Trade and Development: Evidence from the Napoleonic Blockade

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PRELIMINARY AND INCOMPLETE

Abstract

This paper uses a natural experiment to assess whether temporary protection from trade with the industrial leader can foster development in infant industries in follower countries. Using a new dataset compiled from primary sources, I show that regions (départements) in the French Empire which became better protected from trade with the British for exogenous reasons during the Napoleonic Wars (1803-15) increased capacity in mechanised cotton spinning to a larger extent than regions which remained more exposed to trade. Temporary protection from trade proved to have long-term effects. First, after the restoration of peace, exports of cotton goods in France grew faster than Britain's exports of the same. Second, emulation of Britain's success was not inevitable. As late as 1850, France and Belgium - both part of the French Empire prior to 1815, had larger cotton spinning industries than other Continental European countries. Third, within France, firms in areas that benefited from more protection during the Napoleonic Wars had significantly higher labour productivity in cotton spinning in 1840 than regions which received a smaller shock.

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"The principal advantage of the English cotton trade arises from our machines both for spinning and printing (...). It is impossible to say how soon foreign countries may obtain these machines, but even then, the experience we have in the use of them would give us such an advantage that I should not fear the competition." Joseph Smith and Robert Peel, 1786 (quoted in Edwards, 1967 p. 51)

1 Introduction

A long-standing debate in economics is centred around the question of how trade effects growth. The idea that infant industries in developing countries may benefit from temporary trade protection has been around since at least the 19th century. More recently, endogenous growth theory has uncovered mechanisms via which trade can both promote and hinder growth (Grossman and Helpman, 1991, Matsuyama 1992, Young, 1991). This implies that empirical work has an important role to play in determining the relative importance of different mechanisms.

Historically, governments have often attempted to foster structural transformation by protecting infant industries from foreign competition. Both Germany and the US industrialised behind highly protective tariff and non-tariff barriers (O'Rourke, 2000). Many governments in developing countries attempted to foster industrialisation in the post-colonial period using similar policy instruments with mixed results (Amsden, 1997 and Krueger, 1997). Despite the growing number of datapoints, the debate is no closer to being resolved. Cross-country growth regressions have been unable to find a robust correlation between long-term growth and openness (Sachs and Warner, 1995, Clemens and Williamson, 2004, O'Rourke, 2000, Irwin, 2002). Identifying the effect of openness to trade on development is notoriously difficult. By its very nature, economic openness is endogenous to the political process which implements trade policy. In recent years however, various creative approaches have been developed to credibly identify the effect of trade on growth in a cross country setting (Frankel and Romer, 1999, Feyrer, 2009, Feyrer, 2009 and Pascali, 2014). Interestingly, "second generation" cross country results also point to differing effects of trade on growth in different samples.

In this paper, I take a different approach in order to better understand the precise mechanisms at work. I present a setting where regional, within country variation in openness to trade is caused not by trade policy, but by exogenous events outside the country's borders. In particular, I examine the development of mechanised cotton spinning, an important infant industry in the 19th century, across départements of the French Empire during the Napoleonic Wars (1803-1815). These Wars led to a unique historical setting: as a result of asymmetries in naval military power, blockade of Britain was implemented not via naval blockade of Britain itself, but rather by "self-blockade" of Continental-Europe. This meant that Continental powers attempted to stop British and eventually "neutral" ships from entering their ports. In contrast to Napoleon's aims however, smuggling between Britain and the Continent was rife. The balance of military power between Britain and France played a key role in determining where new trading routes were set up. In this paper, I use this variation in the size of the plausibly exogenous shock to trade costs across the French Empire to identify the effect of protection from British competition on the development of capacity in mechanised spinning.

To analyse the question of how the disruption to trade affected the development of the cotton industry across the French Empire, I compiled two new datasets from original sources. Using handwritten prefectural reports from departments in the French Empire, I constructed a dataset on mechanised spinning capacity (number of spindles) at the departmental level. Second, using the Lloyd's List, I have been able to reconstruct how shipping routes between Britain and and Continental Europe were affected by the rupture to trade relations.

Cotton was the quintessential infant industry in the First Industrial Revolution. Throughout the nineteenth century, this sector played a key role in the industrialisation of Britain and with some lag, Western European and American emulators. It is hard to overstate the importance of cotton: between 1780-1860, cotton alone accounted for an astonishing 25% of TFP growth in Britain (Crafts, 1985). Though Britain and France had similar initial conditions in cotton spinning until about the 1750s, their paths diverged dramatically with the breakthrough to mechanisation in Britain (Allen, 2009). First mover advantage mattered. In the 10 years between 1785 and 1795, the real price of fine yarn dropped to a tenth of its previous value (Harley, 1998). British exports of cotton goods increased exponentially (Mitchell, 1988) with the primary destination being Europe, and in particular France and Germany (Crouzet, 1987).

Despite widespread access to mechanised spinning technology across France, adoption proceeded extremely slowly. In 1790, Britain had 18,000 spinning jennies to France's 900 (Aspin and Chapman, 1964). By the turn of the century, the technological gap between Britain and France was apparent. French spun cotton yarn was twice as expensive as that spun in Britain. The flow of technology from Britain faced barriers as both the export of machinery and the emmigration of skilled workers was banned. French produced spinning machines were double the price of those in Britain (Crafts, 2011). Consistent with France's productivity lag, in 1802 and 1803 (on the eve of the Napoleonic Wars), imports of cotton goods made up 8% and 12% of France's total imports respectively.[1]

The Napoleonic Wars (1803-1815) in general, and the Napoleonic Blockade in particular (1806-13) caused enormous disruption to trade between Britain and the Continent (O'Rourke, 2006). A traditional blockade would have entailed the French navy surrounding British ports in order to stop goods entering and leaving Britain. Because of the asymmetry in naval power

[1]See Appendix C for details on French trade statistics.

which favoured the British, Napoleon's Blockade was instead implemented by attempting to deny British goods access onto the Continent. Importantly, trade between Britain and the Continent did not stop. Instead, trade was driven from traditionally water-borne routes to more expensive, and more circuitous land-based routes.

There was significant regional variation in the extent to which the Blockade was successful. While the Blockade was generally well-enforced along the coastline of the French Empire, enforcement outside of France varied. This variation was driven by factors related to military strength and idiosyncratic political events. Most importantly, Napoleon was militarily stronger in Northern Europe, while the British controlled shipping in the Mediterranean. An idiosyncratic political event, the Spanish insurgency against Napoleonic rule from 1808 onwards, reinforced Napoleon's inherently weaker position in Southern Europe. For these reasons, the Blockade was more successful along the North Sea and the Baltic than it was along the Iberian Peninsula and in the Mediterranean. Consistent with the varying geographic success of the Blockade, British exports to the Mediterranean actually increased significantly during these years, while exports to North-Western Europe declined dramatically. (Crouzet, 1987).

Variation in the success of the Blockade meant that traditional routes to French départements were interrupted to a different extent. With direct trading routes between Britain and France effectively closed across the French Empire, British cotton yarn destined for French markets had to be smuggled via more circuitous and more expensive routes driving up the price at which competing British yarn entered a given department. Smuggling of British goods in the North generally took one of two difficult routes, while smuggling via Southern Europe was far easier. I show evidence that, consistent with smuggling capacity constraints in the North during the Blockade, down-river transportation (in the South-North direction) along the Rhine increased dramatically.

During the Blockade, spinning capacity in the French Empire quadrupled. However, this number masks significant regional variation. While some areas, notably departments along the English Channel, prospered, others in particular in the South and South-West of the Empire, stagnated or declined. My identification strategy uses the trade shock as a proxy for the shock to British yarn prices across France. Using a difference in difference specification, I find that higher protection from trade with Britain had a large and significant effect on the adoption of mechanised cotton spinning. Moving from the 25th to the 75th percentile of the shock leads to a predicted increase in spinning capacity per capita that is roughly equal in size to the mean spinning capacity per capita at the end of the Blockade, a sizeable effect.

Despite the enormous disruption to trade with Britain across the Continent, producers were able to import the raw cotton needed for production. The reason for this was that while Britain monopolised supply of cotton yarn, they were never able to monopolise supply of raw cotton. I show that firms in France had access to Brazilian, US, colonial and Levantine cotton throughout the Blockade, though raw cotton prices on the Continent were higher than those in London.

My identification strategy relies on standard assumptions for diff-in-diff estimators; no confounding shocks contemporaneous with, and correlated to the distance shock and parallel pre-treatment trends. To show that these assumptions are likely to hold in my setting, I subject my results to a host of robustness checks. I show that the estimated effect of the trade shock is robust to the addition of the time-varying effect of geographic fundamentals such as access to fast-flowing streams and proximity to coal, a measure of human capital, a control for the effect of labour supply shocks, the location of the downstream sector and institutional change. I also demonstrate that the trade shock had no similar effect for two other industries which were not affected by technological change and whose goods were less intensively traded with the British - wool and leather. Finally, I construct a measure of spinning capacity in the period prior to the Napoleonic Wars to show that the cost distance shock caused by the disruption to trade had no significant effect on this measure of spinning capacity prior to the treatment period.

The second set of results examine the longer-term effects of temporary protection from trade. I examine persistence along three dimensions. First, I show that exports of cotton goods from France increased after peace was restored on the Continent in 1815 relative to British exports of the same. This shows that the increase in spinning activity during the Blockade did more than scale up an inefficient industry which was unable to compete at world prices. Second, I show that emulation of Britain's success was difficult and far from inevitable. Using raw cotton import data as a proxy for the size of domestic spinning industry, I show that in 1850, 35 years after the end of the Blockade two countries, Belgium and France (both part of the French Empire) had larger cotton spinning industries than the rest of Continental Europe. Third, using firm-level data from the 1840s, I show that the trade shock had persistent effects on within country outcomes in France in the sense that firms located in departments that received a larger shock had higher productivity than firms in departments which received a smaller shock.

Theoretically, the result that tariff protection can increase the growth rate of the economy depends on the existence of a market imperfection which prevents entrepreneurs from entering new, "high-growth" sectors.[2] Particularly relevant in this historical context is the role that learning-by-doing (LBD) externalities play. In a world where LBD externalities are the engine of growth, a country can remain permanently stuck in low-growth sectors. Potential entrepreneurs do not internalise the effect that increasing production today would have on the industry-wide cost curve. As they are not competitive at free trade prices today, they do not enter the sector, and will remain uncompetitive in the future. Protection, by increasing

[2] Grossman and Helpman (1991) use externalities in R&D, Rodrik (1996) presents a multiple equlibria model with coordination failures, Krugman (1987), Matsuyama(1992), Lucas (1988) and Young(1991) present models of endogenous growth with learning by doing externalities.

the domestic price, makes entry individually profitable. As cumulative production increases, productivity increases via the learning externality, the country moves down its industry wide cost curve, and firms become competitive at world prices.

LBD externalities, tariff protection and growth have been extensively debated in the literature in relation to the cotton industry in the 19th century, particularly for the case of the US.[3] Learning externalities are plausible in this setting for at least two reasons. First, cotton was the first industry to mechanise and adopt factory production on a mass-scale. The organisation of the flow of work, the division and management of labour changed radically. Small, productivity enhancing improvements in production techniques in one place were rapidly adopted by other firms (Mokyr, 2009). Second, the ban on exports of machinery and workers from Britain during this time period limited direct technology flows from the industrial leader. Would-be adopters had to build and repair the machines domestically. Experimentation via production had an important role to play in driving productivity improvements.

The paper is structured as follows. The next section examines the features of mechanisation in cotton spinning in 19th century France that make it an ideal testing ground for infant industry arguments. I then show how the Napoleonic Wars led to exogenous variation in market protection for departments across the French Empire. In the fourth section, I develop a simple theoretical framework to guide the empirical analysis. The fifth section presents the data collected. The empirical strategy and short-term results are presented in the sixth section. Long term results are discussed in the seventh section. The final section concludes.

2 Mechanisation of cotton spinning in Britain and its effect on France

Textile manufacturing has generally played a dominant role during the initial phase of structural transformation. The sector is relatively labour intensive, it does not require a particularly skilled workforce or complex machinery, making it well suited to a labour-abundant, predominantly agricultural economy. Throughout the 19th century, it was cotton textiles in particular which featured prominently not only in Britain's industrialisation process, but also in that of Western-European followers and their offshoots.

Cotton was the quintessential infant industry of the 19th century. A series of inventions in cotton spinning in Britain during the closing decades of the 18th century drove initial

[3]On this debate see Taussig (1931), David (1970), Harley (1992), Irwin and Temin (2001) for the US. Crouzet (1964) discusses the effect that the French Revolutionary and Napoleonic Wars had on infant industries in Continental Europe.

technological advances. These inventions diffused rapidly across England and Scotland, while in contrast, adoption across the Channel was surprisingly slow despite knowledge and availability of the technology. Learning by doing externalities crucial to standard models of infant industry have widely been documented in cotton manufacturing both using historical and econometric evidence.[4] In this section, I discuss the features which make mechanised cotton spinning in early 19th century France a particularly appealing setting in which to study the development of an infant industry.

2.1 Similar initial conditions in 18th century Britain and France

Britain's absolute dominance of the 19th century cotton industry is a widely known fact. It may thus be somewhat surprising that as late as the middle of the 18th century, Britain and France both had a similarly modest sized cotton industry. It has been estimated that about 3 million pounds of cotton yarn a year were spun in both Britain and France, which compares modestly to Bengal's 85 million pounds of yearly output (Allen, 2009). The cotton industry was not only small in relation to world output, but also relative to the size of other textiles in the domestic economy such as wool, linen hemp or silk.[5]

Why was cotton a relatively marginal sector in Continental Europe prior to industrialisation in Britain? Cotton, as opposed to wool, linen, silk and hemp, was not an indigenous European textile.[6] Asian cotton cloth was initially introduced to the European market by merchants in the 17th century to enormous success. Cotton's immense popularity has been attributed to the fact that cotton printers were able to make bright, lively coloured fabric with complex patterns, something which could not be done with indigenous European textiles such as wool, linen or silk (Chapman and Chassagne, 1981). The boom in the consumption of cotton cloth led to a fierce backlash from traditional textile industries in both countries. To a certain extent, these vested interests were initially successful, as both countries prohibited imports of Asian cloth for domestic consumption. Furthermore, both countries banned the wearing of clothing made from cotton.[7]

However, two important loopholes to the general ban on cottons served as early catalysts in the various stages of production. First, domestic cotton manufacturing was tolerated. O'Brien et al (1991) argue that the ban on imported Asian cloth was instrumental in the

[4] On the econometric evidence, see David (1970), on historical evidence see Mokyr(2009)

[5] For example, Chabert (1949) estimates the size of the industries in 1788 and 1812 in France for textiles as follows (in millions of francs). 1788: Linen and hemp: 235, Wool: 225, Silk: 130.8, Cotton: no number given. 1812: Linen and hemp: 242.8, Wool: 315.1, Silk: 107.5, Cotton: 191.6.

[6] Strictly speaking, silk is not indigenous to Europe either, however silk production had been practised throughout Europe for centuries.

[7] O'Brien et al (1991) discuss the political economy of the cotton industry in both countries in the decades leading up to the beginning of the mechanisation process.

foundation of domestic industry as it would have been difficult for European producers to compete with Asian cloth either in price or in quality. As cotton cloth produced domestically could not be sold in home markets, it was initially used to barter for African slaves (Allen, 2009).

Second, most important European port cities imported plain cotton cloth for printing from Asia, as European spinners and weavers could not initially match the quality of Asian cloth.[8] Chapman and Chassagne (1981) document direct linkages between involvement in cotton printing and the formation of backward linkages to cotton spinning in both countries. Throughout the 18th century, both countries gradually relaxed the constraints on domestic production and consumption.

2.2 Mechanisation in Britain

Based on these observations, up to the mid-eighteenth century, there was little distinction between Britain and France's cotton industry. In both countries, the size of the industry was marginal, and it was a sector not viewed particularly favourably by the state. From these modest beginnings, it is hard to overstate the extent to which the mechanisation of spinning (and later other stages of production) revolutionised the cotton industry in Britain. According to Crafts' (1985) calculations, cotton alone accounted for an astonishing 25% of TFP growth in British industry between 1780 - 1860, for 22% of British industrial value added and 50% of British merchandise exports in 1831.

To understand why the mechanisation of one stage of production - cotton spinning, had such a large effect on the industry, it is useful to examine the production process involved in converting raw cotton into a piece of cloth. First, raw cotton was an imported good for both France and Britain, which were supplied by their respective colonies and the Levant.[9] Upon arrival to Europe, the fibre was prepared - it was cleaned, carded and combed into rovings. The second step involved spinning the rovings into yarn. Spinning was usually performed by women in their own homes, generally as an additional source of income during agricultural down-time. The third step entailed weaving the yarn into cloth. This stage of the production process was also organised as domestic manufacture. The type of cloth woven depended on the fineness of the the yarn (measured as its count) and whether it was mixed with other fibres. Finally, the cloth was coloured and may have also been printed with designs. Printing, because of its greater capital intensity, was usually organised in small workshops. As can

[8] This was true for handspinning, the only technology available at the time. The same was initially true for machine spun yarn, but as a result of continuous improvements in productivity, British machine-spun yarn outcompeted the finest Indian yarn by the end of the Napoleonic Wars (Broadberry and Gupta, 2006)

[9] French colonial supplies of raw cotton were abundant and of a high quality. In fact, Edwards (1967) discusses the fact that as late as the 1780s, British spinners felt that their French counterparts had an advantage in accessing good quality raw material.

be seen, with the exception of printing, cotton manufacturing prior to mechanisation was rurally organised, generally as a putting-out system. As a result, production was dispersed throughout the countryside.

A series of inventions mechanised the spinning of cotton yarn in Britain in the second half of the 19th century. Traditionally, spinners had spun one thread at a time using a simple wheel. Mechanisation increased output per worker as machines were able to spin multiple rovings simultaneously. The relevant measure of production capacity in cotton spinning became the spindle which is the piece of equipment onto which the roving is twisted. A picture of the original spinning jenny invented by James Hargreaves in 1767 with sixteen spindles can be seen in Figure 1. This machine was relatively simple, small and cheap.[10]

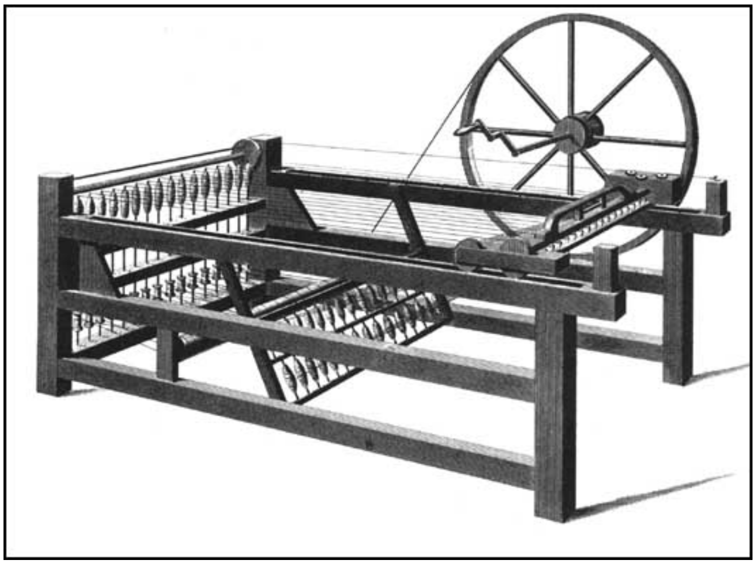


Figure 1: An engraving of a spinning jenny by T. E. Nicholson (1835)

The water-frame and mule-jenny (the second and third generation machines) which arrived in quick succession after the spinning jenny were larger, more complex and more expensive machines. They were better suited to spinning finer (higher count) yarns, and from an early date they were powered by water (Edwards, 1967). The literature on technology diffusion has documented a number of cases where the diffusion of technology has been surprisingly slow.[11] In contrast, mechanisation of spinning in Britain was remarkably fast (Allen, 2009). As we will see below, relatively fast dispersion in Britain adds to the puzzle of why adoption across the Channel proceeded so slowly.

Mechanisation had enormous effects on the cotton industry for a number of reasons. First, the machines disrupted the domestic structure of the industry. The size of the machines, their complexity and their reliance on inanimate power rendered production in the worker's homes

[10]Allen (2009) puts the cost of a jenny at 70 shillings (a spinner would earn a weekly wage of 8-10 shillings.
[11]See Geroski (2000) or Rosenberg (1981).

obsolete and manufacturing was soon organised in large factories. Allen (2009) emphasises that part of the reason that cotton spinning proved to be so revolutionary was that for the first time, production was organised not rurally, in the workers' home, but in large structures that required careful organisation of workflow and management of workers. Historical evidence points to the fact that experimentation via trial and error, small productivity improvements made by anonymous workers and entrepreneurs, and experience acquired on the job were important sources of productivity improvements (Mokyr, 2009).

For example, Chapman (1970) finds that most cotton mills in England had a remarkably similar structure. Chapman quotes a contemporary, Sir William Fairbairn, on the reason for this striking similarity; "The machinery of the mills was driven by four water-wheels erected by Mr Lowe of Nottingham. His work, heavy and clumsy as it was, had in a certain way answered the purpose, and as cotton mills were then in their infancy, he was the only person, *qualified from experience*, to undertake the construction of the gearing." (W. Pole (ed), 1877, quoted in Chapman (1970), my emphasis). Edwards (1967) notes that when the mule-jenny (the third generation spinning machine) "left Crompton's [the inventor's] hands it was a crude device, it had to be improved, and the spinners and weavers of muslins had to acquire their skills." (Edwards, 1967, p. 4) As workers were mobile between firms, and machines and factories were initially built by a handful of men as we have seen, small improvements in one firm could and did spill over to others.

Second, mechanisation had enormous consequences for the productivity of spinning. The improvements in spinning technology are reflected in the price of yarn which declined significantly during the period as is shown in Figure 2. The trend is most dramatic for finer yarns, the real price of which dropped tenfold in as many years but there was also a decline in lower count (less fine) yarns. The improvement in technology in spinning had disruptive effects on other parts of the production process. As mechanisation in weaving did not occur until well into the 19th century, an imbalance in spinning output and weaving capacity soon made British cotton yarn uniquely reliant on exports markets, of which Europe was by far the most important.

Crouzet (1987) estimates that around 56-76% of Britain's cotton output was exported either in the form of cloth or yarn.[12] The largest market for cotton yarn was in Europe. 44% of cotton cloth and a full 86% percent of cotton yarn exports were destined for the European market. In comparison, only 27% of woollens and 8% of silks were destined for Europe. Crouzet notes that prior to the Blockade, only France, Germany, Switzerland and Russia consumed cotton yarn. This reliance on the export market for cottons in general, and the European market for cotton yarn in particular explains why maintaining trade with Europe in cottons was so crucially important during the Blockade, despite the risks and enormous increase in transport costs involved.

[12] As a comparison, 50% of woollens and under a third of silk was exported.

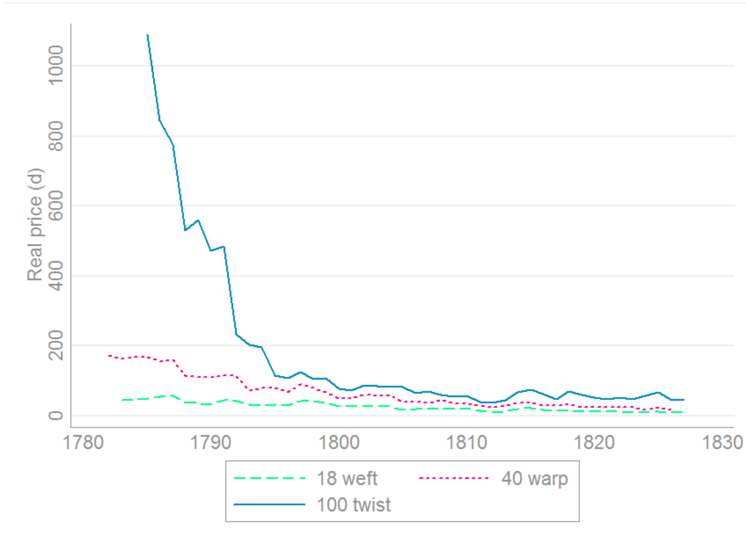


Figure 2: Real price of yarn in Britain, Harley (1998)

[1] Notes: Real price of cotton yarn in Britain. Mechanisation decreased price of finer (higher count) yarns disproportinately. For data sources see Harley (1998).

2.3 Diffusion of technology to France

Mechanisation of cotton spinning in France proceeded extremely slowly relative to events across the Channel. By the turn of the 19th century France's productivity gap vis-a-vis Britain in cotton spinning was apparent. For many years, the conventional wisdom in the literature was that slow adoption was a result of French "retardation" and technological backwardness. The incompetence and economic mismanagement of France in the late 18th century has received much attention, as has Arthur Young's often repeated travel anecdotes of desperately poor, hungry and illiterate peasants across France. In recent decades however, careful comparative analysis of the historical evidence and systematic evaluation of the scarce statistics available in Britain and France has given rise to a different interpretation of events. According to this literature, differences in Britain and France were far smaller than previously thought, and both the state and cotton entrepreneurs played an active and helpful role in fostering economic development in France.[13]

This more recent literature emphasises both indigenous innovation activity in textiles in France simultaneous to those taking place in Britain, and a widespread effort to acquire

[13] Landes' (1969) "Unbound Prometheus" is credited with being the most prominent exponent of French backwardness, while O'Brien - Keyder (1978) were among the first to question the validity of this view. More recently, Horn (2006) and Squicciarini - Voigtländer (2014) show evidence of state and entrepreneurial efforts to modernise the French economy in ways similar to that observed in Britain.

British technology and best practice, once Britain's lead had been established. For example, McCloy (1952) notes that there were numerous inventions in textiles in France throughout the 1700s, but predominantly in the last decades of the century. In particular, "in the carding of cotton and wool a dozen inventions, real or alleged, were made in the 1780's and 1790's", while in spinning, "the French anticipated the spinning jenny of James Hargreaves (1765) with two machines." (pp. 90 - 91.). With respect to the role of the government, Horn (2006) emphasises the importance that frequent industrial exhibitions had in fostering innovation activity and disseminating technological knowledge. For example, in 1800, the government invited submission for spinning machines and rewarded the best ones.

Both entrepreneurs and the French government were well aware of the momentous changes taking place across the Channel in the closing decades of the 18th century, and the need for French entrepreneurs to follow suit if they were to remain competitive in cottons. Importantly for my argument, the British prohibited both the export of spinning machinery and the emmigration of engineers and skilled workers. This put an artificial barrier on the diffusion of technology across the Channel. It meant that while the French were able to acquire blueprints of the machines, and with the help of some English and Irish engineers, British best practice, they didn't have wide scale access to the tacit type of knowledge that is acquired via learning by doing and that would be embedded in the export of machines or workers.

Contrary to traditional accounts of government incompetence, Horn (2006) writes that "the effort pivoted on acquiring English machines and spreading access to them as widely as possible. As is well known, the French state concentrated on acquiring Arkwright's water frame and the mule-jenny, both of which were crucial to England's competitive edge. Industrial spies (...) were commissioned to acquire these technologies. (...) British machine builders were rewarded for coming to France and given subsidies for each set of machines they sold. The Bourbon government paid the wages of at least 100 foreign workers in machine building and provided large subsidies to innovative French entrepreneurs who financed the construction of advanced textile machinery. Before the adjudication of Arkwright's second patent in 1785, no less than three mechanics were building roller-spinning machines in France. Doggedly, if haphazardly, government action enabled hundreds of English style (if not always functionally equivalent) carding and spinning machines to be put into operation in nearly every major industrial district in France between 1786-1789." (p. 78)

However, it was not just the state which fostered technology diffusion. Chassagne (1991) and Horn (2006) both emphasise that entrepreneurs in French cotton spinning played an even more important role technology transfer than the aforementioned efforts on the part of the government. In Toulouse, Francois Bernard Boyer-Fonfrede recruited 12 engineers from Britain to build a six storey, water powered spinning mill which employed over five-hundred workers. After construction of the mill was complete, three were hired by a firm in Aix, and another by a firm in Gironde (Chassagne, 1991, p. 244). In Amiens, another entrepreneur, Jean-Baptiste Morgan, was similarly active in fostering technology transfer. According to Horn, Morgan sent agents to recruit English workers. "Arriving in yearly batches from 1788 to 1790, they provided Morgan with a detailed and precise knowledge of English techniques, and with the mechanical expertise to construct the needed machines and instruct workers in their use." (Horn, 2006, p. 83). Across France, entrepreneurs were engaged in similar forms of technology transfer.

The French Revolution and the subsequent Revolutionary Wars (1793-1802) did not put a stop to, but rather changed the nature of technology transfer. The French government offered English prisoners of war skilled in textile manufacturing the opportunity to work in France, which many took up (Chassagne, 1991). Horn (2006) notes that English machinery continued to be acquired by such important Continental innovators as Francois Bernard Boyer-Fonfrede (Toulouse) and Lieven Bauwens (Belgium).

What is striking about these accounts is the extent to which technology transfer seems to have been reliant on British know-how. What is evident from the accounts is that above and beyond the technological expertise required to build the mills and machinery, French workers were also reliant on British training in acquiring best-practice techniques in mechanised spinning and in training weavers to adapt to using the new type of yarn. As we have seen above, this was not something unique to French labour. Initially, British workers also experimented with and refined spinning techniques in a similar way. The difference between the two countries however, was that when French workers were experimenting and learning to spin with the new technology, they were already facing a more experienced competitor across the Channel.

2.4 Puzzlingly slow adoption across France

The preceding discussion may give the impression that technology adoption was rapidly advancing in France. According to all accounts, this was not the case. Despite both state and entrepreneurial attempts to foster mechanisation of cotton spinning, France lagged far behind Britain.[14] In 1790, the number of spinning jennies was estimated to be 900 in France while the number in Britain was 18,000 (Aspin and Chapman, 1964). Similarly, Wadsworth and Mann (1931) found that while in Britain, 150 firms were using the water-frame, the number in France was four, and the mills were all significantly smaller.

The literature has put forward a number of explanations for slow adoption across Continental-Europe and in particular France, which is widely seen as Britain's closest competitor at the time. French institutional backwardness has traditionally played a prominent role in explaining Britain's primacy in terms of the timing of industrialisation. For example Landes

[14]This was equally true for all of Continental Europe.

(1979) views guild restrictions as particularly harmful for entrepreneurial activity. This view is consistent with a recent literature which explains Britain's primacy in terms of its superior institutions (North and Weingast, (1989), Acemoglu and Robinson (2012)). Another strand of the literature has emphasised the role of differing factor prices between Britain and France. According to this view, Britain invented (capital intensive) mechanised spinning because labour was relatively expensive in Britain, while French entrepreneurs did not have an incentive to switch from (labour intensive) handspinning because labour was relatively cheap (Allen, 2009).

In contrast to these explanations, mechanised spinners active in France unambiguously laid the finger of blame on British competition. Spinners from across the Empire petitioned Napoleon to ban imports of all cotton cloth, and particularly that of British yarn.[15] According to their pleas, the onslaught of competition from English yarn made their products uncompetitive and drove them out of the market. The petitions from spinners feature elaborate statistics and back of the envelope calculations proving that there is sufficient production capacity in place in the Empire to satisfy the demand from downstream weaving once imports are banned.Unsurprisingly, weavers opposed to these measures submitted their own calculations which showed the opposite.

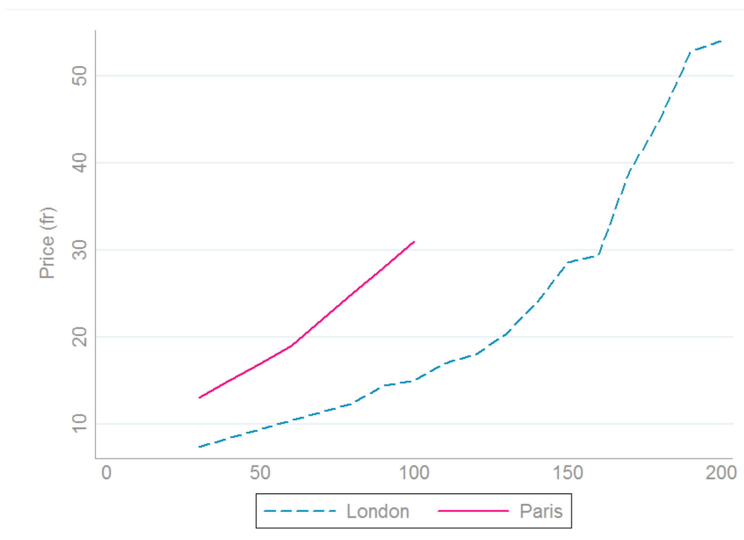


Figure 3: Price of different count cotton yarn in Paris and London, 1806-07

[1] Notes: Price of machine-spun cotton yarn in Britain and France in francs by count. Finer yarn has higher count. See Appendix C for details on sources.

Comparing price data for machine spun yarn in Britain and France confirms the competitive

[15]AN/AFIV/1316 contains a petition from large spinners across the Empire requesting a ban to English yarn imports, while AN/F12/533 contains a petition from the Chamber of Commerce in Rhone (prefecture Lyon) requesting the same.

disadvantage of French spinners. Figure 3 compares Paris and London prices for the full range of counts on the eve of the Blockade.[16][17] The y-axis shows the price in francs, while the x-axis shows the count (finer yarns have higher counts). The solid line shows the Paris price for different counts of French machine-spun yarn, while the dashed line shows the London price for British spun yarn of exactly the same count.

Two points are worth noting from Figure 3. First, not only are French spinners outcompeted in every count but the gap becomes larger for higher counts. Consistent with the evidence in Figure 2, showing that mechanisation benefited higher count yarns more, British advantage over the French was also higher in these counts. More sophisticated, harder to imitate machinery such as Crompton's mule was needed to spin these finer type yarns. Second, French prices are not available for counts above 100, as at this time, the French were not able to spin yarns of this finesse (Chassagne and Chapman, 1981). This is further suggestive evidence of productivity gains acquired through learning-by-doing. Machine spinning finer yarns was more difficult as with a finer thread, breakages were more likely. Better quality (more even) machines and more skilled workers necessary.

Consistent with comparative disadvantage in cottons, France was a net importer of cotton goods at the beginning of the 19th century. In 1802-03, trade was relatively free as peace had been momentarily restored to the Continent. In these years, imports of cotton goods to France made up an astonishing 8% and 12% of total imports.[18] By way of comparison, the respective numbers for linen and hemp together were .7% and .6% respectively and woollen textiles were not listed. The major source countries for the cotton goods are listed as German states, Holland and Switzerland, the US and Denmark. Though some of these states produced small quantities of cloth (Switzerland in particular), most of this is likely to be British in origin.[19]

The historical evidence paints a picture consistent with Britain acquiring a competitive advantage because of first-mover advantage in a sector which features strong learning externalities. As the empirical analysis focuses on within country variation, institutional and factor-price based explanations have to rely on time-varying, within country differences, which are arguably smaller than cross country differences because of the unified polity, lower barriers to labour mobility and capital flows. Nonetheless, I return to the role alternative explanations may play in the empirical analysis and show that my results are robust to controlling for the time varying effect of institutional change and factor price shocks.

[16]The London price refers to the year 1807, while the Paris price refers to January 1806. Raw cotton prices are 6.9 and 5.4 in Britain and France respectively

[17]The data appendix discusses the source of this data

[18]Data sources for French trade statistics are discussed in the appendix

[19]The cotton cloth could also be imported from India. However, because Britain control almost all colonial shipping during the French Revolutionary and Napoleonic Wars, any Indian cloth would have to come via Britain. As Broadberry and Gupta (2006) show, Indian cloth was not competitive with British cloth on European markets by this time, making India an unlikely supplier.

2.5 The cotton industry in the French Empire

The preceding section showed that mechanisation in France proceeded surprisingly slowly. At the turn of the 19th century, France was producing machine spun yarn at a significantly higher price than producers across the Channel. The next section will show that the Napoleonic Wars (1803-1815) disrupted trade between Britain and the Continent to an enormous extent. The plausibly exogenous shock to regions across the French Empire differentially effected the competitive pressure that spinners of cotton yarn faced from Britain. While the disruption to trade coincided with a remarkable increase in mechanised spinning capacity across the French Empire, the regional distribution of gains was disproportionately concentrated in the more northern parts of the Empire, while mechanisation stagnated in the south-east and disappeared from the south-west. This section examines the market structure and development of three parts of the production process. I begin by examining the spatial distribution and market structure for cotton yarn production in 1803, on the eve of the Napoleonic Wars, and then turn to examining the upstream and downstream sectors, raw cotton and weaving respectively.

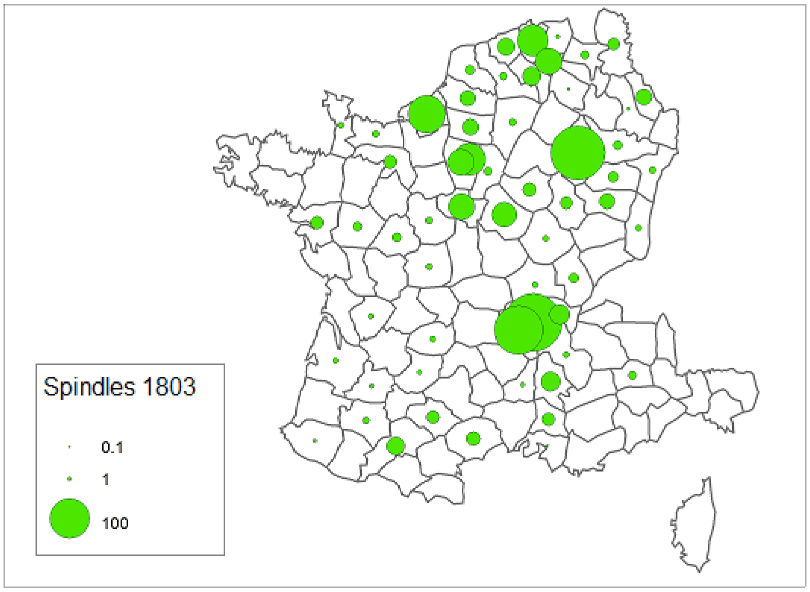
2.5.1 The cotton industry in 1803

At the turn of the 19th century, cotton yarn could be produced using two technologies which produced imperfect substitutes; traditional and mechanised spinning. Figure 4 shows the spatial distribution of mechanised spinning capacity across departments of the French Empire in 1803, the year the Napoleonic Wars started and 1812, the year before the Continental Blockade finally unravelled.[20]. The circles are proportionate to the number of mechanised spindles per capita at the departmental level. I divide everywhere by departmental population in 1811 to account for the fact that some departments are larger than others and may simply have more spinning capacity for this reason. However, the spatial distribution of activity is similar if looked at in levels. In 1803, many departments had some spinning capacity, but total capacity lagged far behind Britain.[21] Moreover, the firms in France were typically very small; the median firm had 490 spindles which was not more than a couple of jennies.

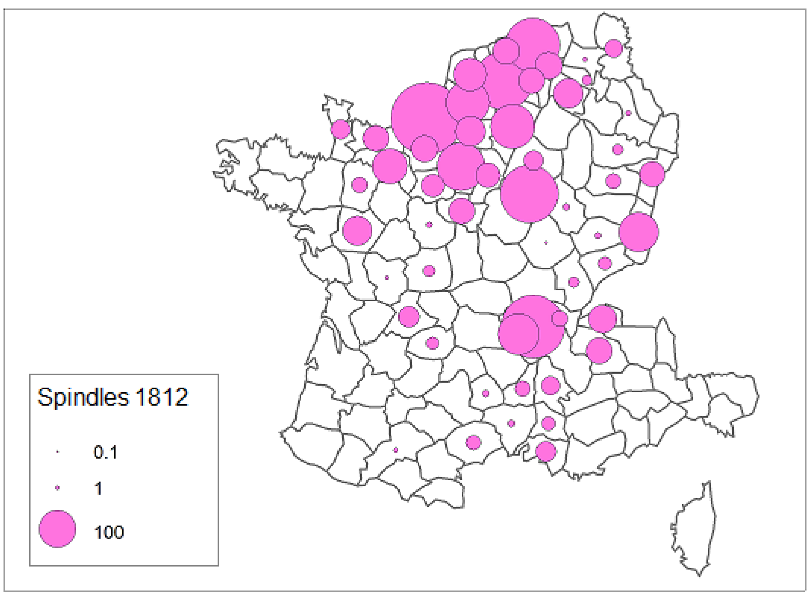
From the point of view of the empirical strategy, it is reassuring to see that mechanisation was widely spread throughout the Empire in 1803. It seems that the location of mechanised spinning in 1803 closely followed the historical location of cotton manufacturing centres. Figure 15 in Appendix B shows the size of the cotton industry around 1789 at the departmental

[20]The data used has been collected from handwritten, primary sources and will be discussed in more detail in section 5

[21]No comparable data is available for Britain. Chapman estimates that there are 1.25 million water spindles in Britain in 1795, numbers for older type machines are not available. In 1803, the French Empire had about 300,000 spindles in total and most were simple, manually operated jennies.



(a) Number of spindles per capita by department, 1803



(b) Number of spindles per capita by department, 1812

Figure 4: Number of spindles by department

Each circle gives the number of spindles per thousand inhabitants by department at the beginning (1803) and towards the end of the Napoleonic Wars (1812). Data sources are discussed in Appendix C.

level based on data collected by Daudin (2010).[22][23] This is consistent with mechanisation technology having diffused to all important cotton districts throughout France, as was argued in the previous section. To the extent that experience in cottons was an important driver of mechanisation in spinning, particularly surprising is the extent to which spinning capacity along the Channel is relatively small, moreover the extent to which capacity in the Loire and Rhone around Lyon is very large.

Turning to handspinning, it is difficult to quantify the importance of the traditional technology relative to mechanisation at the start of the 19th century as no systematic record of handspinning is available. However, reports from prefects across the country indicate a highly active sector. Interestingly, the Journal du Commerce, an important commercial newspaper at the time, reported prices for handspun yarn across the French Empire while prices for machine spun yarn appeared in some locations *in conjunction with* handspun prices only starting around 1809. This indicates that handspun and machine spun yarn were not perfect substitutes. Furthermore, it also suggestive of the fact that markets for handspun yarn were initially thicker than that of machine spun yarn. This implies that there was significant room in local markets for mechanisation to replace handspinning as of 1803.

The market for yarn appears to have been predominantly local during the early stages of development. The reasons for this are primarily due to the generally small firm size in mechanised spinning and the rural, dispersed structure of downstream weaving, both of which made establishing links farther away relatively expensive for most spinning firms at this stage of development. Furthermore, the coexistence of handspinning and mechanised spinning meant that increasing supply of mechanised yarn did not have to simultaneously lead to an increase in weaving capacity even abstracting from changing intensity of British competition. With the exception of some large spinners, most firms sold their output at the local marketplace or had a stable network of rural weavers to whom they gave the yarn. A report from Seine Inferieure (prefecture Rouen) confimrs that it was only the small spinners who brought their goods to the market, while larger firms sold the yarn themselves. Consistent with a predominantly local market, a report from Dyle (prefecture Brussels) states that price differences in yarn across departments even relatively close to each other were not exploited.

Though some firms did integrate spinning and weaving, most large firms found it profitable

[22] The two figures differ to the extent that data from 1789 is available only for areas of France according to its 1789 borders. Important spinning departments in Belgium in the north are thus missing, as are German and Italian regions which are to be annexed to France during the two decades after 1789.

[23] The comparison is slightly misleading to the extent that data for 1789 is a highly imperfect measure of activity in all segments of cotton manufacturing. The data are from the Tableaux Maximum which contain binary indicator variables for whether a given district in France is supplied with a given good from another district. Cotton activity is then measured as the number of districts supplied by a given district. I then aggregate up to the departmental level and normalise by departmental population. See Daudin (2010) for further details on the data.

to maintain the rural, putting out structure of weaving, and this was to remain as such until well into the 19th century. For example, one of the largest cotton cloth printers in the French Empire, Christoff Philipp Oberkampf established a large cotton spinning enterprise to supply his printing enterprise during the Blockade. Even with both the upstream and downstream of weaving integrated in one firm, Oberkampf decided not to integrate weaving. " (...) it proved much easier to subcontract to rural workshop masters, consigning to them boxes of mounted yarns and of barrelled wefts every month. The masters were required to maintain exact accounts of the warps and wefts received and were held responsible for all the pieces they produced that were considered too lightly or badly woven. The supply of completed goods was ensured by the mortgage of the masters' property to Oberkampf." (Chapman and Chassagne, 1991 p. 168).

Evidence on the market structure in the early days of mechanisation is in line with evidence from Britain, which only began to export cotton yarn in 1794, a good two decades after the spinning jenny was invented. Edwards (1967) notes that small spinners with limited capital often sold their yarn to larger spinning mills, which saved them the cost of employing salesmen. Furthermore, receiving an advance in cash, rovings or cotton ensured the continuation of production. He also documents direct links between spinners and weavers. Employing middle-men such as yarn dealers who dealt directly with weavers was expensive and, particularly for the more liquidity constrained spinners, often infeasible as spinners had to wait 3 to 6 months before payment was made.

This is not to say that all demand was local. Both Oberkampf and Lenoir, two large spinners had weavers working for them in numerous departments. Furthermore, even during the Blockade, as the industry developed, larger firms began to look farther away for profitable export opportunities. As early as 1808, spinners from northern departments and the Haut-Rhin began to lobby the government to lift the ban on exports of cotton yarn. In the south, the Chamber of Commerce in Rhone (prefecture Lyon) worried that export markets in Russia and Germany would be disrupted by the Blockade. For most firms however, the local market seems in to have been the main outlet for production.

The market for raw cotton was far more integrated by all accounts. In Britain, dealers of raw cotton were initially not fully specialised, but rather they dealt in many different colonial goods. As opposed to most spinners, they had substantial capital (Edwards, 1967). Consistent with a more integrated market, the Journal du Commerce regularly reported prices for different types of raw cotton from markets across the French Empire together with the price for other colonial products, while yarn was reported only sporadically and in in far fewer locations. Different varieties of cotton (Brazilian, Levantine, US and colonial) were generally available in all markets. However, small and large firms all differed in the means via which they accessed raw cotton input. A report from Seine Inferieure describes how it was predominantly small firms which were effected by the day to day movements in prices, which were to become increasingly important in the uncertain years of the Blockade, as bigger firms secured larger consignments of cotton directly from cotton dealers. For example, Chapman and Chassagne (1991) discuss Oberkampf's efforts in securing Pernambouco (Brazilian) cotton from Lisbon merchants by way of Nantes during the Blockade.

Finally, given that local markets in cotton yarn were important, the location of weaving is an important element of the analysis. As has been discussed, weaving was to remain rural throughout our period of interest. Weavers worked mostly in their own homes or in small workshops across the country, and mechanisation did not take place until well into the 19th century. Figure 16 in Appendix B shows the geographic dispersion of weaving in 1803, where capacity is measured as the number of weaving frames per capita by department. As was the case with mechanisation, weaving closely followed the location of cotton activity in 1789, with important centres being virtually identical. The English Channel, particularly around Rouen, Troyes, south of Paris, the Rhone and Loire around Lyon, and Herault in the South were the important weaving centres. Given the widespread dispersion of weaving activity, it seems unlikely that increasing capacity in mechanisation during the Blockade can be driven by differential demand, however I explicitly address this concern in the empirical analysis.

2.5.2 Development of the cotton industry during the Napoleonic Wars

Between 1803 and 1812 spinning capacity in the French Empire increased by about 370%, from 380,000 to around 1.4 million spindles.[24] As a comparison, it has been estimated that Britain had around 6.8 million water and mule spindles in 1811 (Chapman, 1970). This should be taken as a lower bound estimate on total number of spindles as it does not include older type machines such as spinning-jennies.

It is worth bearing in mind, that the large increase in spinning came at a time when the economic environment was highly uncertain and a number of factors specific to the cotton industry made any form of development surprising. At the turn of the 19th century, France had already been at war for the best part of a decade and was continuously at war during the period of interest. The country had recently emerged from severe hyperinflation and general economic uncertainty was and continued to be pervasive. With respect to the cotton industry, in 1810 prohibitively high import tariffs were placed on raw cotton, the price of which was already much higher than in Britain. Finally, cotton did not enjoy particularly favourable government support. The army used exclusively woollen textiles (Grab, 2003) and Napoleon remained highly ambivalent of developments in the cotton industry because of its reliance on imported inputs.

It is particularly interesting to note that cotton was the only textile to flourish in the French Empire during the Napoleonic Wars,despite it being the only textile singularly reliant on

[24]This figure is calculated using the 88 departments for which data is available in both 1803 and 1812.

an imported input traded via sea-routes. For silks, woollens, linen and hemp there was ample domestic supply of raw material and neighbouring countries also produced significant quantities. This was not the case for cotton wool, and it also explains why Napoleon was never fully supportive of the increase in the spinning capacity in cotton spinning. Heckscher (1922, p. 272) notes “ (...) there was no point where the two opposing tendencies of the Continental System were so much in conflict with one another as here; and the reason was, of course, that the industry was based on a raw material which was for the most part unobtainable by other means than by the forbidden route across the seas.” On the one hand, increasing domestic production in cotton meant a weakening of Britain’s economic advantage, however, the fact that the industry was reliant on an imported input meant that the industry would always remain reliant on sea-borne trade, strengthening Britain’s economic position.

This point should be taken into consideration when thinking both about the importance of state support for the cotton industry. Heckscher recounts that Napoleon was constantly trying to find substitutes for cotton. As early as 1809, he declared that “it would be better to use only wool, flax and silk, the products of our own soil, and to proscribe cotton forever on the Continent” (Heckscher, 1992 p. 277). In 1810, he offered a prize of one million francs for the invention of a flax-spinning machine. Even later, in 1811, when the cotton industry faced a sever crisis as a result of the high tariffs put in place in 1810, he banished all cotton goods from the imperial palaces.

A look at Figure 4 reveals the differential impact of the Napoleonic Wars on mechanisation of cotton spinning across the French Empire. Particularly striking is the increase in spinning capacity along the English Channel. By 1812, the two largest spinning departments in the French Empire were Seine-Inferieure (prefecture Rouen) and Nord (prefecture Lille), both along the English Channel. The enormous increase in spinning capacity in the Nord from an almost irrelevant 2,700 spindles (contrast to Rhone with more than 70,000 in 1803) to over 200,000 spindles is particularly impressive.

In general, the more Southern regions of the Empire stagnated during this time period. The Rhone and Loire, two of the departments with the largest spinning capacity in this region prior to 1803 showed varied performance. Spinning capacity in the Loire decreased significantly (from 47,000 to 37,000 spindles), while the capacity in the Rhone increased (from 72,000 to 96,000 spindles). However it is difficult to know what to make of these latter numbers as spinners in the Rhone moved out from Lyon back into the surrounding countryside (which is where rural spinning was traditionally located), which is the opposite of what we see in Seine Inferieure and Nord where firms tended to concentrate increasingly in Rouen and Lille. The South-West of the Empire along the border with Spain saw outright decline in all departments. Modern firms in these areas went bankrupt and firms reverted back to hand-spinning.

The prefectural reports from various departments paint a picture consistent with the numbers. Southern departments unanimously complain about a collapse in demand. The prefect of Tarn (prefecture Albi) in the south-west described how the spinning machines that were used in the department had not been in use for years and the demand for all forms of cloth had collapsed. The prefect of Rhone (prefecture Lyon) was even clearer in blaming foreign yarn for the collapse in demand. Prefects also pointed to the high price of raw cotton as hurting their competitiveness.

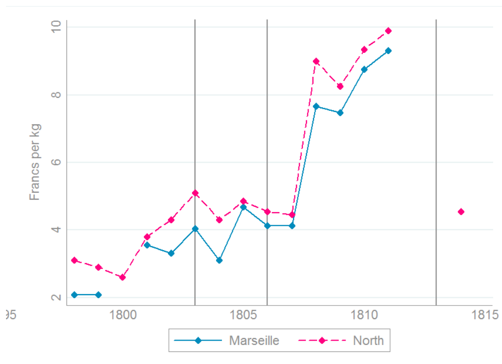
The situation in the more Northern departments could not have been more different. A report from the Nord (prefecture Lille) stated that there was not much change in activity in linens, woollens and hemp. The situation, he stated, was completely different with respect to cottons. In this branch, *despite* the high price of raw cotton, activity had picked up considerably, particularly during 1809 and 1810. Consistent with learning gains, the prefect also described how there had been significant progress made since 1806 in the fineness of the yarn that they were able to spin, claiming that they were now able to spin yarn as fine as 200 counts.

As the prefectural reports show, the high price of raw cotton was felt across the Empire. Interestingly, more northern departments seem to have prospered in spite of the high price of raw cotton, while southern departments complained that the high price of raw cotton contributed to the decline in mechanised spinning activity. Faced with this evidence, one may wonder whether regions may have been differentially affected by the shock to raw cotton prices. Furthermore, one may also wonder how, given the enormous disruption to trade on sea-borne routes, trade in raw cotton was sustained at all. I now turn to examining these questions.

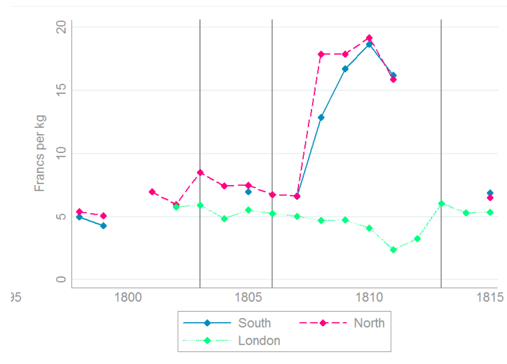
2.5.3 Continued Access to Raw Cotton

Cotton from four different sources was used throughout the Empire during this time period: Levantine, Colonial, US and Brazilian (by way of Portugal). In addition, as supplies from these sources became increasingly scarce and expensive, small quantities of Neapolitan and Spanish cotton were also imported, but their importance should not be overstated. Figure **??** shows prices for these different varieties of cotton in the North and South of the French Empire for our period of interest. For one type of cotton, Pernambouco (Brazilian origin) it is also possible to compare the price at which this variety is sold in Britain.

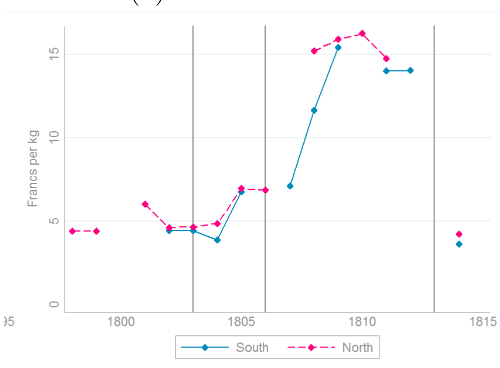
Two points should be evident from examining the time series evidence. First, the Napoleonic Wars and, in particular, the Blockade drove up the price at which regions in the French Empire were able to access cotton. The increase in prices was large; for all varieties prices increased three or fourfold relative to peace years. Comparing the price of Pernambouco cotton in France and Britain also reveals that the prices in the latter remained stable throughout



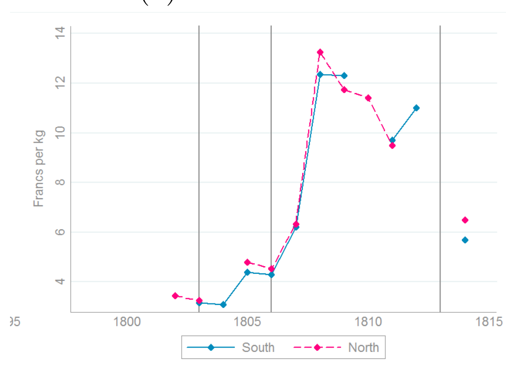
(a) Levantine cotton



(b) Brazilian cotton



(c) Colonial cotton



(d) US cotton

Figure 5: Price of raw cotton in northern and southern regions of the French Empire

Prices are from “Journal du Commerce”. Prices are given in francs per kilogramme for a given day in a given city for a given variety. Within each category of cotton, the exact variety of cotton was matched for a southern and northern location within a short interval of time (within a few days to within a month) for the best comparability possible. Northern cities are: Anvers, Lille, Rouen, Paris, Havre or Gand. Southern cities are Bordeaux, Marseille, Toulouse, Lyon and Bayonne. For Levantine cotton, it was possible to match Marseille to a northern city for each year. See Appendix C for a more detailed description of the data.

the period. This is consistent with Britain's military superiority on the seas which ensured stable access to raw cotton. Second, prices show strong comovement in the south and north of the Empire. This is important from the point of view of identifying the effect of British competition on mechanisation in France, as it rules out a confounding effect driven by a regionally asymmetric shock to the price of raw cotton.

How did the French secure access to raw cotton without naval power? First, the Napoleonic Blockade's unusual implementation is an important part of the explanation. The blockade was implemented against trade from Britain and as such, trade from other countries was not resisted to the same extent. Unless the re-exporter of raw cotton was Britain, inputs were imported into the Empire perfectly legally. Second, it was predominantly the spillover effect of the Blockade which drove up the price of raw cotton imports in the Empire. The British never managed to monopolise raw cotton supplies, but their naval power did make it more uncertain, more difficult and hence more expensive for raw cotton to reach the French Empire. Third, in contrast to British trade, the direction of trade for raw cotton did not substantially change throughout the Blockade. Together, these factors explain why raw cotton prices increased in the French Empire and not Britain, and why the shock to raw cotton prices across the Frenc Empire was symmetric.

Table 5 in Appendix A shows the extent to which suppliers of raw cotton were able to directly export their goods to the French Empire.[25] Until 1808, Portugal and the US generally shipped cotton directly to ports in the French Empire. In 1807, 29% of cotton imports to the French Empire came directly from the US and 45% from Portugal (Chapman and Chassagne, 1991). The Jeffersonian Blockade in the US, and the shifting of allegiances in Portugal put a stop to direct shipping between the two suppliers and France starting in 1808. However, raw cotton arrived via third countries. Figure 17 in Appendix B shows the changing destination of exports of cotton from the US during the Napoleonic Wars. Examining these statistics by destination country shows that while direct exports to France were indeed virtually nil from 1808, exports to North Sea and Baltic countries such as Hamburg, Holland, Russia, Sweden, Norway and Denmark picked up significantly, as did exports to the Azores. These are the locations from which cotton was re-exported to Continental Europe.

Turning to the supply routes for colonial cotton, it is well known that throughout almost the entire period of the French Revolutionary and Napoleonic Wars, France lost direct access to her colonies. She was thus forced to rely on "neutral" carriers such as the US to maintain contacts and trade with the colonies (Johnson, 1964). US trade statistics don't differentiate between re-exports and exports of cotton, colonial cotton is thus encompassed in US trade statistics. Finally, access to Brazilian cotton become highly volatile as sea transportation between Portugal and France became increasingly difficult after 1808. Much of the raw cotton seems to have made its way overland into France across Spain and through the Pyrenees

[25]Throughout the period, colonial raw cotton was re-exported by US ships, and as such, the US numbers contain data on both.

to Southern ports such as Bayonne on the Atlantic. According to government reports, the journey was not only more expensive because of the higher costs of overland transportation but it was also uncertain and organising transportation proved to be difficult.

Levantine cotton was the cotton which was most consistently available in abundant supply throughout the time period of interest. This is despite the fact that direct supplies from the Ottoman Empire were fairly low as is evident from Table 5; direct supplies only accounted for more than 10% of cotton imports in 1810 and 1811. The reason for this was that control of shipping on the Mediterranean by the British navy meant the land-routes were used in conjunction with traditional sea- routes to transport cotton to the Continent. Even when sea-routes were used, Levnatine ships often stopped en-route to Maresille at a "neutral" port. According to Ellis, Strasbourg was the principal inlet for Levantine cotton (Ellis, 1981), though other sources point to a continuing role for sea-trade via Marseille. One government report estimates that 5 million livres poids of cotton entered the French Empire via sea routes as opposed to 8 million overland.

Finally, consistent with Napoleon searching for a substitute to sea-borne trade, there were attempts to grow cotton in locations closer to the French Empire. According to Heckscher, small quantities of Spanish and Italian cotton were imported in later years, but it has been estimated that together, they did not account for more than about 10% of the cotton used in the cotton industry in 1812. There was also an attempt to grow cotton in various Southern departments, but this proved unfruitful.

In summary, mechanised spinning witnessed a surprising and spectacular increase in capacity in some regions during the Napoleonic Wars. In addition to the general difficulties associated with this period of continuous hardship and warfare, the increase in the price of the imported input makes the timing all the more spectacular. In the following section, I show that the Napoleonic Wars led to exogenous variation in the intensity of British competition. Using this variation, we can identify the effect of British competition on mechanisation.

3 The Napoleonic Wars as a Source of Exogenous Variation

The rupture to trade and the resulting geographic variation in the extent to which trading routes between Britain and the French Empire were affected provides a rare opportunity to identify the effect of protection from competition with the industrial leader on infant industries in follower countries. Napoleon's Continental Blockade (1806-1813) took place within the context of the Napoleonic Wars (1803-1815). It is within this historical setting that the motivations of Britain and France can be understood.

Starting in 1803, a newly belligerent French Empire began its expansion on the Continent to the increasing alarm of the British. These wars should be viewed as a continuation of the French Revolutionary Wars which played out between France and various coalitions led by Britain between 1793-1802. Between 1803 and 1815, as in the previous decade, France fought Britain and its allies in a series of campaigns. Though the threat of an actual invasion by the French never completely subsided, following the defeat at Trafalgar in 1805, Napoleon more or less gave up on his plans of direct military invasion of Britain. He instead turned his efforts increasingly towards defeating Britain by economic means.

The primary aim of the Blockade was thus to weaken Britain economically by denying her access to important Continental European markets. However, the stark asymmetry of naval power between Britain and France meant that traditional blockade of British ports by the French navy was militarily infeasible, as Britain unambiguously controlled the seas.[26] In contrast however, Napoleon was increasingly successful in exerting his direct or indirect influence over most of the Continent. In this way, though Napoleon could not blockade British ports, he could use his land-based power to do the next best thing, which was to attempt to stop British goods from entering the Continent. It is in this sense that Heckscher (1922) refers to the Blockade as a "self-blockade".

The political map of Europe in 1812 in Figure 6 shows the extent of the Emperor's power over the European continent. Though Napoleon's power wasn't quite so all-prevailing in 1806, with the notable exception of Sweden, at one point or another all other European powers passed laws in line with the aims of the Blockade. By 1806, the French Empire had expanded in size to include all regions of present-day Belgium, parts of Holland, the entire left bank of the Rhine, regions of present-day Switzerland up to and including Geneva, and regions in the North-West of the Italian peninsula, up to Genoa. In addition, Napoleon's relatives were on the thrones of the Kingdom of Holland, the Kingdom of Italy, the Kingdom of Naples and the Kingdom of Spain. The Portuguese royal family had fled to Brazil and Napoleon's relatives were also in power in key German states (Connelly, 1990).

Historically, when Britain and France had been at war, direct trade between the two countries had collapsed, however the countries were able to continue trading with little interruption by way of neutral carriers and nearby neutral ports.[27] The period that I examine here differs from other wars between Britain and France in the sense that the entire Continent was affected. To understand the disruption to trade, it is worth examining two periods separately; the 3 years leading up the imposition of the Continental Blockade (1803-06), and the the Blockade (1806-13) itself.

Disruption to trade along the North-Sea ports began in 1803 with the onset of the Napoleonic Wars. "Neutral" ports along the North-Sea (Hamburg in particular), together with Dutch

[26] By 1800, the British had twice the number of warships as the French did (Davis and Engerman, 2006)
[27] Figure 8 shows that this was the case during the French Revolutionary Wars (1793-1802).

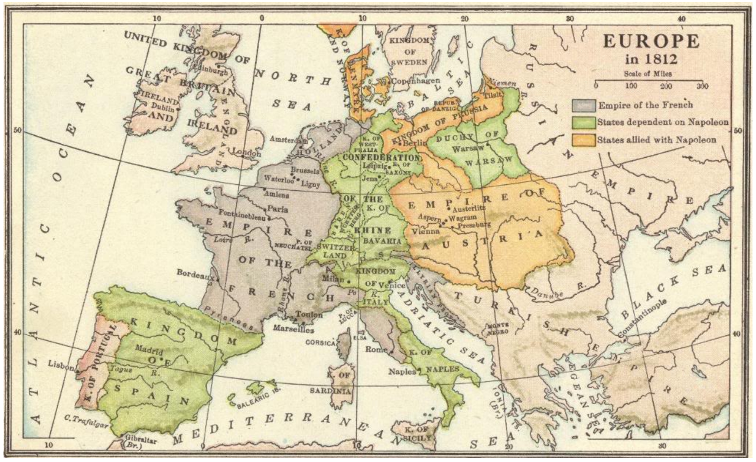


Figure 6: Political map of Europe, 1812

ports had been traditionally used to continue trading with the British in times of war. However, in a highly symbolic event, Hanover (the royal dynasty to which monarchs of Great Britain belonged to) was occupied by the French army. Britain retaliated by imposing a tight blockade of the entire North Sea coast between the Weser and the Elbe, which was then expanded to include ports along the French Channel and the North Sea in 1804 (Davis and Engerman, 2006). Crouzet (1987) considers this period a prequel to the Blockade in the sense that trade to Northern Europe was forced onto land routes for the first time significantly driving up the price at which goods entered the Continent. Goods were taken from Britain to Altona and Tonning (both North of Hamburg). They were then smuggled into Hamburg and taken into Northern Europe via land routes.

The Continental Blockade prohibiting the entry of British goods onto the European Continent was declared in Berlin in late 1806 following the defeat of the Fourth Coalition against France in Jena - Auerstadt. Prussia and Russia, two allies of the British, were forced to implement the Blockade along their coastline. It is generally believed that the outline of the decree had been planned well in advance of the British Orders in the Council which the French used as a pretext on the basis of which to retaliate. The Orders in the Council, declared earlier in 1806, had widened the blockade already in place further west to the home of the French Navy's Atlantic fleet in Brest.

The historical events that followed the introduction of the Berlin Decree are fairly complex and they involve much back and forth retaliation between Britain and the French, the details of which are not relevant for my purposes.[28] The following points are worth noting regarding the implementation of the Blockade. First, the series of laws passed by Britain and France had the effect of completely wiping out neutral shipping on top of the evident damage they did to domestic shipping interests. Neutral carriers such as the US found themselves

[28] The interested reader can consult Davis and Engerman, (2006).

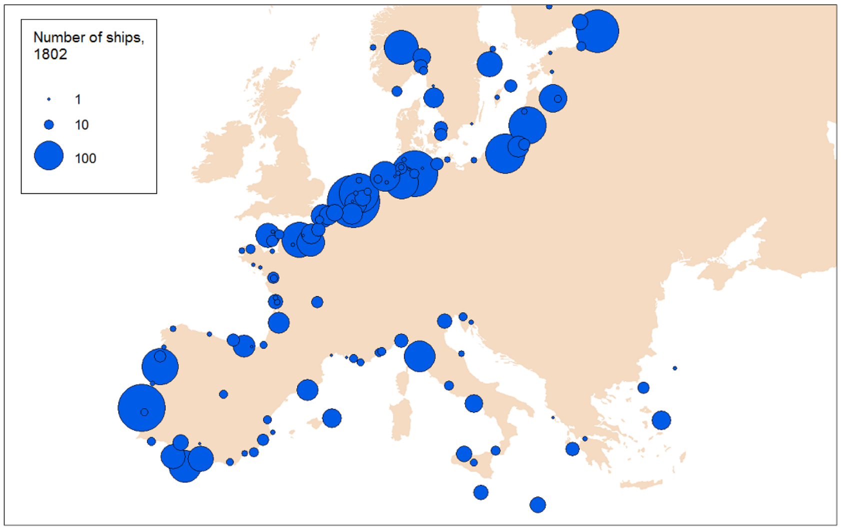
in violation of one or the other powers' decrees which made capture by Britain or France almost inevitable. This had the effect of severely increasing the costs and risks involved with sea-transportation and hence diverting a large proportion of sea-borne trade onto more expensive land based routes. Second, the extent to which Napoleon could ensure successful implementation of the Blockade depended on his ability to keep areas outside of France under his control.

Figure 23 gives a snapshot overview of the intensity of trade with Britain at the port level across Continental Europe in 1802, a year of relatively free trade and 1809, a Blockade year. Each circle is proportionate to the number of ships sailing between Britain and the given port. Comparing these two points in time confirms that while the Blockade dramatically disrupted trade between Britain and the Continent, particularly in France, along the North-Sea coast and the Baltic, shipping between Britain and the Continent did not come to a standstill. There were two main reasons why the Blockade failed in terms of stemming the flow of British goods onto the Continent. First, there were always bound to be "holes" in the system, by virtue of the fact that the British simply controlled a number of ports and islands of strategic importance (amongst others; Gibraltar, Malta and Heligoland). Napoleon's territorial expansions along the North Sea coast and the Mediterranean reflect his efforts to "plug" these gaps in the system.

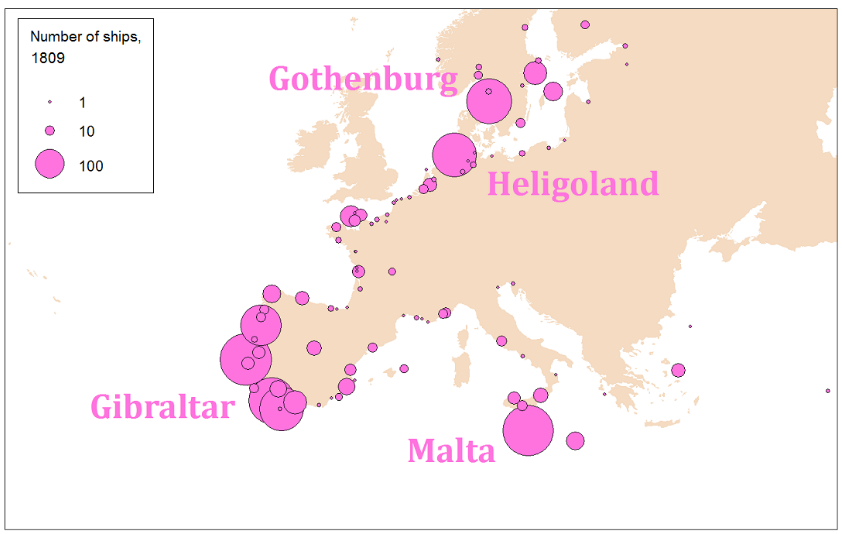
Second, and perhaps most catastrophically, the Spanish insurgency against French rule which started in 1808 meant that the entire Iberian peninsula became open for trade with the British. Together with their control of Gibraltar and shipping on the Mediterranean sea, Southern Europe became the main outlet for British goods, and in particular cotton. French prefects in the south-western regions complained that Spain was awash with British cotton goods which steadily made their way into France through the Pyrenees. French consular reports describe markets for British yarn in Malta and Bosnia. With respect to the latter, the consul notes that there was no domestic demand for yarn in Bosnia, it was purchased exclusively by Viennese merchants for export.

Two features of the Blockade are key to my empirical strategy. (1) The blockade was for most parts well-enforced along the ports of France. (2) The blockade was unevenly successful across Northern and Southern Europe. The reasons for the divergence between the fate of the Blockade in Northern and Southern Europe were driven by the fact that Napoleon was militarily stronger in Northern Europe, while the British unquestionably had the upper hand in Southern Europe. The Spanish insurgency from 1808 reinforced this imbalance to an extreme extent. Figure 8 shows time series evidence of the uneven effects of the Blockade.

In each panel of Figure 8, the same port level shipping data used to construct Figure 23 from the Lloyd's List has been aggregated up to the regional level in order to examine the evolution of shipping over time. Data from 1787 onwards are shown in order to confirm that the Napoleonic Wars induced a rupture to trade different to previous episodes such as the



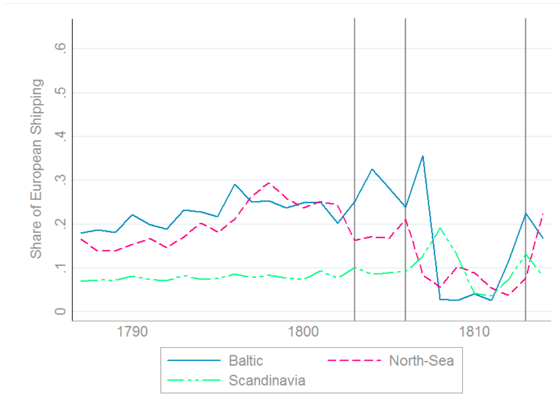
(a) Port usage, 1802



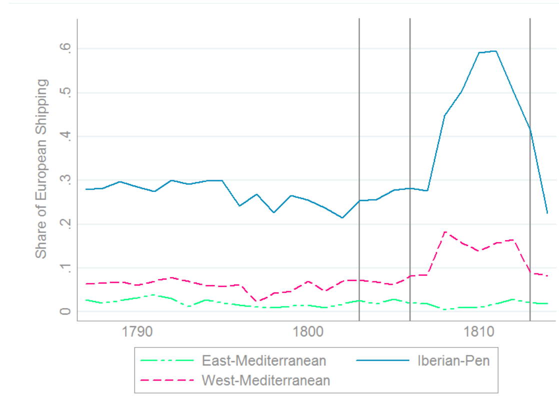
(b) Port usage, 1809

Figure 7: Intensity of port use in trade with the British, Lloyd's List

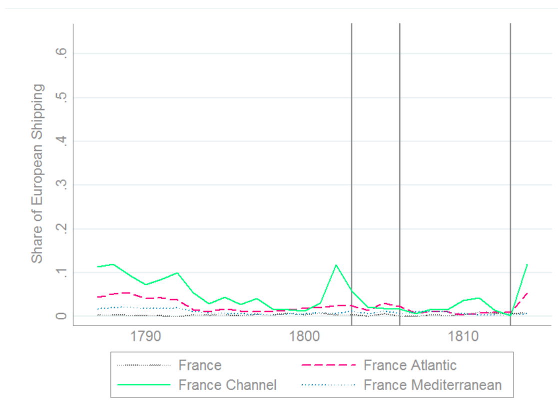
Each circle is proportionate in size to the number of ships sailing between Britain and the given port in the years 1802 and 1809. The former is the last year of peace and relatively free trade between Britain and the Continent, 1809 is a year during the Continental Blockade. Panel B shows the name of the main ports which the British used as smuggling centres during the Blockade: Gothenburg, Heligoland, Gibraltar and Malta. Data are from the Lloyds List.



(a) British shipping with Northern Europe



(b) British shipping with Southern Europe



(c) British shipping with France

Figure 8: British shipping with European regions as share of total, 1787-1814 (Lloyd's List)

Figure 8 shows time series evidence on shipping between Britain and a given region as a share of total European shipping with Britain in order to understand regional variation in the effectiveness of the Blockade. For each year, the shares across the three subfigures add up to 1. The first grey line denotes the onset of the Napoleonic Wars in 1803, the second grey line indicates the onset of the Napoleonic Blockade in 1806 and they third grey line indicates the end of the Napoleonic Wars in 1813. Data from Lloyds List.

French Revolutionary Wars. Each line represents a given region's shipping with Britain as a share of total European shipping with Britain. Panel A examines shipping to the Northern ports of Europe excluding ports that belonged to the French Empire. Panel B examines shipping to Southern European ports, again excluding ports which belonged to the French Empire, while Panel C examines shipping along the various coastlines of the French Empire.

Turning first to Panel, I divide Northern Europe into three regions; the Baltic, the North Sea and Scandinavia. From the onset of the French Revolutionary Wars in 1793 until the peace of Amiens in 1802, there was a clear upward trend along the North Sea and Baltic reflecting substitution from French ports to these regions. The Napoleonic Blockade differed from other trade wars between Britain and France exactly because of the involvement of all European powers. Without neutral shipping to substitute for the loss of direct trade between Britain and France (as was the case during the French Revolutionary Wars), trade costs became significantly larger. The fact that the North-Sea could not be used to substitute for the loss of direct shipping between Britain and France is evident from the first grey line which shows the onset of the British blockade of the North Sea in 1803. The effect of the British blockade of the North Sea coast was to substitute to shipping via the Baltic. Between 1803 and 1806, as shipping along the North Sea declined, the share of shipping to the Baltic picked up. Discussing the effects of the North-Sea blockade on cotton exporters, Edwards writes "During 1804 and 1805, when the Elbe was blockaded, Germany's share of the total cotton exports to Europe dwindled to a mere three percent, while there was a sharp jump in the trade to Denmark and Prussia." (1967, p. 55).

Accessibility of both the Baltic and the North-Sea worsened with the onset of the Continental Blockade in 1806 (denoted by the second grey line) as Prussia and Russia both implemented the Blockade. Edwards (1967) notes that between December, 1806 and March, 1807 there was an almost complete standstill in trade to Northern Europe, with insurance premia rising sharply. With the increasingly difficult situation in Hamburg, some cotton merchants relocated to Tonning and Altona. Their letters to Britain were initially positive about the sales being made, noting that large quantities were being smuggled successfully into France. However, the blockade became even more severe from August, 1807. It was during this time that Gothenburg became the important smuggling centre in the North, which can be seen by the increase in shipping to Scandinavia until around 1808. Marzagalli (1999) describes how merchants from Britain, Holland and Hamburg relocated their business to Gothenburg to organise smuggling routes from this point. However, the problem with Gothenburg was the lack of land connections to the German and French regions, which were the final destination for most of these goods. Crouzet (1987) describes how during a number of months in 1808 when the Blockade was fully effective both along the North Sea and the Baltic, stocks piled up in Gothenburg as ships arriving from Sweden were continuously denied entry.

It was possibly the increasingly difficult situation in the Baltic that encouraged merchants to begin to lobby the British government for trading licenses to Heligoland. This tiny island about 50 kilometers off the German coast, measuring only a couple of square kilometers was taken by the British navy in 1807. The intent was to track movements of the French army along the North Sea. The British government started granting licenses to merchants to trade in Heligoland in late 1808, but smuggling began in earnest in 1809. The increase in the share of shipping to the North Sea is accounted for single-handedly by this tiny island. Heligoland was more advantageous as a smuggling centre for three reasons. First, it was closer to the final destination of the German and French markets reducing the land distances that goods would need to travel. Second, small fishing boats could be used to smuggle goods onto alcoves and inlets on the North Sea coast during the night (Crouzet, 1987), something that had not been possible from Gothenburg. Third, the Baltic was only accessible by military convoy. To get to the Baltic, British ships needed to cross narrow straits controlled by the Danish, who had become Britain's fiercest enemies as a result of Britain's unprovoked bombardment of Copenhagen in December, 1806.

Despite considerable efforts on behalf of both the British government and entrepreneurs to find reliable routes via which to introduce their goods onto the mainland, northern smuggling routes were extremely risky and precarious by virtue of the fact that for both Heligoland and Gothenburg, there was no direct overland connection to Germany and France. The trade via Heligoland in particular was reliant on diminished vigilance along the German coast during Napoleon's campaign against Austria. Kirkman Finlay, a Glaswegian exporter of cottons noted that in 1810 "(...) the trade from Heligoland was also destroyed, since the French emperor whenever peace was made with Austria again closed up entirely every means of introduction from that island" (quotes in Edwards, 1967 p.58). On the other hand, Gothenburg was reliant on Baltic ports granting entry to ships obviously stocked with British cargo. Enforcement again fluctuated with military events and Russia and Prussia's shifting allegiances.

The situation in Southern Europe was completely different as is evident from Panel B which shows the evolution of shipping for the Iberian Peninsula, the West- and East- Mediterranean. First, it is important to highlight the Iberian peninsula's key importance in determining the fate of the Blockade. From the onset of the Blockade in 1806, this region's share of shipping increased dramatically. In fact, for two years, 60% of total European shipping with Britain was conducted via the Iberian Peninsula. Gibraltar carried a large proportion of this trade, as did Lisbon and Cadiz, both of which were under British control from most of the Blockade. Even prior to the Spanish insurgency, with Gibraltar firmly in their possession, and significant sway over much of Portugal, the British had access to a direct, overland connection to France. Edwards, notes that between 1805 and 1807 (prior to the Spanish insurgency) cotton goods were exported in increasing quantities to Portugal, the Straits of Gibraltar, Malta and Sicily in order to penetrate parts of France. The increase in shipping on the West-Mediterranean was driven almost single-handedly by Malta. Crouzet (1987) describes in detail the key importance played by Malta, especially in the smuggling of cotton goods. At one point, 8.8% of exports from Britain were taken into Europe via Malta.

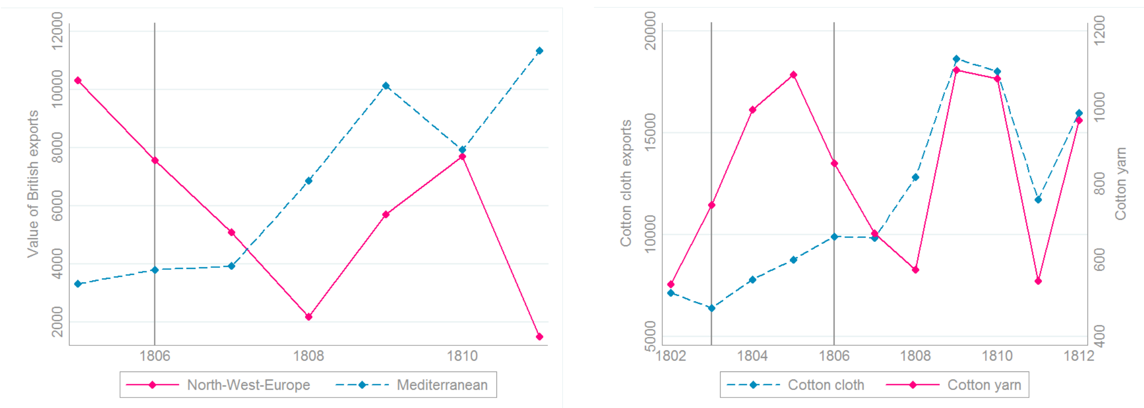
Why was France's military position weaker in Southern Europe? To begin with, the French navy was in a desparate state on the Mediterranean as a result of an indiosyncratic political event which took place during the French Revolution (Rogder, 2006). As Jacobite power was unravelling in Paris, the city of Toulon on the Mediterranean, home to the French navy's Mediterranean fleet, declared revolt. As troops from Paris began to encircle the town, the Toulonnais called in the British navy. As a consequence of the fighting, a significant part of France's Mediterranean fleet was destroyed or captured, an event from which the Mediterranean fleet could not recover during Napoleon's reign.

Furthermore, as a result a Napoleon's misadventure in Egypt (interpreted in Britain as an attempt to reach India), the British made control of the Mediterranean a policy of strategic importance. They controlled a number of points of primary importance in Southern Europe, such as Gibraltar and Malta, both of which became important smuggling centres. Furthermore, they exerted significant influence on Portugal, a historically important ally, but also Sardinia and Sicily. Finally, the British were also directly involved militarily in the Spanish insurrection which began in 1808. Crouzet (1987) describes how throughout the Napoleonic Wars, the British were able to single-handedly control shipping in the Mediterranean, which he called a "British Sea".

Finally, Panel C shows the evolution of British shipping with the French Empire which has been divided into three regions; ports along the French side of the Channel (including Belgian ports), ports along the coast of the Atlantic and ports along the French Mediterranean. First, it is clear that from the point of view of the French Empire, the Napoleonic Wars aren't particularly different from traditional trade war with Britain. The picture that emerges for the French Revolutionary Wars (1793-1801) is basically the same as that which we see during the Napoleonic Wars (1803-1815). In both cases direct trade between the two states collapsed as they went to war. The difference in the case of the Napoleonic Wars was that cheap (water-borne) indirect trade via neutral ports was eliminated as a result of the all-encompassing nature of the Blockade. Second, the French Channel and to a lesser extent the Atlantic coast showed fairly intense trade with Britain in years of peace. In these years, about 12% of all shipping between Britain and the Continent took place between Britain and the French side of the Channel, implying that trade links were strong, and as we have seen, this was particularly true in the case of cottons.

Consistent with evidence form the Lloyd's List, trade statistics for British exports of manufactured goods and other British produce confirm the stark divergence between trade to Northern and Southern Europe as Panel A in Figure 9 makes clear. Exports to the Mediterranean increased threefold from the onset of the Blockade to 1811, while exports to North-Western Europe (comprising France) are consistently lower. In fact, the peak-to trough decrease in exports to these markets was five-fold. Furthermore, consistent with the British using southern trading routes in years when northern smuggling becomes particularly difficult, exports to the Mediterranean are lower when exports to North-Western Europe are higher.

Finally, I examine evidence on cotton exports in Panel B of Figure 9. Absent evidence on exports of cotton goods by region, it is nonetheless important to assess the extent to which cotton goods remained at all traded. If exports of cotton goods dramatically decreased, it would call into question the extent to which regional variation in exposure to British trade was in fact taking place. Figure 9 shows that this is not the case. Exports of cotton yarn were dynamically increasing prior to the onset of the Blockade, and initially they declined by about a third of their value. Remarkably in 1809 and 1810 however, the value of exports is the same as in 1805. The pattern is similar for exports of cotton cloth, though strikingly, exports of cotton cloth are consistently higher than in pre-Blockade years. Unfortunately, these statistics are for total exports, so it is not possible to rule out that part of the pattern was being driven by substitution to export markets outside of Europe. Two factors, however, make this highly unlikely. First, substitution to new markets was generally unsuccessful because of a lack market information. Heckscher's (1922) famous anecdote about ice-skates arriving in Buenos Aires in December is one extreme example of this. Furthermore, cotton yarn was particularly reliant on European markets by virtue of it being an intermediate good. Second, the peak years in 1809-10 coincide with years where enforcement of the Blockade was generally lax, implying that European markets drove the ups and downs for both cotton cloth and yarn during the Blockade.



(a) Exports of British merchandise and other produce

(b) Exports of British cotton cloth and cotton yarn

Figure 9: British exports, '000s pounds)

Panel A gives total value of exports (ex-cluding re-exports) to North-Western and Southern markets. The former comprises of Russia, Sweden, Denmark and Norway, Prussia, Germany (including Heligoland), Holland, Belgium and France, the latter comprises Portugal, Madeira and Azores, Spain, The Canary Islands and Baleares, Gibrlatar, Italy, Sicily, Sardinia, Malta and the Turkish Empire. Panel B gives total value of cotton cloth and cotton yarn exports. Data source: Crouzet (1987)

The Napoleonic Wars and the Continental Blockade thus led to an enormous disruption to trade between Britain and the Continent, which neverthelesss did not lead to trade coming to a standstill. The preceding discussion has described the political and military reasons behind the different outcomes observed in the North and South of Europe. An important building block for my argument about exogeneity relies on the fact that variation was driven by events *outside* of the French Empire. The final question that remains is how goods made their way from the smuggling centres into the French Empire.

To answer this question I rely on historical accounts on the routes which smuggled goods took. There is fairly widespread consensus among historians of the Blockade that one entry point for goods was Strasbourg. From the North, once goods had made their way either into a Baltic port or a point of entry along the North Sea, they were transported overland to Strasbourg. Ellis writes " (...) smuggling was more active along the inland than the maritime frontiers of the Empire. One reason for this was the nature of the terrain (...). Another was the proximity of foreign entrepots like Frankfrurt, Darmstadt, Mannheim, Heidelberg, Rastatt, Kehl and above all Basel. Within the Empire itself there were many smuggling bases up along the Swiss frontier and down the left-bank of the Rhine." (Ellis, 1981, p. 203) [29]

Regarding Southern smuggling, historians agree that many of the goods taken by the British to smuggling centres in the Mediterranean were destined for French and German markets. There seems to have been a number of routes that goods took. First, Livorno (part of the French Empire) seems to have been an important entry point for smuggled goods (Marzagalli, 1999 and Galani, 2011). However, this likely changed with annexation to the French Empire and both authors find that ships arriving from Malta decreased significantly after this date. Second, there is also widespread consensus that another favoured route was that taken via Trieste, consistent with markets for yarn in this region (Marzagalli, 1999, Crouzet, 1987). Heckscher (1922) gives details of a smuggling route that began from Trieste and brought goods up along the Danube into Germany and finally into France.

Finally, smuggling via Spain entered the Empire through the Pyrenees and the effects were catastrophic. Archival sources contain literally hundreds of letters between prefects in south-western departments and the government in Paris. The smugglers were well organised, they were often armed deserters of the army. Clashes between smugglers and the police resulting in casualties were not infrequent. The authorities were evidently outnumbered. Similarly to the inland border on the around the Eastern border, the mountainous terrain provided smugglers with a multitude of potential routes which made detection even more difficult. The Canal du Midi linking the Mediterranean to the Atlantic was supposedly riddled with smuggling centres. All border departments reported a multitude of routes with destinations ranging from Bordeaux, Toulouse and Paris. [30]

[29] It may seem somewhat surprising that goods needed to be taken quite as far down South as Strasbourg. Why weren't they smuggled into the Empire via the Kingdom of Holland, a much shorter route? The Kingdom of Holland proved to be far too permeable to the entry of British goods for Napoleon's liking. While increasing pressure was placed on his brother, Louis, the King of Holland, to increase enforcement of the Blockade, the decision was made to close the Franco- Dutch border from 1808 effectively shutting off the potential entry of any smuggled British goods from the north (Heckscher (1922) p. 181.) For this reason, British goods smuggled via the North took land routes all the way to Strasbourg prior to entry in the Empire.

[30] One worry is that smuggling via the Iberian peninsula is overstated if the British also use the Iberian peninsula as a point of access to markets in Latin America. Crouzet (1987) discusses the trade from Britain to Spanish and Portuguese colonies in detail. He finds that in fact, because of the weakened state of the Spanish and Portuguese monarchy, the British actually had direct access to these markets in contrast to the period

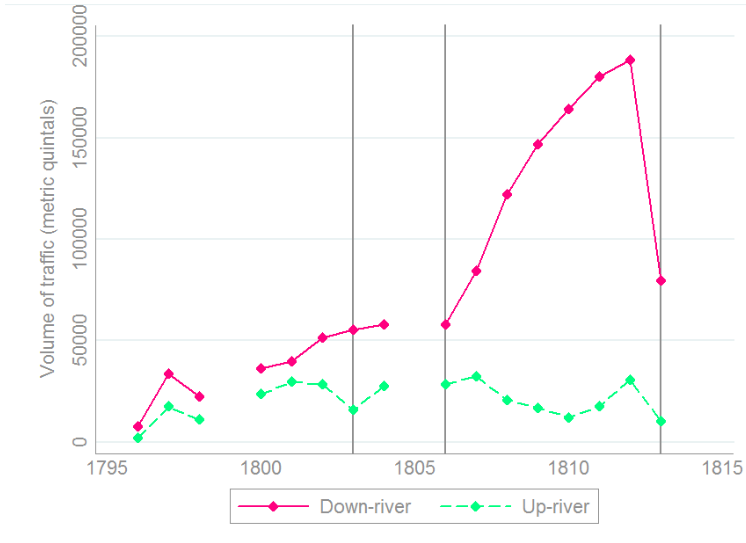


Figure 10: Traffic up-river and down-river from Strasbourg

Data source: Ellis (1981)

Taking evidence from the Lloyd's List together with the historical evidence on overland smuggling routes paints a consistent picture of trade with Britain being relatively easier and more intensive in the South than the North. One final piece of quantitative evidence from internal trade routes within the French Empire confirms that with the onset of the Napoleonic Wars, the direction of trade with Britain within France changed from a North-South route to a predominantly South-North route. Figure 10 shows the time series for trade from Strasbourg up and down-river along the Rhine. Coinciding with the onset of the Blockade, down-river trade (in the south-north direction) increased dramatically, while up-river trade (in the north-south direction) remained stable.

In the previous two sections, I have examined the uneven evolution of mechanised cotton spinning across the French Empire during the Napoleonic wars. I have also showed that these wars led to a disruption to trade between Britain and France disproportionately affecting Northern Europe, and thus Northern France. In the following section, I develop a simple theoretical framework to guide empirical analysis which brings together the effects of the Blockade on both input and output prices.

before the Blockade when British goods could only enter the markets in Latin America indirectly via either Spain and Portugal or smuggling via free-ports in the Carribean. This implies that if anything, comparing shipping between Britain and the Iberian peninsula before and during the Blockade will understate the extent to which the peninsula was used for smuggling.

4 Theoretical Framework

This section develops a simple framework to guide empirical analysis. In this model, geographic distance to the frontier (Britain) plays the key role in determining whether regions are productive enough in the initial period to produce cotton yarn domestically. Absent any shocks, initial specialisation determines how productivity evolves over time as is standard in infant industry models.

4.1 Setup

The world consists of the frontier (Britain), F, and two follower regions $i = 1, 2$ (French regions).[31] F is sufficiently large relative to the combined size of the follower regions, i, such that international prices are set at the frontier as if it were a closed economy. Therefore, follower regions take international prices as exogenously given. The size of the two regions, in terms of their labour force, is the same: $L_i = \bar{L}$. Labour is not mobile across regions, but goods are traded across all three regions. There are three tradeable goods, agriculture (A), cotton yarn (C) and raw cotton (R). Consumers everywhere derive utility from the consumption of A and C, but not R. Raw cotton, R is needed as an input in the production process of yarn, C. All goods are perishable and and all economies live in financial autarky. Consumers maximise the following instantaneous utility function:

$$U(A, C) = A^{\alpha} C^{(1-\alpha)} \tag{1}$$

All goods are produced at the frontier using the following constant returns to scale production technologies: $A_F = L_A$, $R_F = a_R^F L_R$ and $C_F = min\{a_C^F L_C, R\}$. L_A, L_R and L_C are labour employed in agriculture, production of raw cotton and cotton yarn respectively. A and R use labour as the only input in the production process, while producing one unit of cotton yarn requires one unit of raw cotton and $\frac{1}{a_c^F}$ units of labour. The F sub/superscript denotes the frontier region. Time subsrcipts are supressed for economy F as technology is constant over time.

International prices are straightforward. Choosing the agricultural product as numeraire, equilibrium prices given perfect competition, strictly positive final goods demand for A and C and intersectoral labour mobility are as follows: $p_A = 1$, $p_R = \frac{1}{a_R}$, $p_c^F = \frac{1}{a_c^F} + a_R$ and $w^F = 1$.

[31]The framework can be extended to accommodate an arbitrary number of follower regions, however as these economies are allowed to trade with each other, this complicates the analysis significantly without adding much in terms of insights.

No firm in any follower region has the necessary technology to domestically produce raw cotton (this amounts to assuming that $a^i_R = 0, i = 1, 2$, where the supercsript i refers to the region). If a firm in region i want to domestically produce cotton yarn for consumption, the input must be imported. Firms in region i at time t face the following constant return to scale technologies for producing A and C. A is produced using the same linear production technology as at the frontier: $A_{it} = L^i_{At}$, where L^i_{At} is labour employed in sector A in region i at time t . C is produced using the same Leontieff production technology as at the frontier: $C_{it} = min\{a^i_{ct}L^i_{Ct}, R\}$, where L^i_{Ct} is labour employed in C in region i at time t. The efficiency of labour in producing cotton yarn in i is potentially different from the frontier. In particular, the evolution of a^i_{ct} is given by the following equations

$$\begin{cases} \frac{\dot{a}^i_{ct}}{a^i_{ct}} = Q(C^{i,cum}_t), & \text{if} a^i_{ct} < a^F_C \\ \frac{\dot{a}^i_{ct}}{a^i_{ct}} = 0, & \text{if} a^i_{ct} = a^F_c \end{cases} \tag{2}$$

where $a^i_{c0} = \bar{a_C}, i = 1, 2$, $a^i_{c0} < a^F_{c0}$, $C^{i,cum}_t = \int_0^t C_{iz}\mathrm{d}z$, $Q(C^{i,cum}_t) > 0$.

Both follower regions start with an initial productivity disadvantage in C relative to the frontier. They are able to fully close the productivty gap via the production externality. The learning function, Q, is strictly positive in cumulative production but is otherwise unrestricted. I make three stark assumptions about the nature of learning. (1) Productivity gains are fully external to the firm, no firm internalises the effect increasing production today will have on future labour productivity (2) The externality is spatially concentrated within the borders of the region. (3) Learning by doing gains are bounded. At time zero, firms at the frontier have exhausted all productivity gains from LBD.

Follower regions take international prices as given, however, not all goods are available to consumers and firms at these prices. While A is traded costlessly, both R and C face trade costs. In particular, if C is imported to region i, there is a t_i unit shipping cost, which is pure waste. The per unit trade cost is a function of region i's geographic distance to the frontier, $t_j = c(d_n)$, where d_n is (geographic) distance to the frontier and $c(d_n)$ is a function which is everywhere weakly positive and increasing in distance. Shipping one unit of raw cotton, R, incurs a unit shipping cost, τ, which does not depend on geographic distance to the frontier and can be 0. The fact that C's shipping costs depend on distance, while R's does not is motivated by the fact that while Britain was the source for yarn, it was not the source for raw cotton, and regions in France had more even access to raw cotton than to competing yarn. Finally, if follower regions trade, they face symmetric unit shipping costs on cotton yarn, $t_{12} = t_{21}$.

4.2 Static Equilibrium

I assume accessibility of raw cotton is the same across the world, ie. $\tau = 0, \forall i = 1, 2, F$. From the point of view of region i, firms only need to make a decision about whether it is profitable to produce yarn domestically (and import the raw cotton needed for production) or import it from the frontier. At $t = 0$, when $a^1_{C0} = a^2_{C0}$, follower firms will not be competitive in each others' markets, as they are equally productive in producing yarn, but face a nonzero transport cost. Note that A will always be produced as it is needed either to pay for imports of raw cotton or cotton yarn.[32]

Given international prices as faced by agents in region i, we can easily solve for specialisation patterns and equilibrium prices in i. Production of A and intersectoral labour mobility will imply that $w^i_0 = 1, i = 1, 2$. Will region i produce cotton yarn, C, or import it? This depends on whether firms can break even at prevailing prices. Firms in region i will find it profitable to enter C at time 0 if [33]

$$p^F_c + t_i \geq \frac{1}{a_{ci0}} + p_r \tag{3}$$

Inspection of equation 3 reveals that there will be a cutoff distance $\bar{t} = \frac{a^F_c - a^i_{c0}}{a^F_c a^i_{c0}}$.[34] Firms in regions with a trade cost $t_i \geq \bar{t}$ will find it profitable to enter production of cotton yarn, while regions with $t_i < \bar{t}$ will import yarn from the frontier.

Regions with $t_i \geq \bar{t}$, will be incompletely specialised. They will produce agricultural products and cotton yarn. They export agricultural products in exchange for raw cotton needed in yarn production. Prices are as follows: $p_A = 1$ and $p^i_c = \frac{1}{a^i_{c0}} + p_R \leq p^F_c + t_i$. Regions with $t_i < \bar{t}$, will be fully specialised in the production of agriculture. They will export agricultural products in exchange for cotton yarn. Prices are $p_A = 1$ and $p^i_c = p^F_c + t_j$.

[32] At first, it may seem surprising that yarn cannot be exported in exchange for raw cotton. However, given that follower regions at their most productive can produce at p^F_c when catch up is complete and $\tau = 0$, they can only sell in F at $p^F_c + t_i$, ie. a price that is t_i higher than the prevailing market price at the frontier. The only exception to this is if the two follower regions trade with each other. In this case, the region with a comparative advantage in C can be fully specialised, a possibility I explore in the next subsection.

[33] The equation comes from the requirement that at price $p^F_C + t_i$ domestic producers of C must make weakly positive profits

[34] The expression for the cutoff distance substitutes for p^F_c.

4.3 Dynamic Equilibrium

Given the static equilibrium from the previous section, characterising the dynamic path of follower economies is straightforward. Regions which began producing cotton yarn at time 0 will increase their productivity in this sector via the production externality further strengthening their competitive edge in the domestic market until $a^i_{Ct} = a^F_C$ and catch up is complete. Regions which import yarn from the frontier at time 0 will continue to import yarn and $a^i_{Ct} = a^i_{C0}$, ie. productivity will stagnate at the initial level. The dynamic path is slightly more complicated if one region begins producing C at time 0, while the other does not. As productivity in the producing region increases, it becomes possible for the region producing C to become competitive in the region specialised in A. In this case, the two follower regions will integrate. The economy with a comparative advantage in producing C will supply the other with cotton yarn in exchange for agriculture, while both are supplied with R from the frontier. Depending on the parameters, the following outcomes are therefore possible:

1. If $t_i < \bar{t}, i = 1, 2$, both economies will specialise in the production of A and import C. $\frac{\dot{a}^i_{ct}}{a^i_{ct}} = 0, \forall t$ and $p^i_{ct} = p^F_c + t_i$.

2. If $t_i \geq \bar{t}, i = 1, 2$, both economies will be incompletely specialised in producing A and C from $t = 0$ onwards. $\frac{\dot{a}^i_{ct}}{a^i_{ct}} > 0$ and $\frac{\dot{p}^i_{ct}}{p^i_{ct}} < 0$ while $a^i_{ct} < a^F_c$. Once $a^i_{ct} = a^F_c$, $p^i_{ct} = p^F_c, \forall t$.

3. If $t_i \geq \bar{t}$ but $t_j < \bar{t}$ and $p^F_c + t_j = \frac{1}{a^i_{cT}} + p_r + t_{ij}$, for some $t = T$ then i will be incompletely specialised in producing A and C and j will be fully specialised in producing A and importing C from the frontier while $t < T$. However, once $t \geq T$, i will be competitive at exporting yarn to j. This will change the direction of trade and potentially alter specialisation patterns. Trade between the two regions will be as folllows: j is fully specialised in producing A, which it exports to i in exchange for C.[35]

4. If $t_i \geq \bar{t}$ but $t_j < \bar{t}$ and $p^F_c + t_j < \frac{1}{a^i_{ct}} + p_r + t_{ij}, \forall t$, i will be incompletely specialised in producing A and C and j will be fully specialised in producing A and importing C from the frontier. Labour productivity in producing C in i will never be high enough for firms to be competitive in market j. This implies that i and j do not become integrated.

[35] Depending on parameters, i can be completely or incompletely specialised in producing C. It exports (or re-exports) A in exchange for R from the frontier. If $p_r a^i_{ct} \geq 1 - 2\alpha$, i is incompletely specialised in A and C. However, for $p_r a^i_{ct} < 1 - 2\alpha$, i is fully specialised in C. As technology improves via the production externality, complete specialisation becomes more difficult. This is the general equilibrium effect of C becoming cheaper. As C becomes cheaper, consumers in i and j increase consumption of C, but this requires more imports of R, which in turn increases demand for A. Supply of A can only be increased if i becomes incompletely specialised and this requires the wage to fall to one, where production in A is once again profitable.

A number of points are worth noting in light of this result. First, initial specialisation at time 0 will determine whether a domestic cotton yarn producing industry is able to develop in a follower region i. This depends only on geographic distance to the frontier. Second, cotton yarn production is an infant industry in all follower regions. With sufficiently high *temporary* protection from trade with the frontier in the production of yarn (ie. a sufficiently high t_i), all follower economies can develop their own cotton yarn producing sector which is competitive with the frontier at *any* distance to the frontier. To see this, observe that once catch up is complete, $a_{cit} = a_c^F$, follower regions produce with the same technology as the frontier. The extent to which this is welfare improving depends on the speed of learning relative to discounting. If the industry is not competitive at initial distance to the frontier, t_i, consumers are worse off during the time period where the cotton industry is protected, because they pay a higher price for cotton yarn than they otherwise would, but once the sector is competitive they are better off as the price of cotton yarn decreases below that of competing imported yarn. The net effect thus depends on whether the long-term welfare gains outweigh the short term losses.

Finally, to the extent that one follower region is developing, while the other is not, the time paths discussed in (3) and (4) differ only to the extent that under (3) the developing economy integrates with the stagnating economy, while in (4) it does not. The time path discussed in (3) will prevail if productivity gains in C outweigh the trade cost t_{ij} between i and j. In particular, at 0, integration between i and j cannot take place, because i and j have the same productivity, but i produces at a t_i higher unit cost. As i produces in C, and a_{ct}^i increases, it can compensate for the higher trade cost, with higher productivity.

4.4 Understanding the trade shock

I now use this framework to guide empirical analysis. I build on the following two facts. (1) The shock to competition from Britain varied significantly across the French Empire. (2) The shock to raw cotton prices was fairly even across the French Empire. As the framework will make clear, the two shocks together resulted in different changes in competitive pressure across the Empire. The trade shock during the Napoleonic Wars effected cotton spinners' incentives to produce in two ways. First, the effective distance to Britain changed which effected trade costs of British yarn t_i. Second, the shock also drove up the price of raw cotton relative to the price in Britain. Different to the price of yarn however, this shock was even across the French Empire.

In particular, let $\Delta t_i \equiv t_i^{'} - t_i$ denote the shock to trade costs for British yarn in region i, where t_i and $t_i^{'}$ denote the trade costs between Britain and region i before and during the Napoleonic Wars. Similarly, let $\Delta\tau = \tau$ denote the (common across regions) shock to the price of raw cotton.

Given that production technology at the frontier (in particular access to raw cotton) was not affected by the shock, the decision to produce cotton domestically following the shock depends on the following condition

$$min\{p_c^F + t_i'; p_c^j + t_{ij}\} \geq \frac{1}{a_{ct}^i} + (p_r + \tau) \tag{4}$$

This expression differs from Equation 3, because the fact that the shock occurs at $t > 0$ means that, given sufficient learning, i may have been trading in C with j or vice-versa, making $p_C^j + t_{ij}$ the effective price below which domestic firms must go to be competitive.

The effect of the shock, depends on three forces. First, the increase in the price of raw cotton will make all regions less competitive in yarn production relative to the frontier. Second, a larger shock to the trade cost to British yarn makes domestic producers more competitive. Third, if the region was previously producing yarn, then $a_{ct}^i > a_{c0}^i$, meaning the region is, all else equal, more likely to remain competitive at producing yarn despite the shock. I now examine the conditions under which regions switch into and out of production of C.

Switching into C: A necessary condition for an economy i which was not producing prior to the shock to switch into production is that $\Delta t_i > \Delta\tau$ and $\frac{1}{a_{ct}^j} + t_{ij} < \frac{1}{a_{c0}^i}$. The first condition is trivial, domestic production will only become more profitable if the shock to output prices outweighs the shock to input prices. Second, insomuch as economy j was producing prior to the trade shock, increase in productivity cannot have been large enough to outweigh the trade costs between the two regions, otherwise j will continue to have a comparative advantage in producing C as t_{12}, the trade cost between the two follower regions remains unchanged. Sufficiency requires the difference between Δt_i and $\Delta\tau$ to be large enough such that the inequality in equation 3 is reversed.

Switching out of C: A necessary and sufficient condition for an economy which was previously producing to switch to importing C from the frontier is $p_c^F + t_j' < \frac{1}{a_cjt} + p_r + \tau$. Furthermore, any economy i outcompeted by the frontier producer at home will also necessarily be outcompeted in j because of the triangle inequality.

In light of these results, the Napoleonic Wars provide a quasi-laboratory setting where we can examine how cotton production reacted to changes in the competitive environment in the short and long term. Large variation in the size of the shock to output prices, together with a non-negligible increase in input prices introduced exogenous variation to the level of competition across the Empire.

In the short run, given that the shock to raw cotton prices across regions was similar, we expect regions which received a larger shock to their effective distance to Britain to expand their production to a larger extent, than regions which received a smaller shock.

Second, in the longer-term, if dynamic externalities of the type highlighted in this model are important, we expect regions which were able to scale up production to be more productive than regions which remained more exposed to trade. For sufficiently large productivity differences, integration of the two economies as described in the third point of dynamic equilibrium is also possible. In the next two sections, I show that consistent with these predictions, department across the French Empire which received a larger trade shock (1) scaled up production to a larger extent than regions which received a smaller shock, and (2) in the longer run, these regions were not only more productive, but production became more concentrated in these areas.

5 Data

To analyse the question of how the rupture to trade relations effected the development of mechanised spinning within the French Empire during the Napoleonic Wars, I collected data from various primary sources. The most important of these are the Lloyds List, which is the source for port level shipping data presented in Section 3, handwritten prefectural reports from Archives Nationales in France used to construct the panel dataset of mechanised spinning capacity examined in Section 2, and the Journal du Commerce, from which I collected raw cotton prices and was also examined in Section 2. Examples of the original data are provided in Figures 22 and 23 of Appendix D.

I first describe these data and then discuss how I use the theoretical framework to construct a measure of the trade cost shock that can be used in the empirical analysis.

5.1 Industrial surveys measure mechanisation in cotton spinning

Data on the cotton industry is observed at various points in time during the Napoleonic Wars. Data on all time periods is available for 88 of the 111 departments that formed a part of the French Empire in 1803, 1806 and 1812. The most systematic data collection was conducted in 1806 and then tri-yearly from 1810 onwards, but less systematic evidence is available in intermediate years too. Historians have described data from the Napoleonic Empire as the golden age of statistics, as the Imperial administration went to extensive efforts to collect systematic data on all branches of industry and society (Gille, 1980). This remarkable effort means that firm level data is available for French cotton spinners at a very early stage of their development. To appreciate the importance of this data, it is worth noting that no similar data source is available in Britain for the 19th century.

Prefects in each department received four questionnaires in January 1806, one for each branch of the cotton industry; hosiery, mechanised spinning, weaving and printing.[36] Regarding mechanised spinning, the following firm level variables are observed: age of the firm, name of the entrepreneur, number of mechanised spinning machines, number of workers, output, and yarn count (measuring the finesse of the yarn produced) and source of raw cotton. Around half the firms also reported the number of spindles that each machine had. Using this information together with the other firm level variables, I have imputed the average number of spindles for the firms where this data is missing. By aggregating the firm level data up to the departmental level, I have a measure of the number of spindles by department.

As one aim of the census was to evaluate how the industry had developed since the onset of the war in 1803, the questionnaire also asked for the number of machines in 1803 which coincides with the British blockade the North Sea Coast. Using this information, I have also been able to construct a measure of spindles at the departmental level in 1803.[37]

Data on spinning is only observed at the departmental level from 1810 onwards. Prefects were asked to send tri-yearly reports on the state of various branches of industry in their departments including cotton. I observe number of spindles, number of workers and output at the departmental level. The reports were intended to inform the government in Paris about fluctuations in industrial activity. For this reason, there are sometimes large fluctuations in the numbers reported. Furthermore, some prefects reported capacity while others reported active spindles. To gain the best possible measure of capacity, I utilise the reports in the following way. In general, I take data from the year 1812 as this is the year closest to the end of the Blockade where data coverage is still sufficiently large.[38] However, if the number of spindles was larger in earlier reports (1810-11), I use these years. In the letters sent to Paris, prefects usually indicate whether firms have gone bankrupt or whether they are idle for cyclical reasons. I don't use earlier numbers in instances where it is clear that activity in 1812 is lower because firms have gone bankrupt.

5.2 "Journal du Commerce" for Raw cotton prices

Daily raw cotton prices were sporadically reported for various cities during my period of interest in the Journal du Commerce, the commercial newspaper of the time. Within each category of cotton by supplying region (Levant, US, Colonial, Brazilian), the exact variety of cotton was matched for a southern and northern city within a short interval of time (within a few days to within a month) for the best comparability possible. Northern cities are: Anvers, Lille, Rouen, Paris, Havre or Gand. Southern cities are Bordeaux, Marseille, Toulouse, Lyon and Bayonne. For Levantine cotton, it was possible to match Marseille to a northern city

[36] Chassagne (1976) contains a detailed historical discussion on the census

[37] Further details about the construction of the dataset are available in Appendix C.

[38] As Napoleon's power unravelled, and troops invaded the territory of France, fewer and fewer departments submitted their reports.

for each year. These data were supplemented with London prices for Brazilian cotton from Tooke (1848).

5.3 Lloyd's List to measure changing trade routes

Shipping data was extracted using all editions of the Lloyd's List between 1787-1814. The Lloyd's List, one of the world's oldest newspapers was set up by Lloyd's Coffee House in London, which was a meeting point for underwriters of marine insurance at the time. The underwriters needed up to date news on shipping conditions, and for a small subscription fee Lloyd's provided what was generally acknowledged to be the most up to date shipping bulletin of the time. Lloyd's hired paid correspondents in each port to send information on ships arriving to or departing from a given port to the Post Master General with the word "Lloyds" written in the corner. Each edition featured news on ships sailing from and arriving to various ports. The coverage on arrival and departure of ships to all ports in Britain is believed to be a fairly reliable and representative source of information at the time (Wright and Fayle, 1927).

Editions of the Lloyd's List have been digitised by Google. To extract data from this source, I used an OCR programme to convert the images into machine-readable format and then used a text-matching programme that searched for the names of European ports in the Lloyd's List. As port names have changed over time, and even within the time frame that I examine, numerous port names or spelling was in use for the same port, the names of ports were collected by manually searching through editions of Lloyd's Lists. There are multiple sources of measurement error inherent in this procedure. First, the OCR and text-matching programme introduce measurement error both in the form of matching mistakes and omitted names (the ones that could not be matched, or the European ports which I did not identify as such). By comparing samples to the original, I found that incorrectly matched names were minimal, and that the procedure picked up about 70-80% of the ports depending on the quality of the image. Finally, I also had one year (1808) manually entered in order to check that the sample with which I work is representative. There are around 3000 observations for each year.

One potential problem with this data source is that for some years during the blockade, parts of the Lloyd's List were censored to protect smugglers and full information was only provided to insurers at the "Books and Notice Boards in the Subscribers' Rooms" (Wright and Fayle, 1927). Though the censoring will undoubtedly lead to measurement error in quantifying the trade routes, there are a number of reasons to believe that the extent of the measurement error is not large and should not effect my results. First, censoring was only place for part of the Blockade period, and uncensored and censored years show a very similar pattern. Second, the findings from the Lloyd's List are consistent with both historical evidence and other sources of quantitative evidence (British trade statistics). Third, I construct two measures of the trade cost shock, only one of which relies quantitatively on results from the Lloyd's List. Results are robust to instrumenting one measure of the shock with the other.

To conduct falsification checks, I have also collected data on woollen spinning and tanneries across the French Empire. Robustness checks are conducted using data on mean streamflows of rivers, access to coal, a measure of human capital, a measure of institutional change, conscription rates and capacity on weaving in downstream cotton. Data on long term effects are from raw cotton imports for Continental Europe from Mitchell (2007) and firm level data from the first industrial census from Chanut et al. (2000). A more detailed description of these sources is found in Appendix C.

5.4 Quantifying the trade cost shock

The theoretical framework predicts that changes in mechanisation are driven by changes in the trade cost to Britain. I use this insights to construct a measure of the trade cost shock. I construct a second measure of the trade cost shock based on the historical context. Under the assumption that measurement error in the two are uncorrelated, one is a valid instrument for the other, which I exploit in the empirical analysis.

1. **Measure 1: Cost-Distance**

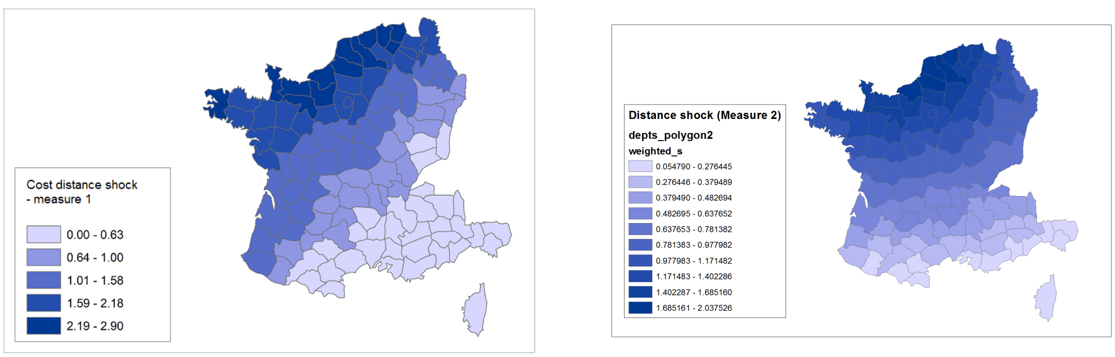
   The first measure uses a shortest route algorithm to calculate the distance between London and the prefecture of any department. I account for one of the most important drivers of increasing trade costs - the difference between water- and land-borne routes, by calibrating the ratio of the two to match the fact that during this period sailing from Rouen to Marseille was 2/3 the cost of going overland (Daudin, 2010). Using this evidence, 1 sea kilometre is equivalent to about 0.15 kilometres on land. Pre-Blockade distance is calculated as the direct shortest route between London and the mean distance to any department. Any port that was in use between 1787-1814 (the years for which shipping data has been extracted) can be used to reach the department.

   To calculate the shortest route between London and the departments during the Blockade, I use historical accounts of smuggling routes discussed in Section 3. In particular, I take Malta, Gibraltar, Gothenburg and Heligoland as the smuggling centres to which goods arrived from London. To make it to France, these goods could either take the Northern overland smuggling route via Strasbourg, or a Southern smuggling route via Trieste, Bilbao or Barcelona. Trieste is a documented smuggling centre, while free shipping in Spain implied that water-borne routes could be used to get goods close to the French border. As Measure 2 will make clear, direct shipping between London and Northern ports in Spain increases to such an extent that Corunna will be classified as a smuggling centre in its own right. This implies that assuming goods came to Northern

Spain via Malta or Gibraltar (from London) is a conservative estimate, as - at least for some years - cheaper Spanish routes were in operation.

For any department i, the algorithm then picks the least cost path. The trade cost shock, defined as the log change in the shortest route to London by department, can be seen in Figure 11, where darker shading shows a larger shock. As expected, departments along the Channel have the highest cost-distance shock. However, the shock worked in a more complicated way than simply increasing from South to North. For example, the departments along the Rhine witnessed almost no increase in their effective distance to London by virtue of their proximity to Strasbourg, the route via which goods entered the department. The routes that goods took prior to the Blockade were almost identical to the routes which they took during the Blockade. In contrast, the Atlantic seaboard witnessed a much larger increase in trade costs, as these departments initially had relatively cheap access via sea-routes, which were not available during the Blockade.

Figure 11: Two measures of the cost-distance shock



(a) Effective distance to London shock (Measure 1)

(b) Effective distance to London shock (Measure 2)

Measure 1 uses a shortest route algorithm to calculate the log-distance between the department and London before and during the Blockade. Measure 2 calculates the distance shock in the following way. Pre-blockade distance is simple Euclidean distance to London. Distance to Britain during the Blockade is calculated as the weighted Euclidean distance between Britain and smuggling centres. Smuggling centres are identified as ports where shipping during the Blockade exceeds 80 yearly shipments, and weights are the share of a given smuggling centre in total smuggling. The log-difference between the two gives the shock. See text for details.

2. **Measure 2: Weighted Distance**

The main source of measurement error in the cost-distance shock stems from the fact that it does not account for capacity constraints and periods where smuggling centres were not open. As I have shown, military events played a role in which areas of the Continent were more or less were open to trade and this variation had a time dimension to it. For example, in years where the Blockade in the North was almost perfectly enforced, goods made their way into Continental Europe exclusively via the South. The second measure therefore focuses on capturing the intensity of use of any smuggling centre between 1803-12 instead of the shortest route approach.

To capture the intensity of port-usage, I use the Lloyd's List to identify ports that were intensively used during the Blockade. A smuggling centre is defined as a port where the number of ships sailing to or from Britain and the given port in any of the Blockade years between 1803-1812 was greater than the amount of ships in any of the years before the onset of the Blockade for which we have data (1787-1802). I use this condition in order to avoid mis-classifying ports which happen to be open to trade with Britain but are not used as smuggling centres. This is a strict condition because shipping to Europe in general decreases, so any port that shows an increase in absolute numbers, should play a role in the new commercial routes. To focus on the quantitatively important smuggling centres, I further refine this measure by using only the ports where the maximum yearly shipment in a Blockade year exceeds 80. The threshold is not particularly strict, as large and important smuggling centres such as Malta have above 300 shipments in peak years.

Based on these conditions, the quantitatively important smuggling centres are: Cadiz, Corunna, Gothenburg, Gibraltar, Heligoland, Lisbon, Malta and Tonningen (which was used between 1803-05). These ports (with the exception of Corunna, whose share is below 2%) all play a prominent role in the historical literature as smuggling centres for British goods as was discussed in previous sections.[39]

The final step is to quantify the relative importance of each centre. I take total shipments between 1803-1812, the Blockade years, and subtract total shipments between 1793-1802. The difference between the two is a crude measure of smuggling. Weights are calculated based on a port's share of total smuggling. Shipments to the Southern smuggling centres account for roughly 70% of total smuggling.

Pre-Blockade distance according to this measure is proxied by Euclidean distance to London, while distance during the Blockade is given as a weighted average of the Euclidean distance to each smuggling centre. I measure distances in this way to capture the idea that supply in the North (ie. Heligoland, Gothenburg and Toning) is plausibly below demand and part of North's demand is satisfied via shipments from the South. Note that by calculating distances in this way, I am being conservative with estimates of the distance shock in the sense that while there is evidence for trade flowing in the South-North direction, (eg. from Malta to the Northern parts of Europe) there is no historical account of trade flowing in the North - South direction (eg. from Heligoland to Southern Europe). This makes sense, seeing as the binding supply constraint was in the North and not in the South. In this way, the measure is probably overestimating the South's distance shock relative to the North stacking the cards against finding an

[39] Cadiz, close to Gibrlatar, played a role similar to Gibraltar as it was under British control for most of these years.

effect of distance on capacity.

6 Empirical Strategy and Results

The theoretical framework presented in Section 4 predicts that a sufficiently large increase in the distance to the frontier will result in departments switching into domestic production in mechanised spinning. The exogenous variation in effective distance to London provides us with a setting which we can use to take theory to the data. Figure 18 in Appendix B takes a first look at the relationship, by showing the scatterplot for the change in spindles per thousand inhabitants as a function of the cost-distance shock for the 88 departments in the sample during the period 1803-1812. There is a clear positive relationship between the two; departments which received a larger trade cost shock also increased their spinning capacity more.

The effect of increased protection on mechanisation in cotton spinning is estimated using the following difference in difference specification, with continuous treatment intensity:

$$S_{it} = \alpha_i + \delta_t + \gamma lnD_{it} + \epsilon_{it} \tag{5}$$

where S_{it} is the number of spindles normalised by departmental population, lnD_{it} is a measure of effective distance to Britain in department i at time t, α_i controls for time-invariant fixed effects at the departmental level, and δ_t controls for the effect of aggregate shocks over time. γ is the parameter of interest, which we expect to be positive if effective distance to Britain is an important driver of mechanisation.[40]

Identification of the effect of British competition on mechanisation in cotton spinning relies on standard assumptions common to difference-in-difference estimators. In particular, it assumes parallel pre-treatment trends and the absence of shocks contemporaneous to, and correlated with the effective distance shock. In the empirical analysis, I address both issues in various ways and show why these assumptions are likely to hold. Before presenting the estimation results, I begin first by examining the extent to which "pre-treatment" firm and departmental level variables differ across areas receiving a lower or higher cost-distance shock. Table 6 in Appendix A divides firms and departments into two groups depending on whether they are above or below the median of the cost-distance shock (defined as the log change in effective distance to London - measure 1).

[40] As is well known, the first-differenced equation, which corresponds directly to the predictions of the theoretical framework, yields identical point estimates, however the standard errors aredifferent. In practice, I estimate equation 5 in order to account for clustering at the departmental level.

For the majority of firm and departmental level variables, there is no statistically significant difference in means between the two groups. This is a stronger statement than what is needed for identification in the DID setting, as - conditional on parallel trends - differences in levels do not undermine identification. Only the quality of yarn spun by the firm is significantly higher for high-trade cost shock firms (at 10%), while conscription rates are higher for low trade cost shock departments (at 5%). In general, based on the point estimates, firms in low trade cost shock areas seem to have been initially larger, both in term of capital and labour employed. This is reassuring from the point of view that larger firms seem to have had an advantage both in terms of better access to raw cotton during the volatile years of the Napoleonic Wars, and in terms of access to a larger market for their output as a result of their size.[41]

In terms of the departmental level variables, significantly higher conscription rates in low trade-cost shock departments are reassuring for our empirical strategy, as conscription rates are used to control for the effects of a potentially uneven labour supply shocks driving mechanisation. The fact that it is the low-trade cost shock departments which had a higher negative labour supply shock, works against a factor price confounder driving the results. The point estimates for mean spinning and weaving capacity at the departmental level are somewhat higher in high-trade costs shock locations, but this is to be expected based on the historical location of the cotton industry.

6.1 Baseline Results

Table 1 contains the results from estimating equation 5. The dependent variable in all columns is spindles per thousand inhabitants.[42] The estimated coefficient is large, and statistically different from zero across all specifications. The point estimate of 33.11 in column (1) implies that moving from the 25th to the 75th percentile of the distance shock leads to a predicted increase in spinning capacity per capita that is slightly smaller in size than the mean per capita spinning capacity across departments at the end of the Blockade. Standard errors are clustered at the departmental level, as Conley's standard errors, which account for spatial correlation, tend to generally give a smaller standard error.

Column (1) estimates the equation using the full sample, while columns (2) and (3) restrict the sample. In Column (2), I show that the effect of protection from the British is

[41]See Section 2 for a discussion.

[42]The baseline specification estimates the equation in levels because of the large number of zeros in the data, but I show that the results are robust to estimating the model as a Poisson conditional fixed effects regression (Table 8 in Appendix A). I divide by departmental population to control for the fact that larger departments may increase spinning capacity by more than smaller departments in response to the same shock simply because of their size, but results are similar when the equation is estimated in levels. The distance measure used is the trade cost shock (measure 1).

quantitatively similar and statistically significant, if the sample is restricted to Northern departments, which are defined as those with higher than median latitude in the sample. This shows that the effect is not estimated simply off a crude "North"-"South" comparison. Rather, the effect of changing market conditions seem to have a continuous effect, exactly as the framework would predict. Second, column (3) restricts the sample to the borders of France as of 1789. This is one way of demonstrating robustness to institutional change,[43] as radical reform ensuing from the French Revolution had the longest and most even effect on these departments. It is also a useful benchmark, as both the falsification tests and the long-term effects are estimated using this sample because of data constraints.

Column (4) instruments the cost-distance measure using the second measure of distance. Consistent with endogeneity resulting from measurement error, the point estimate increases in size by about 20%. Finally, calculating distance from London may not be a good approximation to the distance shock, if cotton was exported predominantly from other ports. Crouzet (1987) identifies London and Liverpool as the main centres from which cotton was exported. For this reason, Column (7) calculates the distance shock using Liverpool as the source port in Britain instead of London. Again, the estimated coefficient is somewhat larger, but similar in magnitude.

Table 1: Baseline estimation results

Spindles per '000	(1) Full sample	(2) North	(3) France	(4) 2SLS	(5) Full sample
Cost distance (Lo)	33.11***	33.82*	40.77***	42.10***	
	(9.775)	(17.11)	(12.44)	(10.29)	
Cost distance (Li)					38.56***
					(12.73)
Time FE	Yes	Yes	Yes	Yes	Yes
Departmental FE	Yes	Yes	Yes	Yes	Yes
Observations	176	88	142	176	176
R-squared	0.337	0.376	0.362		0.290
Number of dept	88	44	71	88	88

The dependent variable is spindles per thousand inhabitants across all columns. Column (1) contains the baseline estimate for measure 1 of the cost-distance shock using London as the source city. Column (2) restricts the sample to departments with higher than median latitude in the sample. Column (3) restricts the sample to "ancien regime" France, Column (4) contains the 2SLS estimates where measure 1 of the trade-cost shock is instrumented with measure 2. Column (5) uses Liverpool as the source location instead of London. Standard errors clustered at the department in parentheses, *** p<0.01, ** p<0.05, * p<0.1

[43] I use a different measure to control for uneven institutional change in Table 2 which includes the full sample.

6.2 Robustness

In this section, I show that the effects of the cost distance shock are robust to controlling for the time-varying effect of a number of variables that are plausibly important for mechanisation. Furthermore, I show that the effect of the cost distance shock has no statistically significant effect on two closely related industries whose products are less intensively traded with Britain, and where technological change is absent; woollen spinning and leather. Together, these results make it unlikely that an unobserved confounder contemporaneous to, and correlated with the trade cost shock is driving my results.

First, Table 2 adds a range of variables which plausibly effect mechanisation in cotton spinning. Across all columns, the coefficient of interest remains highly significant and relatively stable. In Column 2, I examine the time varying effect of location fundamentals such as access to fast-flowing streams and coal deposits. The literature has argued that both these variables were important determinants of the location of the cotton industry. Recently, Crafts and Wolf (2012) have found that in Britain, access to fast flowing streams was a particularly important factor in Lancashire's dominance of the British cotton industry. In my analysis, neither have a statistically significant effect, more importantly the point estimate for the cost distance shock is left virtually unchanged. In the case of coal, the result is not particularly surprising, as steam-power only begins to play a more important role in cotton in later decades of the 19th century. It has also been argued that France was well endowed with fast flowing streams across various parts of the country, and as such, this was not a decisive feature in determining the location of cotton spinning. Figure 19 in Appendix C confirms that access to water power was available across various parts of France. In particular, the area around Lyon seems to have enjoyed particularly good access to fast flowing streams - something which may explain the high concentration of mechanisation in the Loire and Rhone department in 1803.

In Column (3), I explore robustness to adding a measure for human capital across departments interacted with the time dummy. Human capital is measured as the proportion of men able to sign their wedding certificates by department as reported in Furet and Ozouf (1982). The estimated coefficient is large and highly significant, which is somewhat surprising as other studies have struggled to find an important role for human capital measured in this way, at the onset of industrialisation (Squicciarini and Voigtländer, 2014). The coefficient of interest remains highly significant and the point estimate increases somewhat in size.

In Column (4), I address a particularly important confounder - the role of factor price shocks. In Section 2, I discussed the factor price hypothesis as one of two prominent alternative explanations for the slow diffusion of spinning technology across France. According to this hypothesis, labour was relatively expensive in Britain and cheap in France rendering capital biased technological change profitable in the former, and adoption of the new technology unprofitable in the latter (Allen, 2009).

Given this argument, an uneven factor price shock across the French Empire may have rendered adoption of the new technology relatively more profitable in some regions rather than others. During the Napoleonic Wars, conscription was consistently high, and somewhat uneven across departments (Forrest, 1989). This is precisely the type of negative labour supply shock which could drive up wages and push cotton spinners into substituting expensive labour for cheaper capital. For this reason, I collected statistics on conscription by department from Hargenvilliers (1937), and in Column (4), I add a control for the time-varying effect of conscription rates in 1804-05. The point estimate for the cost-distance shock is virtually unchanged. The effect of conscription, while statistically indistinguishable from zero, has the the expected positive sign.

Table 2: Robustness to the inclusion of additional explanatory variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Spindles per ’000							
Cost distance (Lo)	33.11***	34.67***	41.50***	33.56***	22.33***	33.00***	28.78***
	(9.775)	(10.51)	(12.44)	(9.600)	(6.984)	(9.715)	(9.006)
Streams x Time		0.119					-0.799
		(1.155)					(1.301)
Coal x Time		-4.606					1.336
		(3.749)					(4.204)
Lit x Time			49.25**				47.66***
			(21.32)				(15.10)
Conscript x Time				4.411			9.099
				(11.94)			(9.126)
Dstream x Time					3.303***		3.148***
					(0.522)		(0.495)
Inst x Time						-0.85	
						(0.824)	
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Departmental FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	176	176	126	172	176	176	126
R-squared	0.337	0.347	0.426	0.338	0.576	0.340	0.668
Number of dept	88	88	63	86	88	88	63

Dependent variable in all columns is the number of spindles per thousand inhabitants in each department. The trade cost shock is measured as the log change in the shortest route between London and each department (measure 1). Controls are defined as follows: access to fast flowing streams is the (log) of the mean stream-flow of rivers in the department. Access to coal is defined as (log) proximity to coal as in Ferinough - O'Rourke (2014). Literacy is defined as the proportion of men who are able to sign their wedding certificate. Data availability constraints on this measure restrict the sample size to 63. Conscription is the proportion of the population conscripted in 1804-1805. Downstream is a measure of the size of the downstream industry; it is the number of weaving frames in the department per thousand inhabitants in 1803. Institutional change is measured as the data of incorporation into the French Empire. For data sources see Appendix C Standard errors are clustered at the departmental level to account for serial correlation,*** p<0.01, ** p<0.05, * p<0.1

As a further robustness check for factor price shocks, in Figure 20 in Appendix B, I show that the shock does not differentially effect capital-labour ratios across departments in a systematic way. More sophisticated machines with a larger number of spindles substituted for relatively more labour, and thus an uneven factor price shock across the French Empire should alter the capital-labour ratio at the departmental level. Figure 20 shows that this is not the case. The estimated elasticity is small and not statistically significant (point estimate -0.09, se 0.24).

Column (5) controls for the time-varying effect of downstream weaving. Given the importance of local markets at the early stages of development discussed in Section 2, one worry is that mechanisation is simply being driven by demand from downstream weaving. For this reason, I add weaving capacity in 1803 (normalised by population) interacted with the time dummy, to control for the demand side of the market. As expected, the coefficient is positive and significant, implying that higher weaving capacity led to larger increases in mechanised spinning. The effect of the cost-distance shock remains large and statistically significant, though the point estimate decreases somewhat in size.

Weaving mattered somewhat, but the results are not driven simply by the demand side. Recall that handpsinning was still sizeable in France at the time, and thus expansion in mechanisation did not have to lead to a simultaneous expansion in weaving, even if all demand was local. Thus smaller weaving centres, which received a larger shock, could have increased their spinning capacity more than larger weaving departmentseven without an increase in weaving.

In Column (6), I control for the time varying varying effect of institutional change using the approach developed by Acemoglu et al. (2011). In my setting, conquest by France meant annexation, and thus complete adoption of French institutions. For this reason, I use the date of annexation for each department, interacted with the time dummy, to control for the effects of institutional change. Departments belonging to France at the time of its 1789 borders are coded as receiving institutional change in that year. The point estimate on the cost distance shock is left virtually unchanged and remains highly significant, while institutional change enters with the expected negative sign,[44] but is statistically indistinguishable form zero. Finally, the most demanding test for robustness of the cost distance shock is the simultaneous inclusion of all time-varying controls. In Column (7), I add all variables and show that the estimated coefficient remains large, and statistically different from zero.[45]

Table 2 showed robustness to a number of potential confounders. A different approach to showing that the effect I find is indeed driven by changing competitive pressure from Britain is to show that the effect of changing protection from Britain is not present for similar industries which are less intensively traded with Britain and where technological change is not present. Table 3 shows that the effect which I find for cotton spinning is not present for two other industries, wool yarn (a substitute) and leather. Both products are less intensively traded with Britain, and there is no technological change for either. For these reasons, the

[44]Being annexed to France at a later date, at least according to this view, is bad for mechanisation. It should also be notes that the effect of institutional change is indistinguishable from the effect of incorporation into a larger internal market.

[45]In Column (7), I drop institutional change which is highly correlated with the time dummy. The small sample size makes separate estimation of the two infeasible once other explanatory variables are added.

shock should not have a significant effect on the spatial distribution of activity in these industries.

At the turn of the 19th century, both industries were still very much organised as rural, domestic manufacturing in contrast to mechanised cotton spinning. Mechanisation had not been introduced in the woollen industry because of inherent differences in the fibre which made mechanisation of wool spinning more difficult (Landes, 1969). For this reason, in woollen spinning, the dependent variable cannot be anything but labour employed. As I argued previously, wool was not an intensively traded good with the British, and the raw material was also predominantly domestically supplied. Finally, it was an entrenched industry which enjoyed a high level of state support. For example, the army used exclusively woollen products (Bonin and Langlois, 1997). The caveat with using wool spinning is that there may be spillovers from the cotton industry. It is conceivable that in the areas where cotton spinning became widespread, wool spinning was squeezed out.

For this reason, I also collected data on the leather industry. Leather was similarly rurally organised, with some military demand during the period and no significant technological improvement. More than either woollens or cotton, it mostly served local markets and used local supply with access to water being the one locational constraint making it an ideal industry with which to contrast cotton spinning (Bonin et Langlois, 1997).[46]

Table 3 contains the results from estimating the effect of the trade cost shock on capacity in tanning (number of pits), employment in woollen spinning, and, for comparability with the latter, employment in *mechanised* cotton spinning. The estimated effects of the trade cost shock are not statistically different from zero for tanning and woollen spinning, but are large and statistically significant for employment in mechanised cotton spinning.

In the case of capacity in tanning, the positive point estimate is in fact non-negligible. Moving from the 25th to the 75th percentile of the shock leads to a predicted increase in tanning capacity that is equal to about 40% of the mean tanning capacity at the end of the Blockade. However, inspection of the scatterplot in Figure 21 in Appendix B shows that two departments (Var and Ardennes) are extreme outliers. Dropping these leads to a decrease in the point estimate from 0.28 (se 0.21) to 0.03 (se 0.11), which is basically a zero effect.

Consistent with a negative spillover from cotton to woollen spinning, the point estimates in Columns (3) and (4) are negative, albeit not significant. Moving from the 25th to the 75th percentile of the shock leads to a decrease in spinning employment that is about 20%

[46] There are three further considerations which should be taken into account when interpreting the results. First, in the case of both industries, the pre-Blockade data point comes from industrial surveys carried out directly after the French Revolution in 1789. Second, in both cases, the data from the pre-Napoleonic period are generally worse quality simply because the questionnaires were more qualitative in nature. Third, because in this case the first datapoint is in the 1790s (before France's territorial expansion), the sample is restricted to the territory of "ancien regime" France.

Table 3: Falsification test using wool and leather

DepVar	(1) Leather	(2) Leather	(3) Wool	(4) Wool	(5) Cotton	(6) Cotton
Cost distance (Lo)	0.279		-2.228		0.930**	
	(0.215)		(2.919)		(0.390)	
Cost distance (Li)		0.259		-1.689		1.021**
		(0.234)		(3.416)		(0.493)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Departmental FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	122	122	152	152	170	170
R-squared	0.030	0.019	0.194	0.191	0.112	0.095
Number of dept	61	61	83	83	85	85

The dependent variable in columns (1) - (2) is pits per thousand inhabitants employed in leather tanning (measure of capacity), in columns (3)-(4) it is workers employed in woollen spinning and in columns (5)-(6) it is workers employed in *mechanised* cotton spinning. Column (1), (3) and (5) use London as the source port for calculating the cost distance shock, Columns (2), (4) and (6) use Liverpool. Standard errors are clustered at the departmental level to account for serial correlation,*** p<0.01, ** p<0.05, * p<0.1

of mean employment in woollen spinning at the end of the Blockade. The point estimate is also less sensitive to outliers. Repeating the same exercise of dropping the two largest outliers, the estimated coefficient decreases marginally in absolute value from -2.23 (se 2.92) to -2.07 (se 2.01).

The estimated effect on mechanised cotton spinning is large and significant consistent with previous results, though not quite as large as the effect estimated for capital. Moving from the 25th to the 75th percentile of the shock leads to an increase in predicted spinning capacity which is equal to about 75% of the mean employment in mechanised spinning at the end of the Blockade. The finding that the point estimtae effect on employment is smaller than the effect on capital is plausible, as capital should expand to a greater extent than labour as machines with more spindles are increasingly used.[47]

6.3 No pre-treatment trend

The previous section showed robustness to the effect of contemporaneous shocks in a number of ways. I now turn to addressing the question of differential pre-treatment trends. In the absence of similar data for this period, I have constructed an approximation to spindles in 1794 using firm level data from 1806. I take spinning capacity in 1803 for firms alive in 1794

[47]Dropping the two largest outliers leaves the estimated coefficient large and statistically significant. The point estimate decreases from 0.93 (se 0.39) to 0.65 (se 0.29).

as an approximation to actual spinning capacity at the departmental level in 1794, which I don't observe. Of course, this assumes that all growth in spinning capacity took place on the extensive margin and that firms didn't go bankrupt, which will likely be violated. However, for this placebo test to be valid, we only need to make the weaker assumption that bankruptcies and adjustment in spinning capacity at the firm-level between 1794-1803 were not systematically related to the shock.

A piece of evidence suggestive of the fact that the intensive margin is far less important will be discussed in te following section. In particular, I show that, consistent with learning by doing externalities, most adjustment, at least during the initial years of the Blockade, seems to have taken place at the extensive margin. Given this result, we should mostly be worried about the extensive margin of adjustment in the pre-treatemnt period, which is the margin that is observed. The period 1794-1803 is chosen as this time horizon is the same as the treatment period making the estimated coefficient between the two periods comparable. Furthermore, this is also when the Reign of Terror ended in France. Table 7 in Appendix A contains the estimation results. The estimated coefficient for the period 1794-1803 is not only not significant at conventional levels, but the point estimate is also 1/16-th the size of the point estimate for the treatment effect (2.78 vs 33.11).

6.4 Adjustment on the extensive margin

If learning externalities are indeed important, we would expect a substantial proportion of the expansion in spinning capacity to occur at the extensive margin, ie. firm entry. A large intensive margin raises the issue that perhaps the results are being driven by effects internal to the firm. Exploiting the fact that firm level data is available for the initial period of the Napoleonic Wars, ie. during the North Sea blockade (1803-1806), I examine the extent to which adjustment to the shock occurred at the intensive vs extensive margin. In Table 9 in Appendix A I start by estimating the effect of the cost-distance shock at the departmental level for the period 1803 - 1806 (Columns (1) and (3)). The effect is large and statistically significant (point estimate: 8.04, se 2.28 - contrast this to point estimate 33.11, se 9.78, estimated for 1803-12).

I take spinning capacity at the departmental level in 1806, and divide it into an intensive and extensive margin by using firm level information on spinning capacity. I then estimate the effect of the cost-distance shock on the extensive and intensive margin separately. I find that the extensive margin is highly significant and the attributed effect accounts for almost the entire combined effect (point estimate 6.92, se 1.85). In contrast, the effect on the intensive margin is small and statistically indistinguishable from zero (point estimate 1.123, se 0.84). To the extent that this pattern is representative for the full period, the evidence is strongly suggestive of the fact that the driving force behind increasing capacity in mechanisation was not driven by characteristics internal to firms alive in high-trade cost shock areas in 1803.

7 Long Term Effects

The previous section demonstrated that the trade shock induced by the Napoleonic Wars led to a disproportionate increase in spinning capacity in the departments that were better protected from trade with the British. Up to this point, the evidence presented is consistent with inefficient French firms scaling up their production during a period in which they enjoy protection from British competition. This section presents three facts that rule out this hypothesis and are consistent with the predictions of the learning-model.

1. French exports of cotton goods increased after 1815

   Panel A and B of Figure show the evolution of French exports of cotton goods in levels and relative to British exports of the same. French exports initially declined as the Napoleonic Wars drew to a close. The decrease in exports prior to the fall of Napoleon can be explained by a number of events. First, from 1813 onwards military activity was taking place within the borders of the French Empire and prefectural reports from this period indicate that some cotton mills were inactive for this reason. Second, the borders of France were redrawn at the Congress of Vienna in 1815. Important cotton spinning regions in present-day Belgium were detached from the Empire. Third, as British exports to the Continent could again take the the cheaper, direct routes, competition in exports markets and in France became higher.[48]

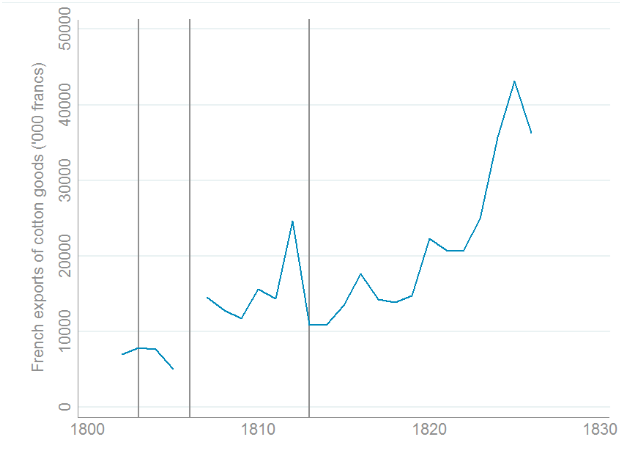
   Following this initial dip however, exports of cotton goods increased continuously, providing evidence that French firms were able to compete at world market prices after peace to the Continent was restored. Furthermore, Panel B shows evidence of modest catch-up vis-a-vis Britain. French exports of cotton goods grew faster over this time period than British exports.

2. Emulation of Britain's success in cotton was difficult

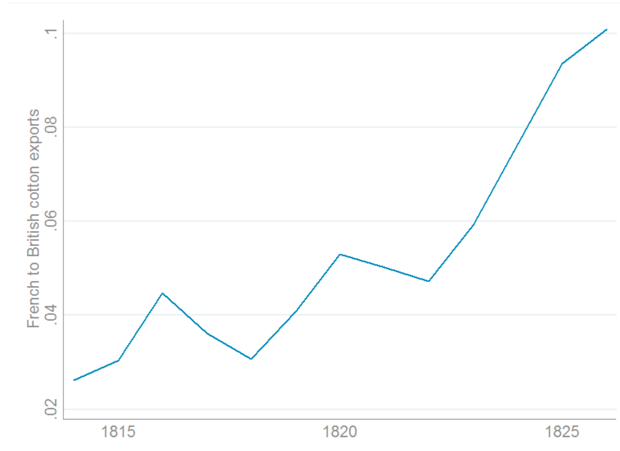
   Figure 13 shows evidence that contradicts the idea that slow-technological diffusion meant that, with time, Continental European countries would inevitably follow Britain's path to industrialisation. Even as late as 1851, at the time of the Chrytsal Palace Exposition in London, Britain's absolute dominance in industry in general, and cotton in particular was evident (Landes, 1969). In cotton spinning, there were two countries, France and Belgium - both part of the French Empire up to 1815, that outperformed the rest of Continental Europe in terms of cotton spinning.

   Figure 13 follows the evolution of raw cotton consumption per capita for various Continental European countries between 1830-50. Raw cotton is a proxy for cotton spinning as this is the primary (imported) input used in production. The size of the industry across Europe in 1850, over 30 years after the end of the Blockade was significantly

[48]French producers faced domestic competition only for a short period of time as the government soon placed a non-tarrif barrier on imports of cotton goods (O'Rourke and Williamson, 1999)



(a) French exports of cotton, Fr



(b) French vs British cotton exports

[1] Panel A displays the time series of French exports of cotton goods in '000s francs during and after the Napoleonic Wars. Panel B shows the same as a ratio of Britain's exports of the same. See Appendix C for data sources.

smaller in all other countries. Note in particular, that Sweden, Britain's most consistent ally throughout the Napoleonic Wars and a key smuggling centre for British products, had no cotton spinning to speak of even in 1850. Note also the time series for the Dutch, as well placed by their proximity to Britain as Belgium and Northern-France to benefit from technology flows, but less well protected during the Napoleonic Wars. The Dutch and Belgian regions were in fact one country between 1815-1830 giving them an even closer source for technology adoption after 1815. With institutions that rivalled Britain's, they are as close to an ideal counterfactual as one could hope. The fact that they have a very small cotton industry according to the data and in line with other historical evidence (Mokyr, 1976), is strongly suggestive evidence against both the claim that emulation was inevitable, and the claim that it was related to distance to Britain.

3. Areas within France which received a higher trade were more productive cotton spinners in 1840

   Data from the first French industrial census of firms conducted between 1839-47 provides information on the spatial distribution of spinning activity.[49] Figure 14 shows the spatial distribution of cotton spinning employment across departments. The figure makes clear that the concentration of industry in the North and North-East became more pronounced over time. A learning externality would imply that with time, firms that are located in areas which received a larger trade shock become more productive

[49] The data was digitised by Chanut et al (2000).

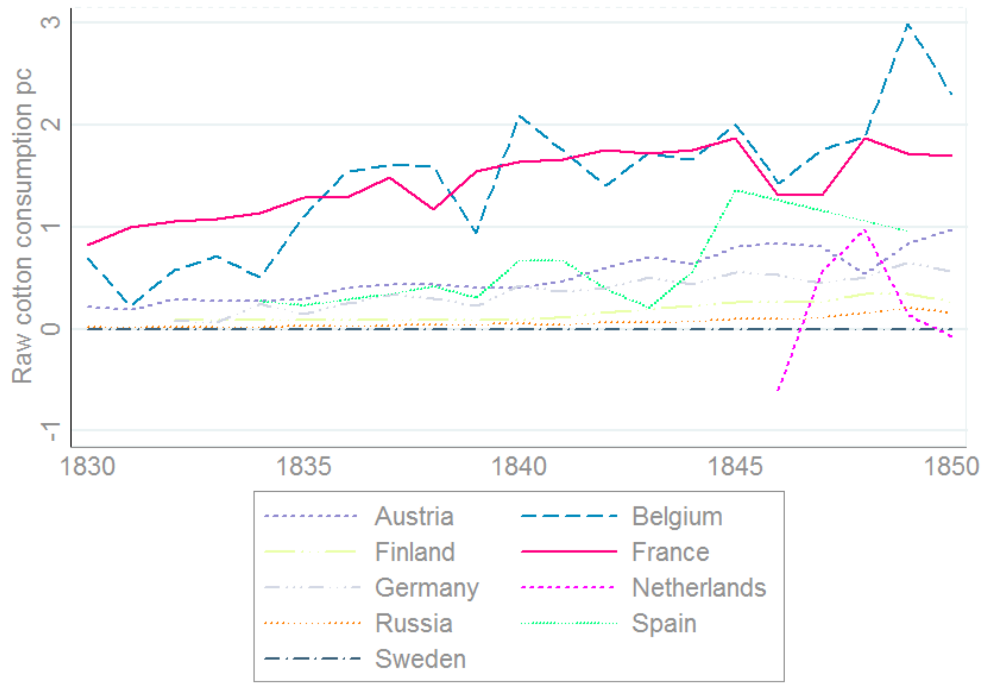


Figure 13: Raw cotton consumption per capita (Mitchell, 2007)

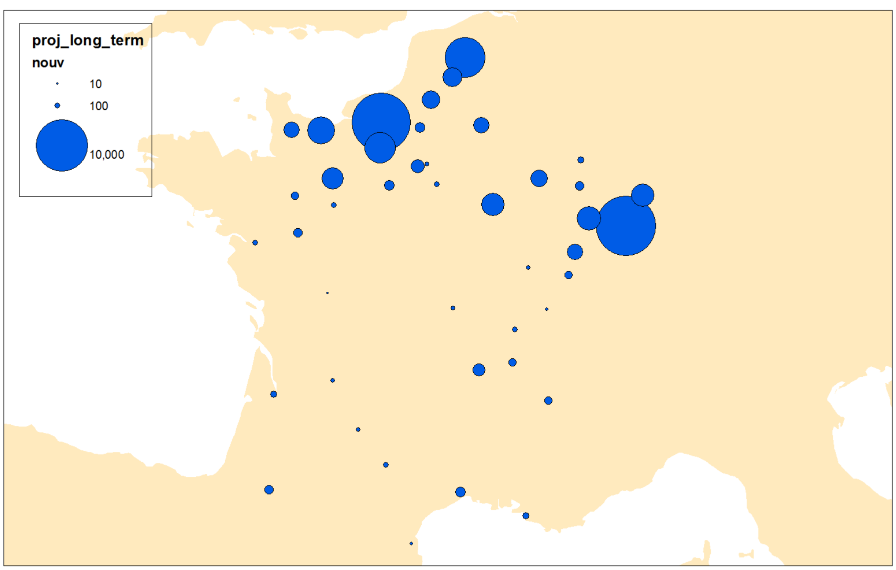


Figure 14: Employment in cotton spinning, 1839-41 (Source, Chanut et al., 2000)

as they moved down their industry-wide cost curve. Table 4 shows evidence consistent with this prediction. In these regressions, I examine whether labour productivity at the firm level is associated with the distance shock. In particular, I estimate the following equation.

$$A_i = \alpha + \beta T_i + \gamma' X_i + \epsilon_i \tag{6}$$

A_i is the log of sales per employee for firm i, T_i is the log-distance shock and X is a matrix of controls. The results of this estimation are presented in Table 4. The elasticity of productivity with respect to the trade shock enters with a positive and significant coefficient across specifications. A one standard deviation increase in the shock leads to a 20-40% standard deviation increase in the predicted log-(productivity). The results are robust to introducing both firm level (firm size, source of power, share of children and female employed) and departmental (population and total sales) controls. Furthermore, the results are robust to trimming the top and bottom 1% of the data (in terms of productivity) to remove the largest outliers.

Taking these facts together makes a strong case for the claim that temporary protection from trade with the British in parts of the French Empire led to the development of a modern cotton spinning sector that was viable in the long term.

8 Conclusion

This paper has documented a sequence of events which suggests that in some settings, infant industries can benefit from temporary protection from trade. The preceding argument has demonstrated that starting from similar initial conditions, the invention of mechanised spinning in Britain led to enormous gains in productivity. Continental Europe did not follow Britain's lead. Mechanisation in France prior to the Blockade proceeded slowly. The price of both yarn and capital (spinning jennies) was higher in France rendering French producers uncompetitive.

The trade shock caused by the Napoleonic Wars led to plausibly exogenous variation in the extent to which trade routes between the French Empire and departments were affected. The paper has shown that regions which received a larger shock were also the ones which scaled up production in mechanised cotton spinning to a larger extent. Temporary protection proved to have persistent effects. French exports of cotton goods increased after 1815 relative to British exports of the same. We do not find similar increases in production capacity in areas of Continental Europe outside the French Empire. Finally, French producers were not only more numerous in the North in 1840, they were also more productive.

The external validity of this particular setting is of course questionable. What can developing

Table 4: Long term effect on within country spinning productivity

	Full Sample			Trimmed (Top-Bottom 1%)		
	(1)	(2)	(3)	(4)	(5)	(6)
Sales per Employee (1840)						
Distance shock (Lo)	0.105***	0.128***	0.205***	0.131***	0.143***	0.216***
	(0.0288)	(0.0191)	(0.0343)	(0.0281)	(0.0187)	(0.0303)
Firm Size		0.275***	0.276***		0.196***	0.209***
		(0.0518)	(0.0470)		(0.0287)	(0.0282)
Share children		-0.649**	-0.680**		-0.515*	-0.569**
		(0.292)	(0.268)		(0.297)	(0.276)
Share women		-0.640**	-0.692***		-0.493*	-0.550**
		(0.262)	(0.246)		(0.256)	(0.248)
Water power		-0.0734	-0.0933		-0.0230	-0.0506
		(0.0885)	(0.0788)		(0.0810)	(0.0708)
Steam power		-0.275***	-0.231***		-0.195***	-0.147***
		(0.0511)	(0.0437)		(0.0605)	(0.0478)
Population 1801			-0.301***			-0.363***
			(0.100)			(0.0980)
Spinning Activity			0.00456			0.0280*
			(0.0178)			(0.0155)
Observations	531	530	530	520	520	520
Number of clusters	43	43	43	40	40	40
R-squared	0.043	0.287	0.300	0.098	0.264	0.292

Notes: Depvar is the log of sales per employee, *Firm size* is proxied for by the log of primary material used (value), *Share women* and *Share children* is the share of the respective category in total employment (excluded is men), *Water power* and *Steam power* are binary indicators for power source employed, *Pop 1801* is the log of departmental population in 1801, *Spinning activity* is the log of total sales in cotton spinning in the department excluding the given firm, Standard errors clustered at the departmental level to account for within group correlation,*** p<0.01, ** p<0.05, * p<0.1

countries hoping to expand their manufacturing sectors today learn? There are two aspects to this question. On the one hand, the technological gap between 19th century Britain and France was far smaller than the technological gap between the richest and poorest countries today. On the other hand, technology flows, in some settings, could arguably be faster as a result of better access to information and lower barriers to the exports of machines and labour. To strengthen external validity, future research should focus on gaining a better understanding of the precise mechanisms at work in order to distinguish contexts in which the economic mechanisms underling infant industry work, and also the cases in which they don't.

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Appendices

A Tables

Table 5: Decline in cotton wool imports direct from the source, 1803-13

Direct Imports of Raw Cotton			
	US	Portugal	Levant
1803	30	23	10
1804	32	35	9
1805	21	36	10
1806			
1807	29	45	5
1808	6	21	3
1809	0	0	7
1810	1	0	31
1811	5	0	30
1812	9	0	11
1813	24	0	20

Direct shipping from Portugal (source of Brazilian cotton) and the US becomes increasingly difficult after 1808. Direct shipping refers to imports of cotton wool which have the producing country as the source. In the case of Portugal, it is referred to as the "source" for Brazilian cotton, as all cotton passes through Portugal. Chassagne and Chapman (1991).

Table 6: Pre-treatment differences in means

	Low trade cost shock	High trade cost shock	Difference	N
		Firm level variables		
Spindles	2207.15	1191.03	-1016.11	375
	(925.52)	(278.09)	(966.40)	
Employees	67.68	51.15	-16.53	360
	(14.53)	(12.61)	(19.24)	
Capital labour ratio	27.81	30.18	2.38	358
	(4.97)	(3.14)	(5.88)	
Foundation	1795.42	1797.79	2.38	375
	(1.86)	(0.75)	(2.01)	
Quality yarn	37.23	49.02	11.79*	231
	(3.72)	(4.86)	(6.12)	
Proportion mule jenny	0.32	0.43	0.10	375
	(0.12)	(0.10)	(0.16)	
		Departmental variables		
Spindles (per 000 inhabs)	10.51	14.80	4.30	102
	(5.08)	(4.41)	(6.72)	
Weaving (per 000 inhabs)	1.25	3.66	2.41	102
	(0.59)	(1.57)	(1.67)	
Access to coal	5.24	5.36	0.12	110
	(0.13)	(0.21)	(0.24)	
Access to streams	1.38	1.96	0.59	110
	(0.40)	(0.20)	(0.44)	
Literacy	0.43	0.46	(0.03)	78
	(0.04)	(0.04)	(0.05)	
Conscription rate	1.50	1.33	-0.17**	106
	(0.05)	(0.05)	(0.07)	
Institutional change	1791.55	1790.42	-1.13	110
	(0.74)	(0.37)	(0.83)	

Notes: Low and high trade cost shock are defined at the departmental level. A department is assigned one or the other group depending on whether their trade cost shock is above or below the median. Firm level variables report standard errors clustered at the departmental level, departmental variables report robust standard errors. Spindles and employees is the number of spindles and workers employed at the firm level, the capital to labour ratio is calculated (in levels) as the ratio of the two former variables, foundation is the year in which the firm was founded, while the quality of yarn spun gives the maximum count of yarn spun by the firm. The capital labour ratio has less observations than both spindles and employees because two firms report zero workers, and for these the variable is undefined. The observations for quality of yarn is low, because Belgian departments reports their quality numbers according to a different scale and these are dropped. The proportion of mule jennys gives the proportion of mule jennys to "filature continus". Departmental variables: "Spindles" and "Weaving" are the number of spindles and weaving frames per thousand inhabitants at the departmental level. Access to coal is defined as the log transformation of the inverse distance to the nearest coalfield as defined in Ferinough and O'Rourke (2014). Access to fast-flowing streams is defined as the (log) departmental average of mean water-flow rates. The literacy rate is defined as the proportion of men able to sign their wedding certificate in 1786-90 by department, conscription rate is the number of conscripts per thousand inhabitants in 1804-05, and institutional change is measured as the dat of incorporation into the French Empire. Further details on variables and their definition can be found in Appendix C *** p<0.01, ** p<0.05, * p<0.1

Table 7: **Parallel pre-treatment rends**

	Pre-treatment		Baseline effect
	(1)	(2)	(3)
Spindles per thous inhabs	1788-93	1794-1803	1803-12
Distance shock (Lo)	-0.22	2.78	33.11***
	(0.78)	(1.72)	(9.78)
Time FE	Yes	Yes	Yes
Dept FE	Yes	Yes	Yes
Observations	176	176	176
R-squared	0.003	0.034	0.337
Number of dept	88	88	88

Notes: Col (1) and (2) estimate the effect of the distance shock on spinning capacity for the periods 1788-93 and 1794-1803 respectively, Col (3) contains the baseline specification from Table 1, Col (1) for comparison. Note that the effects estimated in columns (1) and (2) contain adjustment only at the extensive margin. Standard errors clustered at the departmental level, *** p<0.01, ** p<0.05, * p<0.1

Table 8: **Poisson-fixed effects estimation**

	Levels			Per thousand inhabitants		
Spindles	(1)	(2)	(3)	(4)	(5)	(6)
Cost distance shock (Lo)	0.399*	0.552*		0.429**	0.613**	
	(0.209)	(0.295)		(0.198)	(0.270)	
Cost distance shock (Li)			0.700**			0.736**
			(0.314)			(0.290)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Departmental FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	120	96	120	120	96	120
Number of dept	60	48	60	60	48	60

Notes: Depvar in Col (1) - (3) is spindles in levels , (3)-(6) is spindles in per-capita terms, Col (1)and (4) contains the full sample, Col (2) and (5) restricts the sample to “ancien regime” France, Col (3) and (6) use distance to Liverpool instead of London. Standard errors are clustered at the departmental level to account for serial correlation, *** p<0.01, ** p<0.05, * p<0.1

Table 9: Intensive vs extensive margin of firm level adjustment 1803-06

Spindles per thousand inhabs	(1) total	(2) ext	(3) int	(4) total	(5) ext	(6) int
Cost distance shock (Lo)	8.040***	6.918***	1.123			
	(2.286)	(1.849)	(0.840)			
Cost distance shock (Li)				8.949***	7.540***	1.409
				(2.877)	(2.353)	(0.995)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Departmental FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	202	202	202	202	202	202
R-squared	0.322	0.314	0.072	0.275	0.261	0.069
Number of dept	101	101	101	101	101	101

Columns (1) and (3) estimate the full effect of the cost-distance shock for the period 1803-06 using London and Liverpool as the respective source ports. Columns (2) and (4) use only the extensive margin of firm adjustment, while columns (3) and (6) use only the intensive margin. Standard errors are clustered at the departmental level to account for serial correlation,*** p<0.01, ** p<0.05, * p<0.1

B Figures

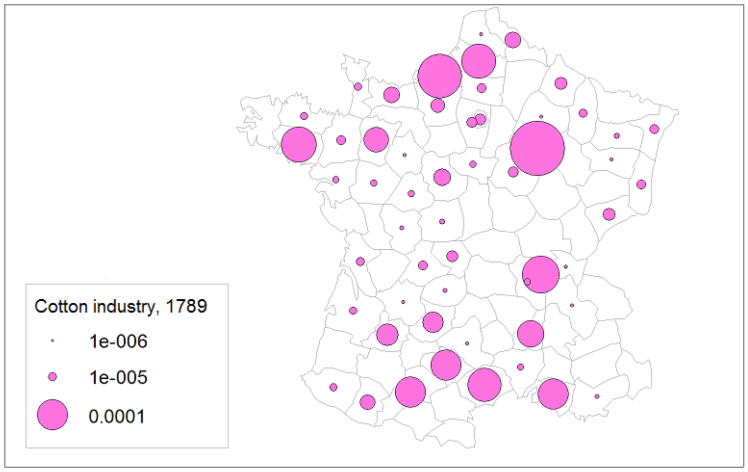


Figure 15: Cotton centres, 1789

Each circle represents the number of districts supplied in cotton goods by all districts in the given department. I normalise the size of departments by population 1811. The data are from Daudin (2010).

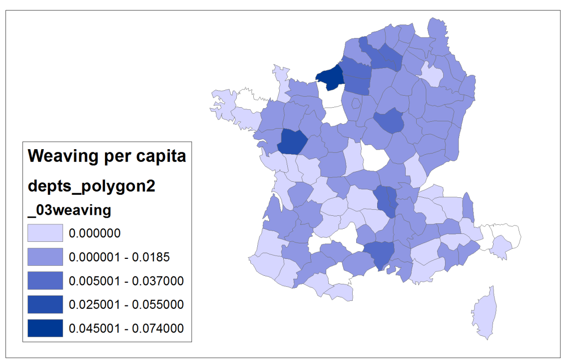


Figure 16: Weaving frames per capita, 1803

Departments are shaded according to the number of weaving frames per capita in the department. Departments left white have not reported data. For data sources see C

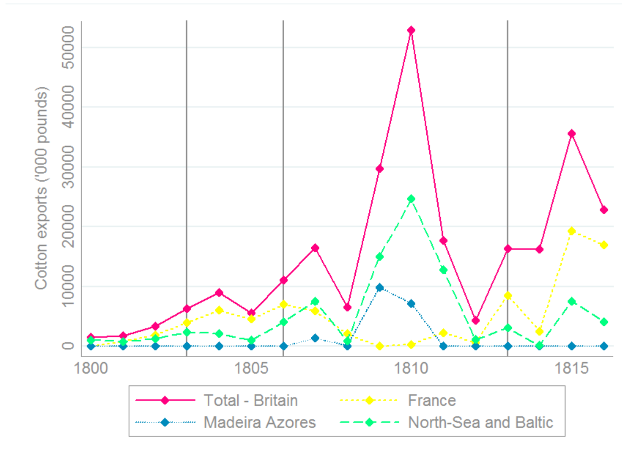


Figure 17: Exports of cotton from the US

The graph shows the changing destination of exports of cotton from the US. Total exports are net of those destined for Britain, as the proportion exported to Britain is so large. The “North Sea and Baltic” category contain exports to Hamburg, Holland, Sweden and Norway, Russia and Denmark. “Madeira Azores” contain Madeira, Azores and Fayal. Data sources are discussed in Appendix C.

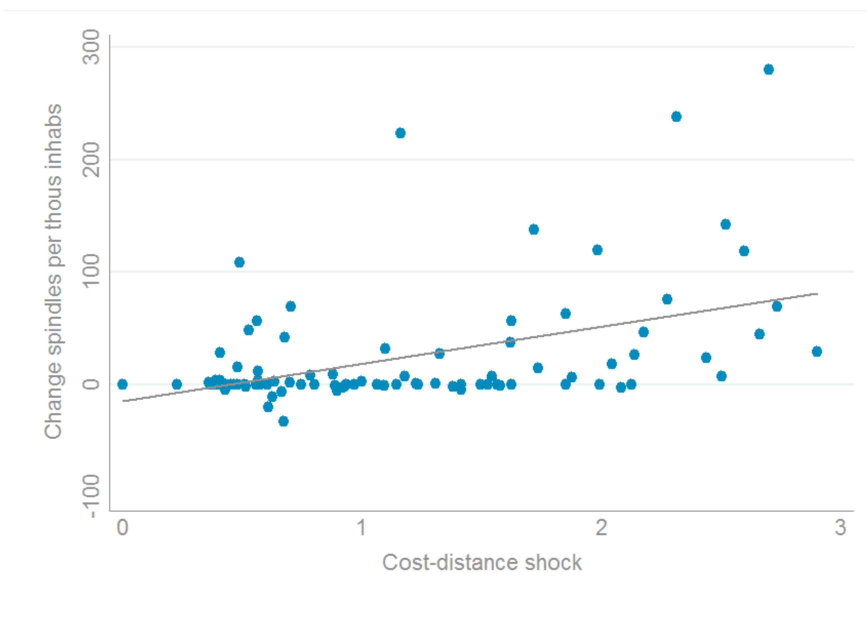
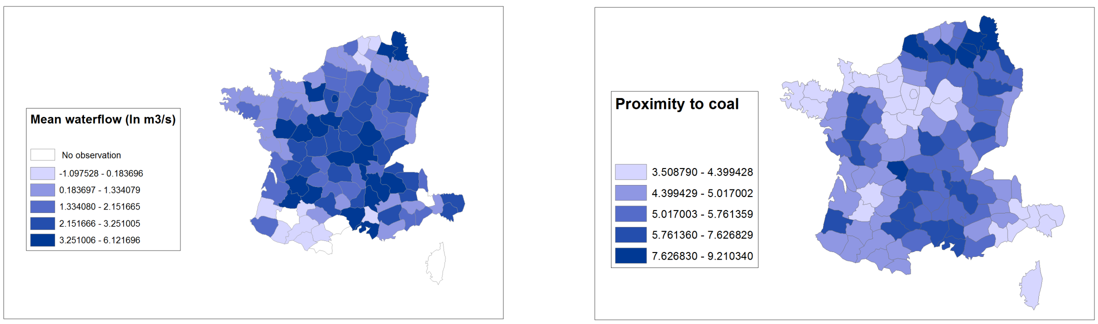


Figure 18: Change in spindles vs. cost-distance shock



(a) Mean flow rate

(b) Proximity to coal

Figure 19: Geographic fundamentals

Notes: The mean flow rates across the French Empire are calculated using the average monthly flow-rate (m^3/s) for each station across the historical boundaries of the French Empire. The mean for each department is then calculated, and the natural log of this mean gives the mean-flow rate for each department. Results are robust to assigning zeros for the mean flow rates in departments with no observations, or assigning a missing value. Access to coal uses the Fernihough-O'Rourke (2014) dataset. To calculate the departmental datapoint I use the minimum distance to any of Europe's major coalfields from the capital of each department. Where data for the capital is not available, I use the closest city from the dataset. This distance is transformed into a proximity measure using the author's measure. See Appendix C for details.

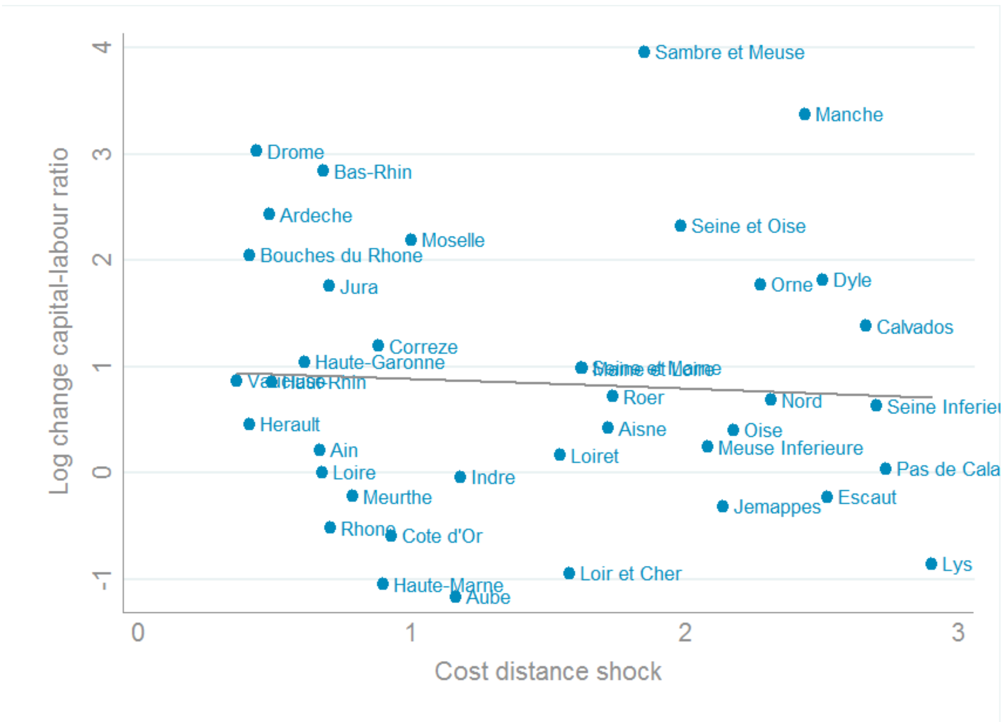


Figure 20: Change in log capital-labour ratio in mechanised spinning vs distance shock

Change in capital labour ratio is the log change in spindles to workers between 1803-12 . The cost-distance shock is calculated based on the shortest route algorithm (measure 1). The estimated elasticity is -0.09, (se: 0.24 with clustering on department).

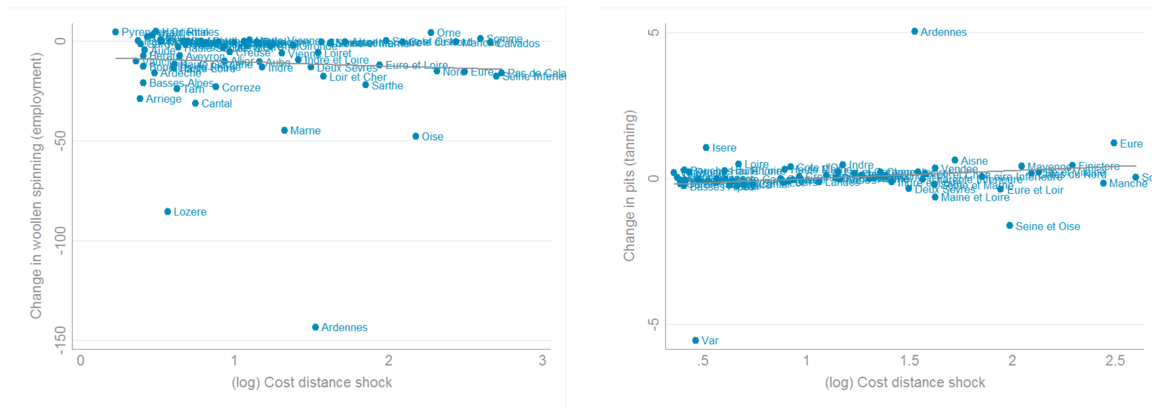


Figure 21: Falsification tests

Scatterplots depict change in woollen spinning employment per thousand inhabitants and change in pits per thousand inhabitants vs. the (log) cost distance shock. Pits measure production capacity in leather tanning. For data sources see Appendix C.

C Data

C.1 Imputation

TO BE ADDED

C.2 Data sources and Variable definitions

C.2.1 Data on the cotton industry during the Napoleonic period

Data source: Champagny's survey: AN/F12/1562-1564, "Enquetes industrielles" 1810-1818: AN/F12/1570-1590, AN/F12/1602

Spinning capacity The baseline measure of spinning capacity in mechanised spinning in 1803 and 1812 is the number of spindles per thousand inhabitants. Robustness checks also use labour employed in mechanised spinning for the same years.

Downstream weaving capacity Initial weaving capacity is measured using the number of weaving frames by department (per thousand inhabitants) in 1803.

C.2.2 Other variables

Departmental population *Data source: Chabert, (1951)* Population data is available for each department from 1811. In 1806, the Corsica was formed of two departments, Golo and Liamone, which were later joined and called Corse. As population data is reported for Corse in 1811, I combined the two departments in 1806 and use this in the analysis.

Woollen spinning *Data source: 1792: AN/F12/1344-1348, 1810: AN/F12/1602*

Data on employment in woollen spinning is available for 1792 and 1810. I measure the size of the woollen spinning industry in each department as labour employed in woollen spinning per thousand inhabitants. The data from 1792 is somewhat noisily measured as data is collected at the level of the district (arrondissement), and it is often impossible to determine whether a district's datapoint is missing or zero. Furthermore, the survey asks for the state of the industry in 1789, before the Revolution. Data for 1810 was collected in the same industrial inquiry as that of cotton. I use 1810 as data coverage is highest for this year. Comparison of data in later years does not show large discrepancies.

Tanneries *Data source: 1792: AN/F12/1467-1472, 1811: AN/F12/1590-1600*

Data on production capacity in lather tanning is available for 1792 and 1811. Capacity in tanning is measured as the number of pits per thousand inhabitants. The data from 1792 is somewhat noisily measured as data is collected at the level of the district (arrondissement), and it is often impossible to determine whether a district's datapoint is missing or zero.

Shipping between Britain and Continental Europe *Data source: Lloyds List, 1787-1814, digitised by Google, made available by the Hathi Trust*

Each datapoint in the shipping dataset is a journey which took place between a port in Britain and a port in Europe (excluding Ireland). Editions of the Lloyds List have been digitised by Lloyds List. A text matching algorithm was used to search for names of European ports in each edition of the Lloyds List for the years 1787-1814.

Literacy rates *Data source: Furet and Ozouf (1982)*

Literacy rates are calculated from departmental statistics which give the percentage of males signing their "acte de mariage" between 1786-1790. The variable takes on values between 0 and 1.

Conscription rates *Data source: Hargenvilliers (1937)*

Departmental conscription rates are defined as the number of men conscripted during the year 13 according to the French republican calendar (September 1, 1804 - August 30, 1805) divided by total departmental population in 1811. This is the last year for which detailed departmental statistics are available. Conscription was supposed to be perfectly equal across departments in line with their population. In reality however, conscription rates differed across departments. According to Forrest (1989), conscription rates had significant persistence over time. Departments in which fulfilling previous quotas had been easier were pushed harder in the following years. By 1813, this was something that even the "Directeur geneal de la Conscription" admitted, when he informed the prefect in Foix that the ability of an area to produce soldiers and past records of recruitement were being used. (Forrest, 1987 p. 41). For this reason, conscription prior to our period of interest should be a reasonable proxy for differences in labour supply shocks during the Napoleonic wars.

Access to coal *Data source: Fernihough and O'Rourke (2014)*

For each city in their dataset, the authors calculate minimum distance (km) from any of Europe's major coalfields using Chatel and Dollfus (1931) for data on the location of coalfields. Cities located within a coalfield are coded as having distance 1km. The authors then transform this into a proximity measure by taking the inverse of this measure. To normalise the distribution, they multiply the inverse distance by 10,000 and take the natural logarithm. I transform this into a departmental measure for proximity to coal, by using the datapoint for the prefecture of the department. In a few cases when data for this city is not available, I use the closest city. I also calculate a different measure which takes the mean across all cities for which data is available in a department with very similar results.

Access to fast-flowing streams *Data source: European Water Archive, EURO-FRIEND River Discharge Data*

Data on monthly mean flow rates for 2412 collection points across the historical boundaries of the French Empire were averaged across time to obtain the mean monthly flow rate for each collection point. The average mean flow rate in each department is the average of all collection point located within the department. In the specifications presented in the paper, I report results which use the natural logarithm of the mean flow rate, but results are similar when levels are used. Median flow rates across collection points for each department also give similar results.

Institutional change *Data source: Wikipedia*

Institutional change is defined as the date of incorpronation into the French Empire for each department. Departments belonging to France proper are coded as 1789.

C.3 Further data sources

Note: The text contains sources for many of the data presented. Here, I only denote the source for archival data.

Raw cotton prices *Data source: Journal du Commerce: BNF/ an 6 - 1814*

Data for daily prices of distinct varieties of cotton across cities in the French Empire.

French trade statistics *Data source: F/12/251*

All values in francs. Data kindly shared by Guillaume Daudin.

D Examples of the Data

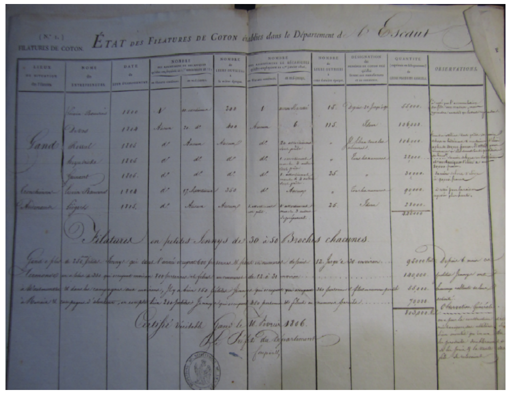
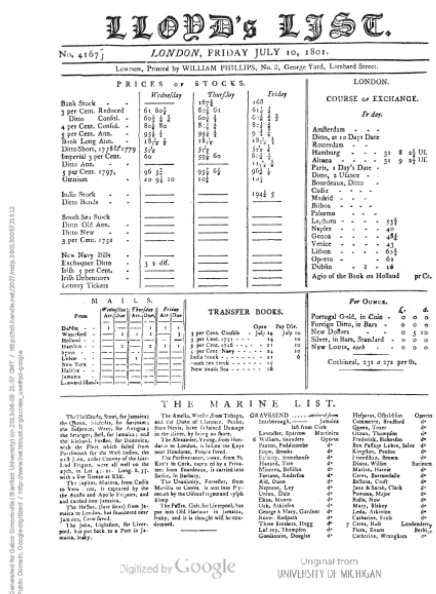


Figure 22: Example of prefectural report from 1806 for Escaut department



LLOYD's LIST.

No. 4167] LONDON, FRIDAY JULY 10, 1801.

LONDON, Printed by WILLIAM PHILLIPS, No. 2, George Yard, Lombard Street.

PRICES OF STOCKS.

	Wednesday	Thursday	Friday
Bank Stock	—	167$\frac{3}{4}$	168
3 per Cent. Reduced	61 60$\frac{7}{8}$	[illegible] 61	[illegible]
Ditto Consol.	[illegible]	[illegible]	[illegible]
4 per Cent. Consol.	[illegible] 80	[illegible]	[illegible]
5 per Cent. Ann.	[illegible]	[illegible]	[illegible]
Bank Long Ann.	[illegible]	[illegible]	[illegible]
Ditto Short, 1778 & 1779	[illegible]	[illegible]	[illegible]
Imperial 3 per Cent.	60	[illegible] 60	[illegible]
Ditto Ann.	—	—	[illegible]
5 per Cent. 1797.	96 [illegible]	[illegible]	[illegible]
Omnium	10 9$\frac{3}{4}$ 10	10$\frac{1}{4}$	[illegible]
India Stock	—	—	194$\frac{1}{2}$ 5
Ditto Bonds	—	—	—
South Sea Stock	—	—	—
Ditto Old Ann.	—	—	—
Ditto New	—	—	—
3 per Cent. 1751	—	—	—
New Navy Bills	—	—	—
Exchequer Ditto	3 2 dif.	—	—
Irish 5 per Cent.	—	—	—
Irish Debentures	—	—	—
Lottery Tickets	—	—	—

LONDON.

COURSE OF EXCHANGE.

Friday.

Amsterdam	
Ditto, at 10 Days Date	
Rotterdam	
Hamburg	31 8 2$\frac{1}{2}$ U.
Altona	31 9 2$\frac{1}{2}$ U.
Paris, 1 Day's Date	
Ditto, 2 Usance	
Bourdeaux, Ditto	
Cadiz	
Madrid	
Bilboa	
Palermo	
Leghorn	53$\frac{1}{2}$
Naples	40
Genoa	48$\frac{1}{4}$
Venice	43
Lisbon	61$\frac{1}{2}$
Oporto	62
Dublin	16
Agio of the Bank on Holland	pr Ct.

MAILS.

From: Dublin, Waterford, Holland, Hambro, Spain, Lisbon, New York, Halifax, Jamaica, Leeward Islands

TRANSFER BOOKS.

	Open	Pay Div.
3 per Cent. Consols	July 14	July 10
3 per Cent. 1751	14	10
3 per Cent. 1726	21	10
5 per Cent. Navy	24	10
India Stock	21	6
South Sea Stock	15	
New South Sea	16	

Per Ounce.

	£.	s.	d.
Portugal Gold, in Coin	0	0	0
Foreign Ditto, in Bars	0	0	0
New Dollars	0	5	10
Silver, in Bars, Standard	0	0	0
New Louis, each	0	0	0

Cochineal, 23s a 27s per lb.

THE MARINE LIST.

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Original from UNIVERSITY OF MICHIGAN

Figure 23: Example of Lloyd's List