

# Stability of Nations and Genetic Diversity

Klaus Desmet  
*Universidad Carlos III and CEPR*

Michel Le Breton  
*Université de Toulouse I*

Ignacio Ortuño  
*Universidad Carlos III*

Shlomo Weber  
*SMU, International School of Economics (Tbilisi) and CEPR*

September 2008

- In determining the stability of a country (and its secession-proofness), one has to account for two opposing forces:
  - Larger countries benefit from scale economies.
  - A larger country pays the cost of an increasingly heterogeneous population.
- This tradeoff has been investigated from the theoretical perspective (Alesina and Spolaore, 1997, Bolton and Roland, 2003, and a vast literature on coalition formation). It is also supported by casual evidence (Alesina, Spolaore and Wacziarg, 2000).
- However, a direct empirical exploration of this tradeoff has been missing. This is what we attempt in this paper.

- Is the current map of Europe stable?
- Which European regions are more likely to secede? Which countries are more likely to cooperate (or even unite)?
- What are the gains (losses) from EU membership?
- Can this model account for the breakup of Yugoslavia?

# Outline of talk

- 1 Theoretical framework
- 2 Genetic distances as proxy for cultural distances
- 3 Stability of Europe: secessions and unions
- 4 Breakup of Yugoslavia (preliminary)
- 5 Gains (and losses) from EU membership
- 6 Global stability

# Summary of theoretical framework

In our theoretical model with multiple regions and countries,

- Agents in every country choose the optimal level of public spending by majority vote.
- There are increasing returns in the provision of public goods, but the utility derived from public goods is decreasing in the country's degree of cultural heterogeneity (similar to cooperative games where players are characterized by their location in a network or geographical space). Also, *homogeneity basis* as in Alesina, Baqir and Hoxby (2004).
- We compare regional welfare across different political arrangements. In particular, we study whether regions or countries would like to unite or secede.
- The stability concept we use requires that the majority of agents in every region affected by such a move should support the rearrangement (see Alesina and Spolaore, 1997).

# Model (1)

- The World  $W$  is partitioned into countries, each consisting of one or several regions. The set of regions is taken as given, whereas the partition of the world into countries can change.
- There are two types of heterogeneity: *income* and *cultural*.
- We assume that there is only intra-regional income heterogeneity and no intra-regional cultural heterogeneity. However, both types of heterogeneity, cultural and income, exist at the inter-regional level.

## Model (2)

- The income distribution in region  $I \in C$  is given by the density function  $f_I(y)$  with the support  $[\underline{y}, \bar{y}]$  common for all regions. The total income in  $I$  is

$$Y(I) = \int_{\underline{y}}^{\bar{y}} y f_I(y) dy$$

- For every two regions we denote by  $d(I, J)$  the cultural distance between a resident of  $I$  and a resident of  $J$ .
- The *cultural heterogeneity* experienced by a resident of region  $I$  in country  $C$  is

$$H(I, C) = \sum_{J \in C} \frac{p(J) d(I, J)}{p(C)}$$

where  $p(\cdot)$  is the population, and  $d(I, J)$  is the cultural distance between  $I$  and  $J$ .

# Preferences (1)

- Agents' utility depends on private consumption,  $c$ , public consumption,  $g$ , and the degree of cultural heterogeneity.
- We adopt the following quasi-linear expression for the utility of an individual in region  $I \in C$ :

$$u(c, g, I, C) = c + V(g, H(I, C)),$$

where  $V$  is twice continuously differentiable, strictly concave, increasing in the amount of public good  $g$ , and is decreasing in the second argument, the level of cultural heterogeneity faced by a resident of region  $I$  in country  $C$ .

## Preferences (2)

- Public goods are financed through a proportional tax rate  $\tau$ , where  $0 \leq \tau \leq 1$ , so that taxation is redistributive.
- Assume a unit linear technology. When country  $C$  selects a tax rate  $\tau$ , the level of the public good will be  $\tau Y(C)$ .
- The indirect utility of an individual  $i$  with income  $y_i$ , residing in region  $I$  in country  $C$ , that adopts tax rate  $\tau$ , is then

$$v(y_i, \tau, I, C) = y_i(1 - \tau) + V(\tau Y(C), H(I, C)).$$

# Preferred tax rate

- The tax rate  $\tau$  in country  $C$ , denoted  $\tau(C)$ , is chosen by majority voting. (Note that for every country  $C$  the preferences of every agent  $i \in C$  over tax rates are single-peaked.)
- Denote by  $\tau(y_i, I, C)$  the preferred tax rate for an individual  $i$  with income  $y_i$  who resides in region  $I \in C$ :

$$\tau(y_i, I, C) = \arg \max_{\tau \in [0,1]} v(y_i, \tau, I, C)$$

- Given single-peaked preferences, majority voting yields the tax rate preferred by the median agent.

# Median decisiveness (1)

- It is crucial that the preferences of a region's median income agent over different geographical arrangements “represent” those of the majority of its residents. This is the *decisiveness* of the median agent (Gans and Smart, 1996).
- For every region  $I$  denote by  $y_m(I)$  the median income, and for every  $I$  in  $C$  let  $v_m(I, C)$  be the value of the indirect utility of the median income agent in  $I$  when the tax rate in  $C$  is given by  $\tau(C)$ :

$$v_m(I, C) = v(y_m(I), \tau(C), I, C).$$

## Median decisiveness (2)

We then have the following result:

**Lemma - Median Decisiveness.** *For every region  $I$  and two different countries  $C$  and  $C'$  with  $I \in C \cap C'$  we have*

$$p(\{i \in I \mid v(y_i, \tau(C), I, C) > v(y_i, \tau(C'), I, C')\}) > \frac{1}{2}p(I)$$

*if and only if*

$$v_m(I, C) > v_m(I, C').$$

## Median decisiveness (3)

- The Lemma states that if the median income agent of a region  $I$  prefers to be in country  $C$ , rather than in country  $C'$ , then a majority of agents in that region also prefer  $C$  to  $C'$ . Note that agents correctly foresee the tax rate that will be chosen by majority vote in the corresponding geographical arrangement.
- Remark: median decisiveness links our model to the theory of *hedonic games*, introduced by Drèze and Greenberg (1980), Banerjee, Konishi and Sönmez (2001), Bogomolnaia and Jackson (2002), where the payoff of a player depends exclusively upon the group to which she belongs.

- There are several stability concepts that have been applied in the literature (see, e.g., Alesina and Spolaore, 1997, Jéhiel and Scotchmer, 2001, Bogomolnaia et al., 2005).
- In this paper, we use a stability concept of *Limited Right of Map Redrawing*, called *B-stability* in Alesina and Spolaore (1997) and *equilibrium with admission by majority vote* in Jéhiel and Scotchmer (2001). It requires, subject to majority voting, the unanimous approval of any border redrawing by all affected regions.

## Stability (2)

- For every partition  $\pi = \{C_1, \dots, C_K\}$  and every region  $I \in N$  denote by  $C^I(\pi)$  the country in  $\pi$  that contains  $I$ .
- We then have the following definition:

**Domination relation.** Partition  $\pi'$  dominates partition  $\pi$  if for every region affected by the shift from  $\pi$  to  $\pi'$ , the majority of its residents prefer the new arrangement  $\pi'$  over the old one  $\pi$ . That is, for every region  $I$  with  $C^I(\pi) \neq C^I(\pi')$  we have

$$p(\{i \in I \mid v(y_i, \tau(C^I(\pi')), I, C^I(\pi')) > v(y_i, \tau(C^I(\pi)), I, C^I(\pi))\}) > \frac{1}{2}p(I)$$

This concept of domination allows us to precisely define stability under *Limited Right of Map Redrawing*:

**Limited Right of Map Redrawing (LRMR).** Let partition  $\pi$  be given. A partition  $\pi' \neq \pi$  generates credible *map redrawing* if  $\pi'$  dominates  $\pi$ . A partition  $\pi$  is *LRMR-stable* or simply *stable* if it cannot generate credible map redrawing.

**Proposition.** *The set of LRMR-stable partitions is nonempty.*

# Measuring cultural distances

- The most crucial issue in linking our model to the data is the empirical measurement of cultural heterogeneity.
- By using genetic distances amongst populations as a proxy for cultural distances, we accept the view that the degree of mixing between populations over the course of history is positively correlated with the similarity of their cultural values.
- Important: we view genetic distances as a record of mixing, and *not* as an indicator of the link between genes and human behavior.
- See Guiso, Sapienza and Zingales (2005) and Spolaore and Wacziarg (2006) for applications in economics.

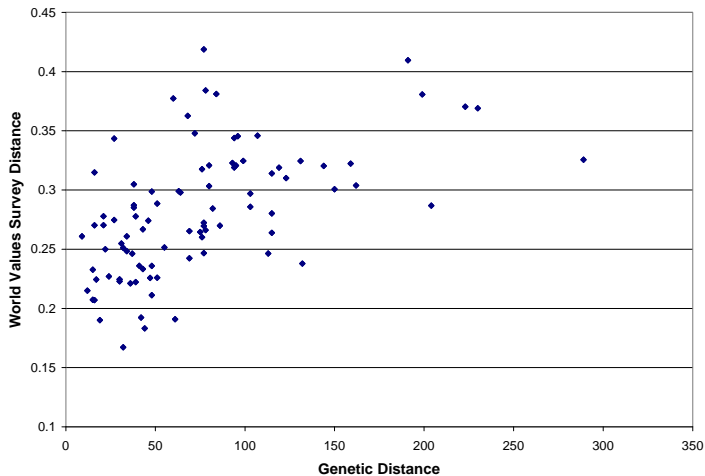
	Bas	Sa	Au	Fr	Ge	Be	Dk	Ne	En	Ire	Nor	Sc	Sw	Gr	It	P	Sp	Fi
Basque	0																	
Sardinia	261	0																
Austria	195	294	0															
France	93	283	38	0														
Germany	169	331	19	27	0													
Belgium	107	256	16	32	15	0												
Denmark	184	348	27	43	16	21	0											
Netherlands	118	307	38	32	16	12	9	0										
England	119	340	55	24	22	15	21	17	0									
Ireland	145	393	115	93	84	75	68	76	30	0								
Norway	195	424	61	56	21	24	19	21	25	79	0							
Scotland	146	357	74	62	53	59	40	48	27	29	58	0						
Sweden	168	371	80	78	39	34	36	41	37	94	18	74	0					
Greece	231	190	86	131	144	103	191	199	204	289	235	253	230	0				
Italy	141	221	43	34	38	30	72	64	51	132	88	112	95	77	0			
Portugal	145	340	48	48	51	31	77	60	46	115	73	97	78	103	44	0		
Spain	104	295	69	39	69	42	80	76	47	113	97	100	99	162	61	48	0	
Finland	236	334	77	107	77	63	96	123	115	223	94	166	82	150	94	119	159	0

# Genetic and cultural distances (1)

- Are genetic distances a good proxy for cultural distances?
- Compare genetic distances from Cavalli-Sforza et al. (1994) to distances based on 430 questions on cultural values from the World Values Survey for 14 European nations.
- Although we do not directly use opinion poll data for our empirical exercise, as they may be biased by short-run events, they still provide a useful test of the relevance of genetic distances.
- Suppose question  $i$  has three possible answers,  $a$ ,  $b$  and  $c$ . The vector  $x_{i,j} = (1/2, 0, 1/2)$  indicates that in nation  $j$ , half of the people answer  $a$ , and the other half  $c$ .
- The *opinion poll distance* between nation  $j$  and nation  $k$  is then

$$w_{jk} = \sum_{i=1}^{430} \sum_{s=1}^q |x_{i,j}^s - x_{i,k}^s| \quad (1)$$

# Genetic and cultural distances (2)



# Correlation between genetic and cultural distances

- The elements of a distance matrix are not independent, so we cannot use standard methods to test for the correlation between genetic distances and opinion poll distances.
- Solution: Mantel test (commonly used in Population Genetics)
- Correlation between genetic distances and opinion poll distances : 0.64 (p-value 0.00014).
- Correlation between genetic distances and opinion poll distances, controlling for geographical distances: 0.32 (p-value 0.02).
- Correlation between genetic distances and opinion poll distances, controlling for both geographical and linguistic distances: 0.28 (p-value 0.04).

- Look for parameter values that render the current map of Europe stable.
- Analyze which regions are most likely to secede, and which countries are most likely to unite.

- Genetic distances between countries and regions (Cavalli-Sforza et al., 1994). Information on 22 countries and 3 regions (Basque Country, Sardinia and Scotland).
- Population and GDP per capita (Eurostat and Penn World Tables)
- Income Distribution (Income Inequality Database v 2.0a)
- Spending on public goods (Government Finance Statistics of IMF)

- In our empirical investigation we adopt the following utility specification:

$$u(c, g, I \in C) = c + \alpha((1 - H(I, C)^\delta) g)^\beta$$

where  $\alpha > 0$ ,  $\beta > 0$  and  $\delta \in [0, 1]$ .

- Estimate (calibrate)  $\alpha$  and  $\beta$  based on OECD data.
- Using data on 22 European countries and 3 regions, find the set of values of  $\delta$  that renders the European map stable.
- By gradually lowering  $\delta$ , determine which regions are most likely to secede, and by gradually increasing  $\delta$ , determine which countries are most likely to unite.

# Choice of $\alpha$ and $\beta$

- Use OECD and European data on tax rate (government spending as share of GDP), median income and total income.
- We assume away cultural heterogeneity within countries:

$$\tau(C) = \left( \frac{y_{m(C)}}{\alpha \beta (Y(C))^\beta} \right)^{\frac{1}{\beta-1}}$$

- Three alternative definitions of government spending (GFS): (i) general public services, defense, public order, environment and economic affairs; (ii) general public services; (iii) defense.
- Nonlinear least squares.

# Finding stable $\delta$

- Use the estimated (calibrated) values of  $\alpha$  and  $\beta$  to determine the range of  $\delta$  for which the current map of Europe is LRMR stable.
- This means:
  - Secession: there is no majority in both the region and the country it belongs to in favor of secession.
  - Unification: there is no majority in any two countries in favor of uniting.
- We only check for possible unions of 2 countries. Of course in principle we should check *all* possible partitions of the 21 countries and 3 regions, i.e., 445,958,869,294,805,289 partitions.

- Range of  $\delta$  that renders the current map of Europe stable:  $[0.0285, 0.1575]$ .
- If  $\delta < 0.0285$ , the weight on cultural distances becomes sufficiently important for secession to occur.
- To analyze the likelihood of secession, we progressively lower  $\delta$ , and rank regions according to how likely it is they break away.
- If  $\delta > 0.1575$ , the weight on cultural distances is sufficiently low for unions to occur.
- To analyze the likelihood of unions, we progressively increase  $\delta$ , and rank country pairs according to how likely it is they want to unite.

# Likelihood of secession

1	Basque Country
2	Scotland
3	Sardinia

# Likelihood of unions

	<b>Benchmark</b>	<b>Geographically contiguous</b>	<b>Same population</b>
1	Austria-Belgium	Denmark-Norway	Denmark-Netherlands
2	Switzerland-Belgium	Austria-Switzerland	Austria-Switzerland
3	Denmark-Norway	Belgium-Netherlands	Belgium-Netherlands
4	Austria-Switzerland	Norway-Sweden	Germany-Switzerland
5	Belgium-Netherlands	Germany-France	Germany-Belgium
6	Belgium-Poland	France-Britain	Belgium-Britain
7	Switzerland-Denmark	Czech Republic - Hungary	Switzerland-Belgium
8	Norway-Sweden	France-Italy	Switzerland-Netherlands
9	Germany-Britain	Denmark-Sweden	Germany-Netherlands
10	France-Germany	Netherlands-Britain	Austria-Belgium

- First three (Austria-Belgium, Switzerland-Belgium, Denmark-Norway):
  - Small countries, similar levels of GDP per capita, and genetically close.
  - United by history, e.g., Norway was under the Danish crown from the Middle Ages until 1814.
- Belgium, the 'battlefield of Europe', is also its 'genetic capital'.
- No unions between large countries, or between large and small countries. Exception: Poland (large & poor) and Belgium (small & rich).
- Unions between, say, Germany and Switzerland, become likely once we ignore their different sizes.

# Yugoslavia: analysis of breakup

- Europe is stable for  $\delta \in [0.0285, 0.1575]$ .
- Use this range of values to study the stability of Yugoslavia.
- Two differences:
  - Allow for unilateral secession.
  - Assume that Serbia, as hegemon, does not secede.
- Note: if  $\delta \in [0.0285, 0.1575]$  none of the peripheral regions in Europe (Sardinia, Basque Country and Scotland) want to unilaterally secede.

# Yugoslavia: genetic distances

Source: Alfred database (<http://alfred.med.yale.edu>) and Cavalli-Sforza

	<b>Croatia</b>	<b>Bosnia</b>	<b>Serbia</b>	<b>Slov</b>	<b>Mac</b>	<b>Mont</b>
<b>Croatia</b>	0	25.12	35.26	26.68	67.38	23.12
<b>Bosnia</b>	25.12	0	22.08	9.15	18.50	0
<b>Serbia</b>	35.26	22.08	0	15.36	82.92	8.50
<b>Slovenia</b>	26.68	9.15	15.36	0	33.12	14.44
<b>Macedonia</b>	67.39	18.50	82.92	33.12	0	0.21
<b>Montenegro</b>	23.13	0	8.50	14.44	0.21	0

# Yugoslavia: GDP per capita and population

Source: Statisticki Godišnjak Jugoslavije and Eurostat  
Average of 1984 and 2004.

	<b>GDP per capita</b>	<b>Population ('000)</b>
<b>Croatia</b>	142	4441
<b>Bosnia</b>	60	3837
<b>Serbia</b>	73	9486
<b>Slovenia</b>	265	1997
<b>Macedonia</b>	59	2029
<b>Montenegro</b>	70	621

# Yugoslavia: no breakup when culture matters very little

Take  $\delta = 0.1575$ .

	<b>Change in utility from unilateral secession</b>
<b>Slovenia</b>	-0.75
<b>Croatia</b>	-2.84
<b>Bosnia</b>	-10.81
<b>Macedonia</b>	-14.87
<b>Montenegro</b>	-26.96

Conclusion: no region wants to secede when culture matters little.

# Yugoslavia: breakup when culture matters more

Take  $\delta = 0.0285$ .

	<b>Change in utility from unilateral secession</b>
<b>Slovenia</b>	11.85
<b>Croatia</b>	9.58
<b>Bosnia</b>	1.02
<b>Macedonia</b>	-2.39
<b>Montenegro</b>	-15.41

- If culture matters, various regions want to secede.
- Note: for this value of  $\delta$  none of the peripheral European regions (Basque Country, Scotland and Sardinia) wants to secede.

# Yugoslavia: sequencing and domino effect

Take  $\delta = 0.0285$ .

	Round 1	Round 2	Round 3	Round 4	Round 5
Slovenia	11.85				
Croatia	9.58	12.56			
Bosnia	1.02	2.76	5.97		
Macedonia	-2.39	-0.66	5.97	5.49	
Montenegro	-15.41	-13.70	-10.93	-8.28	-6.69

- Yugoslavia breaks up, except for Montenegro that continues to prefer being united with Serbia
- Compare this with the real breakup: Slovenia & Croatia (June 1991), Macedonia (September 1991), Bosnia (March 1992), Montenegro (May 2006)

# Yugoslavia: sequencing (monetary gains)

Take  $\delta = 0.0285$ .

	Round 1	Round 2	Round 3	Round 4	Round 5
Croatia	0.92				
Slovenia	0.94	0.92			
Bosnia	0.98	0.93	0.88		
Macedonia	1.05	1	0.94	0.89	
Montenegro	1.27	1.24	1.19	1.15	1.12

- Example: in Round 1 Croatia is indifferent between having 8% less income on its own and being part of Yugoslavia.
- Sequencing is very similar, with the exception of Croatia seceding before Slovenia. (In reality they declared independence on the same day.)

- The order of breakup is determined by economics: the rich and/or the big want to secede first.
- However, for values of  $\delta$  for which peripheral regions in Europe (such as the Basque Country) do *not* want to break away, some Yugoslav republics did want to secede. In other words, for those values of  $\delta$  Yugoslavia was unstable, in contrast to these other European countries.
- The sequencing of the breakup, as predicted by our model, matches what happened in reality, with the exception of Macedonia.

# Gains from EU membership

- Focus on EU-15 (without Luxembourg).
- For each country: compute relative gain of the median income agent from being part of the EU

$$g_{C,EU}(\delta) \equiv \frac{v_m(C, EU) - v_m(C, C)}{v_m(C, C)}$$

- Relative gain depends on  $\delta$ . Assume each  $\delta \in [0.0285, 0.1575]$  is equally likely.

# Ranking gains from EU membership

	Country	Population	Cultural distance	GDP per capita
1	Ireland	3.8	0.095	126
2	Denmark	5.3	0.045	126
3	Finland	5.1	0.105	113
4	Portugal	10	0.051	80
5	Austria	8.1	0.043	126
6	Belgium	10.2	0.027	117
7	Sweden	8.87	0.067	119
8	Greece	10.6	0.142	73
9	Netherlands	15.9	0.041	120
10	Spain	40.3	0.056	92
11	France	59	0.032	114
12	Britain	58.6	0.034	112
13	Italy	56.9	0.042	113
14	Germany (-)	82	0.031	112

# Without cultural differences

Country	Change ranking
Ireland	0
Finland	1
Denmark	-1
Greece	4
Portugal	-1
Austria	-1
Sweden	0
Belgium	-2
Netherlands	0
Spain	0
Italy	2
Britain	0
France	-2
Germany (-)	0

- Previous results limited to unions between 2 countries.
- Two problems:
  - Too many partitions (445,958,869,294,805,289);
  - Decisive agent need not be median income agent.
- Simplify:
  - Limit number of countries to 11 (678,570 partitions);
  - Focus on mean income residents. (Adjust definition of efficiency and LRMR stability)

- We find a  $\delta^* = 0.04066$ , such that
  - for  $\delta < \delta^*$ , keeping all countries separate is efficient and LRMR-stable;
  - for  $\delta > \delta^*$  the union of all countries is efficient and LRMR-stable.
- Caveats:
  - This result is not general. Example: Sweden, Denmark, Greece. For intermediate values of  $\delta$ , the efficient partition would be Sweden and Denmark together and Greece.
  - No restrictions on how unions are formed. It is not because a full union is efficient, that a full union is reached.

- Secessions and unions are two extremes. What about the 'in between' situations?
- Dynamics of cooperation and nation formation. Path dependence. Domino effect. May explain why countries do not want to let regions break away.
- Empirical applications: regionalism in Europe, EU enlargement, etc.