SUPPLEMENTARY MATERIAL

THE POLITICAL GEOGRAPHY OF THE EUROCRISIS

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World Politics

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Supplementary Material
"The Political Geography of the Eurocrisis"

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A. Model details

Individual preferences respond to the following function:

$$V_{ir} = \alpha \frac{(w_{ir}(1-t) - T(w_r - w_u))^{1-\delta_r}}{1-\delta_r} + (1-\alpha)\frac{\left(\frac{\alpha}{1-\alpha} t w_u - T(w_r - w_u)\right)^{1-\delta_r}}{1-\delta_r}. \quad (1)$$

which, as stated in the text, in the case of each regional median voter translates into:

$$V_{mr} = \alpha \frac{(w_{mr}(1-t) - T(w_r - w_u))^{1-\delta_r}}{1-\delta_r} + (1-\alpha)\frac{\left(\frac{\alpha}{1-\alpha} t w_u - T(w_r - w_u)\right)^{1-\delta_r}}{1-\delta_r}. \quad (2)$$

A.1. General result

Solving for the optimal tax rate of individuals across different regional income distributions yields a unique interior solution of the optimal tax rate, t^*:

$$(w_{ir}(1-t^*) - T(w_r - w_u))\left(\frac{w_{ir}}{w_u}\right)^{-\frac{1}{\delta_r}} = \left(\frac{\alpha}{1-\alpha} t^* w_u - T(w_r - w_u)\right),\ 1 > t^* > 0 \quad (3)$$

which would imply that the preferences of each regional median voter (w_m) are driven by:

$$(w_{mr}(1-t^*) - T(w_r - w_u))\left(\frac{w_{mr}}{w_u}\right)^{-\frac{1}{\delta_r}} = \left(\frac{\alpha}{1-\alpha} t^* w_u - T(w_r - w_u)\right),\ 1 > t^* > 0 \quad (4)$$

To interpret this result, it is useful to break the analysis in two steps:

A.2. Geography of Income

In the absence of risk aversion (δ_r=0), our model simplifies to one in which distributive concerns are dominant. This scenario is the one best capturing the distributive dimension of the problem. The following implications emerge from the analysis:

(a) any citizen in any region with income above w_u will want a zero union-wide income tax rate;

(b) any citizen anywhere with income at or below $w_{ir} \leq \bar{w}_{ir} = -\frac{\beta}{\alpha}$ will want $t^* = 1$;hence, if $w_{mr} \leq \bar{w}_{ir}$ then $t* \to 1$)

(c) $\frac{\partial t}{\partial w_{ir}} < 0$ for $w_u \geq w_{ir}$;

(d) the more citizens below w_u, the greater the demand for redistribution;

(e) Last but not least, it is also clear that all citizens in regions with $w_r < w_u$ will support the highest value of T feasible, and those where $w_r > w_u$ will prefer $T = 0$. This applies to the median voters of both regions, as depicted in Figure 1.

A.3. Geography of Production

Three additional formal results are relevant for our understanding of how geographic concentration shapes preferences:

(a) The demand for redistribution, t^*, increases with the scope of realized risks, $1-\alpha$. If the FOC is totally differentiated with respect to t^* and $\alpha/(1-\alpha)$, the result is:

$$\frac{dt^*}{d\frac{\alpha}{1-\alpha}} = -\frac{t^* w_u}{\left(\frac{\alpha}{1-\alpha} w_u + \frac{w_{ir}}{w_u}^{-1/\delta_r} w_{ir}\right)}$$

(b) The demand for redistribution increases with risk aversion. To see this, note that in the solution to the optimization problem, $\frac{\partial t^*}{\partial \delta} > 0$.

(c) As a result of risk aversion, it is also the case that $t^* > 0$ when $w_{ir} > w_u$ (as long as it is not too much greater), whereas with $\delta = 0$ any income above w_u will prefer $t^* = 0$. To see this note that if $w_{ir} = w_u$ then in the FOC $(\frac{w_{ir}}{w_u})^{-1/\delta_r} = 1$, if $\delta_r > 1$, and the FOC then implies with $w_{ir} = w_u$ that $t^* = 1-\alpha$, which is strictly positive for $\alpha < 1$. Hence, a small increase in w_{ir} above w_u implies a small decrease in t^*, and a small enough increase in w_{ir} implies that t^* must remain positive. The key analytical result is that the demand for redistribution increases with risk aversion, which suggest that for sufficiently high levels of specialization wealthier citizens may be willing to invest in insurance despite the short-term costs in tax terms. Accordingly, the resulting tax rate supported by the median voter in a specialized region will be higher as compared to the one driven exclusively by income motives, as depicted in figure 1 for region A.

B. Data details

The European Social Survey is a large scale multi-country survey administered bi-annually in European countries starting in 2002.[1] Its target population are all individuals aged 15 or over, residing in private households (regardless of nationality, language, citizenship or legal status). Interviews are conducted face-to-face. Eurobarometer 74 and 76 are large-scale population surveys administered in European countries. The target population are all individuals aged 15 and over, who are resident in any of the member states.[2]

Table B.1 below lists countries and years included in our analysis using ESS data.

Table B.2 provides descriptive statistics for covariates in our analysis.

[1]For more information see `www.europeansocialsurvey.org/`.

[2]For more information see `http://www.gesis.org/en/eurobarometer-data-service/home/`.

Table B.1
Countries and years included in ESS sample

Austria	2002–2006
Belgium	2002–2012
Denmark	2002–2012
Finland	2002–2012
France	2004–2012
Germany	2002–2012
Ireland	2004–2006, 2010–2012
Italy	2002, 2012
Netherlands	2002–2012
Norway	2002–2012
Portugal	2002–2008,2012
Spain	2002–2012
Sweden	2002–2012
United Kingdom	2002–2012

Table B.2
Descriptives statistics of covariates in ESS and EB samples. Means, standard deviations, and deciles for continuous inputs; percentages for binary inputs.

			Deciles				Deciles	
	Mean	SD	1st	9th	Mean	SD	1st	9th
(A) Eurobarometer surveys								
	wave 74.2				wave 76.1			
Age	51.5	17.0	29	74	53.5	17.0	30	76
Years of education	18.8	5.9	14	25	19.6	5.4	15	26
Income [subjective]	5.6	1.6	4	8	5.7	1.6	4	8
Female		51.8%				52.1%		
Unemployed		8.9%				5.8%		
Retired		30.7%				35.2%		
(B) European Social Survey								
	waves 1-7							
Age	49.0	17.4	26	73				
Years of education	12.7	4.6	8	18				
Income [10000 USD]	3.2	2.4	1	6				
Female		51.8%						
Unemployed		5.5%						
Retired or disabled		26.1%						
Not in labor force		14.8%						

Note: Sample sizes are: ESS: 110,925, EB 74.2: 13,400, EB 76.1: 8,049.

C. The micro logic of redistribution preferences

Here we provide a descriptive exploration of our theoretical models' key premise. The micro-logic of our argument implies that the income polarization of redistribution preferences is larger in countries that rely more on investment-oriented economic strategies.

In order to measure the polarization in redistribution preferences between rich and poor, we require a dataset of substantial size. We use the European Social Survey (ESS). It covers all of the countries in our analysis, and, in its pooled version, provides a large sample of over 100,000 individuals.[3] Another advantage of using ESS data is that it contains a measure of preferences for redistribution widely used in previous research (e.g., Rehm 2009). It elicits a respondent's support for the statement "the government should take measures to reduce differences in income levels" measured on a 5 point agree-disagree scale. We create an indicator variable equal to one if a respondent clearly supports redistribution (i.e., "agrees" or "strongly agrees" with the statement above).

The key right-hand-side variable of this section's analysis is income. To obtain a comparable, continuous measure of income, we follow the exiting literature (e.g., Rueda and Stegmueller 2016) and transform ESS income categories into midpoints.[4] Since the last income category is open ended, we impute its mid-point assuming that the upper tail of the income distribution follows a Pareto distribution. We then deflate incomes to 2005 prices and re-express all currencies in purchasing power parity adjusted international dollars.

The dependent variable for our descriptive analysis is constructed in three steps. First, we estimate for each country in our sample a probit model of support for redistribution accounting for individuals' gender, age, years of education, and labor market status (via indicator variables for unemployment and retirement).[5] Second, for each country, we calculate the probability of supporting redistribution among the poor and the rich, defined as individuals at the 20th and 80th percentile of the income distribution, respectively. The first difference in these two probabilities is our measure of income polarization over redistribution in each country.[6]

In Figure C.1 we plot this measure of polarization over redistribution between rich and poor against economic strategies in Western Europe. Larger negative values indicate more polarization between rich and poor. The position of countries in this plot reveals a strong relationship between economic strategies and polarization (their correlation is -0.74 ± 0.19). In countries that put low priority on investment over consumption policies, such as Italy or Spain, polarization over redistribution is low to almost nonexistent (as in Portugal). By contrast, in high-investment countries, such as the Netherlands, Finland, and Denmark, polarization is high, reaching up to a 10 percent point difference in redistribution support between rich and poor.

[3] We use waves 1 to 6. After limiting the sample to the countries of our analysis we are left with 139,938 cases. After deleting cases with missing data, our final sample size is 109,538 individuals.

[4] Mid-point value assignments differ among survey waves. For 2004-2006 we use mid-points based on common value categories, while for 2008 and beyond, we use mid-points derived from country-specific income deciles. See Appendix B for details on income questions and our transformations.

[5] This amounts to what Gelman and Hill (2007) call a "completely unpooled" strategy, which is feasible here due to the large sample size available for each country.

[6] Note that the choice of percentile is of minor impact. We also obtain a qualitatively similar pattern by plotting income slopes from a linear probability model against economic strategies.

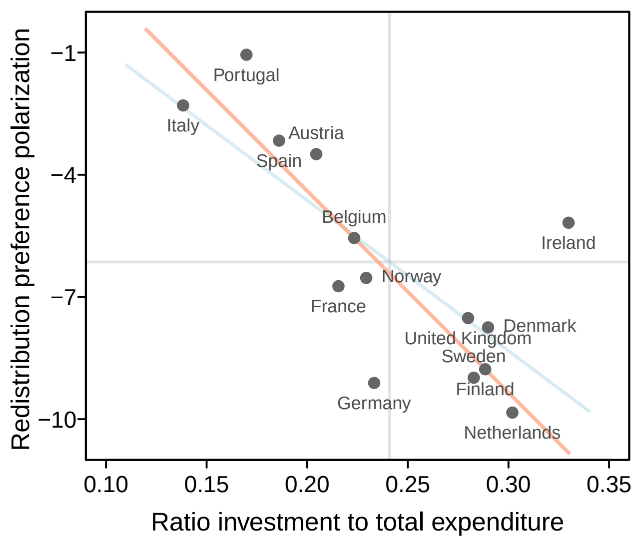


Figure C.1

Polarization of redistribution preferences and its relationship to economic strategies.

The y-axis plots first differences in predicted probabilities of redistribution support between poor and rich. More negative values indicate larger polarization in preferences by income. The x-axis plots investment-oriented economic strategies. The linear relationship between both is indicated by an OLS fit (light blue line) and an outlier-robust median regression (light red line). Gray lines show averages of both variables.

D. Reduction of covariate space

We have a matrix of covariate, $\mathbf{X}$, of size $n \times p$, where n is the number of rows and p the number of columns, i.e., variables. For simplicity set each column of $\mathbf{X}$ to have zero mean and unit variance. The singular value decomposition of $\mathbf{X}$ is (e.g., Strang 2006: 331f):

$$\mathbf{X} = \mathbf{U}\mathbf{S}\mathbf{V}' \tag{5}$$

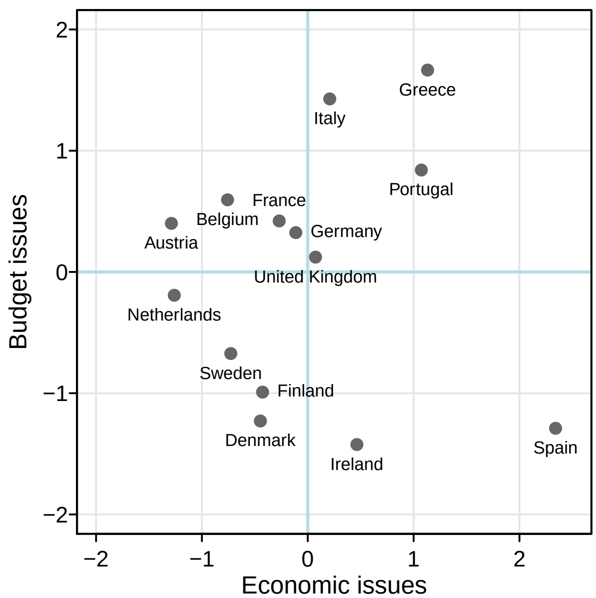
with $\mathbf{S} = \text{diag}(s_i)$ a diagonal matrix of singular values. The columns of $\mathbf{V}$ are principal axes, while the columns of $\mathbf{V}\mathbf{S}/\sqrt{n-1}$ correspond to what are often called loadings in factor analysis. Our aim is to reduce the dimensionality of $\mathbf{X}$ from p to $k < p$. Thus, we select the first k columns of $\mathbf{U}$ and the $k \times k$ upper-left part of $\mathbf{S}$. The product $\mathbf{U}_k\mathbf{S}_k$ is the new $n \times k$ matrix containing the first k principal components. Substituting them into (5) and choosing the corresponding $\mathbf{V}_k$ yields

$$\mathbf{X}_k = \mathbf{U}_k\mathbf{S}_k\mathbf{V}_k' \tag{6}$$

which reconstructs the original data with k principal components. It is of size $n \times p$ but now is only of rank k. It has the lowest possible reconstruction error (see the well-known Eckart-Young theorem; Eckart and Young 1936). We now replace the p variables in $\mathbf{X}$ with the reduced set of k variables in $\mathbf{U}_k\mathbf{S}_k$. We choose $k = 2$ based on both interpretability and a statistical criterion, namely the number of eigenvalues greater than 1 (Jolliffe 2002). The eigenvalues in our decomposition are: $(3.84, 1.44, 0.32, 0.21, 0.15, 0.04)$, which clearly suggests to set $k = 2$. A two-dimensional solution captures 88% of the total variability in $\mathbf{X}$. Figure D.1 shows the position of countries on this two-dimensional vector, as well as the correlation of each column of $\mathbf{X}$ with it.

Finally, we want our newly created variables to capture the part of country differences in economic and budgetary performance which is not caused by economic strategies z (which will be included in the model as well). More precisely, we require $\mathbf{U}_k\mathbf{S}_k \perp z$, which we achieve by residualizing them

$$\mathbf{U}_k\mathbf{S}_k - E(\mathbf{U}_k\mathbf{S}_k|z). \tag{7}$$



Correlation of covariates with	Axis 1	Axis 2
GDP	−0.73	−0.55
Unemployment	0.94	−0.12
Inequality	0.92	0.27
Poverty	0.90	0.33
Debt	0.06	0.92
Deficit	−0.23	−0.90

Figure D.1
Country positions on two principal axes and their correlation with original covariates

E. Accounting for Second Dimension Politics

In this section, we describe results that substantiate that it is unlikely that our results are driven purely by countries' existing levels of second-dimension politics. While we do not deny the relevance of the latter, we argue that our measure of economic strategies captures a fundamental feature of economic organization that shapes preferences independent of other dimensions of political conflict. Table E.1 shows estimates for our fiscal centralization model (based on specification M2 in Table 1) with different forms of fractionalization (Alesina et al. 2003) as additional controls. We use measures of ethno-linguistic and religious fractionalization, since they captures relatively stable, structural characteristics that are a source of political contestation and thus increase the societal relevance of second-dimension issues. We find that accounting for fractionalization leads to virtually unchanged estimates of the relationship between economic strategies and average preferences for fiscal centralization.

Table E.1
Fractionalization as proxy for second-dimension politics. Models of preferences for centralization of European Union tax policy. Estimates for countries' economic strategies, with 90% credible intervals in brackets

	Investment oriented economic strategies	$P(\theta > 0)$
Ethnic fractionalization	−0.419 [−0.677, −0.168]	0.007
Linguistic fractionalization	−0.463 [−0.708, −0.210]	0.003
Religious fractionalization	−0.443 [−0.706, −0.176]	0.006

Note: Bayesian hierarchical probit models. MCMC estimates based on 30,000 samples. Estimates are posterior means. Bayesian directional hypothesis tests $P(\theta > 0)$ give posterior probability of coefficient being of opposite sign. Fractionalization measures are from Alesina et al. (2003).

F. High-tech patents as a proxy measure for economic strategies

In this section we present more details of the alternative measure of countries' dominant economic strategies used in the main text. One observable implication of our argument is that countries that pursue more investment oriented strategies are likely to produce more high-tech innovations. We use this implication to create an alternative measure for economic strategies that prioritize investment over consumptive spending. Our measure is the the number of applications for high-tech patents to the European Patent Office and the US Patent and Trademark Office for each country normalized by the size of its labor force. Data are from the OECD patent database and we use all patents applied for between 2000 and 2007. We count as "high-tech" patens in biotechnology and nanotechnology, medicine, pharmaceuticals, as well as information and communication technology. As Figure F.1 shows, countries prioritizing investment-oriented are much more likely to produce greater number of high-tech innovations (adjusting for the size of the working population). The rank correlation between both measures is 0.74.

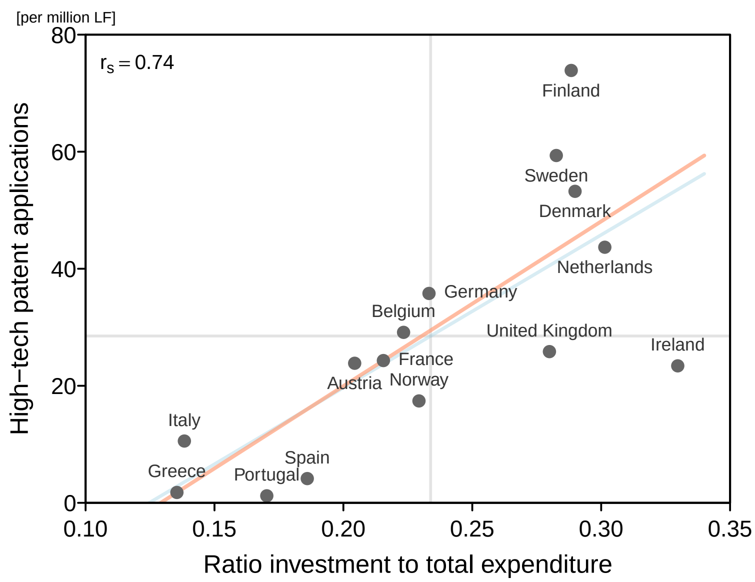


Figure F.1

Relationship between economic strategies and innovation.

Number of high-tech patent applications to European Patent Office and US Patent and Trademark Office [per million labor force]. OLS (light blue) and outlier-robust median regression (light red) lines superimposed. Gray lines show averages of variables.

We now investigate if our results also obtain when using this alternative measure of country strategies. Table F.1 shows estimates from a series of models for citizens' preferences for the centralization of European tax policy. We find our results to be remarkably similar to those in the main text: countries with a higher share of high-tech patents (indicating more investment-oriented economic strategies) are populated by citizens that prefer less centralization of EU fiscal tax policy.

Table F.1

Using High-tech patents as proxy for countries' economic strategies. Bayesian hierarchical probit models of preferences for centralization of European Union tax policy. Estimates, with 90% credible intervals in brackets.

	M0	M1	M2	M3
PC1: economic	—	−0.009	−0.005	0.018
		[−0.336 0.351]	[−0.192 0.197]	[−0.198 0.210]
PC2: financial	—	0.014	0.016	0.045
		[−0.285 0.319]	[−0.150 0.199]	[−0.151 0.242]
High−tech patents	—	—	−0.368	−0.381
			[−0.491 −0.247]	[−0.515 −0.250]
Individual controls	yes	yes	yes	yes
Country random effects	yes	yes	yes	yes, robust
Var(ξ)	0.188	0.223	0.070	0.050

Note: MCMC estimates based on 30,000 samples. Estimates are posterior means.

a Scores from a SVD of covariate matrix including GDP per capita, unemployment rate, inequality, poverty, debt, deficit into two principal components. See appendix D for technical details.

b Robust random effects, $\xi \sim t(\mu_\xi, \sigma^2_\xi, \nu)$ with $\nu = 4$.

G. Eurozone countries

In this subsection, we repeat our two models from the main text while excluding European countries that are not part of the Eurozone. There are good reasons to include these countries in the analysis: some scholars argue that they are *de facto* members of the common currency area (Plümper and Troeger 2008); they make and are affected by centralization and transfer decisions in the council. However, we expect that our results are not driven by the preferences of non-Eurozone citizens. We thus expect to find similar parameter estimates, albeit with larger uncertainty intervals, since excluding countries decreases our (already limited) country-level sample size even more.

Table G.1

Estimates excluding non-Eurozone countries. Panel (A) shows preferences for more fiscal centralization, panel (B) shows preferences for increased inter-regional transfers.

	Estimate	*p*
A: Fiscal centralization		
Investment-orient	−0.312	0.026
economic strategies	[−0.575, −0.057]	
B: Inter-regional transfers		
Exposure	0.184	0.005
	[0.085, 0.282]	

Note: Bayesian hierarchical probit models. MCMC estimates based on 30,000 samples. Estimates are posterior means. Bayesian p-value of directional hypothesis tests in final column.

Table G.1 shows estimates obtained by excluding non-Eurozone countries. Panel (A) shows estimates from citizens' preferences for fiscal centralization regressed on investment-oriented economic strategies (based on specification M2 of Table 1). Even in this more limited sample we find our core results confirmed. The estimate is reduced by about 30 percent, but still of substantive magnitude and statistically distinguishable from zero. Panel (B) shows estimates for citizens' support for inter-regional transfers regressed on our measure of financial risk exposure (based on specification M1 of Table 2). Here we find our estimate to be increased: citizens in countries more exposed to financial risk are more likely to support inter-regional transfers. The credible interval of the estimate does not include zero—although we caution (again) that this result is based on a rather limited number of countries (for which we have IBS data). Nonetheless, the relative robustness of these estimates increases our confidence that our findings do not materially depend on the preferences of citizens in countries that opted not to join the Euro.

H. Prior choices and sensitivity checks

The variance of individual-level residuals is unit-normal $\epsilon_{ij} \sim N(0,1)$ and fixed to identify the scale of the probit model. For all other parameters in our hierarchical models we specify "non-informative" priors. We use regression-type priors for coefficients: $\forall k : \beta_k \sim N(m_0, v_0)$ for individual-level covariates and $\forall k : \gamma_l \sim N(m_1, v_1)$. for macro-level covariates. The variance of random effects is distributed $\sigma^2_\alpha \sim G^{-1}(a_1, b_1)$. Table H.1 column (P1) below shows the parametrization of hyperparameter values. We also conduct prior sensitivity checks studying if or how much our results depend on prior choices. Two sets of hyperparameter values are given in columns (P2) and (P3): in the former we lower the a priori variance of coefficients (putting more weight on zero), in the latter we use a different parametrization of the random effects variance. The final column shows the maximum difference between coefficients in our original model and the sensitivity analyses. We find that our results are not substantively affected by prior choices.

Table H.1
Priors and robustness checks

	Hyperparameter values			
Parameter	P1	P2	p3	MaxΔ^a
$\beta_k \sim N(m_0, v_0), k = 1, \ldots, K_x$	$m_0 = 0, v_0 = 100$	$m_0 = 0, v_0 = 10$	$m_0 = 0, v_0 = 100$	0.001
$\gamma_k \sim N(m_0, v_0), k = 1, \ldots, K_z$	$m_0 = 0, v_0 = 100$	$m_0 = 0, v_0 = 10$	$m_0 = 0, v_0 = 100$	0.012
$\sigma^2_\alpha \sim G^{-1}(a_1, b_1)$	$a_1 = 1, b_0 = 0.005$	$a_1 = 1, b_0 = 0.005$	$a_0, b_0 = 0.001$	<0.000

Note: P1 are hyperparameter values used in main text.
a Maximum of pairwise differences of all coefficients between P1 and P2 and P3.

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