The engine of persistency:
Quantifying regional variation in the quasi-periodicity of institutional change in Europe

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EXTENDED ABSTRACT

Underlying the recent interest in historical persistence is the promise that careful statistical methodology may make the effect of the past on present outcomes observable [1-14]. A typical approach is to concentrate on a specific outcome (e.g., perceived corruption) near a geographical discontinuity in past institutions, such as a historical border. The resulting quasi-experiments tend to rely more on the statistical guarantees of the selected identification strategies, often spatial regression discontinuity, than on detailed modeling of the causal paths that led to the observed outcomes.

However, institutions changed multiple times in the past, due to regime change with or without a corresponding change of state boundaries. Moreover, such boundaries are often endogenous, depending, for example, on defensible geographical features such as rivers or mountain ridges. As a result, clear cut quasi-experiments are hard to come by.

A complementary approach is thus to ask which set of historical institutions and corresponding borders matters the most for today's quantifiable outcomes, and why. A first step in this direction is to understand whether only the most recent past matters or whether mechanisms exist that produce long term memory. Equivalently, once immutable characteristics such as geography have been accounted for, one may ask whether history is dominated by stochastic noise, secular trends (perhaps driven by demography or technology growing exponentially), or quasi periodic evolution. While all these components may be present, the question is which one most affects the present for the outcomes of interest.

We rely on historical atlas data to introduce an indicator of institutional change summarizing a millennium of major historical territorial changes on the European continent.

We quantify institutional instability as a function of time in terms of the fraction of area that changes institutional set-up over 5-year periods spanning the interval from 1000 AD to 2000 AD. This way, our institutional change indicator consolidates a variety of historical events that lead to territorial changes (wars, revolutions, dissolutions of empires, etc.). Averaging over time, we obtain a global indicator of institutional instability shown in the map in Fig. 1. It is immediately clear that geography plays a crucial role in instability, with rugged terrain and high-altitude regions experiencing less instability. However, geography does not fully explain institutional instability.

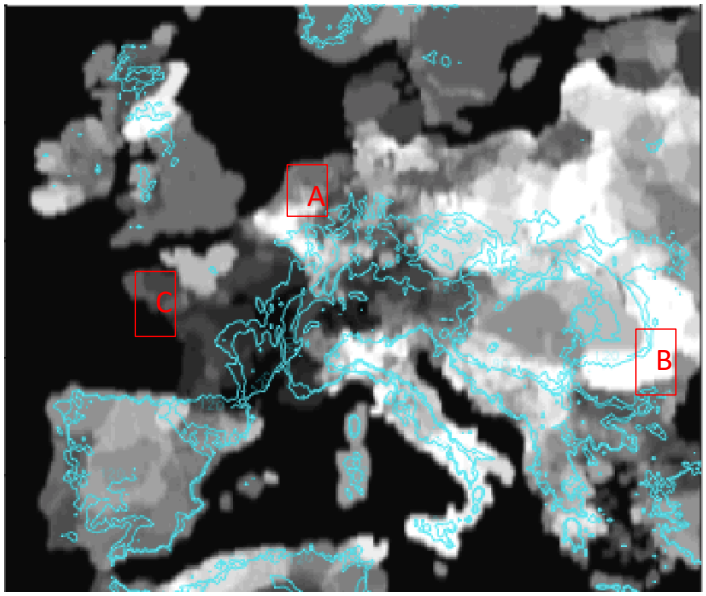

Figure 1: Instability indicator based on the number of times a given pixel changed institutional configuration in every 5 years over the period from 1000 AD to 2000 AD (from black – low instability to white – high instability). The light blue lines are level curves of high altitude. The north European plains (A) and the Wallachian plain (B) are both high instability regions, while north-western France (C), also a plain, is relatively more stable, reflecting the early unification of France. This suggests that geography only partly explains institutional instability patterns.

We further examine the historical change of institutions-geography-economic outcomes relationship by regressing current GDP per capita (proxied by the ratio between the Annual VNL V2 VIIRS night-time lights in 2019 [17] and the Gridded Population of the World (GPW v4 [18]) population count dataset) against our indicator of institutional instability while controlling for geography (polynomial terms with interactions in altitude, latitude, and longitude).

We find that the dependence of modern economic outcome on past institutional instability is non-linear and appears non-monotonic based on the added variable plot regression diagnostic, as shown in Figure 2. In this figure we plot the residuals of regressing institutional instability against geography in the x axis and the residuals of regressing GDP per capita against geography in the y axis. The results show the relation between GDP per capita and instability once the contribution of geography has been factored out.

The hump-like relationship suggests that there may be an optimal amount of institutional instability that a given region must have experienced throughout history to maximize its current prosperity. While it is noted in the previous literature that contemporary institutional change is negatively linked to economic development [19], the effect of past institutional changes on current development levels remain less clear cut. While too much past institutional change can lead to lack of security/stability expectations necessary to kick start economic growth, in addition to the destruction of capital related in case of war, too little institutional change in a region's past can leave in place inefficient structures that result in modern underdevelopment. This view is compatible with the presence of multiple equilibria in the underlying economic structure (see e.g. [15]). This setting is well-known in natural sciences. Optimal levels of noise mediating transitions between equilibria in bistable potentials are found throughout in the complex systems literature, e.g. in the phenomenon of stochastic resonance [20].

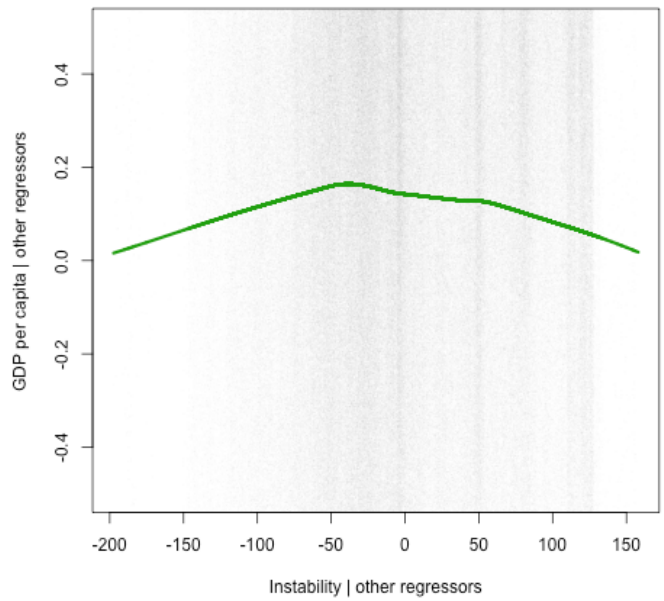

Figure 2: Added variable plot or partial regression plot for the current GDP per capita versus millennial institutional instability regression. The x axis represents the variation in institutional instability not explained by geography (latitude, longitude, elevation and their interactions), and the y axis the variation in GDP per capita not explained by geography. The gray dots are individual pixels from the map in Fig. 1. The green line is a local polynomial regression, showing a non-monotonic dependence. The variation in GDP per capita not explained by geography is maximum for a given level of institutional instability. This absence of monotonicity indicates that nontrivial mechanisms are at work, making some past instability beneficial but too much past instability detrimental.

The next contribution of our paper is the study of the time series of institutional instability through dynamical system methods. We find that the autocorrelation properties of institutional change in Europe are non-trivial, suggesting long-term memory and possibly underlying low dimensional dynamics rather than mere noise (Figures 3-4). This finding is compatible with a quasi-cyclical view of historical process as motion on a low-dimensional attractor, with interesting implications for its predictability. The somewhat philosophical debate on the presence of ‘critical juncture’ points in historical institutional development [16] might be recast in the language of dynamical system theory e.g., in terms of sensitive dependence on initial conditions. We make this more precise by introducing a series of simplified models based on forced bistable oscillators which reproduce the qualitative dynamics of instability in key regions in Europe.

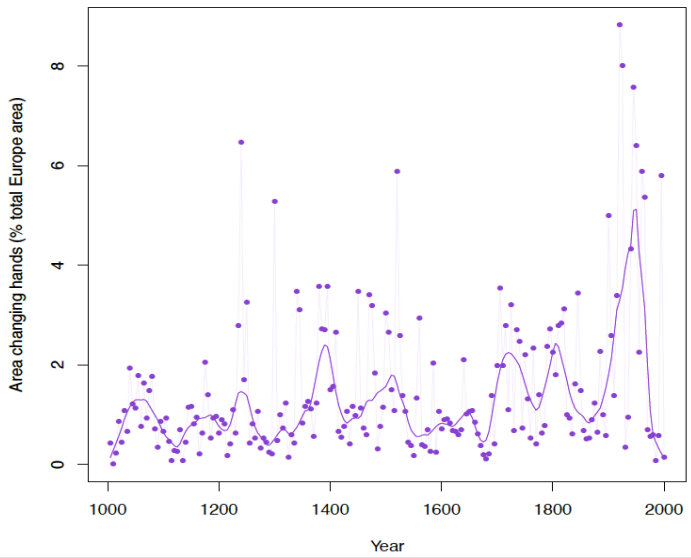

Figure 3: Institutional instability indicator defined in this work as a function of time, integrated over Europe. The purple dots represent the instantaneous value at 5-year intervals. The solid line is a local linear regression smoothing. While the magnitude of intitutional instability increases over time (measured as the percentage of territory changing regime), some ocyclical scillations are apparent.

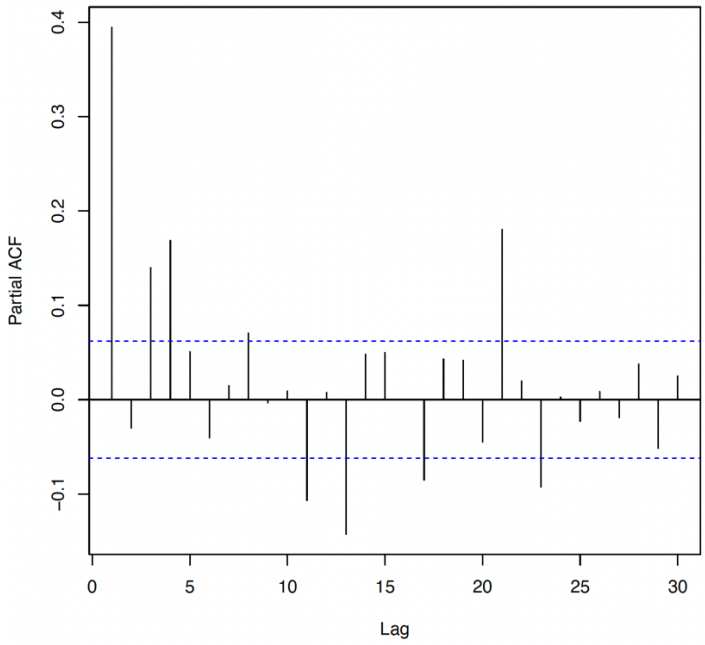

Figure 4: Partial autocorrelation plot for the time series of institutional instability averaged over the whole map of Europe. Significant autocorrelation appears at lags of 11-13, 21 and 23 corresponding to periods of approximately 60 and 110 years.

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