Online appendix to 'Rural transformation, Inequality, and the Origins of Microfinance'

A Mathematical proofs

We now allow the number of cooperatives C to exceed one. In effect, producers can now minimize the cost of capital by founding optimal clubs, subject to the constraints imposed by the region's population distribution. Given two ethnic groups, what is the optimal number of clubs C, and their optimal composition in terms of N_c, H_c? Employing the following two Lemmas is convenient:

LEMMA 1

Segregation ($H_c = 0$) is always optimal if $C = 2$.

PROOF:
The claim is that the cost of capital is smaller under segregation $(H_{c,s}, N_A;\ H_{c,s}, N_B)$ than under any alternative allocation $(H_{c,1}, N_{c,1};\ H_{c,2}, N_{c,2})$ if $C = 2$:

$$
\left(r_b + \frac{1}{\delta q N_A} + H_{c,s}\right) N_A + \left(r_b + \frac{1}{\delta q N_A} + H_{c,s}\right) N_B
$$
$$
< \left(r_b + \frac{1}{\delta q N_{c,1}} + H_{c,1}\right) N_{c,1} + \left(r_b + \frac{1}{\delta q N_{c,2}} + H_{c,1}\right) N_{c,2}
$$

Exploiting the fact that $H_{c,s} = 0$ under segregation, multiplying out the brackets yields:

$$
r_b N_A + \frac{1}{\delta q} + r_b N_A + \frac{1}{\delta q} < r_b N_{c,1} + \frac{1}{\delta q} + H_{c,1} N_{c,1} + r_b N_{c,2} + \frac{1}{\delta q} + H_{c,2} N_{c,2}
$$

Simplifying and eliminating yields:

$$
r_b(N_A + N_B) < r_b(N_{c,1} + N_{c,2}) + H_{c,1} N_{c,1} + H_{c,2} N_{c,2}
$$

Using the fact that $N_A + N_B = N$ and $N_{c,1} + N_{c,2} = N$ and eliminating surplus terms:

$$
0 < H_{c,1} N_{c,1} + H_{c,2} N_{c,2}
$$

which is true unless $(H_{c,1}, H_{c,2}) = (0, 0)$, that is unless both alternative clubs are perfectly segregated too. $\square$

The intuition behind Lemma 1 is as follows: Consider the case of a very small linguistic minority, consisting of two producers, setting up their own club, thus facing very high

capital costs. But shifting one member of this minority into the larger club will incur both a substantial size penalty on the remaining member as well as a heterogeneity penalty on the larger club that cannot be compensated by the small size benefit gained by the large club.

LEMMA 2

For two ethno-linguistic groups the optimal number of clubs is $C \leq 2$.

PROOF:
The claim is that $C > 2$ can never be optimal in the presence of two ethnic groups.

We know from Lemma 1 that segregation is optimal for $C = 2$. The proof is therefore a simple extension from the previous proof. For $C = 3$ we would have:

$$
\left(r_b + \frac{1}{\delta q N_A} + H_{c,s} \right) N_A + \left(r_b + \frac{1}{\delta q N_A} + H_{c,s} \right) N_B
$$
$$
< \left(r_b + \frac{1}{\delta q N_{c,1}} + H_{c,1} \right) N_{c,1} + \left(r_b + \frac{1}{\delta q N_{c,2}} + H_{c,1} \right) N_{c,2} + \left(r_b + \frac{1}{\delta q N_{c,3}} + H_{c,3} \right) N_{c,3}
$$

It is clear that adding any additional club to the right-hand side cannot negate the inequality. $\square$

The relevant decision for Proposition 2 is now between one mixed club ($C = 1$) and the segregated option with $C = 2$.

PROPOSITION 2

Founding two cooperatives rather one cooperative will minimize r_c if:

$$
q H_N N > \frac{1}{\delta}
$$

PROOF:
We want to find the conditions under which $C = 2$ will minimize capital costs.

First note that if individual collateral $q \geq q_T$, $C = 0$, i.e. an individual solution with bank loans, is always optimal compared to any cooperative by construction.

We also know from Lemma 2 that $C > 2$ can be excluded.

$C = 1$, in turn, will offer higher costs than $C = 2$ if:

$$\left(r_b + \frac{1}{\delta q N} + H_N \right) N > \left(r_b + \frac{1}{\delta q N_A} \right) N_A + \left(r_b + \frac{1}{\delta q N_B} \right) N_B$$

Where we have made use of the result from Lemma 1 that under $C = 2$, $H_c = 0$. Multiplying out:

$$r_b + \frac{1}{\delta q N} + H_N > r_b \frac{N_A}{N} + \frac{1}{\delta q N} + r_b \frac{N_B}{N} + \frac{1}{\delta q N}$$

Eliminating and multiplying by N:

$$r_b N + H_N N > r_b (N_A + N_B) + \frac{1}{\delta q}$$

Using $N_A + N_B = N$, eliminating and rearranging:

$$q H_N N > \frac{1}{\delta}$$

which is the inequality proposed. □

B   Summary Statistics

Table B.1: Summary statistics: Dependent variables

Variable	Description	Obs	Mean	Std. Dev.	Min	Max
credit cooperatives	Total number of credit cooperatives	14632	5.241	8.574	0	63
Δ credit cooperatives	Total number of credit cooperatives, change	14632	0.338	1.038	0	21
Production cooperatives	Total number of production cooperatives	14632	0.828	2.014	0	21
Δ production cooperatives	Total number of production cooperatives, change	14632	0.061	0.298	0	6
Other cooperatives	Total number of non-credit cooperatives	14632	1.168	3.139	0	64
Δ other cooperatives	Total number of non-credit cooperatives, change	14632	0.137	0.85	0	36
Δ unlimited cooperatives	Number of cooperatives under unlimited liability, change	14632	0.288	0.975	0	21
Δ poor cooperatives	Number of cooperatives with deposit size $<$100 Mark, change	14632	0.158	0.752	0	21
Δ rich cooperatives	Number of cooperatives with deposit size $\geq$100 Mark, change	14632	0.13	0.653	0	17
Δ dairy cattle	county-level change in dairy cow headcount 1868-1906	236	3651.6	3373.4	-12744	21275
Δ beef cattle	county-level change in beef cattle headcount 1868-1906	236	8781.9	7160.4	-23837	47929
Δ pigs	county-level change in pigs headcount 1868-1906	236	21451.7	12855.7	-12962	71982

Table B.2: Summary statistics: Independent variables

| Variable	Description	Obs	Mean	Std. Dev.	Min	Max
	Prices					
grain prices	Weighted rye & wheat prices / CPI	14632	0.259	0.099	0.015	0.719
Δ grain prices	Weighted rye & wheat prices / CPI, change	14632	-0.003	0.034	-0.18	0.136
grain prices, US	Weighted rye & wheat prices / CPI, USA	14632	0.305	0.148	0.013	1.046
Δ grain prices, US	Weighted rye & wheat prices / CPI, USA, change	14632	-0.008	0.056	-0.232	0.226
grain prices, butter	Weighted rye & wheat prices, butter deflator	14632	0.232	0.094	0.015	0.716
Δ grain prices, butter	Weighted rye & wheat prices, butter deflator, change	14632	-0.002	0.037	-0.229	0.138
Grain price volatility	5-year moving average standard deviation of Δ grain prices	14632	0.032	0.026	0.001	0.199
	Other time varying variables					
limited liability	Co-ops eligible for limited liability (1889)	14632	0.403	0.491	0	1
central bank	Central bank for credit co-ops founded (1895)	14632	0.306	0.461	0	1
incorporation	Co-ops granted status as legal person (1867)	14632	0.758	0.428	0	1
population, varying	Time varying county population, '000	14632	55.283	42.463	14.312	1130.819
linguistic frac., varying	Time varying population heterogeneity, index	14632	0.188	0.198	0	0.648
Δ banks	5-year moving average of bank foundations	12508	0.164	0.418	0	6
GDP growth	Annual German GDP growth, %	14632	1.578	2.503	-3.798	7.842
GDP growth, UK	Annual UK GDP growth, %	14632	1.014	2.502	-5.156	8.39
interest rate	Annual mean commercial interest rate, %	8968	3.17	0.793	1.74	5.12
interest rate, UK	Annual mean Bank of England discount rate, %	14632	3.644	1.125	2	7.333
	Time invariant variables: demographics					
population	County population in 1890, '000	14632	56.388	32.742	18.737	335.186
population growth	County population growth, 1858-1910, %	14632	0.508	1.094	-0.467	11.641
Polish share	Share of Polish speakers in 1890	14632	0.226	0.311	0	0.926
Protestant share	Share of Protestants in 1890	14632	0.656	0.347	0.026	0.996
linguistic fractionalization	Linguistic population heterogeneity in 1890, index	14632	0.183	0.199	0.001	0.633
religious fractionalization	Religious population heterogeneity in 1890, index	14632	0.22	0.177	0.008	0.53
linguistic polarization	Linguistic population heterogeneity in 1890, index	14632	0.349	0.375	0.002	0.995
population density	Population density in 1900	14632	5.194	29.407	0.287	413.338
migration	Net immigration, 1895-1905, %	14632	-4.319	5.474	-11.9	28.55
urbanization	Share of population in urban settlements, 1868	14632	0.261	0.211	0	1
suburban	County surrounding a town	14632	0.085	0.279	0	1
illiteracy	Share of illiterates in the population, 1871	14632	0.162	0.115	0.017	0.597
	Time invariant variables: land					
farm size	Mean farm size, 1882, hectares	14632	12.697	4.809	1.742	31.956
land inequality	Share of total arable land in top size category, 1882	14632	0.451	0.172	0	0.821
land inequality (top 2)	Share of total arable land in top 2 size categories, 1882	14632	0.529	0.169	0	0.903
Gini	Gini index of farm size inequality, 1882	14632	0.799	0.079	0.424	0.952
rye share	Share of total land used for rye, 1878	14632	0.144	0.04	0.014	0.236
wheat share	Share of total land used for wheat, 1878	14632	0.03	0.03	0	0.158
rye share 1852	Share of total land used for rye, 1852	14632	0.143	0.039	0.015	0.227
wheat share 1852	Share of total land used for wheat, 1852	14632	0.026	0.027	0	0.145
soil quality	Excellent share of agricultural land	14632	0.196	0.248	0	0.997
religious inequality	Occupational inequality between confessions, 1882	14632	0.098	0.066	0.001	0.331
	Time invariant variables: economic controls					
banks, 1852	Total number of banks, 1852	14632	0.589	0.734	0	3
industrial employment	Share of employment in manufacturing, 1882	14632	0.135	0.063	0.014	0.5
wages	Mean daily wages, 1892, Mark	14632	1.287	0.244	0.85	2.5
income growth	Growth in labor incomes per capita, 1880-1905	14632	89.026	16.473	36.452	145.794
public spending	Share of public spending in total education spending, 1886	14632	0.59	0.276	0.02	1
pupil-teacher ratio	Pupil-teacher ratio in schools, 1886	14632	78.233	13.389	49.153	120.214
	Time invariant variables: geography					
market potential	Weighted distance to markets, 1868	14632	0.818	0.267	0.424	2.796
Berlin distance	Great circle distance to Berlin, 100 km	14632	2.955	1.527	0.048	6.5
Raiffeisen distance	Great circle distance to Neuwied, 100 km	14632	7.215	1.697	4.058	11.239
military settlers, mean	Mean distance to medieval military settlements, 100 km	14632	3.284	1.341	1.058	5.784
military settlers, min.	Min. distance to medieval military settlements, 100 km	14632	1.931	1.215	0.004	4.388
latitude	Geographical latitude, decimal coordinates	14632	52.579	1.392	49.52	55.72
longitude	Geographical longitude, decimal coordinates	14632	17.059	2.408	11.87	22.57

C   Additional figures
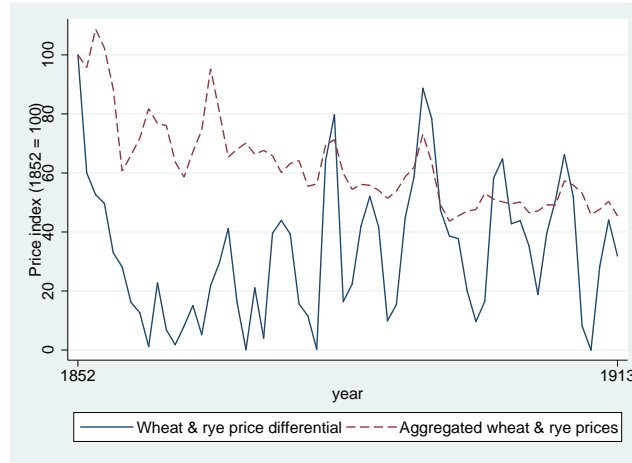
Figure C.1: Rye and wheat price differential and aggregated grain prices, deflated by consumer prices, index
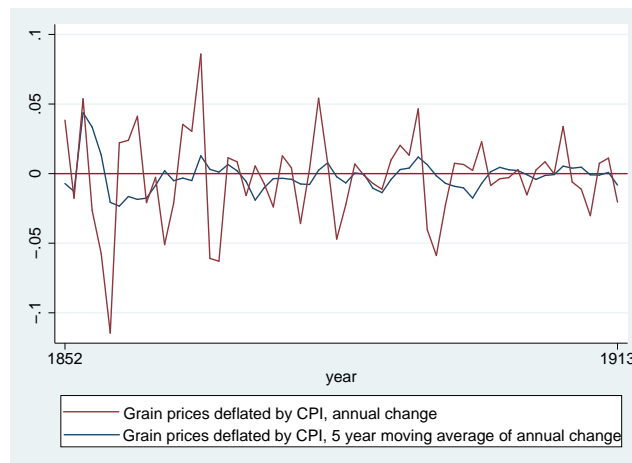

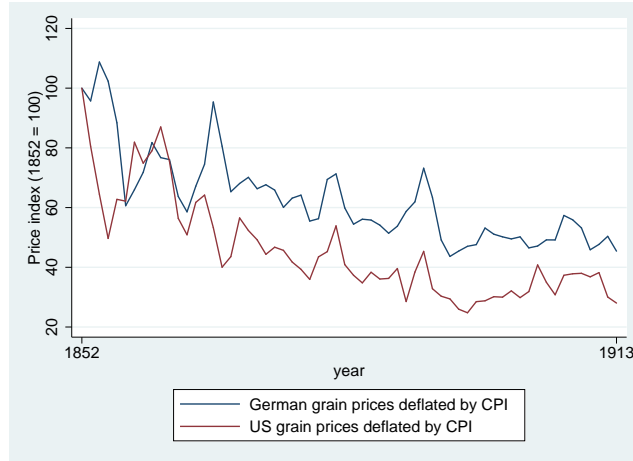Figure C.2: Grain prices deflated by consumer prices, first differences

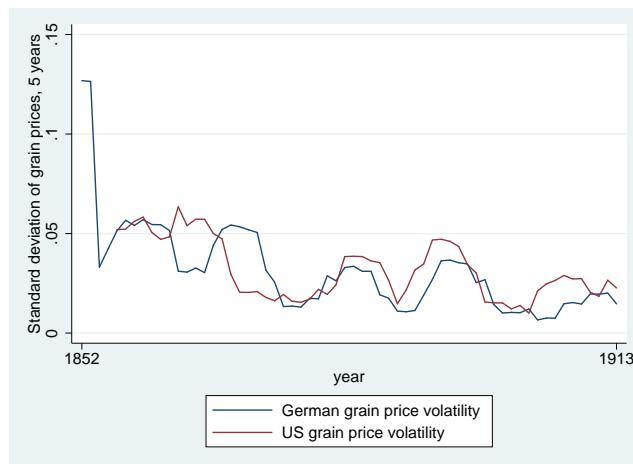Figure C.3: Grain prices deflated by consumer prices, German and US prices

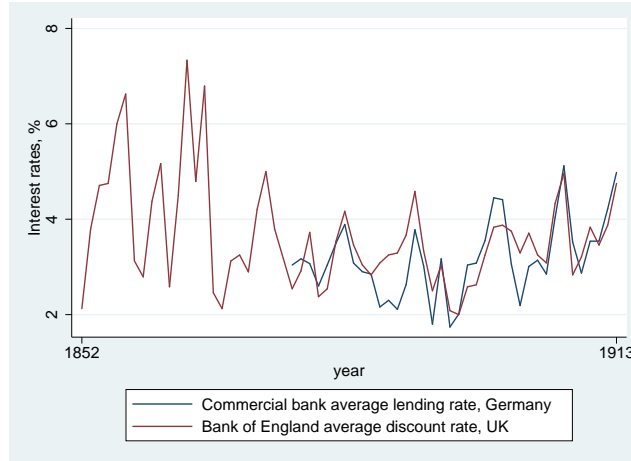Figure C.4: German and US volatility of grain prices over time, deflated by consumer prices

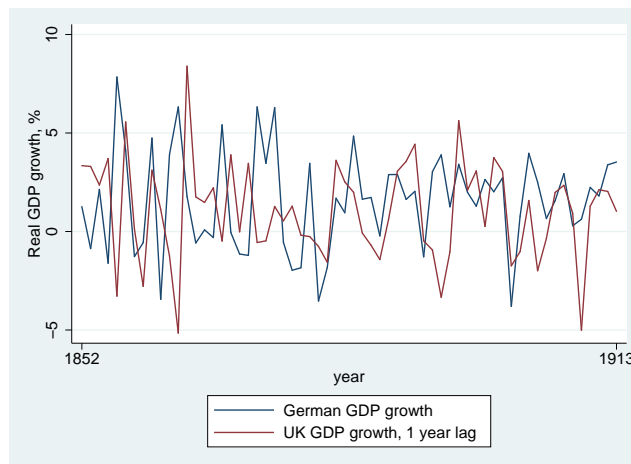Figure C.5: German commercial and Bank of England lending rates

Figure C.6: German and United Kingdom real GDP growth rates

9
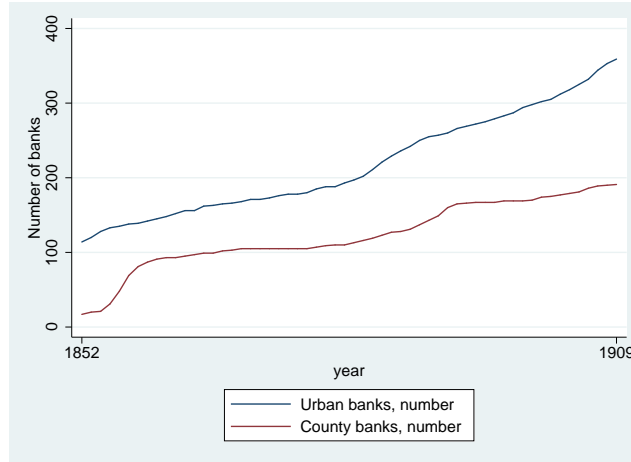
Figure C.7: Urban and county savings banks in the six provinces

D   Administrative divisions

Table D.1: Administrative divisions: the eastern six provinces of Prussia

Prov. #	Province	District #	District	Counties per district
1	Posen	1	Posen	26
		2	Bromberg	14
2	West Prussia	3	Danzig	12
		4	Marienwerder	15
3	Pomerania	5	Stettin	13
		6	Köslin	13
		7	Stralsund	5
4	Silesia	8	Breslau	25
		9	Liegnitz	21
		10	Oppeln	20
5	East Prussia	11	Königsberg	20
		12	Gumbinnen	16
6	Brandenburg	13	Potsdam	16
		14	Frankfurt (Oder)	20
	Total			**236**

Administrative divisions are as used in the empirical analysis, and reflect status of 1900. Small independent towns and their surrounding county are grouped together. Berlin and counties becoming part of Berlin before 1914 are excluded.

E Maps
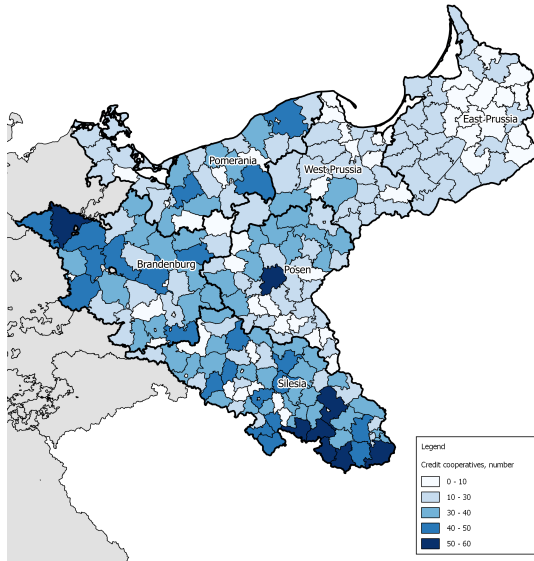
(a) Number of credit cooperatives
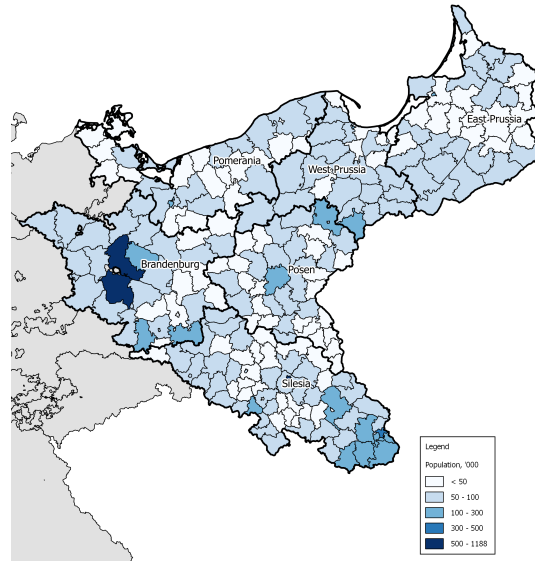
(b) Population, '000
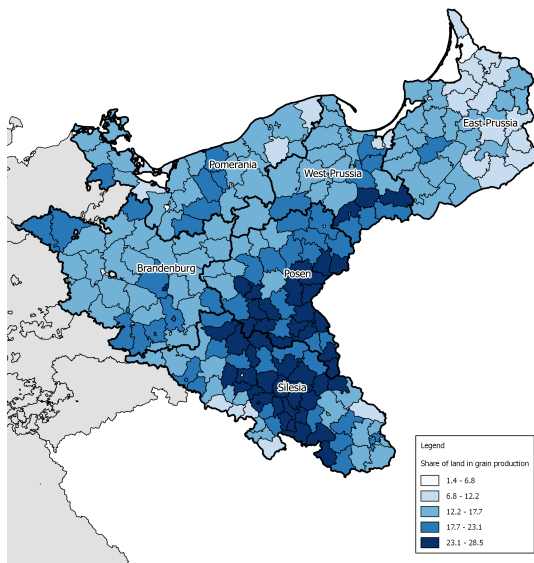
(c) Rye and wheat cultivation, % of total land
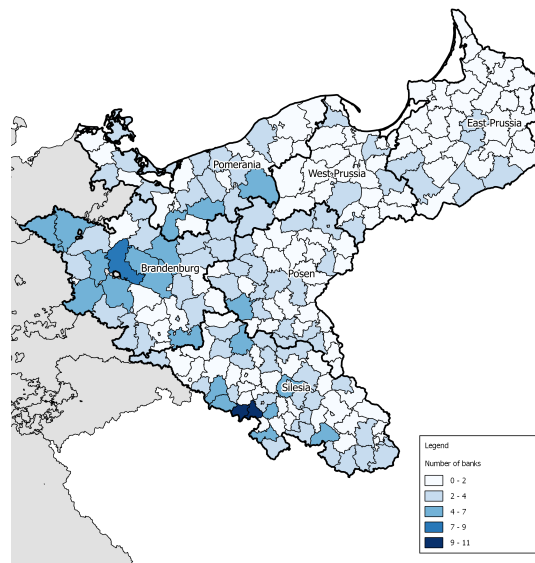
(d) Number of banks

Figure E.1: Count of credit cooperatives and selected independent variables, 1913

(a) Inequality: share of land under large landowners

(b) Mean farm size, hectares

(c) Linguistic fractionalization, index

(d) Religious polarization

Figure E.2: Selected independent variables, 1913

F Additional results

Table F.1: Determinants of credit cooperative growth, county level, Prussia: **Controls**

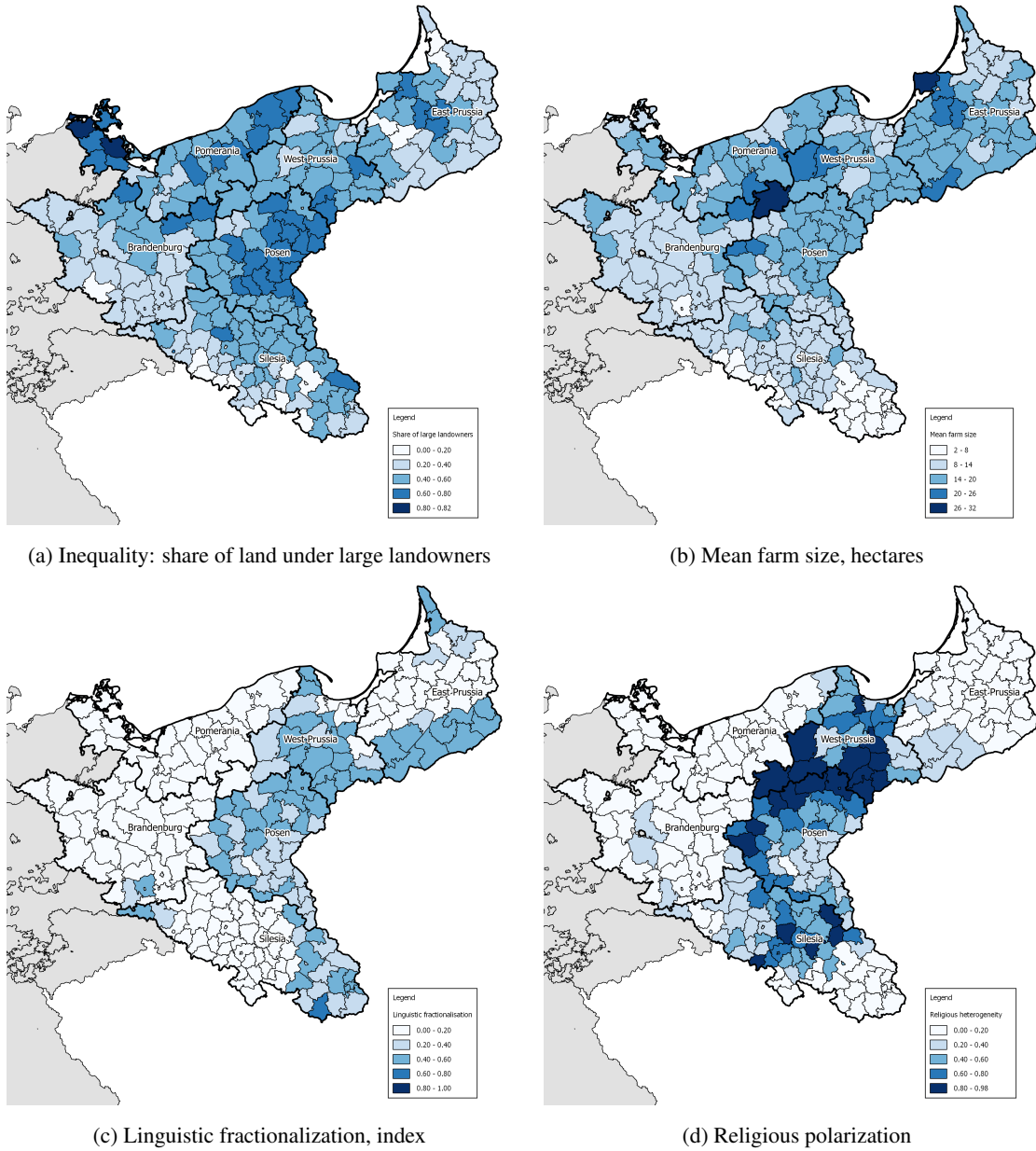|	(1) Wages & income growth	(2) migration & illiteracy	(3) population density & growth	(4) Latitude & Longitude	(5) Time varying population & heterogeneity	(6) Population & heterogeneity fixed in 1852
	Dependent Variable: Number of new credit cooperatives per county					
Δ grain prices	-38.2366***	-38.4741***	-38.6381***	-38.5431***	-38.6481***	-38.1804***
	(3.0214)	(3.0209)	(3.0286)	(3.0648)	(3.0413)	(3.0046)
limited liability	1.5916***	1.5923***	1.5929***	1.5926***	1.5868***	1.5911***
	(0.1539)	(0.1537)	(0.1537)	(0.1539)	(0.1539)	(0.1538)
central bank	1.3891***	1.3887***	1.3883***	1.3882***	1.3683***	1.3898***
	(0.1410)	(0.1410)	(0.1409)	(0.1411)	(0.1411)	(0.1410)
incorporation	0.0660	0.0670	0.0678	0.0675	0.0598	0.0656
	(0.1312)	(0.1313)	(0.1313)	(0.1313)	(0.1313)	(0.1312)
population	0.0086***	0.0082***	0.0090***	0.0069***		
	(0.0013)	(0.0014)	(0.0017)	(0.0013)		
ling. fractionalisation	0.1226	0.1475	0.2414+	0.1216		
	(0.1427)	(0.1476)	(0.1280)	(0.1537)		
farm size	0.0777*	0.1228***	0.1015**	0.1384***	0.1020**	0.0721**
	(0.0357)	(0.0326)	(0.0322)	(0.0342)	(0.0339)	(0.0264)
farm size squared	-0.0021+	-0.0035**	-0.0026*	-0.0038**	-0.0029*	-0.0019*
	(0.0012)	(0.0012)	(0.0012)	(0.0012)	(0.0012)	(0.0009)
land inequality	-0.6882***	-0.7622***	-0.8057***	-0.8866***	-0.7871***	-0.6137**
	(0.1935)	(0.2118)	(0.2053)	(0.2109)	(0.2158)	(0.1870)
wages	-1.0554***					
	(0.2281)					
income growth	-0.0016					
	(0.0013)					
Protestant share	0.0127					
	(0.1586)					
urbanisation	-1.0980***	-1.3080***	-1.4033***	-1.3868***	-1.2479***	-1.0874***
	(0.2509)	(0.2684)	(0.2790)	(0.2718)	(0.3008)	(0.2653)
suburbs	-0.0753	-0.0340	-0.0305	-0.1292	-0.0373	0.0857
	(0.1228)	(0.0949)	(0.0931)	(0.1151)	(0.1381)	(0.1163)
migration		-0.0283***				
		(0.0061)				
illiteracy		-0.5723				
		(0.4059)				
Berlin distance			0.0295			
			(0.0458)			
population density			-0.0010			
			(0.0021)			
population growth			-0.1194***			
			(0.0266)			
latitude				0.1020+		
				(0.0581)		
longitude				-0.0287		
				(0.0348)		
population, varying					0.0015*	
					(0.0006)	
ling. frac., varying					0.1845	
					(0.1871)	
population, 1852						0.0000**
						(0.0000)
ling. frac., 1852						0.1730
						(0.1412)
District F.E.	✓	✓	✓	✓	✓	✓
Urbanization controls	✓	✓	✓	✓	✓	✓
Observations	14632	14632	14632	14632	14632	14632

Sample: Six eastern provinces of Prussia, 1852-1913. Dep. Var. year-on-year change in number of credit cooperatives per county; grain prices are the year-on-year change of the moving average of weighted rye and wheat prices lagged over the past five years, deflated by the consumer price index. Limited liability, central bank and incorporation are time variant policy dummies. Population and fractionalization in (5) are time varying. Other variables are time invariant. Urbanization controls include the share of the population in urban areas and a dummy for suburban counties. See tables B.1 and B.2 definitions. All regressions are Poisson. Standard errors clustered at county level (236 counties). Fixed effects at the level of 14 districts. All regressions exclude Berlin. Standard errors in parentheses: + p<0.1, * p<0.05, ** p<0.01, *** p<0.001

Table F.2: Determinants of credit cooperative growth, county level, Prussia: **Farm size and farm value**

	(1) Interaction with soil quality	(2) Interaction with market potential	(3) Interaction with industrialization	(4) Interaction with migration	(5) Interaction with decadal trends
	Dependent Variable: Number of new credit cooperatives per county				
Δ grain prices	-38.4552***	-38.3691***	-38.3399***	-38.4820***	-30.0960***
	(3.0559)	(3.0575)	(3.0549)	(3.0161)	(2.9856)
population	0.0068***	0.0083***	0.0065***	0.0084***	0.0067***
	(0.0013)	(0.0016)	(0.0013)	(0.0014)	(0.0013)
ling. fractionalisation	0.1450	0.1058	0.1187	0.0663	0.1510
	(0.1537)	(0.1433)	(0.1513)	(0.1437)	(0.1527)
farm size	0.1502***	0.1000*	0.1310*	0.1279***	
	(0.0367)	(0.0456)	(0.0535)	(0.0339)	
farm size squared	-0.0041**	-0.0040**	-0.0036*	-0.0035**	-0.0041***
	(0.0013)	(0.0014)	(0.0013)	(0.0013)	(0.0013)
land inequality	-0.7587***	-0.8022***	-0.8889***	-0.8466***	-0.8489***
	(0.1981)	(0.1949)	(0.2073)	(0.1981)	(0.2024)
soil quality	0.4634				
	(0.4356)				
farm size × soil quality	-0.0383				
	(0.0408)				
market potential		-0.9178*			
		(0.4094)			
farm size × market potential		0.0532			
		(0.0414)			
industrial employment			-0.6753		
			(1.2159)		
farm size × industrial employment			-0.0043		
			(0.1266)		
migration				-0.0330*	
				(0.0140)	
farm size × migration				0.0004	
				(0.0014)	
-1854 × farm size					-0.1862
					(0.1236)
1855-1864 × farm size					0.1630***
					(0.0364)
1865-1874 × farm size					0.1997***
					(0.0350)
1875-1884 × farm size					0.1287***
					(0.0352)
1885-1894 × farm size					0.1750***
					(0.0398)
1895-1904 × farm size					0.1550***
					(0.0350)
1905-1913 × farm size					0.1218***
					(0.0356)
District F.E.	✓	✓	✓	✓	✓
Urbanization controls	✓	✓	✓	✓	✓
Policy dummies	✓	✓	✓	✓	✓
Observations	14632	14632	14632	14632	14632

Sample: Six eastern provinces of Prussia, 1852-1913. Dep. Var. year-on-year change in number of credit cooperatives per county; grain prices are the year-on-year change of the moving average of weighted rye and wheat prices lagged over the past five years, deflated by the consumer price index. Limited liability, central bank and incorporation are time variant policy dummies. Other variables are time invariant. Urbanization controls include the share of the population in urban areas and a dummy for suburban counties. See tables B.1 and B.2 definitions. All regressions are Poisson. Standard errors clustered at county level (236 counties). Fixed effects at the level of 14 districts. All regressions exclude Berlin.

Standard errors in parentheses: + $p<0.1$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table F.3: Determinants of credit cooperative growth, county level, Prussia: **Prices robustness**

	(1)	(2)	(3)	(4)	(5)	(6)
	Full fixed effects	Land use fixed at sample start	Instrument with US prices	Instrument, controlling for price volatility	Instrument land use with soil quality	Deflating by butter prices
			Dependent Variable: Number of new credit cooperatives per county			
Δ grain prices	-38.3070**				-39.6746***	
	(13.5937)				(3.1124)	
Δ grain prices, 1852 land		-39.2433***	-36.0025***	-26.3261***		
		(3.1138)	(5.0490)	(5.4315)		
Δ grain prices, butter deflator						-37.9594***
						(3.1462)
Price volatility, 1852 land				11.1721***		
				(1.9258)		
limited liability		1.5920***	1.5714***	1.4701***	1.6004***	1.6056***
		(0.1539)	(0.1542)	(0.1514)	(0.1536)	(0.1546)
central bank		1.3869***	1.4028***	1.7156***	1.3824***	1.3872***
		(0.1412)	(0.1435)	(0.1514)	(0.1407)	(0.1415)
incorporation		0.0672	-0.1375	0.2308	0.0763	0.1766
		(0.1313)	(0.1421)	(0.1530)	(0.1310)	(0.1337)
population		0.0067***	0.0067***	0.0069***	0.0068***	0.0067***
		(0.0013)	(0.0013)	(0.0013)	(0.0013)	(0.0013)
ling. fractionalisation		0.1448	0.1460	0.1076	0.1477	0.1470
		(0.1525)	(0.1524)	(0.1532)	(0.1519)	(0.1528)
farm size		0.1408***	0.1419***	0.1162**	0.1403***	0.1427***
		(0.0349)	(0.0347)	(0.0359)	(0.0347)	(0.0348)
farm size sq		-0.0039**	-0.0039**	-0.0032*	-0.0039**	-0.0039**
		(0.0013)	(0.0013)	(0.0013)	(0.0013)	(0.0013)
land inequality		-0.8460***	-0.8444***	-0.8461***	-0.8492***	-0.8445***
		(0.2019)	(0.2018)	(0.2015)	(0.2014)	(0.2023)
Year F.E.	✓					
County F.E.	✓					
District F.E.		✓	✓	✓	✓	✓
Urbanization controls		✓	✓	✓	✓	✓
Observations	14632	14632	13688	13688	14632	14632

Sample: Six eastern provinces of Prussia, 1852-1913. Dep. Var. year-on-year change in number of credit cooperatives per county; grain prices are the year-on-year change of the moving average of weighted rye and wheat prices lagged over the past five years, deflated by the consumer price index. "Grain prices, 1852 land use" weighs rye and wheat prices using 1852 land use. "Grain prices, butter deflator", deflates rye and wheat prices using butter prices. Price volatility is the five year standard deviation of the change in deflated rye and week prices, weighed by 1852 land use. Specification (3) and (4) instrument grain prices with US grain prices (available from 1856), using the 1852 land use weighting. (5) instruments wheat and rye land shares with county-level soil suitability. Limited liability, central bank and incorporation are time varying policy dummies. Other variables are time invariant. Urbanization controls include the share of the population in urban areas and a dummy for suburban counties. See tables B.1 and B.2 for further definitions. Regressions (1), (2) and (6) are Poisson, (3) (4) and (5) are GMM. Standard errors clustered at county level (236 counties). Fixed effects at the level of 14 districts. All regressions exclude Berlin.
Standard errors in parentheses: + $p<0.1$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table F.4: Determinants of credit cooperative growth, county level, Prussia: **Reduced forms**

	(1) Grain prices with soil quality interaction	(2) US grain prices	(3) US grain prices with US price volatility	(4) UK GDP growth	(5) Bank of England interest rates	(6) Mean distance to medieval military settlements	(7) Min. distance to medieval military settlements
	Dependent Variable: Number of new credit cooperatives per county						
Δ grain prices				-34.2597***	-28.2212***	-38.2809***	-38.2810***
				(2.9776)	(2.8426)	(3.0493)	(3.0473)
Δ grain prices, soil qual.	-7.0706***						
	(0.5827)						
Δ US grain prices		-20.1711***	-11.4757***				
		(2.3631)	(2.3619)				
US price volatility			22.2255***				
			(2.9418)				
GDP growth, UK				0.0489***			
				(0.0109)			
interest rate, UK					-0.2335***		
					(0.0324)		
limited liability	1.5930***	1.4479***	1.1797***	1.5819***	1.4840***	1.5912***	1.5912***
	(0.1535)	(0.1515)	(0.1473)	(0.1537)	(0.1479)	(0.1541)	(0.1541)
central bank	1.3914***	1.5616***	1.8991***	1.3594***	1.5126***	1.3896***	1.3896***
	(0.1409)	(0.1372)	(0.1414)	(0.1408)	(0.1391)	(0.1412)	(0.1412)
incorporation	0.0623	-0.2083	0.3141*	0.0913	-0.2355+	0.0662	0.0662
	(0.1310)	(0.1327)	(0.1421)	(0.1321)	(0.1379)	(0.1312)	(0.1312)
population	0.0065***	0.0066***				0.0056***	0.0054***
	(0.0013)	(0.0014)				(0.0016)	(0.0016)
ling. fractionalisation	0.1145	0.1427				0.3504*	0.3516*
	(0.1567)	(0.1555)				(0.1571)	(0.1543)
farm size	0.1481***	0.1496***				0.1727***	0.1754***
	(0.0342)	(0.0342)				(0.0377)	(0.0380)
farm size sq	-0.0041***	-0.0041***				-0.0056***	-0.0056***
	(0.0012)	(0.0012)				(0.0015)	(0.0015)
land inequality	-0.8070***	-0.7665***					
	(0.2065)	(0.2059)					
military settlers, mean						0.1604*	
						(0.0782)	
military settlers, min							0.1701*
							(0.0853)
District F.E.	✓	✓				✓	✓
County F.E.			✓	✓	✓		
Urbanization controls	✓	✓					✓
Observations	14508	13806	14508	14508	14632	14632	

Sample: Six eastern provinces of Prussia, 1852-1913. Dep. Var. year-on-year change in number of credit cooperatives per county; grain prices are the year-on-year change of the moving average of weighted rye and wheat prices lagged over the past five years, deflated by the consumer price index. "Grain prices, soil quality" interacts German grain prices with county-level soil quality. "US grain prices" carries out same procedure using US rye and wheat prices. US Price volatility is the five year standard deviation of the change in deflated US rye and wheat prices (available from 1856). Limited liability, central bank and incorporation are time varying policy dummies. UK GDP growth is lagged by one year. BoE interest rate refers to the discount rate. Other variables are time invariant. Distance to medieval military settlements measures mean or shortest parth geodesic distance between a county capital and medieval crusader settlements. Urbanization controls include the share of the population in urban areas and a dummy for suburban counties. See tables B.1 and B.2 for further definitions. All regressions are Poisson. Standard errors clustered at county level (236 counties). Fixed effects at the level of 14 districts. All regressions exclude Berlin. Standard errors in parentheses: + p<0.1, * p<0.05, ** p<0.01, *** p<0.001

Table F.5: Determinants of cooperative growth, county level, Prussia: **Credit cooperative categories**

	(1) Excluding urbanized counties	(2) only unlimited liability cooperatives	(3) Cooperatives with capital contribution < 100 RM	(4) Cooperatives with capital contribution ≥ 100 RM
	Dependent Variable: Number of new credit cooperatives per county			
Δ grain prices	-41.5987***	-41.9636***	-49.5009***	-33.9088***
	(4.4561)	(3.4360)	(5.2061)	(5.2181)
limited liability	1.8194***	1.7190***	2.9012***	0.2819
	(0.1949)	(0.1721)	(0.2847)	(0.1863)
central bank	1.2295***	1.2928***	0.8847***	2.2024***
	(0.1966)	(0.1496)	(0.1724)	(0.2088)
incorporation	0.2545	0.5508***	1.3502***	0.3297*
	(0.1711)	(0.1546)	(0.3784)	(0.1580)
population	0.0100***	0.0060***	0.0062**	0.0068**
	(0.0019)	(0.0017)	(0.0020)	(0.0022)
ling. fractionalisation	0.1004	0.1314	0.1059	0.2260
	(0.1466)	(0.1746)	(0.2806)	(0.3657)
farm size	0.1487***	0.1659***	0.1282+	0.2731***
	(0.0365)	(0.0423)	(0.0661)	(0.0744)
farm size sq	-0.0044***	-0.0044**	-0.0035	-0.0076**
	(0.0012)	(0.0016)	(0.0024)	(0.0024)
land inequality	-0.5799*	-1.0469***	-0.6540+	-1.6755***
	(0.2647)	(0.2391)	(0.3553)	(0.4470)
District F.E.	✓	✓	✓	✓
Urbanization controls	✓	✓	✓	✓
Observations	7316	14632	14632	14632
No. of cooperatives	2617	4212	2307	1905

Sample: Six eastern provinces of Prussia, 1852-1913. Dep. Var.: year-on-year change in number of credit cooperatives (of various characteristics) per county; grain prices refers to the year-on-year change of the moving average of weighted rye and wheat prices lagged over the past five years, deflated by the consumer price index. Limited liability, central bank and incorporation are time varying policy dummies. Other variables are time invariant. Urbanization controls include the share of the population resident in urban areas and a dummy for suburban counties. Regression (1) excludes all counties with urbanisation above the median. See tables B.1 and B.2 in the online appendix for further definitions. All specifications are Poisson. Standard errors clustered at county level (236 counties). Fixed effects at the level of 14 districts. All regressions exclude Berlin.

Standard errors in parentheses: + $p<0.1$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table F.6: Determinants of credit cooperative growth, county level, Prussia: **Sample robustness over time**

	(1) Only years after 1860	(2) Excluding spike 1895 & 1896	(3) Only years before 1895 spike	(4) Only years after 1895 spike	(5) US prices, only years before 1879 tariffs	(6) US prices, only years after 1879 tariffs
	Dependent Variable: Number of new credit cooperatives per county					
Δ grain prices	-39.8564***	-11.3822***	-30.3729***	-40.5544***		
	(3.2412)	(3.0372)	(5.0569)	(3.4742)		
Δ grain prices, US					-7.6074**	-26.8687***
					(2.9069)	(3.3405)
limited liability	1.6017***	1.0806***	1.5379***			1.7719***
	(0.1544)	(0.1602)	(0.1591)			(0.2563)
central bank	1.3814***	1.6791***				1.5631***
	(0.1414)	(0.1720)				(0.1372)
incorporation	-0.5972***	-0.0889	0.0080		-0.1410	
	(0.1327)	(0.1303)	(0.1381)		(0.1112)	
population	0.0067***	0.0075***	0.0041**	0.0071***	0.0051***	0.0068***
	(0.0013)	(0.0013)	(0.0015)	(0.0014)	(0.0012)	(0.0014)
ling. fractionalisation	0.1502	0.0083	0.4655	0.0995	-0.2168	0.1933
	(0.1531)	(0.2051)	(0.4240)	(0.1990)	(0.3364)	(0.1646)
farm size	0.1420***	0.1644***	0.2399**	0.1160***	0.2174***	0.1497***
	(0.0352)	(0.0298)	(0.0802)	(0.0340)	(0.0564)	(0.0372)
farm size squared	-0.0039**	-0.0050***	-0.0060*	-0.0033**	-0.0080***	-0.0040**
	(0.0013)	(0.0009)	(0.0029)	(0.0011)	(0.0020)	(0.0014)
land inequality	-0.8531***	-0.7109**	-2.3437***	-0.5151*	-0.8100*	-0.8116***
	(0.2032)	(0.2273)	(0.3911)	(0.2429)	(0.3957)	(0.2184)
District F.E.	✓	✓	✓	✓	✓	✓
Urbanization controls	✓	✓	✓	✓	✓	✓
Observations	12744	13688	10148	4484	5428	8496

Sample: Six eastern provinces of Prussia, 1852-1913. Dep. Var. year-on-year change in number of credit cooperatives per county; grain prices are the year-on-year change of the moving average of weighted rye and wheat prices lagged over the past five years, deflated by the consumer price index. (5) and (6) use US instead of German grain prices. Limited liability, central bank and incorporation are time variant policy dummies. Other variables are time invariant. Urbanization controls include the share of the population in urban areas and a dummy for suburban counties. See tables B.1 and B.2 for further definitions. All regressions are Poisson. Standard errors clustered at county level (236 counties). Fixed effects at the level of 14 districts. All regressions exclude Berlin.

Standard errors in parentheses: + $p<0.1$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table F.7: Determinants of credit cooperative growth, county level, Prussia: **Sample robustness over space**

	(1) Dropping Posen	(2) Dropping West Prussia	(3) Dropping Pomerania	(4) Dropping Silesia	(5) Dropping East Prussia	(6) Dropping Brandenburg
	Dependent Variable: Number of new credit cooperatives per county					
Δ grain prices	-37.9784***	-38.4256***	-39.8508***	-35.7485***	-36.9494***	-41.0139***
	(3.5237)	(3.2005)	(3.2762)	(3.6413)	(3.1946)	(3.2604)
limited liability	1.7872***	1.6812***	1.6151***	1.1105***	1.6281***	1.6138***
	(0.1727)	(0.1630)	(0.1573)	(0.1710)	(0.1762)	(0.1640)
central bank	1.3203***	1.3527***	1.2604***	1.6141***	1.5814***	1.2956***
	(0.1528)	(0.1478)	(0.1426)	(0.1700)	(0.1634)	(0.1503)
incorporation	-0.1259	0.0175	0.2155	0.1854	-0.0936	0.1949
	(0.1529)	(0.1438)	(0.1358)	(0.1528)	(0.1266)	(0.1486)
population	0.0059***	0.0066***	0.0068***	0.0078***	0.0073***	0.0070***
	(0.0012)	(0.0013)	(0.0014)	(0.0019)	(0.0013)	(0.0017)
ling. fractionalisation	-0.0766	0.1663	0.1705	0.1764	0.3251+	0.2128
	(0.1576)	(0.1670)	(0.1542)	(0.2084)	(0.1751)	(0.1598)
farm size	0.1093**	0.1438***	0.1366***	0.1827***	0.1679***	0.1389***
	(0.0360)	(0.0399)	(0.0351)	(0.0528)	(0.0333)	(0.0344)
farm size squared	-0.0032*	-0.0039*	-0.0035**	-0.0049**	-0.0051***	-0.0037**
	(0.0014)	(0.0016)	(0.0013)	(0.0018)	(0.0011)	(0.0013)
land inequality	-0.7652***	-0.8443***	-0.8449***	-0.6801**	-0.8827***	-1.0717***
	(0.2073)	(0.2182)	(0.2104)	(0.2526)	(0.2286)	(0.2075)
District F.E.	✓	✓	✓	✓	✓	✓
Urbanization controls	✓	✓	✓	✓	✓	✓
Observations	12152	12958	12710	10540	12400	12400

Sample: Six eastern provinces of Prussia 1852-1913, dropping one province per regression. Dep. Var. year-on-year change in number of credit cooperatives per county; grain prices are the year-on-year change of the moving average of weighted rye and wheat prices lagged over the past five years, deflated by the consumer price index. Limited liability, central bank and incorporation are time variant policy dummies. Other variables are time invariant. Urbanization controls include the share of the population in urban areas and a dummy for suburban counties. See tables B.1 and B.2 for further definitions. Regressions (2), (3), and (4) are county fixed effect Poisson regressions (234 counties), (1), (5) and (6) are Poisson with fixed effects at the level of 14 districts. Standard errors clustered at county level (236 counties). All regressions exclude Berlin.

Standard errors in parentheses: + $p<0.1$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table F.8: Determinants of credit cooperative growth, county level, Prussia: **Specification**

	(1)	(2)	(3)	(4)	(5)	(6) Ordinary Least Squares, logarithmic
	Poisson, zero-inflated	Poisson, zero-inflated with controls	Negative Binomial	Negative Binomial zero-inflated	Ordinary Least Squares	
	Dependent Variable: Number of new credit cooperatives per county					ln(new coops + 0.01)
Δ grain prices	-33.2849***	-32.9996***	-36.9780***	-36.0901***	-2.1215***	-2.0859***
	(2.8135)	(2.8094)	(2.8135)	(2.8073)	(0.1714)	(0.6300)
limited liability	1.5785***	1.5721***	1.5374***	1.5365***	0.0842***	
	(0.1607)	(0.1596)	(0.1459)	(0.1465)	(0.0114)	
central bank	1.3582***	1.3623***	1.4393***	1.4318***	0.3396***	
	(0.1506)	(0.1482)	(0.1274)	(0.1294)	(0.0195)	
incorporation	0.0260	0.0258	0.0287	0.0257	-0.0063	
	(0.1321)	(0.1319)	(0.1308)	(0.1309)	(0.0039)	
population	0.0028*	0.0023+	0.0079***	0.0057***		
	(0.0012)	(0.0012)	(0.0016)	(0.0014)		
ling. fractionalisation	0.2519	0.2393	0.1157	0.1407		
	(0.1678)	(0.2146)	(0.1552)	(0.1399)		
farm size	0.1414***	0.1402***	0.1688***	0.1655***		
	(0.0343)	(0.0337)	(0.0400)	(0.0357)		
farm size squared	-0.0038**	-0.0039**	-0.0045**	-0.0044**		
	(0.0013)	(0.0013)	(0.0015)	(0.0013)		
land inequality	-1.0152***	-1.2902***	-1.0984***	-1.1044***		
	(0.1929)	(0.2342)	(0.2220)	(0.1959)		
ln(population)					0.1308***	0.1308***
					(0.0150)	(0.0150)
ln(ling. fractionalisation)					0.0025	0.0025
					(0.0025)	(0.0025)
ln(farm size)					0.2742***	0.2742***
					(0.0521)	(0.0522)
ln(farm size squared)					-0.0450***	-0.0451***
					(0.0124)	(0.0125)
ln(land inequality)					-0.0146**	-0.0146**
					(0.0045)	(0.0045)
District F.E.	✓	✓	✓	✓	✓	✓
Year F.E.						✓
Urbanization controls	✓	✓	✓	✓	✓	✓
Observations	14632	14632	14632	14632	14632	14632

Sample: Six eastern provinces of Prussia, 1852-1913. Dep. Var. year-on-year change in number of credit cooperatives per county; grain prices are the year-on-year change of the moving average of weighted rye and wheat prices lagged over the past five years, deflated by the consumer price index. Limited liability, central bank and incorporation are time variant policy dummies. Other variables are time invariant. Urbanization controls include the share of the population in urban areas and a dummy for suburban counties. Regression (1) is a zero-inflated Poisson with population in the logit predicting zero occurrences. Regression (2) is a zero-inflated Poisson with population, ethnic fractionalization, farm size and land inequality in the logit predicting zero occurrences. (3) is a Negative Binomial specification, and (4) is a zero-inflated Negative Binomial with population in the logit predicting zero occurrences. (5) Ordinary Least Squares (6) Ordinary Least Squares on the natural logarithm of new credit cooperatives and a small constant. See tables B.1 and B.2 for further definitions. Standard errors clustered at county level (236 counties). Fixed effects at the level of 14 districts. All regressions exclude Berlin.

Standard errors in parentheses: + p<0.1, * p<0.05, ** p<0.01, *** p<0.001

G   Historical and institutional background

G.1   The six eastern provinces of Prussia

The focus of our study is on the eastern regions of Prussia from the second half of the 19th century until the First World War. Compared to the rest of Prussia, the regions east of the river Elbe had low levels of urbanization and stayed predominantly agricultural until 1914. Accordingly, they lagged behind other parts of Prussia in terms of income, and exhibited high land inequality. Tables G.1 and G.2 provide a comparison of the eastern regions in our sample with the remainder of Prussia at the district level.

As we see, there was also substantial heterogeneity within the eastern provinces. The city of Berlin, located in Brandenburg, was growing rapidly since the end of the 1850s to become one of Europe's largest financial and industrial centers. In addition, Upper Silesia in the southeast of Prussia was industrializing around booming coal mines and iron ore production (Kiesewetter, 2004, pp. 181 ff.) . However, most parts of the eastern provinces were characterized by agriculture, dominated by grain production.

G.2   Rural transformation

From the 1850s onwards, this rural economy faced growing pressure to change and adjust from several sides. First, the modernization of the Prussian and later German state led to a rising tax burden, which in turn required peasants to produce a larger marketable surplus (Wygodzinski (1911, p. 128), Ullmann (2005, p. 81)). Second, the growth of industry in centers like Berlin, Saxony, Silesia or the Ruhr attracted agricultural labor and thus increased the opportunity costs of work in agriculture (Grant, 2006, pp. 97ff). Peasants and agricultural workers had now the option to leave and find work in a factory, and many did. Related to this, income growth in cities and industrial regions contributed to a strong increase in the demand for products of animal origin such as meat and dairy products. This created new opportunities for agriculture, but it also made old types of agricultural production less attractive. The third and arguably most powerful driver for rural transformation was the decline of grain prices, both in relative and in absolute terms due to international market integration. The average prices for wheat and rye in Prussia declined

Table G.1: Eastern and western districts of Prussia, part 1: Population Statistics

District	Population		Population Density		Urban share		Income p.c.	
	1867	*1900*	*1867*	*1900*	*1875*	*1900*	*1880*	*1905*
Prussia east of the river Elbe								
Königsberg	1,063,340	1,204,386	0.50	0.57	27.70	34.11	260.05	474.76
Gumbinnen	744,778	792,240	0.47	0.50	12.73	18.44	213.86	417.02
Danzig	515,222	665,992	0.65	0.84	32.05	37.79	289.37	499.89
Marienwerder	767,620	897,666	0.44	0.51	21.56	25.73	218.50	436.42
Potsdam	550,895	1,929,304	0.27	0.94	36.89	47.98	394.87	805.61
Frankfurt	702,041	1,179,250	0.37	0.61	34.65	40.50	274.99	520.26
Stettin	993,428	830,709	0.82	0.69	37.57	48.55	330.46	610.67
Köslin	1,020,157	587,783	0.73	0.42	23.98	28.95	239.05	456.03
Stralsund	675,596	216,340	1.68	0.54	40.42	44.18	330.24	583.30
Posen	554,464	1,198,252	0.32	0.68	28.35	32.12	221.14	396.85
Bromberg	215,575	689,023	0.19	0.60	26.41	33.35	255.77	477.48
Breslau	1,364,632	1,697,719	1.01	1.26	31.83	41.93	259.14	472.15
Liegnitz	1,241,320	1,102,992	0.91	0.81	26.60	34.66	268.55	491.34
Oppeln	979,800	1,868,146	0.74	1.41	18.97	24.76	220.72	425.42
Prussia west of the river Elbe								
Magdeburg	832,141	1,176,372	0.72	1.02	42.52	50.21	406.46	714.04
Merseburg	864,853	1,189,825	0.85	1.17	37.39	44.01	353.40	639.29
Erfurt	370,072	466,419	1.05	1.32	41.52	47.99	334.73	619.54
Schleswig	439,213	1,387,968	0.23	0.73	34.15	43.25	450.63	894.71
Hannover	477,122	647,908	0.84	1.13	32.02	55.55	391.94	724.23
Hildesheim	791,361	526,758	1.48	0.98	31.33	39.05	337.59	612.99
Lüneburg	596,493	472,598	0.53	0.42	20.12	29.05	368.59	756.56
Stade	1,243,902	375,017	1.83	0.55	7.75	23.47	423.04	791.16
Osnabrück	555,882	328,600	0.90	0.53	21.47	28.77	296.97	597.65
Aurich	578,889	240,058	1.86	0.77	22.59	29.35	362.66	633.90
Münster	480,192	699,583	0.66	0.96	25.68	31.98	347.02	666.21
Minden	981,718	636,875	1.87	1.21	26.37	33.47	319.08	660.39
Arnsberg	385,957	1,851,319	0.50	2.41	34.28	40.36	439.72	832.71
Kassel	410,210	890,142	0.41	0.88	29.71	34.83	336.80	642.07
Wiesbaden	381,712	1,007,839	0.68	1.79	38.08	52.67	473.78	956.30
Koblenz	301,407	682,454	0.49	1.10	22.21	23.66	383.95	704.81
Düsseldorf	264,475	2,599,806	0.48	4.75	58.57	62.33	452.94	852.72
Köln	193,876	1,021,878	0.49	2.57	38.14	55.07	408.86	793.90
Trier	770,569	840,696	1.07	1.17	16.21	19.09	379.05	710.72
Aachen	609,176	614,964	1.47	1.48	34.42	39.47	404.32	729.22
Sigmaringen	64,632	66,780	0.57	0.59	18.36	12.79	318.47	654.57
Berlin								
Berlin	986,443	1,888,848	155.71	298.16	100.00	100.00	876.98	1,447.18

Population is headcount according to Prussian census, urban share is the share of population residing in urban areas. Income per capita refers to annual labour income in Marks per worker. See table B.2 and text for further definitions. Our sample includes counties in all districts (*Regierungsbezirke*) entirely east of the river Elbe, and excludes Berlin. See table D.1 for more information on the administrative division of Prussia.

Table G.2: Eastern and western districts of Prussia, part 2: Agricultural Statistics

	Agricultural share		Land inequality	Cows	Pigs
District	*1880*	*1905*	*1883*	*1906*	*1906*
Prussia east of the river Elbe					
Königsberg	0.57	0.47	0.45	318,997	713,134
Gumbinnen	0.71	0.61	0.33	228,964	610,484
Danzig	0.49	0.41	0.42	133,607	301,306
Marienwerder	0.65	0.58	0.52	241,382	644,141
Potsdam	0.39	0.21	0.38	247,371	659,594
Frankfurt	0.51	0.44	0.41	229,033	619,385
Stettin	0.46	0.39	0.53	177,362	543,426
Köslin	0.63	0.60	0.63	197,859	544,614
Stralsund	0.45	0.44	0.77	65,137	138,283
Posen	0.65	0.57	0.58	293,478	667,547
Bromberg	0.63	0.56	0.59	170,222	440,417
Breslau	0.42	0.33	0.44	312,827	457,330
Liegnitz	0.47	0.40	0.35	275,352	319,403
Oppeln	0.52	0.35	0.38	277,595	453,744
Prussia west of the river Elbe					
Magdeburg	0.40	0.35	0.32	166,127	718,053
Merseburg	0.40	0.34	0.27	192,784	644,531
Erfurt	0.35	0.31	0.16	62,713	202,874
Schleswig	0.42	0.32	0.17	469,940	1,079,253
Hannover	0.40	0.31	0.07	112,533	568,145
Hildesheim	0.39	0.35	0.18	90,192	331,969
Lüneburg	0.58	0.48	0.07	143,717	622,087
Stade	0.55	0.46	0.03	113,726	399,412
Osnabrück	0.63	0.55	0.01	115,031	371,418
Aurich	0.50	0.50	0.03	93,323	132,985
Münster	0.51	0.33	0.03	159,177	459,133
Minden	0.51	0.37	0.09	128,769	503,438
Arnsberg	0.21	0.12	0.09	137,275	350,307
Kassel	0.47	0.40	0.11	185,470	648,640
Wiesbaden	0.35	0.25	0.02	140,661	206,801
Koblenz	0.50	0.45	0.02	134,903	168,331
Düsseldorf	0.19	0.10	0.03	179,870	463,620
Köln	0.32	0.19	0.05	100,084	99,753
Trier	0.50	0.39	0.03	161,117	264,028
Aachen	0.35	0.27	0.02	104,699	123,988
Sigmaringen	0.63	0.64	0.03	24,892	30,352
Berlin					
Berlin	0.01	0.00	0.18	12,046	9,980

Agricultural share refers to share of working population employed in agriculture. Cows and pigs are headcounts. See table B.2 and text for further definitions. Our sample includes counties in all districts (*Regierungsbezirke*) entirely east of the river Elbe, and excludes Berlin. See table D.1 for more information on the administrative division of Prussia.

in absolute terms from the mid-1850s, partly due to international competition from grain producers from North America (O'Rourke, 1997). In consequence, relative to consumer prices and to prices for meat and dairy products, grain prices continued to decline strongly until the First World War (see figure 1, also (Federico, 2005, p. 28)).

With this, old extensive forms of agricultural production as well as subsistence farming became unsustainable. Farmers faced a choice between giving up (for example, migrating and looking for employment in industry) and investing into the modernization of their business. The latter could mean an intensification of production, a switch towards higher yielding products, such as meat or dairy, or a combination thereof. The costs involved in such a production switch were substantial. As table G.3 shows, evaluated at the average rural wage rate, the price of one head of beef cattle was equivalent to between 120 and 170 days of work. The purchase of a pig would cost the equivalent of at least 1 month's wage. The implication was a strong increase in the demand for capital (Wygodzinski, 1911, p.129). Rural credit cooperatives developed in response to this pressure in Germany from the 1850s onwards as an altogether new type of credit institution.

Table G.3: Cattle prices at the province level: **Value per head of cattle**

	(1) Price of Beef cattle (Marks per head)	(2) Price of pigs (Marks per head)	(3) Rural unskilled wage (Marks per day)	(4) Value of Beef cattle (days of labour)	(5) Value of Pigs (Days of labour)
East Prussia	145	34	1.21	119.5	28.0
West Prussia	184	43	1.28	144.3	33.9
Brandenburg	203	61	1.34	151.7	45.4
Pomerania	242	68	1.43	169.3	47.6
Posen	172	55	1.22	141.3	44.9
Silesia	173	57	1.06	162.7	54.1
Mean (unweighted)	187	53	1.26	148.5	42.2

Cattle prices calculated from aggregate value of cattle (in Mark) and cattle headcount at the province level in 1883. Source: Statistical Yearbook for the German Empire (Statistisches Amt, 1886, pp. 25-26) Daily wages for 1892 are aggregated from the county level, see table B.2. Column (4) = (1)/(3), Column (5) = (2)/(3).

G.3   Sources of rural credit

Why could the demand for credit not be met by the existing sources of capital? To start with, most peasants had little savings of their own (Kersting, F., Wolf, N.,

Wohnsiedler, I., 2019). Next, peasants were unattractive debtors for several reasons. Most importantly, many farmers had only limited assets, which could serve as collateral. Furthermore, accounting practices were hardly known in these regions around 1850, and the valuation of assets was often difficult, for example regarding the value of non-marketable livestock such as young horses, pigs or cows. Moreover, peasants would often require small sums, but over comparatively long periods, due to harvest cycles and the time to grow animals. This also implied that farmers were liquidity constrained over much of the year. Taken together, the lack of (documented) collateral, the small size of loans requested, and the need for relatively long-term credit added to the risk of lending to farmers and prevented them from accessing private banks. The remaining sources for credit were individual moneylenders, often wholesale traders, and saving banks (Wygodzinski (1911, pp. 132f.), Faust (1965, pp. 328ff.)).

Rural moneylenders had a bad reputation at the time and were regularly accused of usury. Interest rates of 30 percent or more were not uncommon (Verein für Socialpolitik (1887), also Guinnane (2001, p. 368)). We note that such accusations may have reflected anti-Semitic sentiment, as many moneylenders were Jewish. Saving banks did spread and prosper in the Eastern Provinces after 1850, but they were often reluctant to extend credit to farmers. The problem was not that they shied away from risky maturity transformation implied by their often short-term deposits and the demanded long-term loans from farmers. As reported by Wygodzinski (1911, p. 134), in 1907 savings banks in Prussia had only 3.53% of their capital invested in personal credit and the remainder in securities (23.83%) and mortgages (60.49%). More likely, savings banks considered lending to small farmers as unprofitable business.

Credit cooperatives emerged as an institutional innovation to this situation (on the following see Guinnane (2001)), pioneered by Hermann Schulze-Delitzsch (1808-1883) and Wilhelm Raiffeisen (1818-1888). They shared a number of important organizational features, which likely contributed to their long-run success and survival. While Schulze-Delitzsch focused on urban craftsmen, and Raiffeisen on rural populations, both emphasized the principle of joint-liability lending (Faust, 1965). Moreover, most rural credit cooperatives following Raiffeisen retained unlimited liability, even though limited liability became a legal option in 1889. Rural credit cooperatives restricted their operations to a small geographic area and a small num-

ber of people, similar to the "Regionalprinzip" of German savings banks. Finally, most credit cooperatives served a double function of credit banks and savings. As discussed in Banerjee et al. (1994), it was the combination of these characteristics that helped to reduce the considerable risk of lending to farmers, because they provided monitoring incentives and simple yet efficient monitoring mechanisms - if heterogeneity within their area of operation was limited.

The rural cooperative movement grew quickly in the decades before 1914, particularly in the 1880s and 1890s, probably helped by the cooperative law (1889) and the foundation of the Preussenkasse, a central bank for cooperatives(1895). In 1913 there were around 19,000 credit cooperatives with a share of nearly 7% in total assets of all financial institutions in Germany (Kluge (1991, p. 89), Tilly (1992)).

G.4   Operation of cooperatives: loan and collateral

A typical rural credit cooperative combined lending (*Aktivgeschäft*) and deposit business (*Passivgeschäft*). Consider the aggregated balance sheets of all credit cooperatives organized into the "Verband der polnischen Erwerbs- und Wirtschaftsgenossenschaften in der Provinz Posen und Westpreussen" in table G.4.[1] This is a rare instance of consolidated microdata being available at the co-op level. The table shows the development of loans, savings deposits and third party bank credit together with the overall size of the balance sheet, 1873-1907. The number of cooperatives increased from 43 (1873) to 225 (1907).

Several findings stand out. First, we see a very substantial increase in the total volume of credit issued by member cooperatives of this association, in particular from the 1890s onwards. Most part of the *Aktivgeschäft* of these credit cooperatives consists of providing loans to their individual members (loans to non-members were ruled out by law since 1889). In this region, it was common practice by both German and Polish credit cooperatives to secure loans by financial bills (Wechsel) and cosigners (Swart (1911, p. 139), Seidel (1897, p. 451)). The exact extent to which such loans were collateralized is rarely known, but it is likely that collateralization became more important in the Eastern Provinces over time. For example, the management committee of the Association decided in September 1907 to provide loans

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[1]This roughly translates as "Association of Polish Economic Cooperatives in the Provinces of Posen and West Prussia".

Table G.4: Aggregated Balance Sheets of Credit Cooperatives organized in "Association of Polish Cooperatives in Posen and West Prussia"

Year	Total Balance Sheet	Loans (Wechsel)	Share loans in Activa	Saving Deposits	Banks (external funding)	Share Saving deposits in Passiva	Share Banks in Passiva	Ratio Savings to Loans
1873	3,739,303	3,321,408	0.89	2,600,870	377,411	0.696	0.101	0.783
1874	4,493,258	4,206,771	0.94	3,345,649	191,888	0.745	0.043	0.795
1875	4,664,843	4,522,160	0.97	3,414,437	289,877	0.732	0.062	0.755
1876	5,833,799	5,299,917	0.91	4,113,766	363,468	0.705	0.062	0.776
1877	6,333,792	6,046,207	0.96	4,533,591	355,089	0.716	0.056	0.750
1878	6,935,886	6,639,366	0.96	4,852,238	456,586	0.700	0.066	0.731
1879	6,894,557	6,393,654	0.93	4,860,377	296,676	0.705	0.043	0.760
1880	7,218,109	6,781,756	0.94	5,219,266	229,032	0.723	0.032	0.770
1881	8,827,849	8,245,228	0.93	6,489,611	229,243	0.735	0.026	0.787
1882	9,223,512	8,315,469	0.90	6,844,717	152,654	0.742	0.017	0.823
1883	10,718,589	10,109,503	0.94	7,937,405	240,720	0.741	0.022	0.785
1884	11,518,278	10,982,232	0.95	8,432,204	259,199	0.732	0.023	0.768
1885	11,890,343	11,334,393	0.95	8,676,014	245,629	0.730	0.021	0.765
1886	12,249,617	11,618,529	0.95	8,908,417	245,248	0.727	0.020	0.767
1887	13,343,992	12,559,960	0.94	9,652,998	259,028	0.723	0.019	0.769
1888	14,472,320	13,331,869	0.92	10,507,893	243,167	0.726	0.017	0.788
1889	15,265,872	13,783,108	0.90	11,121,626	332,281	0.729	0.022	0.807
1890	16,980,742	15,320,179	0.90	12,523,183	302,190	0.737	0.018	0.817
1891	18,942,662	16,650,523	0.88	12,661,911	970,879	0.668	0.051	0.760
1892	15,454,997	14,439,906	0.93	10,782,235	687,405	0.698	0.044	0.747
1893	19,162,825	16,671,612	0.87	13,106,546	593,848	0.684	0.031	0.786
1894	21,401,901	18,197,042	0.85	14,970,083	399,968	0.699	0.019	0.823
1895	24,379,510	20,379,160	0.84	16,774,448	779,923	0.688	0.032	0.823
1896	27,009,274	23,539,093	0.87	19,078,036	441,660	0.706	0.016	0.810
1897	32,825,358	27,923,547	0.85	22,325,160	1,444,052	0.680	0.044	0.800
1898	40,546,919	30,866,931	0.76	26,749,760	1,085,849	0.660	0.027	0.867
1899	46,647,161	38,390,725	0.82	32,462,061	2,104,363	0.696	0.045	0.846
1900	53,559,698	42,266,620	0.79	37,787,516	2,088,746	0.706	0.039	0.894
1901	60,347,493	48,151,082	0.80	42,248,506	3,024,011	0.700	0.050	0.877
1902	68,594,954	54,610,381	0.80	49,282,288	3,191,201	0.718	0.047	0.902
1903	80,771,179	52,278,119	0.65	58,908,668	1,726,624	0.729	0.021	1.127
1904	98,339,437	75,292,663	0.77	70,616,513	2,212,735	0.718	0.023	0.938
1905	117,623,657	87,685,799	0.75	87,421,051	2,986,025	0.743	0.025	0.997
1906	143,541,423	105,214,815	0.73	107,062,057	3,765,857	0.746	0.026	1.018
1907	164,441,955	127,232,979	0.77	123,004,213	5,060,369	0.748	0.031	0.967

Aggregated balance sheet data of the credit cooperatives belonging to the "Association" as gathered by Prussian authorities (Polizei Präsidium Posen, 1909). All amounts in Mark, unless noted as share of total or ratio.

only on financial bills (Polizei Präsidium Posen, 1909, p.12). As argued by Swart (1911, pp. 139f.), "financial bills" in the balance sheet often reflected mortgage loans, which had been transformed into bills. More generally, some form of collateral was required by Raiffeisen's *Musterstatut* according to §31, which demanded that cosigners of a loan had to own land or property that exceeded the value of the loan by at least 1/3 (see also Kraus (1876, p. 32)).[2]

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[2]The *Musterstatut* was a template for cooperative organisation designed by the central Raiffeisen orgranisation that local cooperatives could, but did not have to, adopt.

There is evidence that loans were typically secured by one or two cosigners, and
that in order to qualify as a cosigner, a person had to be known in terms of their
wealth and liabilities (Guinnane (2001, p.378), Schlütz (2013, p. 307)). Schlütz
(2013, pp. 300ff.) provides details on the *Aktivgeschäft* of credit cooperatives in
the Rhineprovince, which indicates that collateral, including land became more im-
portant over time. Von Altrock (1900) describes the credit operations of rural credit
cooperatives in the province of Brandenburg for the years 1897 and 1898 in some
detail. He reports for 101 credit cooperatives that were part of the Raiffeisen-system
the following: in 1897 they had provided loans over 1.72 Million Marks or 356
Mark per member. About 1.47 Million Mark of loans were provided for a fixed
term, where 28.4% for a term of up to 1 year, 48.4% for a term between 1 and 10
years and 23.2% for a term of more than 10 years. A total of 1.48 Million Mark of
those loans were secured by either cosigners or land, in particular 64.1% secured by
cosigners and 35.9% secured by land (Hypotheken, see Von Altrock (1900, p. 49)).

G.5   Relationship of cooperatives to banks and the state

Most important for the loan operation of credit cooperatives however, was the fact
that they combined the function of a credit bank with that of savings banks. Due
to their character of joint-liability institutions and the fact that most often the de-
posits of some members served as capital for the loans to others, the total assets
of members served as implicit collateral for their loan operations (Banerjee et al.,
1994). Sometimes, credit cooperatives used their total members' collateral to ap-
proach third party funding institutions such as banks, but more often regional "cen-
tral banks" controlled by a larger group of credit cooperatives. This mattered espe-
cially for young, small credit cooperatives, which had not yet accumulated sufficient
saving deposits of their own. We see from table G.4 that for the first decades, credit
cooperatives, which were part of the Association, could serve about 80% of their
members' total credit demand using the capital of their savings account. By the
turn of the century, the credit cooperatives in this sample had become on balance
financially "self-sufficient". Similarly, table G.4, shows that third party funding was
important early on, but declined in relative importance. More generally, it was the
Passivgeschäft with interest bearing saving deposits that enabled credit cooperatives
to engage in their *Aktivgeschäft*, providing loans (Schlütz, 2013, p. 352).

The loans provided were typically medium- to long-run, which stood in contrast to loans provided by moneylenders, saving banks or private banks (Wygodzinski, 1911, pp. 139ff.). It seems that most credits were given for more than three months, often up to 20 years with at least yearly installments of repayment (Kluge, 1991, p.191f). Schlütz (2013) shows that for several credit cooperatives in the Rhine Province, loans provided for longer terms and larger amounts were becoming more frequent during the two decades before 1914.

Credit cooperatives proved to be very resilient before 1914, with extremely low failure rates. In particular, rural credit cooperatives failed less often than urban cooperatives (Schlütz, 2013, p. 154). If they did so, this was typically either because they were not part of a larger regional association, which could have helped to refinance their loans, or because they operated under limited liability. As reported in Banerjee et al. (1994, p. 503), in 1909/10 out of 15,000 rural credit cooperatives only three failed (all with limited liability). This resilience is all the more remarkable, given that state intervention remained limited. Rural credit cooperatives were never directly state subsidized, although many of them might have benefited from cheap or free managerial labor, provided by local authorities such as state officials or priests who voluntarily contributed their expertise and time to the cause. However, as argued in Guinnane (2001), this likely mattered only for the early years of cooperatives and can hardly explain their long-run success. However, indirectly, the state supported the credit cooperative movement in two important ways. First, the state provided a legal framework, with the 1867 incorporation law bestowing legal personhood unto cooperatives, and the 1889 law allowing cooperatives to opt for limited liability (Faust, 1965). Second, the foundation of the Preussenkasse in 1895, which was initially endowed with public resources helped to safeguard the credit operations of cooperatives and their regional central banks as a refinancing institution (Guinnane et. al., 2013, pp. 77ff.). However, as we see from table G.4 above, while this certainly mattered temporarily and for some credit cooperatives more than for others, most of them were financially self-sufficient by the turn of century.

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