

Temporary Protection and Technology Adoption

Evidence from the Napoleonic Blockade

Réka Juhász

LSE

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Research Question

1 Can infant industry protection work?

- ▶ Long tradition in the history of economic thought
- ▶ Mechanisms formalised by economic theory
- ▶ Empirical challenges make identification difficult

2 This paper: Natural experiment which replicates infant industry protection

Natural experiment from 19th century France

- ① Context: Development of mechanised cotton spinning across French Empire during and after the Napoleonic Wars (1803-1815)
- ② Empirical challenges
 - ▶ Protection usually implemented at the country-wide level
 - ★ Here: Exogenous, within country variation in trade protection
 - ▶ Protection usually implemented by policy-maker
 - ★ Here: Temporary protection driven by changes in trade costs
- ③ This paper: Costs of trading with Britain increase temporarily and differentially across French regions

Identifying infant industry mechanism in two steps

- ➊ **Short run:** Did regions which became better protected from trade increase capacity in new technology more?
- ➋ **Long-run:** Did the effects persist after pre-blockade variation in trade protection was restored?

Related Literature

① Infant industry

- ▶ Case studies: Baldwin - Krugman 1986, Head 1994, Irwin 2008

② Trade and growth

- ▶ Identification: Geography as an instrument for trade (Frankel - Romer 1999)
- ▶ Exogenous time-series variation in trade costs (Feyrer 2009a, Feyrer 2009b, Keller - Shiue 2014, Pascali 2014)

③ Why was France slow to adopt mechanisation (and industrialise)?

- ▶ Landes 1969, O'Brien - Keyder 1978, Crafts 1995, Crouzet 1990, Allen 2009

④ Can temporary shocks have persistent effects?

- ▶ Industry location is not uniquely determined by location fundamentals (Davis - Weinstein 2002, Redding et al. 2011, Miguel - Roland 2011, Bleakley - Lin 2012, Kline - Moretti 2013)

Outline

- ➊ Introduction
- ➋ Data collection
- ➌ Napoleonic Wars as source of exogenous variation
- ➍ The cotton industry
- ➎ Empirical Strategy and Results
 - ▶ Short-run effects of temporary protection
 - ▶ Long-run effects of temporary protection
- ➏ Potential mechanisms

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Exogenous variation from Napoleonic Blockade

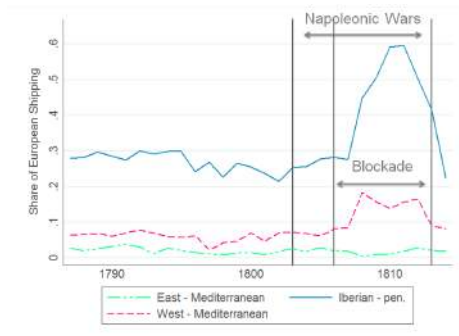
The Napoleonic Blockade against Britain

- Implemented as a “self-blockade”
- Displacement of trade routes increased trade costs with Britain differentially across France

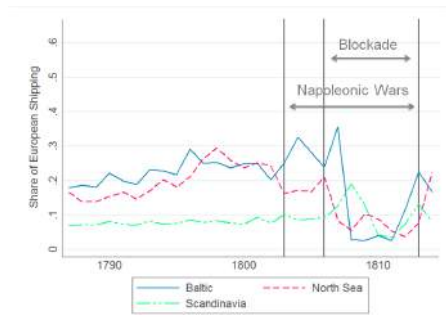
Blockade successful in North, not in South

► cexp ► france ► exports ► rhine

Direction of trade changed



Southern Europe



Northern Europe

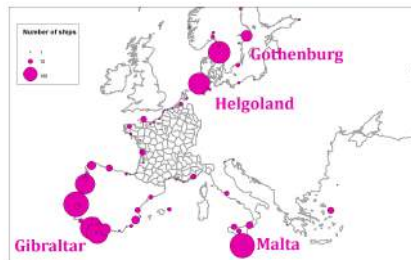
Share of shipping with Britain

Variation in blockade at the port level

Smuggling via stable ports outside the French Empire accessible to Great Britain



Port usage, "Before blockade"

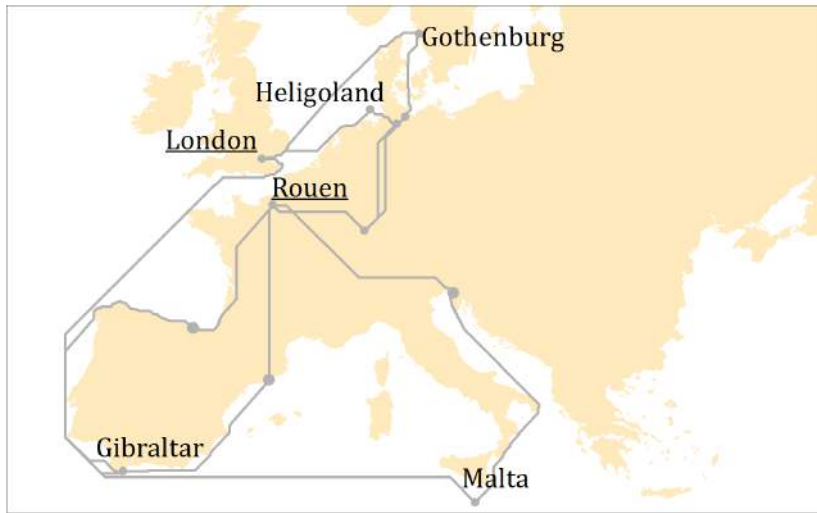


Port usage, "Blockade"

Unconstrained shortest route



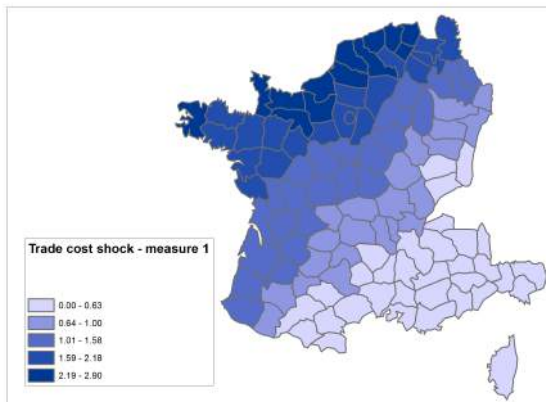
Smuggling routes



Quantifying effective distance to Britain

► meas2

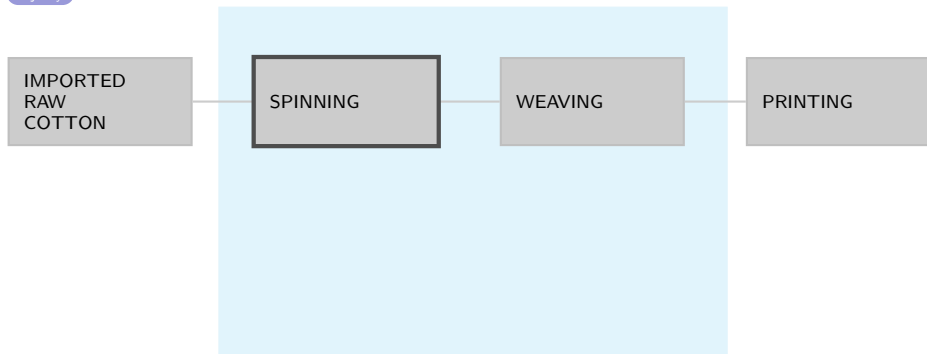
- Unrestricted shortest route prior to Napoleonic Wars
- Restricted to smuggling routes during Napoleonic Wars
- Trade cost shock = $\ln D_{it} - \ln D_{i(t-1)}$



Focus on mechanised cotton spinning

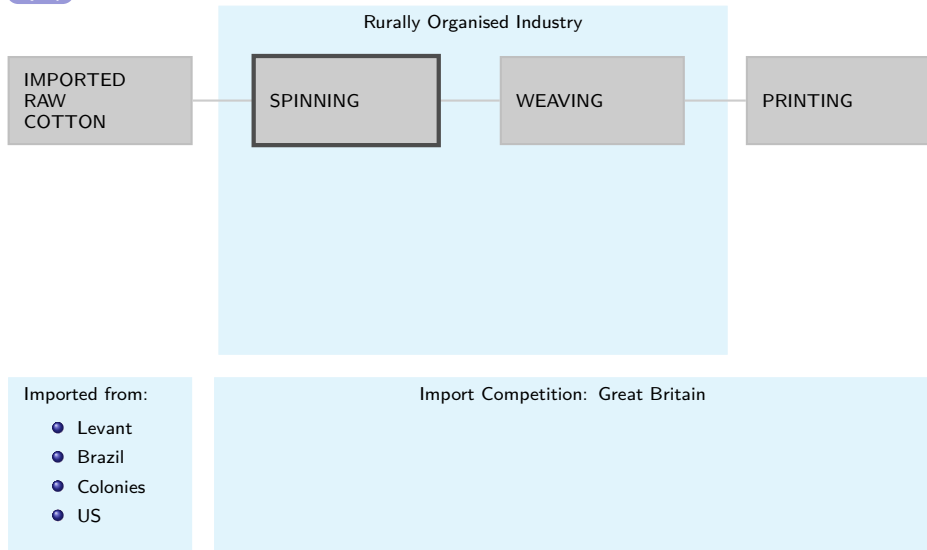
The cotton industry in France

► jenny



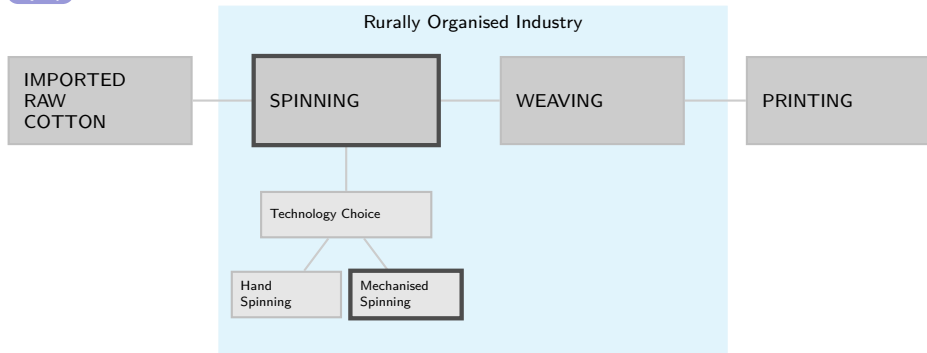
The cotton industry in France

► jenny



The cotton industry in France

► jenny

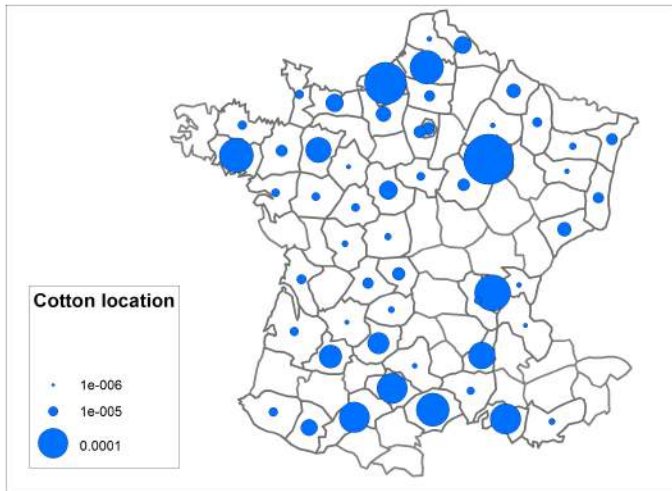


Imported from:

- Levant
- Brazil
- Colonies
- US



Import Competition: Great Britain

Historical location of the cotton industry



Historical location of cotton spinning (Source: Daudin 2010)

Invention and diffusion in Britain vs. non-adoption in France

- Similar conditions prior to mechanisation
- Rapid diffusion of technology in Britain 
- Surprisingly slow adoption in France (1790: 800 vs 19,000 jennies)
- 1800: France not competitive in cottons 

Empirical strategy - Short run

Empirical Strategy - Short run

- Blockade source of exogenous variation in trade costs with Britain
- Baseline specification:

$$S_{it} = \alpha_i + \delta_t + \gamma \ln D_{it} + \epsilon_{it} \quad (1)$$

- Identifying assumption: No contemporaneous shock correlated with trade cost shock to imported yarn

Departmental pre-treatment differences

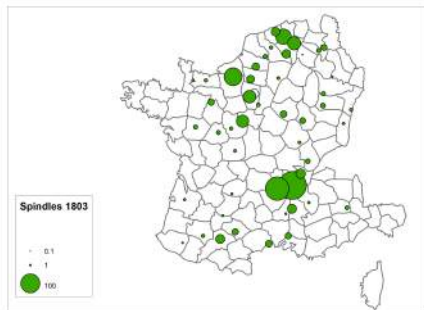
	Low trade cost shock	High trade cost shock	Difference	N
Spindles	11.67 (5.87)	9.95 (2.82)	-1.72 (6.51)	88
Weaving	1.43 (0.68)	4.07 (1.81)	2.64 (1.93)	88
Historical cotton	0.023 (0.007)	0.031 (0.010)	0.008 (0.013)	70
Access to coal	5.25 (0.15)	5.53 (0.24)	0.28 (0.28)	88
Access to streams	1.24 (0.19)	1.88 (0.49)	0.64 (0.53)	88
Literacy	0.42 (0.04)	0.47 (0.04)	0.05 (0.06)	63
Conscription rate	1.51 (0.05)	1.33 (0.05)	-0.18** (0.07)	86
Institutional change	1790.89 (0.71)	1790.43 (0.41)	-0.45 (0.82)	88
Urbanisation rate	0.07 (0.02)	0.08 (0.01)	0.01 (0.02)	66
Population density	52.61 (3.83)	69.25 (5.94)	16.64** (7.07)	88

Robust standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

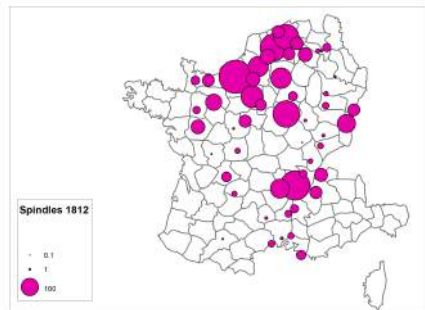
Variation used: 1803-12

► scatter

- 1803-12: spinning capacity quadrupled
- Development highly uneven



“Before”



“After”

Spindles per capita

Trade cost shock affected production capacity in cotton, but not in other industries

	Mechanised cotton spinning		Wool spinning	Leather tanning
Depvar per '000 inhabs	(1) Capital	(2) Labour	(3) Labour	(4) Capital
Trade cost	33.11*** (9.775)	0.930** (0.390)	-2.228 (2.919)	0.279 (0.215)
Time FE	Yes	Yes	Yes	Yes
Departmental FE	Yes	Yes	Yes	Yes
Observations	176	170	152	122
Number of dept	88	85	83	61
R-squared	0.337	0.194	0.194	0.030

Standard errors clustered at the departmental level in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Pre-treatment trends on the extensive margin



	Pre-treatment: 1794-1803			Napoleonic Wars: 1803-1812		
DepVar Spindles	(1)	(2)	(3)	(4)	(5)	(6)
Trade cost	5.539* (3.054)	-0.372 (3.625)	-3.491 (5.116)	33.11*** (9.775)	27.12*** (9.355)	28.74*** (8.654)
Controls 1		✓	✓		✓	✓
Controls 2			✓			✓
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Departmental FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	176	176	118	176	176	118
R-squared	0.181	0.328	0.270	0.337	0.374	0.641
Number of dept	88	88	59	88	88	59

Notes: Controls 1: Streams, Coal, Population density; Controls 2: Urbanisation, Human capital, Historical cotton. Robust standard errors clustered at the departmental level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Robustness

- 1 Input price shock ▶
- 2 Institutions ▶ table ▶ spatial
- 3 Factor prices ▶ wr ▶ kl ▶ cons
- 4 Location fundamentals ▶
- 5 Downstream linkages ▶ table ▶ spatial
- 6 Human capital ▶
- 7 Urbanisation & population density ▶
- 8 Differential choice of machines ▶

Long-term effects

Empirical strategy - Long run within country

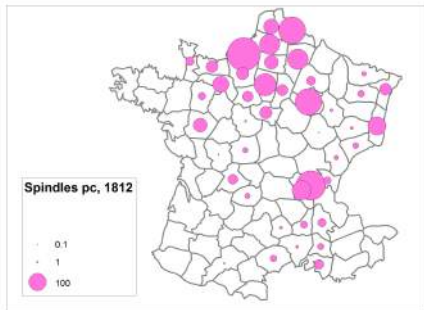
- Temporary trade protection should have persistent effects
- Historical accident of wars affected location of cotton spinning
- Trade cost shock is an instrument for location

$$Y_{i(j)t} = \alpha + \beta S_{i(t-1)} + \gamma' X + \eta_{i(j)t} \quad (2)$$

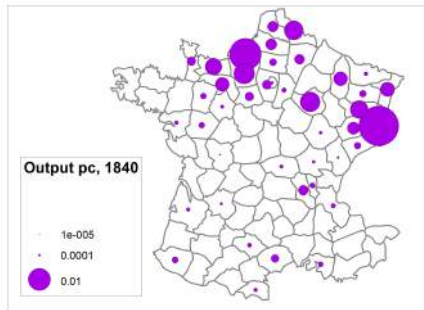
- Identifying assumption: Trade cost shock uncorrelated with other determinants of location of industry and firm productivity

Location of cotton industry 1812-1840

Location seems to be highly persistent



“Post-blockade (1812)”



“Long-term (1840)”

Persistence in location

One sd increase in capacity in 1812 increases output in 1840 by 0.7 sd

	OLS		2SLS	
Depvar	(1) Output 1840	(2) Output 1840	(3) Output 1840	(4) Output 1840
Spindles 1812	113.6*** (24.45)	92.46*** (26.89)	96.68** (40.16)	134.2*** (41.98)
Departmental controls		✓		✓
Observations	74	68	74	68
R-squared	0.464	0.663		

	First Stage		Reduced form	
Depvar	(1) Spind 1812	(2) Spind 1812	(3) Output 1840	(4) Output 1840
Trade cost shock	0.0436*** (0.0146)	0.0284*** (0.0101)	4.212 (2.600)	3.805*** (1.408)
Departmental Controls		✓		✓
Observations	74	68	74	68
KP F-stat	3.74	5.57		
R-squared	0.220	0.379	0.074	0.348

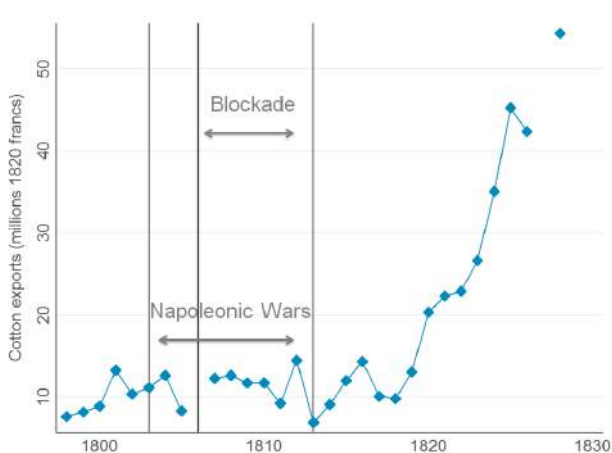
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Mills test: Increasing exports

► crosscountry

► timeseries

Exports of cotton goods increased in real terms



French exports of cotton, millions of 1820 francs

Discussion of results

What drives the previous results?

① Fixed costs of technology adoption (and financial frictions)

- ▶ Fixed costs not large
- ▶ $\frac{K}{L}$ ratio not systematically related to the shock ▶
- ▶ No differential investment in machine type ▶

② Transport costs and IRS (Puga - Venables 1999)

- ▶ Production function does not vary as a function of density of spinning activity

③ Learning externalities (Lucas 1988)

- ▶ Historical evidence
- ▶ Accommodation to the shock on the extensive margin
- ▶ Productivity increases in density of spinning activity

Adjustment on the extensive margin 1803-06

Results driven mostly by firm entry consistent with external EoS

Spindles per thousand inhabs	(1) total	(2) ext	(3) int
Trade cost (measure 1)	7.962*** (2.243)	6.843*** (1.815)	1.119 (0.822)
Time FE	Yes	Yes	Yes
Departmental FE	Yes	Yes	Yes
Observations	204	204	204
R-squared	0.321	0.313	0.072
Number of dept	102	102	102

Notes: Robust standard errors clustered at the departmental level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Productivity Results

One sd increase in capacity increases productivity by 1.3 sd

	OLS		2SLS	
	(1)	(2)	(3)	(4)
Depvar	Prod 1840	Prod 1840	Prod 1840	Prod 1840
Spindles 1812	0.580*** (0.204)	0.425* (0.213)	1.811** (0.746)	3.847** (1.629)
Firm controls	✓	✓	✓	✓
Departmental controls		✓		✓
Observations	492	439	492	439
Number of departments	37	34	37	34
R-squared	0.190	0.288		

	First Stage		Reduced form	
	(1)	(2)	(3)	(4)
Depvar	Spind 1812	Spind 1812	Prod 1840	Prod 1840
Trade cost shock	0.0850* (0.0440)	0.0589** (0.0249)	0.154*** (0.0320)	0.227*** (0.0552)
Firm controls	✓	✓	✓	✓
Departmental controls		✓		✓
Number of departments	37	34	37	34
Observations	492	439	492	439
KP F-stat	8.85	7.86		
R-squared	0.266	0.686	0.234	0.320

Robust standard errors clustered at the departmental level *** p<0.01, ** p<0.05, * p<0.1

Contribution

A historical episode in which effects of trade protection consistent with infant industry

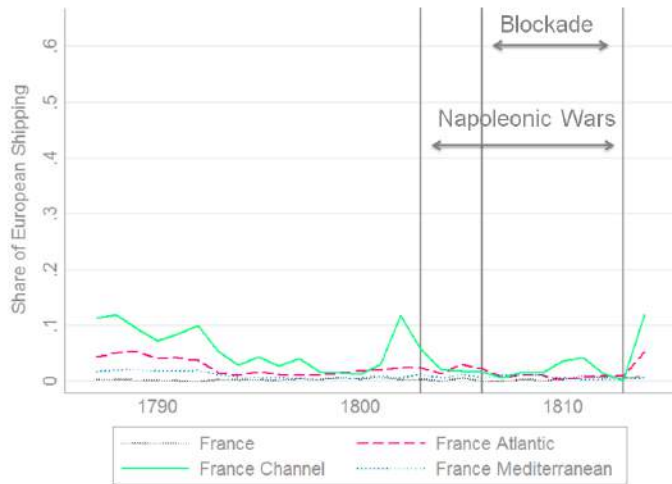
- Exogenous within country variation in temporary trade protection
- Separate economic from political mechanism
- Differential shock to import-competition on output side, but not imported inputs

Conclusion

- ① Mechanised spinning became competitive in parts of France because of increased trade protection
- ② External validity?
 - ▶ General setting
 - ★ Low-skilled labour intensive textile manufacturing
 - ★ Shift in organisation of labour
 - ▶ Initial differences between Britain and France small

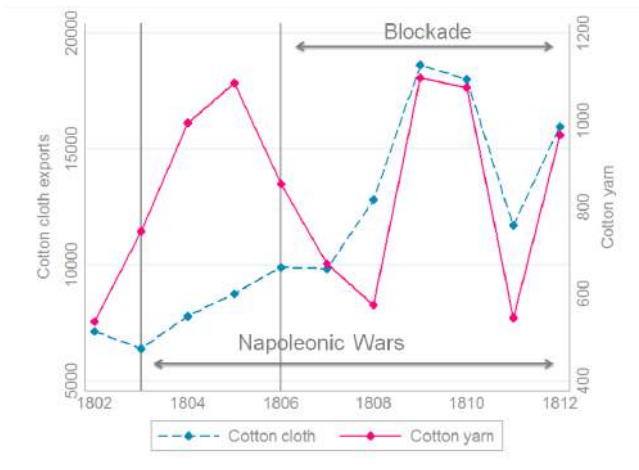
Thank you

Shipping with France



Share of shipping with France

Continuing trade in cottons

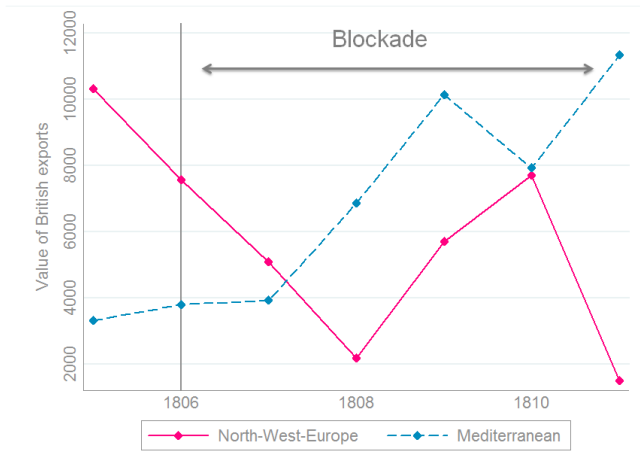


British exports of cotton, Crouzet (1987)

Blockade successful in North, not in South

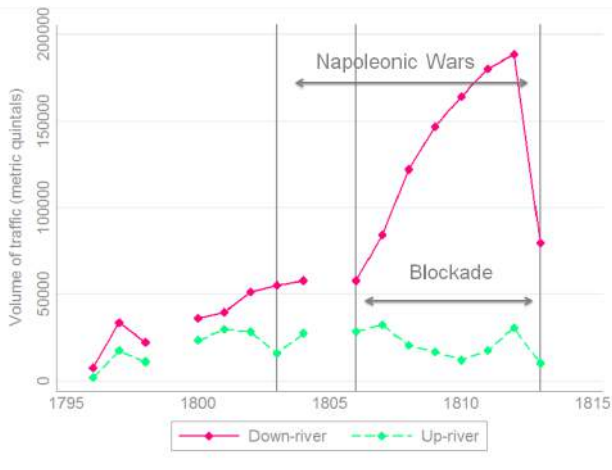
Trade does not stop but **direction** changes

▶ back



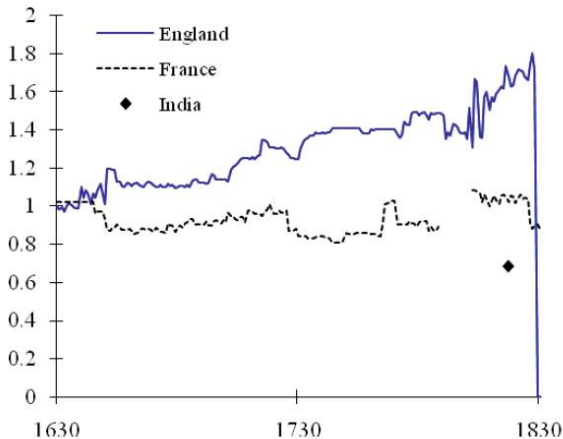
British exports to North-Western and Southern Europe, Crouzet (1987)

South-North trade within French Empire



Traffic up- and down-river on the Rhine, Ellis (1981)

Factor prices



Price of labour relative to capital Allen (2009)

Robustness



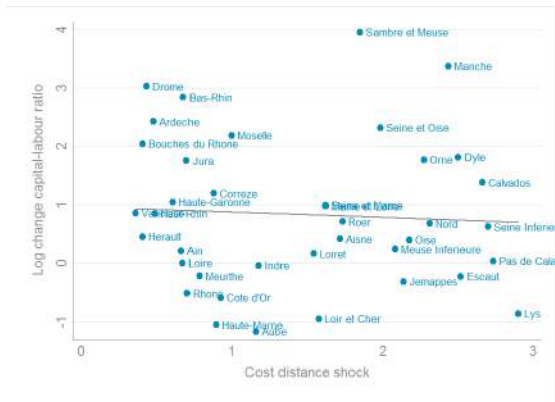
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
DepVar Spindles											
Trade cost	33.11*** (9.775)	33.19*** (9.985)	34.69*** (10.38)	22.33*** (6.984)	34.41*** (10.23)	25.75*** (8.883)	39.87*** (11.75)	41.50*** (12.44)	33.56*** (9.600)	33.00*** (9.715)	27.92*** (7.298)
Streams		-0.261 (1.162)									-0.973 (2.226)
Coal			-4.571 (3.723)								3.072 (3.557)
D.stream				3.303*** (0.522)							2.273*** (0.437)
Hist. cott.					523.2*** (155.5)						303.8 (185.2)
Pop. density						20.88 (13.79)					4.954 (20.58)
Urbanisation							146.3* (78.12)				58.20 (65.24)
Human cap.								49.25** (21.32)			53.41*** (17.31)
Conscription									4.411 (11.94)		14.94 (13.30)
Institution										-0.853 (0.824)	
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Departmental FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Observations	176	176	176	176	140	176	132	126	172	176	118
R-squared	0.337	0.337	0.347	0.576	0.539	0.356	0.400	0.426	0.338	0.340	0.722
Number of dept	88	88	88	88	70	88	66	63	86	88	59

Robust standard errors are clustered at the departmental level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ Robust standard errors clustered at the department in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

No change in capital labour ratio



discussion



Δ Capital-labour ratio vs shock

Poisson fixed effects estimation



	Trade cost measure 1		Trade cost measure 2	
DepVar Spindles	(1) Poisson	(2) OLS	(3) Poisson	(4) OLS
Trade cost (meas 1)	0.495** (0.214)	0.557*** (0.189)		
Trade cost (meas 2)			1.039*** (0.319)	1.220*** (0.259)
Time FE	Yes	Yes	Yes	Yes
Departmental FE	Yes	Yes	Yes	Yes
Observations	176	176	176	176
R-squared		0.254		0.323
Number of departments	88	88	88	88

Robust standard errors clustered at the department in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Binary DD using median trade cost shock as cutoff



Depvar Spindles	Pre-war	Post-war	Difference
Large shock	9.95 (2.82)	51.73 (12.15)	41.78*** (10.42)
Small shock	11.67 (5.87)	18.92 (7.31)	7.25* (3.62)
Difference	-1.72 (6.51)	32.81** (14.18)	34.53*** (11.00)

Robust standard errors clustered at the departmental level in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Evidence on continuous treatment intensity

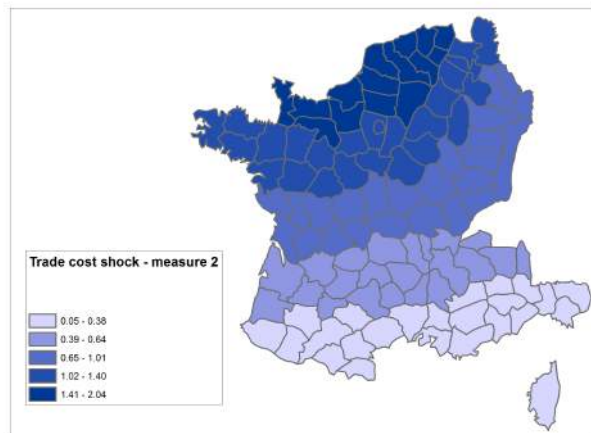
Baseline specification using two different measures of trade costs

	Trade cost (measure 1)			Trade cost measure 2		
DepVar Spindles	(1) Full sample	(2) North France	(3) South France	(4) Full sample	(5) North France	(6) South France
Trade cost (meas. 1)	33.11*** (9.775)	33.82* (17.11)	-2.075 (3.795)			
Trade cost (meas. 2)				58.76*** (14.15)	92.89*** (33.24)	13.99 (12.13)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Departmental FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	176	88	88	176	88	88
R-squared	0.337	0.376	0.056	0.406	0.456	0.075
Number of departments	88	44	44	88	44	44

Notes: Robust standard errors clustered at the department in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Alternative measure of trade cost shock

- Weighted distance
- Trade cost shock = $\ln D_{it} - \ln D_{i(t-1)}$



Type of machine used

► disc

	(1)	(2)
Proportion MJ		
Trade cost	0.0375 (0.0858)	
Trade cost		0.0358 (0.119)
Time FE	Yes	Yes
Departmental FE	Yes	Yes
Observations	112	112
Number of dept	56	56

Robust standard errors clustered at the departmental level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Firm level pre-treatment comparison



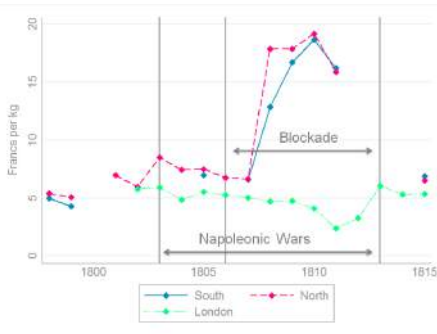
	Low trade cost shock	High trade cost shock	Difference	N
Spindles	2444.24 (1051.13)	1007.65 (280.37)	-1436.59 (1087.87)	304
Employees	75.96 (15.40)	47.54 (14.65)	-28.42 (21.25)	296
Capital labour ratio	25.11 (4.50)	30.52 (3.82)	5.41 (5.90)	294
Age	9.04 (1.86)	4.71 (0.63)	-4.34** (1.96)	303
Quality yarn	39.37 (4.18)	45.66 (3.67)	6.30 (5.56)	208
Proportion mule jenny	0.38 (0.13)	0.40 (0.13)	0.02 (0.18)	304

Robust standard errors clustered at the department. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

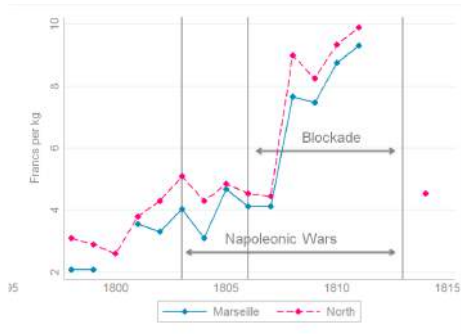
No asymmetric shock to raw cotton prices



- Similar effect for other types of raw cotton



Pernambuco cotton

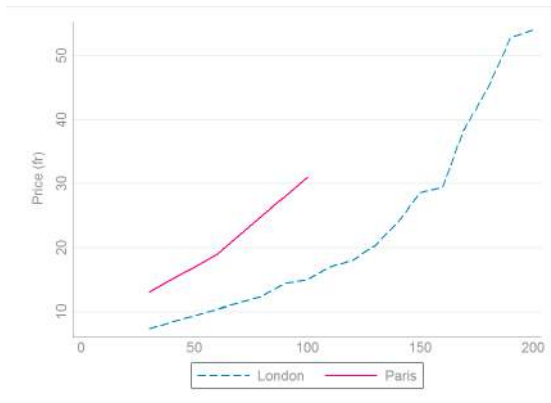


Levantine cotton

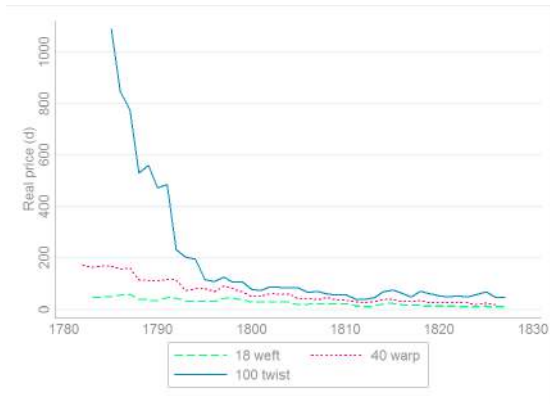
Yarn prices in Paris and London



Yarn prices at least double in 1807 (first year of blockade)

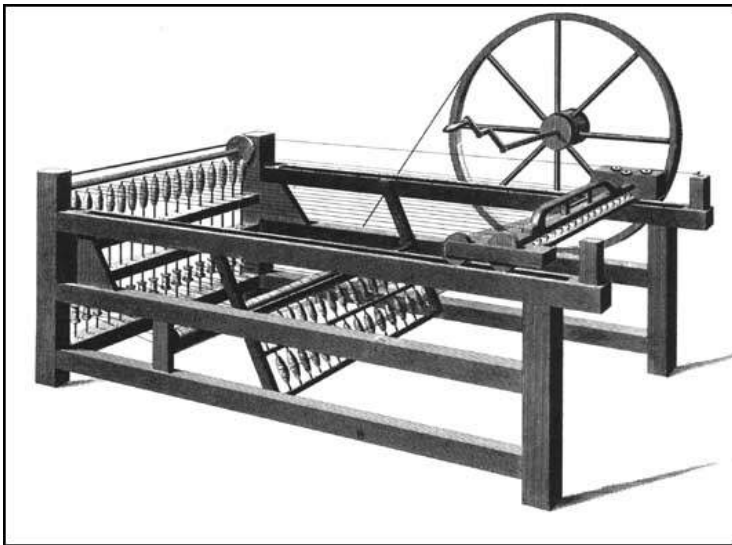


Cotton yarn prices - Britain

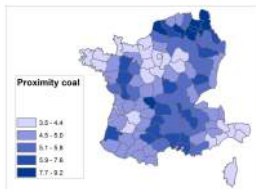


Source: Harley (1998)

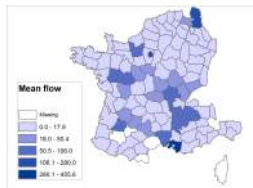
Example of an early spinning jenny



Spatial distribution of potential confounders



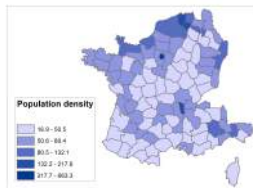
Proximity to coal



Access to streams

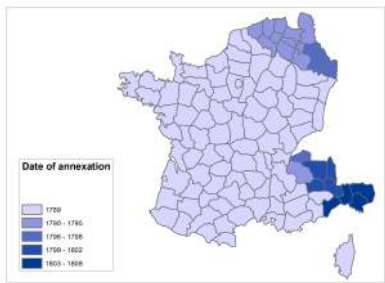


Weaving frames per capita

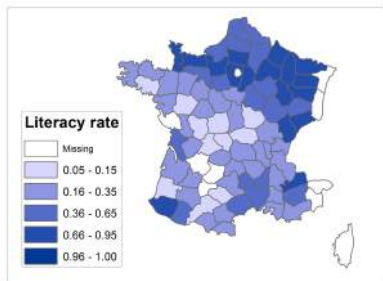


Population density

Spatial distribution of potential confounders



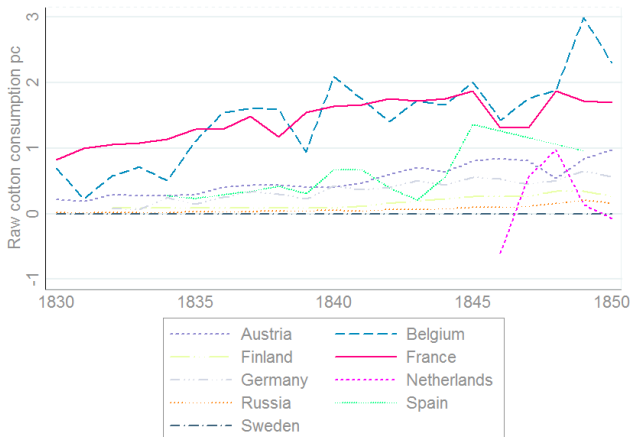
Date of annexation



Literacy rate, 1789

Long Term Effects - Cross Country Comparison

Other Continental European countries had a smaller cotton spinning sector

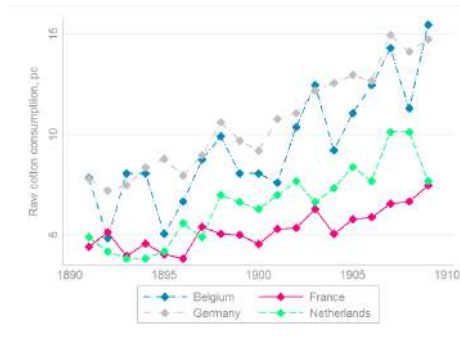
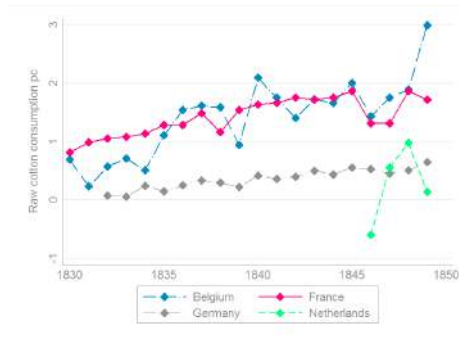


Raw cotton imports per capita, Mitchell (2005)

Why should we care about cotton?



Early and late industrialisers alike: cotton was key industry for structural transformation



Raw cotton consumption per capita, Mitchell (2005)

Change in spindles vs. trade cost shock

