The international platform of Ludwig-Maximilians University's Center for Economic Studies and the Ifo Institute

CESifo Working Papers
www.cesifo.org/wp

Banking and Industrialization

Stephan Heblich
Alex Trew

CESifo Working Paper No. 5503
Category 4: Labour Markets
September 2015

ISSN 2364-1428

CESifo
Center for Economic Studies & Ifo Institute

CESifo *Working Paper No. 5503*

Banking and Industrialization

Abstract

We exploit employment data from 10,528 parishes across nineteenth century England and Wales and find that a one standard deviation increase in finance employment increases the annualized growth rate of secondary labour by 0.8 percentage points. An endogenous growth model with finance and structural transformation motivates the empirical approach. Since initial banking access in 1817 may have been endogenously determined, we use instrumental variables to predict the location of country banks founded before the industrial take-off could possibly be expected. Distance and subsectoral analysis suggest that the effect of finance is highly localized and particularly strong for intermediate secondary sectors.

JEL-Code: O110, O160, O400, N230, R110.

Keywords: banking, industrial revolution, structural transformation, regional economic growth, urbanization.

Stephan Heblich
Department of Economics
University of Bristol
8 Woodland Road
United Kingdom – Bristol BS8 1TN
stephan.heblich@bristol.ac.uk

Alex Trew
School of Economics and Finance
University of St. Andrews
United Kingdom – KY16 9AJ Fife, Scotland
alex.trew@st-andrews.ac.uk

August 30, 2015
We are grateful to Leigh Shaw-Taylor for permission to work with the data produced by the Cambridge Group, to Dan Bogart for the use of the infrastructure data and to Alessandro Nuvolari for the use of the patent data. We thank Thorsten Beck, Sascha Becker, Erlend Berg, Dan Bogart, D'Maris Coffman, Nicholas Crafts, Edmund Cannon, Gilles Duranton, Oliver Falck, Giulia Faggio, Thomas Gall, Steve Gibbons, Moshe Hazan, Leander Heldring, Saumitra Jha, Bill Kerr, Ralf Meisenzahl, Charles Nolan, Giacomo Ponzetto, Frank Neffke, Radek Stefanski, Daniel Sturm, Jon Temple, Christine Valente, Nico Voigtländer, Joachim Voth, Frank Windmeijer, Yanos Zylberberg and participants in seminars at Bristol, Glasgow, Harvard, Heriot Watt, UC Irvine, Sheffield, Southampton, St. Andrews, Stirling, and Warwick as well as the annual SERC meeting and the World Economic History Congress for helpful discussion. Stephan Heblich would like to thank CESifo for its hospitality and excellent working conditions while finalizing this paper.

1 Introduction

Industrialization undoubtedly underpinned the transition to the modern world of sustained high growth rates. The question is: Did it also underpin the spread of banking or did banking underwrite that transition? A voluminous literature following King and Levine (1993a) points in the direction of an important role for finance in causing growth. Despite this, the role of banking in early industrialization has been neglected, leaving us with key questions to which we have no answers: Did banks accelerate the spread of the industrial revolution? Did they hasten the process of urban change? Which financial services did those banks provide, and for which sectors did they matter most? Finally, does shedding light on these historical questions help us understand the finance-growth nexus today? We answer each of these questions using historical data of an extraordinarily high quality, covering the cradle of industrialization from before and after the time of its transition to rapid per capita growth.

Our data cover 10,528 parishes in England and Wales outside London over the period 1817-1881 (Shaw-Taylor et al., 2010). We omit the 157 parishes in London because it was dominated by the Bank of England and since its financial institutions are quite distinct from the country banks in our sample. The dataset holds information on employment in banking which gives us the unique opportunity to analyze the effect of access to finance on industrial employment growth at a high spatial resolution (the average radius of a parish is only 2.1km). To cross-validate the banking employment information, we additionally create a panel of locations and characteristics of 'country banks' (private banks outside of London) from Dawes and Ward-Perkins (2000). Outside of London, country banks represented the only provincial financial institutions since our initial period, 1817, predates the legalisation of joint stock banking in 1826. Since they were private partnerships limited to six partners, the country banks also rarely had a branch network and were of a generally homogenous size (cf. Beck et al., 2013). These characteristics mean we can directly measure access to financial services, helping us recover a robust role that 'traditional' banking activities played. Our period of study includes the substantial local structural transformation that underpinned the acceleration in per capita growth which occurred after the first quarter of the nineteenth century (Crafts, 1994). The detailed occupational information allows us to investigate the channels through which banking affected economic growth. Further, we exploit the spatial dimension of our data to estimate the distance decay of banking access.

One major concern is that 1817 access to banking is not exogenous. Even though our initial observation predates the major takeoff in aggregate per capita growth, it may be that forward-looking bankers chose emerging areas in advance of their growth being realized. In that case, we would overestimate the effect of banking on future economic development. However, if bankers were correctly anticipating the imminent growth but systematically chose the wrong locations, we would expect a downward bias. In this respect, it is important to note that our observation period is characterized by significant changes in the economic geography of production as water is replaced by coal as the predominant energy source. As a result, it may have been that bankers bet on the fortunes of the wrong regions. Indeed, we observe a steep rise in the number of country banks over the period 1805-1812 but these new entrants typically failed quite quickly. To overcome any selection bias, and to identify a causal effect of finance access on regional economic growth, we use two unrelated instruments that each predict the location of country banks founded before the industrial take-off could be expected.

Our first instrument employs the location of Elizabethan (16th century) post towns. These post towns were located along six straight routes out of London that the Crown developed at the end of the 16th century for strategic and military communication purposes. To speed up such communication, horses were changed at posts in towns spaced at regular intervals of 20-24km.[1] These changing places are the 69 Elizabethan post towns that we use as dummy instruments. Post towns turned out to be the preferred locations for country banks who benefited from being able to transport gold specie along the relatively secure connections to London. Our first stage suggests that Elizabethan post town locations were 34% more likely to host bankers in 1817. At the same time, robustness checks clearly reject the possibility that Elizabethan post towns benefited from better access to the road network which may have facilitated the flow of goods and innovative ideas. Our results remain the same in the subset of parishes with direct access to a turnpike road, in placebo estimations where we use other locations along the road network, and in estimations where we control for the number of patents registered in a parish. It is not surprising that post roads did not have a direct effect on growth because, first, canals carried much of the heavy industrial traffic that mattered for growth during the early nineteenth century.[2] Second, access to the roads connecting Elizabethan post towns was not exceptional since there were nearly 400 post towns spread evenly across the country and an even denser network of turnpike roads by the end of the 18th century.[3]

Our second instrument exploits pre-1650 enclosures of common land. Prior to the enclosure movement, traditional, low-scale agricultural production took place within a parish on common land with common rights to its use. An enclosure then involved

[1]The American *Pony Express* changed horses at the same intervals–on average every 24km (Frajola et al., 2005).

[2]Consider Bagwell (1974, p.60): "road haulage remained so expensive that a majority of the goods were despatched by water carriage until, by the early 1850s, the combination of an adequate basic railway network with a rational classification of goods by the Railway Clearing House, gave an increasing advantage to land carriage."

[3]At its peak in 1838, the turnpike road network spanned 35,684km.

the physical containment of land for the private use of a landowner. Before 1650, the economic motivation for the landowner was to attain scale and become a larger agricultural concern. After 1650, when productivity-enhancing technologies made agriculture more capital intensive, there was a rising demand for agricultural banking services. Backed by their land as security, these large-scale concerns were good customers and attracted banking services. In line with that, our first stage suggests that regions which experienced an early enclosure were 14% more likely to host a banker in 1817. In robustness checks, we consider the possibility that individuals who enclosed land and commercialized agriculture accumulated wealth that they then redirected towards secondary sector projects. Reassuringly, accounting for wealth does not affect our results. Moreover, by using non-church land and pre-Parliamentary enclosures, we do not have the concern that 16th-century monastic wealth is related to post-1750 enclosures of land (see Heldring et al., 2015). Placebo tests further show that non-enclosed regions where our mechanism is not at work do not have better access to finance.

Using either instrument, and both combined, we find a strong, consistent role for access to banks in causing industrialization over the period that suggests an elasticity of 1.096. Put differently, a one standard deviation change in the log of finance employment causes annualised growth to be 0.8 percentage points higher – the presence of a bank significantly accelerated industrialization. Our estimated effect points to a truly fundamental role for banking since the coefficient is consistent with the literature that uses contemporary cross-country data. The effect of banking is most pronounced in intermediate secondary sectors which suggests banks played a crucial role in the wider economy. Distance decay estimates further show that the impact of a bank on secondary sector employment growth is limited to less than 10km. Within this range, we also find evidence that having a bank causes urban change: The presence of a bank means that the secondary sector becomes concentrated in the core while agriculture is shifted to the periphery.

Our findings are robust to a variety of checks. We consider variations of our measure of finance access using a new data set on the locations of country banks to cross-validate our main variable of interest. We further show balancing tests for our instruments, discuss possibly confounding effect of first nature geography (including distance to the next port, flexible latitude-longitude controls, and terrain controls) and second nature geography (including controls for market access, wealth, education provision, and patents), show in placebo exercises where the instrument does not work, and present variations of our standard errors. Reassuringly, all these tests do not affect our preferred estimates.

While all robustness checks support the assumption that our instruments are orthogonal to any remaining unobserved drivers of growth, there is still no guarantee that the exclusion restrictions are not violated. Therefore, we assess how sensitive our results are to a violation of the exclusion restriction (cf. Conley et al. (2012)). We find that our estimated effects are qualitatively robust to substantial violations of the exclusion restriction. Our most conservative results suggest that, as long as one is willing to rule out direct effects from being a post town or early enclosure that are larger than 0.1, one would still conclude that there is a causal effect of banking access on manufacturing growth. To put this into perspective: A magnitude of 0.1 implies 11% higher growth over the period of 64 years and is around the same size as the estimated effect of being located on a coal field.

Our findings contribute to a number of different strands of literature. First, we extend existing research on the relationship between finance and growth that followed the pathbreaking contribution of King and Levine (1993a).[4] Studies previously conducted analyses at the country level (Rajan and Zingales, 1998; Levine et al., 2000; Demetriades and Hussein, 1996; Rousseau and Sylla, 2004) or using comparatively large regions within-countries (Jayaratne and Strahan, 1996; Guiso et al.. 2004; Pascali, forthcoming); we extend the analysis to a very high geographical resolution. Despite our quite different period of study, we estimate effects that are quantitatively similar to previous findings which are based on a more aggregate level. This provides some confidence that the effect of finance does not vary substantially across countries and over time. Our results also extend previous findings that distance to finance matters (Guiso et al., 2004) and that finance differently impacts subsectors (Rajan and Zingales, 1998). Finally, we contribute to the historiography of the industrial revolution. Textbook histories of the industrial revolution such as Quinn (2004) have argued that financial development was incidental to the industrial revolution, partly because the *financial* revolution (see Neal, 1990) occurred in London and at a much earlier time. Ventura and Voth (2015) make the case that the large sovereign debt in the UK laid a foundation for the acceleration of the industrial revolution because it diverted investment away from low-return sectors. A few case studies point to more direct growth-generating mechanisms of finance during the industrial revolution, however (Hicks, 1969; Hudson, 2002). As such, we develop a simple model of banking, structural transformation and endogenous growth that helps integrate these case studies into a broader framework where access to finance is local. This interpretation is in line with a large body of literature that stresses the importance of entrepreneurial finance for the diffusion of innovations (cf. Kerr and Nanda (2011) for a summary of the literature). It also suggests a natural link to Temin and Voth (2013) who argue that banking regulation (the Usury Act of 1660, the Bubble Act of 1720) and the demands of war finance constrained private

[4]Excellent surveys of the extensive literature on finance and growth are Levine (2005) and Beck (2008).

banks from hastening an industrial revolution in the eighteenth century. Consistent with Temin and Voth, we show that once many of those restrictions were lifted into the nineteenth century there was indeed a connection from finance to growth, one that was highly localized and not London-based. In summary, we show that banking was an important driver of the "process of regional growth" (Cottrell, 1980: p.19) that made up the industrial revolution.

The remainder of the paper is organized as follows. Section 2 provides a brief history of country banks. In section 3, we develop a simple model that connects access to banking and structural transformation in the context of an endogenous growth framework. In section 4 we present our estimation strategy and introduce the two instrumental variables. We describe the data in section and present the main results, as well a number of robustness checks, in section 5. Section 6 exploits the geographical nature of our data to consider the role of distance in the effect of banking, as well as the nature of urban change. Section 7 discusses the mechanisms through which banking may cause industrialization. Finally, section 8 offers some concluding remarks.

2 A Brief History of Country Banks

> The present prosperous condition of this country is to a certain extent the offspring of the Country Bank system: it calls into being and supports many, who but for the timely aid and fostering hand of Bankers would never have risen above the dull level of the mass; character, industry and intelligence are but the raw material, like ore in the mine, rich and valuable, but unavailing and unavailable, except turned to account by the timely application of capital...
>
> *Sketch of a Country Bank Practice* (1840)

At the turn of the nineteenth century, there were only three distinct forms of financial institution in England and Wales: The Bank of England; private banks in London; and, privately owned banks outside of London – the 'country banks'. Country banks were limited to six partners and, given their limited size, they were predominantly unit banks that served their local area.[5]

The total number of country banks increased from only dozens in 1750 to around 700 in the 1820s (Cameron, 1967). This was an emerging sector – as Ashby (1934, pp.49–50) describes it was "a period of tentative experiment; of trial and error". Those early country banks slowly learned the trade of professional banking, with, for exam-

[5]At 1798, 93% of banks had only one office; the average number of partners was around three and the number of bank customers was typically in the hundreds (Pressnell, 1956).

ple, Martin's Bank writing down the influential pamphlet on 'Proper Considerations for Persons Concerned in the Banking Business' in 1746. Many such country banks emerged as principally agricultural concerns, while others provided financial services to emerging textile and mining areas. The early geographical spread of country banks reflected their partially non-industrial roots: At 1800, the industrial counties of the North West of England had among the lowest number of country banks per head (see Cameron, 1967).

The founders of the first country banks were drawn from a wide range of the populace, from landowners to merchants to agriculturalists and traders (Dawes and Ward-Perkins, 2000). Their clientèle was also drawn from a cross-section of the local public: Farmers and industrialists but also spinsters and labourers. One consistent feature of the early country banks is that they were often extremely long-lived and put down deep, local roots with banks subsequently run by generations of the same family. In 1658 the son of a farmer, Thomas Smith, opened in Nottingham the first private bank outside of London. This bank was run by as many as five generations of the Smith family. Between 1658 and its eventual merger into a joint stock bank in 1902 it operated only 11 branches, of which 10 remained open in 1902. The Doncaster Bank, when purchased in 1865, still had partners that were members of the family that established it 1756. Joseph Pease set up a bank in Hull in 1754 and his descendants were still partners at 1893. Dawes and Ward-Perkins (2000) charts many more of the persistent family histories from the early country banks.

As to the financial services provided by country banks, one of the most important was holding a license to issue notes, since the notes printed by the Bank of England did not circulate far beyond London (Pressnell cites a limit of about 30 miles in the early nineteenth century). Through the issue of notes, and the discounting of bills, a country bank was thus key to the circulation of money in the provinces. Of course, a note-issuing country bank needed to back its liabilities with sufficient supplies of gold specie. That meant,

> [T]here was hurrying to and fro; the hasty journey of partners... to London for supplies of the precious metal, and the hazardous return trip in the post-chaise... and the constant risk of accident or highwaymen. Ashby (1934, p.53)

As we will see below, country banks were thus drawn to the relative security afforded by using the State-managed postal network. Country banks did not locate at post towns for the transport or communication benefit that these roads afforded, as these could be obtained much more widely. It was instead the security of passage to London that led specifically the financial sector to locate in a post town.

Country banks were also engaged in activities beyond note-issue that may be considered 'traditional banking': The provision of short- and long-term credit; overdrafts; mortgages; remittance facilities (particularly to London); the safekeeping of agricultural surpluses; the provision of legal services. As Pressnell (1956, p.265) writes, country bankers were most active in "the mobilization of funds for local investment". The funding of these activities came from providing deposit services, the resources of the bank partners and the London money markets.

Banks that emerged during the boom of country banking in early 19th century tended to be more speculative and failed in shorter order. Ashby (1934, p.48) writes that "many of these had been started by tradesmen on a very insecure foundation." Cash-ratios, for example, varied widely (Pressnell, 1956) making them highly susceptible to crisis. The legalization of joint-stock banking in 1826 was a response to these failures and created a somewhat more stable financial system. Up until 1826, the Bank of England held the legal monopoly on joint stock banking in England and Wales, a regulation that persisted in the wake of the South Sea Bubble (cf. Temin and Voth, 2013). Despite that, as Cottrell (1980, p.16) notes, "The new joint stock banks were generally hardly distinguishable from the private country banks in terms of resources, management and branch networks."

3 Model

Levine (2005) classifies the growth-enhancing functions that a financial sector can provide. Models capturing these functions are generally of only one-sector where greater financial development increases, for example, the intensity of research investment and thus generates higher growth. Our empirical strategy looks to understand the growth of industrial employment so we need to understand how financial development may interact with structural transformation. We outline here a model with structural transformation and endogenous growth, developing it in detail in Appendix F.

3.1 Consumers and firms

Agents live in a parish and are endowed with one unit of labour supply each period. There is no storage good. Workers have preferences over agricultural and manufactured goods as in Alvarez-Cuadrado and Poschke (2011),

$$u\left(c^A(t), c^M(t)\right) = \alpha \ln(c^A(t) - \gamma) + \ln(c^M(t) + \mu) \tag{1}$$

where $\alpha > 0$ is the weight on agricultural consumption and $\gamma, \mu > 0$ are Stone-Geary parameters: γ is a subsistence constraint on consumption of agricultural goods and μ

reflects some endowment of manufactured goods (from, e.g., home production). These preferences mean that as income grows so consumption demand shifts toward manufactured goods. Households earn wages from providing labour and rental income from owning a share of all land. There are no transport costs and labour can move freely across locations and sectors, so real wages and prices are equal across space. Optimal consumption demands means that, on aggregate,

$$Y^M(t) = p(t)(Y^A(t) - \gamma)/\alpha - \mu. \tag{2}$$

A parish is composed of a continuum of firms ordered along an interval [0,1]. A firm at location ℓ in time t produces either agricultural or manufacturing output (sectors A and M) using labour and a fixed amount of land (normalised to one):

$$Y^A(\ell, t) = Z^A F(L^A(\ell, t)) \tag{3}$$

$$Y^M(\ell, t) = Z^M(\ell, t) G(L^M(\ell, t)) \tag{4}$$

where $L^i(\ell, t)$ is labour employed in sector i at (ℓ, t), $Z^M(\ell, t)$ is technology in manufacturing and Z^A is the time- and space-invariant agricultural technology.[6] $F(\cdot)$ and $G(\cdot)$ are constant-return production functions with the usual concavity and Inada-type assumptions.

Total labour supply is normalised to $L = 1$ and is supplied inelastically, so $L^A = 1 - L^M$. Since labour can move freely between sectors, wages in each sector are equal and so the relative price of agriculture is,

$$p(t) = \frac{Z^M(t) G'(L^M(t))}{Z^A F'(1 - L^M(t))} \tag{5}$$

To solve for equilibrium labour choices we can use (2) with (5) to obtain,

$$\frac{\mu}{Z^M(t)} = \frac{G'(L^M(t))}{\alpha F'(1 - L^M(t))} \left(F(1 - L^M(t)) - \frac{\gamma}{Z^A} \right) - G(L^M(t)) \tag{6}$$

Equation (6) implicitly defines $L^M(t) = h(Z^M(t))$ with $h' > 0$: A higher $Z^M(t)$ leads to a higher optimal $L^M(t)$, i.e., structural transformation.

[6] We assume that agricultural productivity is constant across time and space purely to remove some notation. For England and Wales in this period, the evidence favours a labour pull channel, i.e., that manufacturing productivity growth was driving structural transformation.

3.2 Innovation and finance

So far we have assumed $Z^M(\ell,t)$ to be constant across time and space. Suppose that all firms imperfectly observe each others' productivities (including their own); each firm wakes up each period with an initial technology $Z^M_-(t)$ that is the average of all previous period's realised productivities. Firms can borrow to invest in research to potentially obtain a higher $Z^M(\ell,t)$ at their location. Investment in research buys a probability ϕ of taking an innovation step of $\Delta > 0$ at cost $(1+f)\psi(\phi)\cdot Z^M$ where $\psi' > 0$ and $\psi'' > 0$ is the convex cost of an innovation probability, $f > 0$ is the cost of obtaining finance and where the cost is proportional to the level of technology. Expected manufacturing technology at location ℓ that invests in research is,

$$E(Z^M(\ell,t)) = (1+\phi\Delta)Z^M_-(t). \tag{7}$$

As shown by Desmet and Rossi-Hansberg (2012), since land is non-replicable and excludable, firms that occupy land can gain from an investment in research (up until technology diffuses). This can form part of a competitive equilibrium because firms bid for land while taking into account the expected gains from innovation. The maximum land bid in manufacturing is,

$$\begin{aligned} R(\ell,t) = \max_{\phi(\ell,t),L^M(\ell,t)} &(1+\phi\Delta)Z^M_-(t)F(L^M(\ell,t)) - \\ &w^M(t)L^M(\ell,t) - (1+f)\psi(\phi)Z^M_-(t) \end{aligned} \tag{8}$$

Labour is hired, land is rented and investment in innovation happens in advance of productivity realisations. The optimal investment into innovation satisfies,

$$\Delta F(\hat{L}^M(\ell,t)) = (1+f)\psi'(\phi), \tag{9}$$

where $\hat{L}^M(\ell,t)$ is optimal choice of labour.

Let $\phi^*(f, L^M(t))$ be the optimal chosen probability of innovation given f, average manufacturing labour $L^M(t)$. By the strict convexity of ψ, we have ${\phi^*_f}' < 0$ and ${\phi^*_{L^M}}' > 0$: The higher is the cost of finance, the lower is the chosen probability of an increase in manufacturing productivity. Note also that there are scale effects in (9): The higher is manufacturing employment the greater the chosen ϕ^*.

3.3 Growth and structural transformation

Growth accelerates during the process of structural transformation because, in the short-run, a shrinking agricultural sector drags down the aggregate growth generated by the productivity growth. Over time, the size of the agriculture sector approaches a subsistence level and growth is caused by productivity growth in manufacturing alone. The implication for growth is developed in Appendix F.

3.4 Financial development

We now introduce three simple mechanisms through which finance may stimulate structural transformation, as motivated by Levine (2005). In particular, a bank may: Facilitate better investment; provide pooling and diversification services; and, ease exchange and improve contracting. Each of these mechanisms suggest different interactions between subsectors and the effect of banking on industrialisation. One objective of the empirical analysis below is to consider the implications of these channels using the rich occupational data.

Evaluating investments

As in King and Levine (1993b) and Bose and Cothren (1996), suppose that firms cannot observe the quality of researchers. Suppose that the best researchers generate a $\bar{\Delta} > 0$, the worst yield $\underline{\Delta} = 0$. If banks ameliorate the information problem, then the probability of selecting a good researcher may be $s(d_b)$ where d_b is the distance to the nearest bank and $s' < 0$. The expected technology jump is then $\tilde{\Delta} = s(d_b)\bar{\Delta}$. Moreover, the impact of proximity to a bank on the growth would follow from the optimal ϕ^* and (7). Being close to a bank is more important in sectors that have larger gains from screening such as emerging, high-growth sectors.

Pooling and risk

Saint-Paul (1992) and Acemoglu and Zilibotti (1997) focus on the role of diversification in the connection between finance and growth. A related literature highlights the value of such pooling to attracting depositors (Diamond, 1984; Boyd and Prescott, 1985). Country banks made loans and received deposits from within a relatively close locality. The more diversified such a bank, the lower the cost of raising deposits and so lower the fee charged on loans to firms. In the model above, greater diversification that lowers f would increase the rate of industrialisation.

Enforcing contracts and credit constraints

Aghion et al. (2005) take the cost of hiding output to be a measure of financial development. Banks may otherwise specialise in monitoring returns (Blackburn and Hung, 1998; Greenwood et al., 2010). As in Aghion et al. (2005), we assume that there is some fraction $\nu \in (0, 1)$ such that the bank will not loan beyond the amount $\nu\psi(\phi)Z^M_-(t)$.

The expression for optimal investment is a then function of ν; i.e., $\phi^*(f, L^M(t), \nu)$ with $\phi^{*\prime}_\nu < 0$. Again, distance to a bank may determine such constraints, i.e., $\nu(d_b)$ with $\nu' < 0$. As detailed in Hudson (2002), early industrial bankers were often attorneys. If the credit constraint mechanism is important, we may find that the provision of legal services can substitute for the provision of banking services. We may also expect to find the sectors that produce more complex outputs exhibit a larger impact of banking since they are harder to evaluate.

3.5 Access to banking and industrialisation

The previous subsection describes three channels through which banking services may induce technological change: Improving investments ($\tilde{\Delta}$); diversification (f); and, relaxing credit constraints (ν). Each of these can vary by parish, p, along with other determinants of changes in productivity, X_p such as variations in resource endowments and access to markets or a faster catch-up of parishes that have low initial secondary sector employment. From (7), the expected technology jump is,

$$\mathrm{d}Z_p^M = \phi^*(f_p, L_p^M(t), \nu_p)\tilde{\Delta}_p + X_p \tag{10}$$

Using equation (6), we can thus write the change in manufacturing labour as,

$$\mathrm{d}L_p^M = \frac{\partial L_p^M}{\partial Z_p^M} \cdot \mathrm{d}Z_p^M = h'(Z_p^M)\left[\phi^*(f_p, L_p^M(t), \nu_p)\tilde{\Delta}_p + X_p\right] \tag{11}$$

Equation (11) contains the three channels through which finance may cause structural transformation. The expression also highlights the problem we will face in identifying a causal relationship from finance to growth: There is a connection from L^M to the optimal research intensity. Productivity improvements which induce structural transformation will also induce greater demand for financial services.

Let FIN_p be our measure of access to banks in parish p. Divide both sides of (11) by L^M to obtain an expression for the growth of secondary sector labour. We can then approximate[7] the structural relationship between finance and manufacturing employment growth as,

$$\gamma_p^M = \alpha + \beta_1 FIN_p + X_p'\beta_2 + \varepsilon \tag{12}$$

where the coefficient β_1 is to be estimated. The first part of our empirical analysis is to identify the role that access to banking has on industrialisation without connecting

[7] In particular, we assume that the non-linearities in equation (11) can be approximated by taking FIN to be the natural log of employment in finance.

this relationship to any particular channel. Second, we use the occupational detail in the dataset to consider the different channels.

4 Estimation Strategy

Based on our theoretical framework that connects structural transformation towards secondary sector employment to the role of access to finance, we now turn our attention to estimating this relationship. We observe occupational data at the level of the parish p in 1817 and 1881. We describe this data in detail in section . Equation (12) leads to an estimation equation of the form:

$$\Delta_{1881,1817} \ln Empl_p = \alpha + \beta_1 FIN_{p,1817} + X'_{p,1817}\beta_2 + \mu_d + \varepsilon_p \tag{13}$$

where $FIN_{p,1817}$ is either the log of adult males working in finance in parish p at the beginning of the observation period or the log of the number of country banks in parish p. $X_{p,1817}$ is a matrix of control variables. Specifically, we include the log of initial secondary employment to account for possible catch-up; the employment share in agriculture and mining as well log total employment and log area, the female population share and the Herfindahl index of industry concentration of each parish. Moreover, we consider an indicator for whether a parish is located on a coal field,[8] and a vector of transportation infrastructure controls, including parish p's access to the turnpike road and waterway network (measured as network km per km^2 in 1817), the change in railway km per km^2 between 1817-1881, and the employment share in goods transportation. Finally, μ_d is a fixed effect at the level of the registration district, d. In the context of our first difference estimation, these fixed effects pick up trends on the level of 570 registration districts; on average, a registration district nests 26 parishes.[9]

The major concern with this specification is that finance is not assigned to parishes at random. Instead, we expect the provision of financial services to be at least in part determined by expected future demand. To the extent that expectations refer to future prosperity in the secondary sector, ε_p would be correlated with $FIN_{p,1817}$ thus leading to reverse causation. Related to this, omitted variables may be correlated with the initial level of finance and cause subsequent secondary sector employment growth. A final concern is classical measurement error. Since we measure financial employment at 1817, it may be the case that some parishes where we observe finance employment

[8] This coal information is provided by the UK coal authority. It has been derived from information on abandoned coal mine plans and other coal mining related records and information held by the Coal Authority.

[9] Registration districts were early local government units between parishes and counties where the civil registration of births, marriages, and deaths took place. Clearly they will be of different geographical size since there will be some balancing out of population per district.

may have just established these services while other parishes established services just after. This would result in an incorrect measure of initial access to finance.

To overcome these endogeneity problems, we exploit exogenous variation in two instrumental variables, z_p and estimate the following system of equations:

$$\Delta_{1881,1817} \ln Empl_p = \beta_0 + \beta_1 \widehat{FIN}_{p,1817} + X'_{p,1817}\beta_2 + \mu_d + \varepsilon_p \quad (14)$$

$$FIN_{p,1817} = \alpha_0 + \alpha_1 z_p + X'_{p,1817}\alpha_2 + \mu_d + \nu_p \quad (15)$$

For the system to be identified, the instruments z_p have to be sufficiently strong ($\alpha_1 \neq 0$) and must not violate the exclusion restriction ($cov(z_p, \varepsilon_p) = 0$). In the following, we will introduce our instruments and discuss their relevance and validity.

4.1 Elizabethan Post Towns as Instrument

Our first instrument derives from the six 'Great Roads' of the Elizabethan post network (Robinson, 1948). In the wake of the Hundred Years' War, and given ongoing conflicts both within and outwith the British Isles, there was, in the sixteenth century, a growing need to improve and control information flows. The suspicion accorded to privately organised means of correspondence and the growing demand for secure state communication across the realm led Henry VIII to choose Henry Tuke in 1514 to be the first Master of the Posts. Tuke projected the first formal postal network in England and Wales. A post road was a route along which correspondence could be sent securely and rapidly on horseback. The changing of horses took place in post towns that were ordered along these post roads. By the time of Elizabeth I, the post network had developed to connect 85 post towns to London, as depicted in Figure 1.

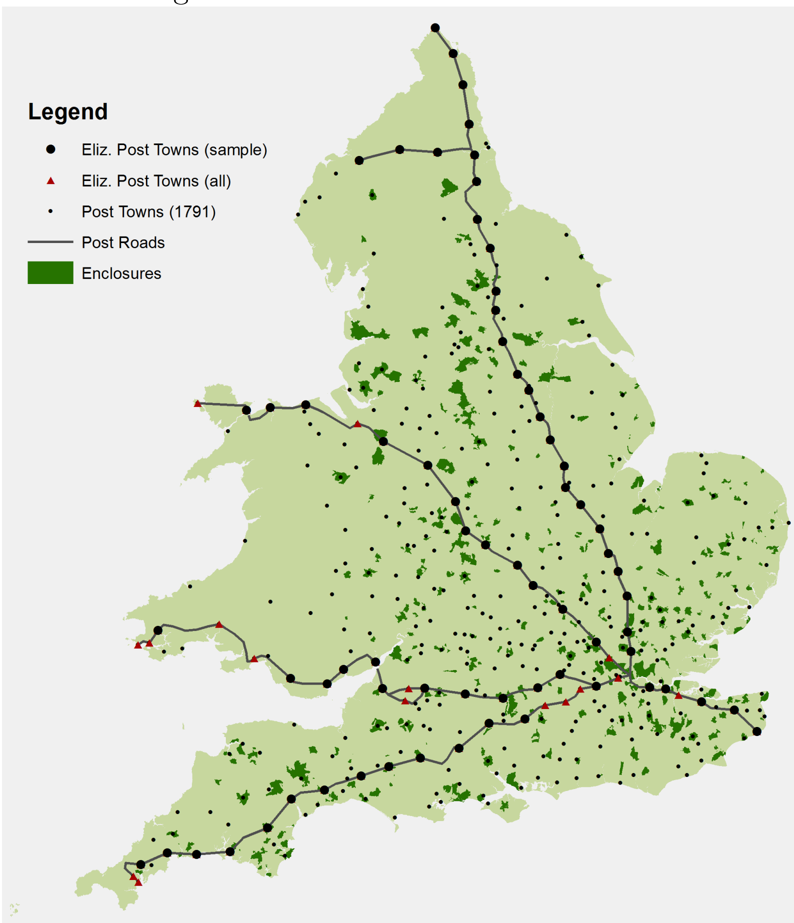
There are two useful characteristics of the organization of this early postal network: First, the roads were laid principally for State purposes; and, second, the post towns along those roads were spaced according to the need to change horses. The importance of the post network in the defence of the realm persisted into the seventeenth century. Thomas Witherings, who was 'Postmaster-General for Foreign Parts' to Charles I, motivated the scheme of inland posts thus,

> Any fight at sea; any distress of His Majesty's ships (which God forbid); any wrong offered by any other nation to any of the coasts of England, or any of His Majesty's forts the posts being punctually paid, the news will come 'sooner than thought'.
>
> *Thomas Witherings, quoted in Hyde (1894), pp.73–4.*

In line with these goals, we can see in Figure 1 clear State motivations for the Elizabethan postal network. A road North permitted communication with and monitoring of Scotland at a time around the execution of Mary Stuart and the prospective succession to the English throne of James VI of Scotland. Two roads to the West allowed for communication with Wales and Ireland during the periods of Plantation that sought to Anglicise the island of Ireland. In the South West, we see a route to Cornwall that acted as a system of beacons to detect an expected Spanish Armada; indeed, the route went through Plymouth where the Armada was first engaged by Francis Drake in 1588. Finally, we see to the South East another road to Dover where information from and about continental Europe, especially France, arrived.

While the start and end points of the six Great Roads where strategically determined, the post towns along those roads arose from the necessity to change horses. Fresh horses were kept in intervals of 10-15 miles along the road to speed up the

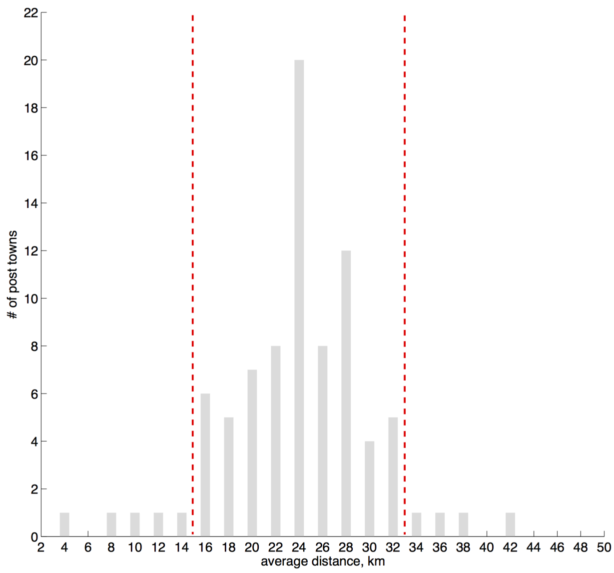
Figure 1: Post Towns and Enclosures



Notes: The map depicts the Elizabethan post towns in the sample (large dots); the Elizabethan post towns excluded because of their extreme average distances (triangles); and, the post towns at 1791 (small dots). The black lines are the Elizabethan post roads. The dark green areas depict the parishes in which a pre-1650 enclosure is reported in Clark and Clark (2001).

Crown's dispatches. As a result, we see post towns lined up as string of pearls and a distribution of distances (see Figure 2) between the post towns shows a peak at around 24km (about 15 miles).[10] Variation in distances results from terrain conditions such as hilly or mountainous terrain, marshland, forests or rivers. The distribution further suggests two natural cut-off points below 16km and above 32km where the assumption of random allocation may be violated. This leaves us with 69 Elizabethan post towns as depicted in Figure 1.[11]

Figure 2: Distances between Elizabethan Post Towns (km)



Notes: The figure shows the distribution of pairwise distances between post towns. We see a clear peak around 24km (c.15 miles). The dashed lines denote our omitted post town distances of less than 16 and greater than 32km.

Appendix A considers the characteristics of these early post towns using the Bairoch (1988) data. We show that the towns were not generally larger, that their size distribution is statistically indistinguishable from that of non-post towns and that they did not grow faster over the following period. Subsequent to this initial network, the number of post roads and towns were extended; towards the end of the 18th century, the network spanned a total of 395 post towns (Robertson, 1961). The later post towns were likely selective and established for economic reasons. We use only the Elizabethan post towns as our instrument.

The evidence in Dawes and Ward-Perkins (2000) demonstrates that out of 150 towns that had a country bank in 1791 (see Figure 1), 130 were a post town. Since

[10]Frajola et al. (2005) show that stations of the US Pony Express were located in similar intervals with an average distances of 24km.

[11]In robustness tests, we will also consider dropping all places below the 25th and above the 75th percentile which would narrow the interval from 19.24-26.85 km including 42 post towns.

Elizabethan post towns persisted into the 19th Century (74 of 85 persisted to 1791) and show a four times higher share of employees working in finance and we expect the instrument to be relevant.

The exclusion restriction further requires the instrument to affect secondary sector growth only through its effect on the initial stock of finance. Since the Elizabethan post towns were setup 250 years prior to the industrial revolution in regular intervals along strategic routes, it is unlikely that they correlate systematically with natural endowments that attract secondary industries. But it may be that post roads follow natural pathways,[12] affecting the ease of transport which would be valuable for manufacturing. To account for this, we will condition all regressions on the share of workers in goods transportation as well as the stock of waterway-km and turnpike-km within a parish. Including these controls accounts for any initial differences in transportation access at the beginning of the period. Finally, since we know that railways rose in importance over our period, we consider the possibility that co-located geographic features that determined the location of post towns or agriculture (i.e. our instruments) predicted railway access over the turn of our observation period.[13] To account for this, we control for the number of railway-km per parish as observed at the end of our period in 1881.

The exclusion restriction may also be violated if better access to a transportation network acts as location factor for banks and secondary sector firms or that post towns were more concentrated which would again be an advantage for banks and secondary sector firms. To alleviate these concerns, it is important to keep in mind that we condition on a number of characteristics at the beginning of our period. Specifically, we account for population density, the initial stock of manufacturing employment, the share of employees working in the primary sector as well as mining, and the degree of specialization measured by a Herfindahl index of industry concentration. These controls pick up initial differences between regions and the registration district fixed effects further provide that we are comparing parishes within a comparatively small geographic range where unobserved location factors are similar. This leads us to believe that, conditional on these controls, Elizabethan post towns predict access to finance in 1817 but not secondary sector growth between 1817 and 1881. In Section 5.5 we discuss a number of additional robustness checks including controls for market access which unanimously confirm the validity of our instrument.

[12] About 62% of the Elizabethan post network overlaps with Roman roads which may have been built along natural pathways. Michaels and Rauch (2013) downplay the persistence of the Roman road network in Britain and argue that transport by water was much cheaper and thus better developed in the medieval ages.

[13] That Atack et al. (2014) find a connection from railway access to bank failures in the U.S. underlines the importance of this robustness check.

4.2 Early Enclosures as Instrument

Our second instrument is the enclosure of land before the mid-seventeenth century. Prior to the enclosure movements, traditional, low-scale agricultural production took place within a parish on common land with common rights to its use. An enclosure involved the mapping and physical containment of land for the private use of a landowner. In practice, this was an encroachment of the landowner or his farmer on the land used by the local populace. The peasant proprietor was converted into a wage-earning labourer. The economic motivation for the landowner can have been simply to attain scale or to implement productivity-enhancing technologies such as fertilisers.

We consider two phases of enclosure in England and Wales. The first occurred during the Tudor and Stuart eras from the late 15th century to the end of the English Civil War (1642-51). During this period a vast amount of agricultural land was transferred from the old feudal-military aristocracy, the Church and the Crown, into the hands of non-noble landholders. These included merchants, professional men, state office-holders and the knight-class who had acquired large landholding, often by buying manors or estates from impoverished members of the traditional feudal aristocracy. With this change in landownership came a change from a feudal mindset to a more capitalist approach with a consequent change in the structure of agricultural production. Instead of looking at land as a means of supporting political and military power these new agricultural capitalists – often of urban professional or mercantile origin – sought to exploit the land for its market potential. As grain prices rose into the seventeenth century, so the incentives to control and expand landholdings grew.

Besides large-scale landowners, Allen (1992) documents the role played by a class of small-scale farmers, the *yeomen*, that emerged during the first wave of enclosures. An important distinction to be made is that early enclosures, which increased the scale of production in some areas, did not in practice generate productivity advantages over the yeomen farmers. Allen (1992) carefully documents that the relationship between enclosures and land yields is small, while many open field yeoman consistently adopted new technologies. In other words, while the early enclosure movement did increase farm scale, the connection, via productivity, to the release of labour for manufacturing was limited.

The pre-1650 enclosures thus created resilient, large-scale agricultural concerns that established areas of demand for agricultural banking services into the eighteenth and nineteenth centuries. An additional channel stressed by Allen (1992) is that large landowners would also present better customers to banks because their estates could serve as collateral. With the growth of the mortgage market through the seventeenth century, emerging country banks were influenced in their location decisions by the presence of large-scale farms (Pressnell, 1956).

After 1650, the nature of the agricultural improvements associated with enclosures began to change, with a second wave of enclosures beginning in the eighteenth century. This second phase of enclosures meant the death of yeoman farming(Allen, 1992) and significant changes in agricultural productivity. Allen (2004) reports agricultural output per worker is roughly stable over the period 1300 to 1600, but nearly doubles from 1600 to 1800. The break in the nature of enclosures was partly political: Following the end of the Civil War, the tension between landowners and the Crown was, to some extent, resolved in favour of the landowners. Where previously the Crown could insulate the peasantry from excessive exploitation by landowners, the State thereafter interfered less with the economic activities of the increasingly influential landed elite (Moore, 1966; Allen, 1992; and, in a different context, Jha, forthcoming). This broke resistance to a wider enclosure movement. Around the same time, a number of new technologies (such as fertilisers, new grasses and crops) increased the incentives for all types of enclosures at different scales and with different agricultural outputs. As Tate (1967, p79) describes it, "The agricultural revolution ... now goes forward in great waves." These later (typically Parliamentary) enclosures were more related with intensive growth and were more closely associated with the processes of the Industrial Revolution (the release of labour into cities) or were even a response to it (such as the mechanization of agriculture). Given their closer connection to the rise of the secondary sector, the later enclosures may imply direct effects. As a result, we do not consider these later enclosures as instruments but focus solely on the early enclosures.

Our information on early enclosures stems from the data in Clark and Clark (2001)[14] which reports the common rights status of farm land owned by charities in England between 1500 and 1839. The dataset contains information from 18,962 maps extracted from over 40,000 pages of descriptions of charity land generated by various enquiries into charitable asset holdings from 1786 to 1912. To match the information with our data, we determine each of the 1851 parish centroids and merge them into our parish units. We then use the information on the fraction of land with common rights to determine locations that were fully enclosed by 1650 and use them to explain the location of country banks and finance employment. This leaves us with 414 parishes with an early enclosure as depicted in Figure 1. Out of those parishes, 139 (34%) hosted a bank or some finance employment. Since the enclosure information is only available for England and not Wales, this instrument is limited to 9,664 English parishes (excluding the London area).

To the extent that pre-1650 enclosures do not affect secondary sector firms' location choice, we can use early enclosure events as an instrument to predict the location of

[14]See 'The Enclosure History Data Set' available here: `http://www.econ.ucdavis.edu/faculty/gclark/data.html`.

country banks founded before the industrial take-off could possibly be expected. We consider a number of potential concerns with this instrument. First, there may be a direct or indirect relationship between enclosures uprooting farm workers and the availability of a large pool of cheap, unskilled labor looking for jobs in the secondary sector (cf. Williamson, 2002). A direct relationship could be via the loss of rights to common land that yeoman farmers relied upon. However, Shaw-Taylor (2012) shows that, for the Parliamentary enclosure movement, labourers did not generally have common rights to lose. An indirect channel could be via agricultural productivity improvements that release labour but, as noted above, there is no evidence that early enclosures generated higher productivity than open farms of the period.[15] That is, enclosures were not offsetting labour, directly or indirectly, by the time of our observational period in 1817. Therefore, we should capture any potentially biasing effects with our controls at beginning of the period controls. A second concern is that the agrarian sector was supplying working capital for the secondary sector. Farmers deposited their idle funds in local county banks who then made loans via the London banks to banks in industrial towns who supplied credit to secondary sector firms. This circulation of capital via London meant that a geographical connection from a local farm to a local manufacturer was no more feasible than between a farm and manufacturer at different ends of the country (Black, 1989). We look to account for this concern by running separate regressions for the North and South. Thirdly, agricultural productivity may be linked to a greater density of economic activity and generally a higher population density. If this implies agglomeration economies that benefited secondary sector firms our instruments will not meet the exclusion restriction. To overcome these concerns, we condition the instrument on the initial employment share in agriculture and a Herfindahl index of industry concentration. We additionally include controls for the transportation infrastructure because better accessibility may have affected the agricultural viability of land and manufacturing. One last concern is that those individuals who enclosed land and commercialized agriculture have specific entrepreneurial abilities and wealth that they now redirect towards secondary sector projects. Ventura and Voth (2015) present a counter-argument to this concern, but we anyway control for a proxy of the level of wealth in each parish.

[15]There is also evidence from relative prices that, at least on aggregate, the dominant cause of structural transformation over this period was productivity growth in the secondary sector (Yang and Zhu, 2013). This would imply a pull into the secondary sector because of productivity growth raising industrial wages, rather than a push out of primary occupations.

5 Results

5.1 Basic Results

We analyze the effects of access to finance on secondary sector employment growth using the occupational geography data described in Shaw-Taylor et al. (2010) for the years 1817 and 1881 (more details and descriptive statistics are provided in Appendix). These data provide a high spatial resolution and detailed occupational classification. We observe adult males in up to 539 occupations (such as coal mining, cotton textiles, and so on) classified according to the PST (Primary-Secondary-Tertiary) system devised by Wrigley (2010).[16] Individuals are nested in 10,528 consistent parishes with an average radius of just 2.1km and an average employment of 230 adult males. The parishes are nested in 587 registration districts which themselves make up 59 counties.

Secondary employment includes manufacturing and construction. We calculate employment growth in occupation i and parish p as $\Delta_{1881,1817} \ln Empl_{ip} = \ln Empl_{ip,1881} - \ln Empl_{ip,1817}$. Our main variable of interest is access to finance. It is measured by the number of adult male employees working in 'Financial services and professions'.[17] All regressions further include a control for territorial changes in the parish between 1817 and 1881 and registration district fixed effects.[18] Since parishes in the same registration district may be subject to similar shocks, we cluster our standard errors on the level of 570 registration districts in our baseline specifications. Estimations where we use one instrument at a time are reported in Appendix B. Alternative and more restrictive specifications will be discussed in our robustness tests in the next section.

Table 1 presents our baseline results from regressions where we instrument access to finance with the Elizabethan post town instrument and the early enclosure instrument. The outcome variable is the log of finance employment in parish p. For a better understanding of potential biases, Column 1 shows OLS results of our growth regression including the full set of control variables from our preferred specification. IV results are shown in Columns 2-7. Column 2 presents a specification with all registration districts and controls for the log of secondary sector employment, area, initial total employment and the female population share. As expected, parishes with a high secondary sector share experience lower growth over the study period; larger parishes, which are

[16]There is no source for 1817 female employment. The 1851 census suggests that, after domestic services, female employment is predominantly in manufacturing (of textiles and clothing), although Higgs (1987) and Sharpe (1995) detail concerns about the enumeration of female occupations in that 1851 census. We control for the proportion of the population that is female in our regressions.

[17]Since we use the log of finance employment in our empirical model, we calculate $\ln FIN_{p,1817} = ln(FIN_{p,1817} + 1)$.

[18]Note that 17 registration districts comprise only one parish. Therefore, the number of observation in our regressions with registration district fixed effects reduces to 10,511 parishes within 570 registration districts.

typically more rural, experience faster manufacturing growth from a lower base; and total employment increases growth which points to the existence of positive agglomeration effects. Female population share has a negative effect reflecting the fact that females were disproportionately often in declining manufacturing sectors like textiles and clothing. In Column 3, we drop London and the surrounding districts to eliminate potential effects from the developed financial market in London. In Column 4, we include further controls for the share of agricultural and mining employment and availability of coal. As expected, the share of agricultural employment has a negative effect on manufacturing growth while mining employment and coal deposits support growth. In Column 5, we add the Herfindahl Index of industry concentration as additional control. Not surprisingly, we observe that sectorally more concentrated parishes grow faster. Finally, in Column 6 we include a comprehensive set of control variables for transportation infrastructure. Specifically, we consider the change in a parishes' railway network density (measured as km/km^2), the initial waterway and turnpike road network density (again measured as km/km^2), and the employment share in goods transportation. These controls account for the possibility that post roads may suggest lower transportation costs. The transport network-specific coefficients are close to zero, the share of employees in good transportation suggests a positive effect of having better access to transportation. Overall, it is reassuring to see that the coefficient on access to finance is only slightly affected by this additional control and remains significant. In fact, this result is what we expected since the main mode of transportation at the beginning of our observation period were waterways and not roads. Column 6 is our fully specified model and preferred specification.

In all specifications, F-statistics of excluded instruments range between 15-17 and all Anderson-Rubin p-values are close to zero. Table 1 further reports p-values for an over-identification test of all instruments, Hansen's J-statistic. The p-value of this statistic ranges between 0.48 and 0.63. This means that we comfortably fail to reject the over-identifying restriction across all specifications. We interpret this as evidence that our two LATE specifications generate fairly homogeneous treatment effects (cf. Angrist, 1991). Specifications where we use one instrument at a time are presented in Appendix Table 7 and 8. We find quite similar coefficients even though our instruments employ different ranges of variation.

The results from our preferred specification in column 6 imply that a 10% increase in a parishes' access to finance in 1817 causes the parishes' secondary sector employment to increase by about 10.96% over the course of the following 64 years. Since the standard deviation of log finance in 1817 is 0.47, a one standard deviation increase in the log of 1817 access to finance causes a 52% increase in secondary sector employment over the next 64 years. This is 58% of the standard deviation of the parish-level

Table 1: Results with Both Instruments

Dep. Variable: Δ log secondary employment	(1) OLS	(2) 2SLS	(3) 2SLS	(4) 2SLS	(5) 2SLS	(6) 2SLS	(7) 2SLS
Log finance employment 1817	0.205***	1.307***	1.256***	1.109***	1.099***	1.096***	1.048***
	(0.023)	(0.327)	(0.301)	(0.299)	(0.297)	(0.298)	(0.318)
Log number secondary employment 1817	-0.598***	-0.363***	-0.376***	-0.584***	-0.588***	-0.567***	-0.554***
	(0.036)	(0.035)	(0.034)	(0.035)	(0.034)	(0.035)	(0.036)
Log area (in km^2)	0.211***	0.198***	0.189***	0.253***	0.254***	0.254***	0.229***
	(0.024)	(0.038)	(0.037)	(0.030)	(0.029)	(0.029)	(0.030)
Log employment 1817	0.467***	0.145**	0.194***	0.330***	0.336***	0.315***	0.334***
	(0.046)	(0.073)	(0.063)	(0.072)	(0.070)	(0.071)	(0.076)
Female population share 1817	-0.476**	-0.598***	-0.611***	-0.570***	-0.572***	-0.586***	-0.709***
	(0.196)	(0.224)	(0.216)	(0.210)	(0.209)	(0.209)	(0.214)
Share primary employment 1817	-1.924***	-	-	-1.242***	-1.416***	-1.302***	-1.201***
	(0.204)	-	-	(0.174)	(0.270)	(0.275)	(0.283)
Share mining employment 1817	-0.198	-	-	0.242	0.149	0.250	0.066
	(0.228)	-	-	(0.266)	(0.288)	(0.293)	(0.290)
Availability of coal	0.124**	-	-	0.103*	0.104*	0.105*	0.024
	(0.060)	-	-	(0.059)	(0.059)	(0.059)	(0.048)
Herfindahl Index 1817	0.468***	-	-	-	0.222	0.225	0.215
	(0.177)	-	-	-	(0.186)	(0.186)	(0.182)
Δ Railway (in km) per km^2 1817-1881	-0.001	-	-	-	-	-0.001	-0.001
	(0.001)	-	-	-	-	(0.001)	(0.001)
Waterway (in km) per km^2 1817	-0.002	-	-	-	-	-0.003	-0.003
	(0.002)	-	-	-	-	(0.002)	(0.002)
Roads (in km) per km^2 1817	0.000	-	-	-	-	0.000	0.000
	(0.001)	-	-	-	-	(0.001)	(0.001)
Share good transportation 1817	0.657**	-	-	-	-	0.636**	0.699**
	(0.258)	-	-	-	-	(0.272)	(0.310)
First Stage:							
Posttown Dummy	-	0.354***	0.359***	0.329***	0.322***	0.318***	0.266***
	-	(0.098)	(0.099)	(0.098)	(0.097)	(0.098)	(0.101)
Enclosure before 1650 (Dummy)	-	0.127***	0.143***	0.136***	0.136***	0.136***	0.136***
	-	(0.033)	(0.032)	(0.031)	(0.031)	(0.031)	(0.031)
Observations	10,511	10,651	10,511	10,511	10,511	10,511	9,528
Number of Registration District FE	570	588	570	570	570	570	523
London districts excluded	Y	Y	Y	Y	Y	Y	Y
Control for Territorial Changes	Y	Y	Y	Y	Y	Y	Y
Hansen's J (p-value)	-	0.481	0.486	0.572	0.589	0.576	0.643
AndersonRubin F-test (p-value)	-	0.000	0.000	0.000	0.000	0.000	0.000
Kleibergen-Paap Wald rk F statistic	-	14.18	16.82	15.10	14.96	14.75	12.92

*Notes: The table presents results from regressions of the log change in secondary employment between 1817 and 1881 in parish p on access to finance measured as log employment in finance. Column (1) presents OLS regressions and Columns (2)-(8) present instrumental variable regressions. The instrumental variables are dummy variables that take the value 1 if parish i is an Elizabethan post town and a dummy that takes the value 1 if parish i was fully enclosed before 1650. Column (2) is a specification that includes London registration districts while the other specifications exclude them. Columns (3)-(6) use our preferred sample and stepwise include sets of control variables. In Column (7) we drop Wales where we lack information on enclosures. All specifications are conditional on registration district fixed effects and control for territorial changes in the parish between 1817 and 1881. Standard errors are clustered on the registration district level in all specifications. *** significant at the 1 percent level, ** significant at the 5 percent level and * significant at the 10 percent level.*

secondary sector growth rate during our study period. This suggests that the effects of finance on secondary sector growth is large in absolute terms. To put this into perspective, we can compare the manufacturing growth to a hypothetical situation without finance. Doing so suggests that access to finance at the beginning of our period explains about half of the overall growth in manufacturing employment outside London over the period 1817-1881.[19]

5.2 Results in the Context of the Literature

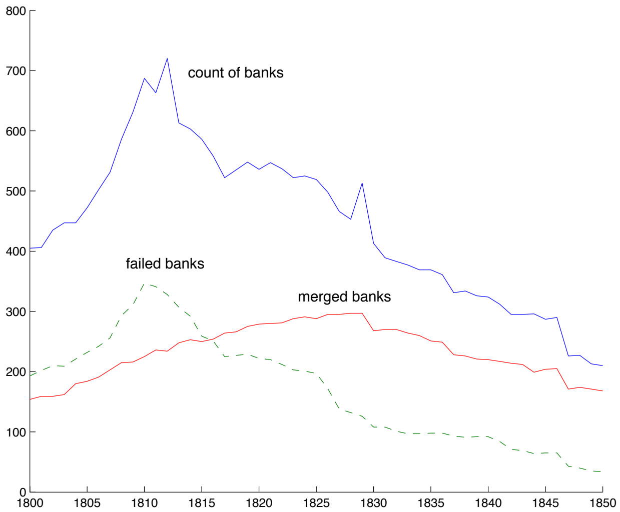
Our preferred estimate of the effect of access to finance on secondary sector growth (Table 1, Column 6) is about 5 times as large as the OLS coefficient of 0.207. Not surprisingly, Durbin-Wu-Hausman tests rejects the null that access to finance in 1817 may be treated as exogenous in all cases. A plausible explanation for this significant difference is a negative selection effect. For a better understanding of this argument, we can use the data in Dawes and Ward-Perkins (2000) to calculate the number of country banks established over the period 1730-1830 and the average number of years they survive. From 1800-1812, we can see in Figure 3 a number of years with sharp increases in the number of country banks. At the same time, we observe a drop in the average years of survival of these banks. A more detailed analysis of the country bank data shows that the majority of banks founded during this boom failed in the following years while established banks persisted.[20] For our initial stock of banks or bankers measured in 1817, this development suggests that we observe a mixture of established country banks and new entrants around with the latter being the remnants of a "gold rush" in banking. During the period 1800-1812, the first wave of the industrialization was at its peak and country banks were one consequence of this boom. However, while the first wave of the industrialization was built on water power as major location factor, there was a shift to steam power (and so need to be proximate to coal) from the second quarter of the 19th century. With this change, banks that were hoping to invest in booming regions suddenly found themselves in comparatively less important areas. Such wrong expectations about future growth prospects are reflected in our downward-biased OLS estimates. By contrast, our instruments are targeting established banks that were founded before the boom period starting in 1800. Therefore, it is consistent that they help us overcome this negative selection effect and provide larger IV estimates.

Beyond selection, it is plausible that the observed downward bias is to a lesser extent also caused by classical measurement error. This argument would imply that

[19]Manufacturing employment outside London county grew from 9.9 million to 24.7 million male employees over the period 1817-1881. In the absence of finance, our estimations predict 17.3 million male employees in manufacturing.

[20]The failure of many country banks in the 1820s led to an institutional change that allowed more partners and eventually joint stock banks.

Figure 3: Country Banks, 1800–50



Notes: The figure presents own calculations for country banks based on Dawes and Ward-Perkins (2000). The solid line indicates represents the sum of country banks that were operating in a given year between 1800-1850. The dashed line represents the number of failed banks in a year and the dotted line the number of merged banks.

individuals did not report their occupation correctly or that the time period when we measured access to finance is a noisy approximation of the "true" stock of finance that determined growth over the next 64 years.

In summary, we have good reason to believe that the difference between the OLS and IV estimates is due to negative selection during the country banking bubble at the beginning of the 19th century. Moreover, it seems plausible that attenuation bias reinforces this downward bias.[21] Our instruments help us overcome these problems.

When comparing our estimates to previous findings in the literature on finance and growth, we need to keep in mind that we are looking at a continuous growth rate, measured as log-difference, over a period of 64 years. For an estimated coefficient of $\beta_1 = 1.096$, this implies that a 1% increase in 1817 finance leads to 0.017 percentage points higher annualized secondary sector growth rate over the next 64 years. In terms of standard deviations, we find that a one standard deviation (0.47) increase in 1817 finance implies an annualized growth rate that is 0.8 percentage points higher.

Given the historic context of our study, it is remarkable how close this measure is to Levine and Zervos (1998) who report that a one standard deviation increase in stock market liquidity or banking development leads to 0.7-0.8 percentage point higher annual growth in income. Levine et al. (2000) find that a one standard deviation increase in

[21] It is also worth noting that IV estimates are regularly greater than OLS estimates in most cross-country finance and growth regressions (see Beck, 2008).

the ratio of private credits to GDP generates 0.9 percentage point higher growth. We are using labour output while these studies look at output growth. Under a strictly concave production function with constant technology we thus possibly over-estimate the impact on growth. As the model in section 3 demonstrates, however, this structural transformation can be associated with increases in the rate of technological progress, so we may be under-estimating the effect of banking on growth. We thus consider our estimates to be broadly in line with the results based on growth in modern periods.

5.3 Robustness to Changes in the Finance Measure

To contest the validity of our measure for finance employment, we construct one additional measure of access to finance based on the locations of recorded country banks. Country banks were partnerships of no more than six partners that contracted to provide financial services to a local area (see Pressnell, 1956). Surviving information on the activities of such banks is limited, but Dawes and Ward-Perkins (2000) contains information on the town, year of establishment, partnership history, ties to London and year of eventual failure or merger of those country banks for which records exist. We digitize this to create a dataset of 1,700 country banks in 600 towns over the period 1688–1953. For the period 1813–20, we observe 736 country banks that were operating in 374 of the parishes (or 3.5% of the total).

Table 2 presents results when we use country banks as alternative measure for access to finance. We find again a larger IV coefficient which is also five times the size of the OLS coefficient and Durbin-Wu-Hausman test reject the null that access to finance in 1817 may be treated as exogenous. The effect on manufacturing growth is a bit larger when using country banks. One plausible explanation is that records of the existence of country banks suffer from a survivor bias that is especially pronounced with more influential country banks or country banks in urban areas. Nevertheless, it is reassuring to see that our main findings do not change qualitatively when we use a different dataset.

Since the bank size at the beginning of our period is limited to a maximum of six partners, we would not expect much heterogeneity in the size of financial employment. In fact, the median number of finance employees in regions with some finance employment is 1.38 (excluding London) and 95th percentile is at 14.4 employees. To see whether our estimations are driven by regions with particularly much financial employment we drop all regions with more than 15 employees. As we see in Column 3 of Table 2, doing so does not affect our results. Similarly, we can drop parishes with fewer than 2 finance employees to see how sensitive our results are to changes at the lower end of the distribution (Column 4). Again, we do not see an effect on our results.

Table 2: Variations of the Finance Measure

Dep. Variable: Δ log secondary employment	(1) OLS Country Banks	(2) IV Country Banks	(3) Finance Employment ≤ 15 employees	(4) Finance Employment ≥ 2 employees
Log number banks 1817	0.392***	1.899***	-	-
	(0.050)	(0.666)	-	-
Log finance employment 1817	-	-	1.106***	1.117***
	-	-	(0.313)	(0.324)
Log number secondary employment 1817	-0.606***	-0.609***	-0.566***	-0.556***
	(0.037)	(0.036)	(0.036)	(0.037)
Log area (in km^2)	0.211***	0.249***	0.252***	0.267***
	(0.025)	(0.034)	(0.030)	(0.032)
Log employment 1817	0.489***	0.441***	0.330***	0.295***
	(0.047)	(0.053)	(0.067)	(0.074)
Female population share 1817	-0.423**	-0.317	-0.527**	-0.601***
	(0.198)	(0.208)	(0.211)	(0.219)
Share primary employment 1817	-2.007***	-1.773***	-1.340***	-1.268***
	(0.206)	(0.218)	(0.266)	(0.292)
Share mining employment 1817	-0.254	-0.073	0.138	0.244
	(0.228)	(0.252)	(0.278)	(0.308)
Availability of coal	0.124**	0.104*	0.118*	0.123*
	(0.060)	(0.060)	(0.063)	(0.063)
Herfindahl Index 1817	0.512***	0.464***	0.278	0.187
	(0.180)	(0.178)	(0.182)	(0.199)
Δ Railway (in km) per km^2 1817-1881	-0.000	-0.000	-0.000	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Waterway (in km) per km^2 1817	-0.002	-0.004	-0.004	-0.003
	(0.002)	(0.003)	(0.003)	(0.003)
Roads (in km) per km^2 1817	0.000	0.001	0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Share good transportation 1817	0.610**	0.409	0.622**	0.652**
	(0.258)	(0.268)	(0.282)	(0.289)
First Stage:				
Posttown Dummy		0.236***	0.399***	0.390***
		(0.060)	(0.106)	(0.114)
Enclosure before 1650 (Dummy)		0.044***	0.122***	0.125***
		(0.014)	(0.030)	(0.034)
Observations	10,511	10,511	10,014	9,803
Number of Registration District FE	570	570	548	546
London districts excluded	Y	Y	Y	Y
Control for Territorial Changes	Y	Y	Y	Y
Hansen's J (p-value)		0.371	0.953	0.588
AndersonRubin F-test (p-value)		0.000	0.000	0.000
Kleibergen-Paap Wald rk F statistic		13.26	15.52	12.42

*Notes: The table presents results from regressions of the log change in secondary employment between 1817 and 1881 in parish p on access to finance measured as log employment in finance. We use two instrumental variables, an Elizabethan post town dummy and an enclosure dummy. All specifications resemble column 6 of Table 3 plus an additional control variable that is specified in the column title. They exclude London, control for territorial changes in the parish between 1817 and 1881, and are conditional on registration district fixed effects. Standard errors are clustered on the registration district level in all specifications. *** significant at the 1 percent level, ** significant at the 5 percent level and * significant at the 10 percent level.*

5.4 Instrument Validity

Table 3 presents results of regressions of our instruments on the control variables. We show these type of balancing tests for a comparison of all parishes versus those where the instruments apply (Columns 1 and 3) and those with some finance employment (Columns 2 and 4). As it turns out, our post town instrument applies to parishes which are smaller than the average while the enclosure instrument applies to larger parishes. Moreover, post town parishes have a lower share or primary sector and mining employment. Parishes that comply with the enclosure instrument have more initial employment, a higher share of females. Compared to the mean, these effects are all rather small and therefore, we take this as indicative evidence that our instruments are not systematically correlated with initial characteristics.

Table 3: Alternative outcomes

	Post Town Dummy		Enclosure Dummy	
	(1)	(2)	(3)	(4)
	All Parishes	Finance Parishes	All Parishes	Finance Parishes
Territorial Changes Dummy	0.165***	0.088	0.004	-0.021
	(0.053)	(0.097)	(0.025)	(0.060)
Log number secondary employment 1817	0.049	-0.025	0.009	-0.041
	(0.060)	(0.035)	(0.014)	(0.034)
Log area (in km^2)	-0.495***	-0.545**	0.217***	0.328***
	(0.189)	(0.237)	(0.036)	(0.127)
Log employment 1817	0.039	0.043	0.040***	0.067**
	(0.082)	(0.034)	(0.013)	(0.030)
Female population share 1817	-0.001	0.000	0.003*	-0.012***
	(0.004)	(0.010)	(0.002)	(0.004)
Share primary employment 1817	-0.042***	-0.037***	-0.006**	-0.007
	(0.015)	(0.010)	(0.003)	(0.010)
Share mining employment 1817	-0.019***	-0.022**	-0.007***	-0.010
	(0.004)	(0.009)	(0.002)	(0.009)
Availability of coal	0.007	-0.044	0.012	-0.021
	(0.027)	(0.041)	(0.011)	(0.031)
Herfindahl Index 1817	0.027	0.013	-0.000	-0.010
	(0.021)	(0.009)	(0.003)	(0.010)
Δ Railway (in km) per km^2 1817-1881	-1.355	-2.938	-0.100	-0.924
	(1.348)	(3.131)	(0.152)	(1.406)
Waterway (in km) per km^2 1817	2.143	6.841	-0.176***	-0.944*
	(1.723)	(5.740)	(0.066)	(0.534)
Roads (in km) per km^2 1817	-6.695**	-13.773	0.753*	4.535
	(3.079)	(8.915)	(0.452)	(3.157)
Share good transportation 1817	0.003	0.003	0.000	-0.009
	(0.006)	(0.010)	(0.002)	(0.008)
Observations	10,513	1,025	10,513	1,025
Number of Clusters	570	250	570	250

*Notes: The table presents reduced form estimations of the control variables on our two instruments, an Elizabethan post town dummy and an enclosure dummy. Columns 1 and 3 represent the full sample whereas Columns 2 and 4 restrict the regression to parishes with finance employment. Each cell shows the coefficient from a separate regression. Columns refer to different models and rows refer to different outcome variables. All regressions include the same controls as those in the basic regressions except the one that is the dependent variable. *** significant at the 1 percent level, ** significant at the 5 percent level and * significantThe Table presents descriptive statistics for our main variables. All variables are means across 10,655 parishes which excludes registration districts in and around London.*

Table 4 considers a number of falsification tests where our instruments should not apply. In Column 1, we locate placebo post towns in the middle of two actual post towns along the six main post roads. Doing so gives us a negative effect, suggesting that these locations are 7.3% *less* likely to have banking access. In a variation of this test, we shift the post roads 15 miles to the south-west (Column 2), the north-east (Column 3); we can also consider the locations from both shifts jointly. In all cases, the first stage relationship is insignificant and economically irrelevant. In Column 4, we randomly draw 69 placebo post towns from the group of parishes with road access that are not in the London area and that are not part of the post town network. Again, there is no first stage relationship. Column 5 and 6 assess the enclosure instrument. First, we consider all those places that were recorded as being not enclosed by 1648. In these places, the assumed mechanism that land as security attracts banks should not work and indeed, we do not find evidence of any effect. The estimated coefficient is highly insignificant and close to zero. Alternatively, we randomly draw enclosure locations from all those places that were most suitable for the cultivation of rain-fed crops and pasture (cf. Nunn and Qian, 2011). In this case, we find a qualitatively small, negative effect suggesting that these areas were 3.5% *less* likely to have banking access.

Table 4: Falsification Tests

Dep. Variable: log finance employment 1817	(1) Between True Post Towns	(2) Shifted 15 mi North-East	(3) Shifted 15 mi South-West
Placebo Posttown Dummy	-0.073**	0.039	0.031
	(0.037)	(0.060)	(0.065)
	-	-	-
Observations	10,511	10,511	10,511
Number of Registration District FE	570	570	570
London districts excluded	Y	Y	Y
Control for Territorial Changes	Y	Y	Y
AndersonRubin F-test (p-value)	0.801	0.471	0.904
Kleibergen-Paap Wald rk F statistic	3.948	0.419	0.233
Dep. Variable: log finance employment 1817	**(4) Randomly drawn Road Location**	**(5) Non-enclosed locations in 1650**	**(6) Random draw from Agricultural locations**
Placebo Posttown Dummy	-0.048	-	-
	(0.042)	-	
Placebo Enclosure before 1650 (Dummy)	-	-0.004	-0.031**
	-	(0.043)	(0.015)
Observations	10,511	10,511	10,511
Number of Registration District FE	570	570	570
London districts excluded	Y	Y	Y
Control for Territorial Changes	Y	Y	Y
AndersonRubin F-test (p-value)	0.374	0.009	0.940
Kleibergen-Paap Wald rk F statistic	1.285	0.00871	4.163

*Notes: The table presents results from regressions of access to finance measures as log employment in finance in 1817 on placebo instruments as specified in in the column title. All specifications resemble the first stage regressions reported in Column 6 of Table 3. All specifications resemble Column 6 of Table 3 plus an additional control variable that is specified in the column title. They exclude London, control for territorial changes in the parish between c.1817 and 1881, and are conditional on registration district fixed effects. Standard errors are clustered on the registration district level in all specifications. *** significant at the 1 percent level, ** significant at the 5 percent level and * significant at the 10 percent level.*

All our instrument robustness tests thus far lead to the same conclusion: Our instruments work as intended and there is no reason to believe that the exclusion restriction is violated. However, since we cannot rule out direct effects with certainty, we explore what happens if the exclusion restriction is violated. Following Conley et al. (2012), we allow the vector $\gamma = [\gamma_{PT}, \gamma_{encl}]$ from a hypothetical regression of manufacturing growth on finance access, our instruments and the full set of control variables to differ slightly from zero, i.e. $\gamma \in [-\delta, \delta]$.[22] By relaxing the restriction $\gamma_{PT} = \gamma_{Encl} = 0$ we allow for small direct effects of our instrumental variables on manufacturing growth and parameterize them. Specifically, we consider the following two scenarios. First, a case where we do not have prior beliefs about the direction of the bias and, second, a case where we impose a direction of the bias. In the most conservative case, we define minimum and maximum allowable violations of the exclusion restriction (Case 1). Alternatively, we assume for both instruments that γ is uniformly distributed on the interval $[-\delta, \delta]$ (Case 2) in the symmetric case or $[0, \delta]$ (Case 3a) and $[-\delta, 0]$ (Case 3b) respectively in the asymmetric case.

Figure 4 shows the results of this robustness test where we assess both instruments jointly. Panel A reports results with no prior information about the bias. The dotted line represents Case 1 and the dashed line Case 2. Panel B imposes prior information that both instruments are upward biased (Case 3a) and Panel C imposes an alternative scenario where post towns imply a positive bias (Case 3a) and enclosures a negative bias (Case 3b). The choice of scenarios is based on the intuition that post towns may provide unobserved location factors that have a positive effect on manufacturing growth. Enclosures would have a positive direct effect if one believed that successful agriculturalists would also make good manufacturing entrepreneurs while we would expect a negative effect if successful agriculturalists would be systematically less inclined to switch to agriculture. All figures suggest that it takes direct effects between 0.1 and 0.2 to accept the null hypothesis that banking access does not affect manufacturing growth. To put this into perspective: an effect of 0.1-0.2 implies a direct effect that implies an 11-22% higher growth rate over the period of 64 years. In our preferred specification in Table 1 Column 6, this direct effect would be comparable to the estimated growth effect of being located on a coal field. This implies that it would take implausibly large violations of the exclusion restrictions to invalidate our findings.

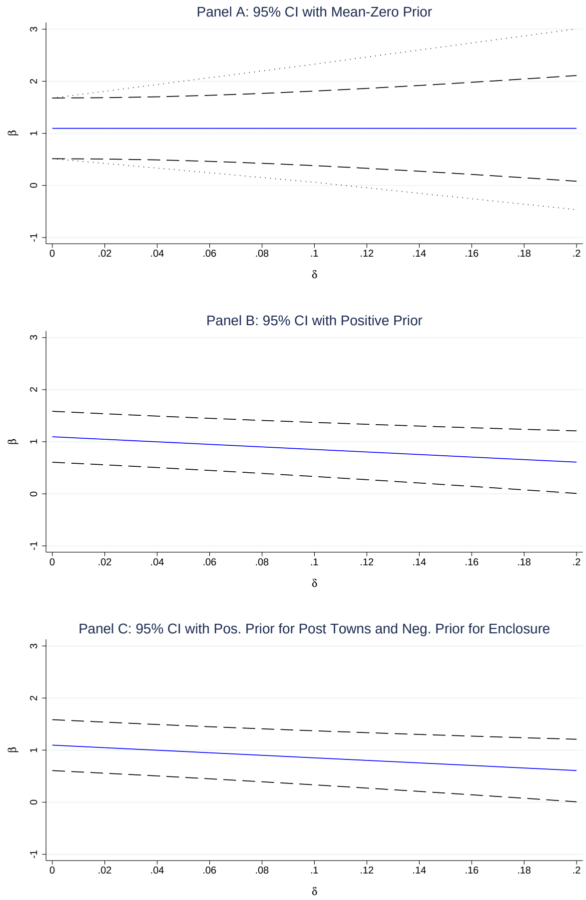
5.5 Robustness to Alternative Specifications

Table 5 presents a summary of additional robustness tests which underlines the robustness of the baseline results to alternative empirical specifications. To facilitate reading, we summarize the robustness checks at this point and refer the interested reader for a detailed description of all robustness checks to Appendix Tables 9-10.

We start with robustness tests where we add proxy variables for within registration district heterogeneity in first nature geography. These proxies include 4th order polynomials in parishes' longitude and latitude to control flexibly for geographic differ-

[22] In particular, $\Delta_{1881,1817} \ln Empl_p = \beta_1 FIN_{p,1817} + \mathrm{Z}_p\gamma + X'_{p,1817}\beta_2 + \mu_d + \varepsilon_p$.

Figure 4: Plausibly Exogenous



Notes: The figure shows point estimates and 95%-confidence intervals for the effect of 1817 banking access on manufacturing growth over the period 1817-1881. In Panel A, dotted lines refer to the most conservative specification that only imposed minimum and maximum allowable violations of the exclusion restriction. The dashed line assumes the same minimum and maximum allowable violations are uniformly distributed on the interval $[-\delta, \delta]$*. Panel B shows estimates under the assumption of a positive upward bias affecting both instruments, i.e.* $\gamma \in U(0, \delta)$ *while Panel C imposes the assumption that post towns have a direct positive effect on manufacturing growth (*$\gamma_{pt} \in U(-\delta, 0)$*) while enclosures have a direct negative effect (*$\gamma_{encl} \in U(-\delta, 0)$*). All estimations are conditional on the controls in our preferred specification in Table 1 Column 6 and standard errors are clustered on the registration district level.*

ences, slope of the land, and distance to the next major sea port since opportunities for international trade may have attracted banks and manufacturing firms simultaneously. Next, given concern that capital circulated from South to North (see Black, 1989), we split England and Wales along the 53° North latitude[23] and run the estimation without the manufacturing-intensive North. Doing so leads to a highly significant coefficient

[23] England and Wales runs from roughly 50° to 56° North.

Table 5: Additional Robustness Tests

	Coefficient	SE
Baseline	1.096***	(0.298)
First-order geography		
xy-Coords., 4th polynomial	1.085***	(0.297)
Slope dummy	1.092***	(0.296)
Distance to nearest sea port	1.090***	(0.298)
Without North	1.460***	(0.490)
Soil suitability	1.093***	(0.298)
Only road parishes	0.862**	(0.429)
Distance between post towns within p25-p75	1.160**	(0.483)
Without Wales	0.921***	(0.324)
Second-order geography		
Log employment within 15km	1.105***	(0.298)
Market town dummy	1.032***	(0.354)
Market access, post town population	1.097***	(0.300)
Market access, post town employment	1.057***	(0.324)
Market access, market town population	1.108***	(0.308)
Market access, market town employment	1.080***	(0.346)
Wealth, measures as share of servants	1.077***	(0.298)
Education, measured as share of teachers	1.055***	(0.280)
Innovation, measured as patents	1.184***	(0.356)
Bartik control for predicted employment growth	0.957***	(0.295)

*Notes: The table summarizes results from instrumental variable regressions of the log change in secondary employment between 1817 and 1881 in parish p on access to finance measured as log employment in finance. All specifications resemble Table 1, Column 6 plus an additional control variable as specified. Each line is the result of a separate regression. The first line repeats the baseline results from Table 1, Column 6. The remaining lines show robustness tests where we add additional control variables to test whether within-registration district heterogeneity biases our results. They each exclude London, control for territorial changes in the parish between 1817 and 1881, and are conditional on registration district fixed effects. Full regression results are available in an online appendix. Standard errors are clustered on the registration district level in all specifications. *** significant at the 1 percent level, ** significant at the 5 percent level and * significant at the 10 percent level.*

that is somewhat larger than that obtained using the whole sample. This makes intuitive sense since the South was in a position of having to catch-up relative to the more heavily industrialized North. Finally, we consider the possibility that certain soil characteristics simultaneously affect productivity in agriculture and manufacturing. To account for that, we include 27 soilscapes from the UK National Soil Resources Institute (NSRI).[24] All robustness tests show that within registration district heterogeneity in first nature geography is unlikely to bias our results.

Next, we consider some specifications where we exclude first nature geography conditions that may selectively affect one of the two instruments. We start with a specification for a subset of parishes that had access to a turnpike road in 1817. By restricting our sample to parishes with road access, we can test whether finance has an effect on

[24]The data come as raster data file with 1km x 1km cells. To aggregate this information to the parish level, we calculate zonal statistics and choose the dominant characteristic. If there are missing, we interpolate with values from neighboring cells.

manufacturing growth that is independent of road-specific factors. Reassuringly, the effect of finance access is smaller but remains significant. Next, we drop all post towns below the 25th or above the 75th percentile in the distance distribution in Figure 2. Doing so narrows the range of distance to the interval 19.24-26.85 km. Reducing the number of post towns from 69 to 42 does not affect our results suggesting that the observed relationship is not driven by post towns at the tails of the distribution where the random allocation argument may not hold. Finally, drop all Welsh parishes where we lack enclosure information and again do not see a substantial change in our basic findings.

We then consider heterogeneity in the geography of interactions between economic agents within-registration districts. Relevant markets are not necessarily confined to political borders. We thus control for the log of employment size within a distance of 15 km.[25] We also include controls for 579 parishes with market town status since market towns were traditional trading places for grain and were thus attractive for manufacturing firms. Finally, we extend our definition of market potential and calculate for each parish p a measure $marketaccess = \sum_{j \in J} \frac{pop_j}{dist_{pj}}$ that captures the distance weighted population (or number of manufacturing employees) where J is the set of all 305 post towns that existed in 1791 or all 579 market towns that existed in 1722. None of these market potential controls changes our baseline results.

Next, we address the concern that individuals who became wealthy through agriculture could have been bankers as well as industrialists. We proxy wealth by the share of employment in domestic services as a proxy. Wealthy parishes may also have a more educated population which benefits economic growth (see Becker and Woessmann, 2009). In the absence of information on individual education, we control for the number of teachers in a parish. Additionally, we consider the number of patents in a parish and its first neighbors since we may be concerned that initial wealth triggered innovative activities or that roads may have facilitated information flows that benefit manufacturing through knowledge production. We see that including these controls does not affect our baseline results.[26]

In a final robustness check, we account for the fact that, while 1817 was prior to the takeoff in per capita growth, there were significant industrial developments before this date. As a result, the initial industry structure may be a good predictor of future growth and correlate with finance access. To account for that, we include a Bartik shift-share control for predicted manufacturing employment based upon employment shares in manufacturing subsectors in parish p in 1817.[27] Including this control should

[25] Using 5 or 10km instead does not change the results.

[26] For more details on the patent data we refer to the reader to Nuvolari and Tartari (2011)

[27] $predictedgrowth = \sum_{m \in M} \frac{empl_{pm}}{empl_m} \Delta empl_{j,1817-1881}$ for all M industries in parish p.

capture all growth effects from potentially confounding initial conditions. Unsurprisingly, controlling for the predicted growth path decreases the finance effect but it remains relevant and significant. At the same time, the coefficient on our predicted employment control is negative suggesting that the industry composition in 1817 is not a good predictor of future growth. This corroborates our argument that the geography of production changed over this period and it also shows that banking access was a relevant driver of this process.

Appendix C.3 further shows that our results are robust to alternative specifications of our standard errors, i.e. clustering on the level of 54 counties, 100×100km or alternatively 50×50km grid squares that enclose all parishes.

6 Spatial Dimension of Banking Access

We are interested in the effect of finance access on manufacturing growth. So far, we have assumed that the effect of finance is localised within a parish. While the costs of distance in 1817 were significant, we may still underestimate the effect of finance in our specifications if, for instance, high population density in the parish with banking access forces secondary sector firms to expand to neighboring parishes. In this section, we will exploit the geographic dimension of our data and test whether banking access available in neighboring parishes may have a positive effect on manufacturing growth in parish p. Moreover, we look at parish p's employment shares in the primary and secondary sector and at changes in its employment density to understand whether banking access may induce a process of urbanization.

6.1 Spillover effects from Banking Access

To understand whether access to finance in nearby locations affects manufacturing growth and how this effect changes with distance, we determine every parish p's first and second neighbors (as defined by parish polygons that share at least one point) and count the number of finance employees among them.[28] In doing so, we assume that effects are additive. Given a parishes' average radius of 2.1km, the rings of first and second neighbors equate to two distance bands covering an average range of roughly 2-6 km and 6-10km from parish p's centroid.[29] Finance employment in parish p and in

[28]We do not know up to what distance firms may benefit from better access to finance but given significantly higher costs of distance at this time, we only consider finance access in the first or second order neighbors which is roughly half the distance between two post towns.

[29]We prefer using neighbors over a specification using distances between finance location and all parishes' centroids because the parishes' average diameter of roughly 4 km does make it harder to interpret distance bands of 1-2 km. In unreported specifications we use distance bands of 2km and find the effect to be restricted to a maximum distance of 4-6km which would just include the first

its first- and second-order neighbors is instrumented with the post town and enclosure dummies described before. Instruments for the first and second neighbor are defined as dummy that takes the value one if at least one neighbor complies with the instrument. Details on the construction of the finance measure and instruments for the neighboring parishes are provided in Appendix D.1.

The results of our spatial spillover estimations are reported in Figure 5 (the corresponding regression tables can be found in Appendix E Table 12 and correspond to the results in Column 3). The estimated coefficients γ_0, γ_1 and γ_2 are (Figure 5, Panel A) enclosed by the 95% confidence interval. The estimations are conditional on the controls in our preferred specification in Table 1, Column 6 plus dummies that control for the number of neighbors and a coastal dummy. The latter two sets of controls account for the possibility that parishes with more neighbors may be more likely to have some finance access while parishes along the coast have less neighbors. Our results show significant though much smaller effects in the first neighbor to a parish with finance employment. A 10% increase in finance in a neighboring parish increases manufacturing growth over the next 64 years by 1.4%, compared to a growth effect of 11.5% in the finance parishes, this is a significant drop. Finance access in a second neighbor are insignificant and close to zero for the case of finance employment.

The most natural interpretation of this strong distance decay is an informational one: The distance between a bank and a parish has a strong bearing on whether that parish can take advantage of the growth-facilitating benefits of financial services. As Guiso et al. (2004) found, distance matters; using this dataset, we are able to demonstrate just how sharply it mattered to the spread of industrialisation during 19th century England and Wales.

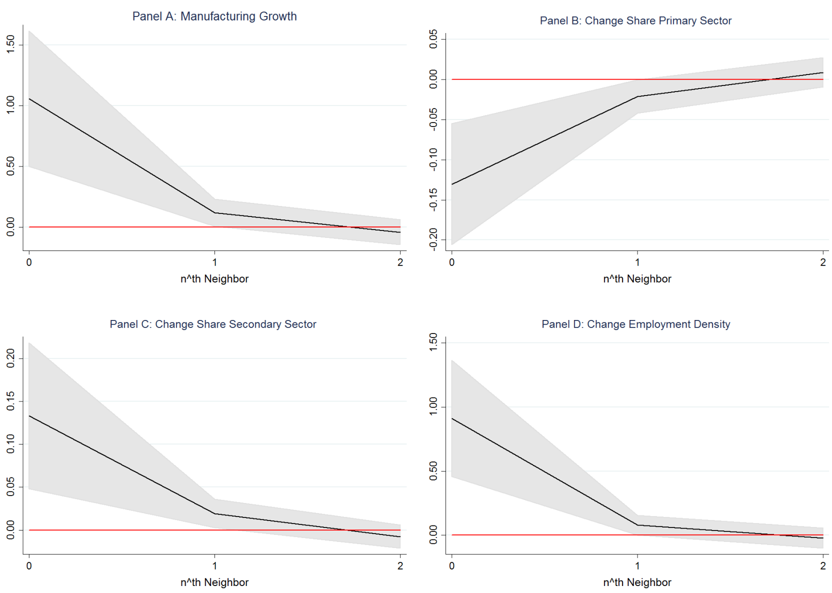
6.2 Finance and Urban Change

We now turn our attention to alternative outcomes in an attempt to understand how access to finance has an impact on the surrounding urban environment. In doing so, we first look at changes in sectoral employment shares around the source of banking services. Specifically, we now use the change in the share of employment in the primary (less mining) and secondary sector as dependant variables, using the same method as subsection 6.1.

We report regression results in Figure 5, Panel B-D where we plot the coefficients on first- and second-order neighbors, enclosed by the 95% confidence interval (and in Appendix E Table 12). The results show a similar pattern for the banking employment specification on the left and the country bank specification on the right. In both cases,

neighbour.

Figure 5: Distance decay of access to finance



Notes: The Figure presents the estimated coefficients $\gamma_0 - \gamma_2$ *(Eq. (16)) from four different IV regression. The outcome variable is the 1817 and 1881 change in log secondary employment (Panel A); the share of primary sector employment (Panel B); the share of secondary sector employment (Panel C); and employment density (Panel D) in parish p. The treatment variable is the log of finance employees in parish p* (FIN_p^0)*, p's first neighbor* ($FIN_p^1 = \sum_{p' \in N_p^1} FIN_{p'}$)*, and p's second neighbor* ($FIN_p^2 = \sum_{p' \in N_p^2} FIN_{p'}$)*. All regressions included the full set of controls specified in Table 1, Column 6. Instrumental variables are an Elizabethan post town dummy and an enclosure dummy indicating for parish p and its first and second-order neighbors. Coefficients are enclosed by a 95% confidence band and standard errors are clustered on the registration district level. The full estimation results underlying this figure can be found in Appendix E Table 12, Panel A.*

we observe lower employment share in the primary sectors in proximity to finance employment and by the second neighbor, the the employment share remains constant. A 10% increase in finance access within the parish decreases the primary sector employment share by 1.4pp and 10% more finance access in the neighboring parish reduces the primary sector employment share by 0.3pp. We do not observe an effect from finance access in one of the second order neighbor parishes.

For the share of secondary employment, we find opposite effects which is in line with the idea that industrialization leads to increasing urbanization with a rising share of secondary sector employment close to the center. We see the strongest increase in the share of manufacturing employment among the first neighbors and again, we observe no changes in the employment shares among the second order neighbors. Comparing the employment shares in primary and secondary employment clearly shows that the phase of industrialization also implies an increase in tertiary employment in proximity to the source of banking services.

While these effects on structural change appear relatively small, the gross effect of banking on the scale of the secondary sector is a combination of structural change and increased employment density. In a last step, we look at the growth of employment density at different distances from the source of finance. As can be seen in Table 12 Panel D, results suggest a strong growth of employment density in close proximity to the source of finance. A 10% increase in finance access within the parish implies 9.7% higher growth in employment density over the next 64 years. Among the first neighbors, the effect drops to 1% higher employment growth for 10% more finance access. Again, this finding suggests that access to finance attracted manufacturing firms which boosted urbanisation.

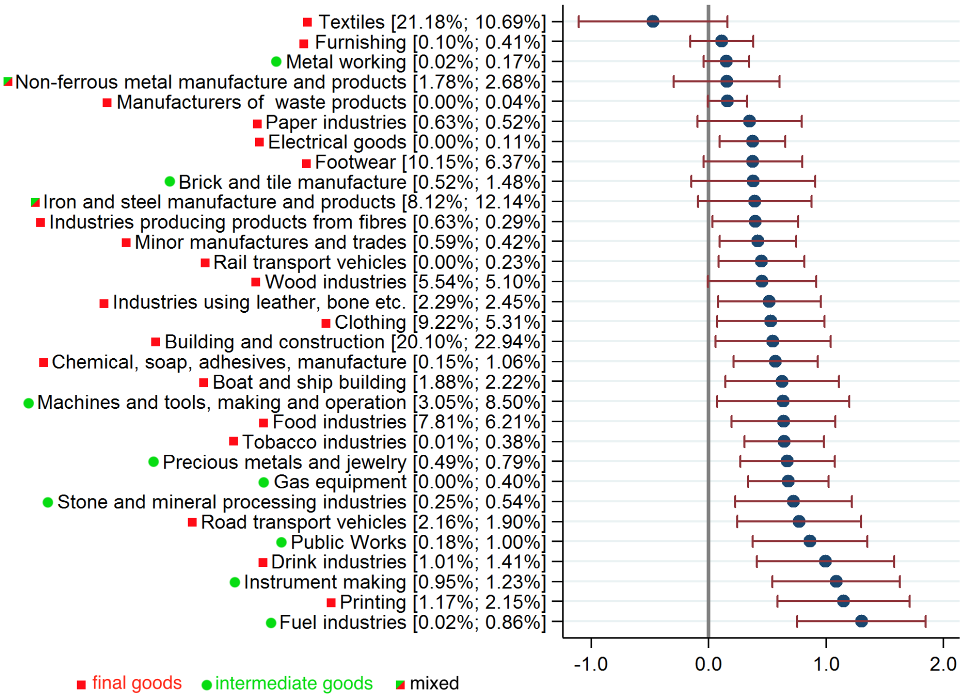
7 Mechanisms

In section 3.4, we discuss mechanisms suggested by Levine (2005) through which finance may affect manufacturing growth. The three broad categories are: i) Investment; ii) intermediation; and iii) credit constraints. In the following, we provide suggestive evidence for the existence of these mechanisms. To consider the investment channel we look at how the estimates for the role of banking varies by secondary subsector. For intermediation we ask whether a measure of sectoral diversification within a parish is related with the impact of banking. For credit constraints, we consider the role of legal professions in affecting the relationship between banking and secondary employment growth.

7.1 Investment

We estimate equations (16)-(19) separately for thirty secondary subsectors using the log of the number of finance employees as measure of finance access. Using the log of the number of country banks leads to the same results. To facilitate comparisons between the subsectors, we summarize in Figure 6 the coefficients from the preferred specification with both instruments (Table 1, Column 6) along with the 95% confidence interval. The Figure shows that more mature industries like textiles and clothing that were characteristic of industrialization in the late 18th and early 19th century benefited less from access to finance. We may expect this for already established industries; financial intermediaries specialise in identifying and monitoring firms in emerging sectors and gain higher returns from doing so. Indeed, we see the largest impact in industries like instrument making, fuel industries and machine and tool making that are mostly intermediate secondary outputs (cf. Horrell et al., 1994). There are at most 11 subsectors that can be classified as intermediate; 7 of those are among the top twelve coefficients. In the light of recent work on intermediate goods and their multiplier effects (Jones, 2011), this would suggest that banking played a crucial role in the working of the aggregate economy. This may also connect to the concept of 'contractual intensity' (cf. Rauch, 1999; Nunn 2007) since intermediate goods tend to be more complex, bespoke outputs. We also estimate the spillover by subsector in Appendix Figure 10.

Figure 6: The impact of finance on secondary subsectors



Notes: The Figure presents results from IV regressions of the log change in secondary employment in 31 subsectors on access to finance (measured as finance employment) using both instruments and the full set of controls specified in Table 1, Column 6). All coefficients are displayed with the 95% confidence interval. Squared brackets display the sectoral employment share at the beginning (1817) and at the end (1881) of our observation period. Standard errors are clustered on the registration district level.

7.2 Intermediation

To look at the effect of pooling and diversification, we use the Herfindahl index as measure of sectoral diversity within a parish. The index varies between 0 and 1 where the lower bound indicates regions that are fully diversified whereas the upper bound refers to fully specialized regions where all employment is concentrated in one sector. A banking sector can be more attractive to depositors if it is more stable and it will be more stable if it is more sectorally diverse. Across all parishes, we observe a mean Herfindahl of 0.36 and a standard deviation of 0.17. To understand how the effect of finance on manufacturing growth differs by sectoral diversity, we plot the relationship between banking access and manufacturing growth for the values defining the 10th and the 90th percentile conditional on the initial controls in 1817.[30] This implies and index range from 0.14-0.58.

Figure 7 graphs the marginal effects of the interaction between log finance employment and the Herfindahl index along with the 95% confidence band. Overall, the results suggest that the level of finance has no positive effect on manufacturing growth in highly concentrated regions. By contrast, it takes strong effect in less concentrated regions. That the parishes with greater diversity benefit from banks more supports the existence of a pooling channel. Regions that are already specialized benefit the least from better access to finance.

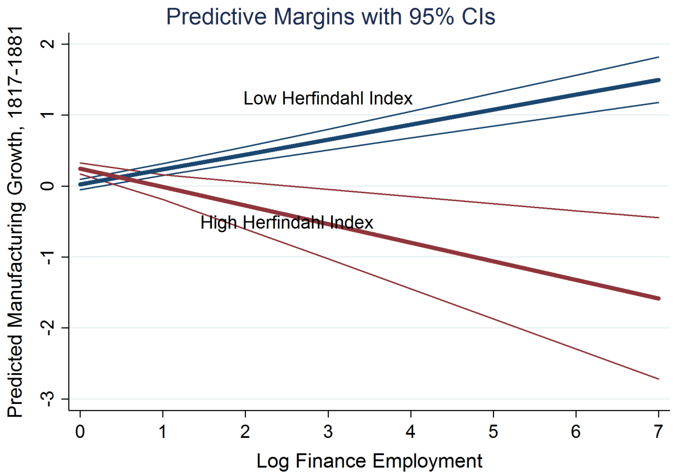
7.3 Credit constraints

To assess credit constraints arguments, we consider the role of legal professionals. Hudson (2002) in particular points to the role of attorneys in the early finance of industry. Their significance derived in part from their efficiency with writing contracts but also from conducting business via existing network of contacts. Hudson also notes that attorneys were reluctant to provide intermediation services since they were not set-up to hold deposits securely.

Again, we exploit the detailed occupational information in our data and determine the number of employees working in legal services at the beginning of the period in 1817. To understand the interrelation between finance and legal services, we interact the two variables and evaluate the effects of finance on secondary employment growth for the case without legal employment (low) and the case of positive legal employment (high). Overall, 16% of the parishes have some employees working in legal services. The results are plotted in Figure 8, again with the 95% confidence band. The result suggest some substitutability between banking access and legal services: In the absence

[30] Only the 10th and 90th percentiles are reported for clarity; results with the intervening deciles are ordered completely within these extremes.

Figure 7: The Effect of finance on manufacturing growth at different levels of industry diversity



Note: The Figure graphs the marginal effects of the interaction between log finance employment and a low (below the 10th percentile) or high (above the 90th percentile) Herfindahl index of industry concentration in 1817. All regressions include on the full set of initial control variables, registration district fixed effects (μ_d). Standard errors are clustered on the registration district level.

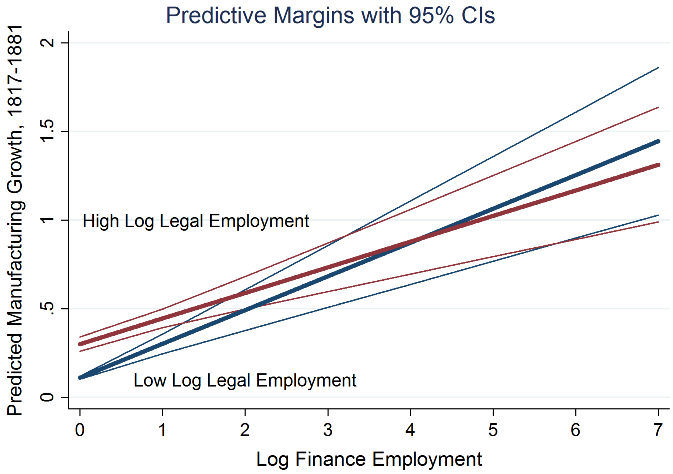
of banking access, legal services can compensate for poor access to banks but this effect does not hold in the case of high financial employment. Legal services become relatively less important once we pass a critical level of banking services. This suggests that at least a part of the impact of banking on structural transformation is via the credit constraint channel.

8 Concluding Remarks

We have found robust evidence to support the hypothesis that access to finance was causally important in the spread of the industrial revolution in England and Wales. To the best of our knowledge, this is the first paper to show a systematic role of finance access on economic development during the time of the industrial revolution. Our estimates of the effect suggest that a one standard deviation change in the log of finance employment causes annualised growth in locations outside London and its surrounding counties to be 0.8 percentage points higher. For the whole economy except London, access to finance at the beginning of our period explains about half of the overall growth in manufacturing employment over the period 1817-1881.

Our findings are surprisingly similar to contemporary studies reporting that one

Figure 8: The Effect of finance on manufacturing growth at different levels of legal services



Notes: The Figure graphs the marginal effects of the interaction between log finance employment and low (no employment) or high (some employment) number of employees working in "Legal Services" in 1817. All regressions include on the full set of initial control variables, registration district fixed effects (μ_d). Standard errors are clustered on the registration district level.

standard deviation more finance leads to 0.7-0.9 percentage point higher annual growth. We interpret the similarity across different development stages and institutional contexts as first evidence that the effect of finance on growth is persistent across space and time. We were further able to quantify the role that distance plays in the impact of access to finance. Analysis of secondary subsectors points to information asymmetry as being an important channel through which banking causes industrialization.

There is substantial scope to deepen our understanding of the role of finance in the process of industrialization. The analysis of subsectors is indicative of the role of information, but our understanding of exactly which sectors were capital-intensive, complex or intermediate in the early nineteenth century is limited. The tertiary sector was incredibly dynamic over this period; what role the financial sector played in the expansion of the railways and subsequent spatial change in other sectors is open to investigation. Further understanding the role of finance in urban development could shed light on the agglomeration forces at work during a period of structural transformation. Finally, a project to connect this nineteenth century data to the census data for twentieth century holds out the possibility of understanding whether the early advantage of access to banking had persistent effects.

References

Acemoglu, D. and Zilibotti, F. (1997). 'Was Prometheus Unbound By Chance? Risk, Diversification and Growth'. *Journal of Political Economy*, 105(5):709–51.

Aghion, P. and Howitt, P. (1992). 'A Model of Growth Through Creative Destruction'. *Econometrica*, 60(2):323–51.

Aghion, P., Howitt, P., and Mayer-Foulkes, D. (2005). 'The Effect of Financial Development on Convergence: Theory and Evidence'. *The Quarterly Journal of Economics*, 120(1). 173-222.

Allen, R. C. (1992). *Enclosure and the Yeoman: The Agricultural Development of the South Midlands 1450-1850*. Clarendon Press.

Allen, R. C. (2004). 'Agriculture during the industrial revolution, 1700–1850'. Chapter 1 in Floud, R. and Johnson, P. (eds.). *The Cambridge Economic History of Modern Britain: Volume 1, Industrialisation 1700-1860*. Cambridge University Press.

Alvarez-Cuadrado, F. and Poschke, M. (2011). 'Structural Change Out of Agriculture: Labor Push versus Labor Pull'. *American Economic Journal: Macroeconomics*, 3:127–58.

Angrist, J. D. (1991). 'Grouped-data estimation and testing in simple labor-supply models'. *Journal of Econometrics*, 47(2-3):243–66.

Ashby, J. F. (1934). *The Story of the Banks*. Hutchinson and Co.

Atack, J., Jaremski, M. S., and Rousseau, P. L. (2014). 'Did Railroads Make Antebellum U.S. Banks More Sound?'. NBER Working Paper No. 20032.

Bagwell, P. S. (1974). *The Transport Revolution from 1770*. B. T. Batsford Ltd. Manchester University Press.

Bairoch, P. (1988). *Cities and Economic Development*. University of Chicago Press.

Beck, T. (2008). 'The Econometrics of Finance and Growth'. Chapter in Mills, T. and Patterson, K. (eds.). *Palgrave Handbook of Econometrics, Vol.2*, Palgrave Macmillan.

Beck, T., Demirgüç-Kunt, A., and Singer, D. (2013). 'Is Small Beautiful? Financial Structure, Size and Access to Finance'. *World Development*, 52:19–33.

Becker, S. and Woessmann, L. (2009). Was weber wrong? a human capital theory of protestant economic history. *The Quarterly Journal of Economics*, 124(2):531–596.

Bester, C. A., Conley, T. G., and Hansen, C. B. (2011). 'Inference with Dependent Data Using Cluster Covariance Estimators'. *Journal of Econometrics*, 165(2):137–51.

Black, I. (1989). 'Geography, political economy and the circulation of finance capital in early industrial England'. *Journal of Historical Geography*, 15(4):366–84.

Blackburn, K. and Hung, V. T. Y. (1998). 'A Theory of Growth, Financial Development and Trade'. *Economica*, 65(1):107–24.

Bleakley, H. and Lin, J. (2012). 'Portage and Path Dependance'. *Quarterly Journal of Economics*, 127(2):587–644.

Bose, N. and Cothren, R. (1996). 'Equilibrium Loan Contracts and Endogenous Growth in the Presence of Asymmetric Information'. *Journal of Monetary Economics*, 38(3):363–76.

Boyd, J. H. and Prescott, E. C. (1985). 'Financial Intermediary-Coalitions'. *Journal of Economic Theory*, 38(2):211–32.

Cameron, R., editor (1967). *Banking in the Early Stages of Industrialization*. Oxford University Press.

Clark, G. and Clark, A. (2001). 'Common Rights to Land in England'. *Journal of Economic History*, 61(4):1009–36.

Conley, T., Hansen, C., and Rossi, P. E. (2012). Plausibly exogenous. *Review of Economics and Statistics*, 94(1):260–272.

Cottrell, P. L. (1980). *Industrial Finance 1830-1914: The finance and organization of English manufacturing industry*. Methuen.

Crafts, N. F. R. (1994). 'The industrial revolution'. Chapter 3 in Floud, R. and McCloskey, D. N. (eds.). *The Economic History of Britain since 1700: Volume 1, 1700-1860*. Cambridge University Press.

Dawes, M. and Ward-Perkins, C. N. (2000). *Country Banks of England and Wales: Private Provincial Banks & Bankers, 1688–1953*. The Chartered Institute of Bankers.

Demetriades, P. O. and Hussein, K. A. (1996). 'Does Financial Development Cause Economic Growth? Time-series evidence from 16 countries'. *Journal of Development Economics*, 51(2):387–411.

Desmet, K. and Rossi-Hansberg, E. (2012). 'Innovation in Space'. *American Economic Review: Papers and Proceedings*, 102(3):447–452.

Desmet, K. and Rossi-Hansberg, E. (2014). 'Spatial Development'. *American Economic Review*, 104(4):1211–43.

Diamond, D. W. (1984). 'Financial Intermediation and Delegated Monitoring'. *The Review of Economic Studies*, 51(3):393–414.

Frajola, R., Kramer, G., and Walske, S. C. (2005). *The Pony Express, A Postal History*. The Philatelic Foundation.

Gollin, D., Parente, S. L., and Rogerson, R. (2002). 'The Role of Agriculture in Development'. *American Economic Review: Papers and Proceedings*, 92(2):160–4.

Greenwood, J., Sanchez, J. M., and Wang, C. (2010). 'Financing Development: The Role of Information Costs'. *American Economic Review*, 100(4):1875–91.

Grossman, G. and Helpman, E. (1991). 'Quality Ladders in the Theory of Economic Growth'. *Review of Economic Studies*, 58(1):43–61.

Guiso, L., P., S., and Zingales, L. (2004). 'Does Local Financial Development Matter?'. *Quarterly Journal of Economics*, 119(3):929–69.

Heldring, L., Robinson, J. A., and Vollmer, S. (2015). 'Monks, Gents and Industrialists: The Long-Run Impact of the Dissolution of the English Monasteries'. NBER Working Paper No. 21450.

Hicks, J. (1969). *A Theory of Economic History*. Clarendon Press.

Higgs, E. (1987). 'Women's occupations and work in the nineteenth century censuses'. *History Workshop*, 23:59–80.

Horrell, S., Humphries, J., and Weale, M. (1994). 'An Input-Output Table for 1841'. *The Economic History Review*, 47(3):545–66.

Hudson, P. (2002). *The Genesis of Industrial Capital: A Study of the West Riding Wool Textile Industry*. Cambridge University Press.

Hyde, J. W. (1894). *The Early History of the Post in Grant and Farm*. Adam & Charles Black.

Jayaratne, J. and Strahan, P. E. (1996). 'The Finance-Growth Nexus: Evidence from Bank Branch Deregulation'. *The Quarterly Journal of Economics*, 111(3):639–70.

Jha, S. (forthcoming). 'Financial Asset Holdings and Political Attitude: Evidence from Revolutionary England'. *Quarterly Journal of Economics*.

Jones, C. I. (2011). 'Intermediate Goods and Weak Links in the Theory of Economic Development'. *American Economic Journal: Macroeconomics*, 3(2):1–28.

Kain, R. J. P. and Oliver, R. R. (2001). *The Historic Parishes of England and Wales*. History Data Service.

Kerr, W. R. and Nanda, R. (2011). 'Financing Constraints and Entrepreneurship'. Audretsch, D. and Falck, O. and Heblich, S. (eds.). *Handbook of Research on Innovation and Entrepreneurship*. Cambridge University Press.

King, R. G. and Levine, R. (1993a). 'Finance and Growth: Schumpeter might be right'. *Quarterly Journal of Economics*, 108(3):717–37.

King, R. G. and Levine, R. (1993b). 'Finance, Entrepreneurship, and Growth: theory and evidence'. *Journal of Monetary Economics*, 32(3):513–42.

Kitson, P. M., Shaw-Taylor, L., Wrigley, E. A., Davies, R. S., Newton, G., and Satchell, A. E. M. (2012). 'The creation of a 'census' of adult male employment for England and Wales for 1817'. Work in Progress. For details of the wider project see http://www.geog.cam.ac.uk/research/projects/occupations/.

Levine, R. (2005). 'Finance and Growth: Theory, Mechanisms and Evidence', in Aghion, P. and Durlauf, S.N. (eds.). *Handbook of Economic Growth*. Elsevier.

Levine, R., Loayza, N., and Beck, T. (2000). 'Financial Intermediation and Growth: Causality and Causes'. *Journal of Monetary Economics*, 46(1):31–77.

Levine, R. and Zervos, S. (1998). 'Stock Markets, Banks, and Economic Growth'. *American Economic Review*, 88(3):537–88.

Michaels, G. and Rauch, F. G. (2013). 'Resetting the Urban Network: 117–2012'. CEP Discussion Paper 1248.

Moore, Jr., B. (1966). *Social Origins of Dictatorship and Democracy*. Allen Lane.

Neal, L. (1990). *The Rise of Financial Capitalism*. Cambridge University Press.

Nunn, N. (2007). 'Relationship-Specificity, Incomplete Contracts, and the Pattern of Trade'. *Quarterly Journal of Economics*, 122(2):569–600.

Nunn, N. and Qian, N. (2011). 'The Potato's Contribution to Population and Urbanization: Evidence from a Historical Experiment'. *Quarterly Journal of Economics*, 126(2):593–650.

Nuvolari, A. and Tartari, V. (2011). Bennet woodcroft and the value of english patents, 1617-1841. *Explorations in Economic History*, 48(1):97–115.

Pascali, L. (Forthcoming). 'Banks and Development: Jewish Communities in the Italian Renaissance and Current Economic Performance'. *Review of Economics and Statistics*.

Pressnell, L. S. (1956). *Country Banking in the Industrial Revolution*. Oxford University Press.

Quinn, S. (2004). 'Money, finance and capital markets'. Chapter 6 in Floud, R. and Johnson, P. (eds.). *The Cambridge Economic History of Modern Britain: Volume 1, Industrialisation 1700-1860*. Cambridge University Press.

Rajan, R. and Zingales, L. (1998). 'Financial Dependence and Growth'. *American Economic Review*, 88(3):559–86.

Rauch, J. E. (1999). 'Networks versus markets in international trade'. *Journal of International Economics*, 48(1):7–35.

Robertson, A. W. (1961). *Great Britain: Post Roads, Post Towns and Postal Rates, 1635–1839*. privately published.

Robinson, H. (1948). *The British Post Office: A History*. Princeton University Press.

Romer, P. (1990). 'Endogenous Technological Change'. *Journal of Political Economy*, 98(5.2):S71–S102.

Rousseau, P. L. and Sylla, R. (2005). 'Emerging Financial Markets and Early US Growth'. *Explorations in Economic History*, 42(1):1–26.

Saint-Paul, G. (1992). 'Technological Choice, Financial Markets and Economic Development'. *European Economic Review*, 36(4):763–81.

Sharpe, P. (1995). 'Continuity and change: women's history and economic history in Britain'. *Economic History Review*, 48(2):353–69.

Shaw-Taylor, L. (2012). 'The rise of agrarian capitalism and the decline of family farming in England'. *Economic History Review*, 65(1):26–60.

Shaw-Taylor, L., Davies, R. S., Kitson, P. M., Newton, G., Satchell, A. E. M., and Wrigley, E. A. (2010). 'The occupational structure of England and Wales c.1817-1881'. Work in Progress. For details of the wider project see http://www.geog.cam.ac.uk/research/projects/occupations/.

Stow, W. (1722). *Remarks on London.* T. Norris and H. Tracy.

Tate, W. E. (1967). *The English Village Community and the Enclosure Movements.* Victor Gollancz.

Temin, P. and Voth, H. J. (2013). *Prometheus Shackled: Goldsmith Banks and England's Financial Revolution after 1700.* Cambridge University Press.

Ventura, J. and Voth, H. J. (2015). 'Debt into Growth: How Sovereign Debt Accelerated the First Industrial Revolution'. NBER Working Paper No. 21280.

Williamson, J. G. (2002). *Coping with City Growth during the British Industrial Revolution.* Cambridge University Press.

Wrigley, E. A. (2010). 'The PST System of Classifying Occupations'. Paper 1 at www.hpss.geog.cam.ac.uk/research/projects/occupations/britain19c/papers/.

Yang, D. T. and Zhu, X. (2013). 'Modernization of Agriculture and Long-Term Growth'. *Journal of Monetary Economics*, 60(3):367–82.

Appendix (not for publication)

Data

Descriptive statistics of the variables used in the study are provided in Table 6. We use the occupational geography data described in Shaw-Taylor et al. (2010) for the years 1817 and 1881. To provide a better understanding of the importance of local access to financial services for subsequent secondary sector growth, we benefit from high spatial resolution and detailed occupational classification of our data. We observe the number of adult males employed in occupations classified according to the PST (Primary-Secondary-Tertiary) system devised by Wrigley (2010).[31] The three Sectors (PST) are composed of 133 Groups (such as agriculture, mining, textiles, financial services etc.) and these Groups are composed of 539 Sections (such as coal mining, cotton textiles, and so on). When we refer to primary sector employment below, we always mean primary less mining.

The occupational data is observed at the level of the ancient parish. For 1817, Shaw-Taylor et al. (2010) map into 11,102 ancient parishes covering England and Wales. Most of the parishes persist over the period, but some are split and a few are merged; at 1881 there are 15,132 parishes. Both sets of parishes are made up of an underlying GIS of historical parishes updated from Kain and Oliver (2001). Using these, we form 10,738 consistent spatial units to create a panel dataset of nineteenth century parish employment. After dropping parishes with zero population in 1817 or 1881, and parishes in and around London, this number reduces to 10,528 parishes. These parishes have an average size of 14.1km^2 (an average radius of just 2.1km) and employ on average 230 adult males. Of these 10,528 consistent parishes, one third (3,464) of parishes connect different spatial units across the two periods and we control for these particular units in all regressions. The parishes are nested in 587 registration districts which themselves make up 59 counties. Note that 17 registration districts comprise only one parish. Therefore, the number of observation in our regressions with registration district fixed effects reduces to 10,511 parishes within 570 registration districts.

The information for 1881 are based on occupational data in the census records of that year. Prior to 1841, however, the UK census did not record occupations. By an 1812 Act of Parliament,[32] it was a requirement on those recording baptisms in parishes to also record the occupation of the father. The data for 1817 thus result

[31] There is at present no source for 1817 female employment remotely comparable to that used here for male employment. The 1851 census suggests that, after domestic services, female employment is predominantly in manufacturing (of textiles and clothing), although Higgs (1987) and Sharpe (1995) detail concerns about the enumeration of female occupations in that 1851 census. In robustness checks below, we control for the proportion of the population that is female.

[32] This is the Parochial Registers Act of 1812, often referred to as 'Rose's Act'.

from a massive undertaking described in Kitson et al. (2012) to create a 'quasi-census' from the occupational information in these baptism records over the period 1813–20 (which we refer to as 1817). Whether such a source is an accurate measure of adult employment rests on whether marital fertility varied by geography and occupation. As Kitson et al. note, there is no convincing evidence that fertility systematically varied by social group within a community. Moreover, the direct evidence on occupational structure that does exist for some small areas at this time is extremely close to the occupational estimates derived from baptism registers. We thus take this data as a good, unbiased measure of the 1817 occupational structure of adult males.

With this information, we can calculate employment growth in occupation i and parish p as $\Delta_{1881,1817} \ln Empl_{ip} = \ln Empl_{ip,1881} - \ln Empl_{ip,1817}$. In a typical estimation, we predict employment growth in occupation i and parish p between 1817 and 1881 as function of access to finance in 1817 conditional on additional parish characteristics observed in 1817.

Our main variable of interest is access to finance in 1817. We measure access to finance by the number of adult male employees working in 'Financial services and professions' which is a subsector of the tertiary sector, per the Wrigley (2010) classification. At the beginning of the period, 88% of the parishes do not have access to banking services in their immediate environment and only half the parishes have at least one employee working in finance within 5km.[33] At a time of poor transport connections, this distance is significant and, in practice, means that a large fraction of parishes could not easily access professional financial services. Over the next 64 years, this clearly changed and in 1881 we observe that one third of the parishes has immediate access to finance and 86% of parishes could access finance within 5km. Considering the improvements in transportation over this time that led to a massive reduction in the importance of distance we can conclude that all regions had equal access to finance at the end of our observation period.

A Post Town Characteristics

Consistent with the idea that these early post towns were strategic, not economic, is their population size. We use the data in Bairoch (1988) to identify those cities with a population of more than 1,000 inhabitants. Out of 55 such cities in 1600, only 14 were an Elizabethan post town. Put differently, only 20% of the Elizabethan post towns had a population greater than 1,000 at 1600. An example of a large city that could

[33]Since we use the log of finance employment in our empirical model, we calculate $\ln FIN_{p,1817} = ln(FIN_{p,1817} + 1)$ to avoid missings.

have been connected but was not is Birmingham.[34]

Moreover, we can consider the (truncated) size distribution of towns. If the post towns are truly unrelated with population size, then their size distribution should match the size distribution of all towns. Figure 9 reports the cumulative distribution of city size (excluding London) at four dates from 1500–1750, i.e., before country banks were widely established. As can be seen, the size distribution of post towns closely follows that for all towns in the run-up to the nineteenth century, matching both the size distribution within a period and the shift of that distribution over time. The two-sample Kolmogorov-Smirnov test fails to reject the Null at 5% significance level that the data are drawn from the same distribution in each period.

Finally, it may have been that the selection of a town to be a post town in the 16th Century caused it to grow faster over the subsequent period, putting it in a position more favourable to industrial change. Using the Bairoch (1988) data, we find no evidence that Elizabethan post towns experienced faster population growth over the period 1600–1850.

B Basic Results with Separate Instruments

These additional specifications use one instrument at a time to provide a better understanding of their effects. The tables follow the structure of Table 1. Table 7 starts with results from regressions where we instrument access to finance with the Elizabethan post town instrument. The outcome variable is the log of finance employment in parish p. For a better understanding of potential biases, Column 1 shows OLS results of our growth regression including the full set of control variables from our preferred specification. IV results are shown in Columns 2-8. Overall, the effects of dropping London and adding control variables (Columns 2-6) are similar when we use only one instrument. Column 6 is again our fully specified model. Conditional on registration district fixed effects and control variables, our estimations on the full sample (Column 2-7) suggest that parishes that host an Elizabethan post town have on average 32-47% more finance employees. F-statistics of excluded instruments between 11 and 14 along with Anderson-Rubin p-values below 0.01 underline the relevance of the instrument. In the second stage, our estimations suggest a statistically significant and positive effect of finance on secondary sector growth across all specifications. Our preferred estimate in column 6 gives a coefficient of 1.271, implying that a 10% increase in 1817 finance increases secondary sector employment by 12.71% till 1881.

[34]By contrast, one may argue that the assumption of randomness may not apply to the case of Bath since there is a clear deviation in the post road to meet it. However, dropping Bath from the set of post towns does not affect our results.

Table 8 presents results from regressions where we instrument access to finance with early enclosures. Again, the table follows the structure of Table 1. Column 1 provides the OLS specification as baseline and Columns 2-6 develop our preferred model with all controls stepwise. All specifications show F-statistics of excluded instruments between 17 and 22 and Anderson-Rubin p-values that are below 0.01 suggesting that our second instrument is also strong. In the second stage, our estimations suggest a statistically significant and positive effect of finance on secondary sector growth across all specifications. Our preferred specification in column 6 suggests that 10% more finance employment in 1817 leads to 9.24% more secondary sector employment 64 years later. Importantly, this effect is quite similar to the coefficients of 1.271 reported in our estimations with the post town instrument (which is why we comfortably fail to reject the over-identifying restriction in the specifications where we use both instruments.

C Robustness Checks

This section reports estimates from several alternative specifications designed to probe the robustness of our main findings. We start with variations of our measure of finance access and then discuss the validity of our identification strategy in detail. Since our preferred specifications include registration district fixed effects (with a registration district covering on average 27 parishes), potentially biasing effects must come from factors that vary within registration districts, attract banks and benefit manufacturing growth at the same time. When discussing reasons for heterogeneity within registration districts, we consider effects from first and second nature geography, show how our instruments relate to the controls, and finally present variations of our standard errors.

C.1 Geography and Effect Heterogeneity

Next, we turn to a set of geographic controls to capture within registration district heterogeneity in first nature geography. We start with controls for 4th order polynomials of latitude and longitude as a flexible control for within-registration district heterogeneity (column 1 of Table 9) and, as can be seen, there is no impact on results. We can also control for the slope of the land calculated as difference between the maximum and minimum elevation in a parish. Again, we find no significant impact on our coefficient (column 2). Finally, we calculate each parishes' distance to the next major port since opportunities for international trade may have attracted banks and manufacturing firms simultaneously. Again, we see no effect on our estimations (column 3).

The enclosure instrument assumes that there is no confounding link between agricultural prosperity and manufacturing growth. One concern relates to the observation that country banks helped reallocate financial resources between regions through their London agents (Black, 1989). In this way, it may be the case that country banks in agriculturally prosperous areas with excess supply of finance transferred money into rising manufacturing regions with excess demand for finance. In that case, we would likely overemphasize the effect of local finance. The most obvious way financial resources would flow is from the agriculturally prosperous south to the rising north. Accordingly, we present a specification where we split England and Wales along the 53° North latitude[35] and run the estimation without the manufacturing-intensive north. As can be seen in column 4 of Table 9, doing so leads to a highly significant coefficient that is somewhat larger than that obtained using the whole sample. This makes intuitive sense since the South was in a position of having to catch-up relative to the more heavily industrialized North.

It may be the case that certain soil characteristics simultaneously affect productivity in agriculture and manufacturing. To account for that, we include a set of indicators for soil characteristics from the UK National Soil Resources Institute (NSRI).[36] The NSRI 'soilscapes' classification of land is based on a variety of location characteristics that are aggregated into 27 soilscapes available for 1km x 1km cells covering England and Wales. Controlling for these functional types, we see in column 5 of Table 9 no indication that the omission of these variables would have biased our results.

Finally, we present some specifications where we exclude conditions that may selectively affect one of the two instruments. First, in column 6, we run a specification for a subset of parishes that had access to a turnpike road in 1817. By restricting our sample to parishes with road access, we can test whether finance has an effect on manufacturing growth that is independent of road-specific factors. Reassuringly, the effect of finance access is smaller but remains significant. In column 7 we drop all post towns below the 25th or above the 75th percentile in the distance distribution in Figure 2. Doing so narrows the range of distance to the interval 19.24-26.85 km. Reducing the number of post towns from 69 to 42 does not affect our results suggesting that the observed relationship is not driven by post towns at the tails of the distribution where the random allocation argument may not hold. Finally, in column 8 we drop all Welsh parishes where we lack enclosure information and again do not see a substantial change in our basic findings.

[35] England and Wales runs from roughly 50° to 56° North.

[36] The data come as raster data file with 1km x 1km cells. To aggregate this information to the parish level, we calculate zonal statistics and choose the dominant characteristic. If there are missing, we interpolate with values from neighboring cells.

C.2 Additional Economic Effects

This subsection considers the geography of interactions between economic agents and asks whether there may be unaccounted, within-registration district heterogeneity in interactions that could bias our results. First, it may be the case that market access varies within registration districts since relevant markets are not necessarily confined to political borders. To account for that, we include control variables that account for the log of employment size within a distance of 15 km.[37] In doing so, we control for potential benefits from having access to a larger pool of workers and also potential consumers. The results are reported in Table 10, Column 1. As we see, controlling for employment within the region does not affect our results significantly. Another concern could be that post towns may be co-located with market towns. Market towns were traditional trading places for grain that had demand for finance and if they were e.g. better accessible and thus attractive for manufacturing firms as well, we would face an upward bias in our estimations. In column 2 of Table 10 we control for whether or not a parish was a market town in 1722 using the list in Stow (1722). Assigning market town status to 583 parishes has no impact on the results. In a last step, we extend our definition of market access and calculate for each parish p a measure $marketaccess = \sum_{j \in J} \frac{pop_j}{dist_{pj}}$ that captures the distance weighted population (or number of manufacturing employees) in all 395 J post towns observed in 1791 or alternatively all 583 market towns that existed in 1722. Again, we find no indication of biasing effects (columns 3-6).

Next, we address the concern that wealth may vary across parishes. Individuals who became wealthy through agriculture could have been bankers as well as industrialists. To account for initial wealth as underlying driver of finance access and manufacturing growth, we use the share of employment in domestic services as a proxy. Reassuringly, the inclusion of this wealth proxy does not affect our estimations (column 7 of Table 10). Wealthy parishes may also have a more educated population which benefits economic growth Becker and Woessmann (2009). In the absence of information on individual education, we run a specification with the number of teachers as control variable (column 8). Additionally, we collected information on the number of patents in a parish and its first neighbors to account for the possibility that wealth may trigger innovative activities or that roads may have facilitated information flows that benefit manufacturing trough knowledge production. Using patents as a control variables does not affect our estimations (column 9).

In a final robustness check, we consider the possibility that the industry structure observed in 1817 may correlate with finance access and at the same time predict fu-

[37] Using 5 or 10km instead does not change the results.

ture growth. To account for that, we include a predicted employment control. Specifically, we calculate a Bartik shift-share control for predicted manufacturing employment based upon employment shares in manufacturing subsectors in parish p in 1817, i.e. $predictedgrowth = \sum_{m \in M} \frac{empl_{pm}}{empl_m} \Delta empl_{j,1817-1881}$ for all M manufacturing industries in parish p. Including this control should capture all growth effects from potentially confounding initial conditions. Unsurprisingly, controlling for the predicted growth path decreases the finance effect but it remains relevant and significant (Column 10). At the same time, the coefficient on our predicted employment control is negative suggesting that the industry composition in 1817 is not a good predictor of future growth. This corroborates our argument that the geography of production changed over this period and it also shows that banking access was a relevant driver of this process.

C.3 Standard Errors

In this last subsection, we explore whether clustering our standard errors on the level of registrations districts is enough to absorb potential spatial autocorrelation. Registration districts are the local government level above parishes. Given the costs of distance, it seems most likely that common shocks occur at this level of aggregation. We now consider an alternative specifications where we cluster standard errors on the level of 59 counties to absorb common institutional shocks on a more aggregate level. One remaining concern is that restricting serial correlation to be within arbitrary jurisdictions may not account for technology shocks that may spread over larger spatial units without stopping at administrative boarders. To detach our cluster strategy from administrative boundaries, we follow the Bleakley and Lin (2012) application of a method by Bester et al. (2011) and cluster on the level of 100×100km or alternatively 50×50km grid squares that enclose all parishes. In Table 11, we show the results for our two instruments separately and for the joint specification. It is reassuring to see that the standard errors are robust to these alternative strategies, suggesting that serial correlation across space does not affect our findings.

D Spatial Spillovers

D.1 Method

We define neighbors in the following way. A first-order neighbor of parish p shares a co-ordinate in the GIS polygon; a second-order neighbour of p shares a co-ordinate with the first-order neighbour of p, but not with p itself. Let N_p^1 and N_p^2 be the set of parish p's 1^{st}- and 2^{nd}-order neighbors, respectively. For each p, we sum the number of finance employees or banks, in the two sets of neighbors. Let $FIN_{p,1817}^1 = \sum_{p' \in N_p^1} FIN_{p'}$ for the first order neighbors and $FIN^2_{p,1817} = \sum_{p' \in N^2_p} FIN_{p'}$ for the second order neighbors. $FIN^0_{p,1817}$ would be the measure of finance in parish p. Following the same logic, we extend our instruments and define a post town instrument $z^1_{1,p} = 1$ if at least one first-order neighbor is an Elizabethan post town location and $z^2_{1,p} = 1$ if at least one second-order neighbor is an Elizabethan post town location. Analogously, let $z^1_{2,p} = 1$ if at least one first-order neighbor experienced an early enclosure and $z^2_{2,p} = 1$ if at least one second-order neighbor experienced and early enclosure.

Using this additional information, we augment our regression equations (14) and (15) in the following way:

$$\Delta_{1881,1817} \ln Empl_p = \beta_0 + X'_{p,1817}\beta_1 + \sum_{n=0}^{2} \gamma_n \widehat{FIN}^n_{p,1817} + \mu_d + \varepsilon_p \tag{16}$$

$$FIN^0_{p,1817} = \alpha_{00} + \alpha_{01}\mathrm{z}^0_p + X'_{p,1817}\alpha^2_{02} + \mu_d + \nu_{0p} \tag{17}$$

$$FIN^1_{p,1817} = \alpha_{10} + \alpha_{11}\mathrm{z}^1_p + X'_{p,1817}\alpha^2_{12} + \mu_d + \nu_{1p} \tag{18}$$

$$FIN^2_{p,1817} = \alpha_{20} + \alpha_{21}\mathrm{z}^2_p + X'_{p,1817}\alpha^2_{22} + \mu_d + \nu_{2p} \tag{19}$$

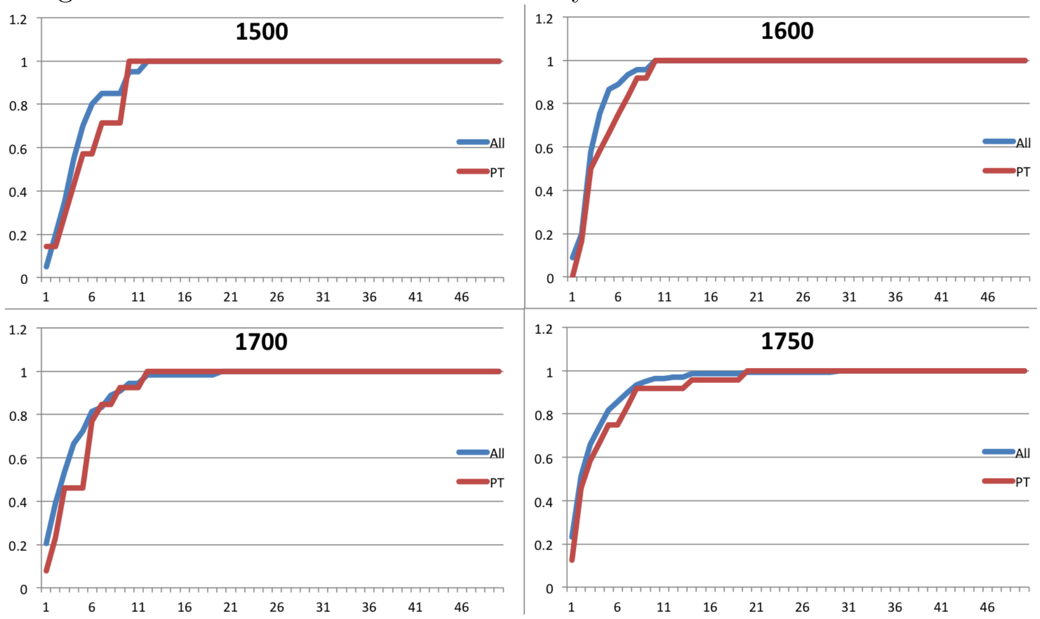
where we regress manufacturing employment growth in parish p on our measures of finance access in the parish itself ($FIN^0_{p,1817}$), the first-order neighboring parishes ($FIN^1_{p,1817}$), and the second-order neighboring parishes ($FIN^2_{p,1817}$), the full set of initial control variables $X_{p,1817}$ (used in Table 1, Column 6), and additional controls for the number of neighbors in the first and second ring of neighbors and a coastal dummy. Controlling for the number of neighbors accounts for the fact that more neighbors increase the possibility to have at least one neighbor with finance access and the coastal dummy accounts for the fact that coastal parishes are surrounded by less neighbors. We further include registration district fixed effects (μ_d) which provide that we are comparing parishes with different degrees of finance access nearby in the same registration district. Importantly, neighbors are not restricted to be within the registration district and capture parishes in neighbouring registration districts as well. We are interested in the coefficients γ_n which indicate the impact of finance access on manufacturing growth at each band of neighbors. To account for the endogeneity of finance, we employ the Elizabethan post town instruments $\mathrm{z}^0_{1,p} - \mathrm{z}^2_{1,p}$ and the early enclosure instruments $\mathrm{z}^0_{2,p} - \mathrm{z}^2_{2,p}$ in the first stage.

D.2 Spatial Spillovers by Subsector

We can estimate spillover effects of banking access on secondary subsectors in the same way as we have done for the whole sector in Section 6.1. Figure 10 depicts the impact of access to banking over distance along with the 95% confidence interval for all those subsectors that have at some point greater than 1% of total employment share. A distance decay similar to that for the whole secondary sector can be observed in many of the subsectors. However, only a small number of the large subsectors have a statistically-significant neighbor effect and only one of those may be considered an intermediate good (machines and tool making). This provides suggestive evidence that the more complex the output, the greater the investment in monitoring activities is required for a given distance to an investment. As distance is an additional component of this monitoring cost, the distance decay is greater in those subsectors where output may have been most complex.

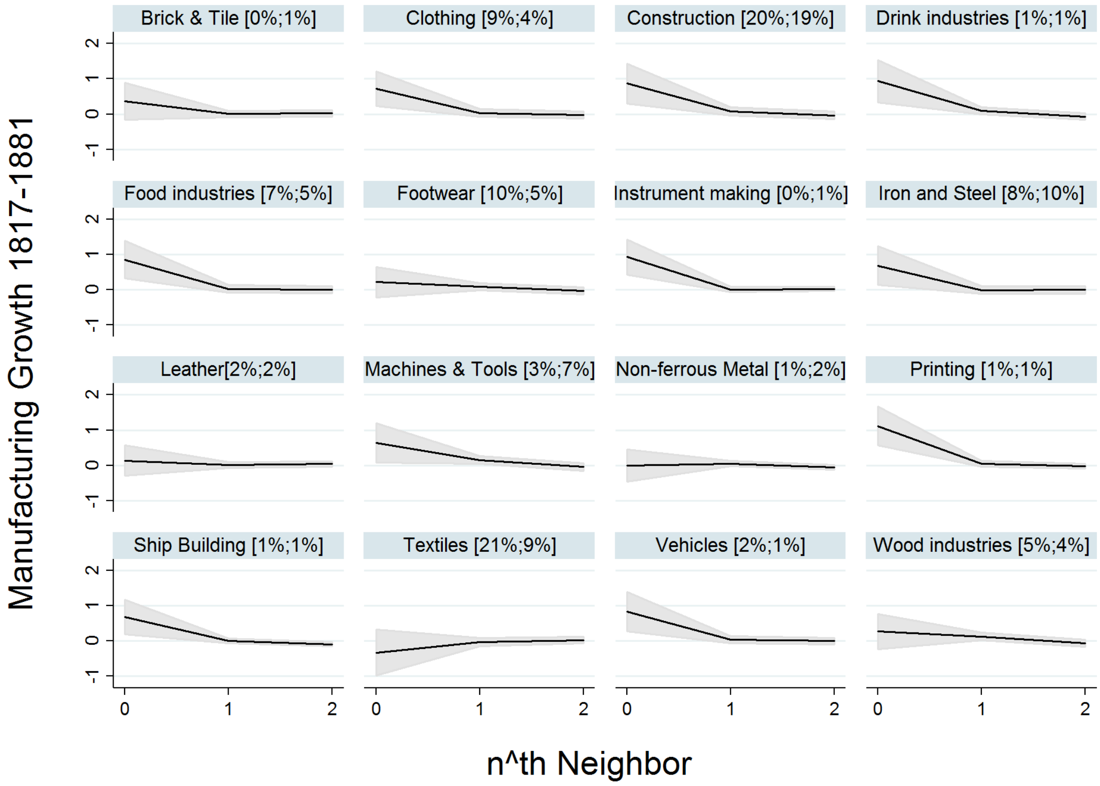
E Additional Figures and Tables

Figure 9: Cumulative distribution of city sizes: All vs. Elizabethan PTs



Notes: The figure shows the cumulative distribution of city size (excluding London) at four dates before country banks were widely established. We rely on Bairoch (1988) to identify cities in England and Wales with a population of more than 1,000 inhabitants. In 1600, only 14 out of 55 listed cities were an Elizabethan post town. The size distributions of post towns closely follows that for all towns in the run-up to the nineteenth century and the two-sample Kolmogorov-Smirnov test fails to reject the Null at 5% significance level that the data are drawn from the same distribution in each period.

Figure 10: The neighbor impact from finance in large secondary subsectors



Notes: The Figure presents the estimated coefficients $\gamma_0 - \gamma 2$ (Eq. (16)) from IV regressions of the log change in secondary employment in 16 subsectors between 1817 and 1881 in parish p on the intensity of finance access in the finance parish (FIN_p^0), the first neighbor ($FIN_p^1 = \sum_{p' \in N_p^1} FIN_{p'}$), and the second neighbor ($FIN_p^2 = \sum_{p' \in N_p^2} FIN_{p'}$). All 16 manufacturing subsectors that have at some point greater than 1% of total employment share. All regressions include the full set of controls specified in Table 1, Column 6). Instrumental variables are an Elizabethan post town dummy and an enclosure dummy indicating for parish p and its first and second-order neighbors. Coefficients are displayed with the 95% confidence interval. Squared brackets display the sectoral employment share at the beginning (1817) and at the end (1881) of our observation period. Standard errors are clustered on the registration district level.

Table 6: Parish-level descriptive statistics

	Mean	Std.Dev.
Secondary Sector Employment in 1817	93.62	442.10
Secondary Sector Employment in 1881	234.56	1431.02
1817-1881 Growth in Secondary Sector Employment (%)	15.67	89.74
Finance Employment in 1817 across all parishes	0.65	11.35
Finance Employment in 1817 in parishes with finance employment	5.64	32.94
Number of Country banks across all parishes	0.05	0.36
Number of Country banks in parishes with a country bank	1.49	1.20
Area (in km^2)	14.10	17.82
Population in 1817	1046.05	3527.54
Employment 1817	229.71	652.55
Employment share in the primary sector (less mining) in 1817 (in %)	60.19	21.34
Employment share in mining in 1817 (in %)	1.35	6.37
Employment share in the secondary sector in 1817 (in %)	26.69	15.85
Employment share in goods transportation in 1817 (in %)	1.98	4.95
Coal Access (% of parishes located on a coal field)	15.41	36.10
Herfindahl index for secondary employment concentration	0.36	0.17
Parishes where the area has changed (in %)	32.90	46.99
Parishes per registration district	26.28	14.21
Parishes per county	294.35	170.78
Canal access in 1817 (in canal-km/sqkm)	0.26	5.33
Change in railway access (in railway-km/sqkm)	0.95	12.65
Road access in c.1820 (in turnpike-km/sqkm)	1.85	25.37
Elizabethan post town (in %)	0.66	8.07
Enclosure (in %)	3.77	19.05
Market Town (in %)	5.50	22.80

Notes: The Table presents descriptive statistics for our main variables. All variabes are means across 10,511 parishes which excludes registration districts in and around London.

Table 7: Results with Elizabethan Post Towns Instrument

Dep. Variable: Δ log secondary employment	(1) OLS	(2) 2SLS	(3) 2SLS	(4) 2SLS	(5) 2SLS	(6) 2SLS
Log finance employment 1817	0.205***	1.497***	1.450***	1.274**	1.260**	1.268**
	(0.023)	(0.513)	(0.507)	(0.511)	(0.514)	(0.524)
Log number secondary employment 1817	-0.598***	-0.373***	-0.388***	-0.579***	-0.582***	-0.561***
	(0.036)	(0.040)	(0.040)	(0.038)	(0.038)	(0.039)
Log area (in km^2)	0.211***	0.213***	0.205***	0.261***	0.261***	0.263***
	(0.024)	(0.052)	(0.052)	(0.038)	(0.038)	(0.039)
Log employment 1817	0.467***	0.121	0.173**	0.303***	0.309***	0.286***
	(0.046)	(0.092)	(0.080)	(0.104)	(0.104)	(0.106)
Female population share 1817	-0.476**	-0.617***	-0.634***	-0.591***	-0.592***	-0.607***
	(0.196)	(0.235)	(0.229)	(0.221)	(0.219)	(0.221)
Share primary employment 1817	-1.924***	-	-	-1.160***	-1.303***	-1.183***
	(0.204)	-	-	(0.269)	(0.391)	(0.399)
Share mining employment 1817	-0.198	-	-	0.307	0.230	0.336
	(0.228)	-	-	(0.322)	(0.364)	(0.371)
Availability of coal	0.124**	-	-	0.099*	0.100*	0.102*
	(0.060)	-	-	(0.059)	(0.059)	(0.059)
Herfindahl Index 1817	0.468***	-	-	-	0.179	0.178
	(0.177)	-	-	-	(0.211)	(0.213)
Δ Railway (in km) per km^2 1817-1881	-0.001	-	-	-	-	-0.001
	(0.001)	-	-	-	-	(0.001)
Waterway (in km) per km^2 1817	-0.002	-	-	-	-	-0.004
	(0.002)	-	-	-	-	(0.002)
Roads (in km) per km^2 1817	0.000	-	-	-	-	0.001
	(0.001)	-	-	-	-	(0.001)
Share good transportation 1817	0.657**	-	-	-	-	0.632**
	(0.258)	-	-	-	-	(0.281)
First Stage:						
Posttown Dummy	-	0.358***	0.363***	0.333***	0.326***	0.322***
	-	(0.098)	(0.098)	(0.098)	(0.097)	(0.098)
Observations	10,511	10,651	10,511	10,511	10,511	10,511
Number of Registration District FE	570	588	570	570	570	570
London districts excluded	Y	N	Y	Y	Y	Y
Control for Territorial Changes	Y	Y	Y	Y	Y	Y
AndersonRubin F-test (p-value)	-	0.001	0.001	0.004	0.003	0.003
Kleibergen-Paap Wald rk F statistic	-	13.31	13.62	11.58	11.26	10.87

*Notes: The table presents results from regressions of the log change in secondary employment between 1817 and 1881 in parish p on access to finance measured as log employment in finance. Column (1) presents OLS regressions and Columns (2)-(6) present instrumental variable regressions. The instrumental variable is a dummy variable that takes the value 1 if parish i is an Elizabethan post town. Column (2) is a specification that includes London registration districts while the other specifications exclude them. Columns (3)-(6) use our preferred sample and stepwise include sets of control variables. All specifications are conditional on registration district fixed effects and a control for territorial changes in the parish specification between 1817 and 1881. Standard errors are clustered on the registration district level in all specifications. *** significant at the 1 percent level, ** significant at the 5 percent level and * significant at the 10 percent level.*

Table 8: Results with Enclosure Instrument

Dep. Variable: Δ log secondary employment	(1) OLS	(2) 2SLS	(3) 2SLS	(4) 2SLS	(5) 2SLS	(6) 2SLS
Log finance employment 1817	0.205***	1.045***	1.032***	0.933***	0.934***	0.927***
	(0.023)	(0.369)	(0.322)	(0.325)	(0.325)	(0.323)
Log number secondary employment 1817	-0.598***	-0.349***	-0.362***	-0.590***	-0.594***	-0.573***
	(0.036)	(0.039)	(0.039)	(0.035)	(0.034)	(0.035)
Log area (in km^2)	0.211***	0.178***	0.172***	0.244***	0.246***	0.246***
	(0.024)	(0.036)	(0.033)	(0.027)	(0.026)	(0.027)
Log employment 1817	0.467***	0.178**	0.217***	0.359***	0.364***	0.344***
	(0.046)	(0.070)	(0.059)	(0.068)	(0.067)	(0.068)
Female population share 1817	-0.476**	-0.572***	-0.585***	-0.548***	-0.552***	-0.565***
	(0.196)	(0.215)	(0.210)	(0.206)	(0.206)	(0.206)
Share primary employment 1817	-1.924***	-	-	-1.329***	-1.532***	-1.420***
	(0.204)	-	-	(0.189)	(0.299)	(0.303)
Share mining employment 1817	-0.198	-	-	0.172	0.066	0.165
	(0.228)	-	-	(0.259)	(0.288)	(0.293)
Availability of coal	0.124**	-	-	0.106*	0.107*	0.109*
	(0.060)	-	-	(0.059)	(0.059)	(0.059)
Herfindahl Index 1817	0.468***	-	-	-	0.267	0.271
	(0.177)	-	-	-	(0.198)	(0.199)
Δ Railway (in km) per km^2 1817-1881	-0.001	-	-	-	-	-0.001
	(0.001)	-	-	-	-	(0.001)
Waterway (in km) per km^2 1817	-0.002	-	-	-	-	-0.003
	(0.002)	-	-	-	-	(0.002)
Roads (in km) per km^2 1817	0.000	-	-	-	-	0.000
	(0.001)	-	-	-	-	(0.001)
Share good transportation 1817	0.657**	-	-	-	-	0.640**
	(0.258)	-	-	-	-	(0.265)
First Stage:						
Enclosure before 1650 (Dummy)	-	0.129***	0.145***	0.137***	0.137***	0.138***
	-	(0.032)	(0.031)	(0.031)	(0.031)	(0.031)
Observations	10,511	10,651	10,511	10,511	10,511	10,511
Number of Registration District FE	570	588	570	570	570	570
London districts excluded	Y	N	Y	Y	Y	Y
Control for Territorial Changes	Y	Y	Y	Y	Y	Y
AndersonRubin F-test (p-value)	-	0.001	0.000	0.001	0.001	0.001
Kleibergen-Paap Wald rk F statistic	-	15.98	21.30	19.71	19.75	19.86

*Notes: The table presents results from regressions of the log change in secondary employment between 1817 and 1881 in parish p on access to finance measured as log employment in finance. Column (1) presents OLS regressions and Columns (2)-(6) present instrumental variable regressions. The instrumental variable is a dummy variable that takes the value 1 if parish i was fully enclosed by 1650. Column (2) is a specification that includes London registration districts while the other specifications exclude them. Columns (3)-(6) use our preferred sample and stepwise include sets of control variables. All specifications are conditional on registration district fixed effects and control for territorial changes in the parish between 1817 and 1881. Standard errors are clustered on the registration district level in all specifications. *** significant at the 1 percent level, ** significant at the 5 percent level and * significant at the 10 percent level.*

Table 9: First Nature Geography

Dep. Variable: Δ log secondary employment	(1) xy-Coords. 4th Polyn.	(2) Slope Dummy	(3) Distance Port	(4) without North	(5) Soil Suitability	(6) Only Road-Parishes	(7) Dist. Post Town p25-p75	(8) without Wales
Log finance employment 1817	1.085***	1.092***	1.090***	1.460***	1.093***	0.862**	1.160**	0.921***
	(0.297)	(0.296)	(0.298)	(0.490)	(0.298)	(0.429)	(0.483)	(0.324)
Log number secondary employment 1817	-0.568***	-0.568***	-0.568***	-0.567***	-0.570***	-0.595***	-0.565***	-0.558***
	(0.036)	(0.035)	(0.035)	(0.040)	(0.035)	(0.047)	(0.039)	(0.035)
Log area (in km^2)	0.254***	0.271***	0.249***	0.298***	0.264***	0.254***	0.257***	0.223***
	(0.030)	(0.033)	(0.029)	(0.041)	(0.030)	(0.033)	(0.037)	(0.027)
Log employment 1817	0.317***	0.313***	0.316***	0.303***	0.310***	0.392***	0.304***	0.356***
	(0.071)	(0.071)	(0.071)	(0.095)	(0.071)	(0.094)	(0.101)	(0.069)
Female population share 1817	-0.588***	-0.579***	-0.582***	-0.609**	-0.591***	-0.598**	-0.594***	-0.694***
	(0.209)	(0.209)	(0.208)	(0.241)	(0.210)	(0.248)	(0.216)	(0.211)
Share primary employment 1817	-1.314***	-1.307***	-1.309***	-1.077***	-1.318***	-1.453***	-1.258***	-1.290***
	(0.274)	(0.274)	(0.275)	(0.321)	(0.276)	(0.373)	(0.362)	(0.311)
Share mining employment 1817	0.271	0.267	0.233	0.437	0.260	0.057	0.282	0.003
	(0.294)	(0.294)	(0.294)	(0.356)	(0.299)	(0.369)	(0.349)	(0.290)
Availability of coal	0.103*	0.112*	0.105*	0.126	0.108*	0.117*	0.104*	0.028
	(0.059)	(0.059)	(0.058)	(0.081)	(0.058)	(0.063)	(0.060)	(0.048)
Herfindahl Index 1817	0.232	0.213	0.227	0.203	0.232	0.255	0.207	0.249
	(0.186)	(0.186)	(0.186)	(0.200)	(0.186)	(0.236)	(0.201)	(0.198)
Δ Railway (in km) per km^2 1817-1881	-0.001	-0.001	-0.001	-0.001	-0.001	-0.002*	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Waterway (in km) per km^2 1817	-0.003	-0.003	-0.003	-0.005*	-0.003	-0.001	-0.003	-0.003
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
Roads (in km) per km^2 1817	0.000	0.000	0.000	0.001*	0.000	0.001	0.001	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Share good transportation 1817	0.626**	0.623**	0.657**	0.482	0.622**	0.959***	0.634**	0.711**
	(0.269)	(0.270)	(0.270)	(0.302)	(0.271)	(0.308)	(0.275)	(0.302)
Additional Controls as specified by Column	-	-0.038*	-0.006***	-	-	-	-	-
	-	(0.021)	(0.002)	-	-	-	-	-
First Stage:								
Posttown Dummy	0.317***	0.318***	0.317***	0.362***	0.320***	0.380***	0.470***	-
	(0.097)	(0.098)	(0.098)	(0.112)	(0.098)	(0.142)	(0.135)	-
Enclosure before 1650 (Dummy)	0.137***	0.136***	0.136***	0.084***	0.137***	-	-	0.138***
	(0.031)	(0.031)	(0.031)	(0.029)	(0.031)	-	-	(0.031)
Observations	10,511	10,511	10,511	8,345	10,511	6,842	10,511	9,528
Number of Registration District FE	570	570	570	427	570	556	570	523
London districts excluded	Y	Y	Y	Y	Y	Y	Y	Y
Control for Territorial Changes	Y	Y	Y	Y	Y	Y	Y	Y
Hansen's J (p-value)	0.609	0.575	0.573	0.913	0.560	-	-	-
AndersonRubin F-test (p-value)	0.000	0.000	0.000	0.000	0.000	0.018	0.005	0.001
Kleibergen-Paap Wald rk F statistic	14.87	14.89	14.72	9.156	14.88	7.19	12.18	19.64

*Notes: The table presents results from regressions of the log change in secondary employment between 1817 and 1881 in parish p on access to finance measured as log employment in finance. We use two instrumental variables, an Elizabethan post town dummy and an enclosure dummy. All specifications resemble Column 6 of Table 3 plus an additional control variable that is specified in the column title. or they report results of a subsample of parishes. All specifications resemble Column 6 of Table 3 plus an additional control variable that is specified in the column title. They exclude London, control for territorial changes in the parish between 1817 and 1881, and are conditional on registration district fixed effects. Standard errors are clustered on the registration district level in all specifications. *** significant at the 1 percent level, ** significant at the 5 percent level and * significant at the 10 percent level.*

Table 10: Second Nature Geography

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
			Market Access							
			Post Town		Market Town					
Dep. Variable: Δ log seco. emp.	Employment within 15km	Market Towns	Pop.	Manu.	Pop.	Manu.	Wealth	Teachers	Innov.	Predicted emp.
Log finance employment 1817	1.105***	1.032***	1.097***	1.057***	1.108***	1.080***	1.077***	1.055***	1.184***	0.957***
	(0.298)	(0.354)	(0.300)	(0.324)	(0.308)	(0.346)	(0.298)	(0.280)	(0.356)	(0.295)
Log number secondary employment 1817	-0.569***	-0.569***	-0.567***	-0.566***	-0.567***	-0.567***	-0.623***	-0.572***	-0.566***	-0.481***
	(0.035)	(0.036)	(0.035)	(0.035)	(0.036)	(0.036)	(0.040)	(0.034)	(0.036)	(0.034)
Log area (in km^2)	0.258***	0.253***	0.256***	0.258***	0.253***	0.255***	0.259***	0.250***	0.260***	0.233***
	(0.030)	(0.030)	(0.029)	(0.028)	(0.029)	(0.027)	(0.029)	(0.028)	(0.032)	(0.030)
Log employment 1817	0.312***	0.321***	0.313***	0.315***	0.314***	0.315***	0.362***	0.331***	0.309***	0.291***
	(0.071)	(0.074)	(0.071)	(0.071)	(0.071)	(0.071)	(0.075)	(0.064)	(0.074)	(0.061)
Female population share 1817	-0.574***	-0.579***	-0.590***	-0.577***	-0.583***	-0.581***	-0.580***	-0.589***	-0.600***	-0.518**
	(0.209)	(0.209)	(0.209)	(0.208)	(0.210)	(0.211)	(0.209)	(0.208)	(0.214)	(0.205)
Share primary employment 1817	-1.296***	-1.328***	-1.297***	-1.298***	-1.298***	-1.302***	-1.501***	-1.265***	-1.294***	-1.099***
	(0.275)	(0.286)	(0.275)	(0.274)	(0.277)	(0.271)	(0.284)	(0.276)	(0.285)	(0.243)
Share mining employment 1817	0.237	0.249	0.255	0.256	0.249	0.254	0.039	0.265	0.248	0.288
	(0.296)	(0.288)	(0.294)	(0.292)	(0.293)	(0.283)	(0.303)	(0.291)	(0.299)	(0.280)
Availability of coal	0.093	0.106*	0.105*	0.100*	0.104*	0.104*	0.104*	0.106*	0.105*	0.098*
	(0.059)	(0.059)	(0.059)	(0.059)	(0.059)	(0.059)	(0.058)	(0.059)	(0.059)	(0.058)
Herfindahl Index 1817	0.220	0.246	0.223	0.224	0.222	0.225	0.143	0.206	0.228	0.029
	(0.186)	(0.195)	(0.187)	(0.186)	(0.188)	(0.186)	(0.188)	(0.187)	(0.188)	(0.168)
Δ Railway (in km) per km^2 1817-1881	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Waterway (in km) per km^2 1817	-0.003	-0.003	-0.003	-0.003*	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Roads (in km) per km^2 1817	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Share good transportation 1817	0.679**	0.638**	0.644**	0.659**	0.624**	0.646**	0.400	0.666**	0.622**	0.572**
	(0.273)	(0.269)	(0.272)	(0.273)	(0.273)	(0.276)	(0.285)	(0.269)	(0.276)	(0.265)
Additional Controls as specified by Column	0.102**	0.078	0.112	0.496	-0.130	0.118	-1.106***	2.493**	-0.256	-0.096***
	(0.051)	(0.103)	(0.179)	(0.473)	(0.193)	(0.504)	(0.253)	(1.003)	(0.166)	(0.021)
First Stage:										
Posttown Dummy	0.319***	0.240**	0.316***	0.292***	0.306***	0.259***	0.317***	0.319***	0.273***	0.289***
	(0.098)	(0.095)	(0.098)	(0.095)	(0.097)	(0.094)	(0.098)	(0.098)	(0.094)	(0.098)
Enclosure before 1650 (Dummy)	0.136***	0.118***	0.136***	0.125***	0.134***	0.121***	0.136***	0.136***	0.117***	0.127***
	(0.031)	(0.030)	(0.031)	(0.030)	(0.031)	(0.030)	(0.031)	(0.031)	(0.030)	(0.031)
Observations	10,511	10,511	10,511	10,511	10,511	10,511	10,511	10,511	10,511	10,511
Number of Registration District FE	570	570	570	570	570	570	570	570	570	570
London districts excluded	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Control for Territorial Changes	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Hansen's J (p-value)	0.540	0.614	0.580	0.570	0.570	0.587	0.561	0.627	0.582	0.606
AndersonRubin F-test (p-value)	0.000	0.004	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.001
Kleibergen-Paap Wald rk F statistic	14.77	10.78	14.70	13.18	14.23	11.99	14.63	14.77	11.29	12.82

*Notes: The table presents results from regressions of the log change in secondary employment between 1817 and 1881 in parish p on access to finance measures as log employment in finance. We use two instrumental variables, an Elizabethan post town dummy and an enclosure dummy. All specifications resemble column 6 of Table 3 plus an additional control variable that is specified in the column title. All specifications resemble column 6 of Table 3 plus an additional control variable that is specified in the column title. They exclude London, control for territorial changes in the parish between 1817 and 1881, and are conditional on registration district fixed effects. Standard errors are clustered on the registration district level in all specifications. *** significant at the 1 percent level, ** significant at the 5 percent level and * significant at the 10 percent level.*

Table 11: Alternative clustering of the standard errors

Dep. Variable: Δ log secondary employment	(1) Baseline	(2) County	(3) 100km	(4) 50km
LATE1: Post Towns				
Log finance employment 1817	1.271**	1.268**	1.268**	1.268**
	(0.525)	(0.630)	(0.550)	(0.510)
LATE2: Enclosure				
Log finance employment 1817	0.924***	0.927**	0.927***	0.927***
	(0.317)	(0.394)	(0.348)	(0.321)
Panel C: Both Instruments				
Log finance employment 1817	1.096***	1.096***	1.096***	1.096***
	(0.298)	(0.399)	(0.368)	(0.314)
Observations	10,532	10,530	10,530	10,530
Number of Clusters	570	54	29	94

*Notes: The table presents results from IV-regressions of the log change in secondary employment between 1817 and 1881 in parish p on access to finance measures as log employment in finance. Each column presents a different way of clustering standard errors. Column (1) sets the baseline where standard errors are clustered on the registration district level. In the following columns, we then cluster on the level of counties, 100x100km arbitrary grid cells, and 50x50km arbitrary grid cells. Late 1 specifciations resemble Table 1, column (6); Late 2 specifications relate to Table 2, Column (6); and the specification with both instruments relates to Table 3, Column (6). Controls and instruments are the same as in the baseline specifications in Tables 1-3. *** significant at the 1 percent level, ** significant at the 5 percent level and * significant at the 10 percent level.*

Table 12: Neighbor effects

	(1) OLS	(2) IV	(3) IV	(1) OLS	(2) IV	(3) IV
	Panel A: Δ log secondary employment			Panel B: Δ Share Primary Sector		
	(0.023)	(0.298)	(0.312)	(0.004)	(0.042)	(0.043)
Log finance access c.1817, 1st neighbor	0.125***	0.117**	0.144**	-0.017***	-0.021**	-0.028**
	(0.016)	(0.057)	(0.064)	(0.003)	(0.011)	(0.012)
Log finance access c.1817, 2nd neighbor	0.031**	-0.042	-0.011	-0.004*	0.009	0.001
	(0.013)	(0.052)	(0.058)	(0.002)	(0.010)	(0.011)
	Panel C: Δ Share Secondary Sector			Panel D: Δ Log Employment Density		
Log finance access c.1817	0.022***	0.145***	0.145***	0.217***	0.929***	0.969***
	(0.003)	(0.049)	(0.049)	(0.019)	(0.241)	(0.254)
Log finance access c.1817, 1st neighbor	0.008***	0.019**	0.021**	0.106***	0.078**	0.100**
	(0.002)	(0.009)	(0.009)	(0.012)	(0.039)	(0.044)
Log finance access c.1817, 2nd neighbor	0.002	-0.008	-0.005	0.028***	-0.023	0.008
	(0.002)	(0.007)	(0.007)	(0.009)	(0.040)	(0.044)
Observations	10,511	10,511	10,511	10,511	10,511	10,511
Number of Clusters	570	570	570	570	570	570

*Notes: The table presents results from regressions of finance access measured as log employment in finance on the log change in secondary employment (Panel A), the change in the share of primary sector employment (Panel B), the change in the share of secondary sector employment (Panel C) and the change in the log of employment density (Panel D) between c.1817 and 1881 in parish p on access to finance. Column (1) reports OLS regressions and Columns (2) and (3) report IV regressions. The instrumental variables are dummy variables that take the value 1 if parish i (or its first or second neighbor) is an Elizabethan post town and a dummy that takes the value 1 if parish i (or its first or second neighbor) was fully enclosed before 1650. All specifications are conditional on registration district fixed effects and control for territorial changes in the parish between c.1817 and 1881. *** significant at the 1 percent level, ** significant at the 5 percent level and * significant at the 10 percent level.*

F A model of structural transformation and endogenous growth

We model structural transformation within a parish using a simple form of non-homothetic preferences; as income grows, so consumption demand shifts toward manufactured goods. Endogenous technological progress is sustained based on assuming that land is an excludable input to production. Firms compete for land by bidding up rent offers; the highest rent bid can include the costs of innovation as in Desmet and Rossi-Hansberg (2012). Combined with delayed diffusion and subsequent labour mobility, we can motivate firm investment in technology as maximising current-period rents without having to handle either imperfect competition or a fully dynamic problem. We introduce the mechanisms by which finance may interact with growth based on the categorisation in Levine (2005). The model is characterised by a transitional non-balanced growth path with structural transformation and an asymptotic long-run balanced growth path without structural transformation.

F.1 Consumers

Agents are infinitely-lived and endowed with one unit of labour supply each period. They each own a diversified portfolio of all land. There is no storage good so agents maximise instantaneous utility each period. Workers have preferences over the consumption of agricultural and manufacturing output with a Stone-Geary form as in Alvarez-Cuadrado and Poschke (2011),

$$u\left(c^A(t), c^M(t)\right) = \alpha \ln(c^A(t) - \gamma) + \ln(c^M(t) + \mu) \tag{20}$$

where $\alpha > 0$ is the weight on agricultural consumption and $\gamma, \mu > 0$ are Stone-Geary parameters: γ is a subsistence constraint on consumption of agricultural goods and μ reflects some endowment of manufactured goods (from, e.g., home production). We assume that the subsistence constraint never binds, i.e., output of agricultural sector is always greater than γ.

Households earn wages from providing labour and rental income from owning land. There are no costs of transporting output from either sector across space so we do not index relative prices by location. Labour can move freely across locations and sectors, so real wages are equal across sector and space. Below we often drop location index ℓ. The household budget constraint is,

$$w^A(t)l^A(t) + w^M(t)l^M(t) + R(t)/L = p(t)c^A(t) + c^M(t) \tag{21}$$

where $p(t)$ is the relative price of agricultural goods, L is total labour supply, $R(t)/L$ is per-agent rental income and l^i is share of time endowment spent working in sector i. The optimality conditions over consumption are,

$$\frac{\alpha}{c^A(t)-\gamma} = \lambda \tag{22}$$

$$\frac{1}{c^M(t)+\mu} = \lambda p(t) \tag{23}$$

where λ is the shadow price of an additional amount of income. Combining these, we have a relationship between different consumption demands, $c^M(t) = \frac{p(t)(c^A(t)-\gamma)}{\alpha} - \mu$. All output from both sectors is consumed which means that, on aggregate,

$$Y^M(t) = \frac{p(t)(Y^A(t)-\gamma)}{\alpha} - \mu. \tag{24}$$

F.2 Firms

A parish is composed of a continuum of firms ordered along an interval [0,1]. A firm at location ℓ in time t produces either agricultural or manufacturing output (sectors A and M) using labour and land:

$$Y^A(\ell,t) = Z^A \mathcal{F}(L^A(\ell,t), N^A(\ell,t)) \tag{25}$$

$$Y^M(\ell,t) = Z^M(\ell,t)\mathcal{G}(L^M(\ell,t), N^M(\ell,t)) \tag{26}$$

where $L^i(\ell,t)$ is labour employed in sector i at (ℓ,t), $N^i(\ell,t)$ is a fixed amount of land used in sector i, $Z^M(\ell,t)$ is technology in manufacturing and Z^A is the time- and space-invariant agricultural technology.[38] For the moment assume that $Z^M(\ell,t)$ is exogenous and constant across time and space. $\mathcal{F}(\cdot,\cdot)$ and $\mathcal{G}(\cdot,\cdot)$ are constant-return production functions with the usual concavity and Inada-type assumptions. We normalise the land used in production so that $N^i(\ell,t)=1$ for all (ℓ,t) and i. If total labour supply is L, the above-mentioned subsistence constraint means we are assuming $Z^A\mathcal{F}(L,1) > \gamma$. Finally, let $F(L^A(\ell,t)) \equiv \mathcal{F}(L^A(\ell,t),1)$ and $G(L^M(\ell,t)) \equiv \mathcal{G}(L^M(\ell,t),1)$.

Total labour is normalised to $L=1$ and is supplied inelastically, so $L^A = 1-L^M$.

[38] We assume that agricultural productivity is constant across time and space purely to remove some notation. Structural transformation can be 'labour pull' (improvements in manufacturing productivity push up wages) or 'labour push' (where improvements in agricultural productivity that 'releases' labour out of agriculture since its income elasticity of demand is less than one). The difference can be observed with data on relative prices (Alvarez-Cuadrado and Poschke, 2011) and for England and Wales in this period, the evidence favours a labour pull channel, i.e., that manufacturing productivity growth was driving structural transformation.

Since labour can move freely between sectors, wages in each sector are equal,

$$w^A(t) = p(t)Z^A F'(1 - L^M(t)) = Z^M(t)G'(L^M(t)) = w^M(t) \tag{27}$$

where $F'(\cdot)$ and $G'(\cdot)$ are partial derivatives wrt labour supply. Relative prices are thus,

$$p(t) = \frac{Z^M(t)G'(L^M(t))}{Z^A F'(1 - L^M(t))} \tag{28}$$

To solve for equilibrium labour choices we can use (2) with (5) to obtain,

$$\frac{\mu}{Z^M(t)} = \frac{G'(L^M(t))}{\alpha F'(1 - L^M(t))}\left(F(1 - L^M(t)) - \frac{\gamma}{Z^A}\right) - G(L^M(t)) \tag{29}$$

Equation (6) implicitly defines $L^M(t) = h(Z^M(t))$ with $h' > 0$: Since the right hand side is strictly decreasing in $L^M(t)$, we see that a higher $Z^M(t)$ leads to a higher optimal $L^M(t)$ – structural transformation that results from improvements in manufacturing technology.[39]

F.3 Land, technological progress and its finance

So far we have assumed $Z^M(\ell, t)$ to be constant across time and space. Suppose that the end-of-period productivities in period $t-1$ were $Z_+^M(\ell, t-1)$. Now let each firm wake up each period with an initial technology $Z_-^M(t)$ that is the average of all previous period's realised productivities, i.e., $Z_-^M(t) = \int_0^1 Z_+^M(\ell, t-1)d\ell$. So 'diffusion' means that all firms imperfectly observe each others' productivities (including their own).

Suppose now that firms can invest in research to potentially obtain a higher $Z^M(\ell, t)$ *at their location.* Firms must borrow to finance the research opportunity at a cost f. Investment in research buys a probability ϕ of taking an innovation step of $\Delta > 0$ at a cost $\psi(\phi)Z^M$ with $\psi' > 0$ and $\psi'' > 0$.[40] So expected manufacturing technology at location ℓ that invests in research is.

$$E(Z^M(\ell, t)) = (1 + \phi\Delta)Z_-^M(t). \tag{30}$$

The focus of endogenous growth models after Romer (1990), Grossman and Help-

[39] That the right-hand side is also increasing in Z^A shows that agricultural productivity improvements also lead to greater $L^M(t)$ in equilibrium. While Gollin et al. (2002) show that one can explain structural change during over this period using improvements in agricultural productivity, the data suggests a steady decline in the relative price of manufacturing over the period. By equation (5), this suggests that the dominant channel is manufacturing productivity.

[40] That the cost is proportional to technology is necessary for balanced growth in quality-ladders-type models. Otherwise continual growth would erode these costs as a proportion of potential output gains; growth would accelerate over time.

man (1991) and Aghion and Howitt (1992) has been on imperfect competition since in a perfectly competitive environment without land, prices equal marginal cost and there is no competive equilibrium in which firms invest in innovation. However, as shown by Desmet and Rossi-Hansberg (2012), since land is non-replicable and excludable, firms that occupy land can momentarily (up until their technology diffuses) gain from an investment in research. Moreover, this can form part of a competitive equilibrium because firms bid for land while taking into account the expected gains from innovation. The maximum land bid in manufacturing is,

$$R(\ell, t) = \max_{\phi(\ell,t), L^M(\ell,t)} (1 + \phi\Delta) Z^M_-(t) F(L^M(\ell, t)) - \\ w^M(t) L^M(\ell, t) - (1 + f)\psi(\phi) Z^M_-(t) \tag{31}$$

Labour is hired, land is rented and investment in innovation happens in advance of productivity realisations. Since all manufacturing firms are identical, either they all invest or none invest: Then maximising rental bid means that the optimal choice of labour is now conditional on investment in a probability of innovation and the analysis above simply follows with $E(Z^M(t))$ instead of $Z^M(t)$. Absent any other frictions, the optimal investment into innovation satisfies,

$$\Delta F(\hat{L}^M(\ell, t)) = (1 + f)\psi'(\phi), \tag{32}$$

where $\hat{L}^M(\ell, t)$ is optimal choice of labour. Desmet and Rossi-Hansberg (2014) show under a similar set-up of labour mobility and productivity diffusion, firms make decisions to maximise current-period profits only.

Let $\phi^*(f, L^M(t))$ be the optimal chosen probability of innovation given f, average manufacturing labour $L^M(t)$. By the strict convexity of ψ, we have ${\phi^*_f}' < 0$ and ${\phi^*_{L^M}}' > 0$: The higher is the cost of finance, the lower is the chosen probability of an increase in manufacturing productivity. Not also that there are scale effects in (9): The higher is manufacturing employment the greater the chosen ϕ^*.

F.4 Solving for growth rates

Suppose that all manufacturing firms in a parish invest in research activity each period, the growth rate of of Z^M is,

$$g_{Z^M}(f, L^M(t)) = \frac{Z^M(t+1)}{Z^M(t)} - 1 = \phi^*(f, L^M(t))\Delta \tag{33}$$

The impact of a higher g_{Z^M} is a faster growth of L^M.

Total output is $Y(t) = p(t)Y^A(t) + Y^M(t)$, i.e.,

$$Y(t) = Z^M \left(\frac{G'(L^M(t))}{F'(1 - L^M(t))} F(1 - L^M(t)) + G(L^M(t)) \right) \tag{34}$$

Output growth is the product of technological progress in manufacturing both directly and via structural transformation. Suppose that time is continuous and we calculate growth rates based on a marginal change in Z^M,

$$\frac{\dot{Y}(t)}{Y(t)} = g_Y(t) = g_{Z^M}(f, L^M(t)) \cdot \left[1 + \Phi(t) \frac{\partial L^M(t)}{\partial Z^M(t)} \right] \tag{35}$$

where $\Phi(t) < 0$.[41] The aggregate growth rate increases during the structural transformation. In the short-run, a shrinking agricultural sector drags down the aggregate growth generated by the productivity growth. Over time, this stabilizes at a subsistence level: In the limit, labour in agriculture is only to provide subsistence consumption,

$$\lim_{t \to \infty} L^M(t) = \bar{L}^M = 1 - F^{-1}(\gamma / Z^A). \tag{36}$$

That is to say, $\lim_{t \to \infty} \frac{\partial L^M(t)}{\partial Z^M(t)} = 0$. Moreover, as $L^M(t)$ approaches $\bar{L}^M$, so g_Y approaches a long-run growth path g_{Z^M},

$$\lim_{t \to \infty} g_Y = \phi^*(f, \bar{L}^M)\Delta \tag{37}$$

[41] In particular,

$$\Phi(t) = \left\{ Z^M(t) F(1 - L^M(t)) \frac{\left[\frac{F'(1-L^M(t))G''(L^M(t)) + G'(L^M(t))F''(1-L^M(t))}{(F'(1-L^M(t)))^2} \right]}{\left(\frac{G'(L^M(t))}{F'(1-L^M(t))} F(1 - L^M(t)) + G(L^M(t)) \right)} \right\} < 0$$