The rise of prosociality in fiction preceded democratic revolutions in Early Modern Europe

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1. Methods

	Ratio	Proxy	Set	Search Terms
English	S-A	Sympathy	Seed	*Sympathy, Compassion, Pity*
			Final	affliction, charity, compassion, distress, endearment, feeling, fondness, gentleness, goodness, humanity, kindness, mercy, pitty, pity, remorse, sensation, sensibility, softness, solicitude, suffering, sympathy, tenderness, warmth, weakness
		Anger	Seed	*Anger, Fury, Rage, Indignation, Choler*
			Final	anger, ardor, ardour, choler, fervour, fierceness, frenzy, fume, fury, grief, hatred, impetuous, indignation, jealousie, jealousy, piping, rage, resentment, seethe, spleen, tempest, torrent, whirlpool, whirlwind, wrath
	T-S	Trust	Seed	*Sincerity, Confidence*
			Final	assurance, belief, candour, confidence, constancy, delicacy, fidelity, friendship, generosity, goodness, gratitude, integrity, kindness, loyalty, sentiment, sincere, sincerity
		Strength	Seed	*Strength, Power*
			Final	authority, courage, firmness, force, fortitude, goodness, greatness, influence, power, rigour, sinew, strength, sway, valor, valour, vigour, virtue
	P-A	Prosociality	Seed	*Comfort, Care, Help, Charity, Assistance, Support*
				advice, affect, affection, aid, approbation, assist, assistance, assurance, attachment, benevolence, bounty, care, charity, civility, comfort, compassion, consolation, cordial, counsel, courtesie, courtesy, delicacy, embrace, embracing, encouragement, engagement, esteem, favor, favour, forgiveness, generosity, gentleness, goodnature, goodness, gratitude, help, hint, hug, humanity, humility, imbrace, inclination, incouragement, instruction, kindness, lend, mercy, piety, pittance, pitty, pity, protect, protection, quittance, redress, refuge, regard, relief, relieve, remission, request, rescue, sanctuary, save, sensibility, sentiment, service, shelter, solicitude, succour, support, sweetness, tenderness, thankfulness
		Authority	Final	*Obedience, Authority, Strength*
				accuse, active, allegiance, approve, ardor, ardors, ardour, authority, bravery, captain, censure, charge, charter, claim, command, condemn, constancy, control, courage, cruelty, demand, determine, disposess, dominion, duty, eminence, empery, energy, enjoin, entreat, entreaty, esquire, extent, fervour, fierceness, firmness, force, fortitude, glory, govern, grandeur, greatness, impulse, infidelity, influence, injunction, judge, judgment, justice,

				landlord, law, lieutenant, lord, loyalty, magnificence, manhood, master, monarchy, nobleness, obedience, obey, observance, patriotic, piety, pomp, power, precept, preeminence, prerogative, privilege, protection, prowess, punish, regal, respect, reverence, rigour, robustness, royalty, rule, sceptre, severity, sinew, sovereignty, splendor, splendour, squire, statute, strength, strictness, subjection, submission, summons, supremacy, sway, title, trophy, tyranny, valor, valour, vassal, vigor, vigour, vivacity
French	S-A	Sympathy	Seed	*Sympathie*, *Compassion*, *Pitié*
			Final	affection, antipathie, bonté, compassion, conformité, contraste, convenance, correspondance, harmonie, instinct, nouveauté, pitié, plainte, prière, reconnaissance, regret, remords, ressemblance, soin, souci, sympathie, timidité, égalité
		Anger	Seed	*Colère, Fureur, Rage, Indignation, Courroux*
			Final	barbarie, colère, courroux, cruauté, dédain, emportement, frayeur, fureur, furie, haine, indignation, inimitié, rage, ressentiment, rigueur, vengeance
	T-S	Trust	Seed	*Sincérité, Confiance*
			Final	affection, complaisance, confiance, discrétion, estime, facilité, franchise, générosité, indulgence, modestie, prudence, confiance, reconnaissance, sincérité, tendresse, zèle
		Strength	Seed	*Force, Puissance*
			Final	adresse, autorité, courage, courroux, dignité, empire, force, forces, suffrage, sévérité, tyrannie, vaillance, valeur, vertu, vigueur, violence
		Prosociality	Seed	*Consolation, Réconfort, Soin, Aide, Charité, Assistance, Secours*
			Final	affection, protecteur, protection, protéger, affliction, aide, aider, allié, amitié, appui, asile, assistance, assister, bienfait, bonté, camarade, charité, civilité, clémence, compliment, concitoyen, confier, conseil, conseiller, consolation, consoler, courtoisie, délivrer, encourager, escorte, favoriser, guérir, générosité, indulgence, inviter, joindre, miséricorde, pardonner, partage, pitié, politesse, prévenir, prêter, reconnaissance, refuge, remerciement, réconfort, salut, sauver, seconder, secourir, secours, sentiment, soigner, soin, souci, soulagement, soulager, soutien, support, supporter, écouter
		Authority	Seed	*Authorité, Obeissance, Force*
			Final	arrêt, autorité, commandement, cruauté, césar, discipline, domination, décret, déférence, déshonneur, empereur, empire, fermeté, fidélité, force, forces, gloire, gouverneur, grandeur, guerrier, honneur, impiété,

				insolence, joug, juge, jugement, juridiction, loi, légion, majesté, maxime, maître, monseigneur, obéissance, ordonnance, ordre, orgueil, persécuteur, piété, police, prince, privilège, puissance, rang, sceptre, seigneur, sire, soumission, subalterne, sévérité, titre, tyran, tyrannie, vaincre, vainqueur, violence

Table S1. Search Terms Lists used to calculate the Sympathy-to-Anger (S-A), Trustworthiness-to-Strength (T-S) and Prosociality-to-Authority (P-A) *Ratios*, based on *Proxy* terms Anger and Empathy, Strength and Trustworthiness, and Prosociality and Authoritarianism. We depict the Seed words from WordNet and the Final set derived from Word2Vec Similarity analysis.

2. Results

2.1. Time models

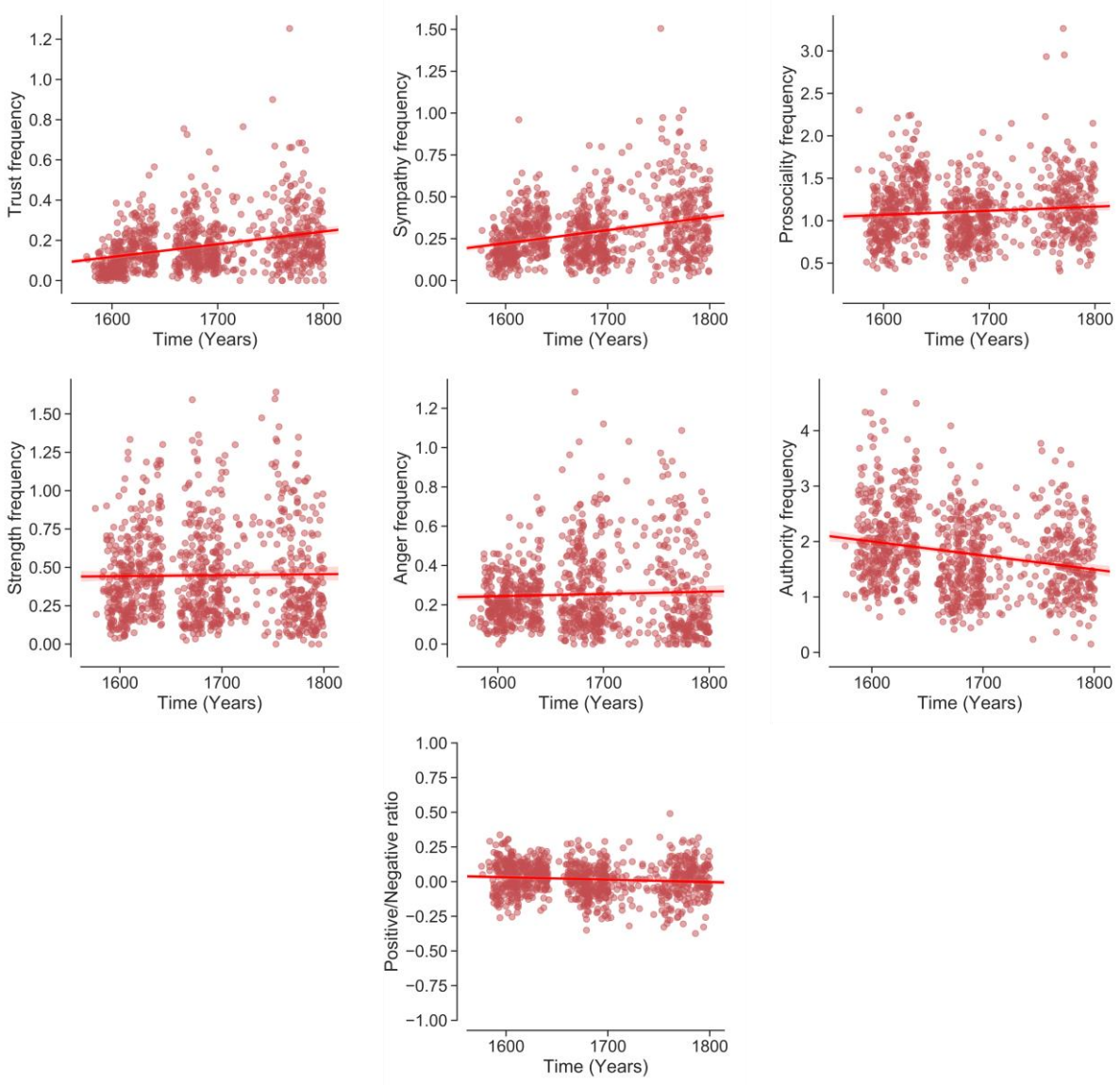

Figure S1. Variation of Trust, Strength, Sympathy, Anger, Prosociality and Authoritarianism across time for England. The bottom panel also depicts the Positive to Negative ratio.

Trust – England

	Trust			Trust		
Predictors	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*
(Intercept)	0.01	-0.07 – 0.08	0.874	-2.76	-3.28 – -2.23	**<0.001**
year	0.34	0.26 – 0.41	**<0.001**	0.38	0.30 – 0.45	**<0.001**
positivity				2.73	2.22 – 3.25	**<0.001**
Random Effects						
σ^2	0.77			0.70		
τ_{00}	0.11 author			0.08 author		
ICC	0.12			0.10		
N	282 author			282 author		
Observations	904			904		
Marginal R^2 / Conditional R^2	0.111 / 0.220			0.211 / 0.288		

Table S2. GLMM results for the Trustworthiness-to-Strength ratio (Trust) in England as predicted by time (year) and positivity. Type II Sum of Squares (top), and Type III (below).

Sympathy – England

	Sympathy			Sympathy		
Predictors	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*
(Intercept)	-0.04	-0.12 – 0.04	0.361	-3.09	-3.62 – -2.56	**<0.001**
year	0.32	0.23 – 0.40	**<0.001**	0.36	0.29 – 0.44	**<0.001**
positivity				3.03	2.51 – 3.54	**<0.001**
Random Effects						
σ^2	0.78			0.71		
τ_{00}	0.15 $_{author}$			0.08 $_{author}$		
ICC	0.16			0.11		
N	280 $_{author}$			280 $_{author}$		
Observations	908			908		
Marginal R^2 / Conditional R^2	0.097 / 0.241			0.216 / 0.300		

Table S3. GLMM results for the Sympathy-to-Anger ratio (Sympathy) in England as predicted by time (year) and positivity. Type II Sum of Squares (top), and Type III (below).

Prosociality – England

	Prosociality			Prosociality		
Predictors	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*
(Intercept)	0.00	-0.08 – 0.08	0.977	-0.53	-1.08 – 0.02	0.058
year	0.28	0.20 – 0.36	**<0.001**	0.29	0.20 – 0.37	**<0.001**
positivity				0.53	-0.01 – 1.07	0.055
Random Effects						
σ^2	0.76			0.76		
τ_{00}	0.16 $_{author}$			0.16 $_{author}$		
ICC	0.18			0.18		
N	308 $_{author}$			308 $_{author}$		
Observations	919			919		
Marginal R^2 / Conditional R^2	0.078 / 0.242			0.081 / 0.243		
log-Likelihood	-1245.737			-1244.269		

Table S4. GLMM results for the Prosociality-to-Authoritarianism ratio (Prosociality) in England as predicted by time (year) and positivity. Type II Sum of Squares (top), and Type III (below).

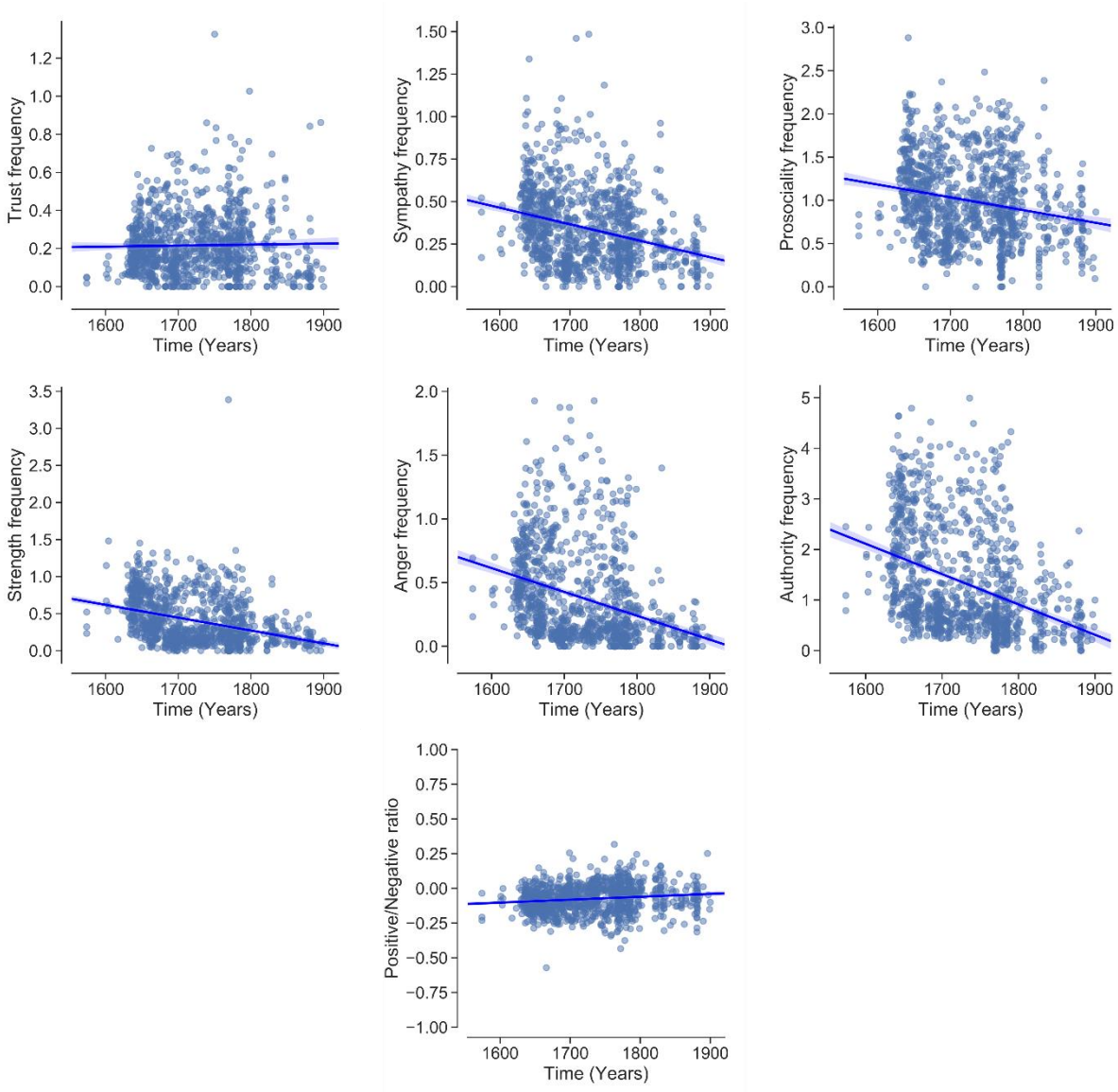

Figure S2. Variation of Trust, Strength, Sympathy, Anger, Prosociality and Authority across time for France. The bottom panel also depicts the Positive to Negative ratio.

Trust – France

	Trust			Trust		
Predictors	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*
(Intercept)	-0.06	-0.15 – 0.04	0.231	-0.05	-0.14 – 0.03	0.234
year	0.33	0.25 – 0.41	**<0.001**	0.28	0.21 – 0.36	**<0.001**
positivity				0.25	0.19 – 0.31	**<0.001**
Random Effects						
σ^2	0.62			0.59		
τ_{00}	0.25 $_{author}$			0.20 $_{author}$		
ICC	0.29			0.25		
N	280 $_{author}$			280 $_{author}$		
Observations	932			932		
Marginal R^2 / Conditional R^2	0.105 / 0.366			0.163 / 0.371		

Table S5. GLMM results for the Trustworthiness-to-Strength ratio (Trust) in France as predicted by time (year) and positivity. Type II Sum of Squares (top), and Type III (below).

Sympathy – France

	Sympathy			Sympathy		
Predictors	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*
(Intercept)	-0.01	-0.10 – 0.09	0.895	0.01	-0.07 – 0.09	0.814
year	0.23	0.14 – 0.31	**<0.001**	0.17	0.09 – 0.24	**<0.001**
positivity				0.39	0.32 – 0.45	**<0.001**
Random Effects						
σ^2	0.74			0.66		
τ_{00}	0.23 $_{author}$			0.15 $_{author}$		
ICC	0.24			0.18		
N	276 $_{author}$			276 $_{author}$		
Observations	934			934		
Marginal R^2 / Conditional R^2	0.045 / 0.272			0.176 / 0.325		

Table S6. GLMM results for the Sympathy-to-Anger ratio (Sympathy) in France as predicted by time (year) and positivity. Type II Sum of Squares (top), and Type III (below).

Prosociality – France

	Prosociality			Prosociality		
Predictors	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*
(Intercept)	-0.06	-0.15 – 0.02	0.136	-0.60	-1.16 – -0.03	**0.040**
year	0.31	0.23 – 0.38	**<0.001**	0.30	0.23 – 0.38	**<0.001**
positivity				0.58	-0.03 – 1.19	0.063
Random Effects						
σ^2	0.71			0.72		
τ_{00}	0.18 $_{author}$			0.16 $_{author}$		
ICC	0.20			0.19		
N	308 $_{author}$			308 $_{author}$		
Observations	1043			1043		
Marginal R^2 / Conditional R^2	0.096 / 0.274			0.100 / 0.267		
log-Likelihood	-1378.897			-1377.459		

Table S7. GLMM results for the Prosociality-to-Authoritarianism ratio (Prosociality) in France as predicted by time (year) and positivity. Type II Sum of Squares (top), and Type III (below).

2.2. Genre analysis

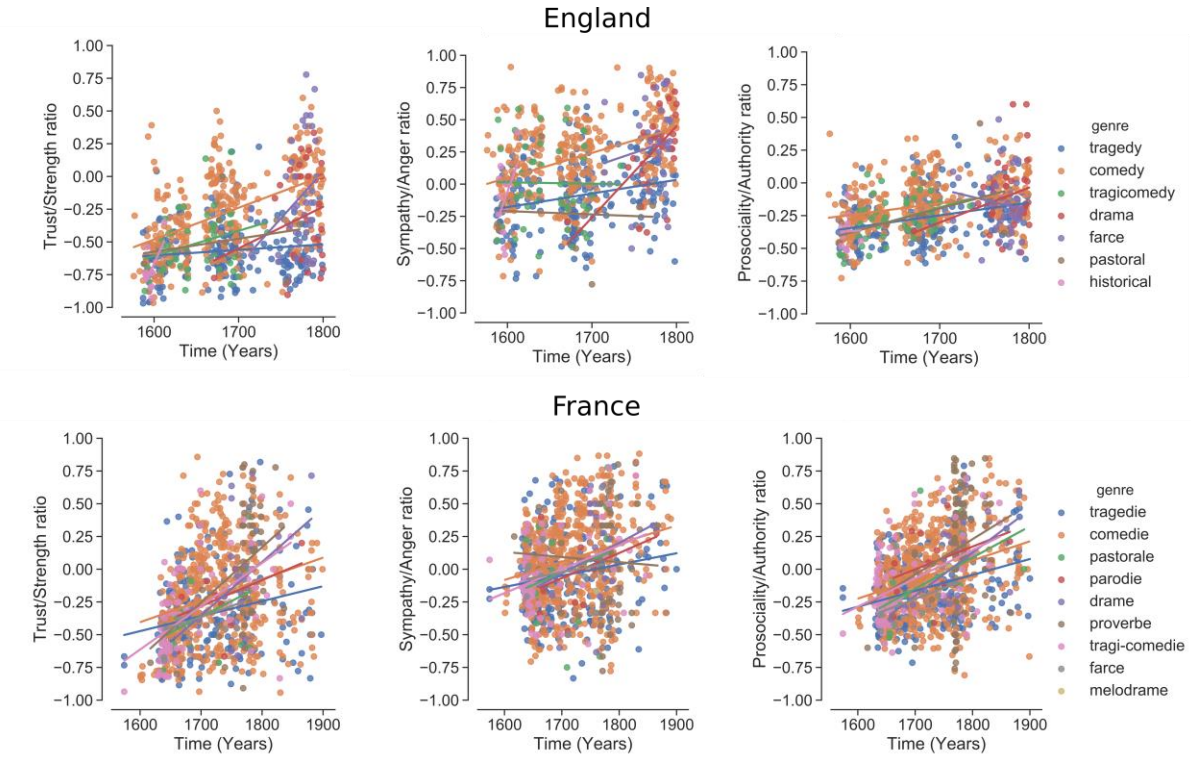

Figure S3. Temporal dynamics of cooperation-to-dominance ratios in both England (top) and France (bottom) across different theatre genres.

2.3. Historical analysis

England

		1. Pre-Civil War	2. Restoration	3. Post-Glorious Revolution
Trust	mean (*±SD*)	- 0.54±0.24	-0.36±0.29	-0.33±0.33
	growth rate (*±SE*)	0.75±0.25	-1.24±0.68	0.39±0.09
Sympathy	mean (*±SD*)	0.04±0.31	0.00±0.32	0.20±0.33
	growth rate (*±SE*)	0.64±0.26	-0.37±0.70	0.53±0.10
Prosociality	mean (*±SD*)	-0.28±0.17	-0.23±0.18	-0.16±0.19
	growth rate (*±SE*)	0.58±0.27	-0.59±0.70	0.12±0.01

Table S8. Trustworthiness-to-Strength (Trust), Sympathy-to-Anger (Sympathy) and Prosociality-to-Authoritarianism (Prosociality) ratios, means and growth rates during different historical periods for England.

	Trust			Sympathy			Prosociality		
Predictors	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*
(Intercept)	0.04	-0.20 – 0.28	0.740	-0.41	-0.65 – -0.16	**0.001**	-0.07	-0.32 – 0.18	0.561
year	-1.24	-2.57 – 0.09	0.068	-0.37	-1.74 – 1.00	0.595	-0.59	-1.98 – 0.79	0.400
period [post glorious revolution]	-0.14	-0.44 – 0.15	0.345	0.18	-0.13 – 0.48	0.252	0.24	-0.06 – 0.54	0.120
period [pre_civil_war]	0.34	-0.22 – 0.90	0.232	0.86	0.28 – 1.45	**0.004**	0.35	-0.26 – 0.95	0.261
year * period [post glorious revolution]	1.63	0.28 – 2.98	**0.018**	0.90	-0.48 – 2.29	0.202	0.71	-0.69 – 2.12	0.320
year * period [pre_civil_war]	1.99	0.57 – 3.41	**0.006**	0.99	-0.46 – 2.45	0.179	1.17	-0.30 – 2.65	0.119
Random Effects									
σ^2	0.76			0.77			0.76		
τ_{00}	0.09 $_{author}$			0.12 $_{author}$			0.16 $_{author}$		
ICC	0.11			0.14			0.17		
N	302 $_{author}$			299 $_{author}$			306 $_{author}$		
Observations	897			901			912		
Marginal R^2 / Conditional R^2	0.148 / 0.241			0.122 / 0.244			0.086 / 0.243		
log-Likelihood	-1196.395			-1216.168			-1234.794		

Table S9. LMM results for Trust, Sympathy and Prosociality in England as predicted by time (year) and historical period (reference period: Restoration).

contrast	*B*	*SE*	*df*	*T*	*p*
Model: Trust					
restoration - post glorious revolution	-1.627	0.691	686	-2.356	**0.049**
restoration – pre civil war	-1.992	0.726	659	-2.745	**0.017**
post glorious revolution – pre civil war	-0.365	0.266	296	-1.372	0.356
Model: Sympathy					
restoration - post glorious revolution	-0.86	0.711	703	-1.21	0.447
restoration – pre civil war	-0.988	0.747	682	-1.322	0.383
post glorious revolution – pre civil war	-0.127	0.276	336	-0.461	0.889
Model: Prosociality					
restoration - post glorious revolution	-0.71	0.719	745	-0.992	0.582
restoration – pre civil war	-1.173	0.755	729	-1.553	0.266
post glorious revolution – pre civil war	-0.460	0.280	389	-1.637	0.230

Degrees-of-freedom method: kenward-roger
P value adjustment: tukey method for comparing a family of 3 estimates

Table S10. Slope pairwise contrasts between historical periods of the models in Table S9.

France

		1. Pre-Revolution	2. French Revolution	3. Restoration and Empires	4. Third Republic
Trust	mean (*±SD*)	-0.26±0.36	-0.09±0.37	-0.15±0.42	-0.16±0.38
	growth rate (*±SE*)	0.50±0.06	3.33±2.5	-0.94±0.54	-1.11±1.97
Sympathy	mean (*±SD*)	0.02±0.34	0.07±0.35	0.23±0.36	0.26±0.35
	growth rate (*±SE*)	0.18±0.06	0.88±2.6	0.23±0.57	-2.38±2.58
Prosociality	mean (*±SD*)	-0.08±0.30	0.07±0.38	0.10±0.33	0.12±0.31
	growth rate (*±SE*)	0.36±0.06	4.5±2.4	-0.36±0.49	-3.7±1.6

Table S11. Trustworthiness-to-strength (Trust), sympathy-to-anger (Sympathy) and Prosociality-to-Authoritarianism (Prosociality) ratios, means and growth rates during different historical periods for France.

	Trust			Sympathy			Prosociality		
Predictors	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*
(Intercept)	1.73	-0.00 – 3.46	0.051	0.09	-1.77 – 1.95	0.923	0.97	-0.63 – 2.57	0.234
period [rep III]	1.18	-7.96 – 10.32	0.801	5.98	-5.92 – 17.89	0.325	8.28	0.77 – 15.79	**0.031**
period [revolution]	-4.54	-9.67 – 0.59	0.083	-0.82	-6.31 – 4.67	0.769	-5.10	-10.07 – -0.13	**0.044**
year	-0.94	-1.99 – 0.11	0.078	0.23	-0.90 – 1.35	0.695	-0.36	-1.33 – 0.61	0.464
period [pre revolution]	-1.69	-3.42 – 0.04	0.056	-0.10	-1.96 – 1.76	0.916	-1.01	-2.61 – 0.59	0.215
year * period [pre revolution]	1.45	0.39 – 2.51	**0.007**	-0.03	-1.17 – 1.10	0.953	0.73	-0.25 – 1.71	0.145
year * period [rep III]	-0.17	-4.18 – 3.83	0.932	-2.53	-7.72 – 2.66	0.339	-3.36	-6.64 – -0.07	**0.045**
year * period [revolution]	4.27	-0.72 – 9.27	0.094	0.62	-4.66 – 5.89	0.819	4.86	0.04 – 9.69	**0.048**
Random Effects									
σ^2	0.62			0.73			0.72		
τ_{00}	0.20 $_{author}$			0.25 $_{author}$			0.16 $_{author}$		
ICC	0.24			0.25			0.18		
N	285 $_{author}$			283 $_{author}$			304 $_{author}$		
Observations	925			927			1036		
Marginal R^2 / Conditional R^2	0.157 / 0.360			0.045 / 0.289			0.114 / 0.277		
log-Likelihood	-1169.262			-1250.526			-1363.873		

Table S12. LMM results for Trust, Sympathy and Prosociality in France as predicted by time (year) and historical period (reference period: Restoration).

contrast	*B*	*SE*	*df*	*T*	*p*
Model: Trust					
restoration - pre revolution	-1.451	0.541	658	-2.685	**0.0373**
restoration - rep III	0.173	2.045	719	0.084	0.9998
restoration - revolution	-4.277	2.556	826	-1.674	0.3383
pre revolution - rep III	1.624	1.977	716	0.821	0.8443
pre revolution - revolution	-2.826	2.5	830	-1.13	0.6708
rep III - revolution	-4.45	3.197	779	-1.392	0.5048
Model : Sympathy					
restoration - pre revolution	0.0534	0.58	648	0.092	0.9997
restoration - rep III	2.5091	2.64	674	0.95	0.7779
restoration - revolution	-0.6506	2.69	847	-0.242	0.995
pre revolution - rep III	2.4557	2.58	667	0.951	0.7774
pre revolution - revolution	-0.704	2.63	852	-0.267	0.9933
rep III - revolution	-3.1597	3.7	757	-0.854	0.8285
Model : Prosociality					
restoration - pre revolution	-0.726	0.50	751	-1.452	0.4669
restoration - rep III	3.355	1.67	787	1.999	0.1889
restoration - revolution	-4.862	2.46	935	-1.973	0.1988
pre revolution - rep III	4.082	1.60	789	2.547	0.0537
pre revolution - revolution	-4.135	2.41	939	-1.712	0.3177
rep III - revolution	-8.217	2.90	889	-2.829	**0.0245**

Degrees-of-freedom method: kenward-roger
P value adjustment: tukey method for comparing a family of 3 estimates

Table S13. Slope pairwise contrasts between historical periods in the models in S8. Rep III: Third Republic.

2.4. Affluence and Cooperation

2.4.1. Affluence and Cooperation (England)

Trust – England

	Trust				Trust				Trust			
Predictors	*Estimates*	*CI*	*Statistic*	*p*	*Estimates*	*CI*	*Statistic*	*p*	*Estimates*	*CI*	*Statistic*	*p*
(Intercept)	-0.00	-0.08 – 0.08	-0.05	0.963	-0.00	-0.08 – 0.07	-0.12	0.905	0.07	-0.16 – 0.31	0.59	0.554
GDPpc	0.29	0.21 – 0.37	7.33	**<0.001**	-0.17	-0.37 – 0.03	-1.65	0.100	-0.54	-1.02 – -0.06	-2.21	**0.027**
year					0.51	0.30 – 0.72	4.84	**<0.001**	0.49	0.18 – 0.81	3.12	**0.002**
GDPpc * period [post glorious revolution]									0.44	-0.12 – 1.00	1.53	0.126
period [pre_civil_war]									0.30	-0.26 – 0.86	1.05	0.292
GDPpc * period [pre_civil_war]									0.84	0.24 – 1.44	2.73	**0.006**
period [post glorious revolution]									-0.17	-0.49 – 0.14	-1.08	0.278
Random Effects												
σ^2	0.78				0.77				0.76			
τ_{00}	0.13 $_{author}$				0.10 $_{author}$				0.10 $_{author}$			
ICC	0.14				0.12				0.12			
N	304 $_{author}$				304 $_{author}$				302 $_{author}$			
Observations	904				904				897			
Marginal R^2 / Conditional R^2	0.083 / 0.214				0.123 / 0.225				0.145 / 0.249			
log-Likelihood	-1224.671				-1214.715				-1199.036			

Table S14. LMM results for Trust in England as predicted by time (year), GDP per capita (GDP) and historical period (reference period: Restoration).

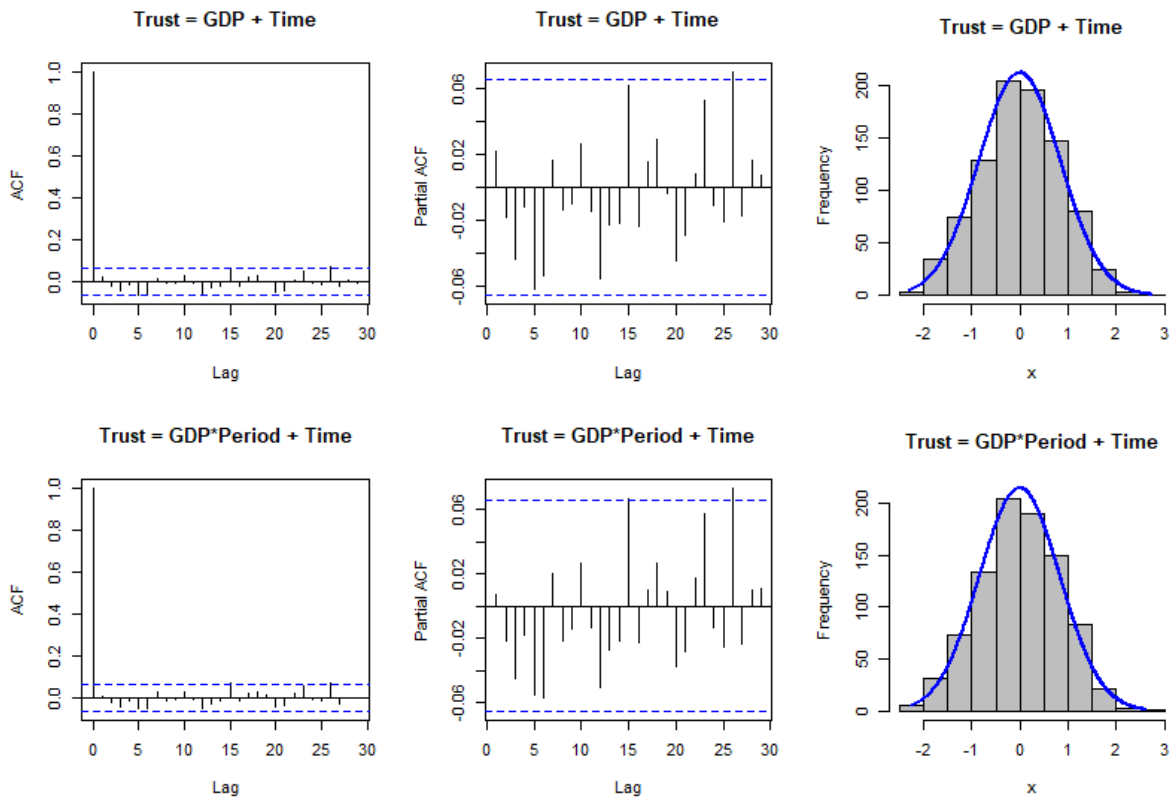

Figure S4. Residuals autocorrelation (ACF), partial ACF, and distribution of the in Table S10.

Sympathy – England

	Sympathy				Sympathy			
Predictors	*Estimates*	*CI*	*Statistic*	*p*	*Estimates*	*CI*	*Statistic*	*p*
(Intercept)	-0.04	-0.12 – 0.05	-0.85	0.393	-0.04	-0.12 – 0.05	-0.87	0.386
GDPpc	0.31	0.23 – 0.39	7.57	**<0.001**	0.20	-0.00 – 0.41	1.94	**0.053**
year					0.12	-0.09 – 0.33	1.10	0.271
Random Effects								
σ^2	0.77				0.77			
τ_{00}	0.16 $_{author}$				0.16 $_{author}$			
ICC	0.17				0.17			
N	301 $_{author}$				301 $_{author}$			
Observations	908				908			
Marginal R^2 / Conditional R^2	0.092 / 0.249				0.097 / 0.250			
log-Likelihood	-1232.716				-1233.418			

Table S15. LMM results for Sympathy in England as predicted by time (year) and GDP per capita (GDP).

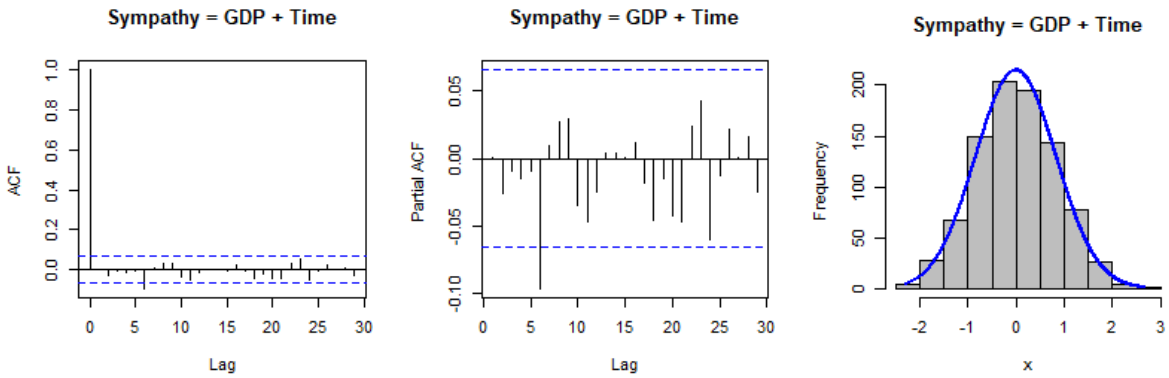

Figure S5. Residuals autocorrelation (ACF), partial ACF, and distribution of Model 2 in Table S15.

Prosociality – England

	Prosociality				Prosociality				Prosociality			
Predictors	*Estimates*	*CI*	*Statistic*	*p*	*Estimates*	*CI*	*Statistic*	*p*	*Estimates*	*CI*	*Statistic*	*p*
(Intercept)	0.00	-0.08 – 0.09	0.08	0.932	0.00	-0.08 – 0.08	0.03	0.977	-0.15	-0.39 – 0.10	-1.16	0.246
GDPpc	0.24	0.16 – 0.32	5.90	**<0.001**	-0.05	-0.25 – 0.16	-0.47	0.639	-0.46	-0.95 – 0.03	-1.86	**0.063**
year					0.33	0.11 – 0.54	3.01	**0.003**	0.15	-0.17 – 0.48	0.92	0.357
GDPpc * period [post glorious revolution]									0.50	-0.08 – 1.08	1.69	0.091
period [pre_civil_war]									-0.14	-0.72 – 0.44	-0.47	0.636
GDPpc * period [pre_civil_war]									0.34	-0.27 – 0.96	1.09	0.274
period [post glorious revolution]									0.25	-0.07 – 0.57	1.52	0.128
Random Effects												
σ^2	0.76				0.76				0.76			
τ_{00}	0.17 $_{author}$				0.16 $_{author}$				0.17 $_{author}$			
ICC	0.18				0.18				0.18			
N	308 $_{author}$				308 $_{author}$				306 $_{author}$			
Observations	919				919				912			
Marginal R^2 / Conditional R^2	0.058 / 0.231				0.078 / 0.242				0.085 / 0.254			
log-Likelihood	-1250.175				-1246.966				-1238.343			

Table S16. LMM results for Prosociality in England as predicted by time (year), GDP per capita (GDP) and historical period (reference period: Restoration).

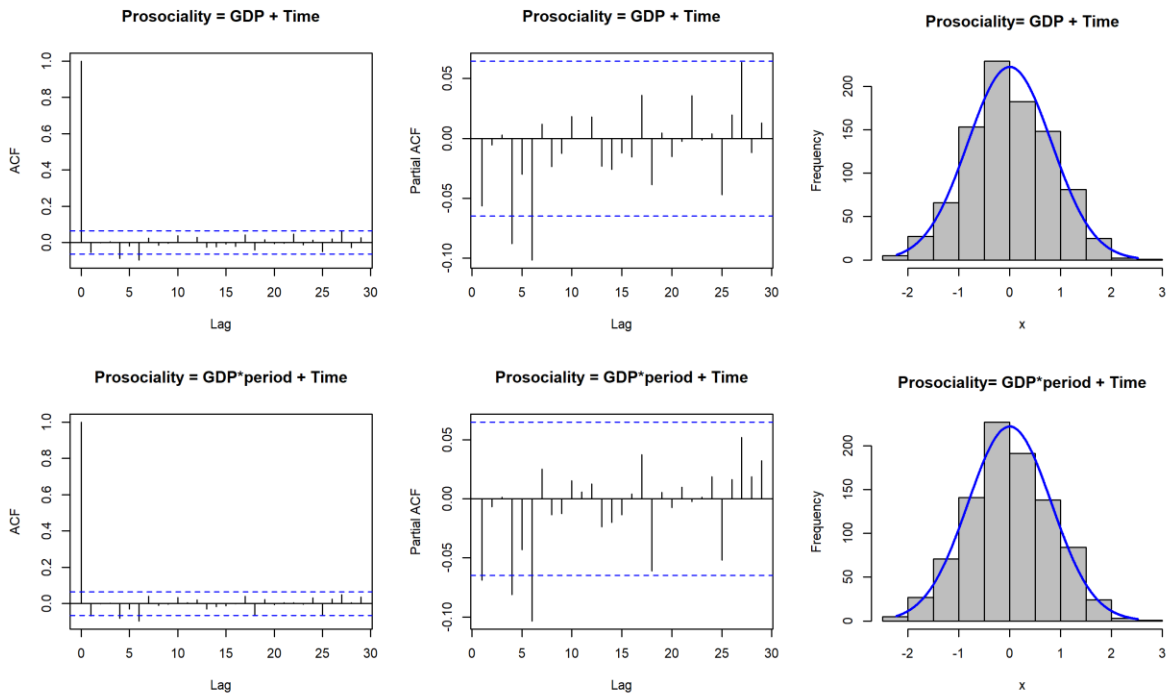

Figure S6. Residuals autocorrelation (ACF), partial ACF, and distribution of Models 2 and 3 in Table S15.

2.4.2 Affluence and Cooperation (France)

Trust – France

	Trust			
Predictors	*Estimates*	*CI*	*Statistic*	*p*
(Intercept)	0.04	-0.05 – 0.13	0.83	0.409
year	0.50	0.39 – 0.61	8.85	**<0.001**
GDPpc	0.03	-0.04 – 0.09	0.81	0.416
Random Effects				
σ^2	0.59			
$\tau_{00\ author}$	0.20			
ICC	0.25			
$N_{\ author}$	233			
Observations	841			
Marginal R^2 / Conditional R^2	0.170 / 0.376			

Table S17. LMM results for Trust in France as predicted by time (year) and GDP per capita (GDP).

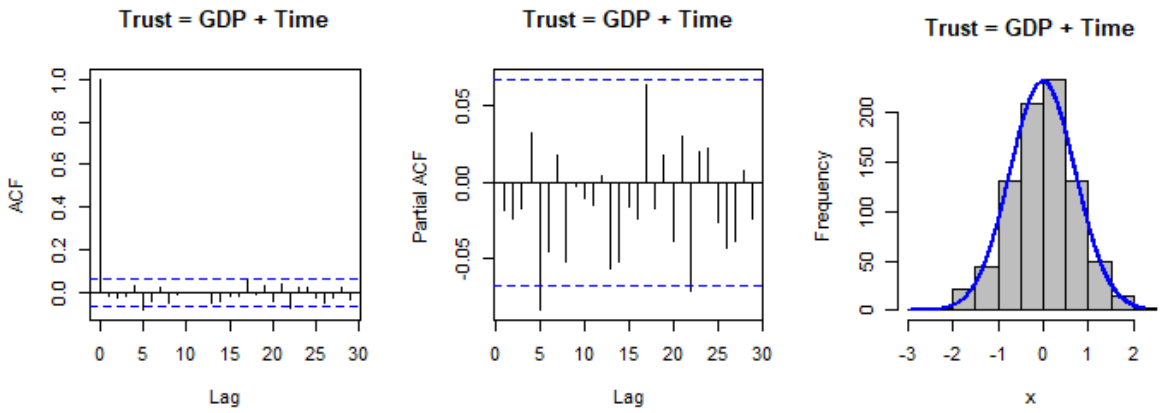

Figure S7. Residuals autocorrelation (ACF), partial ACF, and distribution of Model 2 in Table S12.

Sympathy – France

	Sympathy			
Predictors	*Estimates*	*CI*	*Statistic*	*p*
(Intercept)	-0.03	-0.13 – 0.07	-0.54	0.592
GDPpc	-0.03	-0.11 – 0.04	-0.90	0.369
year	0.19	0.07 – 0.31	3.10	**0.002**
Random Effects				
σ^2	0.74			
$\tau_{00\ author}$	0.23			
ICC	0.24			
$N_{\ author}$	234			
Observations	856			
Marginal R^2 / Conditional R^2	0.020 / 0.252			

Table S18. LMM results for Sympathy in France as predicted by time (year) and GDP per capita (GDP).

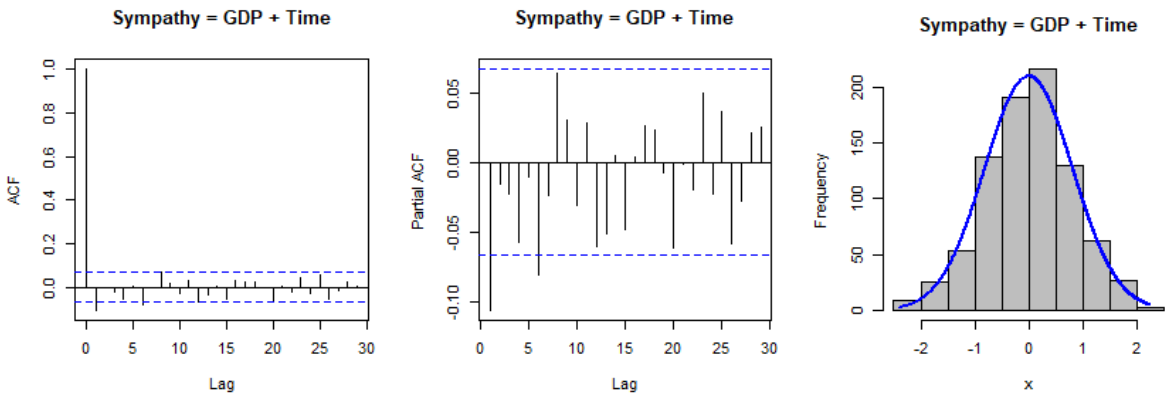

Figure S8. Residuals autocorrelation (ACF), partial ACF, and distribution of Model in Table S17.

Prosociality – France

	Prosociality			
Predictors	*Estimates*	*CI*	*Statistic*	*p*
(Intercept)	0.56	-2.19 – 3.30	0.40	0.691
GDPpc	-0.00	-0.00 – 0.00	-0.42	0.673
year	0.37	0.26 – 0.48	6.50	**<0.001**
GDPpc * period [revolution]				
period [revolution]				
σ^2	0.73			
τ_{00}	0.16 $_{author}$			
ICC	0.18			
N	252 $_{author}$			
Observations	930			
Marginal R^2 / Conditional R^2	0.082 / 0.248			
log-Likelihood	-1235.736			

Table S19. LMM results for Prosociality in France as predicted by time (year) and GDP per capita (GDP).

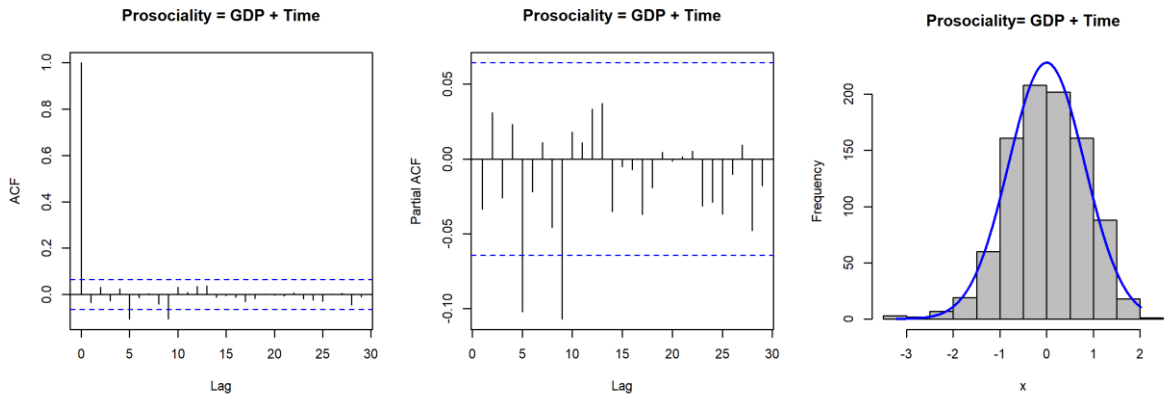

Figure S9. Residuals autocorrelation (ACF), partial ACF, and distribution of Model in Table S18.

2.5. Lag Analysis

2.5.1. Lag analysis (England)

England – Trust

Final Best models with (2) and without time (1) as covariate

		Trust
	(1)	(2)
GDP T+6	**0.473*** **	
	(0.095)	
year		**0.964*** **
		(0.184)
GDPm18		**-0.410** **
		(0.169)
Constant	-0.036	-0.076
	(0.094)	(0.084)
Observations	176	176
Log Likelihood	-217.680	-212.781
Akaike Inf. Crit.	443.360	435.563
Bayesian Inf. Crit.	456.041	451.415
Note:		*p**p***p<0.01

Table S20. Best models for Trust in England as predicted by time (year) and GDP per capita (GDP) at time lags raging from T-20 to T+20. Model selection computed with generalized least squares (GLS) with time (years) as the dimension across other variables are autocorrelated (corrCAR1(form = ~ year)).

England – Sympathy

Final Best models with (2) and without time (1) as covariate

	Sympathy	
	(1)	(2)
year		0.590*
		(0.324)
GDP T-10	0.520***	0.495***
	(0.177)	(0.189)
GDP T-16	0.477***	0.631***
	(0.169)	(0.205)
GDP T+19	-0.447***	
	(0.158)	
GDP T-18		-0.486**
		(0.194)
GDP T+18		-0.659***
		(0.218)
Constant	0.094	0.075
	(0.084)	(0.079)
Observations	179	179
Log Likelihood	-218.445	-215.061
Akaike Inf. Crit.	448.890	446.123
Bayesian Inf. Crit.	468.014	471.622
Note:		*p**p***p<0.01

Table S21. Best models for Sympathy in England as predicted by time (year) and GDP per capita (GDP) at time lags raging from T-20 to T+20. Model selection computed with generalized least squares (GLS) with time (years) as the dimension across other variables are autocorrelated (corrCAR1(form = ~ year)).

England – Prosociality

Final Best models with (2) and without time (1) as covariate

	Prosociality2	
	(1)	(2)
year		0.760***
		(0.293)
GDP+3	0.850***	0.545***
	(0.169)	(0.201)
GDP-14	-0.414**	-0.776***
	(0.162)	(0.209)
Constant	0.060	0.059
	(0.078)	(0.074)
Observations	175	175
Log Likelihood	-223.656	-220.413
Akaike Inf. Crit.	457.312	452.825
Bayesian Inf. Crit.	473.136	471.814
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table S22. Best models for Prosociality in England as predicted by time (year) and GDP per capita (GDP) at time lags raging from T-20 to T+20. Model selection computed with generalized least squares (GLS) with time (years) as the dimension across other variables are autocorrelated (corrCAR1(form = ~ year)).

2.5.2. Lag analysis (France)

France – Trust

Final Best models with (2) and without time (1) as covariate		
	Trust	
	(1)	(2)
GDP T-10	0.570***	
	(0.203)	
GDP T+12	0.723***	
	(0.224)	
Year		1.560***
		(0.170)
GDP T-2		0.423***
		(0.089)
GDP T-18	-1.039***	-0.869***
	(0.289)	(0.280)
GDP T-19	0.933***	0.871***
	(0.292)	(0.281)
Constant	-0.446**	0.499***
	(0.193)	(0.097)
Observations	153	153
Log Likelihood	-190.662	-171.945
Akaike Inf. Crit.	395.324	357.890
Bayesian Inf. Crit.	416.537	379.103
		*p**p***p<0.01

Table S23. Best models for Trust in France as predicted by time (year) and GDP per capita (GDP) at time lags raging from T-20 to T+20. Model selection computed with generalized least squares (GLS) with time (years) as the dimension across other variables are autocorrelated (corrCAR1(form = ~ year)). Type II Sum of Squares (top), and Type III (below). Models marked with (1) do not include time (year) and models with (2) include time.

France – Sympathy

Final Best models with (2) and without time (1) as covariate		
	Sympathy	
	(1)	(2)
year		0.696***
		(0.192)
GDP T-3	-0.731**	-0.805***
	(0.286)	(0.286)
GDP T-4	0.883***	0.814***
	(0.290)	(0.280)
GDP T+18		-0.438***
		(0.157)
Constant	-0.020	0.411***
	(0.093)	(0.131)
Observations	153	153
Log Likelihood	-209.090	-200.996
Akaike Inf. Crit.	428.180	415.991
Bayesian Inf. Crit.	443.332	437.204
		*p**p***p<0.01

Table S24. Best models for Sympathy in France as predicted by time (year) and GDP per capita (GDP) at time lags raging from T-20 to T+20. Model selection computed with generalized least squares (GLS) with time (years) as the dimension across other variables are autocorrelated (corrCAR1(form = ~ year)). Type II Sum of Squares (top), and Type III (below). Models marked with (1) do not include time (year) and models with (2) include time.

France – Prosociality

Final Best models with (2) and without time (1) as covariate

	Dependent variable:	
	Prosociality2	
	(1)	(2)
GDP-15	**0.511*** **	
	(0.158)	
year		**1.073*** **
		(0.158)
Constant	-0.124	0.383***
	(0.094)	(0.090)
Observations	155	155
Log Likelihood	-213.470	-198.912
Akaike Inf. Crit.	434.940	405.824
Bayesian Inf. Crit.	447.114	417.997
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table S25. Best models for Prosociality in France as predicted by time (year) and GDP per capita (GDP) at time lags raging from T-20 to T+20. Model selection computed with generalized least squares (GLS) with time (years) as the dimension across other variables are autocorrelated (corrCAR1(form = ~ year)). Type II Sum of Squares (top), and Type III (below). Models marked with (1) do not include time (year) and models with (2) include time.

2.6. Exploratory analyses with additional socio-economic

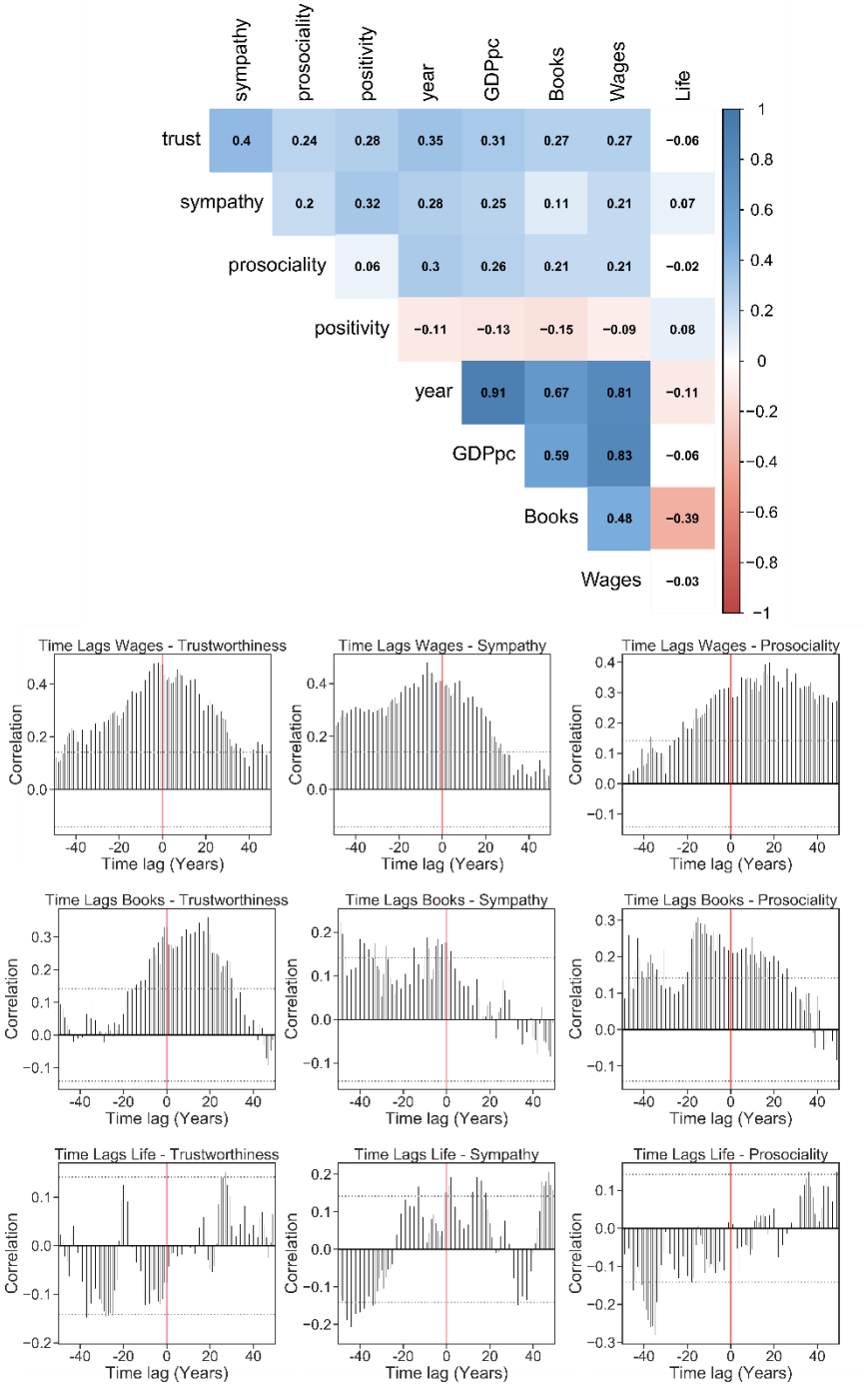

Figure S10. Correlation table and cross correlation analyses with additional socio-economic variables for the English Data. GDP: GDP per capita (see main text); **Books** (Fink-Jensen, Jonathan (2015). Book Titles per Capita. http://hdl.handle.net/10622/AOQMAZ, accessed via the Clio Infra website); **Wages (1), Life** (Zijdeman, Richard and Filipa Ribeira da Silva (2015). Life Expectancy at Birth (Total). http://hdl.handle.net/10622/LKYT53, accessed via the Clio Infra website).

France

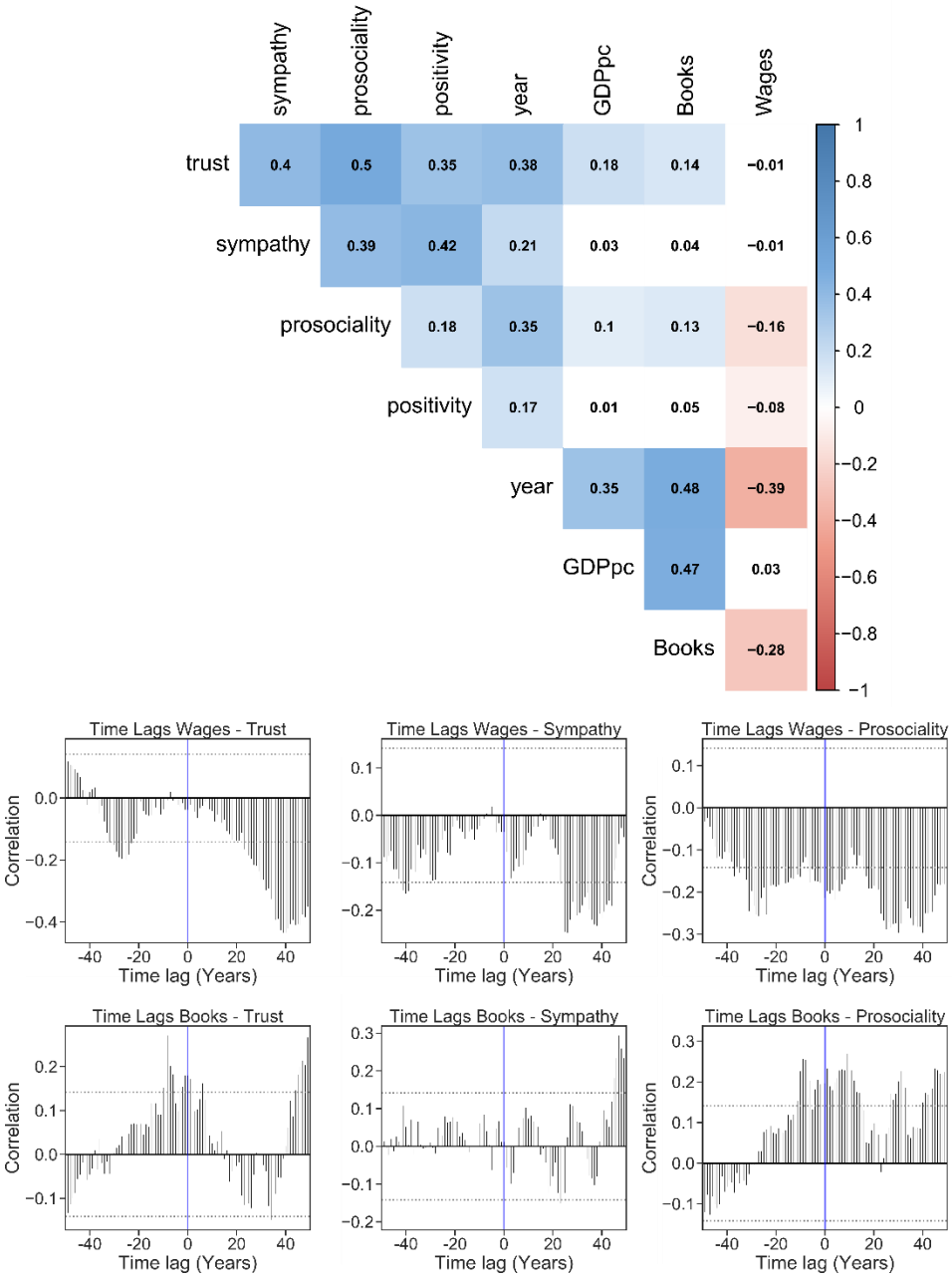

Figure S11. Correlation table and cross correlation analyses with additional socio-economic variables for the French Data. GDP: GDP per capita (2); **Books** (Fink-Jensen, Jonathan (2015). Book Titles per Capita. http://hdl.handle.net/10622/AOQMAZ, accessed via the Clio Infra website); **Wages (3).**

3. Method validation

In this section we perform a series of tests to evaluate whether our tools provide adequate measures of cooperation. In the first section, Internal Validation, we will assess whether our different bags of words related to cooperation form distinct constructs in relation to the bags of words related to dominance. To that purpose we will perform 1) an exploratory Factor analysis with the basic categories Sympathy, Trustworthiness, Prosociality, Anger, Authoritarianism and Strength; and 2) We will assess whether there are particular words within each bag which exert a disproportional influence in the analysis and repeat the analysis without these influential words. In the second section, external validation, we will assess how well our bags of words – which are specifically designed for the early modern period - correlate with modern proxies of cooperation and dominance from the Linguistic Inquiry and Word Count (LIWC) (4, 5).

3.1. Internal validation

3.1.1. Factor Analysis

We performed a factor analysis to assess whether our bags of words related to cooperation measured homogenous constructs across all proxies (trustworthiness, prosociality and sympathy), and most importantly, whether these were distinct from the measures of dominance (anger, strength and authoritarianism).

For English plays, the exploratory factor analysis yielded two factors ($\chi 2$ (4) = 122.04, p <0.001). Anger, Strength and Authority loaded higher in Factor 1, which explained 24% of the variance, while Trust, Sympathy and Prosociality loaded higher in Factor 2, explaining 21% of the variance (Figure S12). For French plays, the exploratory factor analysis also yielded two factors ($\chi 2$ (4) = 34.12, p <0.001). Anger, Strength and Authority loaded higher in Factor 1, which explained 33% of the variance, while Trust, Sympathy and Prosociality loaded higher in Factor 2, explaining 32% of the variance (Figure S12).

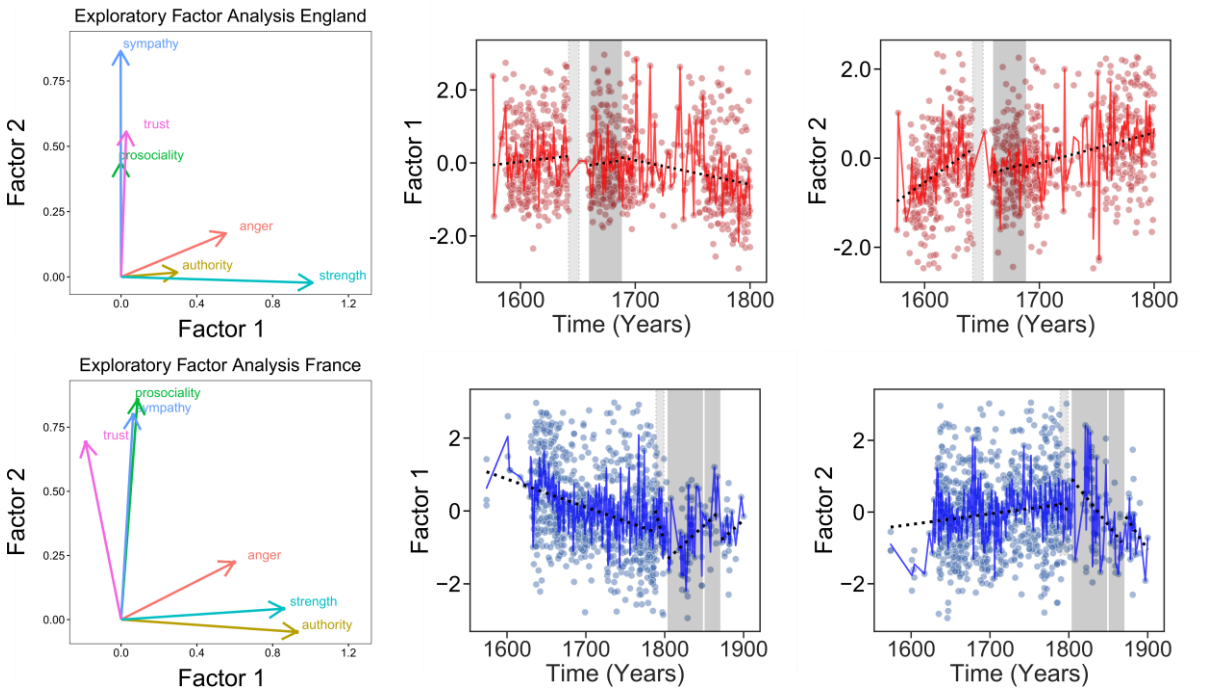

Figure S12. Exploratory factor analysis with the basic bag-of-words categories: sympathy, trust, prosociality, anger, trustworthiness and authoritarianism. For both England and France, we obtain two factors which clearly separate the proxies of cooperation (Factor 2) and dominance (Factor 1). Then we plotted the time distribution of the plays' factor scores and confirm that the for both England and France, cooperation grows the fastest before the revolutionary periods.

3.1.2. Robustness

A potential pitfall of using the bag-of-words approach is that a few words within each bag might be disproportionally more frequent than the others and thus skew the data. In this section, we first assess whether this was the case (Table S25) and then plot the historical analysis while removing the 2 most frequent words within each bag (Figures S12 –S13).

	Category	Mean word frequency (%) in texts	Mean % of text comprised of words in the bag	Top 2 most common words per category (frequency in %)
England	Sympathy	0.01	0.286	pity (0.072) mercy(0.045)
	Anger	0.01	0.25	grief (0.056) rage (0.049)
	Trust	0.001	0.169	friendship (0.038) goodness (0.025)
	Strength	0.02	0.45	power (0.137) virtue (0.092)
	Prosociality	0.015	1.11	care (0.112) help (0.077)
	Authority	0.017	1.79	lord (0.386) master (0.163)
France	Sympathy	0.15	0.33	soin (0.110) bonte (0.042)
	Anger	0.023	0.37	furour (0.058) haine (0.055)
	Trust	0.013	0.21	tendresse(0.045) zele (0.033)
	Strength	0.02	0.39	vertu (0.104) courage (0.054)
	Prosociality	0.016	1.0	soin (0.110) sentiment (0.058)
	Authority	0.024	1.35	seingeur(0.151) honneur (0.135)

Table S26. Word and bag-of-word mean frequencies.

England

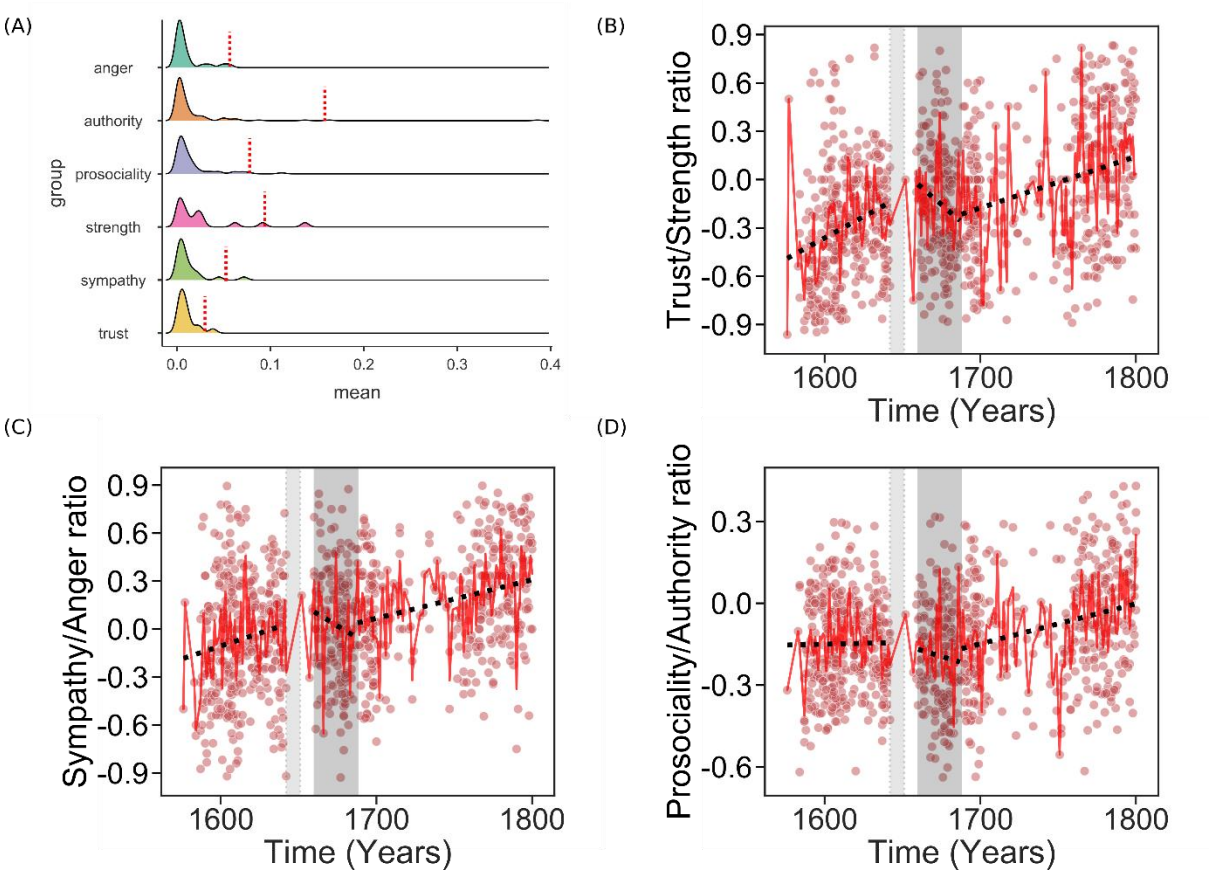

Figure S13. (A) Density plots of word frequencies within each basic category. To test whether our main effects were caused by one or two influential words within each group, we identified the two words with the highest frequency and removed them from the analysis. The vertical red dotted line is a reference for the frequency above which words were removed for each category. Graphs (B)-(D) depict the historical analysis without those high frequency words.

France

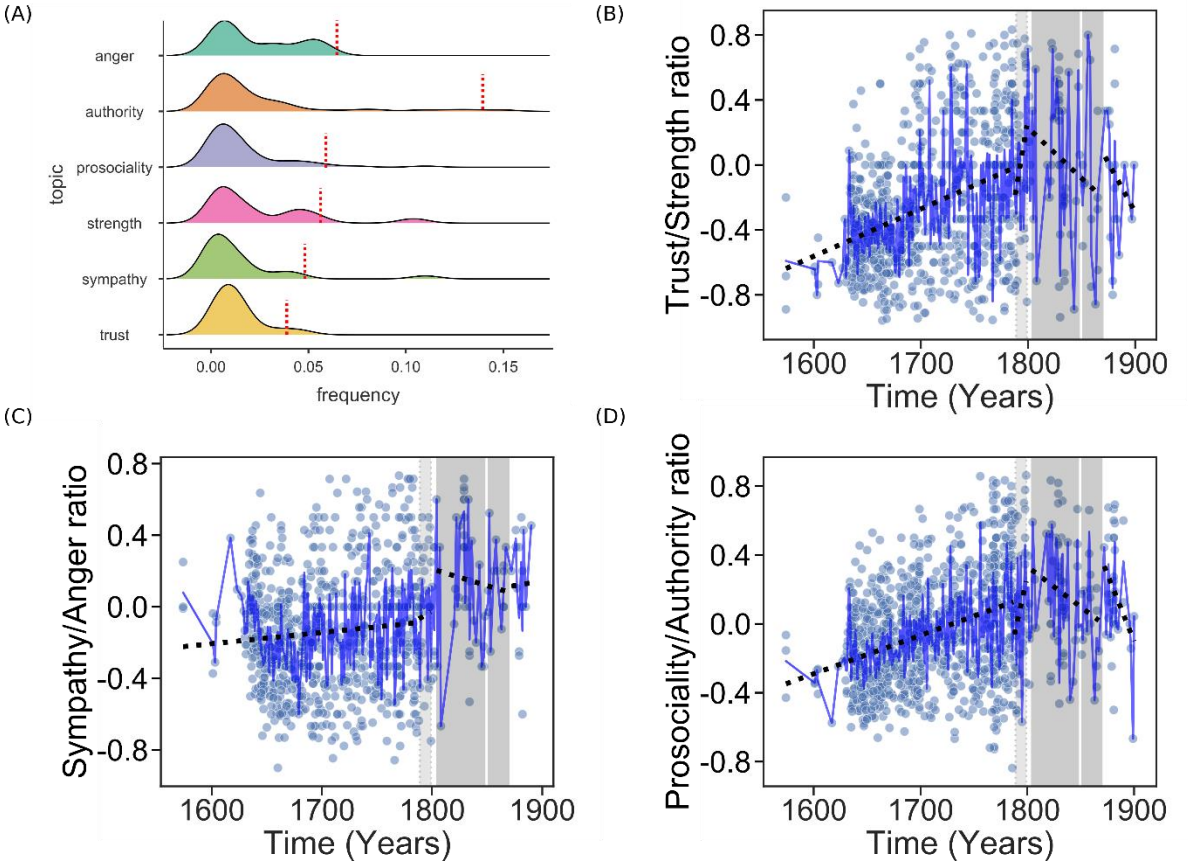

Figure S14. (A) Density plots of word frequencies within each basic category. To test whether our main effects were caused by one or two influential words within each group, we identified the two words with the highest frequency and removed them from the analysis. The vertical red dotted line is a reference for the frequency above which words were removed for each category. Graphs (B)-(D) depict the historical analysis without those high frequency words.

3.2. External validation – Modern word lists

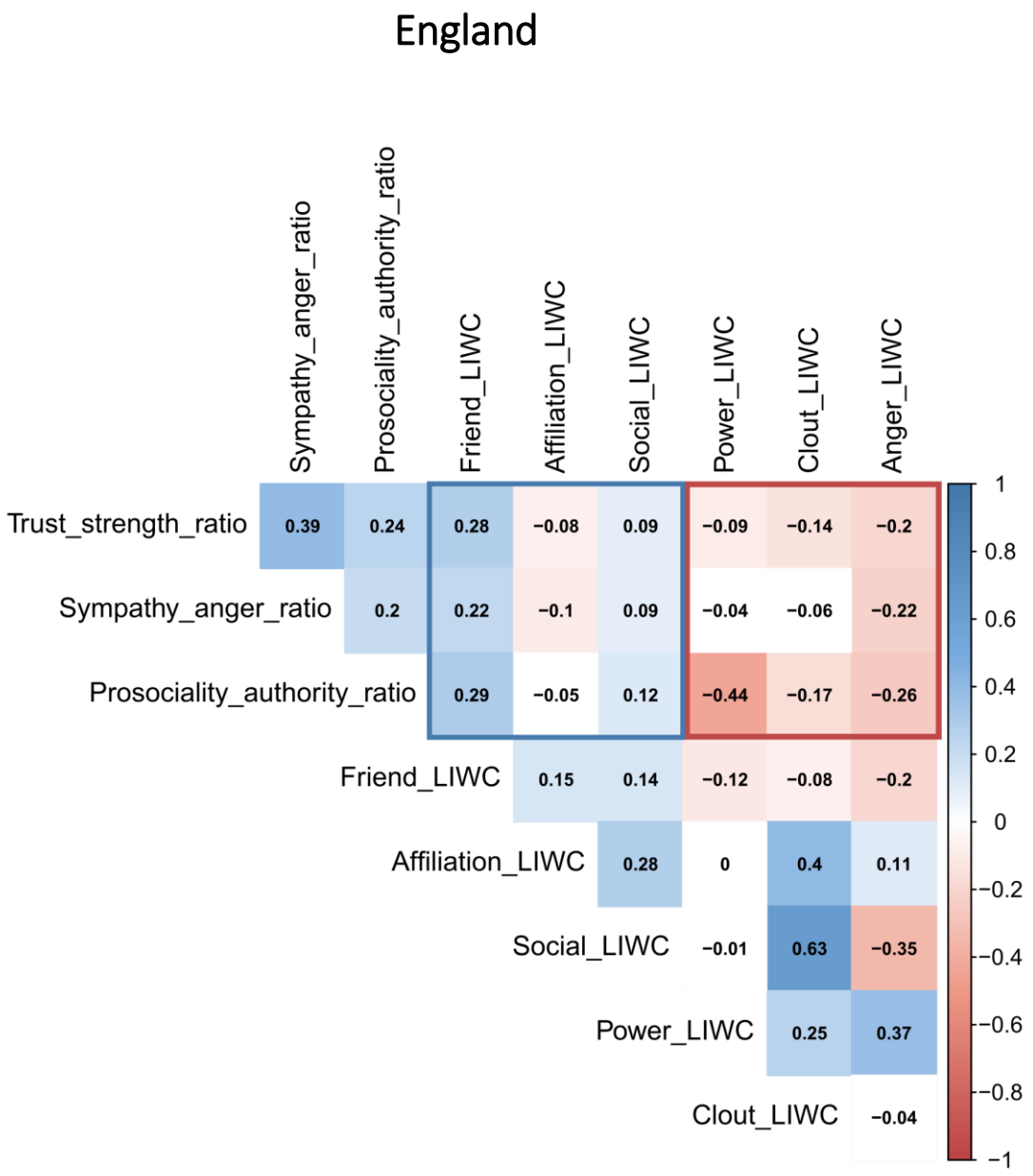

Figure S15. Correlation between our ratios (based on early modern word use) and well-standardized measures for modern english from the Linguistic Inquiry and Word Count (LIWC). The blue area (on the left) depicts the correlation with possible LIWC proxies of prosociality and the red area (on the right) the correlation with possible LIWC proxies od dominance.

France

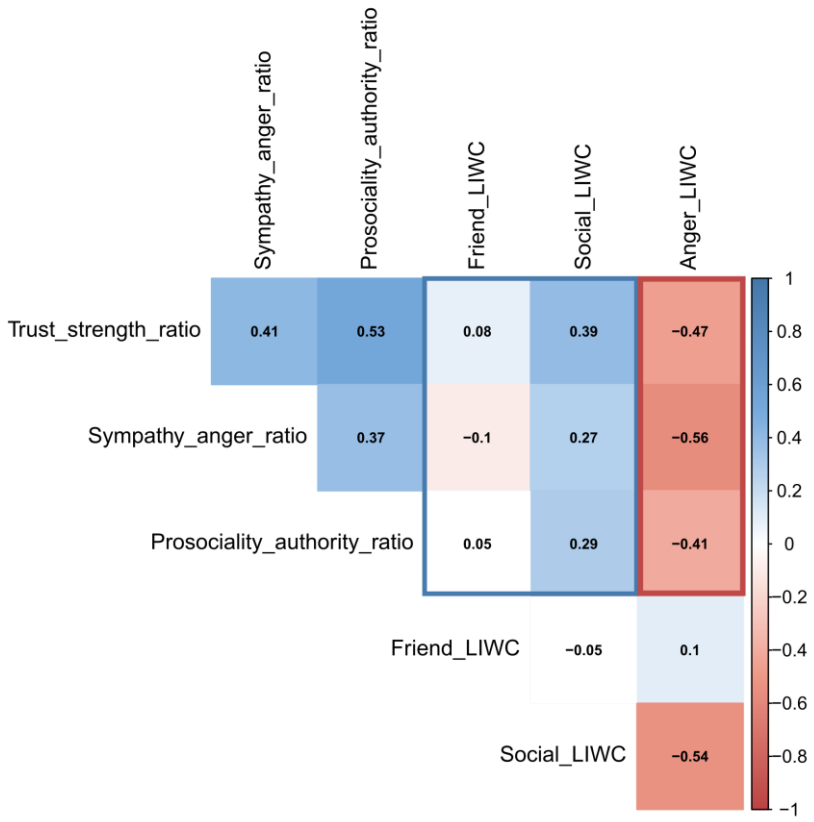

Figure S16. Correlation between our ratios (based on early modern word use) and well-standardized measures for modern french from the Linguistic Inquiry and Word Count (LIWC). The blue area (on the left) depicts the correlation with possible LIWC proxies of prosociality and the red area (on the right) the correlation with possible LIWC proxies od dominance.

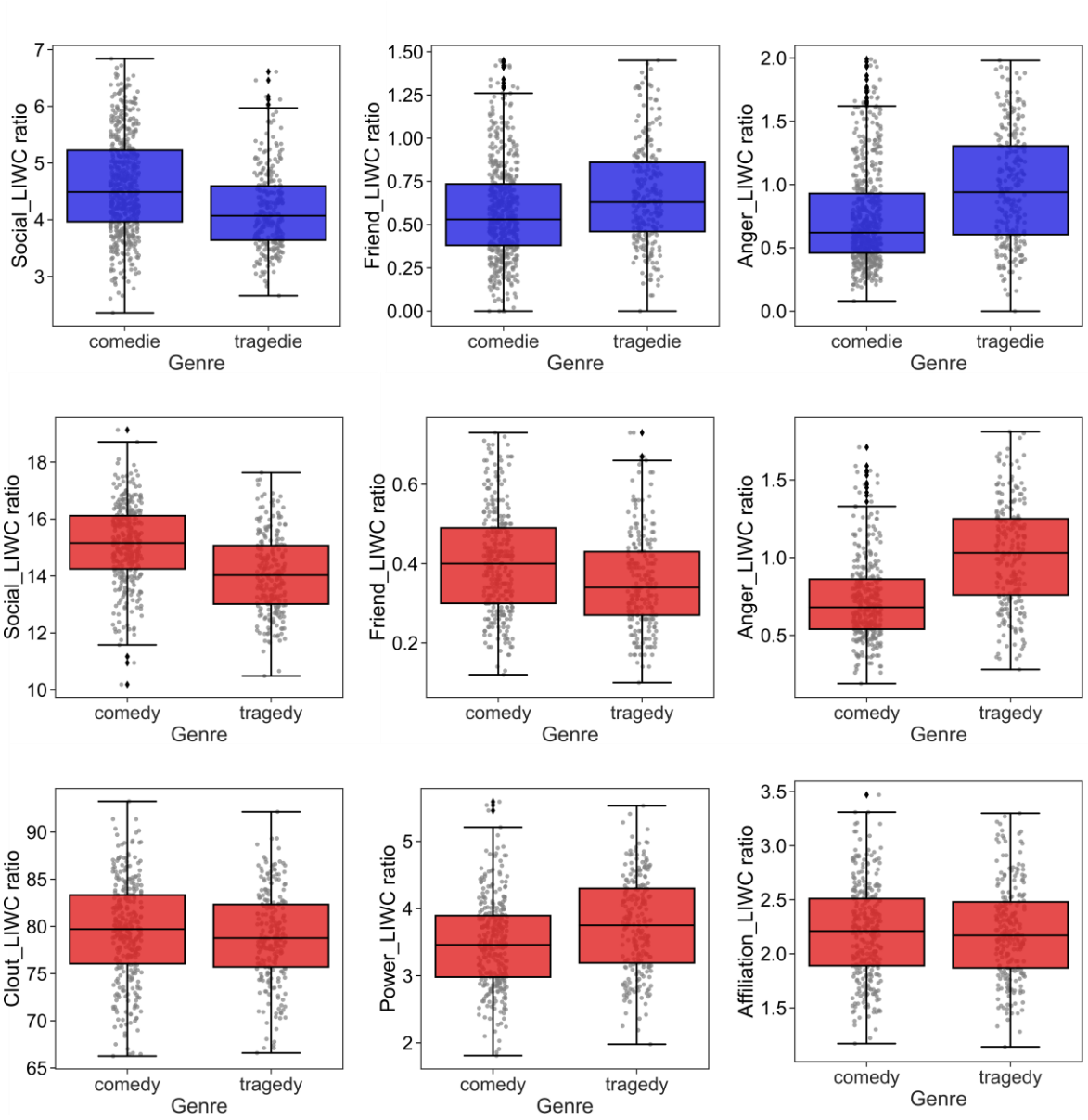

Figure S17. Genre analysis across potential proxies of cooperation (Social, Friend, Affiliation) and dominance (Anger, Clout, Power) from the LIWC tool, which is validated for modern texts. **(Upper row, blue) France.** The 'Social' categories and 'Anger' seem to correctly differentiate comedies from tragedies. The category 'Friend' is higher in tragedies thus is a poor proxy of cooperation. (**Lower rows, red) England.** The 'Social' categories and 'Anger' seem to correctly differentiate comedies from tragedies. The category 'Power' might also be used a s proxy of Dominance. 'Clout' and 'Affiliation' do not distinguish between genres. Note: LIWC have different available categories for different langauges.

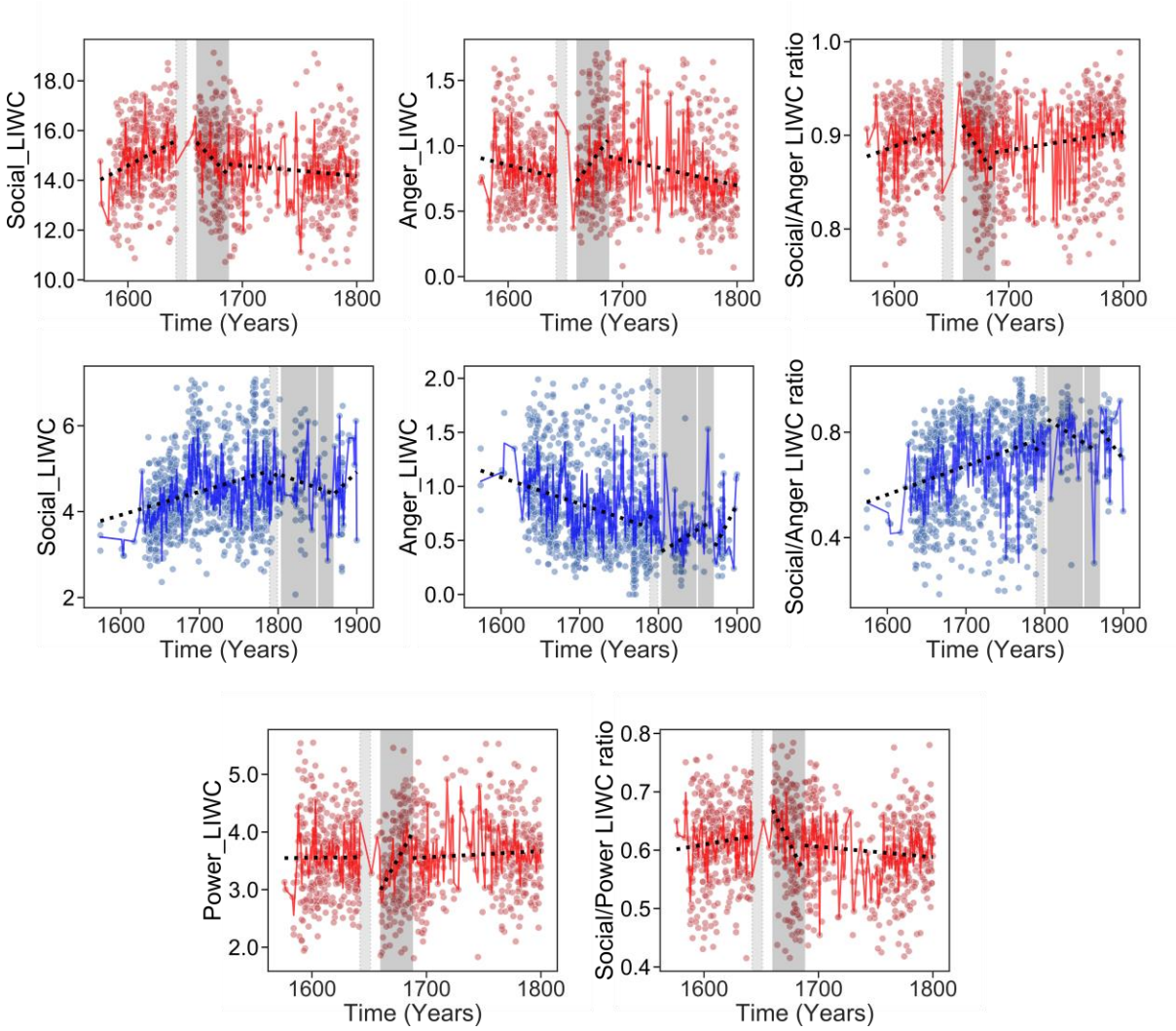

Figure S18. Time series and historical analyses using the adequate LIWC proxies selected from Figure S16, for both England (red) and France (blue). We calculated cooperation-to-dominance ratios - Social-to-Anger and Social-to-Power using a similar formula to own proxies. Crucially, these LIWC ratios generate similar time series and cooperation slopes to those obtained using our own tools.

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