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The long-run impact of the power loom: evidence from 19th century Prussia

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Abstract

Using county-level census data from 19th century Prussia, this paper argues that the introduction of the power loom, a key technological innovation in the Industrial Revolution, had a significant impact on labour market outcomes and composition 40 years later. To combat endogeneity, I use a county's proximity to London as an instrument for the adoption of power looms. The empirical evidence suggests that the spread of the Industrial Revolution increased wages of urban and rural workers of both genders. I also show that the introduction of the power loom significantly reduced the size of the agricultural sector in the long-run.

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1 Introduction

The Industrial Revolution dramatically altered the economic landscape of the world. Productivity and technology dramatically increased during this period. The effect of the Industrial Revolution on wages and living standards, however, has been a matter of debate. A sizeable literature has argued that despite large changes to technology during the period, living standards and wages did not increase by a large amount. Jeffrey Williamson (1984) argued that British growth was too slow during the first Industrial Revolution, and attributed it to debt issued to pay for military conflicts. Charles Feinstein (1998) examined data on British workers from 1770 to 1870 and concluded that real wages did not sharply rise during the period.

Existing evidence tends to rely on cross-country or simple time-series comparisons, however. Such studies often cannot fully control for institutional and cultural differences between geographical areas or productivity shocks. It is therefore unclear whether the increases, or lack thereof, in living standards, productivity, and other economic measures during the same time period can be fully attributed to technological innovations. To properly understand the impact of the Industrial Revolution, it is necessary to pin down channels of technological diffusion and examine the resulting differences in economic outcomes.

In this paper, I examine the transmission of a specific Industrial Revolution-era innovation by using county-level data in 19th century Prussia to examine the long-term effect of the spread of the power loom on wages and agricultural employment. I have exact counts of the numbers of power looms used in each county for 1849, allowing me to track the degree of proliferation of power looms in Prussia. Using this data on the number of power looms, I examine whether counties that introduced power looms had higher wages nearly 40 years later.

The power loom was one of the most important innovations of the Industrial Revolution. First patented by Edmund Cartwright in 1785, it would take several iterations by numerous British inventors until a reliable and practical power loom was designed. Bullough and Kenworthy's Lancashire loom of 1842 was seen as the first automatic power loom. The introduction of the power loom revolutionized textile production. The power loom was a significant improvement over existing looms that utilized flying shuttles because it reduced the amount of physical exertion and labour required to operate a loom.

I also investigate how the earlier introduction of the power loom in a county affected the agricultural employment share. Crafts and Harley (1992) argue that growth due to the Industrial Revolution was limited to a small number of sectors. However, it is possible that growth in these sectors had an indirect effect on other sectors. Specifically, if textile manufacturing expands in a county, this may increase competition for labour, shrinking the relative size of other industries. On the other hand, since the power loom results in factories requiring fewer workers to produce the same output, it is possible that factories will use power looms to substitute for workers. This could have the effect of increasing the agricultural sector.

Although the study here specifically studies power loom diffusion and its impact on wages, power loom use can more generally be seen as a proxy for the spread of the Industrial Revolution. Focusing on one particular innovation is a more satisfactory proxy than more aggregate measures such as urbanization or numbers of factories, especially in light of the importance of the power loom in revolutionizing the textile industry. The power loom can also be specifically traced to one origin, which will aid me in my identification strategy described below.

The issue of reverse causality may cause me to incorrectly attribute any changes in economic outcomes to the introduction of the power loom. For example, richer areas of Prussia could have been the first to adopt the power loom, causing a positive correlation between power loom use and wages. To address endogeneity concerns, I implement an instrumental variables approach, using the distance of a county from London as an instrument for power loom implementation.

The original patent for the power loom in 1785 originated in England, as did every other significant improvement to its design. Power loom technology can therefore be seen as diffusing outward from England. The inspiration for this instrument comes from a sizable literature on the limiting effect of geography and distance on knowledge diffusion, such as Maurseth and Verspagen (2002). In light of my interpretation of power loom use as a proxy for the spread of the Industrial Revolution, the instrument is valid if proximity to London affected wages and agricultural share only through the spread of the Industrial Revolution.

The results in this paper suggest that the introduction of the power loom had a substantial positive impact on real wages 40 years later, for men and women as well as for rural and urban workers. I also find that the introduction of the loom significantly decreased the employment share of the agricultural sector. These results are robust to the use of distance to London as an instrumental variable.

This paper is closely related to other work that examines the effect of the introduction of a particular innovation or technology on economic outcomes. Alesina, Giuliano, and Nunn (2013) found that societies that adopted the plough in agriculture created less equal beliefs about gender roles. Jeremiah Dittmar (2011) uses city-level data to show that cities that established printing presses in the 1400s grew at a significantly faster rate than similar cities which did not establish presses during the same period. My paper differs from these works and others in this branch of literature because it examines the introduction of a technological innovation in geographical areas that share the same institutions and culture.

The rest of the paper proceeds as follows. Section 2 describes the historical background and the data used in this paper. Section 3 provides a description of the empirical specifications used. The empirical results are described in Section 4. Section 5 concludes.

2 Background and Data Description

2.1 Background

In this section, I provide a brief overview of the historical and institutional background in 19th century Prussia, especially as it relates to the Industrial Revolution. For a more detailed summary of the Industrial Revolution in Prussia, interested readers can refer to Henderson (1961) or Becker, Hornung, and Woessman (2009).

The Kingdom of Prussia was a German kingdom formed in 1701 through the merger of Brandenburg and Prussia. As a result of this unification, Prussia enjoyed a common set of institutions and a relatively homogeneous culture throughout its counties by the 19th century.

In the early 19th century, Prussia suffered a series of military defeats to Napoleonic France. This culminated in the Treaties of Tilsit of 1807, in which Prussia was forced to make concessions to France in terms of land, military restrictions, and French garrisons. As a result of Napoleonic rule, Prussia was integrated into the Continental System and was unable to trade with England. Additionally, Prussia's defeat at the hands of a more modern France resulted in the kingdom introducing a sweeping series of institutional reforms, which opened it to the changes already experienced in England.

The combination of historical circumstances as well as the relatively late development of the power loom into a practical piece of machinery during the Industrial Revolution, meant that the power loom was not heavily in use in Prussia by 1849. The empirical analysis takes advantage of the availability of data from 1849 and the incomplete adoption of the power loom by that date to examine the effect of early adoption on late 19th century wages and the size of the agricultural sector.

2.2 Data Description

The main data used are from the ifo Prussian Economic History Database (IPEHD). The IPEHD is based on 19th century Royal Prussian Statistical Office census records that were digitized by the ifo Institute.[1]

The main wave of data I utilize in this paper is 1849 census data, which documents the number of factories, workers, and power looms in each of the 328 counties in Prussia. I use these variables to construct indicators for power loom adoption and industrialization. To examine the long-run consequences of industrialization, I also make use of employment census data from 1882; I use this to construct a measure of the employment share of agriculture in each county. Finally, to study what long-run effect industrialization had on wages, I use wage data from 1892.

In order to compare the various waves of data from different time periods, I must construct definitions of counties that are consistent for the entire period. Since much of the

[1]for a more detailed description of the data, please refer to Becker et al (2014).

data of interest is from 1849 census data, I convert all census definitions to 1849 definitions. The concordance of county definitions leaves me with 328 counties in my sample.

I augment the IPEHD data with additional variables from the data used in Becker, Hornung, and Woessman (2011). The most important variable I use from this source is that county's distance from London, as measured from its capital. I will use distance from London as an instrument for whether the power loom was adopted in that particular county.

The level of infrastructure in a county may be an important omitted variable, since it is possible that counties with better infrastructure have higher wages, but are also more likely to adopt new technologies. In order to control for infrastructure, I make use of two variables. I include a dummy variable for whether a county contained at least one town or city with at least 2,000 inhabitants in 1816. I also use a dummy variable for whether a county had paved streets in 1815.

Summary statistics are provided in Table 1. By 1849, only 18.5% of counties in Prussia were using power looms, suggesting that the diffusion of power looms from England was not complete in Prussia. The average county is 941.9 kilometers away from London, although the differences in the distance to London of the closest and the furthest county is over 1,000 kilometers, suggesting that there is a large degree of geographical variation in the distance instrument.

It is clear that males earn higher wages, whether they are rural or urban workers. Mean daily wages for urban male workers, for example, were 1.495, versus .9484 for female urban workers. Rural workers also exhibit a similar gender wage gap. Interestingly, counties in 1892 do not exhibit a noticeable gap between urban and rural workers of the same sex.[2]

3 Specification

To examine the relationship between power loom use and long-run wage outcomes, I use the following specification:

$$ln(w_{c,1892}) = \beta_0 + \beta_1 LOOM_{c,1849} + \beta_2 X_c + \epsilon_c \tag{1}$$

$ln(w_{c,1892})$ is the log of wages, in Goldmarks, of four types of workers: urban male workers over 16, urban rural workesr over 16, female urban workers over 16, and female rural workers over 16. $LOOM_{c,1849}$ is a measure of power loom use in county c in 1849. X_c is a set of county-level controls described more fully below.

I include a variety of controls within X_c. I include that county's distances to Wittenberg, to control for the effect of diffusion from the birthplace of the Protestant Reformation. I also control for the distance to the nearest provincial capital, as a proxy for market access and geographical remoteness.

[2] The means are not statistically different.

In addition to the aforementioned control variables, I also include the logged population of the county in 1849, the fraction of the population in 1849 under 15 years old, and the primary school enrolment rate in 1849 as population controls. To control for geographical features, I include the size of the county in square kilometers and the fraction of land in the county consisting of loamy soil. The last variable controls for the inherent agricultural productivity of the county. To help control for infrastructure, I use two variables. The first is a dummy equal to one if the county had at least one paved street in 1815. I also include a dummy variable that captures whether that county had at least one town with at least 2,000 inhabitants in 1816.

To test whether power loom use affected the share of agriculture in employment, I use the following specification:

$$agri_{c,1882} = \beta_0 + \beta_1 LOOM_{c,1849} + \beta_3 X_c + \epsilon_c \tag{2}$$

$agri_{c,1882}$ is the agricultural share of total employment in county c, in 1882.

4 Empirical results

Table 2 examines the long-run relationship between industrialization and labour market outcomes and composition. To capture the effect of industrialization on wages, I use 1892 wage data for workers over 16. Wages are separated by urban and rural areas within county, as well as by gender. I also look at the employment share of agriculture, defined as the total number of workers in agriculture divided by the total number of workers in that county. My measure of choice for industrialization is whether that county uses power looms in its textile factories.

The results from Table 2 show that the introduction of power looms in 1849 led to significantly higher wages for men and women, and for urban and rural workers. The wage effect of looms is larger for men than for women. Column 5 of Table 2 shows that counties that introduced power looms experienced a 3.9% reduction in the employment share of agriculture. While power loom use increased wages for all four worker groups almost 40 years later, power loom use did not have any statistically significant effect for the gender wage gap or the urban-rural wage gap.[3]

It is possible that areas with higher wages and lower agricultural labour shares were the first to adopt power looms. In order to determine the causal effect of the introduction of power looms on wages and the size of the agricultural sector, I use a county's distance from London as an instrument for power loom adoption. Under my interpretation of power loom use as a proxy for the spread of the Industrial Revolution in Prussia, the exclusion restriction for my instrument is valid unless there is an alternate mechanism through which proximity to London can affect wages.

[3]results are not presented, but available upon request.

One particular issue may be that proximity to London is correlated with increased trade with England for particular areas of Prussia. However, England at the time was a large textile producer and had created many of the technological innovations in the textile industry, including the power loom; England could therefore be seen as a comparative advantage producer of textiles. Trade with England should therefore have lowered wages, unless it introduced new technological innovations such as the power loom, which is the channel argued in this paper.

Another issue is that counties that were close to London were those that were the most initially inclined to see wage growth. I do not have wage data for any earlier periods than that already used in the analysis. However, I do have the fraction of population in a county that live in cities. As Acemoglu et al (2011) argue, urbanization can be used as a proxy for economic prosperity and growth. I find, in OLS regressions, that proximity to London and the fraction of urban population is not correlated.[4] This additional test serves as additional assurance that there was no initial trend or proclivity towards growth that characterized those counties close to London before the Industrial Revolution.

To demonstrate the validity of the instrument, Table 3 shows the results of a series of specifications that demonstrate the effect of distance from London on textile manufacturing, and specifically power loom use. To show the effect of distance from London on textile manufacturing, I use the number of power looms, number of workers in textile manufacturing, number of textile factories, and a dummy for power loom use as dependent variables.

The results from Table 3 clearly show that there is an inverse relationship between distance from London and textile manufacturing, and specifically power loom use. The coefficient for all four columns except number of looms in column 1 is negative and statistically significant, implying that distance from London is a strong instrument for power loom use. However, most importantly, the dummy variable for power loom use is highly negatively correlated with distance from London. From column 4, a 1,000 kilometer increase in distance from London is associated with a 27.8% decrease in the probability of power loom use.

Table 4 shows the results from instrumental variables estimation of the effect of power loom use on wages and agricultural employment, using distance from London as an instrument for power loom use. The estimated effect of power looms is an order of magnitude larger than the OLS estimates for all dependent variables, and are statistically significant and of the same sign as the OLS estimates. This is likely because of two reasons. The first is that attenuation bias due to measurement error in power loom use lead to lower estimates in OLS, which were corrected in the IV specifications. The second relates to my interpretation of power loom use as a proxy for Industrial Revolution spread. The IV estimates would be larger if the LATE estimate from the instrument also captures some other technological innovations implemented from England other than the power loom, such as the steam engine. Interestingly, the effects of instrumented loom use are larger for women's wages than they are for men's wages in rural and urban areas, in contrast to the OLS estimates. This

[4] The coefficient is -.0159, with a standard error of .0302, implying a t-statistic of -0.53.

suggests that the introduction of the power loom in fact reduced the gender wage gap.

I also report some test statistics for each specification at the bottom of Table 4, which test the validity of the instrument. Specifically, I report F-statistics from a weak identification test, as well as LM statistics from an underidentification test. I also include F-statistics for the first stage regression. For all IV specifications, these statistics argue that the instrument used does not suffer from an underidentification or weak identifcation problem, demonstrating that the instrument is valid.

One particular concern is that the choice of whether to use distance to Berlin or distance to Wittenberg, or both, may impact the estimated coefficient on power loom use, in both the reduced form and IV results. In Tables 5 and 6, I re-estimate the reduced-form and IV specifications and show that the results are very similar if I instead use distance to Berlin, or use both distance to Berlin and distance to Wittenberg as controls. The coefficients are robust to the use of the different distance measures, and the IV test statistics give strong results in all specifications.

4.1 Discussion

The main set of results in this paper show that power loom used significantly increased wages for all types of workers. Despite textile production being primarily concentrated in urban areas, power loom introduction seemed to increase wages for rural workers as well. One possible explanation could be that increased urban wages raised opportunity costs for rural workers, leading to increases in rural wages as well.

While female wages increased as a result of power loom use, the ratio of male to female wages did not respond to power loom use. This result is surprising, since the power loom is seen as disproportionately beneficial for female workers. The power loom was easier to operate by women since it required less physical strength, because much of the power required in its operation was derived from a line shaft.[5] Although female wages are significantly higher in counties that adopted power looms in 1849, the gender wage gap does not narrow for those same counties. This suggests that even though women were afforded more opportunities for work, the gains for men essentially meant that, conditional on working, labour force discrimination remained constant against women.

While the effect of power loom adoption was theoretically ambiguous, ex-ante, the empirical results show that power loom adoption significantly shrank agriculture's employment share in a county.

5 Conclusion

Using historical county-level Prussian data, I show that the mechanization of textile manufacturing through the introduction of the power loom had a significant positive impact of

[5] see Mohanty (2006) for a more detailed description of how power loom use benefitted women.

workers' wages almost 40 years later, and had a negative effect on the size of the agricultural sector for impacted counties. These results suggest that the introduction of the power loom and other technological innovations from the Industrial Revolution played a significant role in the economic development of Prussia. The results stand in contrast to the Malthusian view of growth espoused in recent research by Ashraf and Galor (2011) and others, which states that technological improvements lead to larger populations but not higher standards of living.

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Variable	Mean	Standard Dev.	Min.	Max.
Area, 1000 sq. km.	.8124	.4459	.0016	2.541
logged population, 1849	10.71	.3593	9.521	12.95
Paved road, 1815	.2164	.4124	0	1
Frac. loamy soil	.2488	.2822	0	.9999
Frac. population < 15	.3514	.0276	.2279	.4141
At least 1 large town	.4573	.4989	0	1
primary school enrolment rate, 1849	.8022	.1169	.3337	.9885
No. of power looms	15.12	83.97	0	928
No. of textile factory workers	419.71	1,843.57	0	19,900
No. of textile factories	9.003	30.36	0	338
Power loom implementation	.1859	.3896	0	1
Distance units: 1,000 km				
Distance from Berlin	.3280	.1599	0	.65
Distance from prov. capital	.0855	.0431	0	.28
Distance from Wittenberg	.3319	.1644	0	.731
Distance from London	.9419	.3264	.416	1.534
Wage units: Daily wages, in Goldmarks				
Wages, urban males > 16	1.495	.3543	.85	2.7
Wages, rural males > 16	1.400	.3100	.85	2.4
Wages, urban females > 16	.9484	.2396	.5	1.65
Wages, rural females > 16	.8991	.2292	.5	1.8

Table 1: Summary statistics.

	(1)	(2)	(3)	(4)	(5)
Dep. Variable:	Logged urban wages of males > 16	Logged urban wages of females > 16	Logged rural wages of males > 16	Logged rural wages of females > 16	Agricultural employment share
Loom	0.118***	0.130***	0.123***	0.146***	-0.0390***
	(0.0305)	(0.0330)	(0.0293)	(0.0333)	(0.00769)
Distance from prov. capital	-0.403	-0.213	-0.461*	-0.372	-0.193***
	(0.279)	(0.301)	(0.264)	(0.300)	(0.0696)
Distance from Wittenberg	-0.0687	0.0444	-0.0416	0.0811	0.122***
	(0.0821)	(0.0886)	(0.0804)	(0.0913)	(0.0205)
Paved road, 1815	0.147***	0.167***	0.162***	0.180***	-0.0177**
	(0.0312)	(0.0337)	(0.0298)	(0.0339)	(0.00770)
Area, 1000 sq. km.	-0.0994***	-0.116***	-0.0527	-0.0829**	0.0419***
	(0.0332)	(0.0358)	(0.0325)	(0.0369)	(0.00828)
Logged population, 1849	-0.00940	-0.0251	-0.104**	-0.100**	-0.0240**
	(0.0395)	(0.0426)	(0.0409)	(0.0465)	(0.00979)
Frac. loamy soil	0.0670	0.0674	0.0954**	0.114**	-0.00281
	(0.0438)	(0.0473)	(0.0417)	(0.0474)	(0.0109)
Frac. young in pop., 1849	0.990**	1.335***	1.976***	2.551***	0.190
	(0.464)	(0.501)	(0.466)	(0.529)	(0.115)
Town	0.103***	0.0997***	0.0826***	0.0812***	-0.0345***
	(0.0261)	(0.0282)	(0.0251)	(0.0285)	(0.00655)
Primary school enrolment, 1849	-0.0839	0.0335	0.0657	0.134	0.0336
	(0.119)	(0.128)	(0.115)	(0.131)	(0.0289)
Constant	0.215	-0.336	0.657	-0.124	0.308***
	(0.473)	(0.511)	(0.479)	(0.544)	(0.117)
Observations	320	320	319	319	328
R-squared	0.312	0.299	0.296	0.303	0.477

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2: Reduced-form effect of looms on wages and agricultural employment.

	(1)	(2)	(3)	(4)
Dep. Variable:	# Power looms	# Factories	# Workers	Loom
Distance from London	-7.751	-23.40***	-1,052***	-0.278***
	(17.26)	(6.120)	(391.4)	(0.0827)
Distance from prov. capital	253.3**	43.68	4,037*	1.138**
	(104.1)	(36.92)	(2,361)	(0.499)
Distance from Wittenberg	-68.18**	-8.938	802.8	0.0331
	(31.22)	(11.07)	(708.0)	(0.150)
Paved road, 1815	-4.319	-7.010*	-382.1	0.0305
	(11.90)	(4.219)	(269.8)	(0.0570)
Area, 1000 sq. km.	-49.56***	-21.79***	-1,226***	-0.0970
	(13.04)	(4.622)	(295.6)	(0.0625)
Logged population, 1849	111.6***	39.60***	1,816***	0.342***
	(14.22)	(5.041)	(322.4)	(0.0681)
Frac. loamy soil	-17.94	-13.88**	-415.1	-0.0980
	(16.49)	(5.849)	(374.1)	(0.0790)
Frac. young in pop., 1849	-638.4***	-129.5**	-3,897	-2.221**
	(181.0)	(64.17)	(4,104)	(0.867)
Town	-30.87***	-6.387*	89.86	0.0111
	(9.916)	(3.516)	(224.9)	(0.0475)
Primary school enrolment, 1849	-44.65	-18.02	333.1	-0.0209
	(58.43)	(20.72)	(1,325)	(0.280)
Constant	-829.9***	-301.0***	-15,835***	-2.375***
	(175.7)	(62.31)	(3,985)	(0.842)
Observations	328	328	328	328
R-squared	0.238	0.267	0.187	0.188

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3: Effect of distance from London on textile manufacturing.

	(1)	(2)	(3)	(4)	(5)
Dep. Variable:	Logged urban wages of males > 16	Logged urban wages of females > 16	Logged rural wages of males > 16	Logged rural wages of females > 16	Agricultural employment share
Loom	1.848***	2.317***	1.811***	2.336***	-0.125***
	(0.515)	(0.643)	(0.479)	(0.615)	(0.0460)
Distance from prov. capital	-2.107**	-2.367*	-2.079**	-2.472*	-0.109
	(1.049)	(1.311)	(0.997)	(1.281)	(0.0922)
Distance from Wittenberg	-0.00674	0.123	0.0400	0.187	0.118***
	(0.273)	(0.341)	(0.272)	(0.349)	(0.0239)
Paved road, 1815	-0.00380	-0.0239	0.0369	0.0170	-0.0109
	(0.113)	(0.141)	(0.106)	(0.136)	(0.00963)
Area, 1000 sq. km.	0.201	0.264	0.235*	0.290*	0.0271**
	(0.141)	(0.176)	(0.135)	(0.174)	(0.0124)
Logged population, 1849	-0.586***	-0.754***	-0.661***	-0.824***	0.00443
	(0.213)	(0.266)	(0.207)	(0.266)	(0.0188)
Frac. loamy soil	0.242	0.289	0.271*	0.341*	-0.0112
	(0.154)	(0.192)	(0.149)	(0.191)	(0.0134)
Frac. young in pop., 1849	3.574**	4.601**	4.198**	5.435**	0.0618
	(1.714)	(2.141)	(1.686)	(2.166)	(0.150)
Town	0.0600	0.0455	0.0400	0.0260	-0.0321***
	(0.0874)	(0.109)	(0.0854)	(0.110)	(0.00770)
Primary school enrolment, 1849	-0.292	-0.230	-0.218	-0.234	0.0440
	(0.399)	(0.498)	(0.395)	(0.507)	(0.0340)
Constant	5.216**	5.986**	5.649***	6.352**	0.0608
	(2.143)	(2.677)	(2.125)	(2.730)	(0.188)
F. stat, first stage	12.42	12.42	13.70	13.70	12.33
Test for:					
Underidentification (LM stat.)	12.368	12.368	13.588	13.588	12.284
Weak identification (F-stat.)	12.423	12.423	13.703	13.703	12.334
Observations	320	319	320	320	328

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Instrumental variables estimates of the effect of looms on wages and agricultural employment.

Dep. Variable:	(1) Logged urban wages of males > 16	(2) Logged urban wages of females > 16	(3) Logged rural wages of males > 16	(4) Logged rural wages of females > 16	(5) Agricultural employment share	(6) Logged urban wages of males > 16	(7) logged urban wages of females > 16	(8) Logged rural wages of males > 16	(9) Logged rural wages of females > 16	(10) Agricultural employment employment
Loom	0.118***	0.130***	0.123***	0.145***	-0.0398***	0.0942***	0.0975***	0.0917***	0.104***	-0.0387***
	(0.0305)	(0.0329)	(0.0293)	(0.0333)	(0.00809)	(0.0283)	(0.0288)	(0.0260)	(0.0276)	(0.00774)
Distance from prov. capital	-0.448	-0.183	-0.487*	-0.322	-0.115	-0.486*	-0.326	-0.500**	-0.424*	-0.192***
	(0.273)	(0.295)	(0.259)	(0.295)	(0.0720)	(0.257)	(0.261)	(0.232)	(0.247)	(0.0698)
Distance from Berlin						1.822***	2.486***	2.128***	2.859***	-0.0269
						(0.241)	(0.245)	(0.221)	(0.235)	(0.0652)
Distance from Wittenberg						-1.812***	-2.334***	-2.048***	-2.615***	0.148**
						(0.242)	(0.247)	(0.220)	(0.234)	(0.0658)
Paved road, 1815	0.148***	0.166***	0.162***	0.180***	-0.0183**	0.111***	0.118***	0.117***	0.119***	-0.0171**
	(0.0312)	(0.0337)	(0.0298)	(0.0338)	(0.00811)	(0.0291)	(0.0296)	(0.0266)	(0.0283)	(0.00783)
Area, 1000 sq. km.	-0.0951***	-0.118***	-0.0496	-0.0891**	0.0344***	0.0224	0.0504	0.103***	0.127***	0.0401***
	(0.0328)	(0.0353)	(0.0319)	(0.0362)	(0.00861)	(0.0345)	(0.0351)	(0.0328)	(0.0349)	(0.00937)
Logged population, 1849	-0.00905	-0.0253	-0.104**	-0.0994**	-0.0252**	-0.00701	-0.0219	-0.113***	-0.113***	-0.0241**
	(0.0395)	(0.0426)	(0.0409)	(0.0465)	(0.0103)	(0.0363)	(0.0370)	(0.0359)	(0.0383)	(0.00980)
Frac. loamy soil	0.0671	0.0673	0.0958**	0.113**	-0.00295	-0.00557	-0.0316	0.0235	0.0169	-0.00178
	(0.0438)	(0.0473)	(0.0417)	(0.0474)	(0.0115)	(0.0415)	(0.0422)	(0.0374)	(0.0398)	(0.0112)
Frac. young in pop., 1849	1.001**	1.328***	1.993***	2.518***	0.168	0.530	0.707	1.634***	2.092***	0.196*
	(0.464)	(0.501)	(0.464)	(0.528)	(0.121)	(0.431)	(0.439)	(0.410)	(0.437)	(0.117)
Town	0.108***	0.0964***	0.0859***	0.0748***	-0.0438***	0.0947***	0.0885***	0.0813***	0.0794***	-0.0344***
	(0.0254)	(0.0274)	(0.0243)	(0.0276)	(0.00669)	(0.0240)	(0.0244)	(0.0220)	(0.0235)	(0.00656)
Primary school enrolment, 1849	-0.0369	0.00311	0.0966	0.0742	-0.0503*	-0.433***	-0.443***	-0.265**	-0.310***	0.0386
	(0.105)	(0.113)	(0.0981)	(0.112)	(0.0266)	(0.119)	(0.121)	(0.107)	(0.114)	(0.0314)
Constant	0.145	-0.291	0.616	-0.0435	0.440***	0.556	0.129	1.019**	0.361	0.304**
	(0.466)	(0.502)	(0.471)	(0.536)	(0.121)	(0.438)	(0.446)	(0.422)	(0.449)	(0.118)
Observations	320	320	319	319	328	320	320	319	319	328
R-squared	0.311	0.298	0.295	0.302	0.419	0.420	0.474	0.459	0.530	0.478

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Reduced form estimates, with alternate distance controls

Dep. Variable:	(1) Logged urban wages of males > 16	(2) Logged urban wages of females > 16	(3) Logged rural wages of males > 16	(4) Logged rural wages of females > 16	(5) Agricultural employment share	(6) Logged urban wages of males > 16	(7) logged urban wages of females > 16	(8) Logged rural wages of males > 16	(9) Logged rural wages of females > 16	(10) Agricultural employment employment
Loom	1.848***	2.256***	1.789***	2.248***	-0.180***	1.717***	2.014***	1.572***	1.950***	-0.164***
	(0.519)	(0.632)	(0.476)	(0.595)	(0.0560)	(0.551)	(0.644)	(0.503)	(0.620)	(0.0603)
Distance from prov. capital	-2.119**	-2.337*	-2.078**	-2.418**	-0.0580	-1.995**	-2.109*	-1.868**	-2.131*	-0.0728
	(1.037)	(1.262)	(0.972)	(1.216)	(0.110)	(0.998)	(1.166)	(0.901)	(1.110)	(0.109)
Distance from Berlin	0.0106	0.158	0.0713	0.235	0.119***	0.296	0.683	0.558	0.901	0.0872
	(0.272)	(0.331)	(0.270)	(0.338)	(0.0288)	(0.956)	(1.117)	(0.906)	(1.117)	(0.102)
Distance from Wittenberg						-0.295	-0.541	-0.497	-0.680	0.0330
						(0.959)	(1.120)	(0.899)	(1.109)	(0.103)
Paved road, 1815	-0.00390	-0.0216	0.0366	0.0179	-0.00913	0.00147	-0.0117	0.0421	0.0255	-0.00962
	(0.113)	(0.137)	(0.105)	(0.131)	(0.0117)	(0.104)	(0.122)	(0.0922)	(0.114)	(0.0110)
Area, 1000 sq. km.	0.203	0.266	0.239*	0.296*	0.0257*	0.199	0.259*	0.237**	0.293**	0.0262*
	(0.141)	(0.172)	(0.135)	(0.169)	(0.0151)	(0.130)	(0.152)	(0.118)	(0.146)	(0.0141)
Logged population, 1849	-0.586***	-0.734***	-0.655***	-0.797***	0.0227	-0.543**	-0.655***	-0.588***	-0.705***	0.0177
	(0.215)	(0.261)	(0.205)	(0.256)	(0.0229)	(0.217)	(0.253)	(0.199)	(0.245)	(0.0237)
Frac. loamy soil	0.242	0.277	0.267*	0.325*	-0.0211	0.218	0.232	0.228	0.272	-0.0184
	(0.155)	(0.189)	(0.147)	(0.184)	(0.0164)	(0.158)	(0.184)	(0.142)	(0.176)	(0.0169)
Frac. young in pop., 1849	3.574**	4.478**	4.171**	5.301**	-0.0490	3.309*	3.990**	3.805**	4.799**	-0.0185
	(1.717)	(2.089)	(1.659)	(2.075)	(0.182)	(1.720)	(2.010)	(1.552)	(1.913)	(0.185)
Town	0.0612	0.0486	0.0427	0.0311	-0.0312***	0.0619	0.0497	0.0455	0.0349	-0.0314***
	(0.0875)	(0.106)	(0.0847)	(0.106)	(0.00935)	(0.0813)	(0.0950)	(0.0746)	(0.0919)	(0.00884)
Primary school enrolment, 1849	-0.283	-0.232	-0.205	-0.227	0.0272	-0.334	-0.325	-0.266	-0.311	0.0326
	(0.379)	(0.462)	(0.375)	(0.469)	(0.0392)	(0.400)	(0.467)	(0.356)	(0.439)	(0.0418)
Constant	5.203**	5.815**	5.571***	6.101**	-0.0735	4.904**	5.265**	5.061***	5.402**	-0.0379
	(2.174)	(2.644)	(2.129)	(2.663)	(0.232)	(2.067)	(2.415)	(1.954)	(2.408)	(0.225)
First-stage F-stat.	12.23	12.23	13.53	13.53	12.25	9.40	9.40	9.39	9.39	9.48
Test for:										
Underidentification (LM stat.):	12.180	12.180	13.424	13.424	12.200	9.478	9.478	9465	9.465	9.556
Weak identification (F. stat.)	12.227	12.227	13.530	13.530	12.247	9.401	9.401	9.388	9.388	9.483
Observations	320	320	319	319	328	320	320	319	319	328

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Instrumental variables estimates, with alternate distance controls