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Communication vs. Transportation:

Relative contributions of railways and post offices to British Indian grain price convergence

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Abstract

Rice and wheat markets in British India saw a broad convergence in prices across districts during the late nineteenth and early twentieth centuries. Earlier studies stressed the importance of railways in this type of market integration. Andrabi and Kuehlwein (2010), however, argued that railways were capable of explaining only about 20% of this price convergence, possibly because of alternative pre-existing transportation networks. This paper adds data on post offices from 1881 to 1911 to determine if communication advances can explain some of the unexplained price convergence. We find that it often can. Point estimates suggest that post office density can reduce district price dispersion by 15-20%. This effect actually slightly exceeds the effect estimated for railways. However, in the presence of railways, the impact of post offices shrinks almost to zero. That strongly implies that railways and the post were substitutes for producers and traders.

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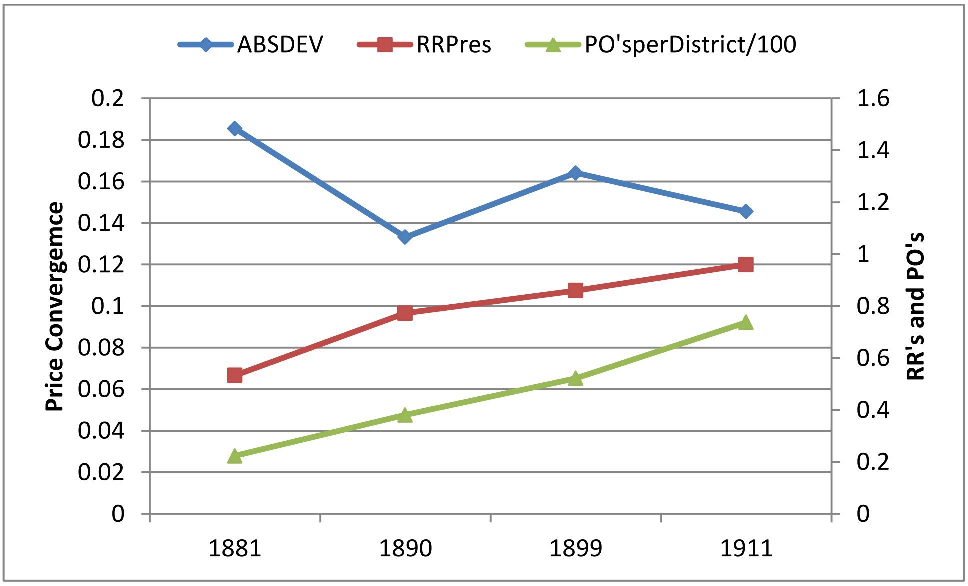
Introduction

This paper focuses on one dimension of market integration: price convergence. A body of literature presents reasons for price convergence, both between and within countries (O'Rourke and Williamson 1999). Within countries, the most important contributing factor is often identified to be the construction of railways (Slaughter 2001, Metzer 1974, Dobado and Marrero 2005). That was true in two studies that analysed grain markets in British India (Hurd 1975 and Mukherjee 1980). Andrabi and Kuehlwein (2010), however, argued that railways were only capable of explaining about 20% of the observed price convergence in rice and wheat markets in British India between 1860 and 1920. They found that districts that were not connected by railways experienced price convergence at almost the same rate as connected districts.

Taking a wider view of the question, one can say that arbitrage caused price convergence, rather than the construction of railways specifically. Trade is the final product of a series of activities involving the collection of information, deciding on the appropriate market to target, transporting the goods and selling them. The literature that focuses on railways construction and price convergence has tended to overlook the other critical activities involved. This paper introduces new data on the location of post offices in British India for four specific years: 1881, 1890, 1899, and 1911. We use the data to add the information collection angle to the explanation for price convergence. Before loading rice or wheat onto a railway car and selling it in a district with higher prices, a merchant needs information on those prices. With over 5,000 offices in British India by 1881, the British Indian postal service could provide that information cheaply and conveniently.

Graph 1: Trends in price deviation, railways and post office growth



ABSPDEV: average absolute value of the difference between each district's log price of wheat and the mean log price of wheat.

RRPres: percentage of district headquarters with a railway.

PO'sperDistrict/100: average number of post offices per district divided by 100

Graph 1 illustrates why post office construction might be relevant in explaining grain price convergence in our sample. It displays the general downward trend in wheat price dispersion. The upward trend in railway construction is an obvious reason why researchers looked to railways to explain price convergence. But the number of post offices also trended upwards, suggesting that they too may have played an important role in the convergence process. Indeed, we find that ready access to postal services was an important determinant of the observed price convergence in rice and wheat markets.

Literature Review

Berry (1943) shows that at the same time that steamships appeared in America, price differences for several goods between New Orleans and Cincinnati fell by over 70% between 1816 and 1860. Slaughter (2001) found similar results for a different sample of nineteenth century US goods during which an extensive system of canals and railroads was being constructed. Metzer (1974) attributes shrinking inter-provincial price differences in wheat and rye in Russia after 1870 to the nation's growing railway system. O'Rourke and Williamson (1999) note that the decline in the Bavarian/Prussian price differential in wheat and oats from 1854-1904 coincided with Germany's expanding rail system. Dobado and Marrero (2005) argue that railroads accelerated the rate of interstate convergence in Mexican corn prices between 1885 and 1908.

Two papers specifically analyse grain market integration in British India. Hurd (1975) reports that the coefficient of variation for district wheat and rice prices dropped 60% between 1861 and 1920 while India was building one of the most extensive railway systems in the world. Mukherjee (1980) finds a similar decline in price dispersion between 1855 and 1912, and links it to railways.

The literature on Indian postal services is sparse in comparison, and as far as we know, has never been used for a study of India's economic history. A few books were written over a century ago and another few in the last few decades. They give overviews of India's postal history to varying degrees – postal regulation, services offered, changes in postage, runner lines, use of railways, *etc*. We mostly use primary data on the location of post offices to study their impact on price convergence. The secondary literature helps with the background and to interpret our findings.

Railway and postal networks

Lord Dalhousie, on taking over as the Governor-General of India in 1848, took several actions which had the effect of making the large sub-continent smaller. He created a detailed plan for railways in the early 1850s and actively pushed the establishment of telegraph lines under William O'Shaughnessy. A committee appointed to study the functioning of the post recommended some historic changes (uniform postage and abolishing franking, among others) which were implemented in 1854. Dalhousie referred to the post, telegraph and railways as the "three great engines of social improvement" (Parliamentary Papers 1856 [245], 16).

Railways construction began in the mid-1850s in Bombay, Calcutta, and Madras, with lines spreading into the interior. By 1871, all three cities were connected to each other, and within two more years, all 20 of India's largest cities were linked. Track mileage grew rapidly from 4,771 miles in 1870 to 35,199 miles by 1920. Railways seem to have been built for three main purposes:

commercial, political, and humanitarian. Railways helped to ensure a reliable source of cheap commodities for the home country, they assisted in the defence of the colony, especially in the northwest, and they stood ready to protect citizens in the event of famine (see Andrabi and Kuehlwein [2010] for details). All three motivations appear to have prompted the expansion of the postal network too.

The East India Company made improvements to India's postal system well before Dalhousie took over. Seventeenth century officers were of the opinion that the post should bring in revenue. But it was only in the latter part of the nineteenth century that the post started breaking even. Lord Robert Clive set out the first rules for efficient mail transfer in 1766, and in 1774 Warren Hastings allowed private letters to be carried for a fee. Clive was acting in the interest of maintaining the freshly won trading rights at key ports at the Battle of *Palāshi*, whereas Hastings was trying to secure British finances. Until 1774, postal lines were meant for administrative purposes only.

All revenue collection headquarters were connected with what came to be called the District post or *zamindāri dāk* because these postal lines (*dāk*) were maintained by local landlords (*zamindārs*). They were allowed a reduction in rent in exchange for supplying runners, even though they were not permitted to use them for their personal communication. This formed a dense network throughout the sub-continent, since police and revenue headquarters in districts, sub-divisions and petty divisions served as post offices. Post offices that were opened later specifically with the intention of carrying private letters, which came to be known as the Imperial post, formed a scant network connecting only large and important cities. During the latter half of the nineteenth century the district post was gradually merged with the Imperial post, and even the remote rural districts could access postal services.

There were four Post Office Acts in the nineteenth century: 1837, 1854, 1866 and 1898.

Table 1: Effects of the Four Post Office Acts of India

Post Office Acts	Major changes
1837	› Enforced a government monopoly of postal services › Tried to ensure uniform postal services across the provinces
1854	› Uniform postage, irrespective of distance, to be prepaid with postage stamps › Establishment of a single postal department for the entire sub-continent
1866	› Franking privileges were curtailed (and abolished in 1873) › Reductions in postage on all categories of mail
1898	› Authority given to postal officers to intercept and detain postal articles that were suspected to undermine British rule in India

Another example of political motivations was the use of field post offices during the Anglo-Afghan wars in 1838, 1878 and 1919. The border districts of Sind and Baluchistan had a sparser postal network than the neighbouring Punjab and Bombay. But temporary field post offices served critical communication and transportation needs, as the British were trying to protect India from the Russian approach of south Asia through Afghanistan. It was also used against Indian freedom fighters during the first war of independence of 1857. The post proved very important for sharing intelligence about the spread of rebellion at times when telegraph lines had been destroyed by the rebels. The Act of 1898 further reveals government anxiety about their weakening hold over the prized colony. It was around this time that the freedom struggle in India was gaining strength under the aegis of the Indian National Congress. Letters to and from prominent members such as Sarojini Naidu, Gopal Krishna Gokhale and Sir William Wedderburn were intercepted. None of this would have surprised Dalhousie, who thought that the military advantages of the post and telegraph were "too obvious to call for notice." (Parliamentary Papers 1856, 19).

Commercial motivations are apparent in the high and fast growing postal density in the cotton growing and coastal district in Bombay province between 1881 and 1911. In the Poona district the sub-divisions that grew pepper, chillies and onions and exported them to Europe had a much higher postal density than the food growing sub-divisions. The convenience of opium merchants was cited as one of the reasons for offering uniform postage irrespective of distance in 1854.

The Act of 1854 also provided huge benefits to the population at large because of the dramatically low postage rates. Savings bank and money order services offered by the post in the 1880s were popular among the poorest people. Low postage on newspapers provided access to news – this went a long way towards strengthening the freedom struggle. In the Poona district, new post offices were set up around the construction sites of new canals for protection against drought. Telegraph services were offered at some post offices in the 1880s. But these were less accessible and much more expensive than the post. As of 1881, a flat rate for a letter was 1/32 of a rupee, whereas a telegram cost a rupee. That same year there were about 1,000 telegraph offices and over 5,000 post offices.

Wheat and rice markets

Wheat production and consumption during this period were concentrated in northern India, principally the Punjab and United Provinces. Rice production and consumption occurred more along the east coast including Bengal, Bihar, Orissa, and Madras. Despite high levels of exports of both crops, most production was for domestic purposes. Wheat and rice producing provinces generally had lower prices for the two commodities, but big cities commanded higher prices. Railway conveyance offered merchants significant advantages over alternative sources of transportation in terms of cost, time, and reliability.

There is plenty of anecdotal evidence to show that the post was also being used on a large scale by merchants. An 1851 report by the commission set up to study the functioning of the post cites several instances of merchants using the post to communicate with their agents in distant markets. In fact, their commercial importance was cited as one of the reasons to make postage calculations depend on just weight and not distance:

> *"[B]y almost annihilating distance … [uniform postage] makes the Post Office, what under any other system it can never be, the unrestricted means of diffusing knowledge, extending commerce, and promoting in every way the social and intellectual improvement of the people." (Report 1851, 16).*

After 1854, when uniform postage was enacted, theirs was the cheapest rate in the world. (Majumdar 1990, 75). According to Clarke (1921, 42) "to such an extent have postage rates been reduced in India that it would be hard to find a man who could not afford to communicate by post with his friends”. This would have been especially true for the districts where the district post had been merged with the Imperial post and many small villages at once became part of a vast network of post offices.

Even for illiterate individuals, which would have been the vast majority of the population, the post could convey useful information. Newspaper circulation was widespread by the early 1880s. Bharat (2012) reports that newspaper circulation in each of the Bombay, Bengal, Madras, Northwest, and Punjab provinces numbered around two million in 1880-81. The arrival of a new newspaper could be an important local event. Townspeople would congregate at the post office to hear someone read the latest news (Ahmed 1981). In that way, current market data could reach a wide audience.

Data

We obtained annual retail wheat and rice price (rupees per *ser* [2.057 lbs.]) by district from the 1896 and 1922 issues of *Prices and Wages in India*. They were collected on a fortnightly basis at district headquarters. There are slightly more districts with rice data than wheat, and all of the districts in our wheat sample are in our rice sample.

Railway opening dates by city are from the 1947 edition of the *History of Indian Railways*. Since our grain prices were measured at district headquarters, the opening date for railways used in our analysis was the first year a railway came to a district headquarters or within 20 miles of it.

Volumes of the *Postal Guide* were published annually starting in 1869. These were meant for the ease of postal sorters and to provide instructions to the public on how to use the various services. Among other things, these volumes contained an alphabetical list of all the towns and villages in British India that had a post office. We digitised four of these lists – 1881, 1890, 1899 and 1911. Data included in this paper are based on the number of post offices in each district for which we have price data (163 for rice and 136 for wheat). We measure postal density with respect to district area or population. Both district area and population data came from censuses. The match between census data and our post office data is not always exact. For our 1890 post office data, we have census data on population and area for 1891. Similarly for our 1899 post office data, we have census data from 1901.

As district postal lines were merged with the Imperial line, they were included in the *Postal Guide*. So any district post office that does not appear in the *Postal Guide* (and consequently does not form part of the data for this paper) was not open to private individuals.

The number of post offices in a district ranges from 0 in 1881 to 302 in 1911, but averages 45 in our wheat sample and 51 in our rice sample. In our wheat sample this works out to one post office per 22,000 people, though that statistic falls from one per 42,000 in 1881 to one per 15,000 in 1911. On average there is also one post office per 76 square miles, with that ratio falling from one per 155 square miles in 1881 to 47 square miles by 1911. The numbers for our rice sample are similar. Averaging over our four waves, there were railroads in 78% of our districts in our two samples, starting at 52% in 1881 and reaching 96% by 1911.

We also have data for 18 native states. However, for at least part of our sample period several of these states had independent postal networks that either did not allow the British government to set up new post offices in their territory or just allowed them to set up a few. This means that the *Postal Guide* list of villages in these native states might not be accurate and the services that they provide might not be at the same level as the post offices in British districts. For this reason, we have dropped all native states from our sample. That leaves us with 137 districts in our balanced wheat sample and 164 districts in our rice sample.

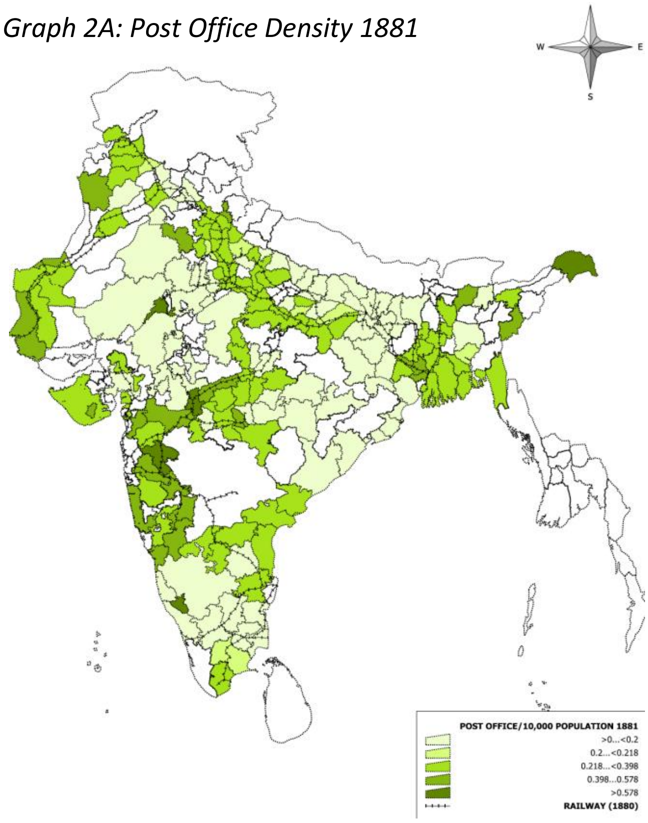
Table 2: Summary Statistics

	Balanced Wheat Sample			Balanced Rice Sample		
Variable	N	Mean	SD	N	Mean	SD
ABSPDEV	548	0.161	0.139	656	0.201	0.177
RAILPRES	548	0.777	0.416	656	0.777	0.416
POCAPITA	548	0.051	0.036	656	0.051	0.034
POAREA	548	0.033	0.148	656	0.037	0.155
INTERACTCAP	548	0.042	0.039	656	0.042	0.038
INTERACTAREA	548	0.031	0.149	656	0.034	0.155
ABSPDEV3Y	548	0.158	0.124	656	0.185	0.160

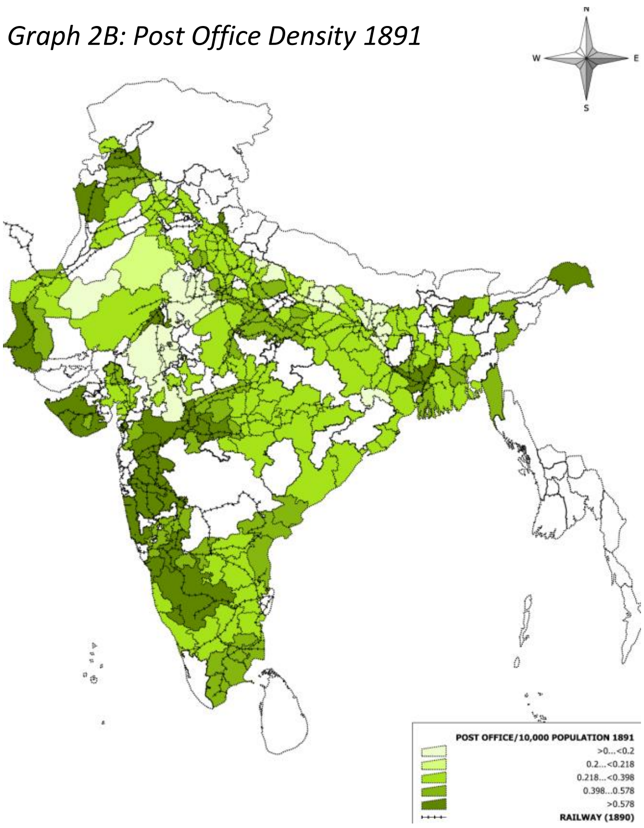
ABSPDEV is the absolute deviation of log price of grain from the mean
RAILPRES is the presence of a rail line at or near a district headquarters
POCAPITA is the number of post offices per 1,000 persons in a district
POAREA is the number of post offices in a district per square mile
*INTERACTCAP is RAILPRES*POCAPITA*
*INTERACTAREA is RAILPRES*POAREA*
ABSPDEV3Y is the absolute deviation of 3-year log price of grain from the 3-year mean
*N is the total number of observations (138 districts*4 years = 548 observations)*

Graphs 2 and 3 display graphically the distribution of post office density by district across the sub-continent. Major railway lines are included for comparison purposes. Density as measured by post offices per capita is especially high in the Central India, Nizam's Territories, Punjab/Delhi/ Northwest and Bombay provinces. Density measured by post offices per square mile is highest in high population areas such as Bengal, Bombay, Madras, and again the Punjab, Delhi, and Northwest provinces. The two measures are positively correlated with each other, but not hugely. The marginal effect of adding post offices per square mile to a regression of post offices per capita on district dummies is only to raise the adjusted R-squared by three percentage points (0.03). That makes it likely that our results with vary with our density variable.

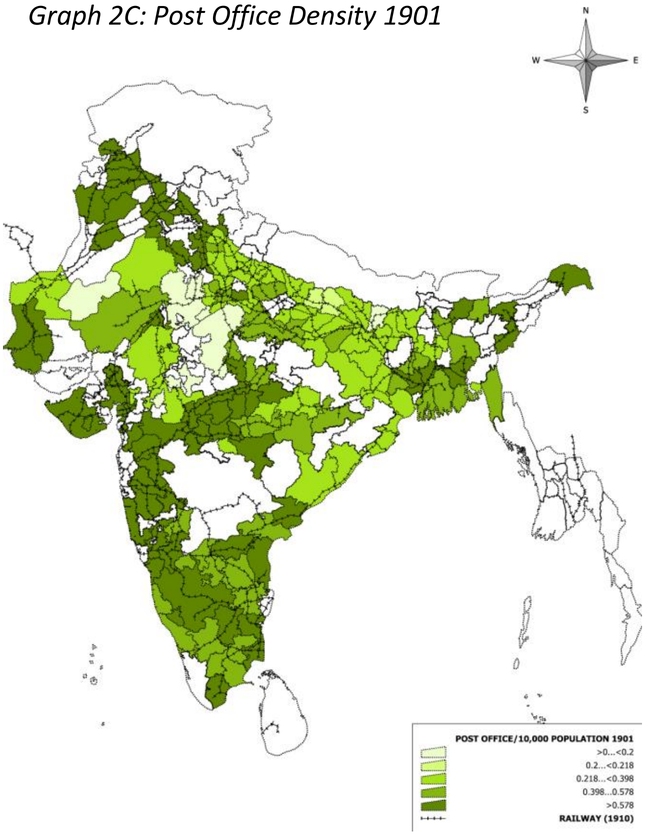
Graph 2A: Post Office Density 1881



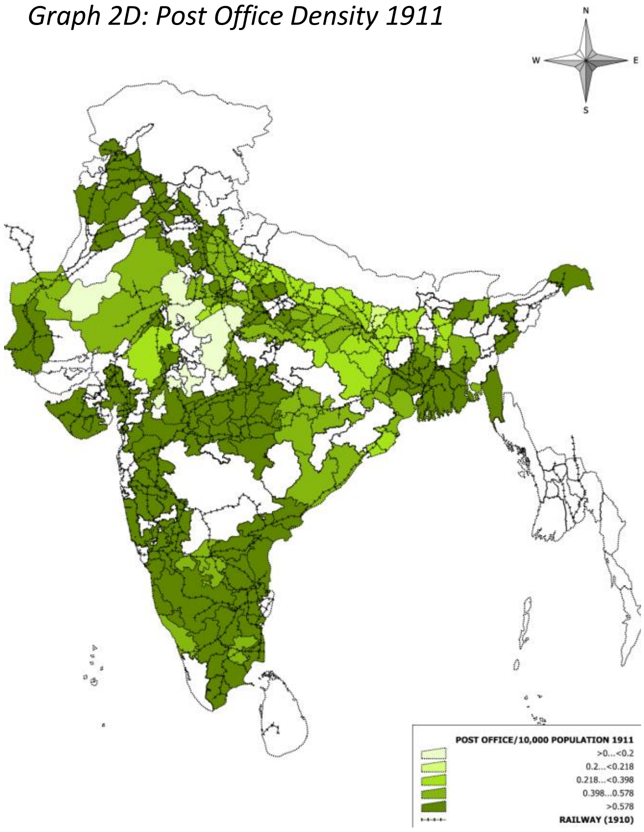
Graph 2B: Post Office Density 1891



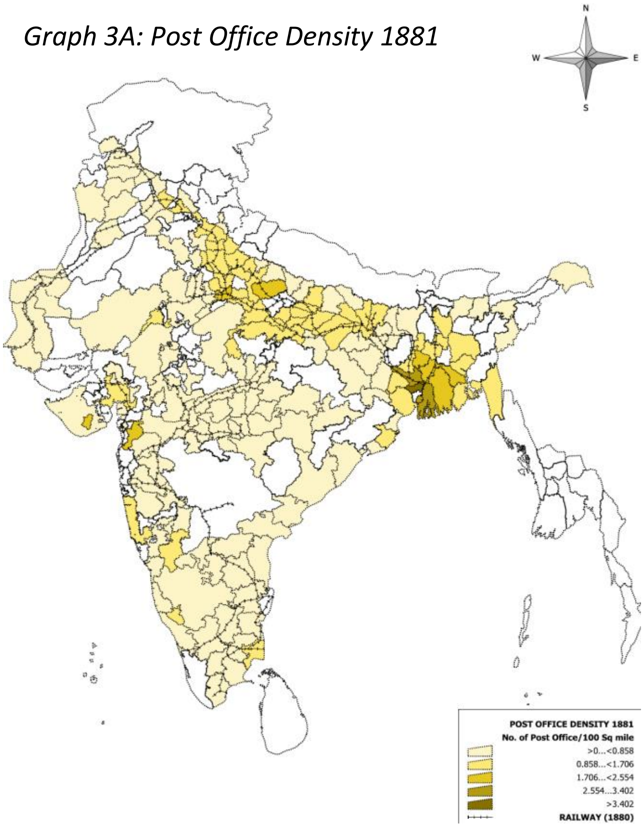
Graph 2C: Post Office Density 1901



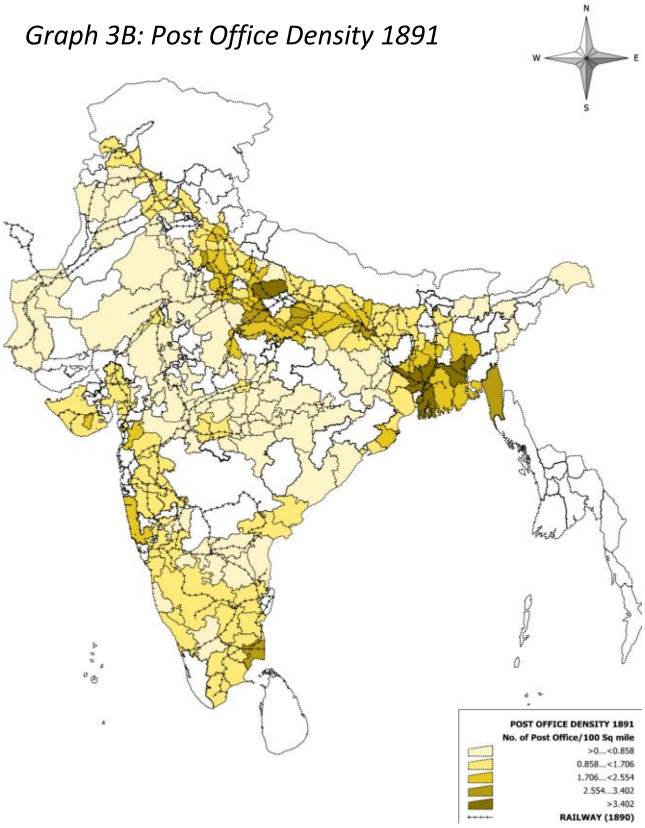
Graph 2D: Post Office Density 1911



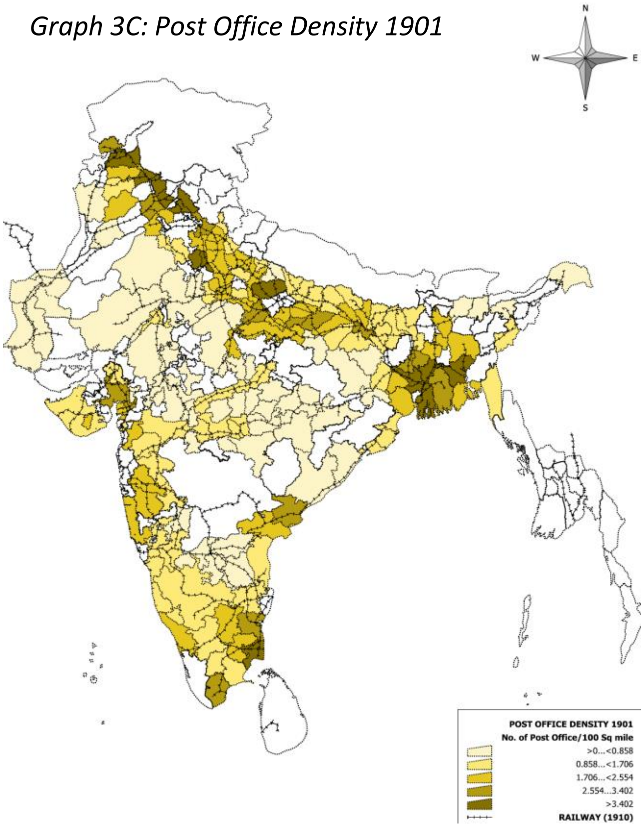
Graph 3A: Post Office Density 1881



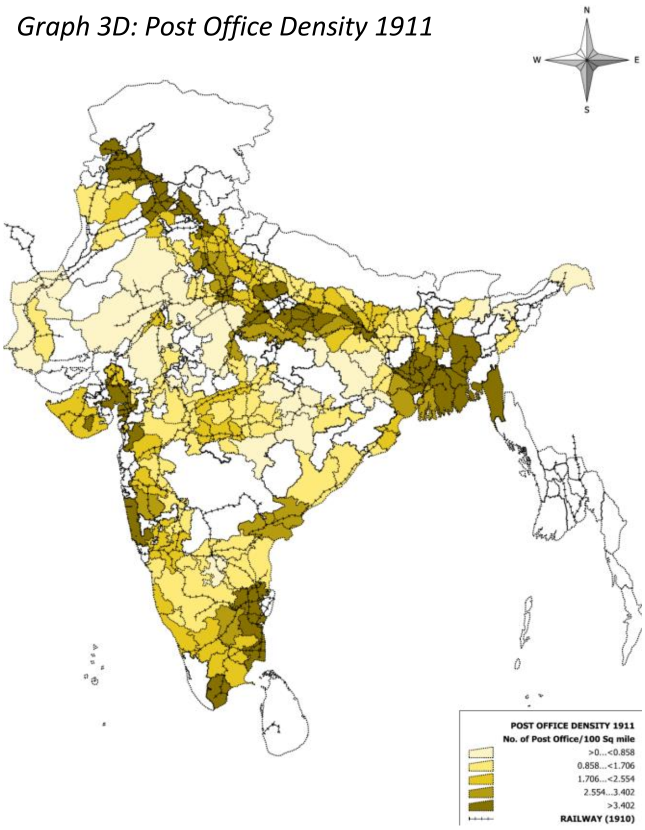
Graph 3B: Post Office Density 1891



Graph 3C: Post Office Density 1901



Graph 3D: Post Office Density 1911



Model

It is common to invoke the "iceberg" model to explain differences in prices across cities or districts. A certain portion of an iceberg melts as it is being transported across the tropical sub-continent. It is profitable to transport the iceberg to another district only if the price there compensates for the loss in transit. The law of one price dictates that the difference in commodity prices between districts must be no greater than the cost of transport between these two districts. If the difference in prices is greater than this band permits, arbitrage will be profitable and the result will be price convergence.

The model therefore implies that the one factor that should lead to price convergence between cities is shrinking transportation costs. That is why so many studies have looked at the introduction of railways to explain price convergence. However, the model assumes complete information, which may well not have held in nineteenth century India. Without that assumption, prices can differ beyond transportation costs. Post offices, on the other hand, can help to provide information about arbitrage opportunities. Farmers or merchants can use the post to communicate with their agents, friends or family and find out how prices in other districts compare with those at their local markets. If prices in another district are higher and profits can be earned after incurring the cost of transport, then grain should be exported to that district. That should push prices together.

On the other hand, without a cheap source of transportation, arbitrage may not be profitable, so such information may not lead to price convergence. However, even in those cases, the proliferation of post offices within districts may still lead to price convergence between different district headquarters. A proof is contained in the appendix, but the intuition is straightforward. Within each district, the price of grain probably varies across towns. Without post offices, that variation could easily be greater, as farmers remain unaware of arbitrage opportunities within their district. Grain prices at the district headquarters could lie anywhere within that range.

When post offices open up in a district, they may provide market data that spurs trade between the district headquarters and other district towns. For a headquarters that started off with an unusually high (low) price in the district, chances are that will pull its price down (up). Over time, as more post offices are opened and more trade occurs within the district, the price of grain in the headquarters should move toward the district mean. That mean reversion can bring prices across district headquarters together. Consider the simple case where two districts have identical price means. Before post offices, the expected absolute value of the price difference between headquarters is positive, as it would be a fluke if the headquarters prices started out identical. But if post offices and within-district arbitrage push each headquarters price to their district mean, the expected price difference between headquarters shrinks to zero. More generally, mean-reversion within two districts reduces the expected price difference across district headquarters as long as the two price ranges overlap. If they don't, mean reversion has no effect on price dispersion across headquarters. So mean reversion can decrease price dispersion across district headquarters and should not increase it. On average, then, more post offices should produce price convergence among district headquarters. But the marginal effect attenuates, as each additional post office moves the headquarters price a shorter distance to the district mean.

These considerations suggest that the more relevant density measure for price convergence is the number of post offices per square mile in each district. As that measure rises, it should mean that more towns within a district have current market information, promoting trade. An exception to that would be if the number of post offices per square mile was rising just because towns that already had a post office got additional ones. In that case, the number of towns with post offices would not increase. But our data indicate that is not what happened. Between 1881 and 1911 9,167 new post offices were built in British India, but only 379 occurred in towns that already had a post office. So 96% of the post offices built during our sample period were in new localities.

Nonetheless one can make an argument that our alternative density measure, the number of post offices per capita, could also affect price dispersion. A small value for that measure could mean crowded post offices with long lines and slow service. That could discourage the use of the post, inhibiting communication and trade. One complication with this measure is that more post offices could boost a district's population by raising incomes through greater commerce. The result could be little growth in post offices per capita, despite the fact that post offices are growing and prices are converging. But this may not be a problem in our sample with the waves about 10 years apart if it takes years for post offices to affect incomes and for incomes to affect the local population.

One final implication of the theory is that it may make sense to exclude the three districts in our sample that are really cities: Bombay, Calcutta, and Madras. Their areas are tiny, ranging from 23 to 32 square miles. The next smallest district in our sample is 892 square miles and the average district area is 4,300 square miles. So these three districts are outliers. That shows up in our post offices per square mile variable, where they are an order of magnitude larger than the rest of the sample. That has the potential to skew our results. It also means that more post offices per square mile in those districts do not represent new towns getting post offices. So that might weaken the estimated effects of that density variable on price dispersion.

Based on this theory, our regression equation can be written as:

$$LPD_{it} = \alpha + \theta_i + \gamma_t + \beta POD_{it} + \mu POD_{it}^2 + \delta Rail_{it} + \lambda Rail_{it} x POD_{it} + \varepsilon_{it} \tag{1}$$

LPD_{it} is the absolute value of the deviation of the log price of rice or wheat in district *i* at time *t* from the mean log price of rice or wheat for all districts at time *t*. Price convergence would require the absolute log price deviation to decline over time. We use log price deviations so that the postal density and railway coefficients can be interpreted as percentage changes caused by these regressors. *POD* is our post office density variable. The measures of density that we use are post offices per 1,000 persons and post offices per square mile in each district. The quadratic POD variable is meant to capture the nonlinear effect of greater communication on price differences mentioned above. *Rail* is an indicator variable which takes a value of one if the district headquarters has a railway line that year and zero otherwise.

An interaction term between railways and post office density is included to allow the effects of better information on price differentials to change in the presence of railways. On the one hand, one might imagine post offices to matter more with railways nearby, as railways would provide the means through which price arbitrage takes place. In that case post offices and railways would be complements. On the other hand, they could be substitutes if railways brought with them the price information that post offices conveyed. The variable θ_i is our district fixed effect. The latter takes care of time invariant unobservable characteristics specific to a district that affect the price of grain. These could include geography (proximity to a port or navigable river), soil quality, and fairly permanent institutions and culture. γ_t is our year fixed effect and it takes care of unobservable characteristics specific to a particular year for all districts, such as significant fluctuations in climate or technology. There was a significant increase in postal density over this time. Not correcting for year fixed effects could lead to a very high POD coefficient due to a spurious correlation between increasing postal density and decreasing absolute price deviation from the mean. Finally, ε_{it} is the random error term. We use standard errors clustered at the district level, as district conditions are likely to be dependent across years.

Results

Table 3 displays our results for wheat prices within a balanced sample of 137 districts. Results for a slightly larger unbalanced sample are similar. District fixed effects and time dummy variables are not reported. First we ran the regression with just the railway variable in it. The presence of a railway near district headquarters significantly reduces district price dispersion. The point estimate suggests that the presence of a railway at district headquarters reduces price dispersion by roughly 7%. That estimate is a bit larger than in Kuehlwein and Andrabi (2010), but the dependent variable is also a little different, so the estimate appears to be reasonable. In the second column we estimate equation (1) using post offices per capita as our density measure. The railway estimate almost doubles in size, but is now only significant at the 10% level. The number of post offices per 1,000 persons in each district is not significant, nor is its square. Furthermore, the interaction terms between post office density and railways are both insignificant.

In the next column we use our other measure of post office density: post offices per square mile. Railways again enter very significantly, this time with a relatively large coefficient compared to our first regression. It suggests that railways reduce price dispersion by approximately 14%. The post office density variable enters significantly at the 5% level and has the predicted negative sign. The squared measure is significant at the 10% level and is positive. This suggests that increasing the number of post offices in a given area has a decreasing marginal impact on price dispersion. Combined, the two point estimates suggest that, at our sample mean of 0.033 post offices per square mile, post offices reduce price dispersion by almost 20%. Not only is this a large effect, it exceeds the estimated impact of railways. However, the effect of post offices on price dispersion collapses in the presence of railways. Both interaction terms are significant, though the squared term only so at the 10% level. Interestingly, their magnitudes are virtually equal and opposite the magnitudes of the post office coefficients. That implies that in the presence of railways, post offices have only a tiny effect on price variability. Evaluated at the sample post office mean, post offices appear to increase price dispersion by about half a per cent. However, an F-test demonstrates that one cannot reject the hypothesis that the two sets of coefficient estimates are exactly equal and opposite. So there is no strong evidence that the effect of post office density on price dispersion in

Table 3: Determinants of Absolute Log Price Difference from the Mean
Balanced Wheat Sample

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.227	0.256	0.303	0.254	0.302	0.259
	(0.22)***	(0.034)***	(0.066)***	(0.035)***	(0.053)***	(0.036)***
RRPres	-0.067	-0.091	-0.124	-0.098	-0.153	-0.069
	(0.025)***	(0.037)**	(0.065)*	(0.040)**	(0.058)***	(0.025)***
PoCapita		-0.895	-3.087			-1.313
		(0.576)	(2.172)			(0.867)
PoCapita2			13.217			4.370
			(11.691)			(3.656)
PoArea				-3.260	-11.176	
				(2.609)	(5.458)**	
PoArea2					138.980	
					(72.320)*	
Interact		0.606	2.094	3.286	11.377	
		(0.552)	(1.946)	(2.607)	(5.447)**	
Interact2			-10.232		-139.062	
			(10.938)		(72.313)*	
N	548	548	548	548	548	548
Adj. R^2	0.49	0.50	0.50	0.50	0.51	0.50

**-Significant at the 10% level*
***-Significant at the 5% level*
****-Significant at the 1% level*
Notes: The dependent variable is the absolute value of the difference between the log price of wheat in district headquarters and the mean log price across all district headquarters that year. RRPres is a dummy variable for whether a railroad was present at district headquarters that year; PoCapita is post offices per 1,000 persons in the district that year; PoArea is post offices per square mile in the district that year. A variable with a 2 at the end indicates that variable squared. Interact is RRPres times the post office density variable in that column. Not reported are district level fixed effects and yearly time dummies. Standard errors are in parentheses, clustered at the district level.

Table 4: Determinants of Absolute Log Price Difference from the Mean
Balanced Rice Sample

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.331 (0.024)***	0.377 (0.037)***	0.455 (0.060)***	0.346 (0.034)***	0.387 (0.052)***	0.339 (0.026)***
RRPres	-0.051 (0.029)*	-0.085 ((0.042)**	-0.182 (0.064)***	-0.065 (0.041)	-0.104 (0.058)*	-0.052 (0.029)*
PoCapita		-1.469 (0.741)**	-5.052 (1.918)***			
PoCapita2			24.526 (9.494) **			
PoArea				-1.533 (1.957)	-7.549 (5.107)	-0.452 (0.597)
PoArea2					100.271 (63.401)	0.229 (0.263)
Interact		0.790 (0.694)	4.921 (1.801) ***	1.584 (1.956)	-6.957 (5.030)	
Interact2			-27.672 (9.420)***		-99.983 (63.364)	
N	656	656	656	656	656	656
Adj. R^2	0.53	0.53	0.54	0.53	0.53	0.53

**-Significant at the 10% level*
***-Significant at the 5% level*
****-Significant at the 1% level*
Notes: The dependent variable is the absolute value of the difference between the log price of rice in district headquarters and the mean log price across all district headquarters that year. RRPres is a dummy variable for whether a railroad was present at district headquarters that year; PoCapita is post offices per 1,000 persons in the district that year; PoArea is post offices per square mile in the district that year; a variable with a 2 at the end indicates that variable squared; Interact is RRPres x the post office density variable in that column. Not reported are district level fixed effects and yearly time dummies. Standard errors are in parentheses, clustered at the district level.

the presence of railways is not zero. These results strongly suggest that post offices and railways are substitutes, not complements.[1] Finally, in the last column we omitted the two insignificant interaction terms from the post offices per capita regression, but it had little effect. Both the linear and quadratic measures of post office density remain insignificant.

Table 4 presents the results of running the same regressions on our rice sample. The default is just railways and those estimates mirror those for our wheat sample. But now when we estimate equation (1) using our per capita post office measure, post offices enter quite significantly, both the linear and quadratic variables. Evaluated at the rice sample mean of 0.051 post offices per 1000 persons, the presence of post offices appears to reduce price dispersion by 18%. This is comparable to the magnitude of the effect found in our wheat regressions for our other post office density measure. Also similar is the fact that the coefficients on our two railway-post office interaction terms are roughly equal to and opposite of the coefficients on our post office variables. Evaluated at the post office mean, the interaction terms reduce the impact of post offices on price dispersion to only 1.5%. An F-test of the hypothesis that the interaction coefficients are equal and opposite the post office coefficients cannot reject it at the 5% level, but can at the 10% level. In any case, it appears that the presence of railways virtually nullifies the impact of post office density on district price dispersion. So again we encounter strong evidence that post offices and railways functioned as substitutes in British India.

In the third column we substituted in our second post office density variable. The results are weak. Measured this way, post offices have no statistically significant impact on price dispersion. In the final column we dropped the insignificant interaction variables to see if that might sharpen our post office estimates. However, the results don't materially change.

It is curious that our two post office measures come in significantly in different samples. The main difference in sample coverage is that the rice sample includes prices from the southern district of Madras, which the wheat sample excludes. That district witnessed significant growth in post offices per capita over our sample period, even relative to the rest of India. Our per capita post office variable might then be entering significantly in our rice sample because of its ability to explain shrinking price dispersion in that region. That region, however, probably matters less for our post office per area variable because other parts of the sub-continent displayed more rapid growth in that metric in our sample.

Price Variability

One limitation of our panel data set is that it covers only four years. One or more of those years could be unusual, especially for grain prices. Grain prices fluctuated closely with weather conditions, which could vary considerably from year to year. Droughts, in particular, were common in this area and time, and led to wide swings in food prices. Srivastava (1968) analysed the occurrence and severity of Indian droughts over our sample period, and his work suggests that India

[1] After the setting up of new railway lines across India, new post offices were often set up along the rail route for convenient sorting and distribution.

had a major drought in one year in our sample: 1899. It affected numerous provinces including Madras, the Central Provinces, Bengal, Central India, and part of Punjab. That may be why mean price dispersion in Graph 1 rose in 1899 despite an overall downward trend. We do try to control for yearly shocks to price dispersion with time dummy variables. However, those variables assume that the shocks affect all districts equally, which would not hold for droughts, which were often regional. If such shocks by chance happened to be negatively correlated with our post office variable, they could lead to a spurious correlation between post office density and lower price dispersion. Even if the shocks weren't correlated with post offices, the additional noise they created could still weaken the estimated relationship between post offices and price dispersion.

To address that, we substituted in a three-year simple average of log district grain prices in place of the log price for just that year. The three years in the average were the previous year, current year, and subsequent year. So, for example, instead of using log wheat prices in just 1899 we used log wheat prices averaged over 1898-1900. If price shocks only last a year, averaging over three years should produce a more reliable measure of normal grain prices for each district. That is consistent with the sample data in Table 2 that indicate that both the mean and standard deviation of price dispersion is smaller using three-year moving averages.

Table 5 displays the results from using the absolute value of the difference between the three-year average log district price and the three-year average log sample price as our dependent variable. In the wheat sample, the two post office density per capita coefficients remain insignificant, along with the interaction terms. Although not reported, dropping the two interaction terms doesn't fundamentally change those results except that the p-value for PoCapita shrinks to 0.11. In the next column, post offices per square mile enters significantly at the 10% level, though the squared version of it is not significant. Neither interaction term is significant, though the linear term has a p-value of 0.11, so it is close. The coefficient on PoArea evaluated at its mean suggests that post offices reduce price dispersion by 22%. This is a large number, though the estimate has quite a wide confidence interval. The point estimates of the two sets of linear and quadratic terms are almost exactly mirror images of each other, suggesting again that in the presence of railways, post offices have virtually no effect on price dispersion.

Switching to the rice sample in column 3, all our variables enter significantly, most at the 1% level. The estimated impact of railways grows to a 16% decline in price dispersion. Evaluated at the mean of post offices per capita, post offices reduce price dispersion by 16% as well. But the railway interaction terms largely nullify that effect. Although one can reject the hypothesis that the coefficients on our interaction terms are exactly equal and opposite to the coefficients on our post office terms (p-value 0.01), in practical terms they almost completely offset each other: the net negative effect of post offices falls to only 2.5%.

In column 4 post offices per square mile comes in significantly at the 5% level in both linear and quadratic forms. The impact of railways drops to an 11% decline. Evaluated at their means, the negative impact of post offices shrinks slightly to 15%. In this case, one cannot reject the null that the interaction coefficients are equal and opposite the post office coefficients. The negative impact of post offices in the presence of railways falls to 2%. Finally, it is worth noting that the goodness of fit improves markedly in these regressions. That is consistent with price averaging boosting the signal to noise ratio in the data.

Table 5: Determinants of Absolute Log Price Differences using 3-Year Averages
Balanced Wheat Sample

Variable	(1)	(2)	(3)	(4)
Constant	0.220 (0.027)***	0.280 (0.054)***	0.226 (0.026)***	0.263 (0.043)***
RRPres	-0.058 (0.029)*	-0.069 (0.053)	-0.074 (0.030)**	-0.108 (0.047)**
PoCapita	-0.457 (0.447)	-1.791 (1.800)		
PoCapita2		7.636 (9.341)		
PoArea			-2.558 (1.674)	-7.673 (4.494)*
PoArea2				82.573 (56.715)
Interact	0.138 (0.428)	0.740 (1.633)	2.542 (1.674)	7.192 (4.477)
Interact2		-4.411 (8.847)		-82.374 (56.708)
N	548	548	548	548
Adj. R^2	0.58	0.58	0.58	0.58

**-Significant at the 10% level*

***-Significant at the 5% level*

****-Significant at the 1% level*

Notes: The dependent variable is the absolute value of the difference between the three-year average log price of grain in district headquarters and the mean three-year average log price across all district headquarters that year. RRPres is a dummy variable for whether a railroad was present at district headquarters that year; PoCapita is post offices per 1,000 persons in the district that year; PoArea is post offices per square mile in the district that year; a variable with a 2 at the end indicates that variable squared; Interact is RRPres x the post office density variable in that column. Not reported are district level fixed effects and yearly time dummies. Standard errors are in parentheses, clustered at the district level.

Table 6: Determinants of Absolute Log Price Differences using 3-Year Averages Balanced Rice Samples

Variable	(1)	(2)	(3)	(4)
Constant	0.350 (0.033)***	0.419 (0.053)***	0.321 (0.030)***	0.3370 (0.045)***
RRPres	-0.085 (0.036)**	-0.169 (0.056)***	-0.075 (0.036)**	-0.119 (0.050)**
PoCapita	-1.383 (0.662)**	-4.538 (1.722)***		
PoCapita2		21.551 (8.715)**		
PoArea			-1.888 (1.900)	-8.673 (4.235)**
PoArea2				114.382 (53.188)**
Interact	0.580 (0.623)	4.186 (1.587)***	1.955 (1.898)	8.103 (4.169)*
Interact2		-24.170 (8.464)***		-114.100 (53.156)**
N	656	656	656	656
Adj. R^2	0.58	0.58	0.60	0.59

**-Significant at the 10% level*

***-Significant at the 5% level*

****-Significant at the 1% level*

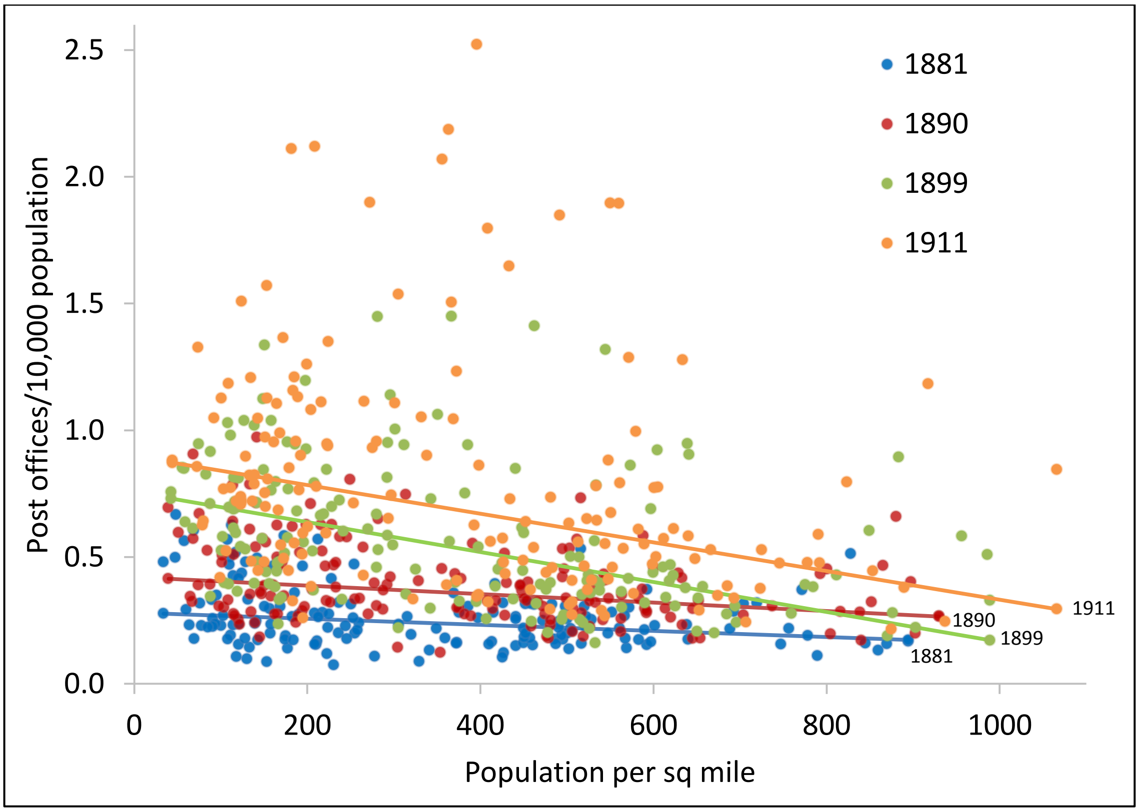
Notes: The dependent variable is the absolute value of the difference between the three-year average log price of grain in district headquarters and the mean three-year average log price across all district headquarters that year. RRPres is a dummy variable for whether a railroad was present at district headquarters that year; PoCapita is post offices per 1,000 persons in the district that year; PoArea is post offices per square mile in the district that year; a variable with a 2 at the end indicates that variable squared; Interact is RRPres x the post office density variable in that column. Not reported are district level fixed effects and yearly time dummies. Standard errors are in parentheses, clustered at the district level.

As mentioned earlier, an argument can be made for excluding the three districts Bombay, Calcutta, and Madras from our sample. They are really cities, not districts, and are outliers, especially for the post offices per square mile density measure. Omitting them from our three year average model did not have a big effect on our results, so they are not displayed. However, the model performed marginally better with the rice data. All estimates using that data from the complete nonlinear model using either density measure now enter significantly at the 5% or 1% level.

Post office placement

So far our analysis has treated the locations of post offices as exogenous. But they were not random, so depending on what did determine those locations, endogeneity could be a problem for our estimation. We have already mentioned that there were commercial, political, and welfare reasons for the building of post offices. What else do we know about post office placement and how it changed over time? Graph 4 shows that even the most densely populated districts saw an increase in their postal density, though this increase was smaller than for sparsely populated districts.

Graph 4: Relation between postal and population densities in British districts from 1881 to 1911



Sources: Post office data are from the Postal Guide 1881, 1890, 1899 and 1911. District level population and area data are from the Census of India records.
Note: Native states are excluded. This graph shows median fit lines instead of mean.

These districts were densely populated because of some natural resource or economic activity or both, that attracted immigrants. The high level of economic activity and the high proportion of immigrant population were both reasons that warranted greater use of postal services. This high demand was being catered to with a few large post offices, like the general post office building at the center of the city. Clarke (1921) cites specific examples of post offices in Calcutta and Benares, both important trading cities, where "the parcel window was the scene of a petty riot every afternoon" (107), hinting at the crowds that tried desperately to attract the attention of one or two clerks through the few tiny windows (just large enough for one hand to fit in) to buy stamps or get their letters or parcels or money orders sent. The postal density had to increase to keep abreast of the increase in the number of persons per square mile using postal services, even if the population density itself was not increasing significantly.

One way to begin to address the question of potential endogeneity is to do some simple regressions involving the number of post offices in each district. Intuitively, if the main purpose of post offices was to connect people, more people in a district would imply more post offices. More people would imply a greater demand for the services that post offices provide, including mailing and receiving letters and packages, money orders, parcel insurance, telegrams, and savings accounts (Hamilton 1910, Chapter XV). Holding the size of the population constant, a larger area would also probably spur the building of more post offices to make them easier to reach. But there may be diminishing returns to more post offices, suggesting a concave relationship between our two regressors and the number of post offices.

Table 9 tests these hypotheses. Yearly dummies were added to allow for the steady growth in post offices over time. A larger population does increase the number of post offices in a district, to the tune of 3 extra post offices per 100,000 persons. Because the quadratic term is insignificant, there is no evidence of a declining effect from a larger population. A larger area also increases the number of post offices by up to almost 3 post offices per 1,000 square miles. The marginal effect diminishes with district size. Overall, these results suggest a definite logic to the establishment of post offices. They also indicate that a significant fraction of the variation in post office placement has already been controlled for in our regressions. A simple fixed effect regression with time dummies is capable of explaining 72% of the variance in the number of post offices in our sample.

A hint of these results is also visible in the maps that show clearly that the heavily populated Ganges belt of the subcontinent has a lower number of post offices per capita and a higher number of post offices per square mile, and the reverse is true for the other sparsely populated parts of the colony.

Sen (1875, 128) writes that after 1867, post offices were opened on a temporary basis for six months. A post office would be made into a permanent establishment only if during that time half of the money earned from postage covered the cost of the establishment. The other half was meant to cover the costs incurred by other post offices that were sending letters to or receiving them from this one. It is not clear how the postal department decided where to set up temporary post offices. This revenue requirement encouraged post offices to open up in more populated and economically successful areas. But, as noted earlier, revenue was not the only reason for setting up post offices. There were political, commercial and welfare motives too.

Table 7: The Determinants of the Number of Post Offices in a District
Balanced Rice Sample

Variable	Estimates
Constant	-15.700 (5.590)***
Population	0.033 (0.008)***
Population2	-0.00001 (0.00003)
Area	2.758 (1.292)**
Area2	-0.148 (0.075)**
1890 Dummy	14.214 (1.006)***
1899 Dummy	31.361 (2.129)***
1911 Dummy	51.649 (3.180)***
N	656
Adj. R^2	0.54

**-Significant at the 10% level*
***-Significant at the 5% level*
****-Significant at the 1% level*
Notes: The dependent variable is the number of post offices in the district. Population is the population of the district in that (or a nearby) year divided by 1000. Area is the area of the district in that (or a nearby) year in square miles divided by 1000. A 2 at the end of a variable implies that the variable is squared. Standard errors are in parentheses, clustered at the district level.

By the 1880s it was felt that the post had not yet reached enough remote villages, so extra-departmental post offices were introduced (Bharat 2012, 11). The administration allowed any literate school teacher or merchant who was willing to operate a post office out of their home or work place to earn a small fee for the service. Since these were extremely cheap to open, the condition that half the postage should pay for the establishment cost (which was just the allowance paid to the post master) was satisfied easily. There was a marked increase in postal facilities following the adoption of this new rule. The number of post offices grew by about 2/3rds between 1881 and 1890 in our two samples, and then slowed down to about half that rate after 1890.

Based on this information, we conclude that endogeneity is not a serious problem for our estimation. Since our regressions include district fixed effects, any missing time-invariant factors that might influence district price dispersion over our four waves are already controlled for. Military post office placement should not lead to reverse causation. And the expansion of postal establishments in rural areas in the 1880s, the start of our sample period, runs counter to the possibility that new post offices were only constructed in booming districts prone to price convergence. We did attempt to test this by rerunning our regressions on districts with headquarters on military, rather than commercial, railroad lines. However, the tiny sample size (32 observations) produced too imprecise estimates to reach any conclusions.

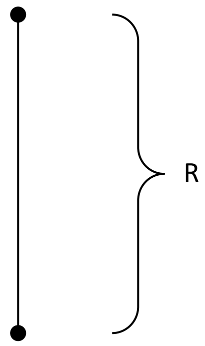
Conclusion

This paper uses new data on the location and density of post offices to identify the forces behind price convergence in the rice and wheat markets in late 19th and early 20th century British India. Previous research found that railways were a significant contributor to that price convergence. This paper suggests that the spread of post offices was also probably important. In the majority of our regressions, a measure of post office density enters negatively and significantly. Estimates of the negative impact of post office density on price dispersion when density enters significantly range from 15-20%. That is actually slightly larger than our estimates of the effect of railways on price dispersion, which ranges from 5-15%. However, post offices only seem to have a large effect on price dispersion in the absence of railways. Once railways are introduced, the impact of post offices shrinks to 2% or less. That strongly suggests that railways and post offices were substitutes for producers and traders.

While there is much research that demonstrates the importance of railways for market integration, the post is a decidedly understudied subject, in spite of its ubiquitous nature. The postal system was fine-tuned by the British government over the course of three centuries for at least three important reasons – political, commercial and welfare. Each of these motivations became important at different points in time, depending on the political and economic situation in British India. These represent the effects that the British government intended the post to have. This paper suggests that market integration can be added to the list of actual effects.

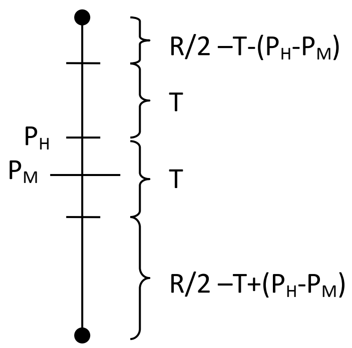
Appendix

Assume prices within a district before arbitrage (under autarky) are distributed randomly and uniformly over range R:



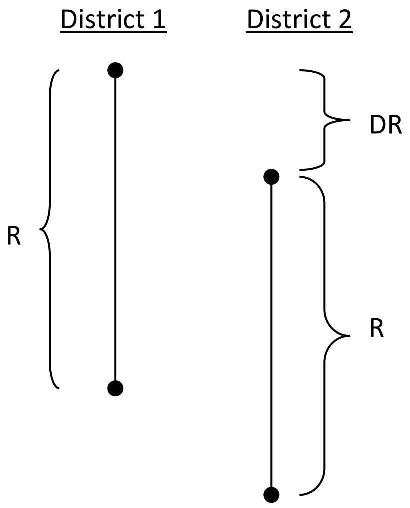
Common factors within the district (e.g. climate) will determine the mean of the range, but idiosyncratic factors in the district (e.g. soil quality) determine the range itself. The price at district headquarters can be anything within that range. Once two post offices open in that district, one at district headquarters and the other in another town, arbitrage will occur unless the cost of transporting goods from one to the other is more than the price differential. Assume the cost of transporting goods between any two towns in the district is a constant T. Also assume T<R/2 to allow for a decent amount of arbitrage (trade) within the district. Label P_H the autarky price of grain at headquarters and P_2 the autarky price at this other town (town 2). When these two post offices are built, if $|P_H - P_2|$>T the headquarters price will move towards P_2. If a third post office is built and arbitrage occurs with headquarters, P_H will move towards P_3. As more post offices are built, the headquarters price will keep getting pushed towards the autarky price of other post offices.

Algebraically, let P_M be the mean price of our uniform distribution. Then the probability that a new randomly picked post office price will be enough above P_H to effect arbitrage and raise the headquarters price is (R/2 -T-[P_H-P_M])/R, and the probability that a new post office price will be enough below P_H to lead to arbitrage that lowers the headquarters price is (R/2 -T+[P_H-P_M])/R:



That means that when P_H>P_M $\rightarrow$ Prob($P_H\downarrow$)>Prob($P_H\uparrow$), so there is a greater probability the headquarters price will fall towards the mean. Conversely, when P_H<P_M, there is a greater probability the headquarters price will rise towards the mean. So greater post office density in a district should lead to the headquarters price being closer to the mean district price.

That mean reversion, in turn, has the potential to reduce the difference between headquarter prices across districts. Consider just two districts. Assume autarky prices within each district are uniformly distributed over range R. Also assume that the mean price for the first district is higher than the mean price for the second district by the amount DR ($0 \leq D \leq 1$):



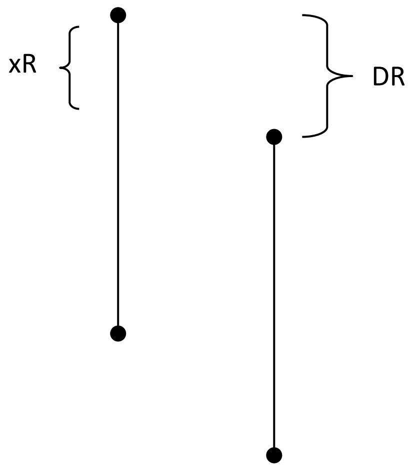
Let $P_{H,1}$ represent the headquarters price in district 1. Without loss of generality, we can write $P_{H,1} = P_{H,1}^{max} - xR$, where $0 \leq x \leq 1$ and $P_{H,1}^{max}$ represents the highest possible price within the range.

Under complete autarky in both districts, expected price dispersion between headquarters equals:

$$E\left| P_{H,1} - P_{H,2} \right| = \int_0^D \left[\frac{R}{2} + (D-x)R\right] dx + \frac{R}{2}\int_D^1 [(x-D)^2 + \{1-(x-D)\}^2]\,dx \qquad (1)$$

The above formula comes from two possible cases for x:

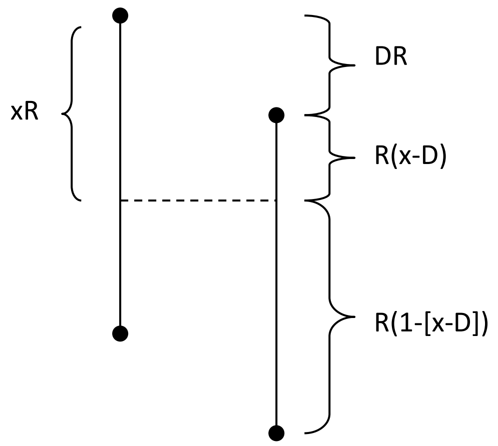
<u>Case 1: x<D</u>



Here: $E\left| P_{H,1} - P_{H,2} \right| = [(D-x)R]/2 + [R+(D-x)R]/2 = R/2 + (D-x)R$.

This is the first term in equation 1. The second term comes from the other possible case:

Case 2: x>D



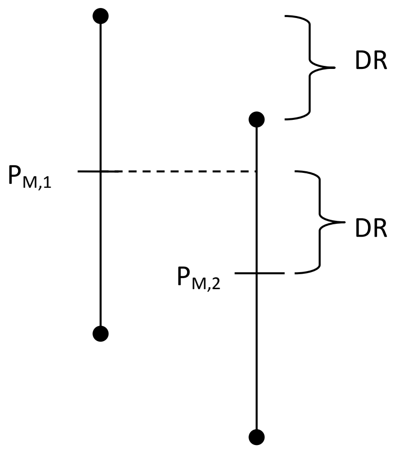
In this case: $E\left|P_{H,1} - P_{H,2}\right| = [R(x\text{-}D)/2] \times [R(x\text{-}D)/R] + \{R(1\text{-}[x\text{-}D])\}/2 \times \{R(1\text{-}[x\text{-}D])\}/R$

$= (R/2)(x\text{-}D)^2 + (R/2)(1\text{-}[x\text{-}D])^2 = (R/2)[(x\text{-}D)^2 + (1\text{-}\{x\text{-}D\})]^2$

Equation 1 simplifies to:

$E\left|P_{H,1} - P_{H,2}\right| = R(1/3 + D^2 - D^3/3)$ "Autarky Result" (2)

Building post offices, on the other hand, leads to mean reversion. So consider the case where the headquarters price in both districts is just the mean for that district:



In that case: $E\left|P_{H,1} - P_{H,2}\right| = DR.$ "Mean Reversion Result" (3)

Comparing the autarky result with our mean reversion result, we have:

DR vs. $R(1/3 + D^2 - D^3/3) \rightarrow D$ vs. $1/3 + D^2 - D^3/3$

And it's easy to show that for D<1: $D < 1/3 + D^2 - D^3/3$

So the expected price difference between headquarters is smaller under mean reversion as long as the two price ranges overlap. Further, the more they overlap, the bigger the decline in price dispersion from mean reversion. In the extreme case where D=0 and the two ranges completely overlap, expected price dispersion under mean reversion is only one-third as large as under autarky. So the difference can be large. It is straightforward to show that when D>1, mean reversion has no effect on expected price dispersion. Finally, the model predicts that there are diminishing returns to adding more post offices: the marginal reduction in the price gap between district headquarters falls as more post offices are built. That derives from the fact that an additional post office is not likely to move the headquarters price much if that price is already constrained by trade with many other post offices in the district. In effect, active trade with many other district post offices gives the headquarters price more weight in comparison to the weight of one more post office. Hence, arbitrage would move the price of the new post office much more than the headquarters price. Since price convergence between district headquarters comes from moving each headquarters price to the district mean, there should be a shrinking marginal effect of higher post office density on price convergence.

References

Administration Report on the Railways in India for Calendar Year 1910. London: His Majesty's Stationery Office, 1911.

Ahmed, Noor H. 1981. *India Post Through the Ages: A Saga of Communications*. Postal History Society of India, 11/63-G, Near Bus Stand, Alur (Kurnool) 518395.

Andrabi, Tahir and Kuehlwein, Michael. 2010. "Railways and Price Convergence in British India". *The Journal of Economic History*, 70: 351-377. Cambridge University Press.

Berry, Thomas. *Western Prices Before 1861.* Cambridge, MA: Harvard University Press, 1943.

Bharat, Sheetal, 2012. "Post Office Allocations in India during the *Raj*: Where and Why?" Chapter in PhD Dissertation, "Where the Runners Went: British Motivations Behind Postal Policy and Allocation in Colonial India", Department of Economics, U.C. Riverside.

Chattopadyay, Basudeb. 2004. *'A Jingle of Bells': A Short History of General Post Office*. Kolkata: K P Bagchi and Co.

Clarke, Geoffrey. 1921. *The Post Office of India and its Story*. London: John Lane.

Connell, Arthur. "Indian Railways and Indian Wheat". *Journal of the Statistical Society of London* 48, no. 2 (1885): 236-76.

Dobado, Rafael and Gustavo Marrero. "Corn Market Integration in Porfirian Mexico". *Journal of Economic History*. 65, no. 1 (2005): 103-28.

Donaldson, Dave. 2010. "Railroads of the Raj: Estimating the Impact of Transportation Infrastructure". *MIT Department of Economics, NBER and CIFAR*, (October).

Gazetteer of the Bombay Presidency Volume XVIII (Facsimile reproduction). 1992. Originally printed in 1885. The Government Photozincographic Press, Pune.

Hamilton, Ivie, G J. 1910. *An Outline of Postal History and Practice, with a History of the Post Office of India*. Calcutta: Thacker, Spink and Co.

House of Commons Parliamentary Papers. 1856.

Hurd, John II. "Railways and the Expansion of Markets in India, 1861-1921". *Explorations in Economic History* 12, no. 3 (1975): 263-88.

Majumdar, Mohinilal. 1995. *Early History and Growth of Postal System in India*. Calcutta: Rddhi-India.

___. 1990. *The Imperial Post Offices of British India, 1837 – 1914*. Calcutta: Phila Publications.

___. 1984. *The Postal History of Zemindari Dawk, 1707-1906*. Calcutta: Rddhi-India.

MacPherson, W.J. "Investment in Indian Railways, 1845-1875". The Economic History Review 8, no. 2 (1955): 177-86.

Metzer, Jacob. "Railroad Development and Market Integration: The Case of Tsarist Russia". *Journal of Economic History*. 34, no. 3 (1974): 529-50.

Mukherjee, Mukul. "Railways and Their Impact on Bengal's Economy, 1870-1920". *Indian Economic Social History Review* 17, no. 2 (1980): 191-209.

O'Rourke, Kevin and Jeffrey Williamson. *Globalization and History: The Evolution of a Nineteenth Century Atlantic Economy*. Cambridge, MA: MIT Press, 1999.

Report from the Commissioners for Post Office Enquiry. 1851. London.

Sams, H A Liert.-Col., (Ed.). 1922. *The Post Office of India in the Great War*. Bombay: The Times Press.

Sen, Ananda Gopal. 1875. *The Post Office of India*. Calcutta: Babooram Sarkar at the Roy Press. Reprinted by Manik Jain, Calcutta, 1996.

Shivanath. 2002. *An Approach to History of Post Offices in India and Other Essays*. New Delhi: Army Postal Service Association.

Slaughter, Matthew. "Does Trade Liberalization Converge Factor Prices? Evidence from the Antebellum Transportation Revolution". *Journal of International Trade and Economic Development* 10, no. 3 (2001): 339-62.

Srivastava, Hari S. 1968. *History of Indian Famines and Development of Famine Policy, 1858-1918*. Agra: Sri Ram Mehra.

Virk, D. S. 1991. *Indian Postal History, 1873-1923: Gleanings from Post Office Records*. New Delhi: Army Postal Service Association.