characteristics. Year fixed effects capture general trends in borrowing over time that could lead to spurious correlation with the falling interest rates.

In the two-way fixed effects model, identification is based on idiosyncratic variation in the town-interest rate that is not explained by common trends over time, time-invariant town

characteristics, or the time-varying controls. The identifying assumption is then that this variation is uncorrelated with contemporaneous demand for public goods. What could cause such variation? The earlier discussion has indicated that much can be explained by differential access to capital markets which, in turn, is explained by differences in the past ability to obtain Local Acts of Parliament. Ability to obtain such Acts would depend on political contacts and abilities that are plausibly exogenous to decisions over investment. Further, many such decisions would be historical, and not driven by present needs for public goods. Specifically, the exact powers conferred by past Local Acts would vary for reasons unrelated to current decisions—for instance, conditions determining whether towns had the ability to refinance or borrow further without returning to Parliament for additional authorization. Alternative sources of variation could simply relate to idiosyncrasies of individual administrators, or variation in the availability of local capital markets.

The second concern is the potential for reverse causality: towns with greater demand for public goods sought out lower interest rates. If there are fixed costs to accessing capital markets, then it could be that only towns with sufficient demand enter those markets and obtain lower interest rates. A similar issue would arise if the historic decisions discussed in the previous paragraph were made in anticipation of future borrowing, or reflect time-varying features not captured by the included control variables.

I carry out a series of additional tests to provide reassurance that reverse causality does not drive the main results. Unfortunately, the dataset does not allow us to observe variation in towns' borrowing options directly. Instead, I restrict the sample to observations where towns did decide to borrow—and so identify the effect of interest rates on the value of loans taken out, conditional on paying any fixed costs associated with borrowing at all. Further, to identify

account for previous differences in access to capital markets, I also condition on both lagged stock of loans outstanding, and lagged interest rate. By doing so, I capture the effect of variation in the interest rate within groups of towns that had similar borrowing costs and infrastructure stock in the previous year.

In addition, I implement a placebo test to check whether lower interest rates are associated with higher government spending on services that did not require borrowing. If the interest rate truly captures an effect on borrowing decisions, there should be no relationship with this variable. If, on the other hand, the interest rate is actually capturing greater demand for government spending in general, then we would expect a negative correlation similar to in the main specifications. A null result thus rules out any differences in demand for public goods that are not specific to borrowing for infrastructure investment.

Before moving on, it is important to note that there are also good reasons to think that the limitations of the average interest rate measure may bias against finding any relationship with sanitation investment. The average interest rate probably underestimates the interest rate for a marginal loan as we cannot observe any loans turned down because the cost was too high.[32] Further, towns with easy access to credit may have been willing to borrow more, leading to higher (average) interest rates on the loans they did have outstanding— meaning reverse causality in the opposite direction to that discussed above. The estimated coefficient could thus be biased downwards.

Finally, towns that could borrow at lower interest rates may also have obtained other

[32] Similarly, there could be some selection bias since we cannot estimate the interest rate at all for towns with no loans outstanding—although this concern is mitigated by the fact that almost all towns were borrowing by 1887.

advantageous borrowing conditions. Borrowing under Local Acts, for instance, also offered advantages such as more flexible repayment terms, longer repayment periods, and the opportunity to avoid Local Government Board oversight. It is possible that the interest measure here captures all of these advantages together—in which case it is better interpreted as a measure of an overall reduction in the cost of borrowing, rather than the interest rate alone.

4.3 Demand for loans

Identifying the effect of lower borrowing costs on investment is complicated by the fact that the demand for sanitation and the ability to repay loans are entwined. Towns with fewer financial constraints would be better able to afford public goods and also be less likely to default on their loans—and hence need to pay lower rates of interest. Local taxation—the rates—was the most important revenue source for most town councils, and the size of the local tax base was thus critical to their ability to repay loans. In addition, some towns received significant revenue from trading services and, at the end of the period, grants for street improvements. Controlling for those constraints is thus an important component of the regression analysis.

The size of the local tax base was the important constraint for councils seeking to expand local expenditure. Both current expenditure and loan repayment had to be funded out of local revenue, of which local taxation was by far the largest component: on average tax accounted for 60% of town revenue (excluding loans). Grants from central government were small throughout the period and were not directed at infrastructure development. Instead, they were limited to those services deemed "national" in character, such as policing and maintenance of lunatics, meaning that many towns received nothing at all, and few received an amount exceeding 5% of their tax revenue. Rather, towns relied on revenue raised from (essentially) proportional taxes on "immovable"

property and consequently towns were constrained by the value of the property in their district.[33]

Previous studies have shown that some town councils were able to use property or operational profits to alleviate the pressure on tax revenue, but these forms of revenue are generally insignificant in the broad sample used in this paper. Large towns sometimes subsidized the rates using the returns from landed estates or profits from gas or other municipal undertakings).[34] However, the financial data show that few other towns acted in this way: revenue from property (sales or rents) accounted for more than 10% of non-loan revenue in fewer than one tenth of towns (with a median of less than 5% of tax value). Trading profits were also not a large contributor to the rate burden: less than a fifth of towns operated the undertakings most likely to subsidize other activities—gas, electricity or tramways—even at the end of the period. Further even where a profit was made, the contribution was generally less than 10% of tax revenue.

A more significant source of non-tax revenue was the grants for street improvements provided by county councils in the 1890s. After 1878, county authorities began to contribute to "disturnpiked roads" in their county, and then in 1890 new county councils, created by the 1888 Local Government Act, gained responsibility for maintaining "main roads" within their jurisdiction—changes that necessitated transfers to town councils within their area.[35] These transfers were funded largely by sources outside of each individual town, through either a county-wide tax or funding from central government. As such, spending on roads could be funded from a wider tax base than the town's own property. The size of these transfers, while not huge, were much larger than other forms of external revenue. Once transfers from the counties are included,

[33] The rationale for central government grants, the structure of taxation, and the determination of the local tax base, are discussed in *Royal Commission on Local Taxation* (PP 1901 [Cd. 638] XXIV.413).
[34] Millward and Sheard 'Urban fiscal problem' pp507-509. Online appendix B discusses municipal trading in detail.
[35] See Webb and Webb 'King's Highway' pp220-224.

the median town received grants worth more 20% of their tax revenue in 1895—of which by far the largest component related to funding of roads. These grants amounted to almost 40% of the median town's expenditure on roads, and so could have made a large contribution to growth in this portion of sanitation expenditure.[36]

Based on this discussion, I include controls for both the tax base (rateable value) per capita in each town and non-tax sources of revenue: receipts from transfers (split between targeted at spending on roads and those for other purposes), receipts from property, and receipts from "tolls and trading". The latter incorporates all revenue from public services (except water supply) including gas, markets, and other municipal undertakings.

Town size and density could also confound the relationship between investment and the interest rate. Large, densely populated cities may have had higher demand for sanitation since cramped living conditions lend themselves to easy spread of disease. On the other hand, larger cities may have benefited from economies of scale in provision since the fixed costs of (for instance) a water plant would be spread over a wider area. Similarly, densely populated areas may have had lower costs since pipes and streets need to be laid for a smaller distance. To capture these effects I include controls for both population and population density—allowing for a flexible relationship by including them in bins, rather than as linear variables.

Finally, in some specifications I include a set of occupational controls to account for other possible sources of variation in demand that could have been correlated with access to credit markets. Water supply was in demand for industrial as well as consumer needs[37], and we might

[36] These figures exclude the "county boroughs" consisting mainly of towns with population above 50,000, who acted as independent counties and so did not receive these transfers.
[37] Hassan, 'Growth and impact'.

also think that sewer systems (particularly drainage) might be in greater demand in more agricultural areas. It is plausible that towns with a large professional middle class would have had a larger sanitary movement and so greater demand for public goods. To capture these relationships, I include dummy variables to identify whether in 1881 the town contained a significant (greater than 10%) share of the total workforce in textiles, minerals (i.e., mining and related concerns), or agriculture, as well as the percentage of workers in either commerce or the professions in the town. Since these variables are measured in only one year they are excluded when town fixed effects are included.

Descriptive statistics for all the variables used for the regression analysis are included in Appendix A. The next section presents the main empirical results.

5 Results

The results in Table 1 show consistent evidence that higher interest rates were associated with lower investment in sanitation infrastructure. Specifications (1) to (3) demonstrate that a one standard deviation decrease in the interest rate (approximately 0.7 percentage points) was associated with an increase of approximately 0.1 standard deviations in the sanitary infrastructure stock (per capita loans outstanding). Specifications (4) to (6) show that—reassuringly—the results are even stronger for annual capital expenditure, with a one standard deviation increase in the interest rate associated with a reduction of 0.20 to 0.23 standard deviations in the per capita amount spent out of loans each year. The average marginal effect from a Tobit specification (column 7) is even higher. The relationship between sanitation investment and the interest rate is thus robust to controlling for financial constraints, town and year fixed effects, and demographic characteristics: it does not appear to be an artefact of lower interest rates capturing differences in the demand for infrastructure.

Further, the results indicate that changing interest rates had an economically significant impact on the provision of sanitation infrastructure. Between 1887 and 1903, the median interest rate fell 0.6 percentage points; the estimates in Table 1 imply that the associated increase in infrastructure was around one quarter of the change in the median infrastructure stock over the period. It is also instructive to compare the coefficients to that on the town tax base: for the stock of infrastructure the estimated coefficient on the interest rate is around 40-50% that of the tax base coefficient, whereas for that annual investment it is between 2 and 4 times *larger* than the comparable coefficient. This suggests that the tax base may have had a larger influence on overall investment infrastructure—not surprising since loans had to be repaid from taxes—but fluctuations in the interest rate determined when investments occurred.

Table 1: Higher borrowing costs associated with lower sanitation investment

	Standardized dependent variables						
	Loans outstanding p.c.			Spending out of loans p.c			
	OLS	OLS	OLS	OLS	OLS	OLS	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Average interest rate	-0.12***	-0.10***	-0.07***	-0.20***	-0.20***	-0.23***	-0.28***
	(0.014)	(0.013)	(0.009)	(0.021)	(0.021)	(0.029)	(0.021)
Tax base p.c.		0.25***	0.13***		0.09***	0.09*	0.06***
		(0.044)	(0.040)		(0.021)	(0.049)	(0.017)
Property receipts p.c.		-0.02	0.01		-0.02	0.00	-0.06**
		(0.015)	(0.007)		(0.012)	(0.011)	(0.025)
Tolls and trading revenue p.c.		0.24***	0.07		0.05***	0.04	0.04***
		(0.046)	(0.050)		(0.019)	(0.081)	(0.012)
Transfers p.c.: county roads		-0.03	0.00		-0.03**	-0.05**	-0.02
		(0.021)	(0.013)		(0.014)	(0.019)	(0.013)
Transfers p.c.: other		0.22***	0.02*		0.01	-0.04***	-0.00
		(0.044)	(0.013)		(0.015)	(0.014)	(0.010)
Population							
10,000-25,000	0.15**	-0.00	0.09	0.02	-0.02	0.20	0.11***
	(0.070)	(0.063)	(0.069)	(0.039)	(0.038)	(0.154)	(0.032)
>25,000	0.86***	0.30**	-0.08	0.08	-0.03	0.30	0.14***
	(0.143)	(0.121)	(0.177)	(0.053)	(0.051)	(0.195)	(0.042)
Population density							
Second tercile	0.05	0.08	-0.09	0.03	0.03	0.02	0.07*
	(0.063)	(0.056)	(0.106)	(0.036)	(0.036)	(0.153)	(0.037)
Third tercile	0.17**	0.19***	-0.17	0.04	0.05	-0.15	0.07*
	(0.079)	(0.069)	(0.113)	(0.043)	(0.043)	(0.180)	(0.040)
Occupational characteristics							
>10% agriculture	-0.01	-0.04		-0.01	-0.01		-0.05
	(0.072)	(0.062)		(0.040)	(0.038)		(0.035)
>10% textiles	0.40***	0.26***		0.05	0.03		0.03
	(0.112)	(0.097)		(0.041)	(0.041)		(0.035)
>10% minerals	-0.06	-0.00		-0.09***	-0.07**		-0.05
	(0.082)	(0.071)		(0.033)	(0.033)		(0.029)
% White collar	0.10**	-0.02		0.05***	0.01		0.03*
	(0.045)	(0.033)		(0.018)	(0.018)		(0.015)
Town fixed effects	N	N	Y	N	N	Y	N
Year fixed effects	Y	Y	Y	Y	Y	Y	Y
Observations	10493	10493	10493	10493	10493	10493	10493
R-squared	0.23	0.37	0.14	0.06	0.07	0.06	-

Coefficients for specification (7) are average marginal effects for comparability with the OLS estimates. Standard errors are clustered by town, and displayed in parentheses. All variables are standardized except for dummy variables. "Transfers p.c. county roads" is the estimated revenue received from county councils for maintenance of main roads; "Transfers p.c. other" captures all other transfers from both county councils and central government.

* p<0.10, ** p<0.05, *** p<0.01

Table 2 presents the main robustness tests discussed in the previous section.[38] In specifications (1) to (4) I restrict the sample to condition on whether towns borrowed at all—that is, these specifications include only positive values of spending out of loans.[39] As we can see, there is consistent evidence of a negative effect with, as we would anticipate, a larger coefficient. Further, these results are similar when controlling for both the lagged interest rate and the lagged stock of loans outstanding—further evidence that the effect of the interest rate is not capturing past differences in borrowing decisions or access to capital markets. We thus do not see any evidence that the negative relationships in Table 1 are due to towns only seeking out (or paying fixed costs to obtain) low interest rates when they have sufficiently high demand.

Specifications (5) and (6) present the results of a "placebo" test, providing further evidence that the coefficient for the interest rate is not capturing higher demand for infrastructure. There is no evidence of a relationship between the interest rate and current (non-loan) expenditure on sanitation. In contrast, the coefficient on the tax base variable has a similar size to that in Table 1, suggesting that the null effect is not due to noise in the current expenditure variable. The interest rate does not, therefore, appear to be picking up any heterogeneity in the demand for public goods that is not directly related to borrowing.

Additional results, presented in Online Appendix C, show that lower interest rates were associated with higher investment in each category of infrastructure—indicating that the negative coefficients are not capturing heterogeneity in interest rates due to loans being used for different purposes. We could observe spurious correlations if, for some reason, interest rates for sanitation

[38] Online Appendix C presents full results of the additional robustness tests referred to in this section.
[39] Restricting the sample in this way allows me to test robustness to logging the dependent variables—again there is clear evidence of a strong negative relationship.

loans were generally lower than other purposes. In that case a town demanding relatively more sanitation investment would mechanically pay an overall lower interest rate on their loans. In fact however, the findings are similar when re-estimating the regressions separately for each component of sanitation investment, for non-sanitation investment, and for total investment.

The results are also robust to alternative specifications and excluding potential outliers. The results are similar when using the lagged interest rate as the main independent variable, or deflating investment by the tax base (rather than population). Including the lagged stock of loans outstanding as an additional control also does not significantly change the estimates, consistent with the argument that the towns had not reached any "saturation" point in the level of investment. Finally, the estimated relationship is the same including only three cross-sections (1887, 1895 and 1903) to avoid issues with autocorrelation, or excluding extreme values for either the interest rate (defined as the top 5% or bottom 5% of values in each year), or the dependent variables (the top 10% of positive values by year).

Table 2: Additional specifications suggest negative relationship is not due to reverse causality.

	Standardized dependent variables						
	Spending out of loans p.c. (conditional on borrowing)					Current spending p.c. (Placebo test)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Average interest rate	-0.40***	-0.42***	-0.41***	-0.45***	-0.43***	-0.02	0.00
	(0.050)	(0.066)	(0.063)	(0.075)	(0.072)	(0.012)	(0.007)
Lag interest rate				-0.11***	-0.14***		
				(0.032)	(0.035)		
Lag loans outstanding p.c.			-0.40**		-0.43*		
			(0.204)		(0.228)		
Tax base p.c.	0.17***	0.16*	0.20*	0.09	0.15	0.33***	0.24***
	(0.039)	(0.091)	(0.105)	(0.093)	(0.108)	(0.039)	(0.039)
Property receipts p.c.	0.04	0.13	0.18	0.15	0.19*	0.01	0.01
	(0.064)	(0.109)	(0.108)	(0.113)	(0.112)	(0.015)	(0.005)
Tolls and trading revenue p.c.	0.05**	0.09	0.25	0.08	0.25	0.11***	0.05**
	(0.024)	(0.122)	(0.198)	(0.132)	(0.215)	(0.024)	(0.024)
Transfers p.c.: county roads	-0.03	-0.05	-0.05*	-0.05	-0.05	0.42***	0.25***
	(0.021)	(0.033)	(0.031)	(0.033)	(0.031)	(0.042)	(0.035)
Transfers p.c.: other	0.01	-0.05**	-0.03	-0.04***	-0.03	0.01	0.02
	(0.022)	(0.020)	(0.022)	(0.016)	(0.020)	(0.025)	(0.014)
Population							
10,000-25,000	-0.16***	0.21	0.23	0.24	0.27	0.12**	0.05
	(0.056)	(0.233)	(0.242)	(0.253)	(0.262)	(0.057)	(0.058)
>25,000	-0.24***	0.36	0.41	0.35	0.41	0.19**	0.05
	(0.071)	(0.272)	(0.299)	(0.292)	(0.322)	(0.085)	(0.098)
Population density							
Second tercile	0.00	0.07	0.06	0.06	0.05	-0.11*	-0.11
	(0.063)	(0.220)	(0.217)	(0.267)	(0.258)	(0.058)	(0.157)
Third tercile	0.01	-0.10	-0.12	-0.12	-0.14	-0.08	-0.23
	(0.077)	(0.253)	(0.254)	(0.280)	(0.276)	(0.072)	(0.180)
Occupational characteristics							
>10% agriculture	0.10					0.12**	
	(0.062)					(0.058)	
>10% textiles	-0.03					0.01	
	(0.060)					(0.061)	
>10% minerals	-0.06					-0.10*	
	(0.049)					(0.053)	
% White collar	-0.03					0.11***	
	(0.023)					(0.034)	
Town fixed effects	N	Y	Y	Y	Y	N	Y
Year fixed effects	Y	Y	Y	Y	Y	Y	Y
Observations	5958	5958	5617	5617	5617	10493	10493
R-squared	0.08	0.06	0.07	0.07	0.08	0.48	0.36

See notes to Table 1. * p<0.10, ** p<0.05, *** p<0.01

Although not our main focus, the results in Table 1 also suggest that interventions by Parliament to relieve town financial constraints could have expedited sanitation investment. The level of the tax base per capita is consistently positive, as is revenue from tolls and trading activities: towns with more revenue sources invested more in infrastructure. Surprisingly, there is a negative correlation between revenue from road grants and investment—suggesting a "crowding out" effect. Further specifications indicate that, indeed, this negative relationship is driven by spending on streets: transfers offered towns an alternative to borrowing. However, the overall effect on street spending (i.e., when also including current expenditure) is positive—crowding out of expenditure was not complete. Although we cannot test whether the money was used efficiently, it appears that the limited grants for sanitation were effective in raising expenditure. More central funding for public goods could, plausibly, have encouraged towns to invest greater amounts earlier.

6 Discussion

The findings in this paper indicate that high interest rates deterred investment in sanitation infrastructure in Britain—and hence potentially delayed urban mortality decline. The estimates in Table 1 imply that if the government had been willing to lend to councils at its own cost of borrowing (the consol rate), total investment in sanitation between 1887 and 1903 would have been 34–40% higher, leading to the stock of infrastructure being 23–27% greater in 1903.[40]

The benefit of reducing the cost of borrowing is not only visible with the benefit of hindsight. Reducing the cost of capital to stimulate local government investment was debated in England from at least 1870s onward, with an 1884 Royal Commission going as far as to state that "the general principle…is that the State should lend at the lowest rate possible without loss to the national exchequer".[41] These suggestions were repeatedly rejected by the Treasury, whose concern was the risk of rapidly growing local debt for the national finances.[42] Even without subsidizing rates, Parliament could have facilitated access to private capital markets by allowing private loans to be traded, or by reducing the regulations regarding the terms on which funds could be borrowed. The confusing mass of statutes and legislative provisions regarding local authority borrowing was not rationalized until the 1930s, despite several opportunities—particularly in 1875—to do so.[43]

[40] The range here is based on specifications (5) and (6) in Table 1, calculated using the change in predicted values from the change in interest rate. Only towns with observations in every year are included to ensure comparability between the numerator and denominator. Estimates from the Tobit specification (7) are even higher (87% increase in spending, and consequently an 60% increase in infrastructure stock) because the large change in interest rate means that nearly all towns are predicted to invest each year—at which point it seems investment opportunities may have been exhausted. This specification also relies on strong assumptions regarding an unobservable latent variable, and so I focus on the OLS estimates.

[41] *Royal Commission on the Housing of the Working Classes* (PP 1884-85 [C.4402 C.4402-I C.4402-II] XXX. 87, 819), p40. The Commission recommended a cost of borrowing of 3.125% percent at a time when the consol rate was 3%.

[42] Bellamy *Administering central-local relations*, pp 90-95.

[43] Page *Local authority borrowing*, p137.

We should also, however, also acknowledge Parliament's successes in stimulating municipal investment. Despite the drawbacks identified here, it is important to emphasize that due to the Public Works Loans Board all towns were able to borrow and invest. Furthermore, by enforcing the need for local audits, and for towns to receive approval for their works before borrowing, they likely facilitated the provision of even private loans. In the United States, it has been argued that constitutional provisions to protect municipal bondholders solved the problem of credible commitment and hence reduced town borrowing costs.[44] These innovations in the UK seem likely to have served a similar purpose by reassuring lenders that their funds would be spent and managed appropriately.

The findings here point to the need for greater understanding of the ways in which urban councils were—and were not—able to access capital markets, both in Britain and beyond. The historical evidence for England and Wales suggests that the ability to obtain Local Acts of Parliament was critical to obtaining cheap capital, but the process through which those Acts were obtained has been little studied.[45] More generally, more quantitative work is needed to understand whether and to what extent central government intervention was required to facilitate local authority borrowing, and hence stimulate sanitation investment.

Better understanding the ways in which councils accessed capital markets can, in turn, help provide better tests of the causal relationship between borrowing costs and investment. This paper has established clear evidence of a negative relationship between the interest rate and public goods investment, controlling for the most obvious confounding factors—town wealth, alternative revenue sources, town population and density, and occupational differences. Ideally we would

[44] Troesken, *Pox of liberty* pp116-123.
[45] Harris and Hinde 'Sanitary investment', p354.

build on this result by implementing a quasi-experimental design with a clearly delineated break in the interest rate. Better identification would not only establish causality more rigorously, but could also pin down the mechanism and improve estimation of the effect size. Further investigation of local government finance should be a priority for researchers interested in either sanitation investment or historical mortality decline.

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A. Appendix

A.1 Descriptive statistics

Appendix Table 1 presents the descriptive statistics for the main variables referred to in the paper.

Appendix Table 1: Descriptive statistics

	N	Min	Mean	Median	Max	SD
Financial Variables						
Average interest rate	10,493	0.03	3.68	3.65	16.00	0.74
Sanitary loans outstanding p.c.	10,493	0.00	3.04	1.92	29.38	3.52
Sanitary spending out of loans p.c.	10,493	0.00	0.21	0.02	14.04	0.56
Tax base p.c.	10,493	1.06	4.44	4.18	21.75	1.67
Property receipts p.c.	10,493	0.00	0.05	0.01	13.47	0.17
Tolls and trading revenue p.c.	10,493	0.00	0.21	0.03	3.48	0.39
Transfers p.c.: county roads	10,493	0.00	0.08	0.05	2.68	0.11
Transfers p.c.: other	10,493	0.00	0.05	0.02	2.62	0.10
% of total loans outstanding for:						
Total sanitation	10,464	0%	69%	75%	100%	30%
Water supply	10,464	0%	26%	13%	100%	31%
Sewers	10,464	0%	30%	19%	100%	31%
Streets	10,464	0%	13%	5%	100%	19%
Population						
1881	657	405	16,577	6,061	552,508	40,603
1891	657	389	19,428	6,557	517,980	47,426
1901	657	331	22,950	7,713	684,958	56,555
1911	657	380	26,128	8,767	746,421	64,040
1891 Density (popn/acre)	656	0	8	4	182	12
Occupation (% 1881 labor force)						
% Agriculture	657	0%	12%	9%	58%	10%
% Textiles	657	0%	11%	2%	64%	18%
% Minerals	657	2%	13%	6%	69%	15%
% White collar	657	1%	5%	5%	24%	3%

Note: Table displays values for the regression sample only. Number of observations in second panel is reduced due to towns with no loans outstanding.
Source: See Section 2.

A.2 Data sources and variable definitions

Financial accounts data

From 1873 the *Local Taxation Returns* contain annual accounts for the urban sanitary authorities set up under the 1872 Public Health Act. Municipal boroughs (incorporated towns) also reported separate accounts relating to their activities as a borough and as a sanitary authority: I combine the two.

Financial variables

This section details the composition of the financial variables used in the paper.[46]

Outstanding loan stock: The *Local Taxation Returns* report only total loans outstanding prior to 1884. After 1884, the loan stock is disaggregated into several components: I define "sanitation loans" as those referring to "Waterworks", "Sewerage and sewage disposal works" and "Street improvements". Table B.1 in the online appendix provides more detail on the precise types of infrastructure that are likely to be included, as well as the estimated length of loan repayment, which proxies the expected life of the assets.[47] The latter fact provides justification for the assumption that the outstanding loan stock represents a good proxy for the infrastructure stock in a town—as the loan was decided to depreciate at a similar rate to the underlying assets.

Current and capital expenditure: I distinguish between capital and current spending based on whether the expenditure was funded "not out of loans" or "out of loans". Expenditure on sanitation is comprised of spending in the three categories "Waterworks", "Sewerage and sewage disposal

[46] The precise item headings vary over time in the accounts, requiring some categories to be reconstituted: here I give example headings to convey the main items contained in each variable.
[47] *Select Committee on Repayment of Loans* (PP 1902, VIII.239), Appendix 1

works" and "Street improvements".

Average interest rate: The average interest rate is calculated using expenditure on interest payments, divided by the average of the total outstanding loan stock at the end of the year and the end of the previous year.

Taxes: All revenue from "rates"—including borough rates, general district rates, and other rates—except water and gas rates.

Rateable Value: Municipal boroughs report different rateable values as a borough and as a sanitary authority. I use the maximum of the two.

Property Revenue: Items such as "Rents and Profits of Property and Land, including Dividends", "Sales of Land", and "Sale of Securities in which Sinking Funds were invested".

Tolls and Trading Revenue: The variable used in the regressions consists of all revenue from "Market Rents , Tolls, Dues, and Duties", "Penalties, Fines and Fees", and revenue from public works and services including "Gas Works", "Electric Light Undertakings", "Tramways", "Public Libraries, Museums, and Schools of Science and Art", and "Other Public Works and Purposes".

Transfers: This category consists of payments from both central government and other local authorities. Payments from central government include i) "Treasury Subventions and Payments", which includes items such "Pay and Clothing of Police", "Prosecutions, Maintenance, and Conveyance of Prisoners, etc", and "Maintenance of Lunatics chargeable to the Borough" (after 1890, these items were distributed via county councils – see below) ii) (from 1898 onward) "Grants under the 1896 Agricultural Rates Act", which allowed agricultural land to be rated at half its value for poor rates and a quarter for district rates—with the central government making up any shortfall. In addition, after 1890 county boroughs received money directly from the "Exchequer

Contribution Account" – money that other councils would receive via county councils.

Prior to 1890, payments from other local authorities include "Receipts from other authorities" and "County Authority Contribution for Main Roads". After 1890, the transfers discussed in the previous paragraphs are received via County Councils under the "Exchequer Account". In addition, a further category of "From County Councils: Other receipts" is listed—predominantly consisting of payments for main roads.

I distinguish between grants targeted for road maintenance and other grants. To do so, I estimate transfers for roads as either those for main roads (where available) or as "other" receipts from County Councils after 1890. Unfortunately from 1898 receipts from County Councils are not disaggregated in this way for non-municipal boroughs. As such, I estimate this variable by assuming that the percentage of the total receipts from the County Council accounted for by the "Other" category remains constant for each town after this point.

Census information

Information regarding town population and area is drawn from the reports of the decennial census between 1851 and 1911. Information for the years 1851–1901 was collected directly. For the 1911 census I use the parish-level data stored at the UK data archive.[48] Intercensal population was estimated using geometric interpolation, adjusting for boundary changes identified in the census reports.

I estimate the proportion of the work force in various occupations using the 100% sample of the 1881 census.[49] Unfortunately, the census only identifies individuals' parish and registration of

[48] Southall *Parish-Level Population Statistics.*
[49] The 100% census sample was collected by Schürer and Higgs *Integrated Census Microdata* and obtained from Minnesota Population Center *North Atlantic Population Project.*

residence—not the town in which they lived. I therefore match each town to registration sub-districts. If the town was entirely within a single sub-district, I assigned the value in that sub-district to the town. Where towns were split across several registration sub-districts, I estimated town characteristics by weighting according to the proportion of the town population in each sub-district.

Online Appendix: Not Intended For Publication

Appendix for "Financing sanitation infrastructure in nineteenth-century England and Wales"

This online appendix contains two sections:

Appendix B: Additional details of town sanitary investment between 1848 and 1903.

Appendix C: Additional empirical specifications mentioned in the main text.

Appendix B: Additional historical background

This Appendix provides additional information on the development of town sanitation in England and Wales before 1900. The first subsection identifies the means towns used to gain sanitary authority before the 1872 Public Health Act. The second uses the financial dataset to analyze the development of municipal trading in England and Wales. The final subsection then presents information relating to the usual length of loan repayment, giving an indication of the useful life of sanitation infrastructure funded by loans.

B1. Local Acts and sanitary authority before 1872

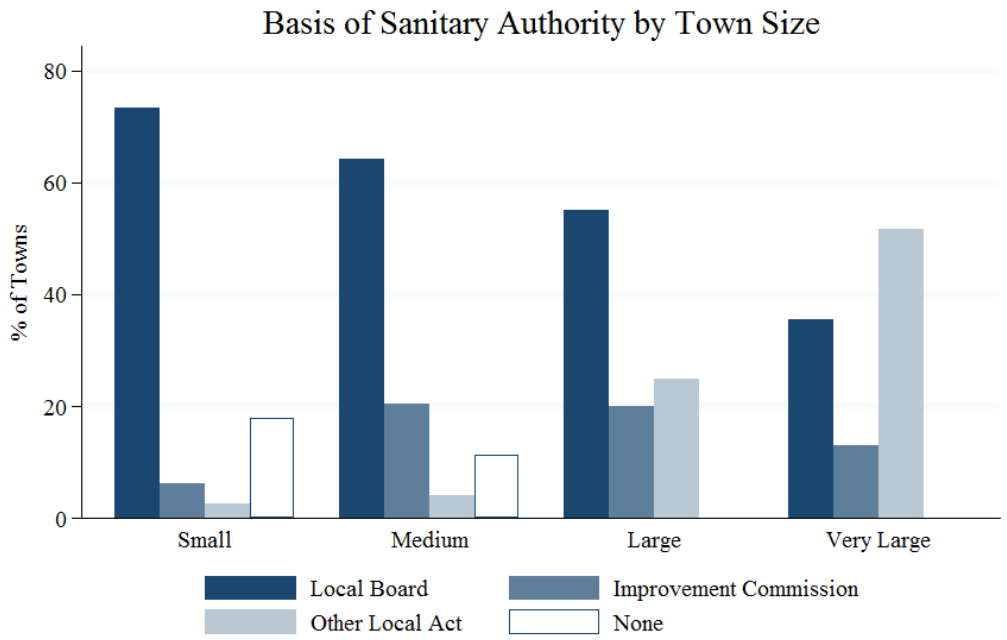
The advantage large towns held in gaining Local Acts of Parliament is exemplified by the process of gaining sanitary authority at all prior to 1872, as shown in Figure A.1. Before the 1872 PHA towns had to opt-in to the power of gaining sanitary authority and, prior to 1848, such powers were obtainable only on a case by case basis through private acts of Parliament ("Improvement Acts"), which imposed an often prohibitive cost on smaller and poorer towns.[1] Few towns obtained powers in such a way: even amongst towns between 50,000 and 100,000 population, only 43% gained sanitary authority under such an Act, and amongst smaller towns the proportion was even lower. Under the PHA, in contrast, local taxpayers ("ratepayers") were given a straightforward procedure to establish a local board of health with standardized powers over sanitary expenditure.[2] Almost 70% of towns had obtained sanitary authority in this way by 1871—however by doing so they did not obtain some of the borrowing powers held by the larger towns that obtained a Parliamentary Act—including the right to raise stock, with the associated

[1] Wilson 'Finance'.

[2] The 1848 Public Health Act was extended by the 1858 Local Government Act, and many authorities acquired powers under the latter legislation. I refer to both as the 1848 Act for simplicity.

disadvantages discussed in the main paper. As such they were not able to avail themselves of low cost alternatives to PWLB loans when they arose in the 1880s and beyond.

Figure B.1: Provisions of 1848 Public Health Act were widely taken up widely, except in largest towns.



Note: "Local Board" includes boards created under the 1848 Public Health Act or the 1858 Local Government Act. "Improvement Commission" includes boards established as local improvement commissions. "Other local act" includes towns where sanitary authority was obtained under a different form (for municipal boroughs only). Town size based on 1871 population: Small: <10000 population, Medium: 10-25,000, Large: 25,000-50,000, and Very Large=above 50,000.

Source: *Census of England and Wales, 1871* (PP 1872 [Cd. C.676]), *Returns showing Boroughs* (PP 1874 (304) LVI.853) and *Local Taxation Returns* data discussed in Section 2.

B2. Municipal trading between 1884 and 1903

The accounts also allow us to estimate the extent to which towns were making profits on their trading activities. Previous authors have emphasized that towns would use gas, tram and electricity undertakings to subsidize other activities—water supply, on the other hand would generally make a loss.[3]

I identify a trading operation in the annual accounts if a town has both current revenue and current expenditure in a single year. Profits cannot directly be calculated in the period we study because loan charges (interest and principal) are not separated by activity. However, we can estimate the extent to which a town made a profit by apportioning these charges according to the proportion of the outstanding stock attributed to that entity. That is, we calculate

$$GrossProfit_i = Revenue_i - CurrentExpenditure_i \quad (2)$$

and estimate:

$$NetProfit_i = GrossProfit_i - \left(\frac{LoansOutstanding_i}{LoanOutstanding_{Total}}\right) \cdot LoanMaintenance_{Total} \quad (3)$$

where *i* in each case refers to the entity (for instance, water or gas supply).

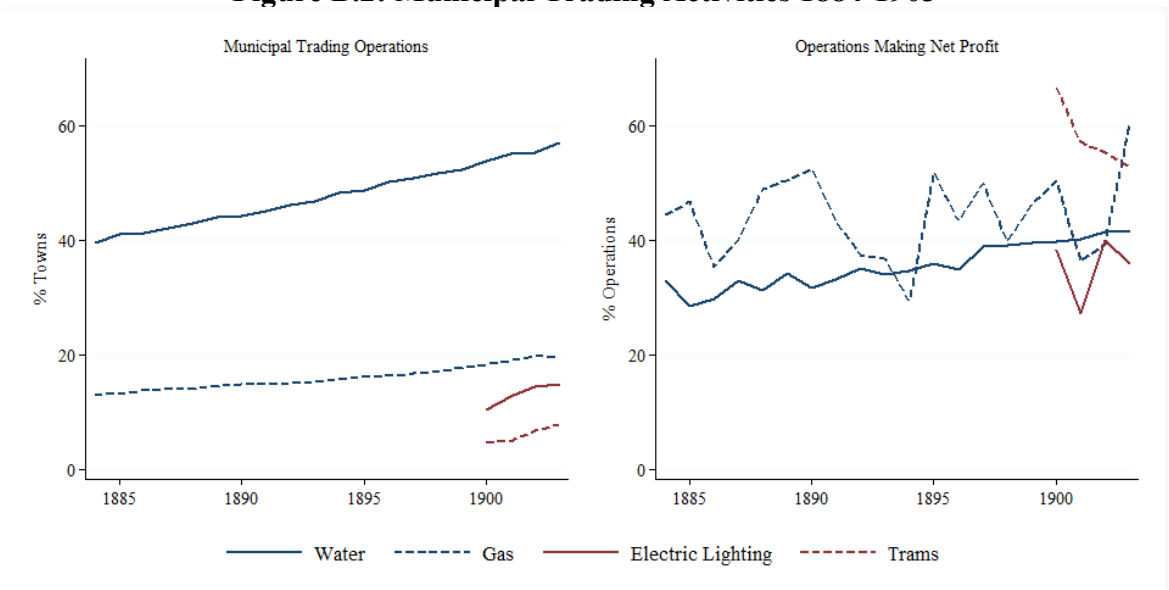
The results of this analysis, summarized in Figure A.2, suggest that, in general, trading profits were not a widespread contributor to town revenue. The left hand panel shows that these trading activities were not widespread across the sample—and less than two-thirds of towns had even water supply operations in 1900.[4] Further, as shown in the right hand panel, most operations were not making profits that could subsidize other operations. Finally, the profits that were made were not huge—the median gas profit was 12% of rate revenue; for water 8%, and just 2% for each of

[3] Millward and Sheard 'Urban fiscal problem'.

[4] The figures for electric light and tram undertakings may be slightly underestimated by this analysis, as they are not split out for non-municipal boroughs during this period. However, the difference is likely to be small—in 1904, only 26 of the of non-municipal boroughs reported outstanding loans in electricity lighting for instance (data for trams was not reported.)

Trams and Electric Lighting.

Figure B.2: Municipal Trading Activities 1884-1903



Note: A town is identified as having a trading activity if they report current revenue and expenditure in that year. Electric Lighting and Gas are only reported as separate categories from 1900 onwards, and only for municipal boroughs. Net profit is calculated based on estimated loan charges: see text for details.
Source: See Section 2.

A comparison to more detailed trading accounts from 1902 supports the conclusion that trading activities did not make a major contribution to rates—although the rate of profit making may have been higher than shown in Figure 3. The report of the *Royal Commission on Local Taxation* (PP 1901 [Cd. 638] XXIV.413) provides detailed profit and loss figures for undertakings in municipal boroughs averaged across the four year period 1898—1902—accounting for operating expenses, depreciation, and also loan maintenance payments. Doing so, it appears that the accounts methodology may underestimate the percentage of profit-making enterprises: 77% of gas and 54% operations are profit-making—whereas the estimated rates for the same entities in a single year (1901) using the methodology above are 54% and 35% respectively. The estimated contribution of profits to rates is, however, similar: around 9% of rate revenue for profit-making gas entities, 4% for water supply –and even less for trams and electricity supply.

B3. Repayment length of loans sanctioned by Local Government Board

Table B.1 shows the usual length of repayment on sanitary infrastructure on loans sanctioned by the Local Government Board. The repayment length was determined based on the expected life of the asset.[5]

[5] Loans were often granted for longer than these usual periods (see *Select Committee on Repayment of Loans*, Appendix 4). However, the life of works was frequently shorter than the repayment period (Select Committee on Repayment of Loans, Qus 17-18 and Appendix 29).

Table B.1: Usual length of loans granted for sanitation purposes

Purpose of Loan	Usual Payment Period (Years)
Sewers	
Tanks, filters etc.	30
Sewage lifts	30
Shone's ejector	15
Polarite	10
Sludge presses	10
Farm Stock	5-10
Street	
First formation	20
Excavation and filling	30
Concrete foundation	20
Granite paving	20
Wood paving (hard)	Up to 10
Wood paving (soft)	Up to 5
Sanitary block or asphalt paving	10
Macadam	5
Kerbing and channeling	15-20
Trees on roads	10
Water supply	
Mains and pipes	30
Reservoirs	30
Water towers	30
Experimental works (boring)	5
Waste water meters	10
Purchase of existing undertaking	Up to 30

Source: *Select Committee on Repayment of Loans* (PP 1902, VIII.239), Appendix 1.

Appendix C: Additional empirical results

This Appendix presents the results of additional empirical specifications discussed in the main text, in the following tables:

Table C1: Correlates of interest rates.
Table C2: Robustness to including lagged loan stock.
Table C3: Results with lagged interest rate.
Table C4: Robustness to excluding observations with extreme interest rates.
Table C5: Robustness to excluding observations with extreme values of dependent variable.
Table C6: Robustness to limiting sample to 3 cross sections.
Table C7: Results including only observations with strictly positive dependent variables.
Table C8: Results with logged dependent variables.
Table C9: Results for investment in water supply.
Table C10: Results for investment in sewers.
Table C11: Results for investment in streets.
Table C12: Results for investment in non-sanitation infrastructure.
Table C13: Results for total investment in infrastructure.
Table C14: Results with investment deflated by tax base.
Table C15: Results with current expenditure as dependent variable.
Table C16: Results with total expenditure as dependent variable.

Table C1: Correlates of interest rates.

	DV = Average Interest Rate:			
	(1)	(2)	(3)	(4)
Population				
10,000 – 25,000	-0.17***		-0.17***	-0.15***
	(0.030)		(0.030)	(0.029)
>25,000	-0.28***		-0.25***	-0.25***
	(0.031)		(0.031)	(0.030)
Tax base p.c.				
Second tercile		-0.13***	-0.09**	-0.05
		(0.038)	(0.037)	(0.036)
Third tercile		-0.18***	-0.13***	-0.06
		(0.038)	(0.038)	(0.037)
Year fixed effects	N	N	N	Y
Observations	10536	10536	10536	10536
R^2	0.02	0.01	0.03	0.12

Standard errors are clustered by town, and displayed in parentheses.
* p<0.10, ** p<0.05, *** p<0.01.

Table C2: Robustness to including lagged loan stock.

	Standardized dependent variables						
	Loans outstanding p.c.			Spending out of loans p.c.			
	OLS	OLS	OLS	OLS	OLS	OLS	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Average interest rate	-0.04***	-0.04***	-0.05***	-0.19***	-0.19***	-0.24***	-0.27***
	(0.004)	(0.004)	(0.006)	(0.021)	(0.021)	(0.029)	(0.021)
Tax base p.c.		0.01	0.03**		0.05**	0.10*	0.02
		(0.004)	(0.013)		(0.020)	(0.054)	(0.017)
Lag sanitation loans outstanding p.c.	0.97***	0.97***	0.84***	0.18***	0.18***	-0.17**	0.16***
	(0.005)	(0.006)	(0.029)	(0.020)	(0.025)	(0.083)	(0.016)
Property receipts p.c.		-0.00	-0.00		-0.01	0.00	-0.05**
		(0.003)	(0.001)		(0.011)	(0.012)	(0.023)
Tolls and trading revenue p.c.		0.01**	0.02		0.01	0.05	0.00
		(0.003)	(0.016)		(0.018)	(0.087)	(0.012)
Transfers p.c.: county roads		-0.00**	-0.01**		-0.02*	-0.05**	-0.01
		(0.002)	(0.004)		(0.012)	(0.020)	(0.011)
Transfers p.c.: other		-0.00	-0.01		-0.03*	-0.03**	-0.04***
		(0.005)	(0.006)		(0.015)	(0.014)	(0.011)
Population							
10,000-25,000	0.00	-0.00	0.04	-0.01	-0.02	0.21	0.11***
	(0.006)	(0.006)	(0.027)	(0.035)	(0.035)	(0.156)	(0.029)
>25,000	0.01	0.00	-0.03	-0.08*	-0.08*	0.29	0.10***
	(0.009)	(0.008)	(0.058)	(0.046)	(0.045)	(0.208)	(0.037)
Population density							
Second tercile	-0.00	-0.00	-0.03	0.02	0.02	0.01	0.05*
	(0.005)	(0.006)	(0.027)	(0.031)	(0.031)	(0.158)	(0.031)
Third tercile	0.00	0.00	-0.07**	0.01	0.02	-0.17	0.04
	(0.007)	(0.007)	(0.033)	(0.037)	(0.038)	(0.185)	(0.035)
Occupational characteristics							
>10% agriculture	-0.00	-0.00		-0.01	-0.00		-0.05
	(0.006)	(0.006)		(0.034)	(0.034)		(0.030)
>10% textiles	0.00	0.00		-0.02	-0.02		-0.02
	(0.006)	(0.006)		(0.032)	(0.033)		(0.029)
>10% minerals	-0.01**	-0.01**		-0.08***	-0.07***		-0.05*
	(0.005)	(0.005)		(0.027)	(0.027)		(0.025)
% White collar	-0.00	-0.00		0.03**	0.01		0.03**
	(0.002)	(0.003)		(0.013)	(0.015)		(0.013)
Town fixed effects	N	N	Y	N	N	Y	N
Year fixed effects	Y	Y	Y	Y	Y	Y	Y
Observations	10493	10493	10493	10493	10493	10493	10493
R-squared	0.96	0.96	0.74	0.09	0.09	0.06	-

Standard errors are clustered by town, and displayed in parentheses. All variables are standardized except for dummy variables. "Transfers p.c. county roads" is the estimated revenue received from county councils for maintenance of main roads; "Transfers p.c. other" captures all other transfers from both county councils and central government.
* p<0.10, ** p<0.05, *** p<0.01

Table C3: Results with lagged interest rate

	Standardized dependent variables						
	Loans outstanding p.c.			Spending out of loans p.c			
	OLS	OLS	OLS	OLS	OLS	OLS	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lag interest rate	-0.13***	-0.10***	-0.08***	-0.13***	-0.13***	-0.13***	-0.15***
	(0.016)	(0.014)	(0.009)	(0.016)	(0.016)	(0.018)	(0.015)
Tax Base p.c.		0.24***	0.13***		0.08***	0.06	0.06***
		(0.044)	(0.042)		(0.020)	(0.048)	(0.019)
Property Receipts p.c.		-0.03	0.01		-0.02	0.00	-0.06**
		(0.016)	(0.007)		(0.012)	(0.011)	(0.027)
Tolls and Net Trading Revenue p.c.		0.23***	0.07		0.06***	0.03	0.04***
		(0.046)	(0.051)		(0.019)	(0.085)	(0.012)
Transfers p.c.: County Roads		-0.03	0.00		-0.03**	-0.04***	-0.02
		(0.021)	(0.012)		(0.013)	(0.015)	(0.013)
Transfers p.c.: Other		0.23***	0.03**		0.02	-0.03**	0.01
		(0.051)	(0.014)		(0.017)	(0.013)	(0.011)
Population							
10,000-25,000	0.15**	-0.01	0.09	0.04	0.01	0.21	0.13***
	(0.071)	(0.064)	(0.071)	(0.039)	(0.039)	(0.175)	(0.033)
>25,000	0.86***	0.28**	-0.07	0.12**	0.01	0.30	0.17***
	(0.144)	(0.122)	(0.199)	(0.054)	(0.053)	(0.218)	(0.043)
Population density							
Second Tercile	0.05	0.08	-0.09	0.04	0.04	-0.03	0.07*
	(0.064)	(0.058)	(0.103)	(0.037)	(0.037)	(0.181)	(0.038)
Third Tercile	0.17**	0.19***	-0.17	0.05	0.05	-0.20	0.07
	(0.080)	(0.070)	(0.110)	(0.044)	(0.044)	(0.201)	(0.042)
Occupational characteristics							
>10% Agriculture	-0.01	-0.04		0.01	0.00		-0.05
	(0.073)	(0.063)		(0.041)	(0.040)		(0.036)
>10% Textiles	0.39***	0.25**		0.07*	0.05		0.06
	(0.114)	(0.098)		(0.042)	(0.041)		(0.036)
>10% Minerals	-0.06	-0.00		-0.10***	-0.08**		-0.06*
	(0.084)	(0.072)		(0.034)	(0.033)		(0.030)
% White Collar	0.10**	-0.02		0.05***	0.02		0.03**
	(0.046)	(0.033)		(0.018)	(0.018)		(0.015)
Town fixed effects	N	N	Y	N	N	Y	N
Year fixed effects	Y	Y	Y	Y	Y	Y	Y
Observations	9815	9815	9815	9815	9815	9815	9815
R-squared	0.23	0.38	0.14	0.04	0.05	0.03	-

Standard errors are clustered by town, and displayed in parentheses. All variables are standardized except for dummy variables. “Total Sanitation” is aggregated spending on Water supply, Sewers, and Streets. “Transfers p.c. county roads” is the estimated revenue received from county councils for maintenance of main roads; “Transfers p.c. other” captures all other transfers from both county councils and central government.
* p<0.10, ** p<0.05, *** p<0.01

Table C4: Robustness to excluding observations with extreme interest rates

	Standardized dependent variables						
	Loans outstanding p.c.			Spending out of loans p.c.			
	OLS	OLS	OLS	OLS	OLS	OLS	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Average interest rate	-0.35***	-0.26***	-0.22***	-0.33***	-0.31***	-0.39***	-0.32***
	(0.050)	(0.044)	(0.019)	(0.026)	(0.026)	(0.035)	(0.024)
Tax base p.c.		0.24***	0.12***		0.07***	0.06	0.05***
		(0.045)	(0.040)		(0.022)	(0.043)	(0.018)
Property receipts p.c.		-0.02	0.01		-0.01	0.00	-0.04*
		(0.014)	(0.007)		(0.011)	(0.011)	(0.024)
Tolls and trading revenue p.c.		0.24***	0.07		0.06***	0.04	0.04***
		(0.047)	(0.050)		(0.019)	(0.080)	(0.012)
Transfers p.c.: county roads		-0.03*	0.00		-0.01	-0.02*	-0.01
		(0.020)	(0.013)		(0.011)	(0.014)	(0.010)
Transfers p.c.: other		0.23***	0.02		0.02	-0.04**	0.00
		(0.045)	(0.016)		(0.017)	(0.016)	(0.010)
Population							
10,000-25,000	0.10	-0.03	0.05	0.04	0.01	0.18	0.09***
	(0.070)	(0.064)	(0.064)	(0.034)	(0.034)	(0.150)	(0.030)
>25,000	0.79***	0.24*	-0.11	0.13***	0.02	0.30	0.13***
	(0.147)	(0.125)	(0.159)	(0.049)	(0.047)	(0.185)	(0.039)
Population density							
Second tercile	0.05	0.06	-0.08	0.04	0.04	0.10	0.06**
	(0.064)	(0.057)	(0.111)	(0.032)	(0.032)	(0.150)	(0.033)
Third tercile	0.20**	0.20***	-0.16	0.06	0.07*	-0.06	0.08**
	(0.082)	(0.072)	(0.123)	(0.037)	(0.037)	(0.190)	(0.036)
Occupational characteristics							
>10% agriculture	-0.02	-0.04		0.01	0.00		-0.04
	(0.075)	(0.064)		(0.039)	(0.038)		(0.033)
>10% textiles	0.36***	0.25**		0.03	0.01		0.00
	(0.117)	(0.101)		(0.041)	(0.040)		(0.034)
>10% minerals	-0.06	-0.00		-0.07**	-0.06*		-0.04
	(0.086)	(0.074)		(0.032)	(0.031)		(0.027)
% White collar	0.10**	-0.02		0.04***	0.01		0.03*
	(0.046)	(0.034)		(0.016)	(0.016)		(0.013)
Town fixed effects	N	N	Y	N	N	Y	N
Year fixed effects	Y	Y	Y	Y	Y	Y	Y
Observations	9459	9459	9459	9459	9459	9459	9459
R-squared	0.24	0.39	0.15	0.07	0.08	0.05	-

Regressions exclude the smallest and largest 5% of observations of the interest rate in each year. Standard errors are clustered by town, and displayed in parentheses. All variables are standardized except for dummy variables. "Transfers p.c. county roads" is the estimated revenue received from county councils for maintenance of main roads; "transfers p.c. other" captures all other transfers from both county councils and central government.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C5: Robustness to excluding observations with extreme values of dependent variable.

	Standardized dependent variables						
	Loans outstanding p.c.			Spending out of loans p.c.			
	OLS	OLS	OLS	OLS	OLS	OLS	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Average interest rate	-0.09***	-0.08***	-0.06***	-0.07***	-0.07***	-0.07***	-0.10***
	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)
Tax base p.c.		0.11***	0.06**		0.02**	0.00	0.01*
		(0.023)	(0.030)		(0.009)	(0.017)	(0.008)
Property receipts p.c.		0.01	0.01*		-0.01	-0.00	-0.03***
		(0.009)	(0.004)		(0.007)	(0.002)	(0.011)
Tolls and trading Revenue p.c.		0.12***	0.04		0.04***	0.05**	0.03***
		(0.022)	(0.031)		(0.009)	(0.023)	(0.006)
Transfers p.c.: county roads		0.01	0.01		-0.00	-0.01	-0.00
		(0.015)	(0.011)		(0.005)	(0.006)	(0.006)
Transfers p.c.: other		0.05**	0.02**		0.01	-0.02**	0.00
		(0.020)	(0.009)		(0.008)	(0.007)	(0.005)
Population							
10,000-25,000	0.08**	0.02	0.05	0.04***	0.02	0.02	0.06***
	(0.040)	(0.039)	(0.054)	(0.014)	(0.014)	(0.036)	(0.014)
>25,000	0.23***	0.07	-0.06	0.15***	0.10***	0.09	0.11***
	(0.069)	(0.069)	(0.074)	(0.025)	(0.025)	(0.071)	(0.020)
Population density							
Second tercile	0.09**	0.10***	-0.09	0.02	0.02	0.07	0.03**
	(0.039)	(0.038)	(0.105)	(0.014)	(0.013)	(0.056)	(0.016)
Third tercile	0.07	0.09**	-0.12	0.04***	0.04***	0.11*	0.05***
	(0.047)	(0.045)	(0.111)	(0.016)	(0.016)	(0.059)	(0.017)
Occupational characteristics							
>10% agriculture	-0.03	-0.05		-0.02	-0.03**		-0.04**
	(0.039)	(0.036)		(0.014)	(0.014)		(0.015)
>10% textiles	0.06	0.03		0.06***	0.04**		0.03*
	(0.045)	(0.043)		(0.018)	(0.017)		(0.015)
>10% minerals	-0.06	-0.03		-0.05***	-0.05***		-0.03**
	(0.039)	(0.036)		(0.015)	(0.014)		(0.014)
% White collar	0.07***	0.02		0.02***	0.01*		0.02***
	(0.022)	(0.020)		(0.007)	(0.007)		(0.007)
Town fixed effects	N	N	Y	N	N	Y	N
Year fixed effects	Y	Y	Y	Y	Y	Y	Y
Observations	9502	9502	9502	9905	9905	9905	9905
R-squared	0.15	0.22	0.14	0.14	0.16	0.09	-

Regressions exclude the largest 10% of positive observations of the relevant dependent variable in each year. Standard errors are clustered by town, and displayed in parentheses. All variables are standardized except for dummy variables. "Transfers p.c. county roads" is the estimated revenue received from county councils for maintenance of main roads; "transfers p.c. other" captures all other transfers from both county councils and central government.
* p<0.10, ** p<0.05, *** p<0.01

Table C6: Robustness to limiting sample to 3 cross sections

	Standardized dependent variables						
	Loans outstanding p.c.			Spending out of loans p.c.			
	OLS	OLS	OLS	OLS	OLS	OLS	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Average interest rate	-0.09***	-0.08***	-0.08***	-0.13***	-0.13***	-0.17***	-0.20***
	(0.019)	(0.017)	(0.021)	(0.031)	(0.030)	(0.043)	(0.029)
Tax base p.c.		0.23***	0.14***		0.10***	0.15*	0.06**
		(0.040)	(0.046)		(0.033)	(0.075)	(0.026)
Property receipts p.c.		-0.04	0.04		-0.03	-0.01	-0.05
		(0.032)	(0.050)		(0.036)	(0.060)	(0.034)
Tolls and trading revenue p.c.		0.24***	0.08		0.05**	0.10	0.04***
		(0.043)	(0.050)		(0.023)	(0.069)	(0.014)
Transfers p.c.: county roads		-0.03	0.01		-0.06**	-0.08	-0.03
		(0.027)	(0.026)		(0.024)	(0.054)	(0.021)
Transfers p.c.: other		0.21***	-0.02		0.02	-0.12**	-0.00
		(0.048)	(0.044)		(0.018)	(0.054)	(0.013)
Population							
10,000-25,000	0.16**	0.02	0.10	0.09	0.05	0.42	0.14***
	(0.066)	(0.060)	(0.102)	(0.063)	(0.062)	(0.265)	(0.046)
>25,000	0.93***	0.35***	-0.10	0.19***	0.05	0.64*	0.20***
	(0.146)	(0.126)	(0.250)	(0.070)	(0.074)	(0.361)	(0.054)
Population density							
Second tercile	0.05	0.07	-0.15	0.14**	0.13**	0.08	0.15***
	(0.063)	(0.060)	(0.183)	(0.058)	(0.056)	(0.322)	(0.051)
Third tercile	0.19**	0.20***	-0.37*	0.12*	0.11*	-0.44	0.14**
	(0.079)	(0.073)	(0.217)	(0.063)	(0.065)	(0.514)	(0.054)
Occupational characteristics							
>10% agriculture	0.02	-0.01		0.05	0.04		-0.00
	(0.070)	(0.062)		(0.058)	(0.057)		(0.047)
>10% textiles	0.45***	0.30***		0.05	0.03		0.03
	(0.112)	(0.097)		(0.060)	(0.060)		(0.047)
>10% minerals	-0.06	-0.02		-0.12**	-0.11**		-0.07*
	(0.083)	(0.070)		(0.048)	(0.048)		(0.038)
% White collar	0.10**	-0.02		0.06***	0.02		0.03
	(0.043)	(0.034)		(0.024)	(0.027)		(0.020)
Town fixed effects	N	N	Y	N	N	Y	N
Year fixed effects	Y	Y	Y	Y	Y	Y	Y
Observations	1852	1852	1852	1852	1852	1852	1852
R-squared	0.23	0.37	0.14	0.06	0.07	0.07	-

Regressions include only observations for 1887, 1895 and 1903. Standard errors are clustered by town, and displayed in parentheses. All variables are standardized except for dummy variables. "Transfers p.c. county roads" is the estimated revenue received from county councils for maintenance of main roads; "transfers p.c. other" captures all other transfers from both county councils and central government.
* p<0.10, ** p<0.05, *** p<0.01

Table C7: Results including only observations with strictly positive dependent variables

	Standardized dependent variables					
	Loans outstanding p.c.			Spending out of loans p.c.		
	OLS	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
Average interest rate	-0.13***	-0.11***	-0.08***	-0.41***	-0.40***	-0.42***
	(0.019)	(0.017)	(0.011)	(0.050)	(0.050)	(0.066)
Tax base p.c.		0.25***	0.13***		0.17***	0.16*
		(0.045)	(0.040)		(0.039)	(0.091)
Property receipts p.c.		-0.02	0.01		0.04	0.13
		(0.014)	(0.006)		(0.064)	(0.109)
Tolls and trading revenue p.c.		0.24***	0.08		0.05**	0.09
		(0.047)	(0.051)		(0.024)	(0.122)
Transfers p.c.: county roads		-0.02	-0.01		-0.03	-0.05
		(0.021)	(0.011)		(0.021)	(0.033)
Transfers p.c.: other		0.23***	0.02*		0.01	-0.05**
		(0.045)	(0.014)		(0.022)	(0.020)
Population						
10,000-25,000	0.14*	-0.02	0.08	-0.13**	-0.16***	0.21
	(0.071)	(0.065)	(0.067)	(0.058)	(0.056)	(0.233)
>25,000	0.84***	0.26**	-0.09	-0.11	-0.24***	0.36
	(0.144)	(0.123)	(0.179)	(0.071)	(0.071)	(0.272)
Population density						
Second tercile	0.05	0.06	-0.07	0.01	0.00	0.07
	(0.065)	(0.058)	(0.107)	(0.065)	(0.063)	(0.220)
Third tercile	0.16*	0.18**	-0.15	0.01	0.01	-0.10
	(0.082)	(0.071)	(0.117)	(0.078)	(0.077)	(0.253)
Occupational characteristics						
>10% agriculture	-0.00	-0.03		0.09	0.10	
	(0.074)	(0.063)		(0.068)	(0.062)	
>10% textiles	0.39***	0.24**		-0.00	-0.03	
	(0.115)	(0.099)		(0.059)	(0.060)	
>10% minerals	-0.06	-0.01		-0.12**	-0.06	
	(0.085)	(0.073)		(0.049)	(0.049)	
% White collar	0.10**	-0.03		0.04*	-0.03	
	(0.046)	(0.033)		(0.024)	(0.023)	
Town fixed effects	N	N	Y	N	N	Y
Year fixed effects	Y	Y	Y	Y	Y	Y
Observations	9979	9979	9979	5958	5958	5958
R-squared	0.21	0.37	0.13	0.07	0.08	0.06

Regressions include only observations with strictly positive values of the relevant dependent variable. Standard errors are clustered by town, and displayed in parentheses. All variables are standardized except for dummy variables. "Transfers p.c. county roads" is the estimated revenue received from county councils for maintenance of main roads; "transfers p.c. other" captures all other transfers from both county councils and central government.
* p<0.10, ** p<0.05, *** p<0.01.

Table C8: Results with logged dependent variables.

	Standardized dependent variables, logged					
	Loans outstanding p.c.			Spending out of loans p.c.		
	OLS	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
Average interest rate	-0.36***	-0.34***	-0.23***	-0.59***	-0.58***	-0.61***
	(0.039)	(0.038)	(0.019)	(0.043)	(0.042)	(0.047)
Tax base p.c.		0.26***	0.10*		0.19***	0.03
		(0.040)	(0.051)		(0.044)	(0.116)
Property receipts p.c.		-0.01	0.01***		0.12*	0.16**
		(0.016)	(0.004)		(0.070)	(0.073)
Tolls and trading revenue p.c.		0.22***	0.03		0.12***	0.25***
		(0.035)	(0.041)		(0.038)	(0.082)
Transfers p.c.: county roads		0.01	0.01		0.02	-0.05
		(0.029)	(0.016)		(0.031)	(0.039)
Transfers p.c.: other		0.13***	0.01		0.06	-0.09***
		(0.034)	(0.008)		(0.045)	(0.029)
Population						
10,000-25,000	0.23***	0.10	0.05	-0.18*	-0.25***	-0.02
	(0.088)	(0.083)	(0.098)	(0.093)	(0.091)	(0.242)
>25,000	0.75***	0.30**	-0.15	0.16	-0.10	0.51
	(0.133)	(0.132)	(0.155)	(0.122)	(0.122)	(0.382)
Population density						
Second tercile	0.26***	0.29***	-0.04	0.04	0.05	-0.20
	(0.098)	(0.094)	(0.120)	(0.102)	(0.102)	(0.332)
Third tercile	0.26**	0.31***	-0.07	0.13	0.15	0.03
	(0.115)	(0.108)	(0.153)	(0.120)	(0.121)	(0.336)
Occupational characteristics						
>10% agriculture	0.02	-0.00		0.12	0.11	
	(0.092)	(0.084)		(0.090)	(0.086)	
>10% textiles	0.28***	0.15		0.18*	0.09	
	(0.105)	(0.096)		(0.104)	(0.101)	
>10% minerals	-0.15*	-0.09		-0.35***	-0.27***	
	(0.089)	(0.080)		(0.093)	(0.086)	
% White collar	0.15***	0.02		0.07*	-0.01	
	(0.047)	(0.041)		(0.039)	(0.041)	
Town fixed effects	N	N	Y	N	N	Y
Year fixed effects	Y	Y	Y	Y	Y	Y
Observations	9979	9979	9979	5958	5958	5958
R-squared	0.22	0.30	0.14	0.10	0.12	0.08

Standard errors are clustered by town, and displayed in parentheses. All variables are standardized except for dummy variables. "Transfers p.c. county roads" is the estimated revenue received from county councils for maintenance of main roads; "transfers p.c. other" captures all other transfers from both county councils and central government.
* p<0.10, ** p<0.05, *** p<0.01

Table C9: Results for investment in water supply.

	Standardized dependent variables						
	Loans outstanding p.c.			Spending out of loans p.c.			
	OLS	OLS	OLS	OLS	OLS	OLS	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Average interest rate	-0.07***	-0.06***	-0.04***	-0.12***	-0.12***	-0.14***	-0.15***
	(0.013)	(0.012)	(0.010)	(0.019)	(0.019)	(0.031)	(0.019)
Tax base p.c.		0.10***	0.07**		0.02	0.02	0.02
		(0.034)	(0.032)		(0.015)	(0.040)	(0.018)
Property receipts p.c.		-0.02	0.00		-0.01	0.01	-0.04*
		(0.014)	(0.006)		(0.010)	(0.012)	(0.024)
Tolls and trading revenue p.c.		0.22***	0.04		0.05**	-0.04	0.07***
		(0.057)	(0.057)		(0.020)	(0.086)	(0.015)
Transfers p.c.: county roads		-0.03*	-0.01		-0.02*	-0.02	-0.01
		(0.018)	(0.008)		(0.010)	(0.012)	(0.015)
Transfers p.c.: other		0.27***	0.01		0.02	-0.05***	0.02
		(0.059)	(0.012)		(0.017)	(0.015)	(0.012)
Population							
10,000-25,000	0.14*	-0.01	0.04	0.02	-0.01	0.02	0.09**
	(0.076)	(0.070)	(0.055)	(0.038)	(0.039)	(0.112)	(0.041)
>25,000	0.84***	0.29**	-0.05	0.10**	0.01	0.02	0.17***
	(0.153)	(0.131)	(0.212)	(0.048)	(0.049)	(0.150)	(0.056)
Population density							
Second tercile	-0.01	-0.00	0.04	0.01	0.00	0.21**	-0.05
	(0.057)	(0.054)	(0.071)	(0.033)	(0.033)	(0.088)	(0.038)
Third tercile	0.12	0.09	-0.00	0.01	-0.00	0.06	-0.05
	(0.076)	(0.070)	(0.076)	(0.037)	(0.039)	(0.107)	(0.044)
Occupational characteristics							
>10% agriculture	0.07	0.04		0.05	0.04		-0.01
	(0.068)	(0.066)		(0.038)	(0.038)		(0.040)
>10% textiles	0.37***	0.24**		-0.00	-0.02		-0.02
	(0.125)	(0.117)		(0.040)	(0.041)		(0.043)
>10% minerals	0.06	0.08		0.01	0.01		0.01
	(0.093)	(0.082)		(0.033)	(0.033)		(0.035)
% White collar	-0.03	-0.08***		0.00	-0.00		-0.01
	(0.037)	(0.030)		(0.015)	(0.014)		(0.020)
Town fixed effects	N	N	Y	N	N	Y	N
Year fixed effects	Y	Y	Y	Y	Y	Y	Y
Observations	10493	10493	10493	10493	10493	10493	10493
R-squared	0.15	0.28	0.05	0.02	0.02	0.02	

Dependent variables relate to investment in water supply. Standard errors are clustered by town, and displayed in parentheses. All variables are standardized except for dummy variables. "Transfers p.c. county roads" is the estimated revenue received from county councils for maintenance of main roads; "transfers p.c. other" captures all other transfers from both county councils and central government.

* p<0.10, ** p<0.05, *** p<0.01

Table C10: Results for investment in sewers.

	Standardized dependent variables						
	Loans outstanding p.c.			Spending out of loans p.c.			
	OLS	OLS	OLS	OLS	OLS	OLS	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Average interest rate	-0.13***	-0.11***	-0.09***	-0.17***	-0.16***	-0.19***	-0.22***
	(0.016)	(0.015)	(0.013)	(0.022)	(0.021)	(0.028)	(0.022)
Tax base p.c.		0.33***	0.19**		0.11***	0.13*	0.09***
		(0.121)	(0.074)		(0.033)	(0.075)	(0.017)
Property receipts p.c.		-0.02	0.01***		-0.02*	-0.01***	-0.05***
		(0.024)	(0.003)		(0.009)	(0.004)	(0.020)
Tolls and trading revenue p.c.		0.05*	0.06		-0.00	0.06	0.01
		(0.032)	(0.044)		(0.016)	(0.066)	(0.010)
Transfers p.c.: county roads		0.05	0.03		-0.01	-0.06*	-0.00
		(0.030)	(0.026)		(0.018)	(0.031)	(0.013)
Transfers p.c.: other		-0.01	0.03***		-0.01	-0.01	-0.01
		(0.025)	(0.011)		(0.016)	(0.014)	(0.011)
Population							
10,000-25,000	0.05	0.01	0.18	-0.01	-0.01	0.35**	0.10***
	(0.075)	(0.074)	(0.124)	(0.040)	(0.039)	(0.173)	(0.031)
>25,000	-0.06	-0.19	-0.07	-0.17***	-0.20***	0.29	0.13***
	(0.114)	(0.119)	(0.150)	(0.047)	(0.048)	(0.185)	(0.039)
Population density							
Second tercile	0.08	0.15**	-0.37**	0.01	0.03	-0.32	0.09**
	(0.094)	(0.075)	(0.186)	(0.040)	(0.037)	(0.257)	(0.037)
Third tercile	0.06	0.18**	-0.39*	0.02	0.05	-0.47	0.07*
	(0.114)	(0.086)	(0.221)	(0.047)	(0.044)	(0.309)	(0.041)
Occupational characteristics							
>10% agriculture	-0.13	-0.12		-0.06	-0.05		-0.07**
	(0.108)	(0.088)		(0.041)	(0.037)		(0.034)
>10% textiles	0.19***	0.14**		0.07**	0.07*		0.12***
	(0.072)	(0.070)		(0.033)	(0.034)		(0.032)
>10% minerals	-0.15**	-0.06		-0.14***	-0.11***		-0.05*
	(0.067)	(0.071)		(0.026)	(0.026)		(0.029)
% White collar	0.25***	0.08		0.04**	-0.01		0.02
	(0.059)	(0.051)		(0.019)	(0.020)		(0.015)
Town fixed effects	N	N	Y	N	N	Y	N
Year fixed effects	Y	Y	Y	Y	Y	Y	Y
Observations	10493	10493	10493	10493	10493	10493	10493
R-squared	0.11	0.18	0.09	0.05	0.05	0.04	-

Dependent variables relate to investment in sewers. Standard errors are clustered by town, and displayed in parentheses. All variables are standardized except for dummy variables. "Transfers p.c. county roads" is the estimated revenue received from county councils for maintenance of main roads; "Transfers p.c. other" captures all other transfers from both county councils and central government.
* p<0.10, ** p<0.05, *** p<0.0

Table C11: Results for investment in streets.

	Standardized dependent variables						
	Loans outstanding p.c.			Spending out of loans p.c.			
	OLS	OLS	OLS	OLS	OLS	OLS	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Average interest rate	-0.05***	-0.03***	-0.02***	-0.08***	-0.08***	-0.08***	-0.11***
	(0.013)	(0.013)	(0.007)	(0.014)	(0.014)	(0.016)	(0.017)
Tax base p.c.		0.17***	-0.00		0.08**	-0.01	0.04*
		(0.047)	(0.065)		(0.031)	(0.061)	(0.021)
Property receipts p.c.		0.01	0.01		-0.00	0.01	-0.02
		(0.031)	(0.009)		(0.014)	(0.013)	(0.027)
Tolls and trading revenue p.c.		0.19***	0.07		0.07*	0.15**	0.04***
		(0.052)	(0.054)		(0.037)	(0.070)	(0.016)
Transfers p.c.: county roads		-0.09***	-0.00		-0.03**	-0.01	-0.06***
		(0.021)	(0.014)		(0.013)	(0.020)	(0.019)
Transfers p.c.: Other		0.03	0.03*		-0.01	0.01	-0.02
		(0.035)	(0.014)		(0.018)	(0.022)	(0.014)
Population							
10,000-25,000	0.10*	0.00	-0.05	0.02	-0.01	-0.03	0.12***
	(0.059)	(0.058)	(0.061)	(0.035)	(0.038)	(0.092)	(0.037)
>25,000	0.96***	0.62***	-0.06	0.42***	0.31***	0.51*	0.33***
	(0.147)	(0.122)	(0.147)	(0.082)	(0.076)	(0.262)	(0.053)
Population density							
Second tercile	0.11**	0.09*	0.09	0.05	0.05	0.14*	0.11**
	(0.054)	(0.053)	(0.070)	(0.033)	(0.032)	(0.082)	(0.044)
Third tercile	0.22***	0.20***	-0.07	0.10***	0.11***	0.29***	0.18***
	(0.069)	(0.067)	(0.108)	(0.039)	(0.040)	(0.107)	(0.047)
Occupational characteristics							
>10% agriculture	-0.07	-0.10		-0.06	-0.07*		-0.08*
	(0.068)	(0.065)		(0.040)	(0.040)		(0.039)
>10% textiles	0.14	0.07		0.07	0.04		0.04
	(0.095)	(0.085)		(0.053)	(0.054)		(0.040)
>10% minerals	-0.21***	-0.17***		-0.10**	-0.08**		-0.09**
	(0.073)	(0.066)		(0.041)	(0.038)		(0.034)
% white collar	0.12***	0.05		0.09***	0.06*		0.07***
	(0.041)	(0.041)		(0.027)	(0.031)		(0.020)
Town fixed effects	N	N	Y	N	N	Y	N
Year fixed effects	Y	Y	Y	Y	Y	Y	Y
Observations	10493	10493	10493	10493	10493	10493	10493
R-squared	0.25	0.31	0.05	0.08	0.09	0.03	-

Dependent variables relate to investment in streets. Standard errors are clustered by town, and displayed in parentheses. All variables are standardized except for dummy variables. "Transfers p.c. county roads" is the estimated revenue received from county councils for maintenance of main roads; "Transfers p.c. other" captures all other transfers from both county councils and central government.
* p<0.10, ** p<0.05, *** p<0.01

Table C12: Results for investment in non-sanitation infrastructure.

	Standardized dependent variables						
	Loans outstanding p.c.			Spending out of loans p.c.			
	OLS	OLS	OLS	OLS	OLS	OLS	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Average Interest Rate (%)	-0.03***	-0.02***	-0.04***	-0.10***	-0.09***	-0.12***	-0.16***
	(0.012)	(0.007)	(0.013)	(0.020)	(0.019)	(0.031)	(0.020)
Tax Base p.c.		0.10***	0.08***		0.09***	0.09**	0.07***
		(0.024)	(0.024)		(0.027)	(0.046)	(0.019)
Property Receipts p.c.		-0.01	0.01		-0.01	0.00	-0.02
		(0.031)	(0.008)		(0.010)	(0.007)	(0.018)
Tolls and Trading Revenue p.c.		0.74***	0.86***		0.23***	0.52***	0.13***
		(0.038)	(0.067)		(0.035)	(0.127)	(0.014)
Transfers p.c.: County Roads		-0.03	-0.01		-0.01	-0.00	-0.01
		(0.025)	(0.012)		(0.021)	(0.027)	(0.015)
Transfers p.c.: Other		0.04**	0.01		-0.01	0.01	-0.01
		(0.018)	(0.009)		(0.013)	(0.012)	(0.008)
Population							
10,000-25,000	0.32***	0.05	0.06	0.11**	0.02	0.11	0.17***
	(0.069)	(0.043)	(0.058)	(0.041)	(0.038)	(0.146)	(0.032)
>25,000	1.22***	0.31***	0.36**	0.43***	0.14***	0.42**	0.29***
	(0.133)	(0.073)	(0.142)	(0.063)	(0.049)	(0.198)	(0.039)
Population density							
Second Tercile	0.10	0.03	-0.03	0.07*	0.06	0.17	0.11***
	(0.059)	(0.042)	(0.089)	(0.036)	(0.036)	(0.129)	(0.036)
Third Tercile	0.11*	0.03	0.06	0.07**	0.06*	0.32**	0.11***
	(0.068)	(0.046)	(0.100)	(0.036)	(0.036)	(0.136)	(0.037)
Occupational characteristics							
>10% Agriculture	0.07	-0.08*		0.01	-0.03		-0.09***
	(0.069)	(0.042)		(0.038)	(0.034)		(0.031)
>10% Textiles	0.31***	-0.02		0.05	-0.05		-0.07**
	(0.106)	(0.053)		(0.047)	(0.042)		(0.031)
>10% Minerals	-0.04	-0.04		-0.06*	-0.04		-0.04*
	(0.075)	(0.040)		(0.036)	(0.031)		(0.025)
% White Collar	0.02	0.00		0.03	-0.01		0.01
	(0.039)	(0.021)		(0.020)	(0.020)		(0.014)
Town fixed effects	N	N	Y	N	N	Y	N
Year fixed effects	Y	Y	Y	Y	Y	Y	Y
Observations	10493	10493	10493	10493	10493	10493	10493
R-squared	0.26	0.72	0.51	0.07	0.13	0.08	-

Dependent variables relate to investment in non-sanitation infrastructure. Standard errors are clustered by town, and displayed in parentheses. All variables are standardized except for dummy variables. "Transfers p.c. county roads" is the estimated revenue received from county councils for maintenance of main roads; "Transfers p.c. other" captures all other transfers from both county councils and central government.
* p<0.10, ** p<0.05, *** p<0.01

Table C13: Results for total investment in infrastructure.

	Standardized dependent variables						
	Loans outstanding p.c.			Spending out of loans p.c.			
	OLS	OLS	OLS	OLS	OLS	OLS	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Average Interest Rate (%)	-0.09***	-0.08***	-0.07***	-0.20***	-0.19***	-0.23***	-0.28***
	(0.012)	(0.010)	(0.011)	(0.021)	(0.021)	(0.031)	(0.022)
Tax Base p.c.		0.21***	0.13***		0.12***	0.12***	0.08***
		(0.029)	(0.030)		(0.023)	(0.045)	(0.018)
Property Receipts p.c.		-0.02	0.01		-0.01	0.00	-0.03*
		(0.020)	(0.008)		(0.012)	(0.010)	(0.019)
Tolls and Trading Revenue p.c.		0.52***	0.47***		0.19***	0.37***	0.12***
		(0.041)	(0.052)		(0.029)	(0.117)	(0.016)
Transfers p.c.: County Roads		-0.03	-0.01		-0.03*	-0.03	-0.02
		(0.021)	(0.012)		(0.016)	(0.021)	(0.013)
Transfers p.c.: Other		0.17***	0.02*		-0.00	-0.02	-0.01
		(0.032)	(0.011)		(0.014)	(0.013)	(0.010)
Population							
10,000-25,000	0.26***	0.02	0.09	0.08*	0.00	0.21	0.12***
	(0.065)	(0.049)	(0.059)	(0.044)	(0.040)	(0.156)	(0.031)
>25,000	1.17***	0.35***	0.12	0.33***	0.07	0.47**	0.17***
	(0.137)	(0.093)	(0.162)	(0.061)	(0.050)	(0.199)	(0.037)
Population density							
Second Tercile	0.08	0.06	-0.08	0.06*	0.06	0.13	0.09***
	(0.055)	(0.045)	(0.095)	(0.038)	(0.037)	(0.128)	(0.034)
Third Tercile	0.16**	0.14***	-0.08	0.08*	0.08*	0.11	0.09**
	(0.067)	(0.052)	(0.092)	(0.041)	(0.040)	(0.149)	(0.036)
Occupational characteristics							
>10% Agriculture	0.03	-0.06		0.00	-0.03		-0.06*
	(0.066)	(0.048)		(0.042)	(0.038)		(0.032)
>10% Textiles	0.42***	0.16**		0.07	-0.02		-0.03
	(0.108)	(0.075)		(0.048)	(0.042)		(0.034)
>10% Minerals	-0.06	-0.02		-0.10***	-0.08**		-0.05*
	(0.077)	(0.054)		(0.036)	(0.032)		(0.027)
% White Collar	0.08*	-0.01		0.05**	-0.00		0.02
	(0.043)	(0.025)		(0.021)	(0.020)		(0.015)
Town fixed effects	N	N	Y	N	N	Y	N
Year fixed effects	Y	Y	Y	Y	Y	Y	Y
Observations	10493	10493	10493	10493	10493	10493	10493
R-squared	0.31	0.62	0.38	0.10	0.14	0.10	-

Dependent variables relate to loans for all infrastructure. Standard errors are clustered by town, and displayed in parentheses. All variables are standardized except for dummy variables. "Transfers p.c. county roads" is the estimated revenue received from county councils for maintenance of main roads; "Transfers p.c. other" captures all other transfers from both county councils and central government.
* p<0.10, ** p<0.05, *** p<0.01

Table C14: Results with investment deflated by tax base.

	Standardized sanitation expenditure as percentage of tax base						
	Loans outstanding			Spending out of loans			
	OLS	OLS	OLS	OLS	OLS	OLS	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Average Interest Rate (%)	-0.13***	-0.12***	-0.09***	-0.23***	-0.23***	-0.26***	-0.30***
	(0.014)	(0.013)	(0.011)	(0.023)	(0.023)	(0.030)	(0.022)
Tax Base p.c.		-0.03	-0.15***		-0.04**	-0.05	-0.01
		(0.031)	(0.035)		(0.016)	(0.040)	(0.015)
Property Receipts p.c.		-0.03*	0.01		-0.02*	-0.00	-0.06***
		(0.018)	(0.005)		(0.010)	(0.008)	(0.023)
Tolls and Trading Revenue p.c.		0.24***	0.06		0.04***	0.02	0.04***
		(0.047)	(0.044)		(0.017)	(0.057)	(0.012)
Transfers p.c.: County Roads		-0.03	0.00		-0.02*	-0.04**	-0.02
		(0.021)	(0.011)		(0.012)	(0.015)	(0.013)
Transfers p.c.: Other		0.24***	0.02*		0.01	-0.05***	-0.00
		(0.050)	(0.009)		(0.014)	(0.014)	(0.009)
Population							
10,000-25,000	0.16**	0.03	0.06	-0.01	-0.03	0.06	0.10***
	(0.073)	(0.069)	(0.075)	(0.036)	(0.037)	(0.155)	(0.031)
>25,000	0.79***	0.31**	-0.16	0.04	-0.02	0.06	0.15***
	(0.141)	(0.130)	(0.139)	(0.049)	(0.050)	(0.179)	(0.041)
Population density							
Second Tercile	0.13*	0.10*	-0.07	0.05	0.03	0.13	0.07*
	(0.066)	(0.061)	(0.103)	(0.038)	(0.038)	(0.131)	(0.038)
Third Tercile	0.26***	0.19**	-0.15	0.06	0.03	-0.06	0.06
	(0.083)	(0.078)	(0.109)	(0.041)	(0.043)	(0.146)	(0.040)
Occupational characteristics							
>10% Agriculture	0.04	-0.01		0.01	-0.00		-0.05
	(0.070)	(0.068)		(0.037)	(0.038)		(0.035)
>10% Textiles	0.44***	0.31***		0.04	0.03		0.03
	(0.113)	(0.105)		(0.043)	(0.044)		(0.037)
>10% Minerals	0.05	0.03		-0.05	-0.06*		-0.04
	(0.085)	(0.077)		(0.035)	(0.035)		(0.031)
% White Collar	-0.04	-0.02		-0.01	0.01		0.03**
	(0.036)	(0.030)		(0.014)	(0.016)		(0.014)
Town fixed effects	N	N	Y	N	N	Y	N
Year fixed effects	Y	Y	Y	Y	Y	Y	Y
Observations	10493	10493	10493	10493	10493	10493	10493
R-squared	0.20	0.30	0.10	0.06	0.07	0.06	-

Standard errors are clustered by town, and displayed in parentheses. All variables are standardized except for dummy variables. “Total Sanitation” is aggregated spending on Water supply, Sewers, and Streets. “Transfers p.c. county roads” is the estimated revenue received from county councils for maintenance of main roads; “Transfers p.c. other” captures all other transfers from both county councils and central government.
* p<0.10, ** p<0.05, *** p<0.01

Table C15: Results with current expenditure as dependent variable.

	Standardized current expenditure per capita on:							
	Total sanitation		Water supply		Sewers		Streets	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Average interest rate	-0.02	0.00	-0.03*	0.00	0.00	0.01	-0.01	-0.00
	(0.012)	(0.007)	(0.015)	(0.009)	(0.016)	(0.009)	(0.012)	(0.007)
Tax base p.c.	0.33***	0.24***	0.10**	0.08	0.17**	0.16***	0.32***	0.21***
	(0.039)	(0.039)	(0.047)	(0.047)	(0.071)	(0.045)	(0.033)	(0.042)
Property receipts p.c.	0.01	0.01	0.02	0.00	-0.01	0.00	0.00	0.01*
	(0.015)	(0.005)	(0.023)	(0.004)	(0.016)	(0.004)	(0.012)	(0.005)
Tolls and trading revenue p.c.	0.11***	0.05**	0.16***	0.06	0.07**	0.04	0.02	0.02
	(0.024)	(0.024)	(0.041)	(0.041)	(0.030)	(0.030)	(0.019)	(0.018)
Transfers p.c.: county roads	0.42***	0.25***	0.04	0.03	0.06***	0.04**	0.52***	0.31***
	(0.042)	(0.035)	(0.027)	(0.022)	(0.023)	(0.017)	(0.056)	(0.051)
Transfers p.c.: other	0.01	0.02	0.00	-0.00	-0.03	0.01	0.02	0.02*
	(0.025)	(0.014)	(0.037)	(0.033)	(0.023)	(0.016)	(0.017)	(0.010)
Population								
10,000-25,000	0.12**	0.05	0.17**	0.07	0.17**	0.03	-0.02	0.01
	(0.057)	(0.058)	(0.082)	(0.099)	(0.083)	(0.069)	(0.041)	(0.038)
>25,000	0.19**	0.05	0.28**	-0.03	0.02	0.03	0.09	0.08
	(0.085)	(0.098)	(0.118)	(0.180)	(0.126)	(0.121)	(0.062)	(0.071)
Population density								
Second tercile	-0.11*	-0.11	0.08	0.39***	0.24***	-0.09	-0.31***	-0.33*
	(0.058)	(0.157)	(0.075)	(0.143)	(0.072)	(0.110)	(0.055)	(0.190)
Third tercile	-0.08	-0.23	0.07	0.30**	0.41***	-0.10	-0.36***	-0.45*
	(0.072)	(0.180)	(0.085)	(0.136)	(0.129)	(0.134)	(0.062)	(0.233)
Occupational characteristics								
>10% agriculture	0.12**		0.05		0.26***		0.01	
	(0.058)		(0.076)		(0.081)		(0.047)	
>10% textiles	0.01		-0.02		0.05		-0.01	
	(0.061)		(0.084)		(0.068)		(0.052)	
>10% minerals	-0.10*		0.04		-0.04		-0.14***	
	(0.053)		(0.072)		(0.059)		(0.046)	
% White collar	0.11***		-0.04		0.16***		0.09***	
	(0.034)		(0.043)		(0.046)		(0.030)	
Town fixed effects	N	Y	N	Y	N	Y	N	Y
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Observations	10493	10493	10493	10493	10493	10493	10493	10493
R-squared	0.48	0.36	0.08	0.06	0.16	0.09	0.57	0.33

Standard errors are clustered by town, and displayed in parentheses. All variables are standardized except for dummy variables. "Current expenditure" is expenditure not out of loans. "Total Sanitation" is aggregated spending on Water Supply, Sewers, and Streets. "Transfers p.c. county roads" is the estimated revenue received from county councils for maintenance of main roads; "Transfers p.c. other" captures all other transfers from both county councils and central government.

* p<0.10, ** p<0.05, *** p<0.01.

Table C16: Results with total expenditure as dependent variable.

	Standardized total expenditure per capita on:							
	Total sanitation		Water supply		Sewers		Streets	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Average interest rate	-0.19***	-0.21***	-0.12***	-0.13***	-0.15***	-0.18***	-0.06***	-0.06***
	(0.020)	(0.026)	(0.019)	(0.030)	(0.021)	(0.027)	(0.014)	(0.012)
Tax base p.c.	0.19***	0.15***	0.03*	0.04	0.15***	0.16**	0.27***	0.14***
	(0.026)	(0.046)	(0.020)	(0.041)	(0.033)	(0.071)	(0.033)	(0.051)
Property receipts p.c.	-0.01	0.00	-0.00	0.01	-0.02*	-0.01***	0.00	0.01
	(0.011)	(0.011)	(0.010)	(0.011)	(0.010)	(0.004)	(0.009)	(0.011)
Tolls and Trading Revenue p.c.	0.08***	0.05	0.07***	-0.03	0.01	0.07	0.06*	0.11**
	(0.020)	(0.074)	(0.022)	(0.087)	(0.017)	(0.063)	(0.034)	(0.051)
Transfers p.c.: county roads	0.10***	0.03*	-0.01	-0.01	0.00	-0.05	0.34***	0.21***
	(0.018)	(0.019)	(0.011)	(0.013)	(0.018)	(0.031)	(0.041)	(0.036)
Transfers p.c.: other	0.01	-0.03**	0.02	-0.04***	-0.02	-0.01	0.01	0.02
	(0.016)	(0.014)	(0.018)	(0.015)	(0.016)	(0.014)	(0.021)	(0.019)
Population								
10,000-25,000	0.02	0.20	0.02	0.03	0.02	0.35**	-0.02	-0.01
	(0.043)	(0.144)	(0.043)	(0.115)	(0.042)	(0.168)	(0.039)	(0.065)
>25,000	0.04	0.29	0.06	0.02	-0.19***	0.29	0.27***	0.39**
	(0.058)	(0.186)	(0.057)	(0.160)	(0.056)	(0.179)	(0.071)	(0.193)
Population density								
Second tercile	-0.00	-0.01	0.02	0.27***	0.08*	-0.33	-0.18***	-0.13
	(0.040)	(0.156)	(0.037)	(0.083)	(0.042)	(0.260)	(0.046)	(0.143)
Third tercile	0.02	-0.21	0.01	0.11	0.14**	-0.48	-0.18***	-0.11
	(0.049)	(0.181)	(0.043)	(0.104)	(0.055)	(0.311)	(0.053)	(0.180)
Occupational characteristics								
>10% agriculture	0.03		0.05		0.01		-0.04	
	(0.044)		(0.042)		(0.042)		(0.044)	
>10% textiles	0.03		-0.02		0.08**		0.02	
	(0.044)		(0.046)		(0.036)		(0.055)	
>10% minerals	-0.10***		0.02		-0.12***		-0.15***	
	(0.037)		(0.036)		(0.031)		(0.043)	
% White collar	0.04*		-0.01		0.02		0.10***	
	(0.021)		(0.018)		(0.023)		(0.031)	
Town fixed effects	N	Y	N	Y	N	Y	N	Y
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Observations	10493	10493	10493	10493	10493	10493	10493	10493
R-squared	0.15	0.09	0.03	0.02	0.08	0.05	0.35	0.14

Standard errors are clustered by town, and displayed in parentheses. All variables are standardized except for dummy variables. "Total expenditure" is the sum of expenditure out of loans (as in Table 1) and not out of loans (as in Table A11). "Total Sanitation" is aggregated spending on Water supply, Sewers, and Streets. "Transfers p.c. county roads" is the estimated revenue received from county councils for maintenance of main roads; "Transfers p.c. other" captures all other transfers from both county councils and central government.
* p<0.10, ** p<0.05, *** p<0.01